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Iskandarova Sh.T., Voronina N.V., Khasanova M.I., Sadivakasov A.U.

HYGIENE. MEDICAL ECOLOGY

Educational manual

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Compilers:

Sh.T. Iskandarova – Doctor of Medical Sciences, Professor, Head of the Department of Public Health and Health Management, Tashkent State Medical University

N.V. Voronina – Doctor of Medical Sciences, Associate Professor, Department of Public Health and Health Management, Tashkent State Medical University

M.I. Khasanova – Candidate of Medical Sciences, Associate Professor, Department of Public Health and Health Management, Tashkent State Medical University

A.U. Sadivakasov – Candidate of Medical Sciences, Associate Professor, Department of Public Health and Health Management, Tashkent State Medical University

Reviewers:

V.E. Tukhtarov -Doctor of Medical Sciences, Professor, Head of the Department of General Hygiene, Samarkand State Medical University

Rakhimov BB, Associate Professor, Department of Environmental Hygiene, Tashkent State Medical University

This educational manual outlines the basic principles of hygiene and examines the impact of environmental factors on the human body.

The main purpose of this educational manual is to help students prepare for practical classes and support their independent learning. This publication is developed in accordance with the requirements of the State Educational Standard for Higher Education in Medical Specialties. Pediatrics 60910300 General Medicine 60910200

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PREFACE

Human health is the most important human value, as well as a foundation for the prosperity and well-being of any state. According to data provided by the World Health Organization (WHO), more than 75% of all deaths worldwide annually are determined by environmental conditions and unhealthy lifestyles. Environmental factors are the leading cause in the development of 90% of all malignant neoplasms.

Therefore, at the current stage of societal development, the creation of health-preserving living conditions for the population of the Republic, including the principles of preventive and prophylactic medicine, becomes a fundamental requirement. This necessity calls for the integration of medical-preventive and hygienic knowledge into educational programs for training professional medical personnel.

In this textbook, special attention is given to practical classes to ensure successful achievement of learning objectives during student training. These classes maintain continuity with lecture-based teaching and help lay the foundation for professional qualifications and applied skills in future specialists. Through practical sessions, students' theoretical knowledge is systematized, reinforced, and expanded.

The proposed situational tasks help students develop professional action algorithms and creative approaches to problem-solving. During these exercises, students acquire skills in calculations, working with regulatory documentation, interpreting tables and diagrams, and using reference and scientific literature. All of these aspects contribute significantly to students' ability to master learning strategies independently and promote self-development.

To assess acquired knowledge, the textbook includes test questions with the possibility of verifying selected answers against the correct ones. Understanding and successful assimilation of the material is further supported by the included terminological glossary.

GLOSSARY

Food Safety – the absence of or presence within permissible limits of harmful (toxic) substances in food products that do not pose a threat to human health.

Protein-Energy Malnutrition – a pathological condition characterized by a deficiency of nutrients and energy, negatively affecting the functioning of all body systems.

Biological Value – an indicator of protein quality in food that reflects the degree to which its amino acid composition meets the body's needs for protein synthesis.

Derived from the Greek term hygieinos (meaning "healthy"), hygiene is a scientific discipline dedicated to examining how external environmental variables impact human health. Its goal is to establish the most favorable standards for professional activities, daily living, dietary habits, and recuperation.

Hospital hygiene is a specialized discipline within the broader field of hygiene focused on establishing standards for healthcare environments. Its primary objectives are to ensure a therapeutic atmosphere for patient recovery and to maintain safe, efficient workplace conditions for medical professionals.

Military Hygiene – a field of military medicine and hygiene that studies the impact of military working and living conditions on the personnel of the Armed Forces.

Hygiene of Children and Adolescents – a branch of hygiene that studies the effects of environmental factors on the growth and development of children and adolescents, and develops standards and measures to ensure their health and normal development.

Community hygiene is a specialized field that investigates how the environmental characteristics of residential zones influence human well-being. It focuses on formulating rigorous sanitary protocols and hygienic benchmarks

aimed at safeguarding collective health and ensuring a high quality of life within human settlements.

Resort Hygiene – a branch of hygiene that develops standards and measures aimed at ensuring proper environmental conditions in health resorts and preserving natural therapeutic factors.

Personal Hygiene (also: individual hygiene) – a branch of hygiene that focuses on maintaining and promoting individual health through the observance of hygienic living practices.

General Hygiene – a section of hygiene that studies the patterns of environmental factor effects on human health and develops methodological approaches for their investigation.

Nutritional hygiene represents a specialized branch of hygienic science focused on the research and formulation of evidence-based dietary guidelines. Its primary objective is to establish the foundations of a well-proportioned diet that effectively sustains physiological well-being and promotes long-term health.

Radiation hygiene is a specialized scientific discipline that investigates the mechanisms behind the creation of radioactive environments and the distribution of ionizing radiation doses. By evaluating the subsequent biological risks to human physiology, it formulates the regulatory frameworks and sanitary protocols necessary to guarantee the radiological safety of both professional staff and the general public.

Rural Hygiene – a branch of hygiene that studies working conditions in agriculture and the living conditions of the rural population, and develops hygienic standards and requirements for agricultural production, as well as for the improvement and sanitary conditions of rural settlements.

Transport Hygiene – a branch of hygiene that studies the working conditions of employees in railway, water, automotive, and air transport, as well as passenger conditions in these modes of transport. It develops hygienic

standards and requirements for vehicles and transport infrastructure, along with sanitary measures for these environments.

Occupational Hygiene – the primary task of this hygiene branch is to study the impact of the industrial environment and labor processes on the human body, and to develop standards and measures to maintain favorable working conditions.

Dietary Products – foods designed to meet the nutritional needs of patients and used for therapeutic purposes.

Calorie – the amount of energy required to raise the temperature of 1 gram of water by 1 degree Celsius. In physics, this unit has been replaced by the joule as the standard, thus energy is now expressed in kilocalories (kcal) or kilojoules (kJ)..

Nutrition Science (Nutriciology)

Nutrition science is a branch of hygiene that studies the mechanisms of healthy eating and the motives behind human food choices. It defines dietary systems and strategies for rationalizing individual nutritional patterns.

Food Products

Food products are substances of animal or plant origin used for human consumption in either natural or processed forms. They serve as sources of energy, essential nutrients, and flavor–aromatic compounds.

Nutrients

Nutrients are the constituent components of food products. They include proteins, fats, carbohydrates, vitamins, minerals, and bioactive substances.

Food (Meal)

Food is a complex mixture obtained through thermal or culinary processing, intended for human consumption.

Nutritional Value

Nutritional value refers to the set of properties of food products that ensure the physiological needs of the human body for energy and essential nutrients.

Food Additives

Food additives are natural or synthetic substances used to preserve or modify the properties of food products.

Balanced Nutrition

Balanced nutrition refers to a diet that supplies the human body with an adequate amount of macro- and micronutrients in appropriate proportions, corresponding to the body's energy expenditure.

Energy Balance

Energy balance is the equilibrium between the energy intake from food and the energy expended during vital physiological processes.

Energy Value

Energy value denotes the amount of energy (in kcal or kJ) released in the human body during the oxidation of essential nutrients.

PART I

HYGIENE OF THE AIR ENVIRONMENT

HYGIENIC ASSESSMENT OF MICROCLIMATE IN HOSPITAL PREMISES

The microclimatic environment in healthcare facilities plays a critical role in the effectiveness of physician-prescribed treatments.

The indoor environment of the room is characterized by a combination of physical factors: barometric pressure, temperature regime, humidity, speed of movement of air masses and intensity of thermal radiation. Under standard conditions, the human body maintains a thermal balance by releasing excess heat to the external environment through radiation, conduction, and evaporation of moisture from the skin. The combination of high temperature and excessive humidity blocks the evaporative cooling mechanisms, which creates a risk of thermal stress. On the contrary, in cold conditions, high humidity accelerates heat loss, since water has a significantly higher heat capacity and conductivity compared to dry air. Increased air circulation usually contributes to cooling, except in cases where the humidified air is hotter than the surface of the body. It is noteworthy that even minor fluctuations in these parameters, which are almost imperceptible by healthy people, can cause serious discomfort in patients with pathologies of the cardiovascular, respiratory or nervous systems.

Measurement of Air Temperature.

Alcohol or mercury thermometers are used to determine indoor air temperature (Fig. 1). The measurement procedure requires a five-minute exposure of the device at the point under study to achieve temperature equilibrium. More accurate readings can be obtained using an aspiration psychrometer, whose dry thermometer is protected from the effects of thermal radiation. If continuous data recording is required for days or weeks, thermographs are used. The design of these recorders includes a sensitive element (a bimetallic plate or a tube with toluene) and a recording device with a tape drive mechanism. In hospital settings, measurements are carried out at a level of 1.5 m from the floor in three zones: in the center of the ward, as well as at the outer and inner walls (at a distance of 10 cm from the latter).. The average temperature is calculated to assess horizontal uniformity (Table 1). Vertical temperature gradients are evaluated at 10 cm and 1.1 m above the floor.

Table 1.

Temperature and Air Exchange Rates per Hour

Room Type	Air Temp. (°C)	Air Exchange Rate (m^3/h)	
		Supply	Exhaust
1. Adult wards	$20\text{-}22^0$	80 $м^3$	2-х
2. Thyrotoxicosis wards	$15\text{-}18^0$	80 $м^3$	2-х
3. ORs, postoperative, burn, ICU, delivery rooms	$22\text{-}24^0$	≤10 (mechanical ventilation)	
4. Premature/newborn/infant wards	25^0	80$м^3$	2-х кратный
5. Infection isolation rooms	22^0	2,5	2,5
6. Staff offices	20^0	1	1
7. Diagnostic labs	18^0	1	3
8. Patient sanitation rooms	25^0	3	5
9. Morgues	2^0	-	3

Measurement of Atmospheric Pressure

Atmospheric pressure is measured using aneroid or mercury barometers (Fig. 2). For continuous monitoring, barographs (aneroid barometers with recording mechanisms) are used. The SI unit for pressure is hectopascals (hPa), where 1 hPa = 0,7501 mmHg (the force exerted by a 1 g mass on a 1 cm^2 surface). Typical pressure fluctuations range within 760±20 mmHg or 1013±26,5 hPa. Before reading an aneroid barometer, gently tap its glass to overcome needle inertia.

Fig. 1. Thermometer

Fig. 2. Aneroid barometer

Air Humidity

Key metrics include:

Maximum humidity: Saturated water vapor content (g/m^3) at a given temperature. Absolute humidity: Actual water vapor content (g/m^3). Relative humidity (RH): Ratio of absolute to maximum humidity (%).

Saturation deficit: Difference between maximum and absolute humidity.

Dew point: Temperature at which air becomes saturated.

In calculations of air humidity, the parameter of greatest importance is the relative humidity. Air-humidity measurements are carried out with psychrometers and hygrometers. An aspirated psychrometer consists of two thermometers whose sensing elements are housed in metal tubes through which air is drawn by a fan. This arrangement shields the thermometers from radiant energy and maintains a constant air-flow velocity, thereby allowing

measurements to be performed under stable conditions. The bulb of one thermometer is wrapped in a thin fabric and moistened with distilled water before each observation. The fan is started with a key, and readings are taken 3–4 min after the fan has begun operating, once a constant aspiration rate has been established.

The absolute humidity is calculated by the following formula:

$$K=F-0{,}5\,(t-t_1)*B/755$$

where

K — absolute humidity sought (g m^{-3});

F — saturation (maximum) humidity at the wet-bulb temperature t_1 (obtained from tables);

t — dry-bulb temperature (°C);

t_1 — wet-bulb temperature (°C);

B — barometric pressure at the time of measurement (mm Hg);

755 mm Hg — mean barometric pressure.

The conversion of the determined absolute humidity into relative humidity is carried out using the following formula:

$$R=K/F_1*100$$

where:

R — desired relative humidity (%),

K — absolute humidity (g/m^3),

F_1 — saturation (maximum) humidity at the dry-bulb temperature (determined from a special table).

In addition to using formulas, relative humidity based on the readings of the aspirated psychrometer can also be determined with the help of special psychrometric tables.

Hygrometers are used for direct determination of relative humidity. Their work is based on the use of a bundle of low-fat hair (human or animal) as a sensitive

element that mechanically transmits data to a pointer. If constant recording of humidity indicators is required, hygrographs are used — devices that combine the functions of a hygrometer and a recorder with a tape drive mechanism.

Methods for estimating air flow velocity:

1. Low speeds (up to 1-2 m/s): In enclosed spaces, measurements are carried out using catathermometers (spherical or cylindrical).

2. High speeds (up to 50 m/s): Anemometers are used for intense air flows.

To measure low air movement velocities indoors (up to 1–2 m/s), kata thermometers are used (Fig. 3), which may be:

a) spherical, or, b) cylindrical.

Kata thermometers may feature either **cylindrical or spherical** reservoirs filled with dyed alcohol.

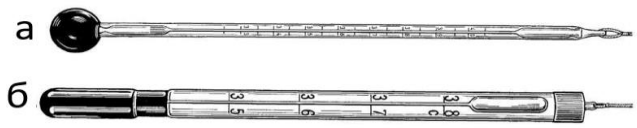

Fig. 3. Kata Thermometers:

a) Spherical type,

b) Cylindrical type.

The **scale of a cylindrical kata thermometer** is specifically calibrated within the range of 35°C to 38°C. The fundamental principle of this device relies on the constant heat loss that occurs as it cools between these two thermal points. This specific loss of energy, measured in microcalories per square centimeter (μcal/cm²), is experimentally verified for each individual instrument and engraved on its surface. To evaluate the cooling capacity of the air, the device is first submerged in a water bath until the alcohol expands into the upper reservoir (filling approximately 50–70% of the bulb). After being

dried and positioned at the sampling site, the time required for the alcohol level to drop from 38°C to 35°C is precisely measured using a stopwatch.

The **cooling capacity** of the air, denoted **H**, is calculated using the formula:

$$H = F/a$$

where:

F — kata thermometer factor (μcal/cm²),

a — time in seconds for the alcohol column to fall from 38 °C to 35 °C.

In contrast to the cylindrical model, the **spherical kata thermometer** features a broader measurement scale ranging from 33.0°C to 40.0°C. While its operational principles mirror those of the cylindrical type, specific criteria must be followed when choosing temperature intervals. Specifically, the arithmetic mean of the starting (T_1) and ending (T_2) temperatures must be exactly 36.5°C. Based on this requirement, standardized intervals such as 40–33°C, 39–34°C, and 38–35°C are utilized for accurate calculations.

In this case, the cooling value **H** is calculated using the formula:

$$H = \frac{\Phi*(T_1 - T_2)}{}$$

where:

Φ — kata thermometer constant, measured in μcal/(cm·°C),

a — time (in seconds) required for the thermometer to cool from temperature T_1 to T_2.

Determining high airflow speeds to measure higher air velocities**,** two types of anemometers are used:

Cup anemometer (Fig. 4),

Vane (propeller) anemometer (Fig. 5).

The **cup anemometer** measures air velocity in the range of **1 to 50 m/s**, while the **vane anemometer** covers the range of **0,5 to 15 m/s**.

Fig. 4. Cup Anemometer **Fig. 5. Vane Anemometer**

Prior to data collection, the anemometer rotor must be allowed to spin for one to two minutes to achieve a stabilized rotational velocity. It is imperative that the instrument is positioned such that the air current strikes the blades at a right angle to their plane of rotation. To ensure precision, the activation and deactivation of the stopwatch must be perfectly synchronized with the operation of the anemometer.

Situational Tasks

Example. Task 1.

Microclimate parameters were measured in a hospital ward. The wall-mounted thermometer shows **T = 28 °C**, and the relative humidity is 24%**.** Assess the microclimate of the ward.

Solution:

According to **Sanitary Norms and Rules (SanPiN)**, comfortable microclimate parameters are:

Temperature: not more than 18–20 °C**,** Relative humidity: 30–60%**.**

Therefore, the microclimate in the ward is not compliant with the standards. Measures must be taken to reduce the temperature and increase the humidity**.**

Recommendations:

Ventilation and airing of the room, air aeration,wet cleaning.

These measures will lead to increased humidity and lower temperature**,** reducing the risk of human body overheating**.** It is also recommended to temporarily reduce solar exposure (insolation) in the room.

Task 2.

A newly developing settlement near a metallurgical plant plans to build its own medical facility**.** Determine the optimal direction in which the healthcare institution can be located relative to the metallurgical plant**,** based on the wind rose — see **Fig. 6**

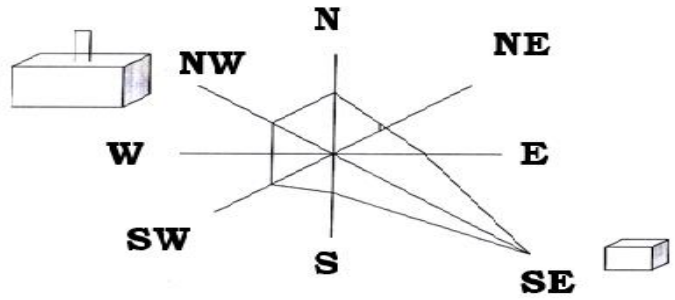

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Fig. 6. Wind Rose

Solution:

The **medical facility (MHF)** is located to the **southeast (SE)** of the planned settlement in relation to the **metallurgical plant**. Since the prevailing wind direction is from the southeast**,** i.e., the wind blows from **SE to NW**, the medical facility is **downwind** relative to the plant.

Tasks

Task 1.

The readings of the aspirated psychrometer in the middle of the hospital ward: Dry-bulb temperature: +26 °C. Wet-bulb temperature**:** +16 °C. Provide a hygienic assessment of the temperature–humidity conditions in the room.

Task 2.

The average air temperature in the hospital ward is +17 °C. Horizontal temperature gradient: +3 °C. Vertical temperature gradient: +2 °C. Humidity**:** 40%. Assess the temperature–humidity regime of the room.

Task 3.

Air temperature is 37 °C, humidity is 20%**.** By which mechanisms is heat released from the human body, and which compensatory reactions should be activated?

Task 4.

Compare **heat loss** under different conditions in a hospital ward:

A) Air temperature: +14 °C, humidity: 30%

B) Air temperature: +16 °C, humidity: 80%

Which microclimate has a **greater cooling effect**?

Task 5.

Which air can **absorb more water vapor**?

A) Temperature: +30 °C, humidity: 70%

B) Temperature: +8 °C, humidity: 30%

What value must be calculated to answer the question?

HYGIENIC ASSESSMENT OF MICROBIAL CONTAMINATION OF AIR IN HEALTHCARE FACILITIES

Airborne microbial contamination has significant epidemiological importance, as many infectious diseases can be transmitted through the air. Bacteria exist in the air in the form of bacterial aerosols, where air serves as the dispersion medium, and liquid droplets or solid particles containing microorganisms form the dispersed phase. There are three phases of microbial aerosols:

- Large-droplet phase – liquid droplets with diameters > 0,1 mm
- Small-droplet phase – droplets < 0,1 mm
- Dust phase – bacterial dust

Examples:

- In the large-droplet phase, even unstable microorganisms like influenza or measles viruses survive.
- In the small-droplet phase: diphtheria bacilli, streptococci, meningococci, etc.
- In the dust phase: Mycobacterium tuberculosis, bacterial spores, fungi.

Monitoring Atmospheric Purity in Clinical Environments

The evaluation of indoor air cleanliness is based on several key microbiological parameters:

– The overall microbial load quantified per cubic meter (1 m^3) of air.

– The concentration of typical respiratory organisms, specifically hemolytic streptococci and staphylococci.

Rigorous surveillance is essential in high-risk hospital areas, including maternity wards, surgical suites, and pediatric units. In these settings, the prevention of healthcare-associated infections (HAIs) is paramount, with a particular focus on mitigating the spread of virulent staphylococcal strains.

. The presence of pathogenic hemolytic staphylococci is considered an integral indicator of microbial air contamination.

A hygienic alert is declared when there's a high frequency of contamination cases. An increase in the number of positive samples indicates contamination with pathogenic microbes in the healthcare facility (HCF). Monitoring antibiotic resistance of microbes is essential for developing sanitary-epidemiological measures to prevent hospital-acquired infections.

Table 2.

Permissible Microbial Content in Air of Maternity Facility Rooms

п/н	Cleanliness Class	Room Type	Total Microorganisms (1 m³)		*Staph. aureus* (1 m³)		Mould Fungi (1 m³)	
			Work area: 1) at the beginning 2) during activity					
			1	**2**	**1**	**2**	**1**	**2**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1.	A – Very clean	Sterile wards for surgery, burns, hematology, delivery rooms, premature infant rooms	> 200	> 500	Not allowed			

2.	B – Clean	Procedure rooms, dressing rooms, ICUs, pediatric wards	>500	>750	Not allowed		
3.	C – Conditionally clean	Regular wards, corridors, infectious disease wards, observation rooms	>750	>1000	Not allowed	>2	Not allowed

Bacteriological Methods for Air Analysis. The following methods are used for bacteriological examination of air:

1. Sedimentation method
2. Filtration method
3. Air-jet impaction method

Sedimentation Method (Koch's Method). Also known as the sedimentation technique, this method is based on the spontaneous settling of airborne microorganisms onto an open Petri dish containing solid nutrient agar. The microorganisms are cultivated through incubation, and subsequently, the number of grown colonies is counted. This method is not quantitative and is used mainly to evaluate the effectiveness of sanitary-hygienic interventions, such as cleaning.

Procedure: Petri dishes with meat-peptone agar are placed in various locations within the room. They are left open for 5–10 minutes. Then the dishes are closed and incubated in a thermostat at 37 °C for 48 hours. After incubation, the total number of colonies is counted across the entire surface of each dish. This method is suitable for comparative studies of air cleanliness in the same room at different times of day or year, or under different ventilation systems.

Filtration Method.

In this method, bacteria are sampled from the air using the POV-I device equipped with a Rechmensky-type bacterio-catcher, followed by spraying the collected air over a nutrient medium.

Air-Jet Impaction Method.

This is an advanced method that uses the Krotov apparatus (Fig. 7), enabling quantitative analysis of air contaminated with microorganisms. The instrument

allows for the calculation of the number of microbes in a specific air volume. The device housing contains an electric motor with a fan. A Petri dish with nutrient agar is placed on a rotating disk at the top of the instrument. Air enters through a slit in the lid and flows evenly over the surface of the Petri dish. Microorganisms are deposited onto the medium and adhere due to the impaction force of the air stream.Uniform microbial distribution across the medium is ensured by the combined effect of the air jet through the slit and the rotation of the Petri dish. To quantify the microbial load, the colonies present on the agar surface are counted and correlated with the air intake rate and exposure time. This data is typically normalized to represent the number of microorganisms per 1 m^3 of air.

Procedure for Bacteriological Air Sampling Using the Krotov Device

1. Connect the device to the power supply
2. Place an open Petri dish with solid nutrient medium on the rotating disk. Use 2% meat-peptone agar for total bacterial count, egg-yolk agar (Chistovich) for staphylococci, and sugar-blood agar with gentian violet (Garo medium) for streptococci.
3. Close the chamber and turn on the electric motor.
4. Use the regulator to set the required air suction rate (approximately 25 L/min).
5. After aspirating the required volume of air (typically 50 L for general analysis, 250 L or more for selective media), turn off the device. Incubate the Petri dish at 37 °C for 48 hours.

а

б

Assessment of Anthropogenic Air Pollution in Indoor Spaces (Based on CO_2 Concentration)

CO_2 concentration analysis is used to assess air cleanliness in residential areas, hospital wards, and public buildings, where anthropogenic air pollution may occur.

Determining CO_2 Concentration in a Classroom.

Required materials: 10 or 20 mL syringe, freshly prepared weak alkaline solution with phenolphthalein. Normal CO_2 concentration range: 0.03–0.1%.

1. Prepare 100 mL bottle with potassium hydroxide solution, add 3–4 drops of phenolphthalein.
2. Fill syringe with 1–2 mL of the prepared solution.
3. Draw in room air to full volume, shake 10–15 times, then release air, leaving the solution.
4. Repeat air exchange until the solution fully decolorizes, counting the number of cycles.
5. Repeat the procedure outdoors with the same solution.
6. Calculate the concentration of carbon dioxide using the formula

$$C_{co}^2 = (K_{outdoor} / K_{indoor}) * 0{,}03\%,$$

where:

K outdoor — number of air volumes that decolorized the solution **outside** the room;

Kindoor — number of air volumes that decolorized the solution **inside** the room.

7. Record the results, compare with sanitary norms, and provide recommendations.

Determining Air Exchange Rate (AER).

To maintain air cleanliness in hospital rooms, at least 37 m^3 of fresh air per person per hour is required. AER depends on the number of occupants and ventilation volume.

Formula: **K = (a × b × c) / V**

Where: a – vent opening area (m^2), b – air velocity (m/s), c – ventilation time (s), V – room volume (m^3).

Air exchange can also be calculated using CO_2 data. The required AER is obtained by dividing the ventilation volume by room volume. In hospital wards, the standard is two air exchanges per hour.

Formula for Calculating Ventilation Volume Based on CO_2 Concentration

$$L=21,6 \cdot n/P-P1L$$

where:

L — ventilation volume, m^3

21,6 — amount of carbon dioxide exhaled by one person per hour (in liters)

n — number of people in the room

P — maximum permissible CO_2 concentration in indoor air (**1,0 L/m^3**, corresponding to **0,1%**)

P_1 — CO_2 concentration in outdoor (atmospheric) air (**0,4 L/m^3**, corresponding to **0,04%**)

Example Task

In a 4-bed ward with 3 patients, ventilation is performed by opening a window 3 times per day for 20 minutes. Room size: 25 m^2, height: 3,3 m, vent area: 0,15 m^2, airspeed: 1 m/s.

Required ventilation: K = 21.6 × 3 / (1,0 – 0,4) = 108 m^3

Room volume = 25 × 3,3 = 82,5 m^3 → Required AER = 108 / 82,5 ≈ 1,3

Actual intake: K_p = 0,15 × 1 × 1200 × 3 = 540 m^3/day → 22,5 m^3/hour

Actual AER = 22.5 / 82,5 ≈ 0,3 (insufficient)

Recommendation: open the window every hour for at least 30 minutes (≥10 times/day).

Assignments

1. CO_2 content measured with syringe method: 32 air exchanges outdoors, 9 indoors. Determine room air cleanliness and give recommendations.

2. Calculate required AER in a dental office with 3 chairs. Room: 30 m^2, height:

3,3 m.

3. CO_2 content: 23 exchanges outside, 7 inside. Assess air cleanliness and recommend.

4. Syringe method: 7 exchanges indoors, 21 outdoors. Calculate indoor CO_2 concentration.

INSOLATION REGIME, ARTIFICIAL AND NATURAL LIGHTING OF HOSPITAL PREMISES AND THEIR HYGIENIC ASSESSMENT

Wherever a person may be, they always require complete visual information about their surroundings. In all living conditions—be it at home, in the workplace, in an educational institution, or in a hospital—lighting is essential for the performance of various functions related to human activity.

The light environment, or light climate, is crucial in spaces intended for human occupation—it is a set of environmental factors that provide illumination.

The visible part of the solar spectrum has significant biological importance. Especially for patients, natural daylight has a positive effect on comfort, mental well-being, and overall health. Exposure to daylight enhances hematopoiesis, stimulates the activity of endocrine glands, boosts metabolism, and supports the synthesis of certain vitamins—factors which play a key role in regulating biological rhythms. A well-regulated lighting regime in conditions of intense illumination improves growth and development of the organism.

Sufficient lighting at workplaces requiring visual strain is essential to reduce visual fatigue. Inadequate lighting leads to reduced mental performance, fatigue, altered psychological state, and even impaired motor coordination.

When natural light is insufficient (at night, during poor weather), or when additional intense lighting is required at the workplace (for tasks requiring high visual accuracy), artificial lighting sources must be used.

Lighting should be sufficiently intense, evenly distributed, adequately saturated, and should not create harsh shadows.

The insolation regime refers to the duration and adequacy of sunlight exposure in a room, depending on external environmental parameters.

Natural Lighting. Natural lighting in rooms depends on the climate, geographical location, local surface conditions, atmospheric transparency, optical and reflective properties of the external environment (albedo), and the light climate. Proper orientation of windows according to cardinal directions is essential for adequate lighting of the workspace**.**

Table 3. Types of Insolation Regimes in Rooms

Insolation Regime	**Orientation**	**Duration of Insolation (hrs)**	**% of Floor Area Insolated**	**Solar Radiation Heat Gain (kJ/m²)**
Maximum	SE, SW	5–6	80%	Over 3300
Moderate	S, E	3–5	40–50%	2100–3300
Minimum	NE, NW	Less than 3	Less than 30%	Less than 2100

Insolation must be considered when planning the layout of buildings, ensuring appropriate orientation for workspaces of various purposes.
From a bioclimatic perspective, window orientation should be tailored to the specific latitude to balance natural illumination with thermal comfort. In northern regions, south-facing windows are prioritized for residential, educational, and medical facilities, whereas southeast or eastern exposures are more effective in southern climates. This strategic placement ensures sufficient solar radiation while preventing excessive heat gain. Furthermore, direct sunlight serves a vital sanitary function; its inherent germicidal properties help disinfect the air and enhance the overall quality of the indoor microclimate.

Certain functional rooms in hospitals require uniform natural lighting with diffuse light, without overheating—such as operating rooms, intensive care units, dressing rooms, and treatment rooms. For these areas, northern, northwest, and northeast orientations are recommended.

Recommended Window Orientations in Healthcare Facilities (Table 4)

The status of natural lighting depends on several factors:

- Duration of natural lighting in the room
- Shape, size, and orientation of windows
- Presence and proximity of shading objects

Indicators of Adequate Lighting in Rooms:

1. Daylight Factor (DF)
2. Light Coefficient
3. Angle of Incidence
4. Window Angle
5. Depth-to-Height Ratio

Table 4. Orientation of Windows in Hospital Rooms

Recommended Window Orientations in Hospital Rooms (Geographic Latitude 45° N and Southward)

Room Type	**Orientation**
Operating rooms, intensive care zones, autopsy rooms	N, NE, NW
Laboratories for bacteriological studies, receiving and handling infectious material	N, NE, NW, SE, E
Patient rooms	S, SE, E, *NE, *NW
Intensive care wards	Not allowed: W and NW
Wards in pediatric units for children under 3 years, playrooms in pediatric departments	S, SE, E

Note:

In patient rooms oriented to the west, protection against overheating from sunlight should be provided (e.g., blinds or other devices). *NE and NW orientations are allowed for no more than 10% of the total number of beds in the department.

The **Daylight Factor (DF)** is considered the central determinant of natural lighting in living spaces. It is the ratio of indoor illumination to outdoor illumination, expressed as a percentage:

$DF = (E_1 / E_2) \times 100\%$

Where:

E_1 = Illumination at the workplace (in lux)

E_2 = Outdoor illumination under an unobstructed sky (in lux)

The **luxmeter** works by converting the energy of light flux into an electric current. The sensing part is a photoelement with light-absorbing filters rated at 10, 100, and 1000. The registering part is a galvanometer that records the resulting current, with the scale calibrated in lux (see Fig. 8).

Fig. 8. Luxmeter

Methods for Determining Natural Lighting Using Geometric Transformations

Light Coefficient (LC) is the ratio of the glazed part of the window to the floor area of the room. LC is represented as a simple fraction: the numerator is the area of the glazed part of the window, and the denominator is the floor area. For operating rooms, delivery rooms, examination rooms, treatment rooms, laboratories, and pharmaceutical assistant rooms, the LC should be 1:4 to 1:5. In day rooms and physicians' offices, the LC should be 1:5 to 1:6.

Depth-to-Height Ratio (DHR) – This is the ratio of the distance from the window wall to the opposite wall to the distance from the floor to the top edge of the window. The DHR should not exceed 2.5 for a room depth of 6 m.

Angle of Incidence (Fig. 9) indicates the angle at which light rays penetrate the workspace. It is formed between two lines: one horizontal line from the window to the work surface, and one from the highest glazed point of the window. The regulated angle of incidence must be at least 27°.

Window Angle (Fig. 9) determines the visible portion of the sky dome illuminating the workspace. It is formed between two lines from the measuring point: one to the top edge of the window, the other to the top of the shading object. The regulated window angle should be at least 5°.

Designations:

- ***L*** – distance from the workplace to the shading object
- ***H*** – height of the shading object (building)
- ***h*** – height of the workplace (e.g., desk)
- ***α*** – angle of incidence
- ***β*** – window angle
- ***h₁*** – height of the window
- ***l*** – distance from the workplace to the window

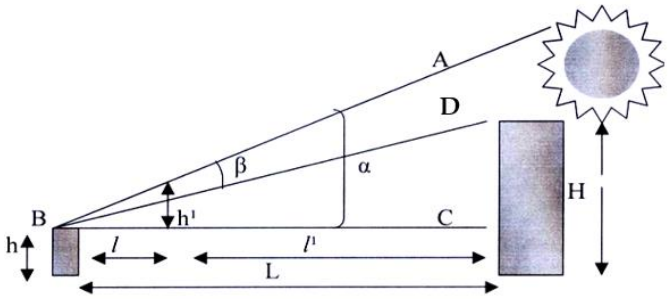

Fig. 9. Determining Angle of Incidence and Window Angle

Rectangular windows are considered optimal for lighting. The top edge of the window should be as close as possible to the ceiling (20–30 cm) to allow deeper light penetration into the room.Factors affecting natural lighting levels include the cleanliness of window panes, shading by curtains, and presence of plants on the windowsill.Wall, ceiling, floor, and furniture colors also influence lighting—lighter colors reflect more light and therefore improve overall illumination.

Steps for Determining the Angle of Incidence and Window Angle (see Fig. 9):

- Draw a scaled floor plan of the room
- Determine the measurement points (e.g., desk)
- Measure window height
- Measure desk height
- Measure distance from desk to window

- Measure distance from window to nearest shading object (e.g., tree, building)
- Determine height of the shading object
- Plot all measurements on the drawing
- Use a protractor to determine angles of incidence and window angles

Angle ABC (α) = angle of incidence

Angle ABD (β) = window angle

The angle of incidence shows how sunlight falls on a horizontal surface (desk). If natural lighting is insufficient, it must be compensated by artificial lighting.

Hygienic Requirements for Artificial Lighting:

- Sufficient intensity and uniformity
- No glare or blinding effects
- No harsh shadows
- Accurate color rendering; spectrum should resemble natural sunlight

Artificial Lighting:

Artificial lighting is created by general and local lighting fixtures. A lighting fixture consists of a light source (lamp) and the lighting housing.

Types of Artificial Light Sources:

1. Incandescent lamps
2. Fluorescent lamps
3. Energy-saving lamps
4. Halogen lamps
5. LED lamps

The choice of lamps, the number of fixtures, and their power depends on the required level of workplace illumination according to hygiene standards.

Solution to the Situational Task:

1. The area of the room is 32 m², and the glazed part of the window measures 5.2 m². The ratio is calculated as 5.2 / 32. When simplified, the Light Coefficient (LC) in the room is 1:6.

2. A luxmeter is used to measure the illumination on the working surface. A horizontal line is mentally extended beyond the room to determine the outdoor illumination. Measurements are taken simultaneously both inside and outside the room.
   For example: Illumination at the desk: 150 lux. Illumination outside the building: 12,500 lux.

   KEO = e 100/E = 150 * 100/12500 = 1,2%

Assignments

Task 1. Determine the Daylight Factor (DF) at a student's desk if indoor illumination is 100 lx and outdoor illumination is 1200 lx.

Task 2. The glazed area of one window is 2,8 m². The classroom has two windows and a total area of 28 m². Calculate the LC. Is it sufficient for a classroom?

Task 3. Simultaneous measurements showed 100 lx indoors and 12000 lx outdoors. Calculate the DF. Is it adequate for a classroom?

QUESTIONS FOR SELF-ASSESSMENT

1. What is the hygienic importance of air temperature?
2. What is the hygienic significance of air humidity?
3. What is the hygienic significance of air movement?
4. What are the main hygienic standards of indoor microclimate parameters?
5. How does barometric pressure affect the physiological state of the body?

PART II.

WATER HYGIENE. HYGIENIC ASSESSMENT OF DRINKING WATER AND WATER SUPPLY SOURCES.

It is well-known that high-quality water should be consumed. But what constitutes high-quality water, and what are its characteristics?

Water used for drinking must be safe and harmless, causing no adverse health effects. Consuming poor-quality water exposes individuals to risks such as infectious diseases, helminth infections, and poisoning by industrial-origin chemicals.

Chemical, bacteriological, organic, and other harmful agents can enter drinking water through various pathways. For example, infections and helminths may contaminate water bodies via domestic and fecal wastewater, while chemical poisoning can result from industrial or agricultural runoff entering water sources.

The waterborne transmission route is typical for microorganisms, including cholera, typhoid fever, paratyphoid, amoebic and bacterial dysentery, enteroviral diseases, infectious hepatitis (Botkin's disease), leptospirosis, tularemia, giardiasis, as well as helminth infections such as ascariasis, trichuriasis, and opisthorchiasis.

Using water containing chemical elements and substances can lead to non-infectious diseases, such as fluorosis, water-nitrate methemoglobinemia, and others.

Drinking water must be of good quality and meet hygienic requirements: favorability, harmlessness, and safety.

Favorability Principle. Drinking water must have good organoleptic properties. **Safety and Harmlessness**. Drinking water must not contain pathogenic microbes or other disease-causing agents and must be chemically safe. In the Republic of Uzbekistan, water hygiene standards are regulated by two GOST standards: "Drinking Water" and "Water Supply Sources."

The "Drinking Water" standard defines water quality requirements based on three principles: favorability, safety, and harmlessness. Chemical substance regulations—maximum permissible concentrations (MPCs)—are set based on their impact on water's organoleptic properties and human health. Indicators of microbiological safety of drinking water are also mandatory. These standards must be observed by water supply services. Water quality is constantly monitored by laboratories at the stages of its intake and treatment, while sanitary services monitor the quality of drinking water in places of its consumption.

The second standard outlines requirements for selecting water sources for domestic and drinking water supply. In this case, the source must possess properties and quality that allow its use as a water supply, specifying methods for improving and treating water to meet drinking water standards.

1. Epidemiological Safety of Water

- Total bacteria count in 1 cm^3 of undiluted water: no more than 100.
- Coliform bacteria count (determined on selective solid media using membrane filtration): no more than 3 per 1 dm^3 (coliform index).
- *Escherichia* (fecal contamination indicator): absent in 300 mL.
- Coliphages: no plaque-forming units (PFU) in 200 mL of water.

2. Favorable Organoleptic Properties of Water

Drinking water must be tasteless, odorless, and transparent. According to the standard:

- Odor at 20°C (heated to 60°C): no more than 2 points.
- Taste and aftertaste at 20°C: no more than 2 points.
- Color on the platinum-cobalt scale: no more than 20° (exceptionally up to 35°).
- Turbidity on the standard scale: no more than 1.5 mg/dm^3.
- Specific odors or tastes from water treatment reagents: no more than 1 point.

Substances altering water's organoleptic quality, whether naturally present or added for treatment, must not exceed the norms (Table 5).

Table5.

Indicators of Chemical Substances Affecting Water's Organoleptic Properties.

Substance Name	Permissible Level (dm^3/m^3 or mg/L)
Dry residue	1000 (in certain cases up to 1500)
Chlorides	250–350
Sulfates	400–500
Iron	0.3
Manganese	0.1
Copper	1.0
Zinc	3.0
Residual aluminum	0.5
Total hardness (mg-eq/L)	7.0 (in some cases up to 10.0)
Hydrogen index (pH)	6–9
Polyacrylamide	2.0
Fluoride	0.7
Nitrates (as nitrogen)	10.0
Lead	0.03

Chemical substances in drinking water are regulated based on toxicity, with limits set as maximum permissible concentrations (MPCs). These requirements are established by the Ministry of Health of the Republic of Uzbekistan for water supply sources. A list of these substances is provided in the "Rules for Protecting Surface Waters from Wastewater Pollution." Over 500 substances already have approved MPCs.

For assessing water toxicity when multiple substances are detected, a calculation method is used, summing the ratios of detected concentrations to their MPCs. The result should not exceed 1.

Calculation formula:

c1/C1+c2/C2+c3/C3+…..+cn/Cn=1

Where:

- \(c_1, c_2, c_3, \dots, c_n \) = detected concentrations (mg/dm^3);

- $C_1, C_2, C_3, \dots, C_n$ = MPCs (mg/dm³).

Exceptions: Fluoride, nitrates, and radioactive substances are not included in this calculation.

For complexes of taste-altering substances (e.g., sulfates, chlorides), the same formula is applied.

Requirements for the Quality of Drinking Water from Local Water Supply Sources

To evaluate the quality of water sourced from local supply systems, various chemical indicators are employed to detect pollution from organic materials. These include ammonia, nitrites, nitrates, and chlorides, along with an assessment of the water's oxidizability.

Organic matter primarily consists of nitrogen-based compounds, with ammonia being a key byproduct of organic decomposition. When **ammonia** levels in water exceed 0.1 dm³/m³, it is typically viewed as evidence of recent contamination from organic matter of animal origin. However, there are exceptions; for instance, in deep groundwater, ammonia may arise from the reduction of nitrates due to low oxygen levels. In such scenarios, ammonia does not necessarily indicate a decline in water quality. Additionally, ammonia can also be found in water derived from plant sources, such as peat.

Nitrites.

Salts of nitrous acid are formed as ammonia undergoes oxidation through nitrification, a process driven by microbial activity. When nitrite levels exceed 0.002 dm³/m³, it suggests potential contamination from organic materials, particularly those containing nitrogen. The detection of nitrites in water serves as an indicator of the persistence of organic pollution.

Nitrates.

Salts derived from nitric acid represent the end result of the breakdown of nitrogen-rich compounds. When nitrates are detected in water without the

presence of ammonia or nitrites, it indicates that the mineralization process has been fully completed. Conversely, finding both intermediate and final products of this mineralization suggests that the process is still ongoing, rendering the water contaminated and potentially hazardous to health. In some cases, elevated nitrate levels in water can be attributed to the leaching of natural soil salts, such as saltpeter. The presence of intermediate nitrogen compounds in drinking water poses a risk of methemoglobinemia, a condition that affects oxygen transport in the body. It is recommended that nitrate concentrations in drinking water, measured by nitrogen content, remain below 10 dm^3/m^3 to ensure safety.

Chlorides make their way into water bodies primarily due to household waste and the dissolution of mineral salts found in soils. The concentration of chlorides in water varies based on the source and the salinity of the surrounding soil. In surface waters that are not tainted by domestic effluent, chloride levels typically remain below 20–30 dm^3/m^3. However, in groundwater located in saline regions, chloride concentrations can be significantly higher without necessarily indicating pollution. An increase in chloride levels above the average for a specific water source, on the other hand, suggests contamination from human waste, such as feces and urine.

Monitoring changes in chloride concentrations over time is crucial for identifying pollution sources and formulating effective water protection strategies. Additionally, the taste of drinking water is influenced by its chloride content; elevated levels can affect various physiological functions within the human body. Regulatory standards set the maximum allowable concentration of chlorides in drinking water at 350 dm^3/m^3.

Water quality assessments also consider oxidizability, which measures the amount of oxygen (in milligrams) needed to chemically oxidize organic materials in one liter of water. High oxidizability often signals the presence of organic pollutants, although it is not always a definitive indicator of severe water contamination. For instance, elevated oxidizability alongside pronounced

coloration might suggest the presence of decomposing plant matter or easily oxidizable iron compounds rather than hazardous pollutants.

A specific indicator of organic water pollution is **biochemical oxygen demand (BOD)**—the total amount of oxygen consumed in the biochemical oxidation of organic substances in 1 liter of water at a temperature of 20°C. Biochemical processes in water occur with the participation of microorganisms.

Selection of a Water Supply Source

In Uzbekistan, new guidelines have been introduced for selecting water sources in accordance with the OzDST standard. This regulatory framework outlines the process for identifying suitable sources for drinking water supply. Key factors to consider during this selection include water quality, reliability, accessibility, potential for quality enhancement, and yield—essentially, the sufficiency of volume.

When it comes to quality, interstratal groundwater, including artesian sources, is deemed most compliant with drinking water standards. Thus, prioritizing underground sources is recommended. Artesian water, in particular, is favored due to its inherent protection, which results from its depth and the presence of an impermeable layer above it. If interstratal sources are unavailable or inaccessible for technical or economic reasons, the national standard suggests exploring alternative options.

The process of selecting a water source is carried out in phases, carefully considering the reservoir's water quality, reliability, and the feasibility of enhancing that quality to meet drinking water standards.

A stepwise assessment is carried out based on decreasing sanitary reliability of the water bodies:

I. Pressurized (artesian) and non-pressurized interstratal waters;

II. Groundwaters, including artificially recharged sources;

III. Surface water bodies, such as rivers, reservoirs, lakes, and canals.

Underground water that accumulates above the first impermeable layer is considered groundwater. These are not protected from surface influences, which results in unstable and variable water composition. Generally, in the absence of significant soil contamination sources, groundwater is not polluted and is low in mineral content, making it potentially suitable for drinking water supply. The selection of a water source also requires a sanitary assessment of the soil in populated areas, as a potential contamination factor for shallow groundwater sources.

Waters located between two impermeable layers are referred to as **interstratal waters**. The advantage of such sources is their reliable protection from atmospheric precipitation and other possible contaminants due to the blocking layer.

Artesian waters are pressurized interstratal waters. A key characteristic of these water sources is their significant depth, which enhances their sanitary reliability. Typically, interstratal waters align well with drinking water standards, exhibiting favorable organoleptic qualities and a consistent chemical profile. This allows for their direct use without the need for prior treatment or quality improvement. The level of mineralization in these waters is largely influenced by the geochemical makeup of the surrounding soil. Both pressurized (artesian) and non-pressurized interstratal waters are regarded as optimal choices for water supply.

Since the volume of underground water may be insufficient for centralized water supply in populated areas, surface water sources may be used. If surface waters do not meet the selection criteria for water sources (see Table 6), this typically indicates regular contamination from household-sewage and industrial wastewater, or mass bathing activities.

Table 6

Requirements for the Quality of Source Water

Indicator	**Standards**
Color	Should not be detectable in a 20 cm water column

Indicator	Standards
Odor and taste	Up to 2 points
BODfull	≤ 3 dm^3/m^3
Total dissolved solids	≤ 1000
Including sulfates	≤ 500
Chlorides	≤ 350
Total hardness	≤ 7 mg-eq/L
Coliform index	Not more than 10,000

In this regard, specific protection measures are established for surface water bodies. Hygienic parameters for the content of chemical substances in source water are developed, maximum permissible levels of microbial contamination are regulated, and methods for improving water quality to transform it to drinking water standards are created.

The various factors influencing surface water sources are interconnected. Consequently, choosing a water source requires more than just a chemical assessment of the water. It also necessitates thorough investigations to evaluate the source's reliability, establish sanitary protection zones around the water body, and explore opportunities for enhancing water quality to comply with drinking water standards.

Examples of Solving Standard Problems

Problem 1. A settlement is equipped with a water supply system that sources water from a river. The water undergoes coagulation, sedimentation, filtration, chlorination, and fluoridation. The results of water sample analysis taken from an outdoor water column are presented in Table 7.

Conclusions: The investigated water from the outdoor water column complies with **GOST standards** for the following parameters: organoleptic characteristics, total dissolved solids, and hardness. The calculated sum of the fractions of the maximum permissible concentrations (MPC) for sulfates and chlorides does not exceed 1: (194/500 + 138/350).

Table 7.

Results of Water Sample Analysis

Indicator	**January 30**	**May 10**
Odor, points	1	1
Taste	Absent	Absent
Transparency, cm	More than 30	More than 30
Color, degrees	17	20
Total hardness, mg-eq/L	6,9	6,5
Total dissolved solids, dm^3/m^3	385,0	205,0
Sulfates, dm^3/m^3	194,0	106,0
Chlorides, dm^3/m^3	138,4	102,8
Fluoride, dm^3/m^3	0,85	0,98
Total bacterial count (per ml)	34	41
Residual chlorine, dm^3/m^3	0,3	0,33

The water is considered epidemiologically safe, with a total bacterial count not exceeding 100 per milliliter. A residual chlorine level ranging from 0.3 to 0.33 dm^3/m^3 provides adequate disinfection. However, there is a concern regarding elevated fluoride levels, which range from 0.85 to 0.98 dm^3/m^3. It is essential to closely regulate the fluoridation process and lower the fluoride dosage to ensure that concentrations remain below 0.7 dm^3/m^3.

Problem 2. Identify an appropriate water supply for a summer camp catering to 330 children, where the average daily water usage is estimated at 100 liters per person. The potential sources of water include an artesian well situated 40 meters deep, which has a yield of 245 cubic meters per day, and a lake located in a grove approximately 1 kilometer from the camp. Water sample analysis results from both sources are presented in Table 8**.**

Table 8.

Results of Water Sample Analysis for the Pioneer Camp

Indicator	**March 10 (Lake)**	**July 11 (Lake)**	**Feb 10 (Well)**	**June 25 (Well)**
Water temperature, °C	4,7	20,0	9,2	8,8
Transparency	>30	>30	>30	>30
Odor, points	1 (swampy)	2 (swampy)	Absent	Absent
Color, degrees	1	2	»	»
Suspended solids, mg/L	8,0	12,6	0,7	1,1
Total hardness, mg-eq/L	4,3	3,9	4,2	4,1
Total dissolved solids, mg/L	125	86,0	266	262
Sulfates, mg/L	31,4	26,6	28,5	26,8
Chlorides, mg/L	15,0	20,4	6,0	5,5
Ammonia (as N), mg/L	0,1	0,25	Absent	Absent
Nitrites, mg/L	0,002	0,01	»	»
Nitrates, mg/L	0,3	0,15	0,19	0,15
Fluoride, mg/L	0,7	0,5	1,2	1,0
Iron, mg/L	0,3	0,2	0,8	0,75
Oxidizability, mg/L	12,4	22,3	1,25	1,34
Dissolved oxygen, mg/L	6,0	8,4	2,4	2,8
Bacterial count per 1 ml	400	1250	8	10

In compliance with GOST standards, it is recommended to utilize artesian water sources for supplying water to a summer camp. These sources typically have lower contamination levels and provide enhanced reliability concerning public health safety.

Calculation of water demand:

100 L/day × 330 children = **33,000 L/day = 33 m³/day**

With a daily yield of **245 m³**, the artesian well is more than sufficient to meet the camp's needs. Quality assessment confirms the **safety** of the artesian water. Microbiological indicators (microbial count of 8–10 per ml vs. permissible 100) confirm its **microbiological safety**. Organoleptic indicators are favorable:transparency: >30 cm, suspended solids: 0,7–1,1 mg/L,no color, odor, or taste, sulfates: 26,8–28,5 mg/L, chlorides: 5,5–6,0 mg/L, total hardness: 4,1–4,2 mg-eq/L

The **lake water is unreliable and polluted**, and cannot compete with underground sources—particularly the artesian well.

The **artesian water** meets regulatory standards and may be used for domestic and drinking purposes in the camp **without additional treatment**.

It is necessary to establish a **sanitary protection zone** with a **minimum radius of 15 meters** around the well.

Methods for Improving the Quality of Drinking Water

To enhance the quality of drinking water, several techniques can be employed, including clarification and disinfection. Clarification involves processes such as coagulation, sedimentation, and filtration, which not only make the water clearer but also diminish its coloration. Disinfection can be achieved through various chemical or physical approaches. Physical methods consist of boiling and exposure to ultraviolet (UV) light, while chemical methods utilize reagents for processes like chlorination, ozonation, and the oligodynamic effect of silver.

Chlorination is a reliable, simple, and widely used method of water disinfection. The bactericidal effect of chlorine compounds is due to the

formation of hypochlorous acid ions in water: $\mathbf{Cl_2 + H_2O \rightarrow HOCl + HCl}$.

Upon dissociation of hypochlorous acid, active radicals such as hypochlorite ions (OCl^-) and chlorine (Cl^-) are formed, which possess high oxidative capacity. These radicals, generated during the breakdown of hypochlorous acid, destroy the microbial cell membrane, leading to the death of the microorganism. The action of active radicals on microorganisms is immediate, but the process depends on the concentration and contact time with the chlorine-containing agent. For example, the pathogenic ***Enterococcus faecalis*** is destroyed within 30 seconds when treated with a 5.25% sodium hypochlorite solution. When the concentration is reduced to 0.5%, the same positive effect is achieved, though only after 30 minutes.

Chlorine gas, bleaching powder, and calcium hypochlorite ($Ca(OCl)_2$) are commonly used for water disinfection. For individual use in the field, tablets containing various amounts of active chlorine—such as Pantocide, Aquasept, and Neoaquasept—are employed as standard means of water disinfection.

Chlorination Methods:

1. Standard Chlorine Doses: The necessary amount of chlorine is calculated based on the specific chlorine demand of the water. This requirement fluctuates according to the inherent characteristics of the water source and is adjusted to meet sanitary standards for residual chlorine levels.

2. Hyperchlorination: In this approach, the chlorine dosage significantly surpasses the water's chlorine demand. This technique is particularly employed in situations where there are unstable epidemiological conditions or a heightened risk of contamination in the water source.

The chlorine dose refers to the quantity needed to achieve effective disinfection. It is established during the chlorination process using standard doses, taking into account all relevant factors for successful disinfection.

The chlorine demand of natural water represents the amount necessary to oxidize organic matter and easily oxidizable inorganic substances while also

providing bactericidal effects, adjusted for a residual chlorine concentration of 0.32–0.5 dm^3/m^3.

When using standard doses for chlorination, the required chlorine amount is determined in a laboratory setting through trial chlorination. The minimum contact time for chlorine with the water is set at 30 minutes during summer months and may extend to 1 hour in winter conditions.

In field conditions, hyperchlorination is most frequently used due to the absence of purification equipment. This method involves using large doses of active chlorine (10–30 dm^3/m^3) and has significant advantages.

Advantages of Hyperchlorination:

1. Effectiveness: Chlorination is capable of disinfecting water that is cloudy, colored, or otherwise contaminated.

2. Ease of Use: The chlorination process does not require prior testing to determine the appropriate dosage. This method is straightforward, as the chlorine amount is chosen based on the characteristics of the water source, including its clarity and color, potential contamination risks, and public health concerns.

3. Rapid Action: The disinfection process is quick, generally taking only 15 to 20 minutes.

In terms of typical chlorine dosages for hyperchlorination: for wells with good water quality, a dose of 10 mg/L of active chlorine is sufficient. For wells with lower transparency or for rivers and lakes that are clear and colorless, the required dosage increases to 15–20 mg/L. In cases of heavily contaminated water or sources that are not safe for drinking (such as artificial ponds), the dosage may reach 25–30 mg/L. In scenarios involving biological threats, chlorine levels can be raised to as much as 100 mg/L. Any excess chlorine is subsequently neutralized using sodium thiosulfate to bring residual chlorine levels down to 0.3–0.5 dm^3/m^3.

Method for Preparing a 1% Bleaching Powder Solution and Subsequent Evaluation of Active Chlorine Content

In the chlorination process, a 1% solution of bleaching powder serves as the active chlorine source. Bleaching powder is inherently unstable and can quickly lose its chlorine content, making it essential to assess the active chlorine concentration before use.

To create a 1% solution, start by weighing out 1 gram of bleaching powder. Grind this powder in a porcelain mortar with a pestle until it becomes a fine paste, then gradually add distilled water to achieve a smooth consistency. Next,

dilute this paste further with more distilled water and transfer the mixture into a graduated cylinder, adjusting the total volume to 100 ml. Stir well and let the solution sit for about 10 minutes to allow any impurities to settle.

To measure the active chlorine content in the bleaching powder in the field, employ a drop-wise titration method. Begin by pouring 100 ml of distilled water into a glass or flask. Add 0.4 ml of the freshly prepared 1% bleaching powder solution, along with 1 ml of diluted hydrochloric acid (at a ratio of 1:5), 1 ml of a 5% potassium iodide solution, and 1 ml of freshly prepared 1% starch solution. Mix the solution thoroughly and then titrate it drop by drop using a calibrated pipette (where 1 ml equals approximately 25 drops) with a 0.7% sodium thiosulfate solution until the mixture becomes colorless. The total number of drops used during the titration corresponds to the percentage of active chlorine in the bleaching powder. Each drop of the 0.7% sodium thiosulfate binds 0.04 mg of chlorine, which relates to one-hundredth of the 4 mg of bleaching powder initially used for this determination—essentially reflecting the 1% concentration.

Procedure: Chlorination with Standard Doses

To establish the appropriate chlorine dosage for water chlorination using standardized concentrations, a preliminary trial is performed. This involves three glasses, each containing 200 ml of the test water. A 1% solution of bleaching powder is introduced into the glasses in varying amounts: 1 drop in the first glass, 2 drops in the second, and 3 drops in the third.

After adding the solution, the contents of each glass are stirred and allowed to sit for 30 minutes, ensuring adequate interaction between the disinfectant and the water. Subsequently, the residual chlorine levels in each glass are measured. From this trial, the necessary quantity of bleaching powder for chlorinating 1 liter of water can be calculated.

For instance, if 2 drops of the 1% bleaching powder solution were added to the second glass containing 200 ml of water, the residual chlorine was determined

using 2 drops of a 0.7% sodium thiosulfate solution. This indicates that for 1 liter of water, a total of 10 drops (calculated as 2 drops multiplied by 5) or 4 ml of the 1% bleaching powder solution is required (noting that there are approximately 25 drops in 1 ml).

In terms of dry bleaching powder, the amount present in 0.4 ml of the 1% solution is significantly lower—specifically, it is 100 times less due to the dilution factor of the solution. Therefore, this amounts to 0.004 g or 4 mg, which translates to a chlorine dosage of 4 mg per liter.

Method for Determining Residual Chlorine

To detect residual chlorine:

In a glass containing 200 ml of the test water, add 2 ml of 5% potassium iodide solution, 2 ml of hypochlorous acid (1:5 dilution), and 1 ml of 1% starch solution.

Mix thoroughly. If residual chlorine is present, the water turns **blue**, with intensity proportional to the chlorine level. Then titrate **drop by drop** using 0,7% sodium thiosulfate solution until **decolorization** occurs. Each drop binds **0,04 mg** of chlorine, which corresponds to **0,2 mg/l** when recalculated for 1 liter (0,04 × 5 = 0,2).

Superchlorination (Hyperchlorination)

When choosing hyperchlorination for water disinfection, it is essential to gather preliminary information about the water source. This includes a sanitary survey map that provides topographic and technical details, along with epidemiological data and fundamental laboratory results regarding water quality.

Task: Using the data provided, calculate the chlorine dose needed for hyperchlorination.

Procedure:

- Pour 1 liter of the test water into a flask.
- Calculate the required chlorine dose based on initial estimates.
- Add 1% bleaching powder solution to the flask (after determining its active chlorine content).

Example Calculation: Let's consider a scenario where the water is heavily contaminated, and we need to apply a chlorine dose of 20 mg/L. Given that bleaching powder consists of 25% active chlorine, this means that in every 100 mg of bleaching powder, there are 25 mg of chlorine. To achieve the desired 20 mg of chlorine, we can calculate the required amount of bleaching powder as follows:

$X = 100 \times 20 / 25 = 80$ mg

Since a 1% solution of bleaching powder contains 10 mg of the dry substance per milliliter, we can determine the volume needed:

$X = 80 \times 1 / 10 = 8$ ml

Therefore, to disinfect 1 liter of water, 8 ml of a 1% bleaching powder solution is necessary.

After using high doses of chlorine-based disinfectants, known as hyperchlorination, the resulting water is no longer safe for drinking due to elevated levels of residual chlorine. It becomes essential to remove this excess chlorine through a dechlorination process. This step is necessary when the residual chlorine concentration surpasses 0.5 mg/L.

. Elevated residual chlorine levels impart a persistent chlorine odor (assessed organoleptically via odor scoring), which leads to consumer rejection of the water.

Dechlorination Agent: Sodium Thiosulfate

The dechlorination process utilizes sodium thiosulfate to neutralize chlorine in treated water. Here's the procedure:

1. After allowing the chlorine to contact the water for 15 minutes, collect a 100 ml sample from the treated batch.
2. To this sample, add the following reagents:
   – 2 ml of hydrochloric acid (diluted at a ratio of 1:5)
   – 2 ml of a 5% potassium iodide solution
   – 1 ml of a 1% starch solution
3. Gradually titrate the sample with a 1% sodium thiosulfate solution, adding it dropwise until the blue color fades completely, indicating the endpoint of decolorization.
4. Record the volume of sodium thiosulfate used in milliliters and convert this measurement into milligrams of the dry substance for your calculations.

Example: Suppose 0,5 ml of 1% sodium thiosulfate solution was used to dechlorinate 100 ml of water**.** Since 1 ml of 1% solution contains 10 mg of sodium thiosulfate, then 0,5 ml contains: To calculate the amount needed for **1 liter** (1000 ml) of water:

Determination of Residual Chlorine in Tap Water

To determine the concentration of residual chlorine in tap water, proceed as follows. Measure **250 ml of the water sample** into a flask.

Add **10 ml of buffer solution** with pH 4,6/. Add a **10% potassium iodide (KI) solution**, then **mix thoroughly**. Titrate with **0,005 N sodium thiosulfate solution** until the solution turns **pale yellow**. Add **1,0 ml of 1,0% starch**

solution, which results in a **blue coloration**. Continue titrating with the thiosulfate solution **until the solution becomes colorless**.

To calculate the amount of **residual chlorine (X)** in **mg/L (or dcm³)**, use the following formula:

X = n*K*0,177*1000/V dm/m³

Where:

X = residual chlorine concentration in mg/L (dcm³),

n = volume (in ml) of sodium thiosulfate used in titration,

K = correction factor for sodium thiosulfate normality,

0,177 = constant conversion factor for active chlorine (mg per ml of titrant),

V = volume of water sample used for the analysis (in ml, here: 250).

Task 1. Water sample **taken from** Lake A **exhibits a** mild grassy odor**.** Question: **What is the expected level of** oxidizability**?**

Task 2. **The water has** good organoleptic properties**, and measured** oxidizability is 4 mg/L**.** Question: **What is the probable source of this water sample?**

Task 3. A routine inspection of a water treatment plant showed that the water undergoes coagulation, sedimentation, filtration, and chlorination. Laboratory results revealed: Temperature: 10°C. Transparency: >30 cm. Odor: 0 points. Taste: 0 points. Color: 20°. Hardness: 7 mg-eq/L. Dry residue: 250 mg/L. Sulfates: 150 mg/L. Chlorides: 60 mg/L. Fluoride: 1,8 mg/L. Coli-index: 2. Residual chlorine: 0,8 mg/L. Question: Do these results comply with the sanitary standards of GOST "Drinking Water"**?** What preventive recommendations can be given?

Task 4. Analysis of surface water from an open reservoir**.** Odor: 3 points. Taste: 3 points. Color: 20°. Transparency: 20 cm. Temperature: 18°C. Question: Can this water body be used for centralized water supply**?**

Task 5. Sanitary analysis of a water body shows. Odor: 2 points. Taste: 3 points. Color: 20°. Question: Are these data sufficient to give a hygienic assessment of the organoleptic and physical properties of this water source?

QUESTIONS FOR SELF-ASSESSMENT:

1. The Role of Water in Human Life; the Concept of Centralized and Decentralized Water Supply.
2. Issues of Water Supply in Uzbekistan; the Concept of Drinking Water Standards.
3. Hygienic Characteristics of Water Supply Sources; Selection of Water Supply Sources.
4. Requirements for Drinking Water – “Potable Water.”
5. Methods for Improving Drinking Water Quality.

PART III.

NUTRITION HYGIENE

Nutrition hygiene, based on the principles of food safety and balanced nutrition, is a key factor in preserving and improving public health. One of the principles of healthy nutrition is ensuring that food intake matches the body's energy expenditure.

ENERGY BALANCE AND CALCULATION OF THE BODY'S ENERGY EXPENDITURE

Food is the primary source of energy for the human body. This process is regulated by a complex system involving physiological mechanisms such as digestion, nutrient absorption, and cellular metabolism. The energy derived from food is primarily used to maintain physiological functions, including the work of the nervous, cardiovascular, respiratory, digestive, and excretory systems. At rest, 60% of energy is consumed by the heart, brain, kidneys, and liver, which account for only about 5% of total body mass. In a healthy individual, the energy produced from food and the total energy expended on daily activities are balanced, meaning the «energy balance is in equilibrium». There are also «negative and positive» energy balances. Insufficient intake of essential nutrients to compensate for the body's energy expenditure can lead to a «negative energy balance». In this case, the body uses internal energy reserves (fat stores, glycogen, etc.). Depletion of these reserves forces the body to break down its own muscle proteins and organ tissues, potentially leading to protein-energy malnutrition. For example, *kwashiorkor*, a severe form of malnutrition in children, results from protein deficiency and is characterized by low body weight, developmental delays, edema, anemia, diarrhea, and skin pigmentation changes.

A prolonged *positive energy balance*, where caloric intake exceeds expenditure, leads to fat accu mulation. Without adequate physical activity, this can result in overweight, obesity, atherosclerosis, hypertension, and coronary heart disease.

A prolonged excess of dietary energy intake relative to the body's energy expenditure leads to a positive energy balance. During this period, the body accumulates adipose tissue, which, when coupled with insufficient physical activity, results in the development of excess body weight and nutrition-related diseases such as obesity, atherosclerosis, hypertension, and ischemic heart disease—i.e., non-specific diseases.

What influences the adequacy of energy derived from food to meet the body's needs? An individual's energy requirements are shaped by the relationship between their caloric intake and the calories they burn. To evaluate this balance, several factors come into play: maintaining good health, having a suitable body weight for one’s height, and engaging in enough physical activity to support both daily functioning and participation in meaningful social interactions. Daily energy expenditure is made up of three key elements: the basal metabolic rate (BMR), the specific dynamic action of food (SDA), and the energy used during various physical activities.

Energy expenditures associated with BMR and SDA are referred to as non-regulated energy expenditures, whereas expenditures for work, study, household chores, sports, and other forms of activity are classified as regulated energy expenditures. Basal metabolic rate (BMR) refers to the energy metabolism required to maintain normal physiological functions under standard conditions.

Standard conditions include complete physical and mental rest following a night's sleep, the absence of food intake for the preceding 12–16 hours, and a comfortable ambient temperature of 18–20°C. BMR is determined by the balance between anabolic and catabolic processes in the human body. It is higher in children than in adults, and on average, 10% higher in men compared to women. In elderly individuals, basal metabolic rate decreases.

Basal metabolic rate (BMR) in an individual is not a fixed constant and may vary depending on the season, climate, increase or decrease in muscle mass, and total body weight. Under the influence of low ambient temperatures,

an individual's BMR increases, while under high temperatures it decreases. Body composition significantly affects the BMR value. At the same body weight, a person with well-developed musculature has a higher BMR than an obese person. Under conditions of starvation or a drastic reduction in food intake, the supply of nutrients to the body decreases. In response to the deficiency of nutrients and energy, adaptive reactions occur in the body, resulting in a reduction of BMR by up to 40% of the expected level. Significant changes in basal metabolism also occur during pathological processes in the body. As a rule, diseases such as tuberculosis, typhoid fever, malaria, and Basedow's disease (Graves' disease) are accompanied by an elevated BMR, whereas in myxedema, BMR is decreased.

The increase in energy metabolism during food intake is referred to as the thermogenic effect or the «specific dynamic action of food» (SDA). This energy is expended by the body for the propulsion of food mass through the gastrointestinal tract, digestion, absorption, transportation of nutrients within the body, cellular metabolism, and other processes.

Proteins have the highest specific dynamic action—up to 30%, followed by carbohydrates at 8.9%, and fats at 2.8%. When a mixed diet is consumed, SDA is equivalent to **10–15% of basal metabolic rate**.

Human energy expenditure during physical activity

The energy expenditure of the human body depends on the nature of the activity, work regimen, physical efforts involved in tasks performed outside of occupational or academic duties, and the way leisure time is spent.

Scientific research has determined the **average energy expenditures** associated with various human activities, some of which are presented in Table 9**.**

Methods for measuring human energy expenditure.

There are various methodological approaches for measuring human energy expenditure.

Table 9.

Energy expenditure for various types of activity (including BMR), in kcal per minute per 1 kg of body weight

Type of Activity	Energy Expenditure (kcal/min/kg)
Eating while seated	0.0236
Dressing and undressing	0.0281
Conversation while seated	0.0525
Conversation while standing	0.2670
Household chores	0.0530
Sweeping the floor	0.0402
Gymnastics	0.0845
Running at 150 m/min	0.1780
Cycling	0.1142
Laboratory work while standing (practical tasks)	0.0360
Laboratory work while seated	0.0250
Surgeon’s work (during surgery)	0.0360
Concrete worker's job	0.0955
Masonry work	0.0952
Agricultural machinery repair	0.0533
Carpenter's work	0.0571
Textile worker's job	0.0460
Chemical operator's work	0.0504

Direct calorimetry method. This method records the heat emitted by the body. Heat loss due to radiation and convection accounts for nearly 80% of total

heat loss, with the remainder attributed to evaporative heat loss. Various calorimeters are used to account for energy expenditure.

Modern calorimeters have been developed, such as specialized equipment like ***Sensewear***, which is equipped with heat production sensors, temperature sensors, and other indicators that determine physiological parameters related to energy expenditure.

Indirect calorimetry method. This approach involves assessing the levels of oxygen and carbon dioxide present in the air we breathe out. The precision of this technique largely relies on how the exhaled air is gathered. A range of devices can be utilized for this collection process. The analysis of the gas composition in the exhaled air is conducted with the help of a gas analyzer.

Doubly labeled water method (using $2H_218O$). This method involves the use of water labeled with stable isotopes $2H_218O$ Energy expenditure is determined by the rate of elimination of labeled water from the body.

The principle of the method is as follows: [18O] is eliminated from the body not only with water but also with exhaled CO_2, whereas deuterium [2H] is eliminated solely in the form of water. The difference in the elimination rates of labeled hydrogen and labeled oxygen reflects the rate of CO_2 production, which directly correlates with energy expenditure. Typically, the daily energy expenditure is measured via oral administration of labeled water. Any physiological fluid can be used for isotope analysis, including plasma, saliva, urine, moisture in exhaled air, etc.

Tabular-Time Tracking Method. This method calculates energy expenditure based on real-time time-tracking (chronometry) of an individual's activities using special reference tables (see Table 9).

Chronometry is conducted in real time by recording each type of activity and its duration minute by minute. This allows calculation of energy expenditure for specific activities as well as for the total daily energy expenditure. The method has an error margin of 10–15%.

Method for estimating energy expenditure based on heart rate

In this method, after recording heart rate during specific work operations or tasks across several attempts, an empirical formula is used to calculate energy expenditure based on heart rate. For example:

$$\mathbf{Q = 2{,}09*(0{,}2*HR - 11{,}3)*t}$$

Where:

Q – energy expenditure (kJ),
t – time (min) spent on a specific task,
HR – heart rate (beats/min) during the activity.

This method is simple to implement. However, it contains possible inaccuracies due to individual differences in heart rhythm.

Estimated Energy Expenditure Method (Harris-Benedict Equation). Theestimated methodof determining energy expenditure allows for an approximate calculation of daily energy consumption usingHarris-Benedict tables**.** This method provides generalized estimates and is easy to apply.

Practical Work*:* Determining Basal Metabolic Rate (BMR) Using Tables and Formulas. Specialized tables for determining basal metabolic rate make it possible to define the average BMR of an individual based on height, age, and body weight (note: the values in the table do not account for dietary habits or climate-specific metabolic variations).

Required materials:

- Stadiometer (height meter),
- Medical scale,
- Tables for determining basal metabolic rate.

The daily basal metabolic rate is calculated as the sum of two values, both of which are found in the corresponding tables:

From Table A – determine the first value according to height and age.

From Table B – determine the second value according to body weight.

The final BMR value is the sum of these two components.

Table A

Basal metabolic rate (kcal/day) depending on height, age, and sex

Women

Height (cm)	Age (years)								
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
100	180	—	—	—	—	—	—	—	—
110	280	—	—	—	—	—	—	—	—
120	600	380	—	—	—	—	—	—	—
130	725	480	—	—	—	—	—	—	—
140	855	580	516	—	—	—	—	—	—
150	958	680	618	582	514	480	431	345	150
160	1040	780	684	632	598	564	530	463	198
165	1095	815	714	657	623	589	555	488	215
170	1150	850	744	682	648	614	580	513	232
175	875	774	707	673	639	605	571	488	249
180	900	804	732	698	664	630	563	500	266

Men

Height (cm)	Age (years)								
	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
100	38	5	—	—	—	—	—	—	—
110	88	45	—	—	—	—	—	—	—
120	133	80	—	—	—	—	—	—	—
130	177	125	—	—	—	—	—	—	—
140	219	165	150	—	—	—	—	—	—
150	259	204	180	161	138	113	99	44	—
160	298	242	209	179	155	130	116	61	—
165	316	256	222	190	166	141	127	71	—
170	335	270	235	201	177	152	138	81	—
175	296	247	207	181	157	132	118	63	—
180	313	259	216	193	169				

Table B.

Basal metabolism (kcal/twenty-four hours) depending on body weight (kg) and sex

Body Weight	Men	Women	Body Weight	Men	Women
3	107	683	35	548	990
4	121	693	40	617	1038
5	135	702	45	685	1085
6	148	712	50	754	1133
7	162	721	55	823	1181
8	176	731	60	892	1229
9	190	741	65	960	1277
10	203	751	70	1029	1325
15	272	798	75	1098	1372
20	341	846	80	1167	1420
25	410	894	85	1235	1468
30	479	942	90	1304	1516

Commented [a1]:

Example of problem solving: Estimate the value of basal metabolic rate (BMR) for a 20-year-old girl with a height of 160 cm and a weight of 55 kg.

Solution:

1. Determine the normative values of basal metabolism using the tables:
   - First value (based on height/age**):** 684
   - Second value (based on body weight): 1181
2. Calculate the normative basal metabolic rate:

   BMR=684+1181=1865 kcal/ twenty-four hours BMR = 684 + 1181 = 1865 kcal/ twenty-four hours

Conclusion: The basal metabolic rate of the girl is 1865 kcal/ twenty-four hours

Task 1: Calculate your own basal metabolic rate using the tables provided.

In addition to the tables, the Harris-Benedict formulas can be used, which apply linear regression relationships to estimate the BMR:

For men:

BMR=66+13.7xBW(kg)+5xH(cm)−6.8xA(years)

For women:

BMR=655+9.5xBW(kg)+1.8xH(cm)−4.7xA(years)

Where: BMR – Basal Metabolic Rate (kcal/ twenty-four hours), **BW** – Actual body weight (kg), **H** – Height (cm), **A** – Age (years)

Task 2: Determine your basal metabolic rate (BMR) by applying the Harris-Benedict equation. Additionally, to gauge the energy expenditure associated with physical activities, Physical Activity Coefficients (PAC) come into play. This coefficient reflects how many times the energy consumed during a particular activity surpasses the basal metabolic rate. For instance, if the overall energy expenditure for various activities is double the BMR for a given age and sex category, the PAC would be 2. Essentially, as energy expenditure increases, so does the PAC.

Based on the Physical Activity Coefficient (PAC), which takes into account the intensity and demands of work, the working-age population is classified into five categories for men and four for women, depending on their occupations. (see Table 10).

Example calculation

Condition: Turner K. Bakhodirov, 35 years old, works at a metalworking plant. His height is 175 cm, and his body weight is 70 kg. Determine the daily energy expenditure of the turner.

Table 10

Coefficients of Physical Activity Depending on the Labor Intensity

Group	Labor Intensity Level (Men and Women)	Types of Occupations	CPA*
I	Very light	Workers engaged primarily in mental labor: teachers, students of humanities specialties, research workers, office employees, computer operators, controllers, dispatchers, control panel operators, librarians, architects, engineers, dealers, brokers, museum workers, designers, tax service employees	1.4
II	Light	Workers engaged in light physical labor: conveyor workers, urban transport drivers,	1.6

Group	Labor Intensity Level (Men and Women)	Types of Occupations	CPA*
		seamstresses, packers, nurses, industrial goods salespeople, service sector employees, communication workers, customs inspectors, tour guides, photographers	
III	Medium	Workers engaged in medium-intensity labor: machinists, locksmiths, adjusters, drillers, bulldozer drivers, excavator operators, railway workers, paramedics, surgeons, gardeners, crop growers, greenhouse farm workers	1.9
IV	High	Workers engaged in heavy physical labor: carpenters, foundry workers, metallurgists, construction laborers, tunnelers, forestry workers, hunters, and agricultural workers	2.2
V	Very high (men only)	Workers engaged in especially heavy physical labor: loaders, concrete workers, earth movers, forest fellers, miners, rescue workers, divers, masons, high-level athletes during training periods, reindeer herders	2.5

Solution:

1. Determine the turner's daily basal metabolic rate:
BMR=66+13,7xBW(кг)+5xH(см)-6,8*A(years). = 66+13,7*70+5*175-6,8*35 BMR =1662 kcal/ twenty-four hours

2. Find the physical activity coefficient for this occupational group using Table No. 10:

PAC for turners (Category III labor) = 1.9

3. We establish the energy consumption of a machine operator per twenty-four hours

E=1662* 1,9 = 3157,8 kcal/ twenty-four hours.

Conclusion: the machine operator's daily energy expenditure was 3157.8 kcal.

Example calculation

Subject: Male, 42 years old, emergency room physician, body weight 70 kg, height 175 cm.

Objective: Calculate the daily energy expenditure using the calculation-table method.
Solution: Determine the basal metabolic rate using the formula:
BMR=66+13.7xBW(kg)+5xH(cm)−6.8xA(years)
=66+13.7x70+5x175−6.8x42=1662 kcal/ twenty-four hours.

We determine the value of the Physical Activity Coefficient (PAC) based on the table (Category III labor), which equals **1.9** (see Table 10).

We proceed to calculate the daily energy expenditure: **E = 1662 × 1.9 = 3157.8 kcal/day**.
Conclusion: The daily energy expenditure of an emergency physician amounts to **3157.8 kcal**.

Task 3. Fill in the missing numbers in the diagram and calculate daienergy expenditure.

Diagram for calculating daily energy expenditure:

Type of Activity	**Duration, hrs**	**PAC**	**PAC x Time**	**Time x PAC x BMR (72.9 kcal/hr)**
Sleep	8	1.0	8.0	583 kcal
Morning jog	0.5	6.6	3.3	241 kcal
Walking	1	3.4	3.4	248 kcal
Studying	6	1.4	8.4	
Laboratory work	2	1.5	3.0	**219 kcal**
Work at the dormitory	1.5	2.7	4.05	
Class preparation	3	1.2	3.6	262 kcal
Rest	2	12	2.4	175 kcal
	24	1.51	36.15	

PAC — Physical Activity Coefficient

MR — Basal Metabolic Rate (used here: 72.9 kcal/hour)

Task 4. Maryam Kosimova attends a ballet studio. To achieve the appropriate physical condition, she needs to normalize her body weight**.** With a height of 165 cm, her body weight is currently 74 kg. The "ideal" body weight for this height is 58 kg**.** Determine her actual daily energy expenditure and the energy expenditure at the "ideal" body weight.

Task 5. Calculate your own daily energy expenditure during study at the institute, following the given example.

Calculation of energy expenditure based on heart rate (HR)

Formula for calculation:

$Q=2.09\times(0.2\times HR-11.3)\times t$

Where:

- **Q** — energy expenditure (kJ/min)
- **HR** — heart rate per minute
- **t** — time spent on a particular activity (in minutes)

Example: Time spent in class: $45\times8=360$ min

$Q=2.09\times(0.2\times65-11.3)\times360=1279.08$ kJ

Since **4.19 J = 1 cal**, then: 1279.08 kJ÷4.19 J=305.2 kcal

Thus, energy expenditure during study at the institute = **305.2 kcal**

SELF-ASSESSMENT QUESTIONS

1. What are the main components of the body's energy expenditure?
2. What is basal metabolic rate (BMR)? What factors influence its magnitude?
3. Which components of energy expenditure can a person influence independently?
4. What is the Physical Activity Coefficient (PAC)?
5. What is the algorithm for calculating a person's daily energy expenditure?

HYGIENIC ASSESSMENT OF THE ADEQUACY OF INDIVIDUAL NUTRITION

One of the most important responsibilities of a general practitioner is to promote the development of rational nutrition habits among the population. Nutrition plays a crucial role in determining our overall health. It is deemed adequate when it not only fulfills the body's physiological requirements based on factors like age, gender, and occupation but also enhances work performance, boosts resilience against environmental stressors, supports a long active life, and contributes to longevity.

To achieve rational nutrition, several hygienic guidelines should be followed:

1. The daily intake must satisfy the body's nutritional and energy needs, tailored to individual factors such as gender, age, and job type. For women, considerations like pregnancy and lactation are also essential.

2. Nutrients should be consumed in balanced proportions. Generally, the ideal ratio of primary nutrients—proteins, fats, and carbohydrates—should be approximately 1:1:4.

3. Meals should be evenly spaced throughout the day, adhering to a consistent eating schedule.

4. A varied selection of foods should be included in the daily menu, emphasizing seasonal fruits and vegetables.

5. When choosing foods, it's important to take into account the body's enzymatic functions as well as cultural dietary practices.

6. Incorporating high-quality and safe food products is vital to ensure that nutrition is both beneficial and secure.

Theoretical hypotheses and experimental studies conducted in the 1990s under the guidance of A.M. Ugolev, and published in the work ***"The Theory of Adequate Nutrition and Trophology"*** (1991), laid the foundation for the modern theory of adequate nutrition.

Fundamental postulates of the theory of adequate nutrition

1. Nutrition maintains the molecular composition and compensates for the energy and plastic expenditures of the organism through basal metabolic substances, external work, and growth.
(This postulate is the only one common to the theories of balanced and adequate nutrition.)

2. Normal nutrition is determined not by a single stream of nutrients from the gastrointestinal tract into the internal environment of the body, but by several streams of nutritional and regulatory substances, which have vital significance.

3. The essential components of food are not only nutrients but also ballast substances (non-nutritive dietary fiber and others).

4. There exists a host-endosymbiont system formed by the intestinal microbiota, with which the host organism maintains complex symbiotic relationships, including nutritional and, to some extent, environmental**.**

5. The balance of nutrients in the body is achieved as a result of the breakdown of nutritional substances from food structures through enzymatic hydrolysis into macromolecules and, in some cases, via intracellular (primary nutrients) digestion, as well as through the synthesis of new substances, including

microbial.
(The intestinal microflora synthesizes essential nutrients. The relative roles of primary and secondary nutrients vary significantly.)

Assessment of the Adequacy of an Individual's Nutrition. The evaluation of nutritional adequacy is conducted after determining an individual's nutritional status. Nutritional status is a complex of clinical, anthropometric, and laboratory indicators that characterize the state of health and physical development, as well as the organism's provision with energy, nutrients, and biologically active substances.

A straightforward approach to evaluating nutritional adequacy involves tracking body weight fluctuations over time. If an individual's weight remains relatively constant for an extended period while maintaining a steady daily food intake, it suggests that their diet is likely sufficient.

To ascertain whether dietary intake meets the body's requirements for essential nutrients, laboratory tests can be conducted. These tests analyze the levels of proteins, fats, carbohydrates, vitamins, and mineral salts in the foods consumed.

Another method for assessing dietary quality is to examine the qualitative composition and caloric content of the diet using food composition databases. This approach necessitates a comprehensive list of all foods included in the daily menu (essentially a sample meal plan). Although this method may lack the precision of laboratory testing, it is more accessible and commonly utilized.

When evaluating actual dietary intake, it is crucial to refer to the officially recognized "Recommended Physiological Requirements for Nutrients and Energy" guidelines (SanPiN).

In summary, assessing an individual's dietary adequacy involves several steps:

1. Gathering information on the types of foods consumed throughout the week and calculating the average daily composition and quantity.
2. Creating a detailed breakdown of food items, including calculations of nutrient content and caloric value for the daily diet.
3. Comparing these findings against established physiological dietary standards.

To evaluate the rational distribution of food intake throughout the day, account for seasonal variations, national dietary traditions, etc., a weekly analysis of actual nutrition quality is recommended. For this purpose, a sample menu breakdown is prepared in accordance with a standardized form (see Table 11).

Using food composition reference tables, the content of nutrients and the energy value of each ingredient are determined.

Table 11

Dish breakdown: "rice porridge" (breakfast)

DisName	Product Name	Quantity (g)	Proteins (g)	Fats (g)	Carbohydrates (g)	Caloric Value (kcal)
Rice Porridge	Milk	200	3.8	6.4	6.3	100.9
	Rice	30	–	0.5	19.2	83.4
	Sugar	10	–	–	9.0	36.9
	Butter (unsalted)	5	–	4.1	0.2	39.0

The total amount of nutrients consumed during the day, the total caloric value of the daily diet, and its distribution across individual meals are then calculated (Table 12).

Table 12

Distribution of the energy value of the daily diet by individual meals (as a percentage of total caloric content)

Meal	Daily Energy Value	
	3-Meal Diet	4-Meal Diet
First Breakfast	30%	20-30
Second Breakfast	—	10-15
Lunch	45–30%	40-50
Dinner	20–25%	15-20

Assessment of the Nutrient Balance and Composition of the Diet. The protein:fat:carbohydrate (P:F:C) ratio is determined. The variety of foods and meals enjoyed is evaluated by considering factors such as seasonal availability, food compatibility, and digestibility. Nutritional guidelines are tailored to different segments of the population, taking into account aspects like occupation, age, and gender.

For the adult workforce, individuals are categorized into five groups based on their physical activity levels (refer to Table 13). In the case of children and adolescents, dietary norms are defined for nine distinct age brackets, with gender distinctions becoming relevant starting at age 10. Additionally, there are targeted dietary suggestions for pregnant and breastfeeding women.

The current standards include recommended values for energy needs, essential nutrients, vitamins, and minerals for each demographic group.

Concept of menu layouts. caloric and nutrient composition calculations using tables

A nutritional regimen implies a proper and even distribution of nutrients throughout the day. This is achieved through the preparation of a menu-layout.

Menu-plan (Menu-rascladka) — A menu plan, also known as a menu breakdown, is essentially a detailed list of dishes along with the specific weights of ingredients needed for each recipe. This breakdown ensures that each dish meets the required levels of macro- and micronutrients as outlined by dietary guidelines.

Menu plans can be created for various timeframes—whether it's for a single day, a week, a month, or even a season. They serve as essential documents for organizing and managing the nutritional quality and quantity of meals provided to groups. To determine the caloric and nutritional values, references such as "Tables of Chemical Composition and Caloric Value of Foods" by I.M. Skurikhin.Calculation Algorithm.

List the ingredients used to prepare each dish.Calculate the amount of proteins, fats, carbohydrates, and calories in each ingredient.Sum the values to determine the total caloric value of the dish.If the meal consists of multiple dishes, perform the calculation for each and sum the results.Determine the caloric content for breakfast, lunch, afternoon snack, dinner, and the total daily intake.

The calculated caloric value needs to be assessed against the daily energy expenditure of the specific population group in question. This comparison allows for an evaluation of whether the diet sufficiently fulfills energy needs. This approach is commonly employed for regular nutritional monitoring in structured environments like hospitals, healthcare facilities, childcare centers, and military organizations. To account for potential inaccuracies, periodic laboratory testing is performed, and the findings are compared to the calculated figures. An acceptable variance is typically within ±10%.

When designing the diet, it is recommended that. Proteins make up at least 14%, fats — 30%, and carbohydrates — no more than 56% of the total caloric intake (*these percentages vary with the degree of labor intensity*). For individuals engaged in light labor, the P:F:C ratio should approximate 1:1:4.

Nutrition of children and adolescents

The physiology of children differs significantly from that of adults. It is characterized by: Rapid development and growth, High rates of oxidation-reduction processes, A positive nitrogen balance, andIncreased energy expenditure.

To ensure proper metabolism, the body must continuously receive nutrients of specific quantity and quality. Not meeting these essential conditions can result in stunted growth and developmental challenges for children, along with an increased risk of various health issues. Children have a basal metabolic rate that is significantly higher than that of adults, ranging from 1.2 to 2 times greater. Their daily caloric needs fluctuate with age: for those aged 1 to 2 years, it's approximately 100 to 90 kcal per kilogram of body weight; for ages 2 to 5

years, it decreases to about 90 to 80 kcal per kilogram; and for children aged 6 to 9 years, the requirement is around 80 to 70 kcal per kilogram. From age 10 onward, energy needs begin to diverge between boys and girls (see Table 14 for details).

Table 13

Recommended Daily Intake of Energy and Essential Nutrients for Various Population Groups

Labor Intensity Groups	Age Groups	Men						Women						
		Energy		Proteins (g)		Fats (g) kJ	Carbo-hydra-tes (g) kcal	Energy		Proteins (g)		Fats (g) kJ	Carbo-hydra-tes (g) kcal	
		kJ	kcal	All	Incl animal			kJ	kcal	All	Incl animal			
Group I	18–29	11,72	2800	91	50	103	378	10,04	2400	78	43	88	324	
	30–39	11,30	2700	88	48	99	365	9,62	2300	75	41	84	310	
	40–59	10,67	2550	83	46	93	344	9,20	2200	72	40	81	297	
Group II	18–29	12,55	3000	90	49	110	412	10,67	2550	77	42	93	351	
	30–39	12,13	2900	87	48	106	399	10,25	2450	74	41	90	337	
	40–59	11,51	2750	82	45	101	378	9,83	2350	70	39	86	323	
Group III	18–29	13,39	3200	96	53	117	440	11,30	2700	81	45	99	371	
	30–39	12,97	3100	93	51	114	426	10,88	2600	78	43	95	358	
	40–59	12,34	2950	88	43	108	406	10,46	2500	75	41	92	344	
Group IV	18–29	15,48	3700	102	56	136	518	13,18	3150	87	48	116	441	
	30–39	15,06	3600	99	54	132	504	12,76	3050	84	46	112	427	
	40–59	14,43	3450	95	52	126	483	12,13	2900	80	44	106	406	
Group V	18–29	17,99	4300	118	65	158	602	–	–	–	–	–	–	
	30–39	17,15	4100	113	62	150	574	–	–	–	–	–	–	
	40–59	16,32	3900	107	59	143	546	–	–	–	–	–	–	

Table 14

Requirements of children and adolescents for energy, essential nutrients, minerals, and vitamins

Requirements	**1–3 years**	**4–6 years**	**7–10 years**	**11–13 years – B**	**11–13 years – G**	**14–17 years – B**	**14–17 years – G**
Energy (kcal)	1540	1970	2350	2750	2500	3000	2600
Proteins (g)	53	68	77	90	82	98	90
Fats (g)	53	68	79	92	84	100	90
Carbohydrates (g)	212	272	335	370	340	400	360
Mineral							
Ca(mg)	800	900	1100	1200	1200	1200	1200
P (mg)	800	1350	1500	1800	1800	1800	1800
Mg (mg)	150	200	250	300	300	300	300
Fe (mg)	10	10	12	15	18	15	18
Vitamin							
C (mg)	45	50	60	70	70	70	70
A (mcg)	450	500	700	1000	800	1000	800
E (mg)	5	7	10	12	12	12	12
D (mcg)	10	2.5	2.5	2.5	2.5	2.5	2.5
B_1 (mg)	0.8	0.9	1.3	1.4	1.3	1.5	1.3
B_2 (mg)	0.9	1.0	1.6	1.8	1.6	1.8	1.6
B_{12} (mcg)	1.0	1.5	2.0	3.0	3.0	3.0	3.0

Children under the age of 3 need about 4 grams of protein for every kilogram of their body weight. This requirement remains the same for those aged 3 to 7 years, but by the time they reach 11, it drops to 2 grams per kilogram. It's essential that at least 60-65% of the protein in children's diets comes from animal sources. Additionally, fats should make up roughly 30% of their total daily energy intake, while carbohydrates should be provided in forms that are easy for them to digest.

During the preschool and early school years, a balanced daily intake of proteins, fats, and carbohydrates is ideally in the ratio of 1:1:3. As children grow older, particularly in their later school years, this ratio adjusts to 1:1:4. When organizing nutrition for children, it is es
under 7 years old. Emphasis should be placed on including dairy products, lean meats, and a wide range of grains, vegetables, and fruits. It's advisable for them to eat at least five meals throughout the day to ensure they receive all the necessary nutrients.

The recommended distribution of daily energy intake is as follows: first breakfast - 25%; second breakfast - 15%; lunch: 25–30%; afternoon snack - 15%; dinner 20–25%.

For school-aged children, a four-meal schedule is recommended: first breakfast 20%; second breakfast 20%; lunch: 35%; dinner 25% of the total daily energy intake.

Nutrition for pregnant women

The dietary needs and nutritional framework for expectant mothers vary based on their stage of pregnancy, lifestyle, height, and weight. During the latter part of the first trimester, a woman's daily energy requirements typically rise by approximately 0.4 to 0.6 MJ (100 to 150 kcal). As the pregnancy progresses into the second trimester, this increase becomes more significant, with daily needs growing by 1.3 to 2.1 MJ (300 to 500 kcal), ultimately reaching around 2900 kcal per day.Nutrition for the elderly

In the nutrition of elderly individuals, it is important to adhere to the following macronutrient ratios**:** Men: 1:1:4.9 (proteins : fats : carbohydrates).Women: 1:1:4.4

It is recommended to limit carbohydrates**,** particularly sugars and **confectionery**, as well as animal fats. The fat requirementshould be met primarily through plant-based fats. The consumption of grains should be increased, as they are a source of essential micronutrients (Mg, Zn, Sr, I), along with vegetables that have anti-sclerotic effects (e.g., cauliflower, green leafy

vegetables, beets, and carrots). Vitamin intake should be enhanced through increased consumption of vegetables.

A four-meal schedule is recommended: First breakfast – 25%; Second breakfast – 15%; Lunch – 35%; Dinner – 25% of the total daily energy intake.

Nutrition for mental workers and students

The daily energy value of the diet for this population group ranges from 2000 to 2400 kcal. The most optimal macronutrient ratio for proteins, fats, and carbohydrates is 1:2.5:4.8. However, for men aged 18–29, a ratio of 1:1.1:4.9 is acceptable, while for women a ratio of 1:1.1:4.7 is considered appropriate.

A four-meal schedule is recommended.

For individuals engaged in intellectual work, the diet must include:

- Anti-sclerotic and lipotropic products,
- Foods rich in vitamins and micronutrients.

Considering the ongoing growth and development of students, along with the significant psycho-emotional stress they face, it is crucial for their diet to include optimal levels and ratios of proteins, fats, and carbohydrates (including sugars and dietary fiber). Additionally, students have heightened requirements for essential vitamins such as A, B-complex, C, and D, as well as various minerals.

For meal planning, both three-meal and four-meal patterns are advisable. In a three-meal plan, the daily caloric distribution is approximately: 30% for breakfast, 45% for lunch, and 25% for dinner. Alternatively, in a four-meal plan, the breakdown is as follows: 25% for breakfast, 15% for a second breakfast, 35% for lunch, and 25% for dinner based on total daily caloric intake**.**

SAMPLE CASE SOLUTION.

An analysis of a menu plan for children aged 7–10 years revealed the following: total energy value of meals: 8110 kJ; total protein: 54.9 g, including 22.6 g of animal protein: total fat: 48.8 g, including 8.2 g of plant-based. Minerals: calcium: 317.5 mg; phosphorus: 1081.5 mg. Vitamins: retinol

(Vitamin A): 0.2 mg; carotene: 0.7 mg; vitamin B_1: 1 mg; vitamin B_2: 0.7 mg; vitamin C: 40 mg

Meal distribution (four meals per day): Breakfast: 33%. Lunch: 33%. Afternoon snack: 12%. Dinner: 22%

Hygienic Evaluation of Nutrition for Children Aged 7–10 Years According to the Menu Plan Energy intake (8110 kJ) is insufficient to meet energy demands, as the physiological norm for this age group **is** 10048 kJ (2400 kcal).

Nutritional quality of the diet**:**

a) Total protein: 54.9 g, which is significantly lower than the recommended 79 g. Particularly insufficient is the animal protein content — only 22.6 g (41%) instead of the required 47 g (60%).

b) Total fat: 48.8 g — also well below the recommended intake of 79 g. The amount of plant fat is almost halved (8.2 g vs. recommended 16 g).

c) Carbohydrates: Slightly reduced — by approximately 16 g.

d) The protein: fat: carbohydrate ratio is 1:0.9:5.7 (54.9:48.8:308), indicating a carbohydrate-dominant diet.

e) There is a severe calcium deficiency (317.5 mg vs. the required 1100 mg) and a phosphorus deficit (1081.5 mg vs. 1650 mg). The calcium-to-phosphorus ratio is 1:3 (317:1081), whereas the optimal ratio is 1:1.5.

f) Vitamin deficiencies are also noted: Vitamin A: retinol 0.2 mg (meets requirement), but carotene only 0.7 mg (vs. 1.5 mg recommended). Vitamin B_1: 1 mg (vs. 1.4 mg required). Vitamin B_2: 0.7 mg (vs. 1.6 mg required). Vitamin C: 40 mg reported, but considering thermal sensitivity during cooking, the actual intake is ~20 mg/day, which is three times lower than the recommended 60 mg/day.

The four-meal approach adheres to hygiene standards, yet the energy allocation among the meals is not well-structured: Breakfast accounts for 33%, Lunch also

33%, the Afternoon snack only 12%, and Dinner 22%. This distribution fails to meet the principles of optimal energy balance.

Conclusion

In summary, children's nutrition is both insufficient and lacking in quality. There is a notable shortfall in essential nutrients, including proteins (particularly high-quality animal proteins), fats, calcium, phosphorus, and vitamins. Furthermore, the diet exhibits nutritional imbalances, such as unfavorable ratios of proteins, fats, and carbohydrates, an inadequate mix of animal and plant proteins, and an imbalance between calcium and phosphorus levels.

To address the identified nutritional gaps, it's advisable to enrich a child's diet with 500 mL of milk and 200 mL of kefir. This addition will contribute approximately 20 grams of animal protein, 25 grams of fat, 840 mg of calcium, 665 mg of phosphorus, and 1817 kJ (434 kcal) of energy. Furthermore, it will enhance the intake of essential nutrients like retinol, thiamine, and riboflavin.

Incorporating these dairy products will significantly improve the overall nutritional balance by optimizing the protein–fat–carbohydrate ratio, enhancing the mix of animal and plant proteins, and crucially, correcting the calcium-to-phosphorus ratio.

To boost vitamin C and carotene levels, adding fresh berries and vegetables—such as blackcurrants, rosehip tea, carrot juice, and green onions—would be beneficial. Additionally, increasing the use of plant oils in meals is recommended. To better regulate meal timing, consider reducing breakfast to about 25% of total daily energy while increasing lunch to encompass 35–40%.

Assignment

Assess the energy value and nutrient composition of the daily diet in relation to standard recommendations.

Determine the energy value of individual meals.

Compare the obtained values with recommended standards and provide a hygienic evaluation.

Evaluate the meal schedule.

5. Recommend Measures to Eliminate Identified Nutritional Deficiencies

Case study 1. Subject**:** 20-year-old trolleybus driver

Dietary intake: Protein: 60 g (including 40 g of animal origin). Fats: 86 g (including 50 g animal fat). Carbohydrates: 500 g (including 300 g from vegetables). Meal frequency: 3 meals per day. Interval between breakfast and lunch: 7 hours. Interval between lunch and dinner: 5 hours. Meal duration: breakfast: 10 minutes, lunch: 25 minutes, dinner: 15 minutes. Caloric distribution: breakfast: 20%, lunch: 50%, dinner: 30% of the total daily energy intake

Case study 2. Subject**:** Physician

Daily intake: protein: 60 g (including 40 g of animal origin); fats: 86 g;(including 50 g animal fat), carbohydrates: 500 g.

Meal frequency: 3 meals per day. Interval between breakfast and lunch: 4 hours. Interval between lunch and dinner: 5 hours. Meal duration: breakfast: 10 minutes, unch: 25 minutes, dinner: 15 minutes.

Caloric distribution: breakfast: 20%, lunch: 35%, dinner: 45%

Case Study 3. Subject**:** Student

Daily intake: protein: 80 g (including 40 g of animal origin), fats: 90 g (including 50 g animal fat), carbohydrates: 500 g.

Meal frequency: 3 meals per day. Interval between breakfast and lunch: 5 hours. Interval between lunch and dinner: 5 hours.

Meal duration: breakfast: 10 minutes, lunch: 15 minutes, dinner: 15 minutes

Caloric distribution: breakfast: 25%, lunch: 25%, dinner: 50% of total daily energy intake

Case Study 4. Subject**:** women paramedic

Daily intake: protein: 120 g (including 60 g of animal origin), fats: 90 g (including 60 g animal fat), carbohydrates: 300 g, meal frequency: 3 meals per

day, interval between breakfast and lunch: 5 hours, interval between lunch and dinner: 5 hours.

Meal duration: breakfast: 10 minutes, lunch: 15 minutes, dinner: 15 minutes

Caloric distribution: breakfast: 35%, lunch: 25%, dinner: 40% of total daily energy intake.

SELF-ASSESSMENT QUESTIONS

1. What hygienic requirements are imposed on rational nutrition?
2. What hygienic requirements are imposed on adequate nutrition?
3. What are the stages involved in evaluating the compliance of an individual's diet with physiological standards?
4. What is the structure and what are the rules for compiling a menu-layout? What is its significance?
5. What are the differences in the construction of rational nutrition for children, pregnant women, students, and elderly individuals?

VITAMINS. STUDY AND ASSESSMENT OF THE VITAMIN CONTENT OF FOOD PRODUCTS

Vitamins are one of the most essential components of adequate human nutrition. Although they are present in small amounts in our diets, these nutrients are essential and largely need to be obtained from food sources. While certain vitamins can be partially produced within the human body, this synthesis mainly occurs in the intestines and relies on the presence of healthy intestinal microflora.

Water-Soluble Vitamins

The category of water-soluble vitamins encompasses vitamins C, B_1, B_2, B_6, B_{12}, PP, along with biotin, folic acid, and pantothenic acid.

Vegetables and fruits serve as the primary sources of these essential nutrients. A deficiency in vitamin intake or production within the body is termed

hypovitaminosis, while a severe lack of necessary vitamins is known as avitaminosis.

The requirements for vitamins in humans are influenced by various factors, including the nature of one’s work, the climatic region, physiological conditions, overall health, environmental factors, and more.

Each vitamin has distinct roles within the body. For instance, vitamin C acts as a potent antioxidant and is crucial for regulating redox processes. The availability of ascorbic acid affects capillary strength and the efficiency of the body's defense mechanisms against environmental stressors and infections.

The demand for vitamin C can fluctuate based on work type, age, and physiological conditions. A healthy individual engaged in moderately intense activities typically requires a minimum of 70 mg of vitamin C daily. Large amounts of vitamin C are found in blackcurrants, citrus fruits, gooseberries, and tart apple varieties. It is also widely present in vegetables such as cauliflower, potatoes, green peas, etc. Ascorbic acid is easily destroyed upon exposure to air, heating, alkaline environments, and in the presence of heavy metal salts. Given, on the one hand, the high importance of vitamin C for the body and, on the other, its significant instability during culinary processing, there is a need for systematic laboratory control over both the body's provision with ascorbic acid and the actual content of vitamin C in the diet of organized population groups, including in preschool and school educational institutions, hospitals, and healthcare facilities.

Methods for assessing vitamin c status in the body

***1. Determination of vitamin c excretion in urine*.** Being water-soluble, vitamin C does not accumulate in the body, and its excess is excreted daily in urine. It is considered that an excretion rate of at least 0.7–1 mg/hour indicates sufficient vitamin C status. For analysis, the second morning portion of urine is collected, noting the time (in hours) from the first urination to the time of sample collection.

The procedure is as follows: measure the total volume of the collected urine sample, then place 2 ml of urine in a conical flask, add 5 ml of 5% acetic acid, and titrate with a 0.001 N solution of Tillmans' reagent (2,6-dichlorophenolindophenolate sodium salt) until a faint pink color appears and persists for 1 minute. A control sample is prepared simultaneously using 2 ml of distilled water instead of urine.

The calculation of hourly vitamin C excretion is performed using the formula:

$$\mathbf{X = (A - B) \times K \times 0.088 \times V / t \times 2\ (mg/hour)}$$

Where:

A = amount of Tillmans' reagent used to titrate the urine sample (ml)
B = amount of reagent used for the control sample (ml)
K = correction factor for the reagent (determined in advance by titrating a solution containing 0.088 mg of ascorbic acid per ml)
0.088 = constant (1 ml of 0.001 N Tillmans' reagent corresponds to 0.088 mg of ascorbic acid)
V = total urine volume (ml)
t = time (hours) between the first urination and sample collection

2. Determination of skin capillary resistance (Nesterov Test). This procedure entails the application of gentle negative pressure (-0.4 kg/cm²) to the inner surface of the forearm for a duration of 3 minutes, utilizing a Nesterov apparatus. Once the cuvette is detached, the petechiae that appear on the skin are counted.

To carry out the test, begin by applying a layer of petroleum jelly to the skin. Next, attach the cuvette from the Nesterov apparatus using a short rubber hose

and secure it with a clamp. Using a syringe, extract 20 ml of air from the cuvette, then clamp the hose and start the timer. After three minutes have elapsed, release the clamp on the hose, cleanse the area with alcohol, and proceed to count the petechiae, either with a magnifying glass or by observing them directly.

Assessment criteria.

- **Normal:** 0–10 petechiae
- **1st degree hypovitaminosis C:** 10–30 petechiae
- **2nd degree hypovitaminosis C:** 30–60 petechiae
- **3rd degree hypovitaminosis C (bordering on avitaminosis):** >60 petechiae

3. Determination of vitamin c by titration with tillmans' reagent

This method is based on a redox reaction between ascorbic acid and Tillmans' reagent (indicator: sodium dichlorophenolindophenolate). As a strong reducing agent, ascorbic acid is oxidized to dehydroascorbic acid, reducing the reagent in the process.

Tillmans' reagent is intensely blue in neutral or alkaline media and red in acidic medium. Upon reduction by ascorbic acid, the reagent is decolorized to its leuco form. The endpoint of titration is the appearance of a pale pink color, indicating that all ascorbic acid has reacted. Any excess reagent in acidic conditions imparts a red color to the solution.

4. Determination of vitamin c in raw and cooked vegetables and vegetable-based dishes

To begin, take a 10 g portion of a vegetable sample or prepared dish and place it in a porcelain mortar. Add a small amount of clean quartz sand and grind the mixture thoroughly. Gradually incorporate 50 ml of 2% hydrochloric acid and allow the blend to sit for 10 minutes. Afterward, transfer the mixture to a graduated cylinder and dilute it with water to reach a final volume of 100 ml. Ensure the solution is well mixed and then filter it through gauze or cotton into a 100 ml flask.

Next, take 5 ml of the filtered solution and dilute it with water to a total volume of 15 ml. Use a microburette to titrate this solution with Tillmans' reagent until you observe a pale pink hue that remains for at least one minute.Calculation of ascorbic acid content:

$$\mathbf{X = (n \times F \times N \times 100 \times 0.088) / (a \times p)}$$

Where:

- **X** = ascorbic acid content in mg per 100 g of product
- **n** = amount of reagent used for titration (ml)
- **F** = correction factor for reagent titer
- **N** = volume of extracting solution (50 ml HCl + 50 ml water)
- **a** = sample volume for titration (ml)
- **p** = sample weight (g)
- **0.088** = mg of ascorbic acid per 1 ml of reagent

In vegetable dishes, the result is calculated in mg per weight of the entire dish.

Vitamin C content is determined by summing values from both raw and thermally processed ingredients. Losses from cooking may be determined via laboratory or standard tables.

Determination of vitamin c in soups (first courses). Begin by measuring a specific amount of soup. Strain the mixture to separate the solid components from the liquid. Use a graduated cylinder to measure the volume of the liquid, and then determine the mass of the solids by subtracting the liquid volume from the total mass.

Next, assess the vitamin C content in the solid portion using the previously outlined method for vegetables. Report the results based on the total mass of the solid.

For the liquid component, take 10 ml and mix it with 1 ml of 2% hydrochloric acid, then dilute this mixture to a final volume of 15 ml. Perform a titration with Tillmans' reagent until you observe a light pink color that persists. Formula for calculation:

$$\mathbf{X = 0.088 \times n \times F \times M / a}$$

Where:

- **X** = ascorbic acid content in the liquid portion (mg)
- **n** = volume of reagent used (ml)
- **F** = titer correction
- **M** = volume of the liquid part of the soup (ml)
- **a** = volume of sample used for titration (ml)

Sum the values of vitamin C from the solid and liquid portions.

Determination of the Vitamin C Content in Rosehip Infusion

Rosehips are widespread in the region and their dried fruits are a rich source of vitamin C (up to 1500 mg/100 g).

Procedure: Take 5 g of dried rosehip fruits, remove seeds, rinse with cold water, grind in a mortar, and transfer to a flask. Add 200 ml of hot water and boil for 5 minutes. Let the infusion steep in the same vessel for 1 hour. The extent of vitamin C extraction depends on the steeping time and degree of crushing.

Filter the infusion through gauze or cotton. Take 1 ml of the filtrate, add 1 ml of 2% hydrochloric acid, and bring the volume to 15 ml with water. Titrate with Tillmans' reagent. If the solution is deeply colored, dilute 5 times before titration and include a control sample.

Formula for calculation:

$$\mathbf{X = 0.088 \times n \times F \times 1000}$$

Where:

- **X** = vitamin C content in the infusion (mg/L)
- **0.088** = constant (1 ml of reagent = 0.088 mg vitamin C)
- **n** = volume of reagent used (ml)
- **F** = correction factor
- **1000** = conversion factor to express in mg/L

Example. For the titration of 1 ml of rosehip infusion, 4 ml of Tillmans' reagent was used. The calculation is carried out according to the formula:

$$\mathbf{X = 0.088 \times 4 \times 1 \times 1000 = 352\ mg/L}$$

Thus, 100 ml of the given rosehip infusion contains 35 mg of vitamin C**.**

Upon Completion of the vitamin C and P content analysis of products, a report must be compiled indicating*:*

- the vitamin value of the tested raw product compared to reference data from food composition tables (see excerpt from Table 15).
- the vitamin value of the thermally processed product in comparison with the raw product, including the percentage of vitamin loss during cooking**.**
- the vitamin C content of the tested rosehip infusion (in mg/L) and the recommended consumption volume needed to meet the physiological requirement in cases of vitamin C deficiency.

Table 15

Vitamin C and P content in selected foods (per 100 g of product)

Food Name	Vitamin C (mg)	Vitamin P (mg)	Food Name	Vitamin C (mg)	Vitamin P (mg)
Dried rosehip	1200	680	Green onion	35	—
Blackcurrant	200	1000–1500	Potato	20	15–35
Parsley (leaves)	150	157	Carrot	5	50–100
Dill	100	170	Beetroot	10	37–75
Sour cherry	15	1300–2500	Black grape	6	290–430
Gooseberry	30	225–650	Black chokeberry	15	4000
White cabbage	45	10–69	Plum	10	110–300
Cauliflower	70	—	Pomegranate	4	200–700
Sorrel	43	500	Lingonberry	15	320–600

Winter apples	16	10–70	Cranberry	15	240–330
Citrus fruits	40–60	500	Wild Strawberry (Fragaria)	60	180–210
Bulb onion	10	—	Pear	5	100–250

Fat-soluble vitamins

According to the current international classification, the fat-soluble vitamins include vitamins A, D, E, K, and F. The primary sources of fat-soluble vitamins are milk and dairy products, animal fats, vegetable oils, meat and meat products, and fish—that is, foods in which the vitamins are dissolved in fats.

Among the fat-soluble vitamins, retinol (vitamin A) is notable for its provitamin form—carotenes—which are found in brightly colored yellow, orange-red, and green vegetables. In the human body, β-carotene is converted into retinol in the intestinal wall under the influence of the carotinase enzyme.

Vitamin A plays a multifaceted role in biological functions. Retinol acetate is crucial for numerous essential processes within the body. It is vital for the proper differentiation of epithelial tissues and the synthesis of visual pigments, such as rhodopsin and iodopsin. Additionally, it aids in the regeneration of cartilage and bone tissue while also binding to and neutralizing free oxygen radicals—harmful compounds that arise in tissues during various pathological conditions—thereby demonstrating its antioxidant capabilities. Inadequate intake of vitamin A in children leads to pronounced negative consequences. This includes noticeable delays in general development and growth, decreased body weight, hyperkeratosis, eye damage, impaired night vision, and profound changes in the epithelium of the respiratory and urinary tracts as well as the gallbladder.

The requirement for vitamin A is expressed in micrograms of retinol equivalents: 1 μg retinol equivalent = 1 μg of retinol or 6 μg of beta-carotene. The daily requirement for an adult is 1.5 mg of vitamin A.

Determination of carotene

Carotene content is determined using a colorimetric method from extracts of the food products under investigation.

Procedure: From a pre-ground sample of the product (e.g., carrot, green onion, rosehip), weigh out 1 gram and place it in a mortar. To begin, incorporate 3 grams of quartz sand or well-cleaned and calcined river sand, along with a pinch of sodium bicarbonate (baking soda). Ensure the mixture is thoroughly ground. If you're working with moist products like fresh vegetables, add 5 grams of anhydrous sodium sulfate and grind again until you achieve a dry consistency. Next, introduce 5 grams of air-dry aluminum oxide (an adsorbent) and continue grinding for 2 to 3 minutes.

Once the powder is ready, transfer it into a 100 mL stoppered cylinder containing 40 mL of clear aviation gasoline (or petroleum ether). Seal the container and shake it vigorously for 2 to 3 minutes, then let the mixture sit undisturbed until all suspended particles settle at the bottom. From the upper layer of the solvent, where carotene is dissolved, carefully extract 10 mL (which is one-fourth of the total volume) into a test tube for carotene content analysis using a colorimetric scale. For calibration purposes, prepare a standard using a 0.072% solution of potassium dichromate in ethyl alcohol (see Table 16).

Table 16.

Colorimetric Scale for Determining Carotene Content

№	Main Solution of $K_2Cr_2O_7$ (ml)	Distilled Water (ml)	Carotene Content (mg per 100 g of product)	№	Main Solution of $K_2Cr_2O_7$ (ml)	Distilled Water (ml)	Carotene Content (mg per 100 g of product)
1	10.0	0.0	16.6	11	4.0	6.0	6.6
2	9.4	0.6	15.6	12	3.4	6.6	5.6
3	8.8	1.2	14.6	13	2.8	7.2	4.6
4	8.2	1.8	13.6	14	2.2	7.8	3.6
5	7.6	2.4	12.6	15	1.6	8.4	2.6

№	Main Solution of $K_2Cr_2O_7$ (ml)	Distilled Water (ml)	Carotene Content (mg per 100 g of product)	№	Main Solution of $K_2Cr_2O_7$ (ml)	Distilled Water (ml)	Carotene Content (mg per 100 g of product)
6	7.0	3.0	11.6	16	1.0	9.0	1.6
7	6.4	3.6	10.6	17	0.4	9.6	0.6
8	5.8	4.2	9.6	18	0.2	9.8	0.33
9	5.2	4.8	8.6	19	0.1	9.9	0.16
10	4.6	5.4	7.6	20	0.0	10.0	0

If the carotene concentration in the extract exceeds 16 mg per 100 g of the product, it is necessary to dilute it with gasoline (petroleum ether) at a 1:2 ratio. Consequently, the results from the colorimetric analysis will need to be multiplied by two to reflect this dilution. Upon completing the analysis, a conclusion should be formulated that outlines the carotene content of the tested product, comparing it to the values listed in standard reference tables for the chemical composition of food items. The main dietary sources of carotene (mg per 100 g of edible portion of the product) include: red carrot – 9.0, rosehip – 2.6, fresh red pepper – 2.0, dark green lettuce – 1.75, apricots – 1.2, peaches – 0.5, green peas – 0.4, black currant – 0.1

Assignment: Familiarize yourself with the example of solving a diagnostic case. Apply this algorithm to independently solve the tasks provided below.

Example: During examination of a patient, the following complaints were identified: fatigue, leg pain, drowsiness, bleeding gums. Upon physical examination: bleeding gums were confirmed. Laboratory results revealed 20–30 petechiae at the site of negative pressure (Nesterov test), urinary vitamin **C** excretion rate – 0.35 mg/hour**.**

Example: During examination of a patient, the following complaints were identified: fatigue, leg pain, drowsiness, bleeding gums**.** Upon physical examination: bleeding gums were confirmed. Laboratory results revealed 20–30 petechiae at the site of negative pressure (Nesterov test), urinary vitamin C excretion rate – 0.35 mg/hour**.**

Based on the patient's complaints and case history, the physician makes a preliminary diagnosis: vitamin C hypovitaminosis.

Based on physical and laboratory findings (bleeding gums, 20–30 cutaneous petechiae, and more than threefold decrease in vitamin C excretion), the final diagnosis is: Stage I Vitamin C Hypovitaminosis

Recommendations:

- Administration of high doses of vitamin C up to 500 mg/day in combination with multivitamins
- Intake of freshly prepared rosehip infusion, up to 4 glasses per day before meals
- Vegetable-rich diet: potatoes, cabbage, fresh fruits (lemon), fresh herbs (dill, sorrel)
- Follow-up examination after two weeks: repeat vitamin C blood and urine analysis, Nesterov test, and adjust the daily vitamin C dosage accordingly

Self-Study Tasks

Task 1. Urine sample volume used for titration: 4.0 mL Amount of Tillmans' reagent used for titration: 0.93 mL Amount of Tillmans' reagent used in control sample: 0.05 mL Correction coefficient (K): 1.02.

Calculate the concentration of vitamin C in daily urine output and assess the body's vitamin C status.

Task 2. The patient exhibits bleeding gums, and the Nesterov test shows numerous petechiae. Vitamin C urinary excretion: 0.25 mg/hour. Determine the stage of vitamin C hypovitaminosis and propose preventive measures.

SELF-ASSESSMENT QUESTIONS

1. What is the significance of vitamins for the vital activity and functioning of the human body?
2. Which indicators are used to evaluate vitamin C status through the capillary resistance (Nesterov) test?
3. What kind of vitamin deficiency is characterized by complaints of fatigue, leg pain, drowsiness, and bleeding gums?
4. Which vitamins are classified as fat-soluble, and in what food sources are they found?
5. Which vitamin is synthesized in the human body under the influence of sunlight?

HYGIENIC ASSESSMENT OF THE NUTRITIONAL VALUE AND SAFETY OF FOOD PRODUCTS

The main goal of hygienic assessment is to examine, from a hygiene standpoint, he quality, nutritional value, and safety of food products for the health of the population.

Compliance with State Standards and Temporary Technical Specifications (TTS) in the cultivation and production of food ensures their high quality.

In Uzbekistan, constant veterinary and sanitary supervision is carried out along the entire food chain — from the animal to the consumer's shelf — including storage, transportation, and culinary processing, with the aim of ensuring the population is provided with high-quality and safe food products.

The hygienic evaluation of the safety of food products is comprehensively carried out at the Republican Sanitary-Hygienic Laboratory.

Stages of the sanitary-epidemiological assessment

- ✓ Preparatory stage and review of product data (familiarization with regulatory documents related to the production technology, storage, and distribution of the product);
- ✓ Inspection of the product batch at its current location;
- ✓ Opening of packaged products and their organoleptic evaluation;
- ✓ Sampling of the product for laboratory testing;
- ✓ Laboratory research and testing of the selected samples;
- ✓ Issuance of a report based on the results of the examination.

During food product assessment, particular attention is paid to the safety of the product for human health. Specific indicators of safety of a food product include: **organoleptic indicator** evaluates the preservation of sensory characteristics (appearance, smell, taste, texture, etc.); **general hygienic indicator**: evaluates the preservation or increase in biological value during storage, culinary processing, or preservation; **technological indicator**: confirms the presence of substances in the processed product in accordance with technological regulations; **toxicological indicator**: assesses the presence of harmful chemical substances not exceeding the acceptable daily intake.

Methods used to assess food quality and safety

- ➢ Organoleptic methods – determining color, odor, appearance, consistency, and taste of the product;
- ➢ Physical methods – determining temperature, density, and moisture content;
- ➢ Chemical methods – identifying chemical composition, pH level, and presence of foreign impurities;
- ➢ Microscopic methods – identifying morphological structure and presence of parasites;
- ➢ Bacteriological methods – determining the degree and nature of microbial contamination;
- ➢ Biological methods – assessing toxicity of food through animal testing;
- ➢ Radiometric methods – detecting radioactive contamination of products.

Hygienic assessment of milk

Milk is a highly nutritious food product that holds significant value for all demographic groups, particularly for children, the elderly, and those in need of specialized diets. Its role in nutrition is especially critical due to its rich biological and nutritional profile.

The chemical makeup of milk can vary widely based on numerous factors, including the breed of the animal, its individual traits and health, the stage of lactation, the quality and amount of feed consumed, and even seasonal changes.

Typically, milk comprises approximately 88.6% water, 2.8% protein, 3.2% milk fat, 4.7% carbohydrates, and 0.7% ash. The caloric value of 100 grams of milk is around 65 kcal.

Within its complex structure, milk contains more than 90 different components, featuring 20 essential amino acids, nearly 20 fatty acids (including beneficial polyunsaturated types such as linoleic and arachidonic), 25 minerals in notable amounts, and 12 vitamins.

The fat content in milk is primarily made up of triglycerides, along with phospholipids, free fatty acids, and sterols. The carbohydrates present are mainly in the form of lactose, which plays a crucial role in regulating fat storage, enhancing the absorption of minerals like phosphorus, calcium, and magnesium, and aiding in the synthesis of B vitamins.The minerals phosphorus and calcium are present in a balanced ratio. Trace elements such as zinc, iron, and copper are bound both to proteins and fat globules, improving their bioavailability.

Fermented milk products produced using specific bacterial cultures acquire therapeutic properties.

Products resulting from milk fermentation — such as cottage cheese, sour cream, and cheese — have high nutritional value.

- Cottage cheese is rich in the essential amino acid methionine
- Sour cream is a valuable source of milk fat

- Cheeses are sources of vitamin A, vitamin B2, and minerals such as calcium and phosphorus in optimal ratios

Sanitary and Hygienic Requirements for Milk

According to national State Standards, milk intended for direct consumption or dairy product processing must comply with approved norms in terms of organoleptic, physico-chemical, and bacteriological indicators.

Colostrum and late lactation milk (milk obtained within 15 days prior to calving) are not permitted for consumption.

Procedure for Laboratory Analysis of Milk

To perform a proper analysis, a sample of at least 250 ml of milk is required. The sample must be thoroughly mixed to ensure accuracy and homogeneity of the results.

Organoleptic Evaluation of Milk:

A visual assessment is conducted to examine: homogeneity, presence of sediment, contamination, color or tint, etc.(see Table 17 for reference).

Table 17.

Organoleptic indicators of milk quality

Indicator	Description
Appearance and Consistency	Homogeneous liquid without sediment or mechanical impurities. For baked milk and high-fat milk – no cream separation.
Taste and Smell	Clean, free from any foreign tastes or odors not characteristic of fresh milk. For baked milk, a clearly expressed high-pasteurization flavor.
Color	White, with a slightly yellowish tint; for baked milk – creamy hue; for skimmed milk – slightly bluish tint.

Determination of Color. Fifty to sixty milliliters of milk is poured into a clear, colorless glass for examination. The assessment is carried out visually, ensuring adequate natural or artificial lighting is available. Whole milk typically appears white with a faint yellowish hue, while diluted or skimmed varieties exhibit a bluish tint. A reddish coloration could suggest the presence of blood, but it might also stem from the animal's diet—such as the inclusion of carrots or beets.

Additionally, a reddish shade may arise from pigment-producing bacteria present in the milk.

In the case of caramelization of carbohydrates**,** the milk acquires a color resembling that of baked milk**.**

Consistency. Milk is poured into a clear glass vessel and gently swirled, allowing it to coat the inner surfaces. The texture is assessed by examining the marks left behind on the walls. When liquid milk flows down, it does so cleanly without any residue. In contrast, whole milk leaves a noticeable white line. If the milk adheres to the walls and exhibits a thick, sticky quality, this could indicate the presence of bacteria that produce mucus.

Smell. To evaluate the scent, milk is transferred into a sealed flask. This flask is then carefully warmed in a water bath. Once heated, the stopper is removed for an olfactory assessment. Fresh milk has a recognizable and pleasant milky aroma. However, if souring bacteria are present, the milk may curdle and release a sour odor. Unpleasant smells like mustiness, hydrogen sulfide, or ammonia suggest the presence of decomposing microorganisms. Additionally, improper storage can lead to strange odors reminiscent of soap, gasoline, cleaning agents, or medicinal products.

Taste. High-quality milk has a pleasant, slightly sweet taste. A sour or musty taste indicates the presence of sour-putrefactive microflora. Salty, bitter, rancid, fishy, or other off-flavors may result from poor-quality feed, the animal's lactation period, disease, or contamination with foreign substances.

Determination of naturalness and wholeness of milk

The naturalness and wholeness of milk are assessed by measuring density**,** fat content**,** and dry residue**.**

Determination of Density. The density of natural milk ranges from1.028 to 1.034**.**

- Adding water decreases density, as the proportion of dense solids in the milk is reduced.

❖ Skimming (removing cream) increases density due to the removal of the lightest component-fat**.**

❖ In cases of milk falsification with flour or starch, the density of diluted milk may fall within normal values or even exceed them.

Determination of Fat Content. Fat content in milk is determined using the ***Gerber method***. This method is based on the fact that all components of milk, except fat, are destroyed by concentrated sulfuric acid**.** The fat is collected, with the help of isoamyl alcohol, into a single layer from the dispersed fat globules. After centrifugation, the fat volume is measured using the scale on the narrow part of the butyrometer (see Fig. 10).

Fig. 10. Butyrometers

***Research Procedure*.** While carefully holding the butyrometer wrapped in a cloth, use separate pipettes to add the following: 10 ml of sulfuric acid, 10.7 ml of milk, and 1 ml of isoamyl alcohol. The neck of the butyrometer is then thoroughly wiped and tightly sealed with a rubber stopper using gentle twisting movements. Hold the butyrometer by its wider part to avoid breaking the narrow tip. Gently stir the mixture until all protein substances are fully dissolved. If the liquid level remains below the graduated section of the butyrometer and cannot be elevated by tightening the stopper, add more isoamyl alcohol. Next, position the butyrometer upright in a water bath set to 65°C for 5 minutes. Afterward, centrifuge it for 5 minutes using a specialized milk centrifuge with a lid. To ensure balance during

centrifugation, arrange the butyrometers symmetrically with their narrow ends facing inward. If you have an odd number of samples, include an extra butyrometer filled with water. Once centrifugation is complete, return the butyrometers to the 65°C water bath for another 5 minutes. Finally, read the fat percentage from the scale: each large division indicates 1% fat, while each small division represents 0.1%. If the fat column appears unclear, place the butyrometer back in the water bath for an additional 5 minutes and repeat the centrifugation process.

Determination of Total Solids (Dry Matter).The dry matter in milk is calculated using the formula: **X= ((4.8×F+D) /4)+0.5**

Where:

X- percentage of total dry matter in milk
F- percentage of fat
D- milk density according to the lactodensimeter at 20°C
4.8 and **0.5** are empirical coefficients

To determine the content of non-fat solids, subtract the fat percentage from the total dry matter.

Important Notice. Caution must be exercised during this procedure. Mixing milk with concentrated sulfuric acid results in a vigorous reaction, causing intense heat release and gas emission. The generated gas can forcefully eject the stopper, potentially splashing the corrosive mixture onto the researcher's hands.

In case of skin contact. Immediately rinse the affected area with cold running water, then neutralize with a 0.1N alkaline solution. In severe cases, seek medical attention.

Table 18. Physico-chemical indicators of different types of milk.

Table 18.

Physico-chemical indicators of different types of milk

Type of Milk	Fat Content %, not less than	Non-fat Solids Content, g, not less than	Acidity (Turner degrees), not more than	Vitamin C Content (mg per 100 g), not less than	Temperature °C, not higher than
Whole normalized and reconstituted	3.2	8.1	21	–	+8

Type of Milk	Fat Content %, not less than	Non-fat Solids Content, g, not less than	Acidity (Turner degrees), not more than	Vitamin C Content (mg per 100 g), not less than	Temperature °C, not higher than
High-fat	6.0	7.8	20	–	+8
Baked	6.0	7.8	21	–	+8
Protein-enriched	2.5	10.5	25	–	+8

Modern laboratories are increasingly equipped with instruments that allow rapid determination of certain milk parameters without the use of chemical reagents. For example, the “Laktan 1-4M” analyzer (see Fig. 11).

Fig. 11. “Laktan 1-4M” Analyzer

The analyzer enables rapid determination of density, protein, and fat content in samples of raw milk as well as long-shelf-life packaged milk.

Indicators of Naturalness of Milk

Whole cow's milk is a homogeneous liquid without sediment or foreign impurities. It is white in color with a slight yellowish tint. The taste and smell are characteristic of fresh milk. At a temperature of 20°C, the specific gravity ranges from 1.027 to 1.034; fat content is not less than 3.2%. Milk of the first grade has an acidity of 16–18 °T (Turner degrees), second grade—19–20 °T, while stale milk shows an acidity of 21 °T or higher. The solid content of whole milk is at least 12.0–12.5%, and for skimmed milk—not less than 8.0%.

Turner's Degree of Acidity (°T) *is defined as the number of milliliters of* ***0.1N sodium hydroxide or potassium hydroxide solution*** *required to neutralize the acids in* ***100 ml of milk****.*

Determination of Milk Freshness

To assess the freshness of milk, analyses are performed to evaluate: acidity**,** coagulation upon boiling**,** and reductase test**.**

Milk Freshness Scale

Turner degrees (°T)	Interpretation
16–17°T	Freshly milked milk
18–19°T	Fresher milk
20–22°T	Acceptable according to GOST standards
24–27°T	Curdles during boiling

Test for Coagulation Upon Boiling. As a result of increased acidity in milk - due to the presence of a large number of peptonizing bacteria (Table 19) or the presence of foreign impurities - the milk may curdle during boiling**.**

Table 19

Bacteriological indicators of milk

Milk Type	Total Bacterial Count in 1 ml of Milk, not more than	Coliform Titre, ml
Pasteurized		
– In bottles and packages:		
Group A	75,000	3.0
Group B	150,000	0.3
– In flasks and tankers:	300,000	0.3

Milk coagulation during boiling is influenced by its acidity levels. When the acidity is between 18 and 22° Turner, the milk remains stable and does not curdle when heated. However, as the acidity rises to 26–28°T, the likelihood of coagulation during boiling increases. Milk with an acidity of 30°T will begin to curdle at a temperature of 77°C. For milk with 40°T, coagulation occurs at a lower

temperature of 65°C. At 50°T, curdling happens at just 40°C, and milk with an acidity of 60°T can spontaneously coagulate even at room temperature..

Method of Study: Pour 5 ml of milk into a test tube. Boil for 1 minute. Cool to room temperature. Examine for the presence of casein flakes (coagulation).

Reductase Test. Milk naturally contains microorganisms that produce the enzyme reductase, which decolorizes methylene blue solution**.** An increase in microbial count reduces milk quality and **accelerates** the decolorization of methylene blue ()

Table 20

Milk quality characteristics based on the decolorization time of methylene blue solution

Decolorization Time	Number of Bacteria in 1 mL of Milk	Quality Assessment	Class
5½ hours or more	Less than 500000	Good	I
From 2 to 5½ hours	500000 to 4000000	Satisfactory	II
From 20 minutes to 2 hours	4000000 to 20000000	Poor	III
20 minutes or less	20000000 and above	Very Poor	IV

***Research Procedure*.** Begin by adding 10 mL of milk to a sterile test tube, then incorporate 2–3 drops of a 1% methylene blue solution. Ensure the mixture is well combined. To shield the mixture from exposure to atmospheric oxygen, carefully layer a thin film of vaseline oil over the milk solution. Next, place the test tube in a thermostat set at a temperature between 37 and 40 °C.

The assessment relies on observing the time it takes for the solution to lose its color. If there is significant microbial contamination, decolorization will typically occur within just a few minutes to an hour. A decolorization period of 5 to 7 hours suggests only minimal microbial presence. It's important to note that while this reductase test serves as a preliminary indicator, it does not substitute for thorough bacteriological analysis.

Determination of Foreign Adulterants in Milk. To falsify milk, certain foreign substances such as flour, starch, and sodium bicarbonate may be added.

Test for Starch Adulteration. In an attempt to simulate thickness after dilution with water, flour or starch is often added. These can be detected using the iodine test.

Procedure:Pour 10 mL of milk into a flask, bring to a boil, and then cool. While stirring, add 1 mL of Lugol's solution. The appearance of a blue coloration indicates the presence of starch or flour in the milk.

Test for Sodium Bicarbonate Adulteration. To prevent souring, sodium bicarbonate (baking soda) is sometimes added to milk with elevated acidity.

Procedure: Pour 5 mL of milk into a test tube and add 4–5 drops of 0.2% rosolic acid solution in 96% ethanol. Evaluate the color change: if the milk contains sodium bicarbonate, the solution turns raspberry-red. Unadulterated milk changes to a yellow-pink color.

Final Conclusion on Milk Quality.

The ultimate assessment of milk's suitability for consumption relies on the findings from organoleptic and physico-chemical evaluations. Milk is considered unfit for drinking if it displays any of the following characteristics: unpleasant odors or flavors (such as putrid, rancid, or soapy), unusual texture (like viscous,

sticky, or overly thick), abnormal coloration (including reddish, bluish, or excessively yellow hues), or any other sensory defects.

The main methods used in milk examination are summarized in Table 21.

Table 21.

Indicator	Method of Determination	Hygienic Standard
Density (Specific Gravity)	Using a lactodensimeter	1028–1034 at 20 °C
Low density – indicates diluted milk; *High density* – indicates skimmed milk	—	—
Fat Content (%)	Using a butyrometer	2.8–3.7%
Presence of Mechanical Impurities	Filtration through clean gauze followed by visual inspection of the filter	No mechanical impurities allowed
Milk Freshness	—	—
A) Acidity	Titration method using 0.1 N NaOH	18–24° Turner
B) Coagulation test	Boiling	Should not curdle
Soda Adulteration	Qualitative reaction with rosolic acid	Yellow coloration only
Starch Adulteration	Qualitative reaction with iodine	Yellow coloration only
Bacteriological Indicators	Culture on nutrient media, microscopy	No pathogenic flora should be present

If defects are detected in milk, sanitary surveillance officers must provide specific recommendations for its use in each case.

Sample Problem Solution

Assignment: Based on the case description, write a **sanitary conclusion**, then solve similar problems independently.

Case: During sanitary-hygienic testing, the following milk characteristics were identified: color: white with a bluish tint; consistency: watery; odor: characteristic "milky"; fat content: 0.3–0.4%; acidity: 22° Turner ; specific gravity: 1026

Assessment of milk quality and recommendations:

The watery consistency**,** bluish tint, and specific gravity below 1028 indicate that the milk has been diluted with water.

Despite the acidity conforming to GOST standards, the low fat content suggests reduced nutritional value.

Conclusion*:* the milk is not recommended for direct consumption, as **it** no longer meets the standards for whole milk in terms of nutritional value.

Recommendation*:*the milk may be used as an ingredient in cocoa, coffee, or for preparing porridge.

Task 1. Write a sanitary conclusion for the following case**:**color - white with a slight tint; consistency-homogeneous; odor- typical “milky”; fat content: 0.1–0.3%. Acidity: 17° Turner. Specific gravity: 1036. Assess the milk quality and provide recommendations.

Task 2. Laboratory analysis revealed: color- white with a bluish tint; odor: specific (typical); taste: slightly sweet; specific gravity: 1010; fat content: 0.81%.

Conclusion**:** Evaluate whether this milk complies with hygienic standards.

Task 3. During testing with rosolic acid, the milk sample turned pink within 30 seconds**.** Question**:** what chemical reaction likely occurred**?** Provide a conclusion about the milk sample**.**

Self-assessment questions

1. What is the main objective of hygienic examination of food products?
2. Which regulatory documents define the requirements for nutritional value and food safety**?**
3. List the methods used to determine food wholesomeness**.**
4. How is milk acidity measured, and in what units**?**
5. What chemical test is used to detect starch adulteration in milk?

HYGIENIC EXAMINATION OF MEAT AND FISH

Meat serves as a vector for numerous infectious diseases in humans, such as anthrax, brucellosis, tuberculosis, glanders, and foot-and-mouth disease. Consequently, only meat derived from healthy animals is deemed safe for human consumption.

The presence of harmful microorganisms and parasitic eggs in meat is completely unacceptable. Additionally, meat must adhere to specific organoleptic and physicochemical standards established by national regulations.

As a highly perishable food item, meat is vulnerable to spoilage, primarily due to microbial activity that leads to the degradation of amino acids and, in some cases, the production of toxic compounds. This can result in foodborne illnesses and parasitic infections.

To ensure safety, hygienic monitoring of meat relies heavily on indicators of freshness. This involves evaluating organoleptic properties along with conducting chemical analyses and microscopic examinations. (Table 22).

Table 22.

Hygienic examination of meat

Indicators	Method of examination	Assessment criteria
Organoleptic	Visual inspection	If deviations are detected: color — deduct 2 to 5 points
– Color		
– Consistency	Finger pressure	If deviations are detected: consistency — deduct 2 to 5 points
– Odor	Heated knife test	If deviations are detected: odor — deduct 2 to 7 points
Chemical	Copper sulfate test	If detected — deduct 4 points
– Presence of volatile fatty acids		
– Presence of ammoniacal nitrogen	Nessler's reagent test	If detected — deduct 2 points
Microbiological	Microscopy of crushed specimens	If detected — deduct 2 points
– Presence of cysticerci and		

Indicators	Method of examination	Assessment criteria
Trichinella		

25-Point System for Meat Evaluation. According to the 25-point system, each parameter is evaluated using a maximum score: From the total 13 points, the breakdown is:

- Volatile fatty acids – 4 points
- Ammoniacal nitrogen – 2 points
- Copper sulfate reaction – 4 points
- Bacterioscopy – 2 points (*according to GOST RUz*)

Organoleptic Examination. On days 1–3 after slaughter, meat should acquire a bright red color. The cut surface appears slightly moist and glossy. During storage, the surface develops a thin dry crust**.** When pressed with a finger, a depression forms, which is considered normal if it quickly levels out. The smell should be fresh and aromatic**.** Fat should have a yellowish tint and feel firm to the touch.

Early Spoilage Detection. To detect early signs of spoilage: A heated knife is inserted into the meat near the bone, then immediately smelled. A putrid odor indicates spoilage. If slight slime is present but no abnormal smell, 2 points are deducted.

If, the color of meat and fat is slightly altered, White mold, darkened dried crust, and slightly sour/musty smell are present, the depression from finger pressure levels slowly, the cut surface is moist, fat is grayish and sticky - deduct 5 points.

If, the surface has slime, sticks to fingers, fresh cut is sticky, meat is loose, depression levels only after One minute, faint putrid odor is present - deduct 7 points.

If, meat surface is dried out and moldy, dark at the cut, depression does not level, fat smells rancid - deduct 13 points.

Meat is Rejected Without Deduction if:

- Surface is gray or greenish,
- Cut is extremely sticky,
- Finger depression does not level,
- Smell is strongly putrid, musty deep in the muscle.

Chemical analysis To detect protein breakdown products caused by microbial activity. Copper sulfate test – detects volatile fatty acids. Nessler's reagent – detects ammoniacal nitrogen

Microscopy. Used to detect **cysticerci** (taenia larvae) and trichinella. Imprint smears can reveal microflora.

Final Evaluation. Based on the point total, meat is classified into:

Points	Assessment
21–25	Fresh meat
10–20	Doubtful quality
0–9	Spoiled meat

Fish and fish products

Fish are a key source of high-quality proteins, with protein content ranging from 8% to 14%.Fat content varies from 0.3% to over 28%.

- Fish fats are rich in polyunsaturated fatty acids and fat-soluble vitamins.
- Fish also provide macro- and microelements: copper, zinc, iodine, fluorine, etc.

Perishability

Fish spoil faster than meat due to microbial penetration from: skin surface, and intestines. Leading to bacterial decay, food poisoning, or helminth infections.

Organoleptic Indicators of Freshness

Fresh fish should have:

- Smooth, shiny scales, covered with clear slime, tightly adhering to skin
- Eyes: bulging, shiny, transparent
- Gills: bright red, odorless
- Meat: characteristic color, firm and elastic, poorly separates from bones

- ❖ No bloating of abdomen, smell is typical of the species

Spoiled fish show:

- ✓ Scales with dirty-gray slime
- ✓ Cloudy, sunken eyes
- ✓ Gills: dirty gray, slimy, putrid/musty smell
- ✓ Muscles: flabby, easily separated from bones, foul odor
- ✓ Bloating of the abdomen
- ✓ Heated knife test: discoloration and bad smell

Chemical tests. In spoiled fish, ammonia and hydrogen sulfide are often present. Reactions to these are prescribed by GOST RUz**.**

Microscopy. Performed by selecting thin slices of muscle tissue**.** A thin meat laye**r** is compressed between slides until translucent**,** then examined under low magnification. Used to detect larvae of: **b**road tapeworm (Diphyllobothrium latum), cat liver fluke (Opisthorchis felineus)

Recommendations for Conclusion Preparation

When assessing the wholesomeness of fish, organoleptic indicators are primary. The final conclusion should be made according to GOST RUz standards.

SELF-ASSESSMENT QUESTIONS

1. Which infectious diseases can be transmitted to humans through the consumption of meat from warm-blooded animals and fish?
2. What are the main indicators used in the hygienic examination of meat?
3. According to which evaluation system is the wholesomeness of meat assessed?
4. What methods are used to assess the suitability of meat from warm-blooded animals and fish?
5. What is the purpose of microscopic examination of muscle tissue in evaluating the suitability of meat from warm-blooded animals and fish?

HYGIENIC EXAMINATION OF CANNED FOOD WHOLESOMENESS

Methods for Examining Canned Products

Depending on the method of preservation, canned food products are produced as either true canned goods or preserves: True canned goods are food products sterilized in autoclaves and sealed in hermetically closed containers. Preserves are food products that are not sterilized (e.g., herring, sprats).

Initial Examination. The inspection of canned foods begins with an evaluation of the packaging and label. In the case of metal cans, special attention is paid to the embossed markings on the lid, which typically consist of 3–4 digits and one letter: The letter indicates the ministry of production:

- "**M**" – Meat and Dairy Industry
- "**P**" – Fish Industry

The first one or two digits denote the factory number.The last digit indicates the year of production.

Example: **M 379**

M – Ministry of Meat and Dairy Industry, 37 – Factory No. 37, 9 – Year 2009

Decoding Lid Embossing (Second Row). A second line of 6–7 digits is also stamped on the lid:

- 1st digit – Shift number
- 2nd and 3rd digits – Day of the month
- 4th digit (letter) – Month of production:
  - А – January, Б – February, В – March

Note: *The letter "3" is skipped to avoid confusion with the number "3"*5th–7th digits – Product code (numeric designation)

The indicators and methods for the examination of canned goods are summarized in Table 23.

Table 23.

Quality control indicators for canned foods

Indicator	Method of examination

Indicator	Method of examination
Label and embossing inspection	Visual
External inspection:	Visual
– Presence of deformation or rust	
– Presence of can swelling (bombage)	
Seal integrity (hermeticity)	Hot water test
Condition of the internal surface	Visual
Organoleptic indicators: color, odor, consistency, taste	Organoleptic evaluation
Physico-chemical indicators:	Laboratory methods
– Acidity	
– Total solids content	
– Table salt (sodium chloride) content	

***Visual Inspection of Cans*.** During visual inspection of cans, special attention should be given to the condition of the lids and bottoms, the presence of swelling (bombage), and any defects or damage to the container.

Bombage (can swelling) may result from several causes**:**

Microbial Bombage. Occurs due to the formation of gases (such as hydrogen sulfide, ammonia, methane, and carbon dioxide) produced by microbial metabolism. In this case, both ends of the can are bulging, they barely depress under pressure, andquickly return to their swollen shape once the pressure is removed.

Physical Bombage.Results from heating, freezing, overfilling, or mechanical deformation of the can body.Only one end of the can is typically bulging.When pressed, it easily bends inward and often does not return to its original position due to the absence of internal gas pressure.If it does return, it does so with an audible snap or pop due to the stiffness of the metal.This type of swelling is also known as "false" bombage.

Chemical Bombage.Occurs when the acid in the preserving liquid reacts with the metal coating of the can, producing hydrogen gas, which leads to swelling of the can end.

Seal integrity test

Procedure*:* Remove the label from the can. Tie string around the can for easy handling.Fully immerse the can in hot water (for 5–7 minutes).Observe the surface of the water:If air bubbles appear, this indicates a loss of hermetic seal and packaging defect.

Inspection of the internal surface of cans

During internal inspection of tin cans, the following defects are noted:

- Dark spots on the inner surface
- Solder build-up along internal seams
- Marbling effect during sterilization (common in meat and fish products)
    - Caused by the release of sulfur compounds from the contents
    - Reaction with iron leads to the formation of ferrous sulfide

Organoleptic evaluation of canned contents. The contents of the can are placed onto **a** plate and subjected to organoleptic testing**,** which includes assessment of: color, odor, taste and consistency

Example of decoding the embossed markings on the can bottom

Metal logo stamping is a process of creating raised or indented markings on the surface of a tin can using a special mold.

Example: Meat Canned Food Can Stamping

- Top Row: **MM2322**
- Bottom Row: **122A35**

Interpretation:

- Top Row:
    - MM – Meat industry code
    - 23 – Factory number
    - 22 – Last two digits of the production year (2022)
- Bottom Row:

- 1 – Production shift number
- 22 – Day of the month
- A – Month index (A – January, B – February, C – March, etc.)
- 35 – Product assortment number

Decoding:

First row: MM – Index of the meat industry; 23 – Factory number; 22 – Last two digits of the year of production (2022)

Second row: 1 – Shift number; 22 – Day of the month; A – Month index (A – January, B – February, etc.); 35 – Product assortment code "Meat preserves with assortment code No. 35 were produced by Factory No. 23, during the first shift, on January 22, 2022."

Control tasks for material comprehension

Task 1. Beef was delivered to a pioneer camp kitchen from the district food supply organization. The invoice stated that the carcass came from an emergency slaughter (due to injury), purchased from a private individual. A veterinary certificate permitting the meat for sale is present**.** A blue stamp is applied to the carcass.

Three days have passed since slaughter. Meat color: dark red, cut surface: shiny and moist**,** elasticity**:** normal**,** smell: fresh and pleasant**,** fat: white and firm, knife test: negative

Provide a conclusion on whether first and second-course meals can be prepared from this meat for child nutrition in the pioneer camp.

Task 2. Upon external inspection of a tin can, a deep dent was noted on the side surface. One end of the can is slightly bulging, but when pressed, it returns to its original position.There are no signs of rust or seal breach.

Embossed markings on the can bottom:Top Row: P 846203, Bottom Row: 601

Assess the wholesomeness of the canned product and decode the can markings.

SELF-ASSESSMENT QUESTIONS

1. What is the difference between canned foods and preserves?
2. What are the causal factors of true bombage in canned products?

3. What are the characteristic signs of true bombage in canned foods?
4. What are the indicators of false (physical) bombage in canned foods?
5. What is the procedure for conducting a hermeticity (seal integrity) test on a can?

FOOD POISONING: DIAGNOSIS AND PREVENTION

One of the primary responsibilities of a physician is the prevention of food poisoning and the promotion of rational dietary habits among the population, which implies food safety—particularly the consumption of wholesome food products. The greatest epidemiological risk is often associated with the consumption of expired or improperly stored perishable food items. Milk, dairy products, meat, fish, poultry, and their derivatives are in high demand among consumers. However, under certain conditions, these can become the cause of severe foodborne illnesses—especially canned foods, which are most frequently responsible for cases of botulism.

Food poisoning refers to acute, and less frequently chronic, diseases that result from the consumption of food that is unsanitary or otherwise unfit for human consumption.

The classification of foodborne illnesses is based on etiological and pathogenetic principles.

Food poisoning is divided into three major groups:

❖***Microbial (bacterial origin)*****:** including foodborne toxicoinfections, bacterial toxicoses, and mixed (polyetiological) bacterial forms;

❖***Non-microbial (non-bacterial origin):*** including poisoning from naturally toxic foods; foods that become toxic under certain conditions; and poisoning caused by chemical contaminants;

❖***Undetermined (unclassified) etiology*****.** Clinically, food poisoning is manifested by intoxication syndromes and symptoms, which are specific to the causative agent in each individual case.

However, all foodborne poisonings share the following characteristic features:

- They occur suddenly in previously healthy individuals;

- There is a clear connection to food intake;
- They typically affect multiple individuals simultaneously;
- The disease is non-contagious to others.

Practical measures for providing medical assistance to individuals affected by food poisoning are outlined in the ***"Instruction on the procedure for investigation, reporting, and laboratory testing by sanitary-epidemiological services in cases of food poisoning."***

Investigation of food poisoning involves a set of activities aimed at identifying the etiology of the disease and the factors that contributed to its occurrence, with the goal of implementing measures to prevent similar cases in the future.

Diagnosis of food poisoning is always based on clinical and epidemiological history, and supported by laboratory testing, including identification of the causative agent in vomitus, feces, food samples, leftovers, beverages, and water.

Prevention of food poisoning relies on both general and individual measures.

General Preventive Measures: These focus on strict adherence to sanitary and hygienic regulations in public catering enterprises, educational institutions, healthcare and medical-educational facilities, industrial canteens, and food manufacturing. Key preventive measures at food service establishments include:

- Procurement of foodstuffs and raw materials in accordance with regulatory and technical documentation and accompanied by documents verifying their quality and safety;
- Receiving goods in undamaged, clean packaging;
- Observing product compatibility rules, storage conditions, and expiration dates in refrigeration units and warehouses;
- Assigning and labeling cutting equipment and utensils for specific processing areas;
- Maintaining strict flow of technological processes in the preparation of culinary and confectionery products;
- Performing daily wet cleaning using cleaning and disinfecting agents in all food-related premises;
- Timely execution of pest control (insects and rodents).

General preventive measures also include veterinary control of livestock, monitoring the condition of water sources, and proper disposal of sewage waste.

Individual Preventive Measures:

- Observance of personal hygiene practices;
- Consumption of safe, boiled drinking water;
- Proper storage and thorough cooking of food products;
- Avoiding the consumption of cream-based culinary products after their expiration date;
- Proper handling of both raw ingredients and prepared meals;
- Routine hand washing and personal cleanliness;
- Regular cleaning and disinfection of waste bins, which must be kept covered.

SELF-ASSESSMENT QUESTIONS:

1. What information must be analyzed to establish a diagnosis of food poisoning?
2. What actions is a family physician required to take when diagnosing "food poisoning"?
3. What distinguishes intestinal infections from foodborne poisonings?
4. What set of public health measures serves as a preventive framework against the emergence of foodborne illnesses?
5. What individual preventive steps are necessary to avoid food poisoning?

HYGIENIC REQUIREMENTS FOR ORGANIZATION OF NUTRITION FOR PATIENTS IN HEALTHCARE INSTITUTIONS

Therapeutic nutrition is considered one of the key components of medical treatment.

Dietary (therapeutic) nutrition implies:

- Correspondence of the chemical structure of food to the actual functional state of the patient's enzymatic systems;
- The use of methods such as therapeutic fasting and detoxification regimens;
- The use of food properties that influence the clinical course of the disease and the nature of the pathological process;

- In combination with pharmacotherapy, it increases treatment effectiveness and mitigates or prevents the side effects of medications;
- It may be the only or primary therapeutic factor in certain diseases such as iron-deficiency anemia, phenylketonuria, and celiac disease.

Contemporary healthcare facilities are placing a greater emphasis on personalized nutrition that aligns with both the progression of a patient's illness and their individual taste preferences. However, the fundamental hygienic standards for food remain consistent.

Dietitians play a crucial role in these institutions by formulating dietary plans and ensuring the quality of food products provided to patients.

Food preparation should incorporate a variety of grinding techniques, including homogenization, along with gentle thermal processing methods that can inadvertently promote microbial growth. This highlights the growing need for rigorous sanitary oversight in hospital nutrition.

Key areas that require particular focus include:

• The promptness of food preparation and delivery

• The conditions under which food is transported and served

• The availability and proper operation of refrigeration units for temporary food storage

• Access to temperature-controlled heating equipment to maintain food warmth

• Adherence to dishwashing protocols and other sanitary practicesDue to the specific nature of hospital food service units, special regulations on space allocation and required facilities have been established.

An important element of hospital nutrition organization is the ward pantry, which is available in each hospital department. Here, food is portioned, maintained at appropriate temperatures (hot or cold), distributed to patient rooms, tea is prepared, and dining and tea utensils are washed and stored.

Special functional tableware is provided for feeding bedridden or severely ill patients.

HYGIENIC REQUIREMENTS FOR NUTRITION ORGANIZATION IN CHILDREN'S INSTITUTIONS

Daily control of nutrition in children's institutions is carried out by the facility's physician and nurse.

Receiving Food Products. The dietitian accepts food products **only** if accompanied by documentation confirming the quality and safety of the products and their belonging to a specific batch. This includes:

- Certificates of veterinary-sanitary examination,
- Manufacturer and supplier documentation verifying origin,
- Certificates of conformity,
- Declarations of compliance.

These documents, as well as the results of laboratory testing of the products, must be retained **until the product is fully utilized.**

There must be **strict control over the condition and hygienic treatment of food containers**. Containers must be washed with a **hot 2% solution of sodium carbonate** (20 g per 1 L of water), rinsed with boiling water, and thoroughly dried.

Monitoring Food Storage Conditions

According to the accepted classification, foods should be stored by category:

- Dry products (flour, sugar, grains, pasta, etc.);
- Bread;
- Meat and fish products;
- Dairy and fats;
- Delicatessen items;
- Fruits and vegetables.

When storing food products, it is essential to observe **strict rules regarding food compatibility**, proper stacking, expiration dates, and storage conditions.

Products with a strong odor (e.g., spices, herring) should be stored separately from those that easily absorb odors (e.g., butter, cheese, eggs, tea, salt, sugar, etc.).

Dry bulk products packed in bags should be stored in **dry, well-ventilated rooms**, equipped with shelves, cupboards, and racks **at least 15 cm above the floor**.

Bread must be stored on racks **at least 35 cm above the floor**, and the racks must be **installed at least 15 cm away from walls**.

In accordance with hygienic standards for **storage conditions and shelf life of perishable goods**, such products must be stored in **refrigerators or freezers**. Each product must be stored **separately**, at its appropriate **temperature** and with strict adherence to **shelf life requirements** (see Table 24).

Table 24.

Maximum shelf life of perishable food products

Product Name	Storage Time (hours)
Large cuts of meat (semi-finished product)	48
Frozen offal	24
Boiled sausage, frankfurters, meat sausages	48
Boiled sausage, vacuum-packed in polymer film	24
Pasteurized cow’s milk	36
Fermented milk (e.g., clabber), kefir	36
Sour cream	72
Curd, curd mass, glazed curd bars	36
Sandwiches with sausage, ham, or fish	3
Boiled, unpeeled vegetables	6

Control over food preparation technology

Food preparation encompasses both cold and heat-based methods. To maintain the vitamins in vegetables meant for raw dishes like salads, it's crucial to wash them thoroughly right before serving. Cooking methods such as boiling, stewing, baking, and braising are vital for safeguarding against parasitic infections and foodborne illnesses.

When it comes to defrosting meat, avoid using warm water immersion or spraying; instead, it should be thawed by hanging or on trays. The cooking process for meat typically involves two phases: initial frying followed by baking (as seen with cutlets). Additionally, boiled meat may require further cooking, either through boiling again or baking in the oven.

Children are served only freshly prepared meals. Cooked items should not remain on the stove for more than 2 to 3 hours. Before serving, all food must be tasted by an appointed committee that includes the head nurse and dietitian. Samples of each prepared dish (with side items kept separate) are collected in sterile containers and stored in a designated refrigerator for up to 24 hours.Dietary orientation of nutrition is based on the principles of mechanical, chemical, and thermal sparing.

Mechanical sparing is achieved by excluding coarse-fiber food and unprocessed meats. Chopped or ground products are used; food is well-cooked or finely grated. Porridges are prepared as liquid, semi-liquid, viscous, or crumbly. Preferred cooking methods: boiling, stewing, steaming.

Artificial food fortification is applied. Ascorbic acid (vitamin C) is added based on the daily requirement: up to 1 year – 30 mg, ages 1–6 – 40 mg, etc. The powder is dissolved in water or liquid food and added to the main pot just before serving (15 minutes prior). Reheating fortified meals is prohibited.

Control over kitchen operations. Ensuring food safety requires strict processing sequence. Raw and cooked foods must be handled on different worktables using clearly labeled cutting boards and knives:

- Meat: MC or MB

- Raw vegetables: CO
- Boiled vegetables: BO
- Bread: X

In the meat/fish unit, poultry, meat, and fish are defrosted at room temperature (or fish in cold water). Peeled raw vegetables can be stored in salted water for up to 1.5 hours. Vegetables for salads are cooked unpeeled and then peeled shortly before use. Peeled boiled vegetables can be stored for up to 2 hours at 2–6°C; unpeeled – up to 6 hours.

Unprocessed eggs must not be stored in rooms for ready meals. Eggs are cleaned in two separate containers using 1% and 0.5% soda solution at ~30°C, then rinsed with running water.

Sausages and cooked meats are peeled and boiled for 5 minutes after boiling begins. Pasta or rice side dishes are rinsed only with hot boiled water.

Milk, fermented milk, juices, and beverages must not be transferred from consumer packaging to other containers. Desserts and beverages (kissels, compotes) are cooled in their cooking vessels in the cold unit. Dishwashing is conducted under strict supervision using detergents.

Sanitary conditions must be maintained with daily wet cleaning and periodic deep cleaning as per the schedule. Different cleaning tools must be used for different kitchen areas, each clearly labeled and stored separately. All equipment must be washed daily with detergents.

Case studies

Case 1: A dietitian received food supplies for a preschool. According to the delivery note: semi-finished meat, sausages (shelf life 4 days), packaged kefir and curd desserts (1-day shelf life), and pasteurized cow milk (2-day shelf life). Some items were rejected.

Task: Identify which products were rejected and why.

Case 2: After breakfast, a summer camp group went hiking in the mountains. Upon return, they were served quickly prepared navy-style pasta.

Task: Provide a hygienic assessment of the situation. What actions should be taken?

QUESTIONS FOR SELF-ASSESSMENT

1. What are the differences between rational and dietary nutrition?
2. What principles underlie dietary-oriented nutrition?
3. What rules must be followed in a food unit to ensure food safety?
4. What protocols must be observed when handling fresh chicken eggs?
5. What are the cleaning specifics for different areas of the kitchen?

PART IV
HYGIENE OF CHILDREN AND ADOLESCENTS

Subject "Hygiene of Children and Adolescents": What Is It?

The mission of the hygiene of children and adolescents is to promote the health of the younger generation by creating healthy conditions in their educational and upbringing environment.

What is the connection with other medical, hygienic, and theoretical disciplines?

The topics studied in this discipline concern one-third of Uzbekistan's population. As of July 1, 2024, the population of Uzbekistan (permanent residents) amounts to 35,640,440 people, including:

- Children under the age of 6 — 3,564,044;
- Children aged 7 to 17 — 4,205,572;
- Youth aged 18 to 29 — 4,276,853;
- Adults aged 30 to 60 — 15,325,389;
- Elderly people over 60 — 7,769,616;
- Among them, 498,966 are long-livers, i.e., individuals over 80 years old.

Children differ from adults in that they are continuously undergoing growth and development. Therefore, they require special conditions, distinct from the hygienic and socio-living standards of adults.

The Main Global Issue in the Hygiene of Children and Adolescents:

The development of a child should be considered in light of the specific conditions life imposes on them, which is essentially the functional maturity of a growing organism.

During the period of growth and development, the child's body undergoes functional changes that, unlike those in adults, require a unique approach in hygienic evaluation and the subsequent development of preventive health measures. This is the specificity of the subject of hygiene of children and adolescents.

Due to the incomplete development of the child's body, it is more susceptible to both beneficial and harmful external influences. This defines the particular nature of the hygiene of children and adolescents. A distinctive feature is that the influence of environmental factors affects children even at lower intensities—often unnoticed or minor for adults.

Another feature of a growing organism is that external influences affect both the functional state and development of the child.

Therefore, a key focus in this area of hygiene is the preservation and strengthening of health. Favorable child development is possible with appropriate evaluation and regulation of environmental factors influencing growth.

Objectives of the Hygiene of Children and Adolescents

These include the study and regulation of the external environment with which the child remains in direct contact throughout growth and development. Due to the constantly changing nature of the child's organism, hygienic standards are structured in steps, and the permissible limits of influencing factors vary in intensity.

Thus, the hygiene of children and adolescents is characterized by the following principles of standardization:

- **Specificity**: Linked to the developmental features of the child's organism.
- **Variability**: In the course of development, the child's organism passes through several stages, each with specific levels of sensitivity to environmental influences. These remain relevant only within certain age intervals and change with age.
- **Transformative Trend of Standards**: There is a need to create conditions that ensure optimal interaction between the child's body and the environment—not only in the present moment but also to support reliable future development.
- **Typology**: Hygienic norms depend on gender and the health status of the developing organism.

Thus, a distinctive feature of the functioning of a child's body is its non-uniformity—**heterochronism** and **wave-like progression**.

All hygiene principles for children and adolescents are based on the concept of heterochronous development of the child's body. Each stage of development and maturation prepares the body to respond to specific influences and parameters that are critical at that stage, making these indicators integral for that age.

The most significant body system at each stage reaches its peak of development, and heterochronism supports the gradual involvement of new systems required for increasingly complex tasks throughout the child's development.

This specific sequence of growth and maturation of certain structural formations is related to the action of specific environmental factors. It results in the gradual and non-simultaneous readiness of the child for different types of educational, labor, and sports activities.

In the process of establishing hygiene standards for the child's environment, a differentiated approach is required.

As the sensitivity to environmental factors changes with age, so too do the hygienic standards throughout the maturation process.

The unique challenge that life poses to children is growing up, and the hygiene of children and adolescents is the field that evaluates and studies the growing organism and its functional maturity.

STUDY AND ASSESSMENT OF THE PHYSICAL DEVELOPMENT OF CHILDREN AND ADOLESCENTS

Patterns of Growth and Development of the Child's Body

The growth and development of a child and their individual organs and systems occur asynchronously (*heterochronically*).

According to P.K. Anokhin, “Selective and accelerated maturation is ensured by those structural formations and functions that determine the organism’s survival.”

It is well established that each age is characterized by specific **morphofunctional features**.

Patterns of growth and development in children and adolescents have been identified (see Fig. 12):

- During the **first year of life**, a child increases in height by approximately **47%**.
- By the age of **three**, height increases by an additional **9%**.
- Between the ages of **4 and 7 years**, height increases by approximately **6% annually**.
- From **8 to 10 years**, the average annual growth rate is about **3%**.
- During **puberty** (ages **16–17**), there is a marked **growth spurt**, followed by a deceleration.
- By the age of **18–20 years**, growth **virtually ceases**.

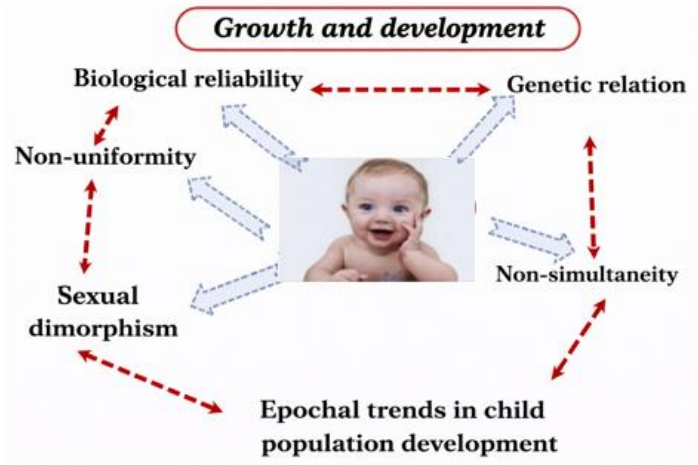

Figure 12. Parameters of a Child’s Growth and Development

Body weight doubles by 4–5 months of age, and by 12 months it nearly triples from the initial weight. Between the ages of 3 and 7, the average annual weight gain is about 5–7,5%, gradually decreasing with age. It increases again only during the period of puberty.

Sexual Dimorphism

In addition to common developmental patterns, boys and girls exhibit specific differences in the rate and timing of growth and development indicators. When regulating physical activity within the educational process, it is essential to consider sexual dimorphism (Figure 13).

Figure 13. Sexual Dimorphism

The growth and rate of development of various parts of a child's body also differ. During the growth process (Figure 14), body proportions change.

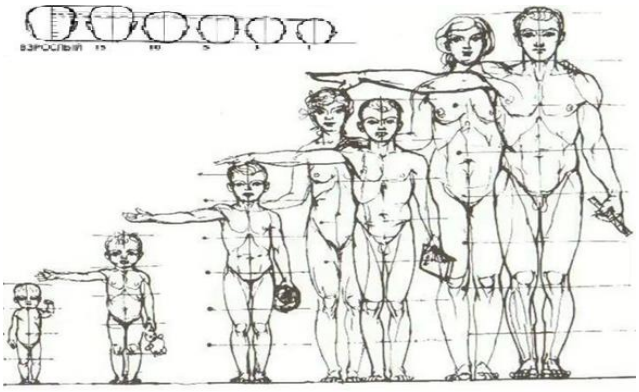

Figure 14. Changes in Body Proportions with Age

Body proportions undergo significant transformation during growth. The transition is observed from:

- Large-headed, short-legged, long-torsoed body types in infancy to:
- Small-headed, long-legged, short-torsoed body types in adulthood.

A.A. Markosyan proposed the concept of the biological reliability of growth and development systems**.** This level of regulation ensures optimal development of the organism. The human body possesses a reserve potential that can be urgently mobilized as an adaptive tool to cope with new conditions and return to its original state. Throughout the entire process of ontogenesis—from birth to natural end—a person progresses with a reserve of vital energy and capabilities. These reserves allow for the optimal course of life processes, regardless of changing environmental conditions.

For example, biological reliability may be based on:

- Redundancy and interchangeability of certain organs (e.g., two kidneys, lungs),
- The body's ability to quickly restore homeostasis,
- The dynamic interaction between systems.

The **genetic program** governs the cycle of individual development through a well-coordinated gene-switching mechanism that regulates the timing of developmental stages depending on environmental changes.

- **Chronogenes** are responsible for the gradual, time-dependent differentiation of cell and tissue functions, corresponding to the child's developmental stages.
- **Switching genes** control processes of cell differentiation or proliferation in organs during development.
- **Gene regulation** stabilizes the growth and development program. For example, premature infants often catch up in development to their peers by the age of three.

Epochal Trends in Child Population Development

Human ontogenesis demonstrates **cyclical processes** that cause fluctuations in the growth and development of the child population. These include:

- **Secular trend**
- **Acceleration (Akseleratsiya)**
- **Retardation of growth and development**

The **secular trend** reflects long-term population-wide dynamics in growth and development.

Over the past century, the following changes have been noted:

- Acceleration in the growth and development of children,
- Increased life expectancy,
- Changes in definitive (final) body size,
- Transformation in disease structure and morbidity patterns.

Factors Influencing Physical Development and Growth:

Key environmental and social factors impacting growth and physical development include:

- Air quality,
- Drinking water quality,
- Solar radiation exposure,

- Living conditions and socioeconomic status.

A child's **functional readiness** for specific activities (e.g., educational, labor, sports) emerges at different times during ontogenesis. This necessitates a **differentiated approach** to regulating environmental influences and assessing their effect on various functional systems.

As the developing child's body evolves, so does its resistance to environmental factors. This creates the need for **age-specific hygiene interventions** tailored to each stage of development.

Thus, **age periodization** must be grounded in the concept of **heterochrony**—the uneven pace of growth and development in children and adolescents. Children of different ages are grouped together for educational and developmental activities (see Table 25). Establishing age boundaries is essential for:

- Enrollment in nurseries, kindergartens, and schools,
- Assessing the timing for the start of adolescent labor activity,
- And similar regulatory purposes.

Table 25.

Age Periodization of Ontogenesis in Children

Period	**Age Range**
Neonatal Period	From 1 to 10 days
Infant Age	From 10 days to 1 year
Early Childhood	1 – 3 years
First Childhood	4 – 7 years
Second Childhood	
– Boys	8 – 12 years
– Girls	8 – 11 years
Adolescence	
– Boys	13 – 16 years

Period	Age Range
– Girls	12 – 15 years
Youth	
– Young men	17 – 21 years
– Young women	16 – 20 years

Development and the Musculoskeletal System

A noticeable increase in body size is observed during the first year of life and at the age of six. An intensive increase in foot size is noted in girls starting from age 7, and in boys from age 9. Between the ages of 5 and 7, the length of the limbs changes sharply, exceeding the growth rate of the body. Body weight gain lags behind the rate of height increase.

A deficiency of minerals and vitamins during this period can lead to skeletal deformities (deformations in the development of the spinal column and limbs), which may result in the occurrence of scoliosis and flat feet. This period requires special attention to the organization of a proper sitting posture for schoolchildren and the use of regulated physical activities.

The organ of vision develops up to 7–10 years of age. Prolonged visual strain, poor lighting, unsuitable school furniture, and unsafe educational materials lead to the development of myopia.

Sexual Differences. From birth, changes in physical development can be observed: boys typically have a higher body mass and chest circumference than girls. Girls between the ages of 12–13 are taller than boys, but by 14–15 years of age, boys surpass them in development, showing higher physical parameters.

Neonatal Period

The sudden change in living conditions stimulates the child's body to adapt to an environment unfamiliar to it. In the first days after birth, newborns exhibit weight loss of about 6–10%, intensified breakdown of erythrocytes, and temporary insufficiency of liver function, resulting in jaundice. Thermoregulation is still immature, and body temperature is highly dependent

on ambient conditions. With proper care, most deviations are practically eliminated by the second week of life. Breast milk is the primary complete nutrition source for newborns.

Infant Age

The first year is marked by significant weight and height gain. Up to 6 months, a child typically gains up to 600 g monthly, with height increasing by 2,5–3 cm.

Teething: By 6 months, the lower incisors usually erupt first, followed by the upper, then lateral incisors and canines. The first molars typically form by the first year.

The digestive system develops during this period. Any change in diet, quality, or quantity of food can cause digestive disturbances. The primary food until 6 months remains breast milk.

By age one, the maturity of the digestive system and the presence of 8 teeth indicate readiness to transition from breastfeeding to a general diet.

Intensive development of functional systems occurs in the early years. The nervous system enables adaptation to constantly changing external conditions, with increased mass of the brain and spinal cord.

Speech Development: Early sounds—cooing—progress to babbling by 4 months and syllables by 6 months. By one year, a child can understand adult speech well and articulate up to 10 words.

Due to high neural activity, infants tire quickly and require sleep for adequate rest.

During this period, the skeleton grows rapidly. Cervical and lumbar spinal curvatures form, trunk and leg muscles strengthen. The child learns to sit, stand, and attempts to walk, although movements are still uncoordinated.

Age 1 to 3 Years – Nursery Age

The development rate slows down. Annually, height increases by only 8–10 cm and weight by 4–6 kg. Body proportions change. The musculoskeletal system continues to form intensively. Nervous system development accelerates.

Coordinated movements allow independent walking and running. Speech develops, vocabulary reaches 200–300 words. Children can construct full phrases.

This is a critical period for structured educational work with children.

Preschool Age (3 to 7 years)

The growth rate continues to slow: height increases by 5–8 cm per year, and weight by about 2 kg. The body becomes more proportional.

The development of higher nervous activity and the muscular system enables children to perform various physical activities. They can run, jump, play musical instruments, draw, sculpt, etc.

Improved nervous activity allows sustained attention to tasks.

From the third year, speech signals become the main tool for behavior regulation. The vocabulary significantly expands.

Adult attention and proper upbringing play a crucial role in a child's mental development. Lack of attention leads to undesirable behaviors: tearfulness, irritability, aggression, fatigue, and poor concentration, often accompanied by unstable and depressed mood. These behavioral changes can trigger functional disturbances and illnesses.

School Age (6–7 to 17 years)

Junior School Age (7 to 11–12 years). All organs and systems continue to develop. Notably, the replacement of baby teeth with permanent teeth begins—a process that typically spans around 10 years. Jaw formation completes by ages 14–16. Skeletal ossification and muscle mass accumulation continue.

Enhanced intellectual development fosters independence, marking the beginning of the school period. Special attention must be paid to health during this transitional phase. Children with developmental delays or chronic illnesses require individualized assessment and care tailored to their physiological and functional capabilities.

Senior School Age (12 to 17 years). This stage is marked by the appearance of secondary sexual characteristics and the achievement of sexual maturity. The

timing varies by sex: generally between 12–16 years for girls and 13–18 years for boys. The culmination of this period is a surge in both physical and psychological development.All body systems undergo restructuring. There is increased activity of the gonads and the endocrine system. A "hormonal storm" occurs—adolescents produce more sex hormones than adults.

A rapid growth spurt occurs: girls up to 15, boys up to 16–17 years. Body proportions shift—first the head, hands, and feet grow, followed by limbs, and finally the torso. Internal organ maturation lags, affecting heart, lung, and brain circulation, leading to fluctuations in vascular and muscle tone. This causes changes in physical condition and mood. A new level of sexual identification emerges, reflected in behavior (masculinity or femininity). Social mimicry develops—adolescents perceive themselves as grown-ups and unique, which manifests in appearance, behavior, etc.

Conclusion: One of the key tasks of hygiene for children and adolescents is to understand the mechanisms of transformation in a child’s ontogenesis, primarily through the assessment of morphological and functional changes. Physicians must be able to assess a child's somatic development and the congruence between their biological and chronological age.

STUDYING THE LEVEL OF BIOLOGICAL DEVELOPMENT

Physical development is a complex of morphological and functional characteristics that ensure high working capacity in humans. While it is projected by hereditary factors, physical development is also significantly influenced by sanitary and living conditions, as well as the level of environmental pollution. The degree of physical development is one of the key indicators of health in children and adolescents.

The phenomena of **acceleration** and **retardation** observed in modern children highlight the necessity of conducting a thorough evaluation of physical development. This, in turn, requires a reconsideration of existing standards for school furniture, reassessment of physical activity levels, and the development of new pedagogical technologies for teaching and education.

Such transformations in children's growth and weight result in changes in physical strength levels and an increase in muscle mass. **Morphological maturity** is evaluated based on changes in the musculoskeletal system, body proportions, muscle strength, endurance, and motor coordination. This also includes assessing **school readiness**, that is, the degree to which a child's development is sufficient to begin formal schooling.

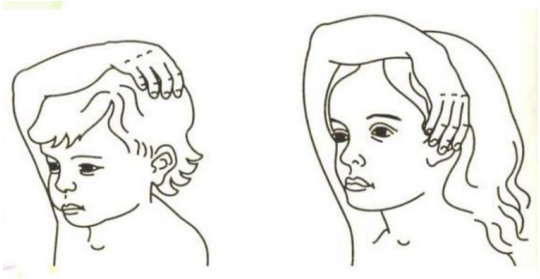

Figure 15. The Philippine Test

An example of assessing maturity can be the Philippine test (Fig. 4), which determines morphological maturity based on the lag in the growth of the head and neck compared to the accelerated growth of the limbs.

Physical development is assessed using the following methods:

I. Somatometry (measurement of height, weight, and chest circumference);

II. Somatoscopy (visual examination of the body);

III. Physiometry (assessment of functional criteria).

I. Somatometry

This method involves measuring **absolute indicators** such as:

- Height (standing)
- Height (sitting)
- Chest circumference
- Body weight

These measurements allow for a comparative evaluation of physical development levels.

II. Somatoscopy

A **visual inspection** of the body is used to assess:

- **Body type** (constitution, proportionality, musculoskeletal development, fat distribution)
- **Posture**
- **Chest shape**
- **Leg shape and foot condition**
- **Development of secondary sexual characteristics**
- **Skeletal maturity** (evaluated by the timing and extent of bone ossification)
- **Dental maturity** (based on the timing of primary and permanent tooth eruption, and tooth wear)
- **Morphological and psychological maturity**

III. Physiometry allows for the determination of the functional indicators of the human body. To assess physical development, the following are measured: vital lung capacity (spirometry), hand muscle strength, back extensor strength (dynamometry), heart rate, and blood pressure.

The pace of a child's physical and mental development is individual and can vary significantly among peers. A distinction is made between biological age and chronological (passport) age.

ASSESSMENT OF DEVELOPMENT

Biological age reflects the morphological and physiological state of the organism — the actual level of development achieved. While it is influenced by the genetic blueprint, environmental conditions and lifestyle play a direct role in shaping it.

To determine biological age, the following criteria are used:

I. Level of Puberty – Sexual Maturity

II. Timing and Degree of Skeletal Ossification – Skeletal Maturity

III. Timing of Tooth Eruption – Dental Maturity

IV. Body Shape and Constitution

V. Characteristics of Psychophysiological Development

VI. Muscular System Level – Strength, Endurance, and Coordination

Chronological (passport) age - refers to the time elapsed from the moment of birth to the moment of examination. It is calculated using standard age tables (e.g., Table 26).

As the child grows, the diagnostic relevance of each biological age criterion changes, and a comprehensive assessment requires considering age-specific indicators.

Key Criteria for Determining Biological Age:

1. Body Length (Height) — compared to age-related normative values using the formula: $\mathbf{M \pm \sigma}$, where

$\boldsymbol{M}$ is the average height for the age $\boldsymbol{\sigma}$ is the standard deviation

2. Annual Growth Increments —

   For children over 7 years, compare the rate of annual height gain and the proportional relationships between developmental characteristics.

3. Number of Permanent Teeth —

   For children under 10 years, biological maturity is partly assessed by the number of erupted permanent teeth.

4. Secondary Sexual Characteristics —

   For children over 10 years, the level of sexual development (e.g., appearance of body hair, breast development in girls, voice change in boys) is evaluated.

5. Bone Age —

   Determined by the degree of ossification (development of bone tissue and closure of growth plates), usually assessed through X-ray examination (e.g., of the hand and wrist bones).

Table 26:

Determination of Chronological Age at the Time of Examination

Month of Birth	Month of Examination											
	1	2	3	4	5	6	7	8	9	10	11	12
1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	+11
2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10
3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8
5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7
6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6
7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5
8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4
9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3
10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2
11	10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1
12	11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

Example: A child was born on **October 7, 2013**, and examined on **September 10, 2023**. Subtracting the year of birth from the year of examination yields an age of **10 years**. At the intersection of the **horizontal (October = 10)** and **vertical (September = 9)** columns of Table 2, the value is "**–1**." This means the child is lacking **1 month** to complete 10 years. Therefore, the child's **actual age at the time of examination was 9 years and 11 months**.

One of the most reliable indicators of biological maturity is the **ossification of the bones of the hand**, but this method is rarely used due to the necessity of radiographic examination, which may pose health risks for the developing body.

An **accelerated or delayed rate of individual biological development** compared to chronological age requires timely and accurate assessment. Determining biological age is especially important during the school years.

In students with **accelerated development**, work capacity tends to be **lower** than that of peers whose **biological age corresponds** with their chronological age. Students who are **biologically delayed** often exhibit low activity in lessons,

increased distractibility, poor adaptation to physical and mental stress, and elevated visual fatigue. They are also subjected to significant strain on the **musculoskeletal and cardiovascular systems**.

Children with delayed biological development commonly exhibit **reduced somatometric parameters** and are more prone to **functional disturbances** in the **cardiovascular, nervous, and musculoskeletal systems**.

Methodology of Somatometric Measurements

Height measurement is carried out using a **stadiometer**. A stadiometer is a vertical stand fixed on a platform, usually up to 2 meters tall, equipped with a measuring scale in **0,5 cm increments**. A movable slider with a horizontal headboard (platen) is used to take measurements. When measuring **sitting height**, the child is asked to sit on a **foldable bench** attached to the stadiometer's platform.

Measurement of Standing Height

The child should stand **upright**, with **arms hanging down**, **heels together**, and **toes slightly apart**. The **heels, buttocks, and area between the shoulder blades** should touch the stadiometer stand. The **head should be positioned** such that an **imaginary horizontal line** connects the **upper margin of the ear tragus** to the **lower margin of the eye socket**. The headboard of the stadiometer is then gently lowered until it touches the **top of the skull** (see Figure 16).

Figure 16. Methodology for Measuring Height

Measuring the Height of an Infant

In infants, height is measured using a **horizontal stadiometer** while the child lies on their **back**. The **head** must be positioned **firmly against the head plate**. The infant's **legs are gently straightened**, and the **knees pressed down**. The **footplate** is moved until it touches the **infant's heels** (see Figure 5). The measurement should be performed **at least three times**, and the **average value** is recorded as the final result.

Measurement of Sitting Height

The child sits on the stadiometer bench, touching the upright support with the inter-scapular region and buttocks. The head is positioned the same way as during standing height measurement. The legs are bent at the knees at a right angle.

The feet rest on a platform, and the arms are relaxed and lowered (see Fig. 16).

Fig. 17. Method for Determining Body Mass

Determining Body Mass

Medical scales are used to determine body weight. Before weighing, the scales are calibrated. Children and adolescents are weighed in a fasting state, with a bare torso and without shoes. The child is placed in the center of the scale platform.

Method for Weighing an Infant

The weighing platform is treated with a disinfectant solution. First, the weight of the diaper is measured. The infant is undressed and placed on the scale — first with the buttocks, then the shoulders and head, while holding the legs gently (Fig. 17).

Measuring Chest Circumference

A standard measuring tape is used to measure chest circumference. It is measured at rest, during maximum inhalation, and during exhalation. The

subject is asked to raise their arms; the tape is placed posteriorly under the lower angles of the shoulder blades and anteriorly along the edge of the nipple area in boys and along the fourth rib in girls. During breathing movements, the tape should follow the chest contour without restriction.

Methodology for Somatoscopic Examination

Assessment of Skin and Mucous Membranes — includes evaluation of color, turgor, and moisture.

Fat Deposits are measured by the thickness of a skinfold on the abdomen. The fold is measured to the side of the navel and under the shoulder blade using a small caliper. The measured thickness is divided in half. Fat deposits are considered **average** if the fold thickness is between 1–2 cm, **below average** if less than 1 cm, and **above average** if more than 2 cm.

Skeleton Type

Types of body build include: slender, stocky, and intermediate.

- **Slender type**: narrow shoulders and chest.
- **Stocky type**: broad shoulders and chest, large hands and feet.

Chest Shape

The chest may be cylindrical, conical, flat, or mixed.

- **Cylindrical chest** appears uniformly developed, with the subcostal angle close to 90°, and a rounded shape.
- **Conical chest** has a broader, forward-projecting lower section, with a subcostal angle greater than 90°.
- **Flat chest** is elongated and flattened, with a narrow subcostal angle less than 90°.

Spine

Types and examples of spinal forms are shown in Fig. 18.
A **normal spine** in the sagittal plane has an S-shape. The cervical and lumbar curves are mild and directed anteriorly.

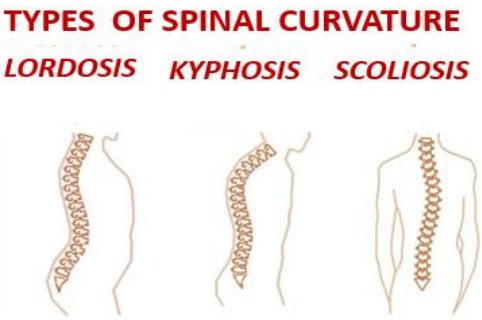

Fig. 18. Forms of the Spine

Lordotic Spine. The lordotic spine is characterized by a slight cervical curvature and a pronounced lumbar curvature.

Kyphotic Spine. In the kyphotic spine, both the thoracic and cervical convexities are sharply pronounced.

Scoliosis. Right- and left-sided scoliosis are classified as spinal deformities. Depending on the severity and location of the scoliosis, asymmetry of the shoulders and shoulder blades varies in expression.

- In Grade I scoliosis, the defect is not fixed and can be corrected by muscle tension.
- In Grade II scoliosis, a clear lateral curvature to the left or right is observed, along with the formation of compensatory muscular ridges.
- Grade III scoliosis is marked by severe spinal curvature and deformity of the rib cage.

Simple Method of Spinal Examination

A basic method for examining the spinal column involves sliding a finger along the spinous processes of the vertebrae. This technique allows for the detection of spinal curvature or deviation from the normal alignment.

Leg Shapes

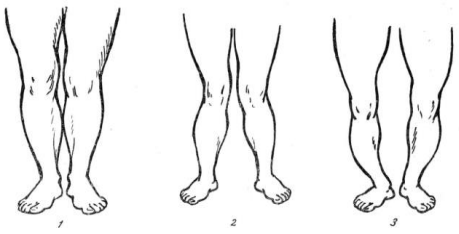

Fig. 19. Leg Shapes

There are three recognized forms of leg alignment (Fig. 19):

1. **Normal shape**
2. **X-shaped (valgus deformity)**
3. **O-shaped (varus deformity)**

To assess leg alignment, the child is positioned as shown in Fig. 19. In the case of a **normal leg shape**, the knees touch at the joint line. In an **O-shaped alignment**, the knees do not touch, and in an **X-shaped alignment**, one knee overlaps the other.

Foot Arch Shape

Foot shapes include:

- **Normal (arched)** foot
- **Flattened** foot
- **Flatfoot (planovalgus deformity)**

The method used to examine foot flattening is called **plantography** (Fig. 20). There are two diagnostic techniques: classical and computerized.

Classical Method:

The soles of the subject's feet are coated with methylene blue solution or a 10% solution of sesquichloride of iron. The child then stands on a clean sheet of paper, and the resulting footprint is examined.

For analysis:

- A tangent line is drawn along the most prominent points of the inner contour of the footprint.
- A perpendicular is drawn from the midpoint of the tangent to the outer edge of the footprint.

- The section of the perpendicular intersecting the footprint is measured and expressed as a percentage of the total length.

Interpretation:

- If the isthmus width is up to 50% — the foot is **normal** (arched).
- If it is between 50–60% — the foot is **flattened**.
- If it exceeds 60% — **pronounced flatfoot** is diagnosed.

Computerized Plantography:

This method does not require dye application. The child stands barefoot on a scanning device, and the analysis is performed using specialized software that processes the footprint data and provides a detailed assessment.

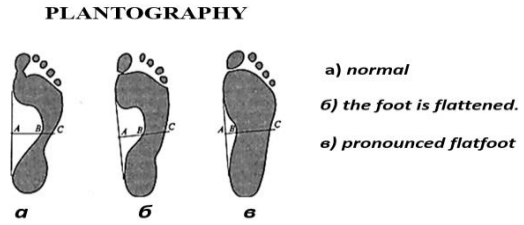

Fig. 20. Foot Shape.

Puberty Period

When assessing the physical development of girls from the age of 9–10 and of boys approximately a year later, it is essential to consider the level of sexual maturation. In male adolescents, hormonal changes during puberty lead to significant transformations in the body:

- Voice mutation occurs (commonly referred to as voice "breaking"),
- The size of the thyroid cartilage (Adam's apple) increases,
- Pubic, axillary, and facial hair begins to grow.

In girls, **puberty** begins with the development of the **mammary glands**, followed by the growth of **pubic and axillary hair**. The **onset of menstrual function** is a key indicator of completed sexual maturation in females.

The **degree of development** of these characteristics is assessed using the system presented in **Table 27** (not shown here).

Table 27.

Determination of the Stage of Adolescents' Development.

1.	Stages of Pubic Hair Development:
P_0	– No hair;
P_1	– Isolated short hairs;
P_2	– Hair in the central pubic region, moderately dense;
P_3	– Hair covers the entire pubic triangle, dense and long,
P_4	– extending to the inner thighs and upward along the linea alba (male pattern of hair distribution).
Stages of Axillary (Underarm) Hair Development:	
Ax_0	No hair;
Ax_1	Sparse individual hairs;
A_{X2}	Hair localized in the center of the axilla, clearly visible;
Ax_3	Hair covers the entire axillary region, dense.
Stages of Mammary Gland (Breast) Development (for females):	
Ma_0	Prepubertal stage;
Ma_1	Nipple is elevated above the areola; glands are not prominent;
Ma_2	Areola enlarges and, together with the nipple, forms a cone; glands become slightly pronounced;
Ma_3	Nipple and areola retain the conical shape; mammary glands are more elevated and cover a larger area;
Ma	Mature female stage: the nipple is elevated above the areola; the glands reach size and shape typical of an adult woman.

A certain level of sexual maturation is expressed using a formula that indicates the stage of development of secondary sexual characteristics (see **Table 28**). For example, in girls: **$Ma_3Ax_3P_3$** — indicating Stage 3 development of mammary glands (Ma), axillary hair (Ax), and pubic hair (P).

Table 28.

Age Norms for the Development of Secondary Sexual Characteristics in Children

Age (years)	Boys	Girls
10	Ax_0 P_0	Ma_0 Ax_0 P_0
11	Ax_0 P_0	Ma_0 Ax_0 P_0 or manifestation of one or two indicators at Stage 1
12	Ax_0 P_0	Ma_1 Ax_1 P_1, Ma_2 Ax_2 P_2, or manifestation of one or two indicators at Stage 1 or 2. Absence of menstruation (Me–)
13	Ax_0 P_0, Ax_1 P_1 and one indicator at Stage 1, the other at Stage 0	Ma_2 Ax_2 P_2, Ma_3 Ax_3 P_3 or manifestation of one or two indicators at Stage 2 or 3. Menstruation may or may not be present
14	Ax_1 P_1, Ax_2 P_2 and one indicator at Stage 1, the other at Stage 2	Ma_3 Ax_3 P_3 or manifestation of one or two indicators at Stage 2. Presence of menstruation (Me^+)
15	Ax_3 P_3 or one of the indicators at Stage 1	Ma_3 Ax_3 P_3 or one of the indicators at Stage 2. Presence of menstruation (Me^+)
16–17	Ax_3 P_3, Ax_3 P_4	Ma_3 Ax_3 P_3. Presence of menstruation (Me^+)

Study of Physiometric Indicators

Vital capacity of the lungs (VCL) is measured using a device called a **spirometer**.

Fig. 21. Spirometer.

For the examination, the child takes a maximum inhalation and exhales all the air into the spirometer tube (Fig. 21). The assessment is carried out two to three times, and the best result is recorded.

Sometimes, a computational method is used to determine the required

“normal” vital lung capacity using a formula. It is necessary to know the height and weight. Then, by substituting the obtained values into the formula, the theoretical volume — vital lung capacity — is calculated.

Calculation formulas for the required vital lung capacity:
Boys aged 8–12: RVLC (L) = Height (cm) × 0,052 – Age (years) × 0,022 – 4,6;
Boys aged 13–16: RVLC (L) = Height (cm) × 0,052 – Age (years) × 0,022 – 4,2;
Girls aged 8–16: RVLC (L) = Height (cm) × 0,041 – Age (years) × 0,018 – 3,7;

Hand muscle strength.

Assessed using a hand dynamometer. The child extends the arm sideways at a right angle and must try to squeeze the dynamometer spring as hard as possible (Fig. 22). The maximum result (in kilograms) is recorded.

Fig. 22. Hand and back dynamometers.

The power of the back extensors, often referred to as back strength in the context of deadlifting, is assessed with a specialized device known as a back dynamometer (see Fig. 22). To perform the test, the individual positions their feet firmly on the dynamometer plate located on the floor and grips the handle of the apparatus. They then exert effort to stand upright, pulling the handle upwards as much as they can. The highest value achieved, measured in kilograms, is noted for evaluation.

The heart rate is calculated by counting the pulse for one minute. Blood pressure in schoolchildren is measured starting from the age of 7, and it is a mandatory part of medical examinations.

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ASSESSMENT OF PHYSICAL DEVELOPMENT

Physical development is an indicator of each child's health status.

It is assessed based on characteristic indicators and the degree of a child's development, comparing them with the average values of their respective age and sex group. Indicators used reflect the development of a child under similar living conditions. For this purpose, standardized assessment tables are compiled.

Observation and monitoring of a person's physical development begin from birth. A combination of morphological and functional properties of the body is referred to as physical development, which determines the harmony of body growth, its dimensions, structure, and physiological characteristics.

There are three main groups of indicators for assessing population health:

1. Demographic indicators;
2. Morbidity and disability rates;
3. Physical development.

Every physician should be familiar with methods for assessing physical development, including:

- The sigma (standard deviation) method with development profiling;
- The regression scale method;
- The centile method;
- The complex method.

Such assessments help evaluate a child's health status and develop health improvement measures.

During mass medical check-ups for children, somatometric examinations are conducted, including measurements of height, weight, and chest circumference. The data is grouped by age, sex, nationality, and social living conditions, then statistically processed. The result is standardized tables known as “standards of physical development.”

Timelines for assessing physical development:

1. For children under 1 year – monthly;
2. From 1 to 3 years – every 3 months;

3. From 3 to 7 years – every 6 months;
4. For children over 7 years – annually.

Existing methods for assessing physical development:

- Sigma deviation method;
- Regression method;
- Centile method;
- Complex method.

Assessment of physical development using the sigma deviation method and development profile:

This method is based on comparing an individual child's parameters with the average values for a given age group. Average values are assessed using standardized tables.

Next, the integrated physical development indicators (height, weight, and chest circumference) are plotted on a graph to create a physical development profile.

To construct these tables, arithmetic means (M) for each parameter are calculated.

Example:

A group of 100 boys of the same age stands in a line. We calculate the average value (see Fig. 23) separately for all the parameters.

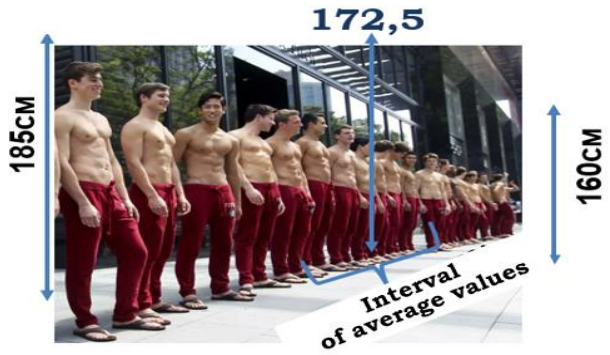


Fig. 23. Example of calculating average values

$$\mathbf{M\ cp} = \frac{\mathbf{M_1 + M_2 + M_3 + \ldots\ M_n}}{\mathbf{100}}$$

Let's assume the average height (M_{av}) = 172,5cm. However, among these 100 boys, no one has exactly this height. So how do we determine who falls into the group with average values? For this, the method of calculating **standard deviation** (σ) is used.

Let's assume in our case:

$$\delta = \pm\sqrt{\frac{\sum(Xn-\Delta X1)^2+(Xn-\Delta X2)^2+(Xn-\Delta Xn)^2}{n-1}}$$

σ = ±2,5 cm

Thus, we obtain the **range of average values**, calculated as: $\mathbf{M_{av} \pm \sigma}$, that is:

Upper limit = 172,5 + 2,5 = **175,0 cm**

Lower limit = 172,5 – 2,5 = **170,0 cm**

Where:

M = arithmetic mean of the trait. **σ** = standard deviation

The result of assessing the physical development of children and adolescents by the value of sigma deviations is:

- **Proportional development** — when all parameters fall within the same evaluation range.
- **Disproportional development** — if differences exceed **one sigma (σ)** between indicators.

Depending on the magnitude of sigma deviations, five groups of physical development are identified (Table 29):

Table 29.

Groups of Physical Development

(Will be translated in the next message if you provide the content of the table.)

Group of Physical Development	Sigma Deviations
I — Average	from M − 1σ to M + 1σ
II — Above Average	from M + 1σ to M + 2σ

Group of Physical Development	Sigma Deviations
III — High	from M + 2σ to M + 3σ
IV — Below Average	from M − 2σ to M − 1σ
V — Low	from M − 3σ to M − 2σ

Example:

A 9-year-old girl has a height of 131 cm, weight of 28,5 kg, and chest circumference of 65,5 cm. To determine her level of physical development, use the standard table for 9-year-old girls to find the **mean (M)** and **standard deviation (σ)** for height, weight, and chest circumference (Table 30). Based on these values, a table of **sigma (σ) deviations** is constructed.

Table 30.

Levels of Physical Development

Indicator	Examined subject's value	M (Mean)	σ (Standard Deviation)	Difference between M and subject's value	Sigma deviation value
Height (cm)	131,0	132,9	12	−1,9	−0,3
Weight (kg)	28,5	29,7	5,65	−1,2	−0,2
Chest circumference (cm)	65,5	63,3	5,02	+2,2	+0,44

Based on the magnitude of the standard deviations of the studied indicators, a graph is constructed — the anthropometric profile of the child's physical development.

Phisical development profile (fig.24)

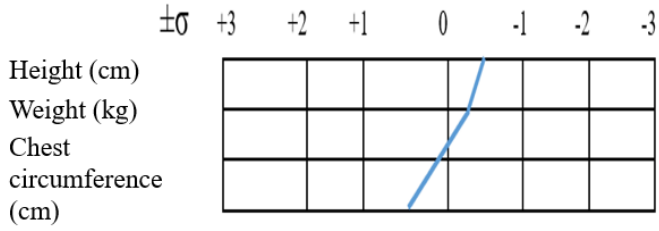


Figure 24. Physical Development Profile

Conclusion: The physical development of the girl is assessed as average and proportionate.

Assessment of Physical Development Using the Regression Scale Method

The **main disadvantage** of the sigma deviation method is that it evaluates each indicator separately.

To assess **harmoniousness**, the configuration of points on the sigma deviation graph for each indicator is analyzed:

- If all values lie within **±1σ** (sigma) — the development is considered **harmonious**.
- If indicators differ by **more than 1σ** — the development is **disharmonious**.
- If differences exceed **2σ** — it is considered **sharply disharmonious**.

Assessment by Regression Scale Method

Regression scale tables are created based on the **correlation relationship** between somatometric traits, with **body length (height)** as the main indicator.

- The **correlation coefficient (R)** measures the strength of the linear relationship between variables.
- An **R close to 1** indicates a strong linear dependence.
- An **R close to 0** means little or no linear correlation.

This **regression analysis method** has long been used in **medical statistics**. It builds a mathematical model to recognize patterns in objects (like children's anthropometric data), classifying them based on growth parameters such as **height, weight, and chest circumference**.

Advantages of the Regression Method:

- It allows **evaluation of interrelations** among the studied traits.
- It determines both the **level of physical development** and the **degree of its harmony**.

Procedure:

1. Use **standard regression tables** to determine the **growth category** (e.g., low, average, high).
2. Based on this category, compare the child's **weight** and **chest circumference** with the standard expected values for that height.
3. The **difference between the child's actual values and the standards** shows how harmonious or disharmonious their physical development is.

These calculations are pre-built into the **evaluation table (Table 31)**.

Table Foundation:

The child's **body length** (height) is categorized into **five groups**: I. Low . II. Belowaverage. III.Average. IV. Above average. V. High.

Determining Morphological Harmony:

- Development is considered **harmonious** if **weight and chest circumference** correspond to body length or **differ by no more than one sigma (M ± δR)**.
- Development is **disharmonious** when the **weight or chest circumference** is too low or too high relative to the child's height.

Example:

Disharmonious development could be observed in **underweight children with low stature**, indicating a nutritional or developmental concern.

Table 31

Parameters for Assessing Physical Development

Physical Development	**Magnitude of Sigma Deviation of Body Mass and Chest Circumference**
Harmonious	≤ 1,0
Disharmonious	From ±1,1 to ±2,0 (due to increased (+) or decreased (–) body mass or chest circumference)

Physical Development	Magnitude of Sigma Deviation of Body Mass and Chest Circumference
Sharply Disharmonious	≥ ±2,1 (due to a sharp increase (+) or decrease (–) in body mass or chest circumference)

Table 32

Regression Scale for Assessing Physical Development Based on Height in 10-Year-Old Children

Signal Deviation Boundaries	Boys			Girls		
	Height (cm)	Weight (kg)	Chest Circumference (cm)	Height (cm)	Weight (kg)	Chest Circumference (cm)
Low from M−2σ and below	121	22,3	61,7	120	20,9	58,2
	122	22,9	61,9	121	21,5	58,5
	123	23,5	62,2	122	22,1	58,9
	124	24,1	62,4	123	22,7	59,2
Below Average from M−1σ to M−2σ	125	24,7	62,7	124	23,3	59,6
	126	25,3	62,9	125	23,9	59,9
	127	25,9	63,2	126	24,5	60,3
	128	26,5	63,4	127	25,1	60,6
	129	27,1	63,7	128	25,7	61,0
	130	27,6	63,9	129	26,3	61,3
	131	28,3	64,2	130	26,9	61,7
Average from M−1σ to M+1σ				131	27,5	62,0
	132	28,9	64,4	132	28,1	62,4
	133	29,5	64,6	133	28,7	62,7
	134	30,1	64,9	134	29,3	63,1
	135	30,7	65,1	135	29,9	63,4
	136	31,3	65,4	136	30,5	63,8
	137	31,9	65,6	137	31,1	64,1
	138	32,5	65,9	138	31,7	64,5
	139	33,1	66,1	139	32,3	64,8
	140	33,7	66,4	140	32,9	65,2
	141	34,3	66,6	141	33,5	55,5
	142	34,9	66,9	142	34,1	65,9
	143	35,5	67,2	143	34,7	66,2
	144	36,1	67,4	144	35,3	66,6
				145	35,9	66,9

Above Average from M+1σ to M+2σ	145	36,7	67,7	146	36,5	67,3
	146	37,3	67,9	147	37,1	67,6
	147	37,9	68,1	148	37,7	68,0
	148	38,5	68,4	149	38,3	68,3
	149	39,1	68,6	150	38,9	68,7
	150	39,7	68,9	151	39,5	69,0
	151	40,3	69,1	152	40,1	69,4
High from M+2σ and above	152	40,9	69,4	153	40,7	69,7
	153	41,5	69,6	154	41,3	70,1
	154	42,1	69,9	155	41,9	70,4
	155	42,7	70,1	156	42,5	70,8
	156	43,8	70,4	157	43,1	71,2
M	137,74	32,36	65,84	137,96	31,72	64,48
± σ	6,4			6,8		
$R_{y/x}$		0,59	0,24		0,56	0,34
$\pm \sigma_R$		3,64	3,60		3,92	3,72

If a child shows parameters with body weight below the established limits, they are referred to a physician for consultation. The pediatrician should pay particular attention to weight deficiency. In cases of excess body weight exceeding the limits, the child is referred to an endocrinologist to assess the possibility of obesity.

Children with height below the established parameters are referred to an endocrinologist as well, due to the potential risk of general physical development delay.

When assessing physical development (Table 32), corresponding to the child's sex and age, first the height is determined. Then, following the horizontal line, the normal values for body weight and chest circumference corresponding to that height are identified. After that, the actual values are compared with the standard indicators for body weight and chest circumference to determine the factual deviation.

Example:

A 10-year-old girl has a height of 136 cm, a body weight of 30.2 kg, and a chest circumference of 62 cm. Evaluate her physical development using the regression

scales. Based on the chart for girls aged 10, a height of 136 cm indicates an average (normal) level of physical development. Her physical growth appears to be well-balanced.

Comprehensive Approach to Assessing Physical Development

This thorough framework enables the evaluation of individual morpho-functional growth and its overall balance. It is particularly effective for assessing a child's physical development.

The assessment follows a two-step process:

1. Evaluate the level of biological development relative to chronological age.

2. Assess the harmony of the morpho-functional condition.

Table 33.

Scheme for Comprehensive Assessment of Physical Development

Biological Level	**Morpho-functional Condition**	**Weight, Chest Circumference**	**Functional Indicators**
Corresponds to Age	Harmonious	M ± up to M ± 1.1 and higher due to muscular development	M ± and above
Ahead of Age	Disharmonious	From M – 1,1 to M − 2 or M + 1,1 to M + 2 due to increased fat accumulation	From M − 1 to M − 2
Lagging Behind Age	Sharply Disharmonious	From M – 2,1 and lower or M + 2,1 and higher due to excessive fat accumulation	From M – 2,1 and lower

The biological age of children and adolescents is determined based on their height and annual height increase, the timing of the eruption of permanent teeth (Table 34), and the degree of development of secondary sexual characteristics.

The obtained data are compared with regional age-based reference tables for biological age indicators.

Important parameters of biological development in preschool age (from 5 years) and early school age include:

- **Height**,
- **Annual height increment**, and
- **Number of permanent teeth**.

Table 34.

Age Standards for the Eruption of Permanent Teeth (units)

Age, years	Boys (bpm)	Girls (bpm)	Age, years	Boys (bpm)	Girls (bpm)
5,5	0–3	0–5	9,5	12–18	13–19
6,0	1–5	1–6	10,0	14–21	15–22
6,5	3–8	3–9	10,5	15–22	16–24
7,0	5–10	6–11	11,0	16–24	18–25
7,5	6–12	8–13	11,5	18–26	21–27
8,0	8–14	11–14	12,0	21–27	22–28
8,5	11–17	12–17	12,5	25–29	26–29
9,0	12–17	12–18			

Table 35.

Vital Lung Capacity in Schoolchildren

Age (years)	Boys (M ± m, mL)	Girls (M ± m, mL)
7	1387 ± 32,5	1372 ± 40,8
8	1633 ± 23,8	1516 ± 24,0
9	1921 ± 26,4	1734 ± 25,0
10	2086 ± 27,5	1859 ± 24,3
11	2223 ± 26,5	2060 ± 30,7
12	2493 ± 28,1	2370 ± 35,8
13	2841 ± 33,7	2632 ± 34,8
14	3160 ± 40,2	2833 ± 36,5
15	3729 ± 47,7	3037 ± 33,7
16	4085 ± 56,1	3048 ± 33,0

Age (years)	Boys (M ± m, mL)	Girls (M ± m, mL)
17	4481 ± 51,7	3028 ± 49,2

Table 36.

Handgrip Strength of Schoolchildren (in kg)

Age (years)	Boys – Right Hand (M ± m)	Boys – Left Hand (M ± m)	Girls – Right Hand (M ± m)	Girls – Left Hand (M ± m)
7	11,77 ± 0.25	10,83 ± 0.26	9.90 ± 0.26	9.46 ± 0.27
8	13,51 ± 0.20	12,38 ± 0.20	11.12 ± 0.17	10.30 ± 0.17
9	15,13 ± 0.25	14,05 ± 0.23	12.40 ± 0.21	11.52 ± 0.21
10	17,61 ± 0.26	16,18 ± 0.26	14.05 ± 0.23	12.93 ± 0.21
11	19,56 ± 0.31	17,08 ± 0.26	15.20 ± 0.21	14.11 ± 0.23
12	20,78 ± 0.31	18,85 ± 0.34	17.45 ± 0.30	15.87 ± 0.26
13	26,33 ± 0.55	23,13 ± 0.46	20.21 ± 0.35	18.87 ± 0.32
14	33,15 ± 0.70	29.00 ± 0.71	22.47 ± 0.38	20.72 ± 0.30
15	40,00 ± 0.78	37.98 ± 0.64	23.68 ± 0.40	21.92 ± 0.44
16	46,00 ± 0.78	40.27 ± 0.73	26.64 ± 0.44	

Table 37.

Degree of Physical Development in School-Aged Boys

Age (years)	Body Height M ± m (cm)	Annual Height Gain (cm)	Number of Permanent Teeth M ± m	Degree of Development of Secondary Sexual Characteristics
7	125± 5,2	4-6	8±3	PoAxo
8	128± 6,0	4-6	11±3	PoAxo
9	133,7± 6,2	4-6	14± 3	PoAxo
10	138,5± 6,4	4-6	17±3	PoAxo
11	144,5± 7,0	4-6	20± 3	PoAxo
12	146,2± 7,2	4-6	24±2	PoAxo
13	153,7± 8,2	7-10	26± 2	PlAxl

14	160,7± 8,9	7-10	27± 1	Pl,2Axl
15	165,4± 8,7	4-7	28	P2,3Ax1,2
16	170,4± 8,4	3-4	28	P3,4Ax3
17	172,8± 8,2	1-2	28	P3,4Ax3

Table 38

Degree of Physical Development of School-Aged Girls

Age (years)	Body Height M ± m (cm)	Annual Height Gain (cm)	Number of Permanent Teeth M ± m	Degree of Development of Secondary Sexual Characteristics
7	125± 5,2	4-5	10±3	MaoPoAxo
8	128± 6,0	4-5	12± 3	MaoPoAxo
9	133,7± 6,2	4-5	15±3	MaoPoAxo
10	138,5± 6,4	4-5	19± 3	MaoP1,oAxo
11	144,5± 7,0	6-8	22±2	Ma1P1,2Ax1,2
12	146,2± 7,2	6-8	26± 2	Ma2P1,2Ax1,2
13	153,7± 8,2	4-6	27± 1	Ma2,3P2,3Ax2
14	160,7± 8,9	2-4	28	Ma3P3Ax2,3
15	165,4± 8,7	1-2	28	Ma3,4P3Ax3
16	170,4± 8,4	1-2	28	Ma3,4P3Ax3
17	172,8± 8,2	0-1	28	Ma4P3Ax3

In preschool age, the "Philippine test" is used to assess biological maturity. During the middle and high school years, assessing biological maturity involves examining factors such as height, yearly growth rates, and the development of secondary sexual characteristics (refer to Tables 12 and 13).

To determine the annual height increase, one calculates the difference between the child's current height and their height from the previous year. Additionally, the evaluation includes counting the total number of permanent teeth, taking into

account all teeth regardless of whether they have erupted or how developed they are.

The "Philippine Test" methodology (illustrated in Fig. 15) involves the child placing their right hand on top of their head, ensuring that the palm makes contact with the scalp and the extended fingers reach towards the left ear. A positive result is indicated if the fingertips touch the auricle of the left ear.

Assessment of Pubertal Development. Sexual maturation is determined by evaluating the development of secondary sexual characteristics, including:

- Pubic hair
- Axillary hair
- Facial hair
- Breast development (in girls)
- Onset of menarche
- Voice deepening
- Development of the laryngeal prominence (Adam’s apple)

Biological Development Indicators (Fig. 25)

The biological development of a child is assessed in relation to their chronological (calendar) age as follows:

- Within normal limits – if indicators correspond to average age- and sex-specific values;
- Advanced development – if indicators exceed average age-appropriate norms;
- Delayed development – if the child's indicators fall below the average.

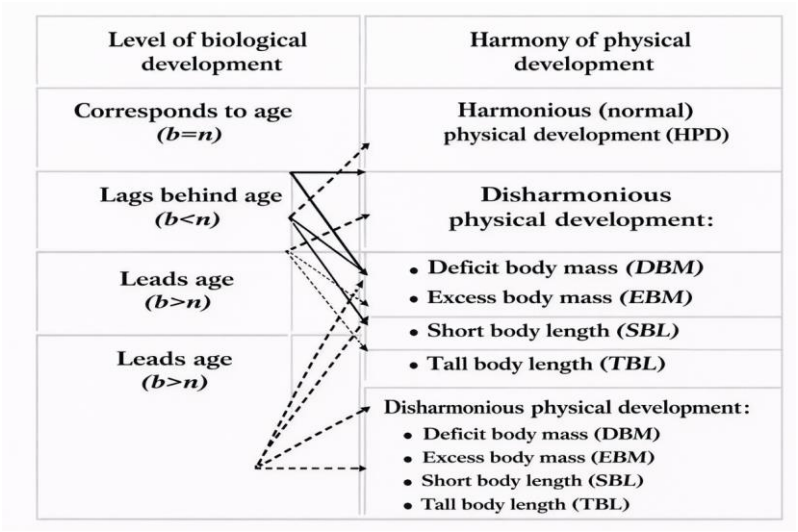


Fig. 25. Indicators of Biological Development

Table 39.

Levels of Biological Development

Morphofunctional Status	Corresponds	Advanced	Delayed
Harmonious	–	1	1
Disharmonious due to body mass deficit, with reduced functional indicators	1	2	2
Disharmonious due to excess body mass	2	2	2
Markedly disharmonious due to body mass deficit or excess	3	3	3

The **morpho-functional status** of a child (Table 39) is evaluated using regional regression scales of height, body weight, and chest circumference. A conclusion regarding the physical development of the child under study can be drawn by assessing the level of biological development and the harmony of development (Figure 25).

Centile Method for Assessing Physical Development of Children and Adolescents

The **non-parametric method** of evaluating physical development is called the **centile method**.

In medical and biological research practice, the distribution of somatometric indicators does not always follow a normal (Gaussian) distribution; therefore, a non-parametric method of analysis is used.

The **centile method** is a mathematical analysis approach that does not evaluate increases or decreases in indicators, since it examines all possible values in a variational series. A **centile** is one-hundredth of a variational scale.

Centile measurements accurately and objectively reflect the distribution of measurement values among healthy children of the studied age-sex group. The concept of the centile method is as follows: all values of a given indicator among children of the same sex and age are arranged in ascending order and divided into 100 equal intervals (centiles).

For example, if a child's height falls within a certain centile range:

- Up to 3% — **Very short**
- 3%–10% — **Short**
- 10%–25% — **Below average height**
- 25%–75% — **Average height**
- 75%–90% — **Above average height**
- 90%–97% — **Tall**
- Over 97% — **Very tall**

To assess the level of physical development, **7 established centiles** are used: 3rd, 10th, 25th, 50th, 75th, 90th, and 97th — resulting in **8 centile intervals**. The centile probability is defined as a percentage, forming **8 centile corridors** (intervals): 1 through 8.

The centile method also allows determination of the **somatotype**.

Somatotype is determined by the sum of corridor numbers for:

- Body length (height)

- Chest circumference
- Body weight

Three somatotypes:

- **Microsomatic** — Physical Development (PD) below average (sum = 3–10)
- **Mesosomatic** — PD average (sum = 11–15)
- **Macrosomatic** — PD above average (sum = 16–21)

Assessment of Development Harmony in Children

- **I. Harmonious development** — if the difference between any two of the three parameters does not exceed 1.
- **II. Disharmonious development** — difference of 2.
- **III. Sharply disharmonious development** — difference exceeds 3.

When assessing physical development and other health parameters, both **parametric and non-parametric** standards are applied.

The developed normative tables allow for:

- Evaluation of a child's physical development
- Determination of somatotype
- Assessment of development harmony
- Evaluation of the individual's nutritional status

Example

A centile-based physical development assessment is required for an **18-year-old male living in Tashkent**:

- Height: **172,0 cm**
- Weight: **62,8 kg**
- Chest Circumference (CC): **82,5 cm**

1. **Height** is evaluated using **Table 40**: 172.0 cm falls into **Zone 4**.
2. **Weight** is assessed using **Table 41**: 63 kg falls into **Zone 5**.
3. The combined assessment of height and weight (Table 31) determines the status as **"Normal physical development."**
4. **Chest circumference** falls into **Zone 4** (Table 42).

5. The sum of the zone numbers:
    - Height (4) + Weight (5) + Chest Circumference (4) = **13 points**.
    - According to the classification, this corresponds to the **mesosomatic type**, i.e., **average physical development**.

Since the **difference in zones between any two of the three parameters is 1**, the individual is classified as having **harmonious physical development**.

Conclusion

The **18-year-old male** residing in an urban environment is developing **harmoniously** and has **normal physical development**.

Table 40.

Height (cm) of conscription-age young men living in urban areas.

Agein years	Centile															
		3		10		25		50		75		90		97		
	1		2		3		4		5		6		7		8	
18		163,11		167,0		169,3		172,0		175,0		178,8		182,9		
19		163,4		167,2		169,9		172,1		176,0		179,7		182,9		
20		164,0		167,2		169,9		172,4		176,0		180,0		183,3		
21		164,5		167,5		169,9		173,3		177,0		180,4		183,4		
22		165,0		167,9		170,0		173,4		177,8		180,9		184,0		
23		165,6		166,0		170,2		173,8		178,0		181,0		184,1		
24		165,8		168,0		170,2		174,0		178,1		181,2		184,3		
25		165,9		168,0		170,3		174,1		178,2		1818		185,4		
26		166,8		168,4		170,5		174,4		178,2		182,0		185,7		
27		169,0		170,0		170,5		175,0		178,3		182,3		186,3		

Table 41.

Body Weight (kg) of Conscription-Age Young Men Living in Urban Areas

Agein years	Centile															
		3		10		25		50		75		90		97		
	1		2		3		4		5		6		7		8	
18		52,2		55,3		56,3		59,9		65,0		74,3		79,3		
19		54,3		57,6		60,7		65,0		69,9		75,0		79,5		
20		55,4		57,5		60,8		65,3		70,5		76,2		82,4		
21		55,4		57,5		60,8		65,9		71,0		76,5		83,8		

22		55,9		57,5		61,0		66,4		71,5		78,6		83,8	
23		59,2		58,2		62,4		68,7		78,3		79,1		85,6	
24		56,7		58,3		62,6		68,8		78,4		86,6		95,1	
25		56,8		58,9		63,6		71,1		79,9		89,8		96,0	
26		57,0		59,5		64,6		71,6		80,7		90,1		99,5	
27		57,2		61,2		65,0		73,7		82,6		91,3		99,7	

Table 42.

Chest Circumference of Conscription-Age Young Men Living in Urban Areas

Agein years	Centile															
		3		10		25		50		75		90		97		
	1		2		3		4		5		6		7		8	
18		74,2		77,22		82,1		86,20		90,08		94,17		99,82		
19		81,10		84,4		86,20		90,20		94,05		97,05		100,1		
20		81,23		84,5		86,30		90,3		95,05		98,02		101,8		
21		81,12		84,7		88,10		91,10		95,20		99,10		103,6		
22		82,06		84,95		88,20		91,40		95,30		99,65		104,2		
23		82,22		85,1		88,40		92,05		95,40		99,92		104,4		
24		82,2		85,15		90,10		93,12		99,05		103,5		106,5		
25		83,2		85,33		90,30		94,07		99,20		107,4		108,4		
26		84,05		86,04		90,82		94,20		99,38		107,8		110,4		
27		84,2		87,32		90,95		96,55		100,2		109,2		111,0		

SITUATIONAL TASKS

Task 1.

During an examination on December 10, 2020, Rustam, who was born on October 23, 2015, was found to have the following parameters: Height: 108,5 cm.Weight: 21,2 kg. Chest circumference: 57,8 cm

Determine Rustam’s physical development using the centile method.

Task 2.

During an examination on April 5, 2021, Ibragim, who was born on May 5, 2014, was found to have the following parameters:Height: 104,2 cm.Weight: 20,4 kg

Chest circumference: 60,1 cm Determine Ibragim’s physical development using the centile method.

Task 3.

During an examination on October 10, 2019, Vakhid, who was born on April 28, 2012, was found to have the following parameters: Height: 122,2 cm.Weight: 19,2 kg. Chest circumference: 54,9 cm. Determine Vakhid’s physical development using the centile method. Assess the degree of underweight**.**

QUESTIONS FOR SELF-ASSESSMENT

1. What anthropometric research methods do you know?
2. How is a child's physical development assessed?
3. What is a child's biological age?
4. How is physical development evaluated using the comprehensive method?
5. Name the methods used to study physical development.

HYGIENIC ASSESSMENT OF THE HEALTH STATUS OF CHILDREN AND ADOLESCENTS

Health is characterized not only by the absence of functional abnormalities in the body and the harmoniousness of physical development. It is also essential to determine the presence or absence of chronic diseases. One must establish the functional capabilities of children in relation to learning, labor, and sports.

A child's health is influenced by several factors, including upbringing, nutrition, the condition of educational institutions, adherence to sanitary and hygienic standards, and the educational process.

Sources of Health Risk in Children

I. Healthcare Level – Activities of Medical Institutions

- Biological characteristics of an individual – gender, age, heredity, constitution, temperament, and adaptive capacity.

II. Environmental Components

- Social factors and “lifestyle” – the socio-economic structure of society, level of education and culture, traditions and customs, family, and personal characteristics.

Child health is a complex construct consisting of four primary components:

1. Physical health
2. Mental health
3. Reproductive health
4. Psychosocial health

One of the key concerns in the hygiene of children and adolescents is the study of the health status of the growing generation.

To determine the effectiveness of health-improvement activities, children are categorized into health groups. This involves studying the dynamics of physical growth and development in correlation with disease incidence.

Any abnormalities in physical development may indicate a child's functional unpreparedness for school, or limitations in future professional suitability. Therefore, physical development and its evaluation should be regarded as an effective method of socio-hygienic diagnostics and a basis for timely development and implementation of medical-preventive and health-promotion interventions.

An essential requirement is the assessment of a child’s functional capabilities related to learning, sports, and labor.

Integrated Assessment of Child Health Status

This consists of the following stages:

1. Analysis of health status based on evaluation criteria
2. Conclusion – determination of the health group
3. Recommendations for children across all health groups

Health Groups

Group I – Healthy children with normal physical and mental development, no anatomical or functional defects, and no morphofunctional abnormalities identified.

Group II – Children who are generally healthy but have some functional and morphological deviations. These children exhibit low resistance to acute and chronic illnesses. They do not have evident developmental delays or chronic diseases but may include convalescents (those frequently ill with acute respiratory diseases – 4 or more times per year). Physical development deviations may be noted, such as overweight, underweight (less than M-1σ), weakened vision, etc.

Group III – Children with chronic diseases in a stage of compensation or full remission, with preserved functional capabilities. Possible exacerbations occur without complications of the primary disease. Deviations in body weight or height may be observed.

Group IV – Children with chronic diseases and congenital malformations in a state of subcompensation, with reduced functional capacity. These children often experience exacerbations and require ongoing maintenance therapy to sustain remission. This group includes children with injuries or learning and labor limitations.

Group V – Children with severe chronic diseases in a state of decompensation, with significantly reduced functional capacity. Remissions are rare, and frequent attacks and complications require continuous treatment. These are children with disabilities. Such children do not attend general education institutions. This group includes children with physical disabilities and functional impairments of certain organs, often accompanied by work restrictions.

Periodic Medical Examinations of Schoolchildren

These allow for the identification of developmental patterns and health formation in children.

Preventive medical examinations (Table 43) are conducted to assess a child's health status, diagnose diseases during their progression, identify existing chronic conditions, and evaluate the risk of disease advancement. Based on the results of preventive examinations, a health group is determined for each child, taking into account their individual characteristics.

Table 43.

Frequency of Medical Examinations.

Period	Age Group	Frequency
10 days to 1 month	Neonatal	Once a week
Up to 1 year	Infancy	Monthly
1–3 years	Early childhood	Four times a year
4–6 years	Middle childhood	Three times a year
From 7 years onward	School age	Once a year

Schoolchildren's Physical Fitness Classification for Physical Education Classes

Students are divided into four physical readiness groups for physical education lessons:

Group I – Main Group

This group includes healthy children without any identified deviations. Physical activity corresponds to age-appropriate norms and educational curricula. They are allowed to fulfill physical fitness standards, attend sports clubs, and participate in competitions.

Group II – Preparatory Group

This group consists of nearly healthy children with optimal physical development but slight functional deviations in certain bodily functions. They may engage in physical activity with adjusted intensity. However, meeting physical fitness standards and participating in mass events is prohibited without additional medical evaluation.

Group IIIA – Special Group A

This group includes children with functional health fluctuations. Physical activity is restricted. Typically, these children are either overweight or underweight (Grade II), with developmental delays in their neuropsychological development. Medical supervision is mandatory during therapeutic exercise sessions.

Group IIIB – Special Group B

Children in this group suffer from chronic illnesses with functional impairments in specific organs or systems. Therapeutic physical education is required.

Case Studies

Case 1:

Examination Date: 12.12.2002.Subject: Ilhom.Date of Birth: 20.12.1991
Height – 141,0 cm, Weight – 35,0 kg, Chest Circumference – 66,9 cm
Annual Height Gain – 5,8 cm.Permanent Teeth – 24Sexual Maturity – R0, Ax0
Muscle definition – well-developed.Vital Lung Capacity (VLC) – 2218 ml
Grip Strength – Right Hand: 18,3 kg, Left Hand: 16,9 kg.No illness during the year. No chronic diseases.

Practically healthy. Participates in the **Main Group** for physical education.

Evaluation:

Health status – practically healthy.Physical development – consistent with age

Health Group: I

Physical Education Group: Main Group

Case 2:

ExaminationDate:15.01.2011 Subject: Odil. Date of Birth: 02.04.2000
Height – 128,6 cm, Weight – 22,9 kg, Chest Circumference – 63,0 cm
Annual Height Gain – 3,1 cm. Permanent Teeth – 14.Sexual Maturity – R0, Ax0
Muscle definition – poorly developed.Vital Lung Capacity (VLC) – 1925 ml
No fat folds.Grip Strength – Right Hand: 16,77 kg, Left Hand: 15,2 kg
Chronic disease – bronchiectasis.Exempt from physical education.

Evaluation:

Health status – has chronic illness.Physical development – lagging

Health Group: III

Physical Education Group: Special Group B

Case 3:

Examination Date: 26.04.2010.Subject: Iroda.Date of Birth: 15.01.1997
Height – 168,8 cm, Weight – 64,2 kg, Chest Circumference – 88,8 cm. Annual

Height Gain – 7,1 cm. Permanent Teeth – 28. Sexual Maturity – Ma2, R2, Ax2, Me12.Muscle definition – low. Fat fold – pronounced.VLC – 2628 ml Grip Strength – Right Hand: 20,0 kg, Left Hand: 18,2 kg No illness during the year. No chronic diseases. Cannot meet standard physical education demands.

Evaluation:

Health status – practically healthy.Physical development – overweight, low muscle tone

Health Group: II

Physical Education Group: Special Group A

Self-Assessment Questions

1. What is physical development in the growing generation, and why is it studied as a health indicator?
2. How many health groups are there, and what are they?
3. How are children aged 3 to 18 classified by age group?
4. Describe the characteristics of each health group.
5. How many physical development groups do you know?

HYGIENIC PRINCIPLES OF PLANNING AND EQUIPPING EDUCATIONAL INSTITUTIONS

In accordance with sanitary regulations in Uzbekistan, certain hygienic standards are established for educational institutions.

General education schools and preschool educational institutions should be located within residential zones and within walking distance. When placing educational institutions in residential areas, it is necessary to consider the size of the sanitary protection zones of industrial enterprises, the sanitary buffer distance from garages and parking lots, and the distance from highways, subway systems, railway facilities, and aviation landing sites. It is essential to maintain sanitary clearances from residential and public buildings to ensure proper insolation and natural lighting in the premises of educational institutions

Placement of General Education Institutions

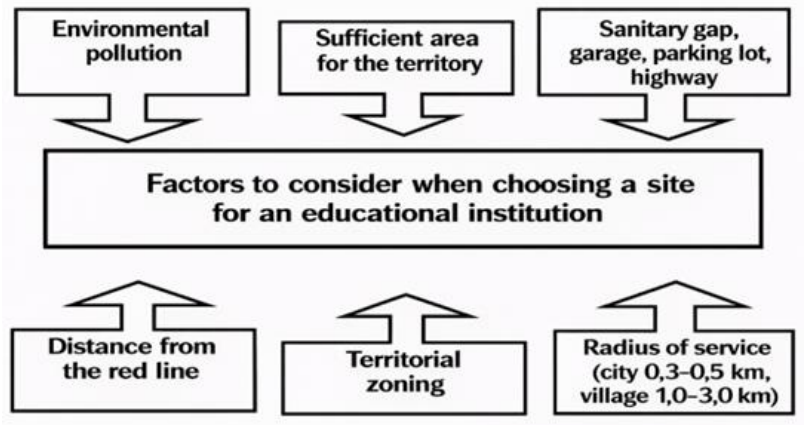


Figure 26. Selection of a Land Plot.

Educational institutions should be located in the **inner quarters of residential microdistricts**, away from urban roads in the second or third tier of development. This layout helps reduce air pollution and attenuates noise levels.

In urban environments, general education schools should be placed within a **walking radius of no more than 0,5 km**, and up to **0,8 km in densely built-up areas**. In rural areas, this distance should not exceed **1,5 km**, or a **maximum of 15 minutes on foot one way**. If this threshold is exceeded, transportation services must be provided.

Requirements for the Territory of General Education Schools

A general education school must have a **dedicated and isolated land plot** (see Fig. 26), distanced from sources of noise and air pollution. No major utility infrastructure—such as water supply, sewage systems, heating pipelines, or power lines—should pass through the school's territory. The **size of the land plot** depends on the **student capacity** of the general education school (see Table 44).

Table 44. Land Area of General Education Schools Depending on the Number of Students (in m²)

Number of Students (persons)	Land Area per Student (m^2)
From 40 to 630	50–55
From 631 to 945	35–40
More than 945	22

The **school site must be fenced and landscaped**. Landscaping should cover **at least 50%** of the total area. The territory should be planted with **deciduous trees and shrubs**, arranged in two tiers: a **minimum 1.5-meter strip** along the entire perimeter of the fence, and **at least 6 meters wide** on the side facing the street. The **distance from the school building** must be **at least 10 meters to trees** and **5 meters to shrubs**.

The territory of a general education school is divided into **zones**:

- a **green zone** (minimum 50%),
- a **recreation zone**,
- **sports facilities**,
- a **service area**, and
- an **educational-experimental zone** (not exceeding 25%).

The **sports zone** should be located near the **gymnasium**, and the **service area** next to the **cafeteria or kitchen block**.

The **sports zone** includes various playgrounds for **football, volleyball, and basketball**. Running tracks must have a **hard surface or frost-resistant synthetic coating**, the football field must have **grass turf**, while volleyball and basketball courts must have **hard or polymer surfaces**. **Jumping pits** (for long and high jumps) should be filled with **sand**. If **synthetic or polymer coatings** are used, they must have a **sanitary certificate** confirming they are **safe for children's health**.

The **recreation zone** is designated for **outdoor games** and, if necessary, for **conducting educational or ceremonial activities outdoors**.

The **service area** includes a **waste collection site** with a **waterproof (concrete) surface**, equipped with **tightly sealed waste containers**. The

platform's dimensions must **extend 1 meter beyond the base of the containers on all sides**. The **minimum distance from the building** must be **20 meters** (see Fig. 27).

Fig. 27. Waste Collection Containers.

The **service area** must be located **20 meters away** from the main building and **screened with green plantings**. It must also have a **separate entrance** from the street. In **rural areas**, facilities such as **boiler houses and pump stations with water towers** are located within the service area. **Driveways and walkways** leading to service buildings and waste collection platforms must be surfaced with **asphalt or other hard coverings**.

Access roads to buildings must have a **solid surface**. In front of the **main entrance**, **foot washers** and **drinking fountains** must be installed. The site must be equipped with **artificial lighting**. **Irrigation systems** must be constructed with a **slope** to allow the drainage of wastewater.

Architectural and Planning Solutions of the Building

Educational institutions (**EIs**) should be **located only in separate, stand-alone buildings**.

Capacity requirements:

- **Preschool institutions (kindergartens)** should not exceed **350 places**.
- **Schools** should be designed for **no more than 1000 students** assuming **single-shift instruction**.

Preschool buildings must be **two-story**, and schools must be **three-story**. (In special justified cases, four-story school buildings are permitted.) Educational institutions must **not be located in basements or semi-basements**.

For buildings, the following are regulated:

- Layout
- Area
- Depth and height of rooms
- Finishing materials
- Arrangement of equipment and furniture

Requirements for Premises in Educational Institutions

I. Ensure favorable conditions for the **educational process** (classrooms, subject-specific rooms, workshops, gyms).
II. Ensure proper conditions for **food service** (canteens, kitchens). Provide spaces for **rest and physical activity** (sleeping rooms, recreational areas).
III. Create conditions for **medical services**.
IV. Ensure **optimal lighting conditions**.
V. Ensure **optimal air and temperature conditions**.
VI. Provide **sufficient access to drinking water**.
VII. Enable **efficient disposal of solid and liquid household waste**.

Types of Construction

- *Centralized*
- *Decentralized*
- *Block (modular)*

All rooms in a general education school are categorized into:

- *Main (primary) rooms*
- *Supplementary rooms*
- *Auxiliary rooms*

Educational Rooms

Main rooms are classified according to their function:

- Subject-specific classrooms with laboratories
- Vocational training workshops
- Information technology classrooms
- Sports halls
- After-school care rooms

Supplementary rooms include:

- Offices for the principal **and** academic administrators
- Teachers' lounge
- Library
- Medical office

Auxiliary rooms include:

- Kitchen
- Cafeteria
- Cloakroom
- Restrooms (toilets)

The **area of educational rooms** (see Table 45) is planned based on a **minimum of 2,5 m² per student**, with a **room depth not exceeding 6,0 m**, **length between 8,0–8,4 m**, and **ceiling height up to 3 m**.

Table 45. Room Area Standards per Student

№	Rooms	Minimum area per student (m^2)
1	General education classrooms	2,5
2	Laboratories and classrooms for natural sciences, drafting, drawing, and initial military training	3,5
3	Computer science classroom	4,5 per workstation6.0 if room has 12 stations
4	Language labs (linguaphone rooms)	2,4
5	After-school program room	4,0
6	Vocational training and socially useful labor workshops (excluding industrial training workshops)	6,0
7	Gymnasium	10,0 Ceiling height: 6,0 m

№	Rooms	Minimum area per student (m^2)
8	Assembly hall	0,65 per seat

Width of Corridors and Classroom Allocation

The **width of recreation corridors** depends on the layout of classrooms:

- With **one-sided classroom arrangement** – at least **4 meters**;
- With **two-sided classroom arrangement** – at least **6 meters**.

Primary school students should be taught in **dedicated classrooms** permanently assigned to each class group.

First-grade students must be located exclusively on the **ground floor**, within an **isolated primary school block** that has separate access to an outdoor area.

Grades 2–4 should be placed **no higher than the third floor**.

Grades 8–11 may be located **above the third floor**.

Laboratory Classrooms for Natural Sciences

Dedicated laboratory spaces must be provided for classrooms in natural sciences such as **physics, chemistry, and biology**, with an area of **15–24 m^2**.

Sanitary and Technical Equipment

Classrooms, laboratory preparation rooms, subject-specific cabinets (chemistry, physics, drawing, biology), **workshops**, **home economics rooms**, and **medical offices** must be equipped with **washbasins**.

The height of washbasins must match students' **age and growth characteristics**:

- For **grades 1–4**: height from floor to sink rim should be **0,5 m**.
- For **grades 5–11**: **0,7–0,8 m**.

Sanitary Facilities (Toilets)

Each floor must have **separate toilets for boys and girls**.The number of sanitary fixtures is determined as follows:

For girls:1 toilet per **20 girls,** 1 washbasin per **30 girls.**

For boys:1 toilet, 1 urinal, and 1 washbasin per **40 boys**

Toilet cubicle dimensions: **0,8 × 1,0 m**, separated by partitions of **at least 1,75 m** in height.**Pedal-operated lid bins** must be provided for waste collection.

A **separate sanitary unit** must be provided for **school staff**.

Classroom Parameters

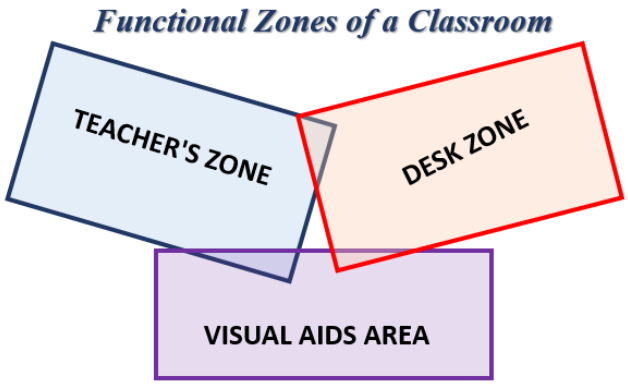


Figure 28. Functional Zones of a Classroom

In the learning environment, it is essential to designate several zones for instructional and methodological purposes (see Fig. 28). **Student desks are typically arranged in three rows.** The **distance from the blackboard to the first row of desks should be no less than 2,65 meters** to ensure optimal visual comfort and effective interaction between students and the instructional area.

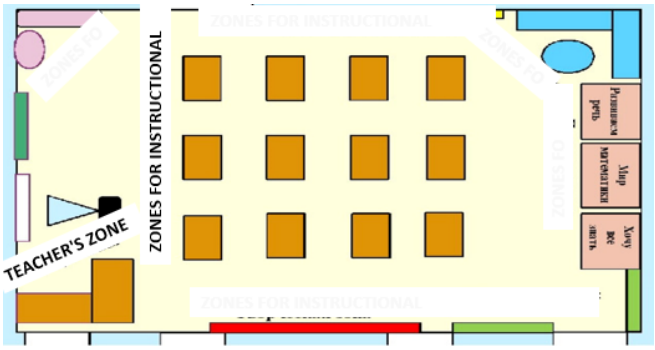


Fig. 29. Arrangement of Equipment and Classroom Furniture

When equipping educational spaces (see Fig. 29), the following passage widths and spatial distances (in meters) must be observed to ensure safety, comfort, and compliance with ergonomic standards:

- **Minimum distance between rows of two-seat desks** – 0,60 m;

- **Distance between the row of desks and the outer longitudinal wall** – not less than 0,50–0,70 m;
- **Distance between the row of desks and a wall running parallel** – at least 0,50 m;
- **Distance from the first desk to the blackboard** – not less than 2,40 m;
- **Maximum distance from the furthest student desk to the blackboard** – 8,60 m.

The **angle of visibility** from the edge of a 3.0-meter-wide blackboard to the midpoint of the front-row student's desk should be at least **35° for primary school students** and **no less than 45° for secondary school students**. The **lower edge of the instructional board** should be positioned **70–90 cm above the floor**.

Computer science classrooms and computing laboratories (see Fig. 30) must meet the following requirements:

- Be equipped with an **air conditioning system**;
- Include an **additional room for lab technicians** (area up to 18 m²);
- Be provided with **sound insulation**;
- Contain a **first-aid kit**, **thermometer**, and **psychrometer** for environmental monitoring.

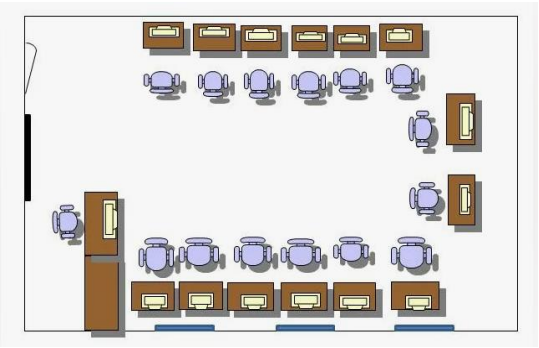


Fig. 30. Arrangement of Equipment in a Computer Science Classroom

In physics and chemistry classrooms, the **demonstration table** must be installed on a **raised platform** (podium) to enhance visibility of instructional

materials and experiments. The desks in these classrooms should be **resistant to aggressive chemical agents**, and **fume hoods** are additionally installed in chemistry laboratories to ensure safe handling of chemicals.

Vocational Training Workshops

(***Carpentry, Metalworking, Home Economics***)

Workshops are typically located **at least 50 meters away** from the main school building. Their equipment must promote **proper posture**, minimize spinal load, and provide **favorable conditions for visual tasks**.

Carpentry Workshops. Equipped with workbenches installed at a 45° angle to the window **or arranged** in three rows perpendicular to the windows**, ensuring light falls from the** left side**. The** minimum front-to-back distance between workbenches **is** 0,8 meters**.**

Metalworking Workshops. Lighting can be either left-sided **or** right-sided**, provided benches are arranged** perpendicular to the light-bearing wall**. The distance between rows of** single-user benches **must be at least** 1.0 meter**, and for** double-user benches **–** 1,5 meters**.** Vices **on workbenches are fixed at intervals of** 0,9 meters**. Metalworking benches must be** shielded with protective mesh**,** 0.65–0,70 meters in height**.**

Machines such as **drill presses, grinders**, etc., must be:

- Installed on **solid foundations**, and
- Equipped with **protective screens or guards** (mesh or glass) to ensure operator safety.

Textile and Sewing Workshops. Require tables for cutting patterns **and** sewing machines**. Sewing machines should be placed** parallel to windows **to utilize** left-sided natural lighting**, or** facing the window **to receive** direct natural illumination**.**

Home Economics Kitchen Classroom. Must comply with hygienic standards for food preparation areas. Includes double-basin sinks **with hot and cold water,** work tables with hygienic surfaces**,** refrigerators, electric stoves, baking ovens**,** and storage furniture for kitchenware**.**

Only **approved detergents** may be used for washing dishes.

All **vocational training workshops** and **home economics rooms** must be equipped with **first-aid kits**.

Gymnasium (Sports Hall)

Located **on the ground floor** and usually in a **separate building or annex**. The **type and size of the gymnasium** depend on the type and capacity of the educational institution (see Fig. 31).

Standard dimensions of sports halls include:

- 9,0 × 18,0 meters,
- 12,0 × 24,0 meters,
- 18,0 × 30,0 meters.

The **minimum ceiling height** of a sports hall must be **no less than 6,0 meters** during the design stage.

Fig. 31. School Sports Hall

The design of a sports hall includes the following:

- **Two changing rooms** (male and female) at **10,5 m² per child**.
- A **sports equipment storage room** (equipment room) with an area of **16–32 m²**.
- **Two showers**, each with an area of **9 m²**, adjacent to the changing rooms.
- **An instructor's office**.
- **Two restrooms**.

Medical Unit Requirements

All medical rooms must be grouped in a single block located on the **ground floor** of the building and include:

Doctor’s office, **psychologist’s office**, **dental office**, **treatment room**, and **vaccination room**.

Room dimensions: Total area of the medical block: **not less than 21,0 m²**. **Minimum length** of space for hearing and vision acuity testing: **7,0 m**. **Treatment and vaccination rooms**: **≥14,0 m²**. **Psychologist’s office**: **10 m²**. **Dental office**: **≥12,0 m²**, equipped with a **fume hood**.

Required equipment for medical rooms:

1. Medical scales
2. Height measuring stand (stadiometer)
3. Plantograph
4. Refrigerator
5. Chairs
6. Examination couch
7. Measuring tape
8. Medical procedure table
9. Sphygmomanometer with pediatric cuffs, stethoscope
10. Medical thermometers
11. Work desk and medical table
12. Medical cabinet for drug storage
13. Cabinet for storing medical records

Flooring Standards. Classrooms, offices, and recreation areas **must have floors made of** wooden boards**,** parquet**, or** linoleum**, free from** defects, gaps, or mechanical damage**.** Toilets and washrooms **must have** ceramic tile flooring**. All** construction and finishing materials **must be** non-toxic and safe **for children.**

Natural and Artificial Lighting in Educational Institutions

Natural Lighting

Optimal orientation for classrooms: **east, southeast, or south** (E, SE, S). All classrooms must have **natural lighting** from the **left side**. The **daylight factor (DF)** at the work surface must be at least **1,5**, with a **light coefficient** of no less than **1:6**. Classrooms must be designed for **uniform illumination** of the students' desks. **Combined lighting** (top and side) is recommended.

No natural lighting is allowed only in:

- Equipment storage rooms
- Washrooms, showers (adjacent to gyms)
- Storerooms
- Server and radio control rooms
- Book storage
- Utility and engineering areas

Double-sided or side lighting is used in:

- Vocational training rooms
- Auditoriums
- Sports halls

Curtains, drapes, and other devices that reduce natural lighting **are not allowed** in classrooms.

Adjustable sunshades (blinds) with high light-diffusion and transmission may be used **without compromising natural light**.

To ensure proper lighting:

- Window glass must **not be painted**.
- **No flowerpots** on windowsills.

- **Glass cleaning** must occur **at least twice per year** (spring and fall), or as needed.

Minimum duration of insolation (sunlight exposure) in classrooms:

2 hours in central zones, **1,5 hours** in southern zones

Exceptions (no insolation required):

Computer science rooms, Physics and chemistry labs, Drawing and drafting classrooms, Gymnasiums and fitness rooms, Canteens, Administrative and service areas.

Artificial Lighting

All rooms in general education schools must meet **sanitary requirements for artificial illumination**, as defined in **Table 46**.

Table 46.

Lighting Requirements in Educational Institutions

Premises	**Illuminance Levels**
Classrooms (at students' desks)	300–500 lux
Technical drawing and art classrooms	500 lux
Computer science classrooms (at desks)	300–500 lux
Chalkboard/whiteboard surfaces in classrooms	300–500 lux
Assembly halls and sports gyms (measured at floor level)	200 lux
Recreational areas and corridors (measured at floor)	150 lux

Artificial Lighting Requirements

For artificial lighting, **ceiling-mounted luminaires** are used to ensure a favorable luminance level within the visual field. The primary light sources are **fluorescent lamps** with color temperatures emitting: White, warm white, neutral (natural) white, as well as **LED luminaires**.

To achieve **uniform lighting distribution** in educational spaces, **matte finishing materials** in white or light pastel tones are used, with **high reflectance coefficients**, for example: **Ceilings**: 0,7–0,9, **walls**: 0,5–0,7.

Air and Thermal Environment Requirements

To maintain optimal **hygienic parameters of the microclimate** (see Table 47), educational institution buildings must be equipped with **centralized heating and ventilation systems**.

The following are **not permitted** in schools:

- Steam heating systems,
- Infrared radiation heaters,
- Portable heating appliances.

These regulations ensure thermal safety, comfort, and adherence to public health standards for students and staff.

Table 47.

Recommended Indoor Air Temperatures in Educational Facilities

Room/Facility Type	**Air Temperature**
Classrooms, subject-specific rooms, psychologist and speech therapist offices, laboratories, assembly hall, cafeteria, recreation areas, library, vestibule, and cloakroom	**18–20 °C**
Gymnasiums, rooms for extracurricular (sectional) activities, and workshops	**17–20 °C**
Sleeping areas, playrooms, and preschool educational rooms	**20–24 °C**
Medical offices and sports hall changing rooms	**20–22 °C**
Shower rooms	**25 °C**

Temperature Control and Ventilation Requirements in Educational Institutions.

To monitor the thermal conditions, classrooms and specialized subject rooms must be equipped with thermometers. The **relative humidity** in educational facilities should be maintained between **40–60%**, and **air movement velocity** must not exceed **0,1 m/s**.

In facilities using **stove heating**, furnaces must be located in the corridor. Chimneys must be closed only after complete combustion of fuel and no less than **two hours before** the arrival of students. **Stove heating is prohibited** in newly constructed or renovated educational buildings. **Portable heaters ("potbelly stoves") are strictly forbidden.**

Cross-ventilation should be carried out before and after classes. During lessons, it is permissible to ventilate only recreation zones.

Physical education classes and sports activities must be held in **well-ventilated gymnasiums**.

Windows must be fitted with transoms or vents, with an area of at least **1/50 of the floor area**.

Water Supply and Sanitation Requirements

Educational buildings must be equipped with **centralized drinking water supply and sewage systems**. In settlements without such infrastructure, **cold water supply** must be arranged at minimum for kitchen units, medical offices, and restrooms. In boarding schools and preschools, a **hot water system** must be available.

In rural areas **without sewage systems**, schools must install **local treatment facilities** (e.g., internal dry closets). If necessary, **outdoor toilets** may be installed, located **at least 20 m from the school building**.

School Cafeteria (Food Service Block)

The cafeteria block includes a range of spaces:

- **Production zones** for hot meal preparation,
- **Storage rooms** (for meat, vegetables, bulk products),
- **Dining halls** for students.

These are divided into functional **kitchen sectors (workshops)**:

- **Meat and fish processing zone**
- **Vegetable preparation area**
- **Cold kitchen** for salads and cold dishes
- **Hot kitchen** for preparing main meals and beverages

- **Food serving area** (distribution line)
- **Student dining hall**

Hygienic Standards for Preschool Educational Institutions (PEIs)

These sanitary rules regulate:

- Location conditions of PEIs,
- Equipment and maintenance of the premises and surrounding areas,
- Indoor lighting (natural and artificial),
- Heating and ventilation,
- Water supply and sanitation,
- Medical support,
- Daily schedule and routine,
- Physical education practices.

Categories and Types of PEIs

- For **infants (up to 3 years)**,
- For **preschool children (ages 3–7)**,
- **Specialized PEIs (SPEIs)** for children with physical or mental impairments,
- **Multiprofile institutions**,
- **Sanatorium-type PEIs**.

By Duration of Attendance

- **Short-term stay** (3–4 hours/day),
- **Reduced-day** (up to 9 hours/day),
- **Full-day** (up to 10,5 or 12 hours/day),
- **Round-the-clock stay**.

Group Sizes in Specialized PEIs *(based on health and age of children)*

Category	**Children per group**
Speech disorders (dysarthria, alalia, stuttering, aphasia, etc.)	10–12
Deaf children	8–10
Hard-of-hearing children	10–12

Category	Children per group
Blind children	8–10
Visually impaired (amblyopia, strabismus, etc.)	10–12
Musculoskeletal disorders	15–18
Hemiparesis, monoparesis, plegias	10–12
Intellectual disabilities (mild)	8–12
Intellectual disabilities (moderate to severe)	6–10
Autism (age 3+)	8–10
Cerebral palsy	8–10
Developmental delays (under 3 years)	6
Developmental delays (over 3 years)	10–12
Children with tuberculosis infection	15–20

Hygienic Requirements for PEI Territories

Site Selection Criteria:

- **Dry soil** (groundwater level no closer than 1,5 m to the building foundation),
- **Sanitary safety** (no contamination by biological or chemical agents),
- **Good ventilation and solar exposure**.

Location of preschool buildings follows the same **urban planning guidelines** as for schools:

- **Inside residential neighborhoods**, away from noise and pollution,
- **Walking accessibility** for families.

Table 48.

Capacity of Preschool Educational Institutions (PEIs)

Category of PEI	Capacity
Located in **standalone buildings**	Not more than **385 places**
Located on the **ground floors of multi-story residential buildings**	Up to **75 places**
Located in **rural areas**	Up to **60 places**
Located in **attached premises to individual residential houses**	Up to **150 places**

Requirements for the Preschool Institution (PEI) Site

- The perimeter must be **fenced** with a **minimum height of 1.6 meters**.
- Along the **external perimeter**, **trees (preferably deciduous)** and **shrubs** should be planted in a strip of **no less than 5 meters wide**, and **no closer than 10 meters** to the building.
- The site must have **at least two entrances**: a **main** and a **service (utility)** entrance.
- There must be **convenient access roads** to the site.
- The site should be **remote from sources of noise and air pollution**.

Zoning of the PEI Territory

The territory of the preschool educational institution should be divided into functional zones:

- **Group zones** – including **playgrounds**, **physical activity areas**, and **utility areas**.
- The planning must allow for **children's bicycle riding** or **skiing** (in appropriate seasons).

Each group must be provided with its **own individual playground**, directly accessible from the group room's exits.

- **Covering** should preferably be **grass-based**, and **mandatory for children under 3 years**.
- In other cases, **compacted soil** or **non-toxic synthetic materials** may be used.
- **Asphalt** pavement is **not allowed** throughout the entire PEI territory.

Play Area Requirements

- Each group must have a **separate shaded canopy** with a **minimum area of 1.5 m² per child**.
- The flooring under the canopy should be **wooden** or in some cases **made of safe synthetic materials**.

Sandboxes Requirements

- Must be equipped with **closing flaps or covers**.
- Sand must meet safety standards:
  - Free from radionuclides and heavy metal salts;
  - Safe in terms of **microbiological** and **helminthological** indicators;
  - Must be **moistened and stirred** before use;
  - **Contaminated sand** must be **replaced** with clean sand;
  - Covered every night

Physical Activity Zone

- Must be equipped with **age-appropriate and height-specific** sports and play equipment.
- Equipment should be **waterproof** and **chemically resistant** for effective **disinfection** and **cleaning**.

Wading Pools for Hardening Procedures/

Pools should have an area of 20–25 m², **with a** variable depth of 0.1 to 0,5 m**.** Daily water changes **are required. To reduce contamination:**

A **foot bath** with **continuous running water**, **up to 1 meter wide**, and **Steps with handrails** should be installed at the entrance.


Figure 32. Equipment of the Group Zone

The **utility (service) area** should be located **adjacent to the kitchen block and laundry**, **no closer than 25 meters** from the main building. It must be **separated by green plantings** and have a **separate access road** from the street.

On a **waterproof concrete platform**, which is **maintained in a clean condition**, **metal or plastic waste containers** and **food waste bins** with **tight-fitting lids** are placed. The **volume of containers** should be calculated so that their **filling does not exceed two-thirds per day**. Food waste must be removed **daily**, and empty containers should be **washed using detergents**, **rinsed**, and **dried**.

Basic Principle of PEI Planning and Construction: Group Isolation

Each **group cell**, regardless of the mode of attendance (full-day, extended-day, or 24-hour stay), must include the following **set of premises**:

- **Reception area** and **cloakroom** with **individual lockers** clearly marked with **child-friendly identifiers**;
- **Playroom**, used for play and educational activities;
- **Sleeping room**, furnished with beds, also marked with recognizable signs for each child;
- **Dining area**;
- **Buffet zone** (for dish storage, drying, and washing);
- **Linen storage space**;
- **Sanitary unit** and **cleaning equipment closet**.

Architectural and Functional Planning Requirements for PEI

- The **kitchen block** should be designed as a **stand-alone** or **attached** facility.
- If a **separate central kitchen/dining area** is used, it must be connected to group cells via **heated passageways**.
- Separate **dishwashing rooms** must be provided, equipped with:
    - **Cupboards** for storing dishware per group;
    - **2- or 3-compartment sinks**, separate for each group.

Orientation of Spaces

- **Playrooms** should be oriented **to the East, Southeast, or South (E, SE, S)** to maximize natural daylight.
- **Sleeping rooms** should face **North (N)**.

- All **playrooms** must be provided with **natural lighting**.

Medical Support in PEI

A **medical office** must be established in PEIs and located **on the ground floor**, with **independent access** from the corridor and an **exit through the isolation room to the yard**.

The **medical block** includes:

- **Medical room**
- **Isolation room**
- **Psychologist's room**
- **Speech therapist's room**

Each with an area of **12–16 m²**.

Also included:

- **Sanitary unit**
- **Room for preparing disinfectant solutions**

Figure 33. Medical Room

Where possible, a **laundry facility** should be organized within the preschool institution. This laundry must **not be used to wash items from other organizations**. If a dedicated laundry is not available, a **centralized laundry service** may be organized for multiple PEIs, with one serving as the base.

Only **non-toxic building and finishing materials** that are **safe for children's health** may be used. Wall materials in rooms must be **resistant to disinfectants and wet cleaning**.

Lighting Requirements

The levels of **natural and artificial lighting** in PEIs must meet the **sanitary standards** adopted in the **Republic of Uzbekistan** for residential and public buildings.

For **artificial lighting**, **fluorescent lamps** are used, ensuring a minimum illuminance of **300 lux** at the work surface. In **music and gymnastics halls**, lighting standards apply at a height of **0,5 m from the floor**; in **changing rooms**, the standard is **on the floor level**. In **bedrooms and medical isolation rooms**, lighting should be **150 lux** at **0,5 m above floor level**.

When **incandescent lamps** are used, **fixtures must have fully or partially enclosed diffusers directed toward the ceiling**. For **fluorescent lighting**, only enclosed fixtures are allowed.

Flooring and Sanitary Zones

In group areas, **floors must be smooth, non-slippery**, tightly fitted (no gaps), and made of **child-safe materials** that allow for disinfection.

Sanitary units must include:

- A **washroom area** with sinks;
- A **toilet area** with:
    - Child-sized toilets in **semi-enclosed stalls** without locks;
    - One **adult toilet** in a lockable stall.

All toilets and sinks must be **age-appropriate** and **ergonomically positioned**.

Multipurpose Halls

Halls for **musical and physical activities** must be provided based on **4 m² per child**, but **not less than 30 m²**. For **combined-use halls**, the minimum area is **50 m²**.

PEI Equipment Requirements

Table 49. Standard Dimensions of Tables and Chairs for PEI Children

Age	Child Height (cm)	Furniture Group	Table Height (cm)	Seat Height (cm)	Color Code
2–3 yrs	90–100	B	43	24	Blue

Age	Child Height (cm)	Furniture Group	Table Height (cm)	Seat Height (cm)	Color Code
4–5 yrs	100–115	G	48	28	Orange
5–6 yrs	115–130	D	54	32	Yellow

Tabletops must be light-colored with **matte finishes**. All furniture materials must be **resistant to disinfectants and cleaning agents**.A **wall-mounted chalkboard** (0,75 × 1,5 m) should be installed with the **bottom edge at 0,7–0,8 m** above the floor. Chalkboards should be made of **high-adhesion surfaces**.

Seating Arrangements

Children must be seated according to:

Height (see Table 49), **Health condition**, **Vision and hearing** impairments.

Children with:

Frequent colds — seated away from windows/doors;

Hearing loss or myopia — seated at the **front** at height-appropriate desks.

Toy Storage and Hygiene

Toy storage **cupboards** must be included in play areas.

Toys must be:

Made from safe materials;

Washed and disinfected regularly: **2× per day** in nursery groups, **1× per day** in older groups using a **2% soap-soda solution**.

Soft toys should be **washed monthly** and **quartz-sterilized**.

Sleeping Area Equipment

Beds must be:

Age-appropriate**,** comfortable**, and** Accessible for cleaning, disinfection, and pest control**.**

If **bunk beds** are used:

The **upper bunk** must have **guardrails at least 30 cm high**. **Clear space** between bunks must allow a child to sit **upright** on the lower bed.

Folding cots are strictly prohibited in PEIs.

Bed layout must:

- **Allow free access** for children and cleaning staff.
- All **beds, mattresses, pillows, and blankets must be labeled**.
- **Bedding and towels** must be changed **at least once per week**.
- Each child must have **at least two sets** of bedding and towels.
- Clean items must be **stored in designated linen cabinets**.

Table 50.

Bed Dimensions

Parameters	**Up to 3 years old**	**3–7 years old**
Bed length	120 cm	140 cm
Bed width	60 cm	60 cm
Bed height from the floor	15–30 cm	15–30 cm

Requirements for Heating and Ventilation Systems

Heating and ventilation systems in preschool educational institution (PEI) buildings must comply with the regulatory requirements applicable to public buildings and facilities.

In cases where stove heating is necessary, the stove must be installed in an area inaccessible to children—preferably outside or from the corridor side. The stove should be lit in the morning and extinguished at least one hour before the children arrive. The installation of stoves of the "bourgeois" type is strictly prohibited.

Microclimate parameters: Air temperature from **20°C to 25°C**, **relative humidity 40–60%**.

Regardless of the season, rooms must be **aired crosswise** at least **twice daily** in the absence of children.

Water Supply and Sewage

Preschool institutions must be provided with water that meets the sanitary standard of **"drinking water"**, supplied via centralized cold and hot water systems at the rate of **150 liters per child**.

In the absence of centralized water supply, local sources (artesian wells, wells) or water delivery and storage systems must be organized based on **75 liters of drinking water per child**, ensuring proper storage conditions in reservoirs. It is mandatory to supply both drinking and heated water through a local distribution system to the kitchen, medical rooms, laundry facilities, and restrooms of each group unit.

For children with disabilities or limited mobility, specialized PEIs must be arranged, providing necessary conditions for **corrective and rehabilitative education**.

The organization of therapeutic and preventive healthcare activities in such PEIs requires **an expanded set of premises**, including medical facilities in accordance with the institution's specialization.

Requirements for Sanitary and Disinfection Measures

All rooms must undergo **wet cleaning twice a day** using cleaning agents. In sleeping rooms, cleaning is carried out after both night and daytime sleep. In playrooms, wet cleaning is performed after each meal. Tables in group and dining areas must be washed with hot water and soap **before and after each meal**, using designated cloths. These cloths must be washed, dried, and stored dry in **specially marked containers with lids**. Carpets must be vacuumed or brushed wet daily and, if necessary, beaten clean. Potties must be cleaned using brushes and detergents, then soaked in a disinfectant solution. Toilets are cleaned **twice daily** using toilet brushes, and sinks are scrubbed with cleaning brushes and cleaning agents. **Once a week (on Saturday)**, all sanitary fixtures must be disinfected. Brushes are to be **disinfected daily** with working solutions containing chlorine. All cleaning equipment must be washed, rinsed, and dried after use. **Disinfectant solutions** are prepared in the medical office and stored in **dark containers**.

SITUATIONAL TASKS

Task 1:

The administration of a preschool educational institution has received increasing complaints from parents regarding frequent infectious illnesses among children in the younger group. A sanitary-hygienic inspection revealed the following:

Air temperature: **19°C.**Relative humidity: **70%.**Airflow speed: **0,3 m/s.**Air exchange rate: **1,5 times/hour.** CO_2 content: **0,17%.** Class duration: **20–25 minutes.** Breaks between lessons: **5–10 minutes.** Outdoor time: **1–2 times per day**, total no more than **3 hours.** No hardening (conditioning) procedures were implemented.

Question: Identify the possible causes of frequent infectious diseases among children.

Task 2:

Secondary School No. 14, designed for **464 students**, is located within a residential block, **50 m** from inter-quarter driveways. A **boiler room** is located **100 m** upwind from the school. The land plot is rectangular and occupies **2,1 hectares**. It includes the following zones:Physical education and sports zone.Educational and experimental area.Recreational zone.Utility yard with a separate entrance from the street. The area of green spaces totals **12,000 m²**.

Question: Evaluate the proposed architectural and planning solution for the school grounds.

Task 3:

A classroom with dimensions **6 m x 4 m** contains **2 windows**, each **1,5 m wide** and **2 m high**.**Light coefficient**: 1:5.**Natural light coefficient (KEO)**: 1%.**Light incidence angle at the farthest desk**: 20°. **Illumination with fluorescent lights**: 110 lux. All desks have **green marking**.

Question: Assess the hygienic conditions in the classroom. How can they be improved? What pathologies may develop in students, and how can they be prevented?

QUESTIONS FOR SELF-CONTROL

1. Describe how zoning of educational institution territory is carried out.
2. How are children's educational institutions located in a city plan?
3. Name the main hygienic principles of planning and construction of educational institutions.
4. List the main premises in an educational institution.
5. State the parameters of the air-thermal regime in preschool institutions.

HYGIENIC REQUIREMENTS FOR SCHOOL FURNITURE AND EDUCATIONAL SUPPLIES

Specific hygienic requirements are established for the furnishing of educational institution (EI) premises, particularly regarding the **dimensions of desks and chairs**, which must be **grouped and marked accordingly**.

In various instructional spaces designated for different functions, **diverse types of student furniture** are utilized (see Table 51). These include **single or double student desks**, **standing desks**, **drawing desks**, and **laboratory desks** with **chemical-resistant surfaces**, all of which are used in combination with chairs. The use of **stools or benches instead of chairs is strictly prohibited**.

Student furniture must be manufactured using **materials that are safe for children's health**, and its **dimensions and shape must correspond to the ergonomic and anthropometric requirements** appropriate for the students' **age and stature**.

For students in **primary general education**, the most suitable type of student furniture is a **school desk equipped with an adjustable inclination mechanism** for the working surface, allowing an **inclination angle of 7–15°** to facilitate comfortable conditions for **writing and reading**.

The **front edge of the seat surface** should extend **beyond the front edge of the working surface** of the desk by:

- **4 cm** — for desks of size No. 1,
- **5–6 cm** — for desks of sizes No. 2 and 3,

- **7–8 cm** — for desks of size No. 4.

Table 51.

Dimensions of Student Furniture and Their Color Markings

Furniture Number	*Height Group, mm*	Height from Floor to Edge of Desk Surface (facing the student), mm	Color Marking	Height from Floor to Front Edge of Seat, mm
1	1000-1150	460	orange	260
2	1150-1300	520	purple	300
3	1300-1450	580	yellow	340
4	1450-1600	640	red	380
5	1600-1750	700	green	420
6	over 1750	760	blue	460

Rules for Seating Primary School Students

In primary school settings, students may belong to three or even four different height groups. Therefore, seating arrangements must accommodate **at least three sizes of student furniture** (see Table 51). Pupils of **shorter stature** and those with **visual or auditory impairments** should be seated in the **front row**.

Students with weakened health, those suffering from **rheumatism**, or prone to **respiratory illnesses** should **not be seated near external walls or by windows**.

To **prevent postural disorders** and reduce the risk of **strabismus**, it is recommended to **rotate students** sitting in the far-left and far-right rows **two to three times per year**, while maintaining consistency between **height and desk size**.

A properly selected desk is a safe desk!

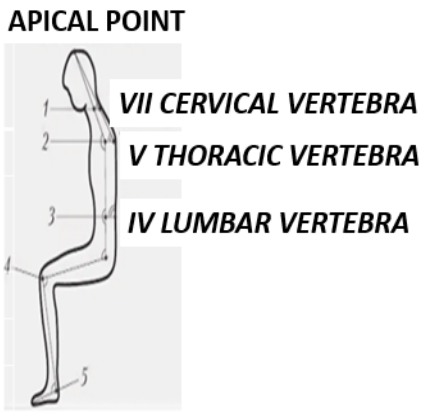
A student seated at such a desk maintains a **maximally safe and ergonomic posture** (see Fig. 34). The parameters of the school desk ensure correct seating position (see Fig. 35), which include:

1. **Height of the desk edge** facing the student
2. **Height and depth of the seat**
3. **Differentiation (difference between seat and desktop heights)**

4. **Negative distance** (the horizontal distance from the front edge of the desk to the backrest)
5. **Backrest distance**

Fig. 34. ***Angles formed during a rational (ergonomic) student seating position***

Indicator	Value, degrees
Head inclination	26–51°
Thoracic spine flexion angle	41–62°
Trunk inclination	85–100°
Knee angle	75–105°
Ankle (tibio-tarsal) angle	75–105°



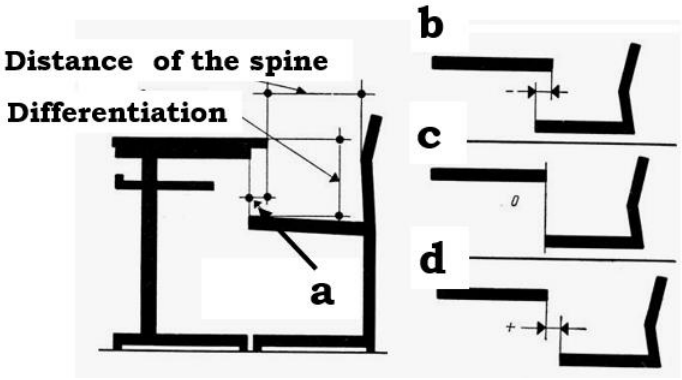


Figure 35. Mutual Arrangement of Desk and Chair:

a – Seat distance

b – Negative distance

c – Zero distance

d – Positive distance

The set of dimensions between the desk and the seat is referred to as the *backrest and seat distance*.

The backrest distance (see Fig. 35) is defined as the horizontal space between the rear edge of the desk surface and the backrest of the chair. This distance should exceed the anteroposterior size of the child's torso by 3–5 cm. If the distance is too large, the child may increase trunk inclination, whereas if it is too small, the child will be compressed between the tabletop and the chair backrest, which may hinder the expansion of the thoracic cage during breathing.

The seat distance is measured along a vertical line from the front edge of the seat to the edge of the desk:

Negative seat distance (b): the desk edge extends 3–5 cm beyond the bench edge.

Zero seat distance (c): the edges of the desk and the seat are aligned vertically.

Positive seat distance (d): the vertical line passes in front of the bench edge.

Correct seating posture of a child at the desk from a hygienic standpoint depends on appropriately selected school furniture.

It is essential that the lines connecting the centers of the eyes, shoulders, and ischial tuberosities form a horizontal alignment parallel to the edge of the desk and seat. The head should incline slightly toward the desk surface such that the distance from the eye line midpoint to the working surface equals 30–35 cm. The forearms rest on the surface of the desk at nearly a right angle to each other, forming an angle of approximately 45° with the edge of the desk, with the elbows positioned near the edge of the table. The feet are placed flat on the floor, the thighs are in a horizontal position, and the lower legs (shins) are oriented vertically (see Fig. 36).

The Rule of Three Right Angles:

1. A 90° angle is formed at the bent knees under the desk.
2. A 90° angle exists between the thighs and the back.
3. A 90° angle is formed at the bent elbows.

To prevent posture disorders and spinal deformities, modern types of furniture have been developed:

- Dynamic furniture
- Functional furniture
- Growing furniture
- Transformable furniture

The transformable model of student furniture (*Fig. 37*) allows the desk to be adjusted according to the individual body proportions of the student. The corners and edges of tabletops, seats, and chair backs are rounded, with no sharp or protruding parts, ensuring safety and comfort.

Figure 37. Transformable Model of Student Furniture.

In classrooms for natural sciences (chemistry, biology, physics), student desks and laboratory tables are installed.

Classrooms for painting and sculpture are equipped with drawing tables and easels.

Computer science classrooms are furnished with electronic computing machines in accordance with sanitary norms and regulations.

In foreign language classrooms, desks may be open or enclosed and may include acoustic semi-cabins or be without them.

Hygienic Requirements for Textbooks

Modern individuals process a large volume of information daily, much of which is received through reading, utilizing typefaces. The unit of reading is the

word, and letters are symbols that facilitate comprehension and information retrieval. A typeface is a specific system of graphic characters, and the design of the characters of each alphabet is one of the most important elements in the typographic layout of any printed material.

Reading, especially in its initial visual stages, requires not only visual acuity, accommodation, and eye movements, but also the involvement of mental functions such as the speed of visual differentiation, visual attention, and visual memory. Accommodation allows a person to see objects clearly at varying distances. The process of focusing by the ciliary muscles to change the curvature of the lens is known as accommodation. Continuous strain of these muscles can lead to fatigue and eventually to accommodation spasm, a precursor to myopia (nearsightedness).

Prevention of Myopia Includes:

- Adequate lighting of the workspace.
- Left-sided lighting (for right-handed students)
- Proper distance between the eyes and the text
- Correct student posture
- Desk inclination angle
- Use of safe fonts suited to the age characteristics of the student

Key Requirements for Children's Textbooks and Books:

The main criterion is readability.

Parameters of Textbook Safety:

Text visibility depends on paper quality, including texture (color, opacity, smoothness)

Contrast between print and background, ink density and durability

Hygienic safety standards, including:

- Typeface parameters
- Text formatting techniques
- Reading volume per session
- Age of the user

- Font proportions should follow hygiene norms, with proper ratios (typically 66,5% to 78% depending on font family)
- Readability (impact of printed text on vision)
- Chemical safety – no risk from excessive levels of harmful chemicals in the materials

Ease of visual perception is a fundamental requirement for working with books. To achieve this:

- The text should stand out clearly against its background
- Images or letters must be large and sharply rendered
- Visual representation must be projected accurately onto the retina

Depending on the age group and visual system development of students (according to pediatric and adolescent hygiene norms), educational publications are classified by age for:

- Primary education
- General secondary education
- Secondary special and professional education (colleges and lyceums)

By Educational Purpose, publications are categorized as:

- Textbooks
- Instructional aids
- Practicals and workbooks
- Anthologies

By Type of Information, publications are divided into:

- Humanities
- Natural sciences
- Formal sciences (e.g., mathematics)
- Specialized (for professional training)

The weight of educational materials is an important factor in preventing spinal curvature, as it directly impacts the total weight of a student's backpack. This will be elaborated in Table 52.

Table 52. Backpack Weight

Grade Level	Backpack Weight
Grades I–II	from 1,2 to 1,5 kg
Grades III–IV	from 1,5 to 2,2 kg
Grades V–VI	from 2,0 to 2,5 kg
Grades VII–VIII	from 2,5 to 3,0 kg
Grades IX–XI	from 3,0 to 3,7 kg
For students of secondary specialized professional schools	from 3,5 to 4,2 kg

The younger the student, the more detailed and expansive their reading process. All elements of the text are visually perceived without omission, leading to line-by-line reading without refixation, which in turn slows down the reading speed.

Therefore, for Grade 1 students, fonts with a minimum height of 4.75 mm are used; for Grade 2 — no less than 4.15 mm, from the group of sans serif or low-contrast new fonts, with a double inter-letter spacing.

Accordingly, the requirements for primary grades include double spacing between words, minimum line length, and regulated print density. Font type must be normal or semi-bold (no less than 65%), with strictly sans serif font family.

By Grades 7 to 9, the eye movement organization reaches near perfection. Reading is performed with virtually no refixation and highly structured eye movement. The font height should be between 3.1 mm and 2.9 mm respectively for Grades 7 and 9. Print density is regulated, and line length depends on the subject.

Font Design Identification for Age Appropriateness

This identification method was developed in 2015 by A.U. Sadyvakasov. It assesses font readability using the MBP-2 microscope and determines sizes in both non-parametric systems (used internationally) and metric SI units. Font sizes are measured in points: in Europe, 1 point = 0,3759 mm; in the USA, 1 point = 1/72 inch = 0,3528 mm.

Readability Assessment

Readability allows textbooks to be designed and printed in a way that is safe for children's health, reduces visual strain, and prevents fatigue. Key characteristics of font design include:

- Font family and height
- Font style
- Line length and print density
- Word spacing and letter spacing (kerning)
- Line spacing (leading)

The method using a microscope provides strict control over safety standards in font design, in compliance with Sanitary Norms.

Hygienic Safety Requirements for Games and Toys

In Uzbekistan, toys must comply with sanitary regulations regarding:

- Materials used
- Construction design
- Physical-chemical and toxicological-hygienic properties

From a hygienic standpoint, toys should:

- Match the child’s age group
- Pose no risk to health
- Be simple in shape, without sharp edges
- Have durable, water- and saliva-resistant coatings

This is especially important for infants and toddlers. Sanitary control over toys includes:

- Inspection of raw materials
- Monitoring compliance with technical production standards
- Approving new material formulas and process changes
- Supervision of storage, sale, and usage conditions

From an epidemiological perspective, toys must be free of pathogenic microorganisms, bacteria, and fungi.

Case Studies

Case Study 1:

In Grade 3 at Beruni School, there are 23 students:8 students are 122–130 cm tall.10 students are >130–135 cm.5 students are >135 cm. The classroom contains two-seater desks as follows: desk No.1 – 2 units, desk No.2 – 6 units, desk No.3 – 4 units.

Question: Provide a hygienic assessment of the desk arrangement in the classroom.

Case Study 2:

Evaluate the feasibility of toy production.Toy: "Rocket," designed with a launch mechanism producing 75 dBA noise, intended for children aged 7–10 years. Specifications:Height: 420 ± 5 mm, mass: 0,45 ± 0,02 kg, two-part design, surface is smooth, Odor intensity: 2 points (sample), 1 point (model environment).Decorative coating resists moisture, saliva, and sweat

Question: Provide a hygienic conclusion on the feasibility of production.

Case Study 3:

Toy: "Lion" figurine for children aged 3–6 years. Specifications: height: 180 ± 5 mm, weight: 0,4 ± 0,05 kg, made of two orange parts (head and body), head is attached via hinges, creating a 6 mm gap.Head has a wig made of red synthetic fibers.

Lab test results:

No migration of zinc, lead, arsenic, cadmium, or barium detected. Coating is resistant to moisture, saliva, and sweat

Question: Provide a hygienic conclusion on the feasibility of production.

SELF-ASSESSMENT QUESTIONS

1. What are the hygienic requirements for school furniture?
2. What are the main parameters of a student desk?
3. What are the seating rules for students in classrooms?
4. What are the hygienic requirements for children's toys?

5. What are the key font design parameters in textbooks?

PREVENTION OF FATIGUE. HYGIENIC FOUNDATIONS OF THE DAILY REGIME

The modern educational environment not only ensures the development of the individual but also prioritizes the preservation of the health of both students and teachers. For a child transitioning from play-based activity to academic learning, the surrounding environmental conditions change significantly, as do the parameters of their time spent indoors. The biological organism of the child is subjected to increasing demands—both physiological and psychological—which can lead to a range of negative consequences.

As the young organism undergoes transformation, it becomes our responsibility to ensure that the child adapts to new conditions with **minimal risk to their health**.

A contemporary strategy in optimizing the performance of children in modern educational institutions involves creating **safe and health-preserving conditions** that support the proper functioning of the body during learning processes. There are several directions in which the study of disease risk and its prevention is approached:

I. Physical Direction

This domain explores the **impact of anthropometric and biomechanical characteristics** on physical activity. It examines the working posture, repetitive movements, design of the workspace, safety of furniture and equipment, and the adaptation of the workstation to the anthropometric and physiological characteristics of the human body.

II. Organizational Direction

Aimed at optimizing work processes, this area involves the **organization of educational activities**, work schedules, communication and relationships within student groups, and **management of the quality of knowledge acquired**. It

seeks to ensure that learning is not only effective but also structured in a way that supports student well-being.

III. Cognitive Direction

This field focuses on the **study of mental (cognitive) processes**, including perception, creativity, analysis, logic, memory, reasoning, and motor response, and their roles in the learning process. It also investigates the **development of fatigue**, emergence of **stress responses**, and **occupational burnout among teachers**.

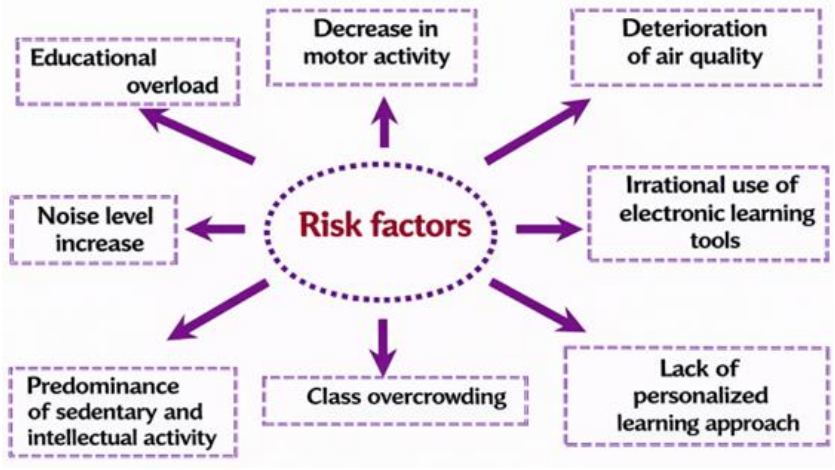


Fig. 38. Risk factors contributing to disease development in children within educational institutions

What, then, can influence the educational activity of a child (Fig. 38)? The following elements of working conditions can be identified:

I. Sanitary and Hygienic Factors:

These include microclimate, natural and artificial lighting, air movement, humidity, noise, and contamination of indoor air and the surrounding environment.

II. Psychophysiological Factors:

These are characteristics of the educational process, including mental workload, which can be evaluated in terms of the expenditure of nervous and physical energy by the child.

III. Physical Load on the Child's Body:

Both dynamic and static physical loads must be considered (hourly workload, posture, furniture, lighting).

IV. Aesthetic Factors:

These involve creating an environment that is cozy, aesthetically pleasing, and safe. The color scheme of a room is not limited to the color and texture of walls and floors but also includes curtains and furniture. Important aspects include furniture arrangement, adequacy of equipment, area, and volume of the room.

V. Socio-Psychological Factors:

These include the psycho-social climate, number of children in groups and classes, discipline, teaching style and methods applied in the educational process, motivation strategies, and the use of computing and information technologies.

The modern educational process must align with the child's health capabilities. Ensuring harmonious personality development while preserving working capacity and health, and preventing fatigue, is a fundamental goal of child and adolescent hygiene.

Fatigue and Its Mechanisms

School learning is primarily a mental activity. According to physiological principles, prolonged and unregulated mental activity gradually leads to fatigue. Hence, studying the impact of educational processes on a child's physical condition is essential.

Fatigue is a core concept in the physiology and hygiene of labor. Fatigue, resulting from previous activity, is a temporary condition characterized by decreased performance. Fatigue can be mental or physical, depending on the primary activity.

"Fatigue is the process of temporary reduction in the functional capacities of the body caused by intense or prolonged work, manifested in a decline in both the quantity and quality of performance and a disruption in physiological coordination."

Fatigue leads to reduced performance quality. It is a complex phenomenon, involving physiological, psychological, and occasionally social factors.

Components of Fatigue:

- Decreased work capacity
- Impaired attention
- Disruption in coordination and movement rhythm
- Memory and cognitive decline
- Drowsiness

Mental work primarily engages the cerebral cortex, which is especially susceptible to fatigue. Sensory organs (vision and hearing) are also involved. Muscular activity is part of the learning process—writing and sitting require tension in neck and back muscles. Fatigue symptoms may not immediately match subjective feelings—interesting tasks may mask fatigue, whereas dull tasks can hasten it.

Stages of Fatigue in Children:

Stage I – Motor Restlessness: Increased excitability and reduced internal inhibition.

Stage II – Reduced Excitability: This leads to decreased strength of conditioned reflexes, reduced speed and accuracy of tasks, and delayed response times.

Recovery from Fatigue:

To restore mental efficiency, children need active rest, exposure to fresh air, and positive emotions. Signs of fatigue in schoolchildren are typically temporary and disappear quickly after a break.

Types of Fatigue:

- Mental fatigue: Reduced intellectual productivity and attention.
- Physical fatigue: Disruption in muscle function, including coordination, rhythm, intensity, and speed of movements.

Overfatigue:

Overfatigue is a pathological state caused by chronic physical or psychological overload. Clinically, it manifests as functional disturbances in the central nervous system. Though fatigue is a protective physiological response, prolonged exposure without adequate recovery can lead to health consequences.

Factors Affecting Mental Work Capacity:

These include both exogenous (external) and endogenous (internal) factors, which often act simultaneously.

Exogenous Fatigue Factors:

1. Lesson difficulty – more cognitively demanding subjects such as mathematics, foreign languages, physics, chemistry.
2. Work rhythm – slow-paced tasks may induce faster fatigue.
3. Sedentary behavior – prolonged immobility.
4. Psychological stress – fear of poor grades, public speaking, or parental scolding.
5. Environmental conditions – noise, lighting, indoor climate.

Endogenous Fatigue Factors:

- Child's health condition
- Level of preparation
- Motivation
- Individual characteristics of the student

Best Rest Strategy:

Prolonged, demanding tasks require regular breaks. Ideal rest is not complete inactivity but a change of activity type. For schoolchildren, this includes walks, sports, preferably outdoors.

Manifestation of Fatigue:

Fatigue appears similarly across all students due to the uniformity of mental and physiological mechanisms. Initial physiological changes occur in the speech-related cortical zones, followed by breakdowns in motor and speech reflexes. Physical restlessness increases, and subjective fatigue signs appear.

Subjective Fatigue Influencers:

- Age and gender
- Mood and interest in subjects
- Health status
- Preparedness
- Talent
- Teacher feedback (praise or criticism)

Emotional Responses and Adaptation:

Emotional responsiveness significantly affects physiological adaptation. Emotions boost learning interest and delay fatigue.

Three Categories of Schoolchildren by Work Capacity:

- High capacity: ~33%
- Average capacity: ~50%
- Low capacity: ~17%, marked by inattention, hyperactivity, and low academic performance.

Hygienic Principles for Regulating Student Activity:

To ensure an optimal healthy state, mental and physical workloads must not exceed the body's capabilities.

Without preventive measures, fatigue occurs. If recovery is not achieved through daily or weekly rest, it can progress to overfatigue, which can impair growth, development, and general health.

Signs of Early Overfatigue:

- Behavioral changes
- Academic decline
- Loss of appetite
- Irritability
- Cardiovascular symptoms

These cases may require prolonged rest, treatment, rehabilitation, and a healthy lifestyle.

Fatigue Prevention Methods:

I. In-Class Strategies:

- Physical exercise breaks
- Stretching sessions
- Eye gymnastics

II. Group-Level Strategies:

- Differentiated instruction based on cognitive styles
- Lesson planning according to difficulty
- Psychological comfort and humor
- Motivational techniques

III. Individual Strategies:

- Personalized instruction pace
- Regulated homework
- Learning behavior strategies
- Custom exercise programs (Fig. 38)

Fig. 38. Physical Exercise Breaks and Pause Activities

Physical Exercise Breaks and Pauses

From a hygienic standpoint, the following factors are subject to regulation, measurement, and control:

- Microclimate indicators of educational spaces
- Ventilation and airing of classrooms
- Sanitary maintenance of educational buildings
- Planning, surface area, and volume of classrooms
- Organization of educational activities, including work and rest regimens

- Scheduling based on subject difficulty and hourly workload
- Selection and arrangement of student furniture, seating plans, and posture control

Lesson Design and Physiological Soundness

All school subjects vary in content, teaching techniques, and applications of knowledge.

From the psychohygienic point of view, the difficulty of a lesson should be evaluated by:

- Volume of new information
- Complexity
- Degree of novelty in the material

Prevention of Overfatigue

Key measures include:

- Structured work-rest cycles and a balanced daily schedule with adequate sleep
- Hygienic requirements in the education process
- Regular and appropriate holiday periods
- Balanced distribution of class periods and breaks
- Regulation of study loads (especially when using multi-shift systems)

Requirements for Rational Educational Organization

A healthy educational process must:

- Comply with sanitary norms
- Use age-appropriate teaching forms, methods, and technologies
- Employ health-preserving pedagogical tools
- Ensure adequate motor activity
- Maintain a positive psychological environment, including emotional climate and the development of student self-confidence

Elements of a Healthy Daily Routine

A child’s day should be organized to include:

- Free time

- Self-selected motor activity levels
- Alternation of various activities
- Full night's sleep and fresh air breaks
- Adherence to principles of balanced nutrition

Fatigue Prevention Includes:

- Sufficient, evenly distributed lighting that avoids glare and sharp shadows
- Building orientation, classroom size, window placement
- Class size limits
- Comfortable indoor climate (temperature, humidity, air movement)
- Control of indoor air quality
- Font design of textbooks matching age-specific visual needs
- Usage of regulated school furniture matched to height (marked, desk tilt adjustable)
- Proper desk arrangement and seating by height
- Correct seated posture during lessons

Objective Evaluation of CNS Functional Status

To assess the quality of educational process organization, objective physiological indicators are used, especially those reflecting central nervous system (CNS) function.

PHYSIOLOGICAL METHODS FOR ASSESSING CNS FUNCTIONAL STATE AND WORKING CAPACITY IN SCHOOLCHILDREN

Such methods help assess whether the educational environment is properly structured.

Methods applied in hygiene and psychophysiology studies include:

- Testing for stable clear vision
- Assessing visual-motor and audio-motor reactions
- Measuring fine motor coordination
- Studying performance via dose-based tasks
- Observing behavior in class

Assessment of Visual Stability

A commonly used test is the Landolt Rings, suitable for diagnosing attention in young children.

This test measures voluntary attention, work capacity, and resistance to monotonous tasks. It is conducted using standard forms (see Fig. 39), containing rows of Landolt rings with small breaks in different directions.

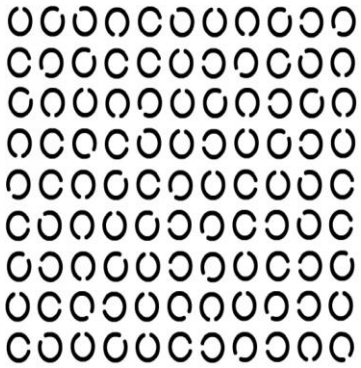


Fig. 39. Landolt Rings

Methodology

The duration of the test is 3 minutes, during which the participant continuously looks at the gap in the Landolt ring and informs the examiner of the moments when the gap is visible and when it becomes unnoticeable.

- The outer diameter of the ring is 7 mm
- The gap width and the thickness of the shaded (black) part of the ring are 1,5 mm
- The participant observes the Landolt ring from a distance of 5 meters

This test is used to assess:

- Voluntary attention
- Sustained focus
- Resistance to monotony

Table 53. Results of the Study on Voluntary Attention

Participant's Response	**Stopwatch Readings (in seconds)**

Participant's Response	Stopwatch Readings (in seconds)				
Sees the gap	0	25	45	10	45
Does not see the gap	10	35	25	30	60

The duration of clear vision is:10 + 10 + 20 + 20 + 15 = **75 seconds**

Stability of Clear Vision (SCV) is calculated as:75 × 100% ÷ 120 = **62,5%**

Assuming the SCV before classes was 100%, and based on the research findings, by the end of the lesson a **20% decrease** was observed, it indicates that the **child's working capacity has decreased**.

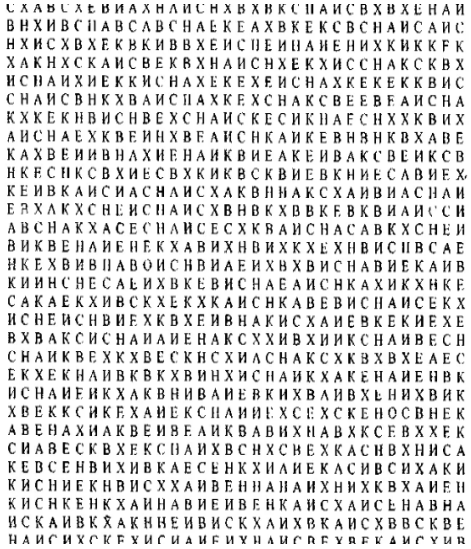


Figure 40. Anfimov's Proofreading Test.

Methodology:

I. Scan each line (from left to right) and cross out the letters "Х" and "*И*" with a single diagonal line.

Upon the command "Start," continue working for 1,5–2 minutes until the command "Stop." Mark the stopping point.

II. Continue crossing out the letters "Х" and "*И*" in all cases **except** when the letter "Х" is preceded by the letter "В", and the letter "*И*" is preceded by the

letter “E”. In these cases, the combinations “ВХ” and “ЕИ” should be **underlined** with a single line.

Calculation of Work Volume:

Determine the total for the entire 4-minute trial and separately for each 2-minute interval (A_1 and A_2); the number of complete lines × 40 + the number of characters in the incomplete line.

Calculation of Coefficient K using the formula:

$K = A / A_9$

Table 54

Assessment of Work Capacity Based on Correction Tests

Change in Work Capacity	**Work Volume Performed**	**Number of Errors**
Increases	↑	↓
	→	↓
Unchanged	→	↓
Decreases	↓	↑
	→	↑
Unchanged	↑	↑

Legend:

↑ — Increases. ↓ — Decreases. → — No change

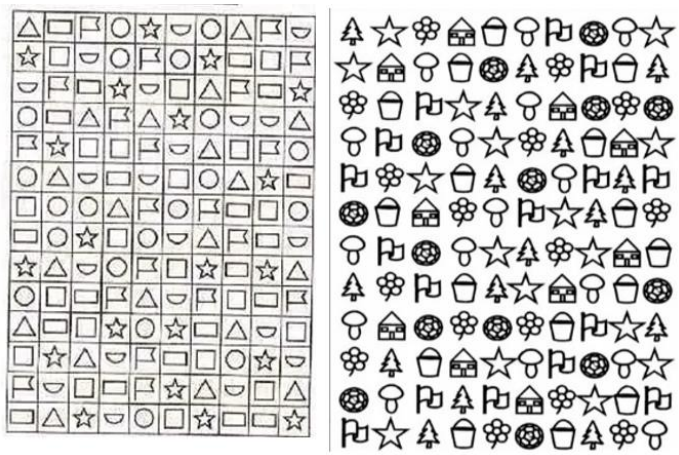


Fig. 41. Correction Tables for Children Who Cannot Read

Example:

A child scanned 60 characters and made 7 errors.Recalculated per 100 characters, this will be: **(7 × 100) / 60 = 11,6**

The **coefficient of mental work productivity (Q)** is calculated using the formula:

$Q = C^2 / (c + d)$ where:**c** — number of characters scanned, **d** — number of errors made.

Each skipped line is excluded from the total number of scanned lines but is counted as **one error**.

Example calculation:

$Q = 60^2 / (60 + 7) =$ **53,7**

Method for Determining the Speed of Attention Switching Gorbov-Schulte Table

The subject is presented with a square sheet divided into small squares, each containing randomly arranged numbers from 1 to 25 in **black** and from 1 to 24 in **red**.

The subject performs a sequential search of numbers according to the following tasks:

1. Search for **black numbers only** in **ascending order**.
2. Search for **red numbers only** in **descending order**.
3. **Mixed search** of black and red numbers, during which the subject must **switch attention** between the two sequences.

7	8	13	11	22	19	6
1	20	24	3	8	13	10
17	14	4	16	11	10	22
9	23	19	5	17	12	1
14	23	9	12	18	5	21
4	2	25	15	15	2	16
6	20	18	7	21	24	3

Fig. 42. Gorbov-Schulte Table

T = C – (A + B), where **A, B, C** are the time values taken to complete the tasks using the tables. The time spent on each of the tasks allows for assessment of the **attention switching speed**.

Chronoreflexometry

Study and assessment of visual-motor and auditory-motor reactions

This method is used to evaluate and study the **functional state of the nervous system**. It enables the determination of changes in the **balance between excitation and inhibition**.

Tasks include:

1. **Assessment of visual-motor and auditory-motor reactions**
2. Use of **equipment for tremorometry analysis**

The test measures the **motor reaction time** of the subject in response to a **visual or auditory stimulus**, which provides information about the **speed of neural processes** and the **functional condition** of the corresponding **reflex arcs** (see Fig. 43-1).

Fig. 43. Chronoreflexometry

Tremorometry (Coordination Measurement)

Motor coordination is measured using the **PFKK coordinatometer** or a **chronotremorometer**.

The subject, holding a stylus in their right hand and keeping it suspended, guides it through a groove as quickly as possible while trying not to touch the sides. The **number of contacts** between the stylus and the walls is recorded, and the **average number of touches per second** is calculated by dividing the total number of contacts by the total test duration across three trials.

Assessment of Mental Work Capacity Through Timed Tasks

This method involves having subjects complete **special tasks** within a **strictly limited time frame**.The complexity of the tasks is adjusted to suit the **age and preparedness** of the students so that most can complete them within 3–5 minutes.

Examples of tasks include:

- **I.** Solving arithmetic problems
- **II.** Writing sample dictations

Tasks are selected according to the **difficulty level** and the **capabilities** of the subjects.

During data processing, the following parameters are determined:

1. **n** — number of students participating in the task
2. **t** — time spent completing the task (minutes)

3. **v** — total number of tasks given
4. **V_1** — number of tasks solved
5. **V_2** — number of correctly solved tasks

Indicators characterizing work capacity:

K = (V_1 / V) × 100 — percentage of tasks solved out of total tasks

K_1 = (V_2 / V_1) × 100 — percentage of correctly solved tasks out of those attempted

$$t_1 = \frac{t \times n \times 60}{V_1}$$

t — time to solve one task

Observation Methods for Studying Work Capacity During Classes

The behavior and work performance of children and adolescents during class sessions can be studied **without interrupting the learning process** using **time-motion study methods** such as:

1. **Distraction logging**
2. **Time-motion study (chronometry)**
3. **Photographic time-motion study**

1. Distraction Logging

This method determines the **degree of distractibility**, although it does not measure the **duration** of distractions.

Distractions are recorded every 5 minutes in a protocol.

2. Chronometry

In this method, major behaviors are logged in a protocol, including:

- Engagement with main task
- Attentive listening to the teacher
- Episodes of distraction

Analysis of such time-motion records helps determine the **lesson density** and the **proportion of each activity**. The **duration** of each activity can be calculated as a **percentage of the total class time**.

3. Photographic Time-Motion Study

This involves recording the **start and end times** of each observed activity using a stopwatch. This method "photographs" the entire sequence of a student's work in terms of **duration and alternation of actions**. However, **this method observes only one child at a time**.

HYGIENIC REQUIREMENTS FOR THE ORGANIZATION OF THE EDUCATIONAL PROCESS

A rationally structured class schedule can ensure **optimal performance and efficiency** of students.

When designing a lesson timetable, it is essential to take into account the **dynamics of work capacity** changes throughout the school day and week, as well as the **need for alternating different types of activities**.

Hygienic principles for organizing children's education in school:

- Alignment of academic load with the student's age
- Consideration of the body's biological rhythms
- Adaptation of academic load to the child's individual characteristics
- Alignment of academic load with the child's health condition

Phases of Human Activity

Research into human functioning has shown that activity progresses through several **transitional phases**:

I. ***Pre-work phase – mobilization***

II. ***Adaptation (warming-up) phase***

III. ***Stable work capacity phase***

IV. ***Fatigue and recovery of functions***

Children experience **two peaks of mental performance** during the day:

- First peak: **8:00 to 12:00**
- Second peak: **17:00 to 19:00**

Performance is notably low:

- In the **afternoon** (13:00 to 15:00)

- At **night** (21:00 to 5:00)

Weekly Dynamics of Biological Rhythms

Weekly rhythm studies show:

- **Monday and Tuesday** – "Activation" or adaptation days
- **Wednesday and Thursday** – Days of **optimal performance**
- **From Friday onward** – **Decline** in work capacity

For children, especially in **primary school** with a **5-day week**, the weekly activity phases are as follows:

- **Monday** – Activation into learning activities
- **Tuesday and Wednesday** – High productivity
- **From Thursday** – Decline in performance

Characteristics of Activity Phases

Mobilization and Adaptation Phase

This is the **transition** from rest to work readiness. Mobilization typically lasts **15 to 40 minutes** and includes:

- Heightened metabolic activity
- Activation of body systems: nervous, cardiovascular, respiratory
- Optimization of coordination between the brain and working organs

Once the individual enters this phase, they usually settle into a steady rhythm for **1,5 to 2 hours**.

Stable Work Capacity Phase

This phase is characterized by **optimal conditions** for activity, with **stabilization of key performance indicators**.

For students, the **clarity of understanding** and **knowledge retention** serve as primary indicators of this stable state.

Key factors for evaluating work capacity:

- Nature of the performed task
- Gender and age
- General and emotional health
- Level of knowledge, skills, and abilities

Fatigue and Function Recovery Phase

During this stage:

- Productivity **declines**
- Reaction speed **slows down**
- Error rate **increases**
- **Energy resources** are depleted

Recovery Stage

Recovery time depends on the **intensity of the previous workload**:

- After light work: recovery takes **around 5 minutes**
- After a single intense task: recovery may take **60–90 minutes**
- After prolonged physical exertion with exhaustion: recovery can take **several days**

Requirements for Lesson Organization

A **rational structure of lessons** significantly impacts both **work capacity** and thus **academic success** and **student health**.

From a hygienic standpoint:

- In **Grade 1**, lesson duration should not exceed **35 minutes**
- In **higher grades**, not more than **45 minutes**

To **prevent fatigue**, schools not only regulate the **duration of lessons**, but also the **structure of lesson content**, applying the **principle of alternating activity types**, such as: writing, mathematics, reading, foreign language, oral activities, physical education

Physiological methods used to assess work capacity have established **subject difficulty levels for students of various ages** (see **Tables 55 and 56**).

Table 55

Rank Scale of Subject Difficulty for Students in Grades 2–4

No.	**Subject**	**Score**
1	Mathematics	12

No.	Subject	Score
2	Uzbek (or Russian) Language in schools with Russian (or Uzbek) instruction	11
3	Foreign Language	10
4	Literature	7
5	"Man and the World" (Environmental/Social Studies)	5
6	Physical Education	4
7	Labor/Technology Education	3
8	Visual Arts	2
9	Music	1

Table 56.

Rank Scale of Subject Difficulty for Students in Grades 5–11

No.	Subject	Score
1	Mathematics	12
2	Foreign Language	11
3	Uzbek (or Russian) Language in schools with Russian (or Uzbek) instruction	10
4	Physics, Chemistry, Informatics	9
5	Biology	8
6	History, World History, Social Studies	7
7	Geography, Natural Sciences	6
8	Literature	5
9	Labor/Technology Education, Drafting	4
10	Physical Education	3
11	Visual Arts	1

Table 57. Hygienic Guidelines for Maximum Permissible Academic Load per Day and Week

- **Grade 1** – No more than **4 lessons per day**, and **1 day per week** may include **5 lessons**, provided the additional lesson is **Physical Education**.
- **Grades 2–4** – No more than **5 lessons per day**, and **once a week** up to **6 lessons**, with the additional lesson being **Physical Education**.
- **Grades 5–6** – No more than **6 lessons per day**.

- **Grades 7–11** – No more than **7 lessons per day**.

Table 57.

Weekly Distribution of Academic Workload (in Academic Hours)

The academic load must be distributed evenly throughout the week.

Grade	6-Day Week	5-Day Week
1	–	22
2–4	26	23
5	32	29
6	33	30
7	35	32
8–9	36	33
10–11	37	34

Work and Rest Regimen

Classes at school should begin no earlier than 8:00 a.m. “Zero” periods (lessons before the official school day) are not permitted. Breaks between lessons must be no less than 10 minutes. A longer break, usually after the third lesson, is recommended to last **20–30 minutes** to allow time for eating. Active games should stop **1,5–2 minutes** before the lesson begins. If a school operates in two shifts, **grades 1, 5, and graduating classes (9–11)** must study **exclusively in the first shift**.

Conditions for Timetable Planning in Schools

When drawing up class schedules, it is necessary to consider:

- the nature of the work,
- the difficulty of the subject,
- the degree of strain on the nervous, muscular, and cardiovascular systems,
- biological rhythms of work engagement during the day and week,
- the predominance of static and dynamic components in lessons.

The **first lesson** falls within the **adaptation period**, while the **last lesson** occurs during **fatigue onset**. Lessons with a **pronounced dynamic component**, such as **Physical Education**, are best scheduled **first**, as they promote faster entry into

the work rhythm. Less demanding subjects should also be placed early in the schedule.

During periods of **stable working capacity**, **complex subjects** (e.g., language, literature, mathematics) should be scheduled.

Recovery periods after **Physical Education** classes must also be considered.

For **junior grades**, subjects of equal difficulty **should not be scheduled consecutively**.

Double periods (two consecutive lessons of the same subject) for **senior grades** are allowed **only for major (profile) subjects**, and only **before the long break (30 minutes)**.

The **last lesson** should consist of **easily perceived subjects** such as **Music** or **Art**.

Placement of the Most Difficult Subjects in the Schedule

- **Grade 1** – during the **2nd lesson**
- **Grades 2–4** – during the **2nd–3rd lessons**
- **Grades 5–11** – during the **2nd–4th lessons**

Rules for Drawing Up the Timetable

- ✓ For **Level I education**, the core subjects are **Mathematics, Russian Language, Foreign Language, Natural Science, and Informatics**; they must be alternated with **Music, Art, Labor, and Physical Education**.
- ✓ For **Level II and III education**, **natural and mathematical subjects** should be alternated with **humanitarian subjects**.

Hygienic Requirements for the Organization of the Educational Process in Grade 1

Requirements:

- Classes must be conducted only in the **first shift**;
- The **school week is 5 days**;
- A **reduced academic day** should be set in the middle of the week;
- The workload should **gradually increase**.

I. In the **first semester**, a **"stepped" (gradual) mode of learning** is applied:

- **First quarter (September–October):** 3 lessons of 35 minutes each;
- **Second quarter (November–December):** 4 lessons of 35 minutes each;
- **Third and fourth quarters (January–May):** 4 lessons of 45 minutes each.

II. From the **second semester**, the total academic load for first graders is **22 hours per week** in a **5-day school week**.

III. A **dynamic pause** of at least **40 minutes** must be arranged in the middle of the school day.

IV. Homework is not assigned to first-grade students, and **numeric grading of academic performance is not applied**.

V. Physical activity breaks ("physical culture minutes") should be conducted **during every lesson**, lasting **15 to 25 minutes** in total. A **physical culture pause** should be included in lessons involving high mental activity or prolonged static tension.

Evaluation of the timetable is conducted using the criteria mentioned above, along with **ranked lesson difficulty (Tables 55, 56)** and takes into account **weekly work adaptation** when compiling the **lesson schedule assessment chart**.

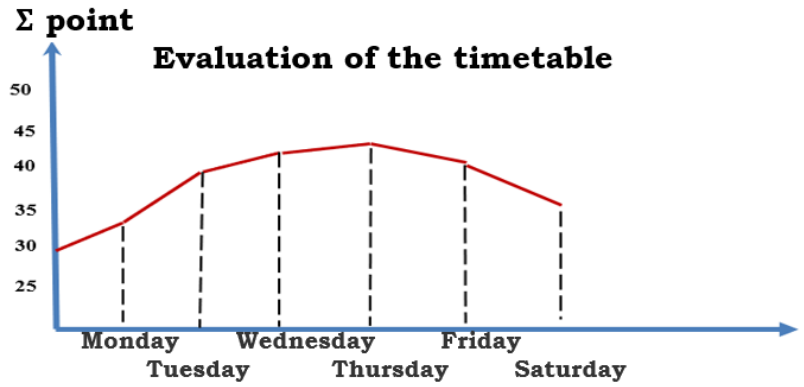


Fig. 44. Schedule Evaluation Chart

SCHOOL READINESS

A sufficient level of child development that enables easy and smooth adaptation to new life and activity conditions is called **"school readiness."** Such physiological and psychological changes help children learn, acquire new competencies, and express new forms of behavior and levels of life activity.

According to S.M. Grombach, **"School maturity is the level of development of several biological systems and individual functions that ensures students meet all school requirements without harm to health and normal development, and without excessive strain."**

Only at a certain age can a child express the developmental traits and social skills necessary for transitioning to a new stage. **Age** is a specific stage of human development.

Functional readiness of a child for school education refers to the set of required skills and the degree of development of cognitive functions.

It is the level of a child's growth and development that guarantees schooling without health damage or extreme tension.

Assessment of "School Maturity" Level

I. Methods for determining the level of morphological development in a child

II. Methods for assessing psychophysical development

III. Methods for evaluating mental functions, motivation, and personality traits

Thus, a child standing on the threshold of school should be mature:

- **Physically**
- **Mentally (Intellectually)**
- **Emotionally**
- **Socially**

The Degree of Development Depends On:

- Growth and development of the preschool child's body
- Level of formation of mental processes
- Upbringing and social environment
- Personal qualities

- General learning skills

Medical Criteria of Readiness

Medical readiness criteria are determined through an in-depth medical examination, with the mark “HEALTHY!”

The child's **biological development** must correspond to their **passport (chronological) age**; **developmental delays are unacceptable**.

Medical and Hygienic Aspects of Functional Readiness of Children for Systematic Education

Medical and hygienic components of a child's school readiness include:

- The state of the child’s health
- Endurance and working capacity of the organism
- High resistance level of the body
- Harmonious physical and neuropsychological development, including motor skills
- Compliance of morphological and physiological development with age-specific indicators

acquisition of cultural and hygienic skills by the child;

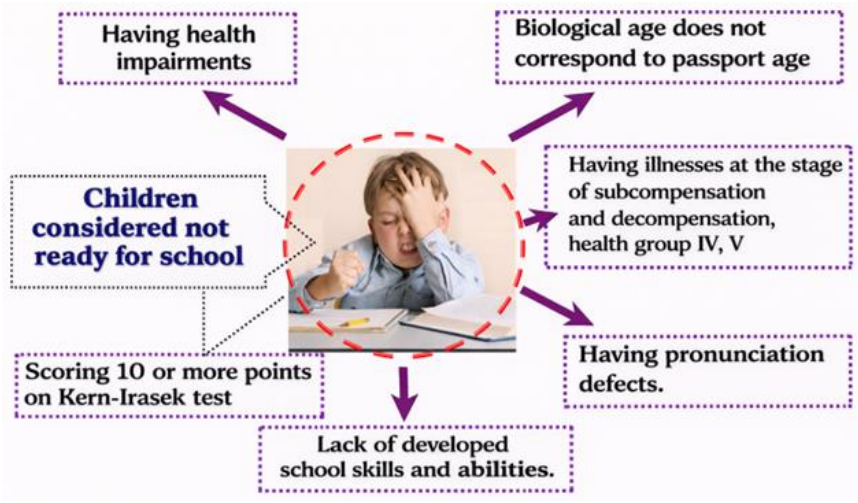


Fig. 45. Medical and hygienic components of a child’s readiness for school.

Psychological Readiness

The psychological characteristics of each age period are determined by the leading activity of the child.

A schoolchild becomes a pupil, and their social position changes. Play activity shifts to educational activity. There is a change in the social environment. Specific reactions appear, in particular, the fear of failure.

For a schoolchild, educational activity requires the development of perseverance. Motor activity is subject to specific requirements; rules are established by adults. A certain level of development of speech, thinking, analysis, and logic is necessary.

Determining Children's Readiness for School

The pedagogical approach determines the development of academic skills:

- ability to count, read, write, etc.;
- skills in both forward and backward counting (from 0 to 10);
- performance of basic mathematical operations;
- recognition of printed letters or ability to read, copy letters;
- clarity of pronunciation, diction, ability to recite poems and retell content;
- the child's general knowledge.

Psychological-pedagogical readiness is defined by the ability to complete tasks independently, whether the child can follow rules, their level of discipline, ability to communicate with unfamiliar children and adults, understanding of the purpose of school and desire to study, as well as neatness and ability to organize their belongings.

Psychological Readiness for Schooling

The position of a schoolchild.

For example, a child may be curious, enjoy reading books, ask many questions, have a desire for new experiences of school life, and adopt the role of a schoolchild with its attributes (schoolbag, pens, notebooks, etc.).

- Ability to follow rules, meet requirements, and control behavior.
- Ability to listen attentively and complete tasks.

- The ability to play the role of a student in school life begins to appear.

Methods for Assessing School Readiness

I. The Philippine Test (Fig. 15)

II. Test for determining the child's internal position:

1. Would you like to go from kindergarten to school? Why?
2. What do you like about school? What would you most like to do at school?
3. Or maybe it's better to stay in kindergarten for a bit longer? Why?
4. What do you think is better – school or kindergarten?

III. Test to determine the leading activity: play or cognitive.
The child is offered to carefully examine some toys and remember them. Regular toys are placed on the table (favorite toys should not be included). Then a story is told or read that the child has not heard before. Reading is stopped at the most interesting point, and the child is asked what they would prefer to do at that moment – play with the toys on the table or listen to the end of the story.

IV. Kern–Yerasek Test

Indicative test of school maturity

Task No. 1: Draw a person.

Task No. 2: Look, something is written here — write or draw the same.

Task No. 3: Look — here are some dots. Draw the same ones next to them.

Fig. 45. Medical and hygienic components of a child's readiness for school.

Psychological Readiness

The psychological characteristics of each age period are determined by the leading activity of the child.The child becomes a pupil, and his or her social position changes. Play activity is replaced by educational activity. A shift occurs in the social environment. Specific reactions emerge, particularly the **fear of failure**.

The pupil's educational activity demands the development of **perseverance**. Physical activity becomes subject to certain rules. These rules are imposed by adults. A certain level of **speech development**, as well as the ability to think analytically and logically, is required.

Determining Children's Readiness for School

Pedagogical Approach – Development of Learning Skills:

- The ability to count, read, write, etc.;
- Skills of forward and backward counting (from 0 to 10);
- Performing basic mathematical operations;
- Recognition of printed letters or reading and copying them;
- Clear pronunciation, diction, recitation of poems, and retelling content;
- The child's general awareness and knowledge.

Psychological and Pedagogical Readiness

This is defined by a child's **ability to independently complete tasks**, **obedience to rules**, level of upbringing, communication skills with unfamiliar children and adults, **understanding of the purpose of school**, desire to study, neatness, and ability to organize and collect their belongings.

Psychological Readiness for Schooling

Pupil's Position – for example:

- Curiosity;
- Love for books and reading;
- Tendency to ask many questions;
- Desire for new experiences related to school life;

- Assumes the role of a pupil, with appropriate attributes (school bag, pens, notebooks, etc.).

The child should be able to:

- Follow rules and demands;
- Control their behavior;
- Listen attentively and complete tasks;
- Play the role of a pupil within the school setting.

Methods for Assessing School Readiness

I. The Philippine Test (see Fig. 15)

II. Test to Determine the Child's Internal Position

1. Would you like to move from kindergarten to school? Why?
2. What do you like about school? What would you most like to do in school?
3. Maybe it's better to stay in kindergarten a bit longer? Why?
4. Where do you think it's better – in school or in kindergarten?

III. Test to Determine the Leading Type of Activity (Play vs. Cognitive)

The child is shown toys and asked to remember them. The toys should be ordinary (favorite toys should not be used).Then a previously unknown fairy tale is read or told to the child.Reading is stopped at the most interesting part, and the child is asked what they would prefer to do at that moment:play with the toys on the table or listen to the end of the story.

IV. The Kern–Yerasek Test

Indicative test for school maturity

- **Task No. 1**: Draw a person.
- **Task No. 2**: “Look, something is written here – draw/write the same.”
- **Task No. 3**: “Look – here are some dots. Draw the same ones next to them.”

Fig. 46. Children drawing Task No. 1 of the Kern–Yerasek Test.

Evaluation of the Kern–Yerasek Test:

- **3 to 5 points**: The child is considered mature in terms of psychomotor development – **ready for school**.
- **6 to 7 points**: **Average** level of readiness – "developing maturity." A favorable prognosis can be made.
- **8 to 9 points**: **Below average** level of school readiness – this child requires additional classes.
- **10 or more points**: The child is considered **immature** in psychomotor development.

V. Motometric Test

Materials:

- Cards sized **6 x 6 cm**, made from drawing paper, with **two concentric circles** drawn using a compass – diameters **5 cm** and **5.3 cm**.
- **Scissors**: 18–20 cm long with **rounded ends** and a **cutting surface of 70 mm**.
- **Clock with a second hand** or a **stopwatch**.

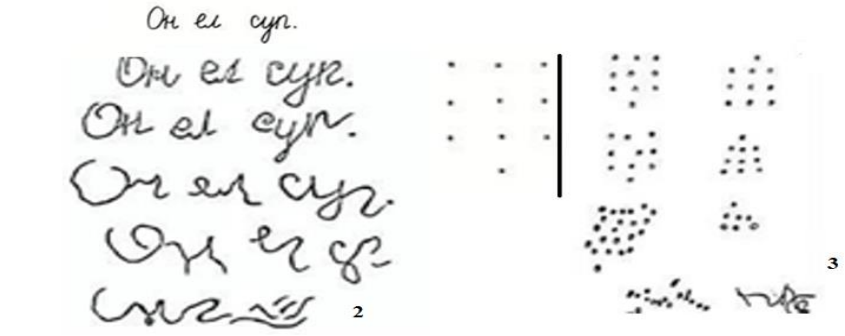


Fig. 47. Children drawing Tasks 2 and 3 of the Kern–Yerasek Test.

Task (Fig. 48):

"Look, here two circles are drawn. Try to cut out the first one (show which one) without cutting into the second."

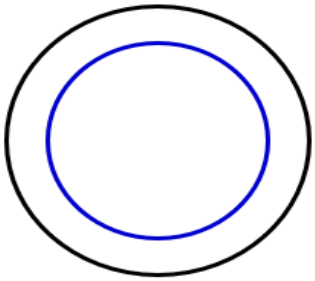


Fig. 48. Motometric test.

If a child is ready for school, this task is completed in under 1 minute, with no more than two errors (cuts) on either circle.

I. Assessment of phonemic perception clarity

Includes 4 tasks. Four sets of 7–8 cards each. Each card depicts specific objects whose names contain the following sound groups:

- [r] hard and soft,
- [l] hard and soft,
- Sibilants: [s] hard and soft, [z] hard and soft.

MAIN FUNCTIONS OF A SCHOOL PHYSICIAN

I. Medical and preventive work:

- Ensure an in-depth medical examination once per academic year, including somatometry and physical development assessment of students. The order is issued by the chief physician of the district polyclinic with a list of all involved specialists.
- Analyze the data from in-depth student examinations.
- Conduct follow-up medical monitoring of children with health deviations. Assign students to health groups (I, II, III, IV) and medical groups for physical education (preparatory, main, special).
- Provide guidance on career orientation.

II. Anti-epidemic work:

- Prevent the spread of diseases within the institution: record infectious cases, monitor quarantined classes, inspect kitchen staff daily for pustular diseases, control food preparation and storage.
- Administer preventive vaccinations according to the immunization schedule.

III. Sanitary and hygienic work:

- Assess sanitary-hygienic learning conditions (lighting, microclimate).
- Hygienic evaluation of lessons, seating arrangement of students in classrooms, analysis of class schedules, work/rest balance (duration of lessons and breaks).
- Supervise the organization of labor training and its sanitary conditions.
- Control the organization of student meals.
- Prevent injuries during physical education classes.

IV. Sanitary-educational work:

- Conduct discussions and lectures for students, parents, and teaching staff on hygiene, infectious disease prevention, daily routine, career guidance, and more.
- Organize a “Health Corner” and exhibitions on student health and healthy lifestyle topics.

Labor Training in General Education Schools

Labor training is only allowed if hygienic standards for organization and conditions of labor and polytechnic education are met.

It is conducted throughout all stages of schooling:

- In primary school as manual labor;
- In middle school: technical labor for boys and service labor for girls;
- In high school (grades 10–11): at vocational training centers.

All labor classes must comply with sanitary and hygienic standards relevant to the type of work.

Manual labor lessons in primary school:

Focus on developing movement coordination and fine motor skills of the hand for writing (e.g., gluing, paper cutting, fabric, molding with clay).

Requirements for labor training in grades 5–9:

Labor training in grades V–IX develops skills in household tasks (social role of homemaker), and instills respect for labor.

Vocational training in grades 10–11:

Conducted at vocational training centers. Students are admitted only after medical and professional consultations considering the conditions of the base enterprise.

Students are introduced to:

- Production processes,
- Mechanics,
- Measuring techniques,
- Technical documentation,
- Modern economic trends,
- Labor legislation.

Special emphasis is placed on developing students' technical creativity.

Part of the vocational training schedule is dedicated to career guidance. Vocational training should not exceed 6 hours per week.

Socially Useful Labor

Only healthy children may fully participate. Children with health deviations may only participate with a doctor's recommendation.

Types of socially useful labor may include:

- Work in industry, agriculture, services,
- Environmental protection, landscaping,
- School-related work,
- Recycling collection,
- All must comply with hygiene norms and legal regulations for involving minors in labor.

CASE STUDIES

Case 1:

To assess school readiness, Samir was examined on November 16, 2016. Born: October 15, 2010.Medical examination conducted by: pediatrician, orthopedic surgeon, ophthalmologist, neurologist, speech therapist, and dentist.Height: 110,5 cm. Body weight: 21 kg. Chest circumference: 56,5 cm. Number of permanent teeth: 4. No chronic diseases. Had infectious hepatitis earlier in the year. Kern–Yerashek test score: 9 points.No speech sound defects identified.

Questions:

1. Determine Samir's age.
2. What is the level of Samir's biological and physical development?
3. Assess his health status.
4. Assess his psychophysiological school readiness criteria.
5. What conclusion can be made about his ability to start school?

Case 2:

Provide a hygienic evaluation of the class schedule for Grade 7 (Uzbek language instruction).What adjustments are needed considering the physiological functions and work capacity of students during the school day and week?

Table 58

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday (Electives)
Uzbek Language	Reading	Reading	Drawing	Foreign Language	Foreign Language (elective)
Physical Education	Mathematics	History	Mathematics	Russian Language	Mathematics (elective)
Geography	Russian Language	Life Safety (OBZh)	Foreign Language	Informatics	Russian Language (elective)
Russian	Labor	Uzbek	Physical	Russian	Uzbek

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday (Electives)
Language		Language	Education	Literature	Language (elective)
Mathematics	Labor	Music	Geography		

Case 3.

Evaluate the organization and structure of a math lesson for grade 3. The lesson consists of**:** Introductory part – 5 minutes. Main part – 35 minutes. Final part – 5 minutes. The duration of continuous oral counting was **7 minutes**, Explanation of new material – **20 minutes**, solving arithmetic problems – **10 minutes**.

Case 4.

In a school in the city of Bukhara, the mental performance of 4th-grade students was studied during a Russian language lesson. The lesson was conducted:

- using **technical teaching aids (TTA)** – ***Variant I***,
- and **without using TTA** – ***Variant II***.

The results are presented in Table 59**: Table 59**

Indicators of Mental Performance During a Russian Language Lesson

Performance Indicators	**Variant I (with TTA)**		**Variant II (without TTA)**	
	Before Lesson	**After Lesson**	**Before Lesson**	**After Lesson**
Average number of tracked characters	365,4	353,4	347,0	332,0
Average number of errors per 500 characters	2,1	1,75	2,25	2,1
Total number of solved arithmetic problems	121,0	127,4	122,0	115,6

Performance Indicators	Variant I (with TTA)		Variant II (without TTA)	
Number of errors in solving arithmetic problems, in %	19,2	16,9	18,7	20,9
Average latent reaction time to weak light, in milliseconds (ms)	406,5	413,5	408,5	411,7

QUESTIONS FOR SELF-CONTROL

1. Hygienic criteria for organizing the school day, week, and year.
2. Hygienic principles of organizing the educational process.
3. Periodicity of mental performance throughout the day and week.
4. Hygienic foundations of preparing children for school.
5. The concept of school readiness and methods of its assessment.
6. Fatigue and overfatigue, age-specific characteristics.
7. Provide the physiological basis for the hygienic regulation of the pedagogical process.

PART V

HYGIENE OF MEDICAL AND PREVENTIVE INSTITUTIONS

Hygienic Requirements for the Placement and Layout of Medical and Preventive Institutions

In the healthcare sector, the paramount concern is the caliber of medical services rendered to patients. To tackle this challenge effectively, several critical initiatives must be undertaken:

• Increasing the number of medical and preventive institutions (MPIs), with a strong emphasis on specialized facilities such as maternity wards and hospitals for infectious diseases.

• Developing new MPIs and renovating existing ones to meet contemporary standards, alongside the creation of specialized medical and diagnostic centers.

MPIs represent a diverse array of healthcare organizations dedicated to delivering both general and specialized medical services to the community. This category includes clinics, hospitals, outpatient facilities, polyclinics, dispensaries, maternal and child health centers, and sanatoriums.

The task of hygiene in medical and preventive institutions is to study the working conditions, develop sanitary and hygienic rules and standards for the functioning of these facilities, and monitor compliance with these requirements.

Specialized medical organizations that provide the full range of medical services to individuals with various diseases are known as medical and preventive institutions (MPIs). To ensure a patient's recovery in an MPI, it is necessary to organize appropriate conditions. Currently, the key issue is the organization of a safe hospital environment. This is also the most complex task, as it concerns not only patients but also medical staff.

A patient in an MPI is not able to fully ensure their own safety; treatment requires diagnostic procedures, specific medical care, comfortable conditions within the facility, and adequate nutrition.

Therefore, modern MPIs must ensure the following conditions:

1. Favorable and comfortable conditions for the patient.
2. Prevention of nosocomial (hospital-acquired) infections.
3. Safe working conditions for medical personnel.

To meet and comply with this complex of requirements, the Republic of Uzbekistan enforces the "Sanitary Rules and Norms for the Design, Construction, and Operation of Medical and Preventive Institutions."

Safe Hospital Environment

A safe hospital environment is one that guarantees patients and medical personnel a setting of safety and comfort, enabling them to effectively perform all their vital functions.

During the provision of preventive, therapeutic, or rehabilitative care to patients, the hospital environment can impact the health of both patients and healthcare staff. This is because there is a risk of infectious disease transmission within medical and preventive institutions (MPIs), which can exacerbate pathological processes in patients and contribute to the development of occupational diseases in medical personnel.

Aggressive Factors of the Hospital Environment

- **Infectious Factor** — the risk of infection for both patients and medical personnel by various infectious diseases, including highly dangerous ones.
- **Toxic Factor** — unsafe exposure to chemical substances (medications, disinfectants, etc.), with a risk of developing occupational diseases such as allergic reactions, dermatitis, and others.
- **Physical Factor** — during the working day, physical exertion and overload of the musculoskeletal system among medical staff.
- **Psychological Factor** — medical personnel, due to their constant involvement in patient care, are exposed to continuous emotional tension and psychological stress.

Therapeutic and Protective Regimen

Objective — to organize favorable conditions for patient treatment and recovery.

This is a complex system encompassing preventive and therapeutic measures aimed at ensuring maximum physical and psychological comfort for both patients and medical personnel.

The activities of MPIs aimed at providing physical and psychological protection to patients and staff from the adverse effects of the hospital environment include the following elements:

1. Organization of an emotional safety system;

2. Strict adherence to the internal hospital regulations;
3. Ensuring a system for appropriate physical and psychological activity;
4. Epidemiological safety;
5. The necessity for medical personnel to adhere to the principles of deontology.

In ensuring a therapeutic and protective regimen, it is essential to remember and uphold the parameters of emotional safety, which includes psychological comfort.

Emotional Safety Regimen

Implementing an emotional safety regimen in wards and departments guarantees both patients and healthcare workers the ability to effectively meet their basic needs: to communicate "safely," to "be healthy," and to "avoid danger."

The objectives of measures aimed at creating this regimen are:

- Eliminating the negative impact of the hospital environment on the emotional sphere and psyche of both the patient and the healthcare worker;
- Assisting patients in adapting and overcoming psychological discomfort during their inpatient stay, while promoting more positive emotions, which in turn facilitates faster recovery.

The creation of psychological comfort for the patient depends on the following factors:

- Aesthetic interior design of the facilities,
- Wall and ceiling color,
- Comfortable beds (functional hospital beds),
- Rational lighting,
- Silence—"quiet regimen,"
- No more than four patients per ward,
- Ward equipment,
- For bedridden patients: the color of the ceiling and the level of the window.

Thus, the hospital environment plays a critical role. Comfortable conditions are ensured through design decisions in medical and preventive institutions (MPIs), specific construction materials, material and technical equipment, provision of soft and hard inventory, availability of medicines and medical equipment, the microclimate and sanitary amenities of the premises, waste collection and disposal systems, and the internal hospital regimen.

To prevent the emergence and spread of nosocomial (hospital-acquired) infections, in medical facilities, a range of sanitary, hygienic, anti-epidemic, and organizational strategies are put into practice. Collectively referred to as the sanitary-epidemiological regimen, these protocols are crucial for creating a conducive environment for patients. They also ensure that medical procedures and other activities within the hospital are carried out effectively and in accordance with established standards.

Hygienic Regimen

To ensure the patient's comfort during their stay in an MPI, it is necessary to maintain air and thermal conditions, natural and artificial lighting, heating, ventilation, drinking water supply, sewerage systems, and waste collection and disposal. Activities aimed at fulfilling these sanitary-hygienic requirements are referred to as the **Hygienic Regimen of the Medical Institution**.

Creating comfortable conditions in hospital wards includes installing functional (adjustable) beds, providing practical and cozy bedding, and maintaining an optimal number of patients per room. Patient placement should consider the nature, course, and stage of illness, as well as the age and gender of the patients.

Wards should be arranged according to aesthetic principles, with rational lighting, and wall and ceiling colors chosen to promote psychological comfort.

Noise level reduction for patients can be achieved through planning measures such as:

- Locating the hospital unit away from noise sources,
- Thoughtful site planning,
- A reasonable number of green plantings,

- Minimizing internal transport traffic to essential use only,
- Logical interior layout,
- Organizational protocols within the hospital (e.g., managing alarm sounds, loud conversations, etc.).

Optimal microclimate and clean air are maintained through proper ventilation and heating systems, and air exchange management in rooms.

Lighting comfort in MPI premises, according to sanitary standards, includes both natural and artificial lighting, as well as proper insolation.

To maintain personal hygiene, cleanliness in the premises, access to safe drinking water, and a functioning sewage system, the following **sanitary improvement measures** must be implemented.

Particular attention should be paid to:

- Collection, disposal, and utilization of medical waste,
- Instrument sterilization, and
- Execution of disinfection protocols within the premises.

Sanitary and Epidemiological Regimen

The implementation of a set of sanitary-hygienic and anti-epidemic measures aimed at preventing the emergence and spread of nosocomial (hospital-acquired) infections is referred to as the **sanitary and epidemiological regimen**.

The sanitary and epidemiological regimen of a medical and preventive institution (MPI) includes the following aspects regarding order and regulation in hospital premises and departments:

1. Sanitary control of inpatient facility operations, detection of infection carriers among staff and patients, assessment of bacterial contamination in the hospital environment;
2. Daily wet cleaning of premises at least twice a day, and up to three times a day in the summer period;
3. Procedures for disinfection and sterilization of medical instruments and care items;
4. Mandatory sanitary-hygienic treatment of patients upon admission;

5. Collection and disposal of epidemiologically hazardous waste.

One of the most pressing modern healthcare issues globally is nosocomial infections (NIs). The provision of high-quality medical care is directly linked to infection safety. The development of NIs in patients within a medical and preventive institution is associated with the duration of their treatment and diagnostic procedures.

The epidemiological mechanism of infection transmission in a hospital includes:

- Direct contact with an infected person or contaminated personal items;
- Contaminated food or water;
- Airborne transmission (e.g., viral diseases such as measles, rubella, chickenpox, etc.).

In addition, there are specific transmission pathways associated with medical and diagnostic procedures within MPIs. These include **artificial mechanisms of infection transmission** during diagnostic interventions, infusions, and surgeries. For instance, infections such as HIV or hepatitis B, C, and D may be transmitted through blood transfusions.

In May 2022, the World Health Organization (WHO) published data on the spread of nosocomial infections. It was reported that 5–10% of hospitalized patients acquire NIs, and of those, 27% to 52% may die. Notably, up to 70% of these infections could have been prevented by adhering to basic hygienic preventive measures, beginning with personal hygiene practices.

Currently known causes of the rise in nosocomial infections include:

- Selection of so-called “hospital strains” of microorganisms, which are drug-resistant and highly virulent. These resistant strains often develop due to uncontrolled, inappropriate, and sometimes senseless use of antimicrobial therapies;
- High incidence of pathogenic microflora carriage among medical staff, particularly *Staphylococcus aureus*;

- Concentration of frequently weakened patients in polyclinics, limited space in inpatient departments, and the construction of large hospital complexes with their own specific ecologies;
- Noncompliance with sanitary-hygienic standards of asepsis and antisepsis.

Nosocomial infections are classified by the principle of infection origin:

- **Exogenous infections** – transmitted from external sources through various pathways;
- **Endogenous infections** – develop as a result of activation of pathogens already present in the patient's body. Activation can occur due to weakened immunity, for example, in the postoperative or postpartum period. Pathogens may also enter the bloodstream from the intestines and other sources;
- **True hospital-acquired infections** – any infectious diseases acquired within a hospital setting.

A subtype of nosocomial infections is the **ambulatory-acquired infection**, which arises and spreads within outpatient clinics.

Nosocomial infections can also be classified into:

- **Associated infections**, e.g., neonatal sepsis, postoperative purulent complications;
- **Superinfections**, where a patient already infected with one illness acquires an additional infection.

WHO research shows that, on average, 8.4% of hospitalized patients globally acquire nosocomial infections. The rate is 7.7% in European countries, nearly 5% in the United States, and up to 6.7% in Russia. According to Uzbekistan's Ministry of Health, nosocomial infections have been recorded in up to 2.2% of cases (excluding COVID-19 patients), with lethality reaching up to 60% in some regions during generalized cases.

In Uzbekistan, 38 nosological forms of NIs have been identified. Of these, 50% of cases were recorded in the postoperative period, most commonly involving wound infections. The most widespread nosocomial infections in the country are

considered to be hepatitis B, HIV, and frequent detection of gram-negative bacilli (*Enterobacteriaceae*) and *Staphylococcus aureus*.

Departments with **high epidemiological risk** of NI transmission include surgical, obstetric, and dental units.

In recent years, WHO documents have adopted the term **Healthcare-Associated Infections (HAIs)** instead of "nosocomial infections," as this term more accurately reflects the transmission of infections in healthcare settings.

A **critical factor in ensuring effective treatment** is the **prevention of nosocomial infections**. In Uzbekistan, sanitary norms titled *"Prevention of Nosocomial Infections"* are in effect.

A unified **system of registration and accounting for nosocomial infections** is implemented in medical and preventive institutions.

Prevention of Nosocomial Infections Includes:

- Identification, isolation, and sanitation of the infection source;
- Interruption of transmission pathways;
- Measures aimed at strengthening the individual resistance of patients and healthcare personnel.

Complex of Preventive Measures

Architectural and Planning Measures begin with the division of the inpatient facility into distinct hospital departments. This type of layout—particularly for infectious, surgical, maternity, and pediatric departments—allows for the isolation of each unit, taking into account the potential for contamination of the hospital environment.

Special emphasis is placed on the **admission department**, which functions as a barrier to the spread of nosocomial infections (NIs).

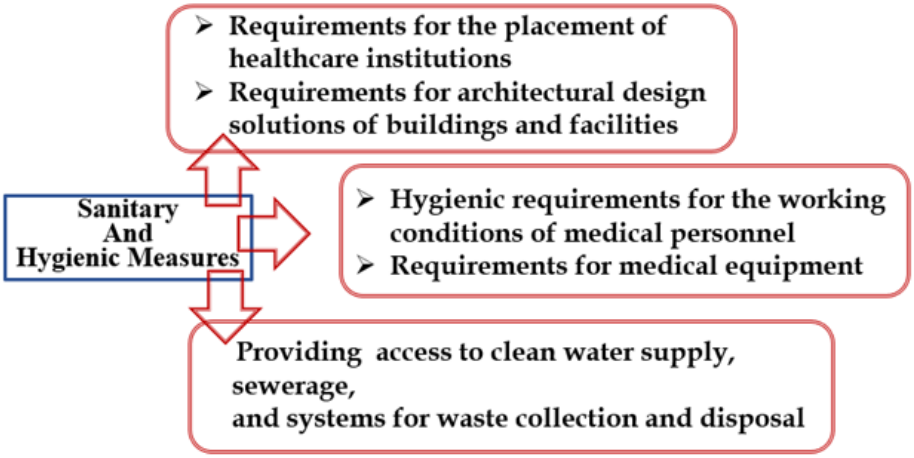


Fig. 49. Planning, Construction, and Operation of Medical and Preventive Institutions

Sanitary and hygienic practices encompass a well-defined timetable for cleaning and airing out spaces, alongside the use of ultraviolet light for room sanitation. A fundamental aspect of these measures is the thorough sterilization of instruments, linens, and clothing. Additionally, promoting personal hygiene among staff and patients is essential, which includes ensuring access to clean water, effective sewage systems, and proper waste collection and disposal methods.

Organizational Measures implemented in inpatient facilities include, for example:

- Quarantine protocols;
- Maintaining **flow principles**, meaning the separate intake of patients with different pathologies;
- Regulations on communication between patients and visitors.

General health-strengthening measures include:

- **Vitamin supplementation**,
- **Vaccination**, and

- **Immunization** of medical personnel.

In **Uzbekistan**, the primary requirements for medical institutions are prescribed in the **sanitary norms for the design and operation of medical and preventive institutions (MPIs)**.

Medical and Preventive Institutions are categorized as follows:

1. **Outpatient Type** – including primarily:
    - Polyclinics,
    - Women's health consultation centers,
    - Dispensaries, and
    - Emergency care stations.
2. **Inpatient Type** – including:
    - Hospitals,
    - Specialized clinics,
    - Maternity hospitals,
    - Sanatoriums.

MPIs by Administrative Level:

- Republican Level
- Regional (Oblast) Level
- District Level
- City Level

MPIs by Function:

Educational Institutions affiliated with medical universities (e.g., Tashkent Medical Academy Clinics, Clinics of the Tashkent Pedagogical Institute);

Research Institutions affiliated with medical research centers (e.g., Research Institute of Cardiology, Research Institute of Obstetrics and Gynecology, Research Institute of Sanitation, Hygiene, and Occupational Diseases).

Fig. 49. Planning, Construction, and Operation of Healthcare Institutions

Sanitary and Hygienic Measures — These include cleaning schedules, ventilation of premises, sanitation of rooms using ultraviolet rays, mandatory sterilization of instruments, linens, and clothing, and facilitation of personal hygiene practices for both staff and patients. They also cover water supply, sewage systems, and the collection and disposal of waste.

Organizational Measures implemented in inpatient facilities include quarantine protocols and adherence to the principle of patient flow, i.e., the separate reception of patients with different pathologies, and regulation of patient-visitor interactions.

General Prophylactic Measures involve hardening procedures, vitamin supplementation, vaccination, and immunization of medical personnel.

In Uzbekistan, the main requirements for medical institutions are defined by sanitary norms for the design and operation of healthcare facilities (LPU).

Healthcare Facilities are categorized as follows:

1. **Ambulatory type** — primarily polyclinics, maternity consultation centers, dispensaries, and emergency medical stations.
2. **Inpatient type** — hospitals, specialized clinics, maternity hospitals, and sanatoriums.

Classification of Healthcare Facilities by Level of Subordination:

- Republican level
- Regional (oblast) level
- District (rayon) level
- City level

Classification by Function:

- **Educational** — associated with medical universities (e.g., clinics of Tashkent Medical Academy, Tashkent Pedagogical Institute)
- **Research** — affiliated with scientific research institutes in the medical field (e.g., Research Institute of Cardiology, Research Institute of Obstetrics and Gynecology, Research Institute of Sanitation, Hygiene, and Occupational Diseases)

Ambulatory-Type Healthcare Institutions

Polyclinic — The primary objective is to provide primary medical and sanitary care to the urban population within a designated territory. Polyclinics operate based on a territorial-district principle. The architectural plan must include specialized medical departments, such as therapy, surgery, functional diagnostics (with an X-ray room), and physiotherapy (with a procedural room).

Medical-Sanitary Unit — A healthcare facility that serves employees of large enterprises, associations, or corporations. It operates based on departmental (industrial) healthcare principles.

Rural Medical Station (SVP) — Provides primary medical and sanitary care to the rural population.

Dispensary — Offers specialized medical assistance to a specific group of patients with established diagnoses. Examples include neuropsychiatric, narcological, dermatovenereological dispensaries, etc. The main tasks are the medical supervision and long-term follow-up of these patients.

Maternity Consultation Center — The primary focus is the assessment of the health status of pregnant women and those with gynecological pathologies.

Inpatient Healthcare Institutions

Inpatient Facility (from Latin ***stationarius*** — fixed, immobile) refers to a healthcare facility intended to provide long-term, 24-hour medical supervision and care for patients.

According to WHO recommendations, a modern inpatient facility should fulfill the following functions:

- Diagnosis and treatment of diseases
- Emergency medical services
- Patient rehabilitation
- Preventive care
- Scientific research and educational activities

Types of Inpatient Healthcare Facilities

Hospital — Designed for diagnosis and subsequent treatment of patients requiring continuous medical supervision and care. Hospitals can be:

- **Monoprofile** (specialized in one medical field)
- **Multiprofile** (with various departments such as therapy, surgery, etc.)
- **Specialized** (e.g., cardiology hospitals)

Clinic — Distinguished by its combination of medical-diagnostic services with educational or research functions. Staffed by highly qualified professionals and equipped with modern medical technology.

Hospital (Military) — Specialized healthcare facilities providing medical care to military personnel and veterans.

Sanatoriums and Health Resorts — Resort-based healthcare institutions focused on patient rehabilitation and restoring working capacity. Types include:

- Climatological
- Balneological
- Physiotherapeutic
- Other specialized sanatoriums

Maternity Hospitals — Specialize in obstetric care, including the provision of therapeutic and diagnostic services to women.

Hospital Layout Systems

All hygienic requirements must be addressed at the design stage of the healthcare facility. To ensure compliance with the therapeutic and protective regime, specific architectural and planning standards must be followed. Hospital development systems include:

- **Centralized system**
- **Decentralized system**
- **Mixed system**

Decentralized System (Pavilion Type) — Departments are located in separate 1 to 3-story buildings (pavilions). This arrangement allows for the isolation of

departments, helping to prevent nosocomial infections. It also facilitates better insolation (sunlight exposure) and aeration.

The garden-park area surrounding each department is typically divided by pavilion zones for patient walks. However, this system also has drawbacks, including the need for a large land area to space out the pavilions adequately. As a result, utility lines such as water supply, sewage, and heating must be extended, which complicates and increases costs.

Additionally, food delivery from the kitchen unit is affected by distance and weather conditions (e.g., rain, snow), and some diagnostic functions and equipment must be duplicated, making this system economically less viable. (See Table 60)

Table 60

Decentralized System: Advantages and Disadvantages of Development

Advantages	**Disadvantages**
Complete isolation of patients	Duplication of diagnostic departments
Creation of a garden and park zone for each department (building)	Increased total area of the hospital
Possibility of strict compliance with sanitary and therapeutic-protective regime	Complexity of food transportation
	Increased construction project costs

This type of development system involves the placement of somatic, radiological, physiotherapeutic, and clinical-diagnostic departments in separate buildings—pavilions. The modern construction system introduces connections between these buildings, resulting in an improved development system known as the **block system**.

One of the key characteristics of the centralized development model is that all primary departments are situated within one large multi-story structure. When designing this system, it is essential to ensure that the polyclinic and utility departments are placed in distinct buildings..

With centralized development, medical and diagnostic offices are arranged in a rational manner, simplifying operation; engineering communication routes are shortened; the movement of medical personnel between departments is unaffected by weather conditions; food delivery from the kitchen to wards is accelerated. Most importantly, both construction and operational costs of the building are reduced.

The advantages and disadvantages of the centralized clinic development system are presented in **Table 61**.

Table 61

Centralized System: Advantages and Disadvantages of Development

Advantages	**Disadvantages**
1. Rational use of the diagnostic department	1. Difficulty in organizing sanitary and therapeutic-protective regimes; increased risk of healthcare-associated infections (HAIs)
2. Convenient use of internal communications	2. Contact between patients and visitors
3. Possibility of mutual consultations among specialists	3. Deterioration in the use of garden and park zones due to the congregation of all patients in one place

A more advanced development system that considers the advantages and disadvantages of the primary planning approaches is the **mixed development system**. In this framework, certain departments are consolidated within a single structure, whereas those that necessitate strict separation—like the infectious disease, maternity, radiotherapy departments, and the pharmacy—are situated in independent buildings.

The modern approach offers an improved version of the mixed system, known as the **centralized-block system**.

This system has several advantages. To begin with, akin to the mixed model, some structural units are housed within a unified monoblock. Meanwhile, departments that necessitate separation are situated in distinct buildings linked by sheltered walkways.This system helps reduce costs by avoiding duplication

of laboratory and diagnostic facilities, instead organizing a centralized diagnostic department. The issue of department isolation is addressed, thus reducing the risk of healthcare-associated infections (HAIs). This design is also economically advantageous in terms of technical operation.

Modern clinics both abroad and in Russia are being constructed following this centralized-block system.

The composition, layout, and placement of blocks and sections are determined based on the profile of the healthcare facility. The need for centralization of certain functional departments is taken into account, and the structure of subdivisions within blocks is aligned with the organization of medical service zones.

Before commencing construction, every medical student—as a future chief physician or head of department—must understand the requirements for planning, site selection, and designing a healthcare facility. Later, they should develop the ability to evaluate projects in terms of compliance with key hygienic norms and regulations, including: the correctness of the site selection for construction, the appropriateness of the land plot layout, the composition and sufficiency of departmental spaces, the adequacy of their surface areas, and the rationality of sanitary and technical equipment, among other aspects.

Scheme for Designing and Constructing Healthcare Facilities (LPU)

1. Determination of capacity (number of beds, number of visits) of the healthcare facility.
2. Preparation of the design assignment.
3. Selection and allocation of a land plot.
4. Designing.
5. Construction.
6. Connection to engineering communications.
7. Commissioning and handover for operation.

The document containing the main conditions and requirements of the client, along with the list of necessary works, is called the **design assignment**. The

design assignment includes all architectural and engineering-technical tasks and the methods of solving them for the construction of the facility.

Design Assignment

The design assignment serves as the basis for construction, reconstruction, or renovation of a healthcare facility and requires the approval of higher authorities.

Characteristics of the facility include its capacity (e.g., number of beds), type of development, number of stories, and specific features of the departments (e.g., surgical department with an operating unit and sterilization area). Engineering and technical conditions must account for the possibility of connecting to existing infrastructure: water supply, heating, sewage, gas supply, and electricity.It also defines the construction materials used for interior finishing of premises, the organization of the system for waste collection, storage, and disposal.

The design must include a landscaping and greening system for the surrounding territory.

Funding methods for the construction of the healthcare facility may include public or private financial sources and investments.

Selection and Allocation of a Land Plot

The selection of a land plot must comply with sanitary norms and regulations. Healthcare facilities (LPU) are typically situated in residential areas, green zones, or suburban zones at specific distances (in accordance with urban planning standards) from public, industrial, municipal, and utility enterprises. This placement must also align with the planning and development requirements of urban, rural, and suburban settlements, as well as the hygienic regulations related to sanitary protection zones.

The allocation of a land plot must be coordinated with state sanitary-epidemiological oversight authorities, who issue a formal conclusion confirming that the selected plot meets all sanitary rules and standards.

Psychiatric, infectious disease, and tuberculosis hospitals must be located at least **100 meters** away from residential (habitable) areas. For facilities of these profiles with a capacity of **1,000 beds or more**, placement should be in green or suburban zones, with a minimum distance of **500 meters** from residential zones.

During construction, LPU buildings must be located **at least 30 meters** from the red line (the boundary of the street) and **30–50 meters** from residential buildings.

When selecting a site, it is necessary to consider the surrounding sanitary conditions and identify the prevailing wind direction. The plot should possess favorable natural characteristics: dry, non-marshy soil; good ventilation; sufficient solar exposure (insolation); and abundant vegetation. The selected hospital site must be removed from sources of noise (airports, railways, major city highways) and from potential sources of air, soil, or water pollution.

It is strictly prohibited to construct healthcare facilities on former landfill sites, sewage fields, animal burial grounds, cemeteries, or other areas with contaminated soil based on sanitary indicators.

The wind rose (prevailing wind pattern) must be taken into account when selecting the site, and the facility should be located **upwind** of any pollution sources.

Since a core principle in the construction of healthcare facilities is to bring medical services closer to the population, clinical complexes (e.g., hospital with outpatient clinic and maternity ward) should be built within residential zones but in close proximity to green zones.

The healthcare facility site should be connected to the served settlement by well-developed access roads and pedestrian paths.

For optimal arrangement of buildings and infrastructure, it is preferable for the site to have a **rectangular shape** with aspect ratios of **1:2** or **2:3**. The groundwater level must be no closer than **2 meters** from the base of the building’s foundation.

The required land area depends on the bed capacity of the healthcare facility (see Table 62).

Table 62

Land Area per Hospital Bed (in square meters)

№	**Capacity (Number of Beds**	**Land Area per Bed (m²)**
1	Up to 50	300
2	51- 100	300-200
3	101-200	200-140
4	201-400	140-100
5	401-800	100-80
6	801-1000	80-60
7	Over 1000	60

Note: For pediatric beds, the land area norm of the entire hospital is applied with a **coefficient of 1.5**.

When placing a hospital in a **green or suburban area**, the land plot is increased by:

- **15%** for infectious disease and oncology hospitals;
- **25%** for tuberculosis and psychiatric hospitals;
- **20%** for rehabilitation hospitals for adults and
- **40%** for children.

Hospital site development should not exceed **12–15%** of the total land area. The remaining part must be landscaped. The **green area** should account for at least **50%** of the total land plot. In some cases, the area of the garden-park zone is calculated as **no less than 25 m² per bed**.

The premises of inpatient or outpatient facilities must be surrounded by a **double row of green plantings**, **10–15 meters wide**, consisting of **deciduous trees and shrubs**.

For proper functioning, **at least two driveways (entry/exit points)** should be organized on the healthcare facility premises.

Zoning of Healthcare Facilities (LPU)

The territory of a healthcare facility is divided into zones:

- Treatment departments and buildings for **non-infectious patients**, **maternity hospitals (obstetric departments)**, **pediatric**, **psychosomatic**, **dermatovenereological**, and **radiology** units;
- **Infectious disease block**;
- **Garden-park zone**;
- **Laboratory-diagnostic area**;
- **Outpatient clinic**, **women's consultation center**;
- **Pathology-anatomical department**;
- **Pharmacy**;
- **Utility/service zone**;
- **Wastewater disinfection zone**;
- **Water intake zone**.

The **infectious disease block** must be separated from other buildings by a **green buffer strip**.

For adequate **solar exposure (insolation)**, the placement of buildings must consider cardinal directions (see Table 4).

Notes:

When ward windows face **west**, sun protection devices (such as **blinds**) must be installed to reduce heat from sunlight.

The **minimum spacing between healthcare facility buildings** must follow:

- Not less than the **height of the facing building**, and **no less than 15 meters**;
- The **pathology department** must be located **at least 30 meters** away from all other buildings;
- The **radiology block** must be located **no closer than 25 meters** from other structures.

The **ritual (mortuary) section** of the pathology block must be **maximally isolated** from inpatient wards and **not visible** from patient windows.

Construction and Utilities

Construction must follow **building codes and regulations**.

A **permit is required** to connect to engineering networks.

- In the **absence of centralized water supply**, a **local decentralized system** using its own water source must be arranged.
- **Sewage systems** should be centralized; in **rural areas**, local small-scale systems are often used.
- **Electricity** is supplied through connection to the existing power grid.
- **Heating systems** in urban areas are **centralized**, while in **rural areas**, local heating and hot water systems are implemented.

Commissioning

Upon completion of construction, a **commission reviews** the completed works for:

- Compliance with legal documentation;
- Fulfillment of the design project;
- Adherence to sanitary and hygienic requirements.

Facilities built according to the approved project, connected to utilities, and prepared for operation are submitted to the **state acceptance commission** for commissioning.

Tasks of the State Acceptance Commission

To assess the compliance of the completed construction and installation works with the project-estimate documentation, as well as with the construction norms and regulations.

The working acceptance commission for evaluating a healthcare facility (LPU) consists of representatives from the following:

- the client (customer);
- the general contractor;
- the state architectural and construction oversight authority;

- the Center for State Sanitary Supervision;
- the fire safety supervision authority.

Based on the evaluation results, the working commission prepares an **act of readiness** of the buildings and structures and submits it to the **State Acceptance Commission**, which, after reviewing, approves the facility for commissioning.

Peculiarities of LPU Layout Planning

The compliance of medical institution layouts with state standards is evaluated based on project-estimate documentation.

The following types of projects exist:

- Situational plan
- Master (general) site plan
- Architectural design projects
- Engineering design projects
- Landscaping and site improvement project
- Estimate documentation

Situational Plan of the Plot

This is a part of a geographical map that shows what surrounds the selected area for the healthcare facility (LPU).

The situational plan diagram includes:

- boundaries of the land plot;
- presence of buildings at the time of site selection;
- residential (urban) zone;
- access roads and routes;
- infrastructure.

The situational plan is necessary to gather information about the land allocated for construction. It is a schematic representation of the area with all physical objects (immovable structures), the utilities passing through the plot, landscape features, and access roads.

The situational plan is required before planning the construction of an LPU facility in order to:

- align the planned building with the existing environment;
- assess landscape features for future site improvement and design;
- ensure the installation and connection of water, gas, power supply, and sewage systems;
- determine the presence and proximity of noise and air pollution sources.

The **wind rose** and **scale** must be indicated in the situational plan.

General Site Plan

The **general plan** (Fig. 50) of the hospital site is a schematic layout of the inpatient facility's territory, indicating the placement and spatial relationships of hospital buildings, utility and auxiliary structures, pathways, and green areas within the designated land.

The general site plan enables the assessment of:

- the **zoning** of the land plot,
- the **type of development** of the healthcare facility (LPU),
- the **number and efficiency** of entry points,
- and the **distances between buildings**.

The **size of the site** to be developed is determined based on the number of beds and the construction system employed (see Table 63).

Table 63.

Hospital Site Area (in hectares) Depending on the Development System

Number of Beds	Decentralized Development	Mixed Development	Centralized Development
100	3,0 ha	2,5 ha	2,0 ha
300	4,5 ha	4,0 ha	3,5 ha
600	6,5 ha	6,0 ha	5,5 ha
1000	11,0 ha	10,5 ha	10,0 ha

Figure 50. General Site Plan of a Hospital

Architectural Projects

The architectural project is a component of the design documentation required for construction work and consists of two main parts:

1. **The textual part** — This section provides a detailed description of the **interior and exterior** of the structure under construction, the **architectural, structural, and technological solutions** applied, a list of **building materials** used, and **calculations** related to ventilation, heating, natural lighting, and other relevant indicators.
2. **The graphical part** — This includes **drawings** such as **facade plans**, **floor plans** (horizontal or vertical sectional views of the building), **engineering schematics** of utility systems, and other specified plans and diagrams.

A **detailed site improvement plan**, aimed at enhancing the visual appearance of the territory while making the most of the site's characteristics, is referred to as the **landscaping (or site beautification) project**. It incorporates modifications

for the **functional, comfortable, and efficient** use of the area, including elements such as **paths**, **paved areas**, **gazebos**, **benches**, **fountains**, and **greenery**.

Architectural and Planning Requirements for Inpatient Medical Facilities

Hospital buildings must ensure the implementation of **sanitary-hygienic and anti-epidemic protocols**, provide **comfortable conditions for patients**, and a **convenient working and resting environment for medical staff**.

Medical facility structures typically should not rise beyond six stories. Pediatric hospital wards, especially those designated for children under three years old accompanied by their mothers, should ideally be situated no higher than the fifth floor. Additionally, wards catering to children under seven and child psychiatric units should be limited to a maximum of two stories. Healthcare facilities must be designed according to the **principle of flow separation**, meaning that **zoning of the site and room layout** must ensure the **separation and non-intersection** of "clean" and "contaminated" patient flows.

The **main planning unit** of a healthcare facility is the **hospital (ward) section**, which includes:

I. A set of patient rooms totaling 30 beds.

II. Medical and auxiliary rooms, including:

- Head of department's office,
- Doctor’s (on-call) room,
- Treatment/procedure room,
- Nurse’s station,
- Dressing room (in surgical departments),
- Enema room.

III. Utility areas:

- Pantry, dining room, laundry room,
- Housekeeper’s room,
- Head nurse's room,
- Verandas.

IV. Sanitary facilities, including:

- Storage for cleaning supplies,
- Women's personal hygiene room (for maternity hospitals and wards).

V. Recreation and movement spaces:

- Ward corridor, stairwell, and elevator.

The ward layout may feature **single-sided or double-sided corridor designs**.

An important structural unit of the department is the **patient ward** — the room where a patient stays during inpatient treatment. Wards can be **general-purpose or specialized** (e.g., for cardiology, traumatology, etc.). Regardless of bed count, each patient must have **40–50 m³** of space in the ward.

The **interior finishes** (wall and ceiling colors) should reflect the department's medical profile, and **furniture selection** depends on the patient population.

Lighting (natural and artificial) should match patients' conditions and support specific medical procedures. The **maximum room depth** should not exceed **6 meters**.

Required Ward Equipment:

- Functional hospital beds,
- Bedside tables,
- A shared table and chairs for patients,
- Refrigerator for food storage,
- Portable privacy screens,
- Individual electric lamps,
- Emergency nurse call system.

Microclimate parameters:

- Temperature: **20–22°C** in warm seasons, **18–20°C** in cold seasons,
- Relative humidity: **50–60%**,
- Air movement: **0,15–0,2 m/s**.

For a 30-bed department, the layout typically includes **1-bed and 2-bed rooms**, and **no more than 4 beds** per ward are allowed. Specific room area requirements depending on patient age and ward type are listed in **Table 66**.

Bed distribution per section:

- 8 wards with 3 beds,
- 2 wards with 2 beds,
- 2 wards with 1 bed.

Table 64.

Room Areas in Inpatient Departments

Department Type	Patient Category	Area per Bed
Infectious and Tuberculosis Ward	Adults	7,5 m²
	Children	6,5 m²
Non-infectious Ward	Adults	7,0 m²
	Children	6,0 m²
Day Hospital Rooms	Adults	5,0 m²
	Children	4,0 m²
Intensive Care	–	13 m²
Isolation Room (1 bed)	–	22 m²
Neurosurgical, Burn, and Radiological Rooms for Adults	–	12 m² + 9 m² for each additional bed
Intensive Care and Postoperative Rooms	–	14 m² + 12 m² for each additional bed
Neonatal Intensive Care Unit	–	9 m² per incubator + 3 m² for each additional incubator/crib

In hospital wards, beds are arranged in such a way that access to the patient is possible from three sides. To ensure this, a distance of at least 1 meter is maintained between beds, allowing free access for examination, transferring patients, and carrying out medical procedures.

Features of the Layout of Various Hospital Departments

A modern multidisciplinary hospital provides a comprehensive range of medical services. This requires a specific set of rooms where qualified specialists can provide care, treat patients, or conduct various medical diagnostics using modern medical and diagnostic equipment. To deliver a full spectrum of medical

services, a contemporary clinic typically includes the following structural departments:

- Patient admission and discharge areas
- Inpatient (ward) departments
- Therapeutic and diagnostic departments
- Laboratories
- Central sterilization department
- Pharmacy
- Kitchen unit
- Pathological anatomy department
- Administrative offices

Planning of Buildings, Blocks, and Sections

The system of development—planning, building placement, and composition of sections—is determined based on the profile and capacity of the healthcare facility. The number of beds and rooms, as well as the set of rooms for performing various medical and therapeutic functions, depends on the category and profile of each department.

Admission Department

The diagnostic department of a clinic is referred to as the admission department. Its main tasks include patient registration, examination, admission, triage, provision of emergency medical care, establishment of a preliminary diagnosis based on examination and laboratory tests, determination of the appropriate department for further treatment, documentation of initial medical records, mandatory sanitation procedures before admission, transportation to the appropriate department, and observation in isolation-diagnostic units.

Room composition:

- Head physician’s office
- Registration area
- Examination room
- On-duty doctor’s office

- Diagnostic room
- Procedure room
- Isolation room
- Casting (plaster) room
- Minor operating room with dressing area
- Sanitary inspection room
- Linen storage room
- Restroom (toilet)

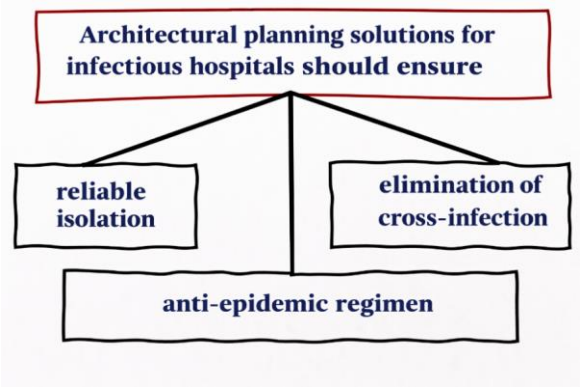
The admission department is located in the main building of the healthcare facility and is responsible for admitting patients to all non-infectious departments. Separate admission departments must be provided for pediatric, obstetric, infectious, dermatovenereological, and psychiatric patients. These are located adjacent to or integrated with the corresponding specialized blocks or buildings.

The polyclinic, which includes an admission area for outpatient care, is situated within the polyclinic building. In a multidisciplinary hospital, the polyclinic must have a separate entrance for patients and a designated access point for vehicles. It is not permitted to place the entrance to the admission department, the polyclinic, storage facilities, or the pharmacy beneath the windows of inpatient wards.

FEATURES OF LAYOUT AND SANITARY REGIME IN CERTAIN SPECIALIZED HOSPITAL DEPARTMENTS

Layout features of the infectious diseases department

The infectious diseases department or hospital is designed for the treatment of patients with various viral and bacterial infectious diseases. Regardless of the construction system used, the infectious diseases department must be planned as a separate standalone block or building with an isolated territory and a designated green (park) area.



The core principle of planning infectious diseases departments and hospitals is the system of isolating patients with different infectious conditions and the division of flows into "clean" and "contaminated" zones.

Fig. 51. Architectural and Planning Solutions of Infectious Disease Departments

All units and departments, both medical and auxiliary, are organized taking into account the separation of "clean" and "contaminated" routes (for patients, staff, etc.). Each route is completely isolated from the others.

Medical personnel, students with their instructors, and visitors use the clean routes. The transport of medicines, linens, and food is also carried out along clean routes. For discharging recovered patients, special discharge rooms are located in the clean zone. Patients from isolation boxes are discharged through an external vestibule. Under no circumstances should the "clean" and "contaminated" zones intersect.

When planning an infectious disease department, it is essential to account for the potential admission of patients with various infections. Therefore, several isolated sections must be provided. For greater reliability of isolation, airlocks are organized between the corridors to prevent the spread of airborne infections. Typically, an airlock is equipped with a bactericidal lamp at a rate of 4–5 W per square meter.

Infectious patients enter the department through the admission area. They are received in special admission and examination isolation boxes.

The basic planning unit of an infectious disease department consists of boxes, semi-boxes, and box-type wards. According to sanitary design standards, the following number of isolation boxes is required:

- For a department with 30 beds — 1 box
- For 30–60 beds — 2 boxes
- For 60–100 beds — 3 boxes

Additionally, if the department has more than 100 beds, 3% of the total number of beds should be allocated to boxes.

A guarantee against hospital-acquired infections is a fully isolating box, also known as a "Meltzer box," named after the engineer E.F. Meltzer, who proposed its design. Patient admission and discharge occur through a vestibule with an exit to the street. The box is connected to the rest of the department through an airlock.

Area standards:

- For 1 bed — up to 20 m²
- For 2 beds — up to 27 m²

The dimensions of the rooms in isolation boxes or semi-boxes are provided in Table 65.

Medical staff enter the box from a conditionally “clean” corridor through an airlock, where they change into special clothing, wash, and disinfect their hands before coming into contact with the patient. For this purpose, the airlock is equipped with sinks and coat hangers. A pass-through window is installed in the airlock for delivering food to the patient. Each box for an isolated patient includes its own sanitary unit with a toilet, bathtub, and sink. A window is also installed in the wall of the box facing the department corridor for observation of the patient.

Fig. 52. Diagram of the Isolation Box:

1. Airlock
2. Anteroom (pre-box area)
3. Isolation box

4. Sanitary unit (toilet)
5. Airlock for medical personnel
6. Entrance to the box
7. Pass-through window for food delivery
8. Bed
9. Table

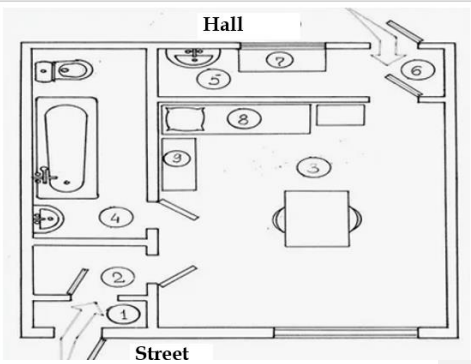


Table 65. Room Area of Isolation Boxes or Semi-Boxes

	Наименование помещения		Площадь, м² (не менее)
1	**Isolation Box**		17 m² for 1 bed, , 24 m² for 2 beds
		Patient Room	12 m² for 1 bed, 14 m² for 2 beds
		Sanitary Unit	4 m²
		Airlock	2 m²
		Vestibule	2 m²
2	**Semi-Box**		15 m² for 1 bed, 20 m² for 2 beds
		Patient Room	9 m² for 1 bed, 14 m² for 2 beds
		Sanitary Unit	4 m²
		Airlock	2 m²

The purpose of a semi-box is the same as that of a full isolation box. The difference lies in the fact that it does **not have direct access to the outside**. Patients are admitted to a semi-box **from the general corridor of the department through a sanitary checkpoint**. This presents a **risk of airborne contamination** of the corridor with pathogenic microflora and its penetration into other rooms. Semi-boxes are designed for **1 to 2 beds**.

To reduce the risk of contaminated air entering or exiting the box or semi-box, **the doors of the airlock must be tightly closed and kept shut**.

Boxed wards (for 1, 2, or up to 4 beds) differ in that they **do not have a bathtub**, and the **sanitary unit is shared by several wards**, equipped with a toilet and a sink. These wards are connected to the corridor through an airlock.

Patients in boxed wards must have the **same disease profile**. However, their use is **limited**, since **they do not provide complete protection against the spread of airborne infections**.

LAYOUT OF THE SURGICAL DEPARTMENT

The main task of the surgical department is to provide specialized medical care. Medical assistance in the surgical department is delivered through the performance of surgical or microsurgical operations, followed by observation and treatment. The areas of the main rooms are presented in Table 66.

Main structural units of the surgical department:

- Operating block
- Patient wards
- Head of department's office
- Doctors' staff room (on-call room)
- Senior nurse's office
- Nurses' station
- Treatment room
- Procedure room
- Housekeeper nurse's room
- Buffet–dining area
- Patient lounge (rest area)
- Linen room
- Enema room
- Sanitary units (toilets)

Table 66.

Room Areas in the Surgical Department

Room Type	**Area, m² (minimum)**
Ward for 1 surgical bed	9 + 7 for each additional bed
Neurosurgical wards (including rehabilitation), burn and radiology wards for adults	12 + 9 for each additional bed

Room Type	Area, m² (minimum)
Orthopedic and trauma wards	
– for adults	9
– for children with mothers staying during the day	10
– for children with mothers staying overnight (24-hour stay)	13
Intensive care units, post-operative wards	14 + 12 for each additional bed

Planning of the Surgical Department

A key feature of the surgical department is the presence of an **operating block**. One of the most important requirements for the operating block is ensuring **aseptic conditions**. In modern multidisciplinary hospitals, centralized operating blocks are commonly used. However, in maternity and infectious disease departments, **independent operating blocks** are still organized.

Operating Block

Operating blocks are located in **isolated extensions or blocks**. These may be standalone buildings or isolated sections connected to the main hospital via corridors. There must be **no connection** to vertical engineering systems such as elevators, trash chutes, or utility shafts.

For **emergency surgeries**, operating rooms are often planned as part of the **admissions department**. Access for personnel to the operating block is organized **through sanitary checkpoints**.

Surgical departments are categorized into **"clean" and "septic"**. Each department must have its **own operating block**. If this is not feasible, in emergency situations, surgeries involving purulent infections are conducted on **designated days** or **after scheduled clean surgeries**, followed by **thorough disinfection** of the operating block and all equipment.

A **mandatory design requirement** is that **septic operating rooms must be located above the clean ones**. The design of surgical departments follows the

principle of flow separation, meaning patient and staff movement must follow strict paths:

- **Sterile flow**: for surgeons, surgical nurses, delivery of clean linen and medications.
- **Contaminated ("dirty") flow**: for waste disposal, dirty linen, etc.

Cross-contamination or intersection of these flows is strictly prohibited.

Table 67:

Main Rooms of the Operating Block

Primary Rooms:

- Operating room
- Pre-operative room
- Pre-sterilization room
- Sterilization room

Auxiliary and Support Rooms:

- Senior nurse's office
- Medication storage room
- Instrument and equipment storage room
- Separate storage for clean and dirty linen
- Transfusion room
- Staff lounge and dining area
- Anesthesiology service room
- Housekeeper nurse's office

PLANNING OF THE SURGICAL DEPARTMENT

The main objective of the surgical department is to provide specialized medical care. This care is delivered through surgical or microsurgical operations followed by postoperative monitoring and treatment. The area of key rooms is presented in Table 66.

Main structural units of the surgical department include:

- Operating block
- Patient wards

- Head of department’s office
- Doctor’s on-call room
- Senior nurse’s office
- Nurse’s station
- Treatment room
- Dressing room
- Procedure room
- Housekeeper nurse’s room
- Buffet–dining room
- Resting hall for patients
- Linen storage
- Enema room
- Sanitary facilities

Table 67.

Area of Rooms in the Surgical Department

Room Type	**Area (m^2)**
Ward with 1 surgical bed	9 + 7 per each additional bed
Neurosurgical (including rehabilitation), burn, and radiological wards for adults	12 + 9 per each additional bed
Orthopedic-traumatology wards for adults	9
Orthopedic-traumatology wards for children with daytime maternal stay	10
Orthopedic-traumatology wards for children with round-the-clock maternal stay	13
Intensive care and postoperative wards	14 + 12 per each additional bed

Operating Block

A distinctive feature of the surgical department is the presence of an operating block. A critical requirement for the operating block is the assurance of aseptic conditions. In modern multidisciplinary hospitals, centralized operating blocks

are used. However, in obstetric and infectious disease departments, independent operating blocks are arranged.

Operating blocks are typically located in an isolated annex. This may be a separate building or isolated sections connected to the inpatient facility via corridors. There should be no connection to vertical engineering systems such as elevators, garbage chutes, or utility shafts. For emergency surgery, operating rooms are planned within the premises of the emergency (admission) department. Entry for personnel into operating blocks is organized through sanitation checkpoints (sanitary inspection rooms).

Surgical departments are categorized as either “clean” or “purulent.” Each department should have its own operating block. If this is not feasible, in emergency cases, operations involving purulent processes are scheduled on designated days or performed after routine operations, followed by thorough disinfection of the operating block and all equipment.

A mandatory design requirement is that septic (infected) operating rooms must be located above clean ones. A fundamental feature of surgical department design is ***flow separation***, in compliance with medical facility (LPU) standards. Sterile pathways are designated for surgeons and surgical nurses, including delivery of clean linen and medications. “Dirty” pathways are used for waste removal, dirty laundry, etc. Crossing or contact between these flows is strictly prohibited.

The area and list of operating block rooms are presented in **Table 67**.

Operating Block: Main Rooms

- Operating room
- Preoperative room
- Pre-sterilization room
- Sterilization room

Auxiliary and support facilities include:

- Senior nurse's office
- Medicine storage room

- Instrument and equipment storage
- Separate storage for clean and dirty linen
- Transfusion room
- Staff rest and dining area
- Anesthesiology service room
- Housekeeper nurse's office

Table 67.

Composition and Areas of Main and Auxiliary Rooms of the Operating Block

No.	Room Name	Area (m^2, minimum)
1	**Operating Room**	
– General profile, incl. orthopedic-traumatology	36	
– Cardiac, vascular, and neurosurgical operations*	42	
– Cardiac operations with heart-lung machine, X-ray operating room*	48	
2	**Preoperative Room**	
– For one general-purpose OR	12	
– For two general-purpose ORs	15	
– For one specialized OR	15	
3	**Supply Room (Material Room)**	
– General	4	
– For specialized clinics	20	
4	**Minor Operating Room**	24
– Preoperative room	8	
5	**Instrument Room**	6
6	**Instrument Disassembly and Disinfection Room**, incl. endoscopic equipment	4 per OR, minimum 10
7	**Plaster Room** (for trauma/orthopedic and emergency clinics)	20

No.	Room Name	Area (m², minimum)
8	**Surgeon's Office** **	6 per doctor, minimum 18
9	**Sanitary Checkpoint for Personnel** **	3–6 per OR
10	**Airlock Entrance to Septic and Aseptic Units** (for specialized surgical departments)	12

Notes:

*) According to the design assignment;

**) In surgical units with more than two operating rooms, designated storage rooms must be provided.

In surgical units containing more than two operating rooms, at least two storage rooms must be arranged for storing cleaning equipment and disinfectants.

To maintain a sterile environment, surgical units are divided into specific functional and hygienic zones, conventionally separated by a "red line." The surgical unit is isolated from the surgical wards by an anteroom. Everyone entering the operating area must wear shoe covers. Medical staff not involved in the operation are prohibited from entering the surgical unit.

The following zones are distinguished within a surgical unit:

I. Zone of sterile (absolute sterility) regime
II. Zone of strict (relative sterility) regime
III. Zone of limited regime
IV. Zone of general regime

I. Zone of Sterile Regime (Absolute Sterility)

This zone is designated for conducting surgeries and sterilizing instruments. An operating room designed for one surgical table must have an area of at least 36 m²; for two surgical tables—at least 56 m². The ceiling height of the operating room must not be less than 3.5 meters. Walls are covered with ceramic

tiles or oil-based paint, which allow for cleaning and disinfection. The color of the walls should not cause irritation but instead have a calming effect on the patient's psyche; therefore, cool tones and shades are preferable. The ceiling surface should be matte. The floors in specialized rooms of the surgical unit (operating rooms, anesthesia rooms, preoperative rooms) must be covered with waterproof materials that are easy to clean, can be treated with disinfectant solutions, do not accumulate static electricity, and allow for smooth transport of patients, materials, and equipment. Heating devices must be embedded in the walls, providing heating via convection.

II. Zone of Strict Regime (Relative Sterility)

Rooms included:

- Preoperative room for staff hand disinfection
- Changing cabins for donning sterile clothing
- Sanitary checkpoint and showers
- Cloakroom for staff to change clothes

These rooms are arranged sequentially. Staff proceed from the sterile clothing cabin through the corridor to the preoperative room.
This zone also includes entrances to rooms for storing surgical instruments, equipment, and medications. Adjacent areas include the blood transfusion room, on-duty team room, senior surgical nurse's office, and a sanitary unit for surgical staff.

III. Zone of Limited Regime

This is the technical zone housing facilities essential to the operation of the surgical unit. It includes air conditioning equipment, oxygen and anesthetic gas supply systems, vacuum installations, emergency lighting battery substations, and other necessary equipment.

IV. Zone of General Regime

This includes offices for the head of the unit and senior nurse, as well as auxiliary rooms.
If centralized sterilization is unavailable, sterilization rooms must be organized

within the surgical unit for ongoing instrument sterilization. Sterilized instruments are then transferred into the operating room through a pass-through window.

Maintaining aseptic conditions requires the operating room to be a closed, isolated space. In modern surgical practice, contamination risks are minimized by prohibiting entry of individuals not involved in the procedure (e.g., students). For educational purposes, video surveillance or glass ceilings may be installed instead.

To ensure constant sanitary air quality and proper microclimatic conditions, operating rooms are equipped with air conditioners or an isolated supply and exhaust ventilation system with mandatory bacteriological filtration of incoming air. The air supply must provide a tenfold air exchange rate. Air is introduced from the top and extracted from the bottom of the room.

Maintaining air cleanliness is also supported by allowing the operating room to "rest" between procedures, performing thorough wet cleaning, and "quartz treatment" of the air—exposure to artificial ultraviolet rays 1 to 1.5 hours prior to surgery.

FEATURES OF MATERNITY HOSPITAL LAYOUT

In maternity facilities, whether they are standalone institutions or part of larger multidisciplinary hospitals or perinatal centers, it is crucial that architectural and planning choices prioritize distinct zoning for various departments. This includes a well-organized layout that facilitates efficient occupancy and sanitation practices, regulates the movement of individuals within the hospital, and enhances the working environment for healthcare staff.Obstetric care is provided in maternity hospitals, perinatal centers, and maternity departments.

A **maternity hospital** is an independent healthcare institution.

A **maternity department** is a subdivision of a healthcare facility that provides qualified obstetric and gynecological care to women during pregnancy, childbirth, and the postpartum period, as well as medical care for newborns.

If a maternity department is planned within a multidisciplinary healthcare institution, it should be located in a separate building with independent access routes and an adjoining isolated landscaped area. Placement in the same building as other departments is allowed only if an autonomous ventilation system is provided.

The list of required premises for maternity institutions is presented in **Table 68**.

Main departments of a maternity hospital include:

- Admission and discharge department
- Obstetric department
- Gynecological department
- Department of pregnancy pathology
- Women's consultation department
- Clinical diagnostic laboratory
- X-ray department
- Functional diagnostics department
- Pharmacy
- Auxiliary services (kitchen, laundry, disinfection department)

Table 68

List of Required Premises in Maternity Institutions

No.	Name of Room	Minimum Area, m²
1	Delivery room with one bed and a newborn's toilet	24
2	Preparation room for staff, with a shower	6
3	Operating room	See Table No. __ of these regulations
4	Single-bed ward	12
5	Multi-bed ward (2 beds or more)	10 per bed (mother and child)
6	Single-bed room with one baby cot, including airlock and sanitary unit*	12 + 3 + 6
7	Duty nurse's station	6
8	Treatment room	12
9	Treatment room for newborn vaccinations	12

No.	Name of Room	Minimum Area, m^2
10	Room for personal hygiene of postpartum women**	8
11	Head of department's office	12
12	Senior nurse's room	12
13	Staff room	12
14	Housekeeping nurse's room	10

Notes:

*) May be used as an isolation room.

**) Also used as an enema room.

The admission department is located on the first floor, with convenient transport access to other departments.The layout must ensure a streamlined flow to separate two groups: infected and non-infected women. Therefore, maternity hospitals and departments are organized into two divisions: **physiological** and **observation** (see Fig. 53).

A **filter area** must be arranged in the admission department. The woman in labor passes through this filter, where she undergoes an examination (including temperature measurement and skin inspection), anamnesis collection, and assessment for the presence of infectious or viral diseases.

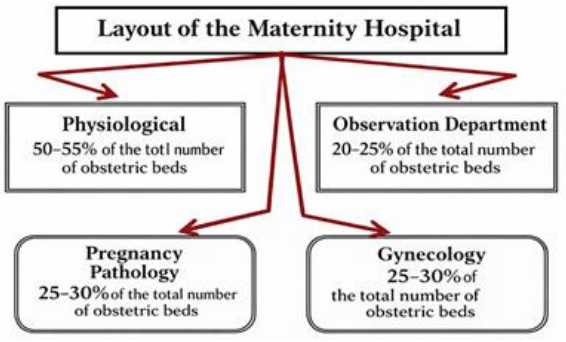


Fig. 53. Distribution of the total number of beds in the maternity hospital.

After that, the woman is directed to an examination room according to the appropriate stream—either to the physiological or observation department. If an infectious disease is suspected, the woman is admitted to the observation department.

Each examination room is equipped with a **sanitary treatment room with a shower**. After undergoing sanitary treatment, the woman in labor is admitted to the hospital.

Discharge of postpartum women from both the **postnatal physiological** and **observation departments** is carried out through their **respective visitor waiting areas**.

Physiological Maternity Department

When designing this department, provision is made for an **airlock with a sanitation checkpoint** for medical staff. The department includes **labor and delivery rooms**, an **operating block**, and **auxiliary rooms**.

Labor rooms include:

- Examination areas,
- Prenatal wards for 1, 2, or 4 beds,
- Delivery wards for 1 or 2 beds,
- Each equipped with a treatment area and toilets for newborns.

An **operating block** is provided within the department with the full required set of premises.

The department also includes offices for the **head of department**, **on-duty doctor**, **senior midwife**, **housekeeping nurse**, a **pantry**, and **clean linen storage**.

Postnatal Physiological Department

The postnatal physiological department is designed in accordance with the requirements for **therapeutic units**. It includes wards for **postpartum women**, **newborns**, and **supporting rooms**.

In modern maternity hospitals under construction, **rooming-in** (joint accommodation of mother and newborn) is prioritized. Previously, postpartum women and newborns were accommodated in **separate departments** (postnatal and neonatal units).

In rooming-in wards, no more than **2 maternal and 2 infant beds** are allowed. In separate accommodation wards, the number of **adult beds** should not exceed **4**.

A crucial requirement is that **admission and discharge** of postpartum women must occur on the **same day**.

In the **neonatal unit**, infants are placed in **isolated sections** designed for no more than **20 cribs**. Entry into the section is only possible through an **airlock**. A **nurse station** is located within this section.

Observation Department

This department is located **separately** from other departments and is designed to be **non-through** (no through-traffic). Isolation must be ensured for **pregnant women, women in labor, and postpartum mothers with newborns** in individual delivery boxes.

Like the **Mehlzer isolation box**, it has **an anteroom connected to the street**, and an **entrance from the corridor via an airlock**.

Requirements include:

At least 3 delivery rooms, each for one bed, fully equipped, including an **operating room** and **auxiliary rooms**.

Postpartum wards with one or two beds, considering cyclical occupancy.

Provision of **reserve beds** for mothers who need to remain more than 5–6 days.

Newborn wards in this department are designed as **boxed units**. Only **separate accommodation** of mother and newborn is allowed in the observation department.

Other required premises include: **treatment rooms**, **medical staff offices**, **pantry-dining rooms**, **enema rooms**, **toilets** and **women's hygiene rooms**.

Gynecological Department

This department provides both **surgical and conservative treatment**. It is designed with **complete isolation** from the maternity department.

It is located in a **separate block or building wing**, with a **dedicated admission area**.

The gynecological department is designed similarly to a **surgical department**, with a full range of necessary rooms in its structure.

Department of Pregnancy Pathology

The primary task of this department is to provide **specialized, round-the-clock care** for women with **pregnancy complications** and to **prepare them for delivery**.

The department of pregnancy pathology is designed similarly to a **therapeutic department**, with a full set of relevant premises.

CHILDREN'S WARD

The main objective of modern pediatric departments and hospitals is to provide **intensive care or specialized assistance** and to **restore the health of sick children**. These facilities offer **medical care for children and adolescents up to the age of 17**.

The pediatric inpatient department typically includes the following components:

- **Admission department**
- **Pediatric units**
- **Medical and diagnostic department** with a laboratory
- **Pathological and anatomical unit**
- **Pharmacy**
- **Kitchen unit**
- **Utility and service area**

Distinctive Features of Pediatric Departments and Hospitals:

Modern children's hospitals are planned and operated taking into account the physiological, psychological, and social characteristics of children. Therefore, pediatric facilities require:

1. **Zoning** for different age groups and infection control.
2. **Bright and friendly interior designs** to create a comforting environment.
3. **Increased safety measures** (non-toxic materials, rounded corners, child-proof furniture, etc.).
4. **Spaces for parents' stay**, especially in long-term care wards.
5. **Educational and play areas** for children's emotional and developmental support.
6. **Special ventilation and climate control systems** due to children's higher sensitivity.
7. **Separate isolation wards** for infectious diseases.

Children's departments should also provide **psychological support** and **rehabilitation therapy** as part of the healing process, which may include **occupational therapy, speech therapy, and counseling**.

Table 69

Required Area, Temperature, and Air Exchange Rate

Room Type		**S м²**	**t C°**	**Air exchange**	
				inflow	**outflow**
Infectious ward	Pediatric	6,5	20	2,5 м³	3,5 м³
	Adult	7,0	20	2,5 м³	3,5 м³
Non-infectious ward	Pediatric	6,0	22	80 м³	
	Adult	7,5	20		

Placement

The pediatric department, as part of a multidisciplinary hospital, is fully isolated and located on the ground floor with its own admission/discharge and treatment-diagnostic units. In front of the department, a designated area is planned for the organization of a garden-park zone with playgrounds for the games and walks of sick children.

Layout and Room Allocation

The requirements for the design of non-infectious pediatric departments are presented in Table 68.

To ensure the isolation of a sick child in the case of a suspected infectious disease, an isolation ward (boxed room) is provided within the pediatric department. A playroom is planned for activities and games for preschool and school-age children. Wards with additional space are provided to accommodate mothers' beds.

When designing the admission unit of children's hospitals and departments, isolation rooms for children with undiagnosed conditions, admission and examination boxes, and a sanitary checkpoint for personnel are incorporated.

The number of boxes is calculated based on the department’s capacity (number of beds). Specifically, isolation boxes are planned to comprise 5% of the total number of beds, while admission-examination boxes account for 2%. In surgical hospitals, the number of boxes is calculated as 4% of the total number of beds. The list and composition of rooms are the same as those in the admission department of general-profile hospitals.

Ward sections of the pediatric department are designed to be non-through and isolated to allow for complete quarantine measures, if necessary.

In facilities catering to children under the age of 3, all patient rooms are designed as individual boxed spaces. For those aged between 3 and 7 years, approximately 40-50% of the rooms follow this boxed layout, while for children over 7, only about 10-20% are designed in this manner.

Infants and toddlers require their mothers to be present at all times during their hospital stay. To accommodate this need, the design includes wards that allow for shared lodging. Additionally, there are separate rooms for visiting parents, equipped with their own entrances for relaxation and meals, including dining areas, lounges, and restrooms. The capacity of these facilities is planned to accommodate up to 50% of the total number of beds designated for children under 3 years old.Outpatient and Polyclinic Institutions

Objectives of Urban and District Polyclinics:

- Provision of qualified specialized medical care to the population, either in the polyclinic or at home;
- Implementation of preventive health measures;
- Monitoring and dispensary observation of the population;
- Promotion of a healthy lifestyle among the population.

Main Departments of the Polyclinic

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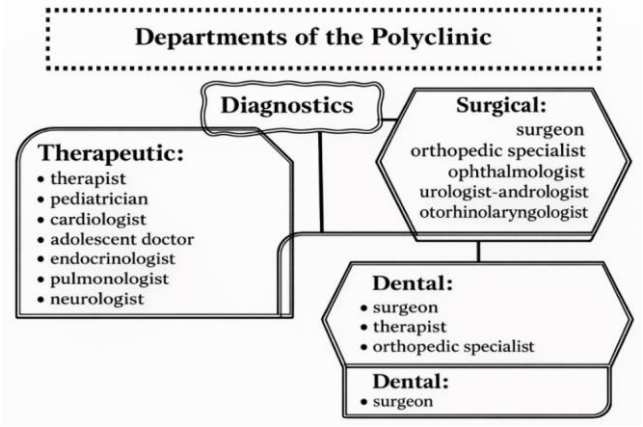


Fig. 54. List of Polyclinic Premises

Table 70. Composition of Outpatient and Polyclinic Institutions

Room	**Area (m^2)**
1. Vestibule–cloakroom for visitors with filter zone	0.38 per visitor, but not less than 10
2. Pharmacy kiosk	According to standards
3. Waiting area*	From 0.38 to 1.2 per visitor, but not less than 10
4. Registration area	8 per registrar, but not less than 10
5. Filter-box for receiving sick children (minimum of 2), with separate entrance	12
6. Physician consultation rooms: allergist, hematologist, endocrinologist, pediatrician,	12

Room	Area (m^2)
general practitioner, neurologist, psychiatrist, adolescent physician	
7. Family doctor's office (general practitioner)	16
8. Speech therapist's office	18
9. Cardiologist's office with ECG equipment	12 + 6
10. Injection room	12
11. Treatment room*	12
12. Surgeon's office	12
13. Minor operating room with pre-operative area**	24 + 8
14. Traumatologist-orthopedist's office	12
15. Obstetrician-gynecologist's office with gynecological chair	12 + 12 (depending on number of visits)
16. Otolaryngologist's office	12
17. Ophthalmologist's office (with darkroom if necessary)	12 + 8
18. Dentistry department – doctor's office with one dental chair	14 per chair
19. Dermatologist's office	12
20. Radiology department	According to regulatory documents
21. Laboratory	According to regulatory documents
22. Functional diagnostics department	According to regulatory documents
23. Medical review commission office	16
24. Staff room*	3–12
25. Sanitary unit***	3

SPECIFICS OF MEDICAL WASTE

In Uzbekistan, the processes of gathering, transporting, and disposing of medical waste adhere to established Sanitary Rules and Regulations specifically designed for healthcare facilities. These guidelines are intended to ensure that all practices related to the collection, storage, removal, and treatment of waste produced by medical institutions meet the necessary health and safety

standards.Unlike domestic waste, medical waste is categorized separately. Medical waste is a byproduct of the professional activities of various healthcare institutions and comprises a wide range of refuse. This includes:

- Used dressing materials — bandages, gauze dressings;
- Consumables — single-use instruments such as syringes, probes, catheters, and infusion systems;
- Special clothing for staff, patients, and visitors — gowns, gloves, caps, shoe covers;
- Human biological waste — vomitus, feces, and various excretions including urine, blood, mucus, pus, etc.;
- Food leftovers;
- Unused portions of medications;
- Malfunctioning medical devices and equipment;
- Auxiliary materials — furniture, paper, utensils, and similar items.

Healthcare facilities generate a substantial amount of waste daily. A portion of this waste is toxic and hazardous, and therefore, medical waste is classified into distinct hazard classes.

Rules for Handling Medical Waste

Waste management encompasses activities related to the collection, disinfection, disposal, and transportation of waste.

Disinfection of waste is the process of sanitizing waste to eliminate its epidemiological hazard.

Neutralization of waste refers to the destruction of hazardous properties of waste to prevent harmful effects on the environment and human health.

Waste disposal involves the storage or burial of waste.

Waste storage refers to the placement of waste in institutions for subsequent disinfection, burial, or utilization.

Waste burial is the containment of waste in specialized storage facilities to prevent the release of harmful substances into the natural environment.

Stages of the system for collection, storage, and transportation of waste:

- Collection of waste within healthcare facilities (HCFs);
- Internal transportation of waste on the HCF premises from departments to temporary storage sites;
- Disinfection/neutralization;
- Transportation of waste off the HCF premises;
- Burial or destruction of medical waste.

For each type and class of waste, specific requirements are applied depending on the epidemiological, toxicological, and radiological hazard of the waste.

Mixing of different classes of waste in a single container at any stage of handling is strictly prohibited.

Medical waste (Fig. 55), depending on the degree of epidemiological, toxicological, and radiological hazard, as well as its negative impact on the environment, is classified into five hazard classes:

Class A – Non-hazardous waste, similar in composition to municipal solid waste (MSW);

Class B – Epidemiologically hazardous waste;

Class C – Epidemiologically extremely hazardous waste;

Class D – Toxicologically hazardous waste (hazard classes 1 to 4);

Class E – Radioactive waste.

Fig. 55. Classification of Medical Waste

Non-hazardous Waste — Class A

These wastes are non-toxic and have had no contact with biological fluids of patients or with infectious patients. They include food waste (except from

infectious disease departments of healthcare facilities), broken furniture, inventory, out-of-service equipment that does not contain toxic components, paper, and construction debris.

Hazardous (Risk-Associated) Waste — Class B

These are **potentially infectious wastes**, including:

- Materials and instruments contaminated with biological fluids such as blood;
- Various patient excretions;
- Waste from pathological departments;
- Surgical waste (e.g., removed organs, tissues, etc.);
- Waste from infectious disease departments, including food waste;
- Waste from microbiological laboratories;
- Waste from vivariums (laboratory animal facilities).

Class B waste must undergo disinfection and neutralization.

The method of neutralization is determined during the development of the medical waste disposal scheme.

Fig. 56. Containers for Collecting Class B Medical Waste

Class B waste (Fig. 56) is collected in **yellow containers** or containers with **yellow labeling**. The packaging may be either rigid or flexible.

Extremely Hazardous Waste — Class C

These substances have been in contact with patients suffering from **especially dangerous infections**. For example, waste from laboratories working with **highly virulent microorganisms** of **pathogenicity groups 1–2**. This also includes:

- Waste from tuberculosis (phthisiatric) and mycology departments and hospitals,
- Waste from patients with **anaerobic infections**.

Specific requirements are imposed on the handling of **Class C waste**, in accordance with protocols for working with **group 1–2 pathogens** (highly pathogenic agents).

Medical waste of this class must be disinfected using physical methods—such as **thermal**, **microwave**, **radiation**, and similar techniques.

Chemical disinfection methods are allowed only for the **neutralization of food waste and patient excretions**.

Fig. 57. Containers for Collecting Class C Medical Waste

Packaging (Fig. 57) for collecting Class C waste consists of **red-colored containers** or those bearing **red markings**.

Class D Waste

These are **comparable to industrial waste**, including:

- Expired medications;
- Waste from diagnostic agents;
- Disinfectants and opened, unusable medical preparations;
- Cytostatic agents and other similar chemical substances;

- Instruments and equipment containing mercury.

Class D medical waste must be collected in containers of **any color except yellow or red**, clearly marked, with **tightly fitting lids**, and stored in **designated, isolated rooms**.

Class E Waste

These are **radioactive wastes**.

Handling of Class E waste (collection, storage, disposal) is carried out in accordance with the legislation of the Republic of Uzbekistan ***"On Radiation Safety"*** and ***"Radiation Safety Standards"***.

Class E waste must be removed by **specialized organizations** that have **permission and a license** to handle radioactive materials.

Situational Tasks

Task 1

Context:

The infectious disease department of the Bukhara city district hospital consists of 60 beds and is located in a single-story building situated deep within the hospital grounds. Patients bypass the central admission unit and enter directly through three designated **admission-examination boxes**. Patients suspected of dysentery, following sanitary treatment, are admitted to the **intestinal infections unit**, which includes **semi-box** and **fully isolated (boxed)** wards.

Each **semi-box** is designed for **2 beds** and is connected to the corridor via an **airlock**. The **area** of each semi-box (excluding the bathroom) is **21 m²**, with a **ceiling height** of **3,2 m**. **Walls** are painted light blue with oil paint to a height of 1,8 m. The **floor** is covered with linoleum. Wards are equipped with **washbasins with hot and cold water supply** and a **toilet with a flush WC**. **Orientation**: Southeast-facing windows. **Window height from floor**: 2,7 m; glazed area: 2,7 m². **Angle of light incidence**: –23°, **opening angle**: 8°. **Illumination at the wall opposite the window**: 120 lux; **external illumination**: 13,100 lux.

Microclimate in July:

Temperature: 24 °C. Wet-bulb temperature (Assmann psychrometer): 19 °C. Atmospheric pressure: 740 mmHg. Cooling period of globe catathermometer: 118 s (instrument constant: 568 mcal/cm²)

Ventilation:

Supply: 185 m³/hour, exhaust: 165 m³/hour, CO_2 concentration in indoor air: 0,16%

Evaluate:

a) Internal layout of the semi-box;

b) Air-thermal conditions in the department;

c) Natural lighting;

d) Ventilation efficiency and air exchange rate (supply and exhaust);

e) Air cleanliness.

Task 2

Context:

A sanitary-hygienic inspection was conducted at a **maternity hospital** due to a **significant increase in purulent infections** in newborns and complications in breastfeeding mothers.

Statistics:

20% of newborns developed **umbilical sepsis, pneumonia, or pyoderma** within **4–5 weeks after discharge**. Nearly **6% of breastfeeding mothers** developed **mastitis** within **2–4 weeks** postpartum. **Inspection Results – Postnatal Department:**

Two **newborn wards**, each with **6 bassinets**. The department is located at the **dead end of a corridor**. **No airlocks** are present in front of the wards. The **nurses' station** is in the corridor, adjacent to the infant wards. Mothers are housed in rooms with **3 to 4 beds**.

Ward Specifications:

Square-shaped, **5 m x 5 m**; **ceiling height**: 3,2 m. Walls coated with **light blue oil paint** to a height of 1,8 m. Linoleum flooring

Microclimate:

Temperature: 23 °C, wet-bulb temperature (Assmann psychrometer): 18.5 °C, globe catathermometer cooling period: 98 s (instrument constant: 598 mcal/cm²)

Windows:

Orientation: one southeast-facing, one south-facing, glazed area: 4,8 m², sill height from floor: 2,9 m, outdoor illumination: 8,600 lux.Illumination on the surface of the medical instrument table: 85 lux. Light incidence angle: 25°, **opening angle**: 3,5°

Ventilation: Supply: 220 m³/hour. Exhaust: 210 m³/hour

Air Quality: CO_2 concentration: 0.12%. Total microbial contamination: 3,200 microbial bodies/m³. Hemolytic ***Staphylococcus***: 12 organisms/m³.

The same **pathogenic strain of** *Staphylococcus* isolated from infected children and mothers was found on: Changing tables, baby scales, hand swabs from nurses, clothing of breastfeeding mothers.

Laundry and clothing protocols:

- **Staff uniforms**, **bed linens**, and **personal garments of mothers** were changed **once per week**.

Evaluate:

a) Internal layout of the newborn ward;

b) Air-thermal conditions;

c) Natural lighting;

d) Ventilation efficiency and air exchange rate;

e) Air quality in terms of CO_2 and microbial contamination.

Question : What violations of the anti-epidemic regime are present?

QUESTIONS FOR SELF-PREPARATION

1. What types of healthcare facility construction layouts do you know?
2. Provide a description of a safe hospital environment.
3. What aggressive factors of the hospital environment are you aware of?
4. What is the main structural unit of an inpatient facility?

5. List the key design characteristics of an infectious disease ward.
6. Provide examples of specific planning features of a maternity hospital.

PART V.

OCCUPATIONAL HYGIENE. METHODS OF STUDYING AND HYGIENIC ASSESSMENT OF WORKPLACE ENVIRONMENTAL FACTORS

Labor, as a special form of interaction between humans and their surrounding environment, represents a unique aspect of human activity. **Occupational hygiene** is a branch of hygiene that studies the effects of work processes and factors of the workplace environment on the human body. It develops hygienic standards and preventive measures aimed at ensuring favorable working conditions and preventing the development of occupational diseases.

In its research, occupational hygiene employs various methods:

To study the active factors of the workplace environment — **physical, chemical, and biological methods.**

To analyze the mechanisms of action of workplace factors on the human body — **physiological, pathophysiological, morphological, and biochemical methods**;

To assess the health status and morbidity of workers — **clinical and statistical methods**.

HYGIENIC ASSESSMENT OF INDUSTRIAL DUST

Industrial dust is a common and, in some production processes, a major harmful factor.

Dust is a physical state of matter that has been ground into extremely small particles. When inhaled or when it comes into contact with the skin, these particles can exert both mechanical and toxic effects, determined by the chemical composition and chemical properties of the dust particles. Due to their size, ranging from several microns to millimeters, they remain suspended in the air as aerosols and settle slowly.

Industrial dust is classified into different types: by origin, by formation method, and by degree of dispersion (particle size).

By origin, dust is categorized as organic, inorganic, and mixed. Organic dust can be of natural origin, either animal or plant-based (from wood, cotton, wool, etc.), or artificial (plastic, rubber, resins, dyes, etc.). Inorganic dust includes metallic (zinc, iron, copper, lead, etc.) and mineral (asbestos, quartz, silicate, etc.) types.

Depending on the method of formation, aerosols are classified as condensation or disintegration aerosols. Condensation aerosols result from thermal processes such as evaporation of solid substances (electric welding, melting, etc.) or cooling and condensation of metal and non-metal vapors. Disintegration aerosols are formed through mechanical grinding of solid substances (crushing, drilling, milling, disintegration of rocks, etc.) or by mechanical treatment of products (casting cleaning, polishing, etc.).

Dust that is not overtly toxic may still lead to the development of chronic nonspecific lung diseases, characterized by productive responses involving connective tissue growth, pneumoconioses, as well as bronchitis, tracheitis, pneumonia, and conjunctivitis of dust-related etiology. Depending on the chemical composition of non-toxic dust, pneumoconioses may occur, such as those containing SiO_2 (silicosis, silicatous pneumoconiosis,

anthracosis), metal-related pneumoconioses (aluminosis, siderosis, stannosis, etc.), and mixed dust pneumoconioses (silicoanthracosis, silicosiderosis, etc.).

The most hazardous is dust with a high degree of dispersion. Aerosols of disintegration with particles smaller than 5 microns and condensation aerosols with particles smaller than 0,3–0,4 microns possess pronounced fibrogenic activity.

Aerosols have high penetration capacity and can be deposited directly in the alveoli.

Larger particles are usually retained in the upper alveolar pathways and are then expelled with sputum.

One of the preventive measures for reducing dust in the workplace is the installation of various dust collectors.

Determination of Dust Content in the Air

The dust content in the air is determined by various methods. The **gravimetric (or weight-based) method** involves determining the mass of dust per unit volume, expressed in **mg/m³**.

The **counting (or microscopic) method** makes it possible to count the number of dust particles in **1 cm³** and determine their size.

To collect air samples for determining the dust content, **aspirators** are used (see Fig. 58).

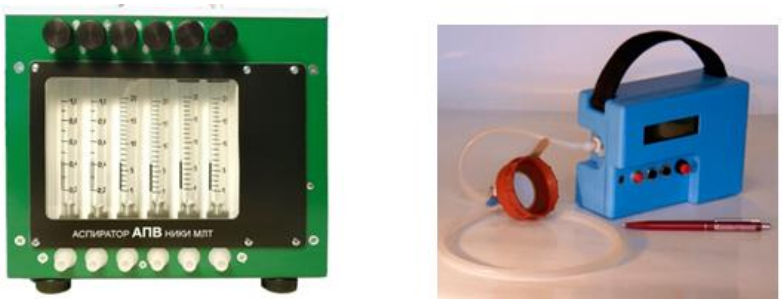


Fig. 58. Aspirators APV, MPT, and BRIZ-3

Determination of the Dispersed Composition of Dust

To assess airborne dust levels, the FPP-15 fabric filter is first weighed and then placed on a microscope slide for clarification using acetone vapors, all conducted within a fume hood equipped with fire safety measures. The slide is positioned near the neck of a flask containing heated acetone in a water bath. This process quickly clarifies the filter fabric, allowing it to bond to the glass as a thin, transparent layer that captures the dust particles.

Once clarified, the microscope slide is positioned on the microscope stage for high-magnification dust analysis. Prior to this, the division value of the ocular micrometer in the microscope eyepiece is established. This involves placing an objective micrometer on the optical stage of the microscope, centering it in the field of view under low magnification. Subsequently, under high magnification, the lines of the objective micrometer are aligned with those of the ocular micrometer for accurate measurement (**Fig. 59**). The division value of the ocular micrometer is calculated by counting the number of divisions until alignment with the lines of the objective micrometer.

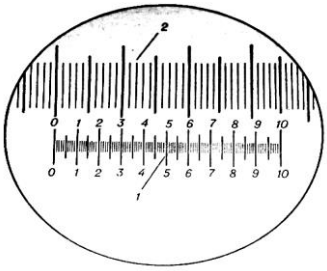


Fig. 59. Measurement of the Division Value of the Ocular Micrometric Scale

In Figure 59, it is illustrated that, under specific optical conditions, 100 divisions of the ocular micrometer align with 35 divisions of the objective micrometer, which has a division value of 10 μm. This means that each division of the ocular micrometer corresponds to a certain measurement.

Next, the objective micrometer is removed from the microscope stage and replaced with the sample being examined. By maneuvering the sample in various directions, at least 100 dust particles are counted, and their dimensions are measured using the ocular micrometer. These measurements are meticulously recorded in a table. Additionally, the morphology of the dust

particles is analyzed, noting aspects such as shape, edge characteristics, and other defining features. Investigating the morphology of these dust particles provides insights into their composition—whether they are mineral-based, plant-derived, or otherwise—and helps to understand their potential impact on human health.Based on the calculations of dust content, its dispersion, and shape in the studied samples, conclusions are drawn about the sanitary and hygienic conditions in the workplace and the potential impact of these conditions on workers' health.

Assignment:

Familiarize yourself with the equipment used for air sampling to measure dust content in the air.

INDUSTRIAL NOISE AND ITS EFFECT ON THE HUMAN BODY

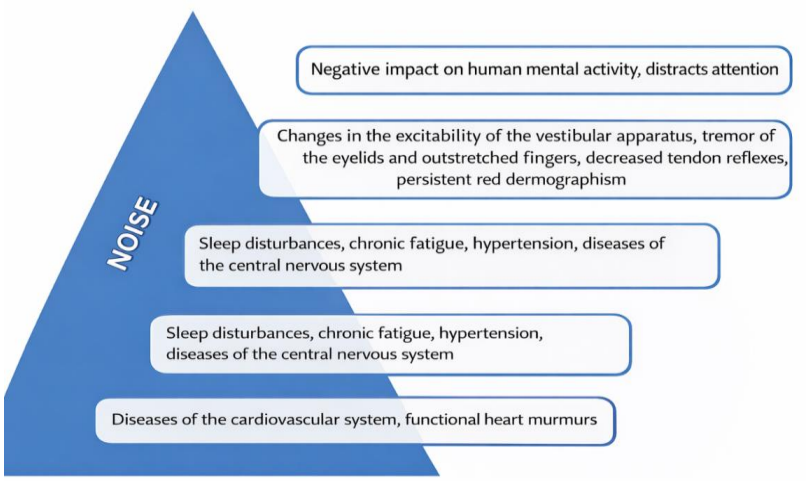
Noise is considered a combination of sounds of various frequencies and intensities. The most important physical property of noise is its intensity — the strength, which is determined by the amount of sound energy (the energy threshold for sound perception is 10 W/m^2) and depends on the amplitude of the sound wave.

Noise is characterized by strength (intensity) and loudness.

The strength of sound is determined by the sound energy transmitted per second through a unit area.

The term "loudness" refers to the individual perception of sounds by the human auditory system.

The negative effects of noise depend on its intensity, duration, spectral characteristics, and the initial functional state of the organism exposed to the noise (see Diagram 2).



EFFECT OF NOISE ON HEARING FUNCTION

Exposure to noise can lead to the development of occupational hearing loss or deafness. During the initial stage of auditory adaptation, noise exposure causes a decrease in hearing sensitivity. In the second stage, due to a decline in adaptive reserves, auditory fatigue develops. If this condition becomes chronic, it may progress to the third stage—progressive hearing loss.

Persistent impairment of hearing sensitivity is caused by damage to the sound-perceiving apparatus of the auditory organ, including degenerative changes in the hair cells and other elements of the organ of Corti. The primary signs of noise-induced hearing loss include symptoms associated with asthenovegetative and asthenoneurotic syndromes, which often manifest earlier than actual hearing deterioration.

In industrial settings, sound and noise primarily arise from the vibrations of solid and liquid materials, as well as variations in air pressure that create zones of compression and rarefaction. Sound waves are characterized by their pressure (P), which represents the difference between the peak compression of gases and the surrounding atmospheric pressure, measured in N/m^2.

These sound waves carry energy known as sound intensity (I), expressed in watts per square meter (W/m^2). When assessing noise from a health perspective, it is not the absolute physical characteristics—such as pressure or energy—that are important, but rather the relative measures that reflect human perception of sound. Although an increase in sound intensity is associated with louder sounds, this relationship is not straightforward; our perception of loudness grows at a slower rate compared to the rise in sound pressure. This logarithmic relationship informs the sound pressure level scale, which is based on logarithmic values of sound energy relative to the threshold of hearing (W/m^2), set at zero and extending up to the threshold of pain (W/m^2). This scale is typically expressed in bels (B) or decibels (dB), with common values ranging from 0 to 140 dB (0–14 B).

Noise can be classified by frequency into three primary categories: low-frequency (16–350 Hz), mid-frequency (350–800 Hz), and high-frequency (above 800 Hz). The human ear is especially attuned to higher frequencies, which requires a customized approach to acceptable noise levels that considers frequency, exposure duration, and the specific type of work being conducted.

In accordance with GOST standards, measuring noise levels in industrial environments necessitates taking readings at a minimum of three different locations. The microphone should be positioned at a height of 1.5 meters and directed toward the noise source. During these assessments, overall sound pressure levels, spectral composition across octave bands, and equivalent levels in decibels (dBA) are documented, adhering to GOST regulations. Utilizing dBA measurements facilitates the easy identification of excessive noise levels without the need for intricate spectral analysis.

When conducting a hygienic evaluation of noise, it is important to consider not only the noise level but also its temporal characteristics. For instance, short bursts of noise may be perceived differently than a constant background noise

lasting throughout the workday. Therefore, the concept of the **equivalent sound level** is often applied, allowing noise fluctuations to be presented in a more analyzable and assessable form. This involves calculating the average sound pressure level over a defined time interval, accounting for both peak and background levels.

Principle of Operation of Noise Measurement Instruments:

These devices operate by converting changes in electrical current, influenced by sound energy, into measurable values using a microphone. These changes in current are registered by special indicators (see Fig. 60). Loudness values, measured in decibels, are displayed on the instrument's electronic dial.

Fig. 60. Sound Level Meter

Physiological Methods for Studying the Effects of Noise on the Human Body

To explore how noise affects the human body, various techniques are utilized to monitor alterations in central nervous system activity. One approach involves examining the latent period of a conditioned reflex with a chronoreflexometer. Additionally, the responses of the auditory system are analyzed through tonal audiometry and by identifying the critical frequency of "auditory flicker." The cardiovascular system's response is evaluated using methods like pulsotachometry, arterial oscillography, and fatigue assessments guided by Anfimov's correction tables, among other strategies.

Threshold Tonal Audiometry.

Threshold tonal audiometry enables the measurement of the minimum intensity of sounds at various frequencies perceived by each ear separately. Sounds of different intensities are delivered to the subject's ears via air-conduction headphones. The measurement begins with a 1000 Hz tone, followed by tones of

other frequencies. The sound intensity is reduced until it becomes inaudible, then increased until it is barely perceptible again. After several repetitions, the average of these measurements is taken as the threshold intensity of the stimulus.

Critical Flicker Frequency

Critical flicker frequency is determined using a noise generator that produces intermittent noise. This method allows for establishing the maximum number of interruptions per second at which the noise is still perceived as intermittent.

Arterial Oscillography

This method is used to measure the minimum and maximum arterial pressure, as well as the average pressure dynamics both before and during noise exposure. Measurements are conducted using an arterial oscillograph.

Pulse Tachometry

Pulse tachometry allows for the recording of heart rate over specified time intervals. The device's sensor is placed on the fingertip, while a light source is positioned on the nail side. The instrument's scale registers changes in pulse rate in beats per minute at the time of measurement.

Chronoreflexometry

Chronoreflexometry focuses on studying the latent period of a motor conditioned reflex. By comparing physiological parameters before and during noise exposure, this method enables the assessment of changes occurring in the body under the influence of noise with specific frequency **characteristics.HYGIENIC ASSESSMENT OF VIBRATION**

Vibration is the mechanical oscillation of elastic bodies at low frequencies (3–100 Hz) with large amplitudes (0,5–0,003 mm). Oscillations with a frequency of 6–9 Hz, which is close to the natural frequency of human body oscillations, are especially harmful.

The main characteristics of vibration include:

- Frequency of oscillations per second (Hz),
- Amplitude of the oscillatory motion,
- Velocity and acceleration of the oscillating point.

Types of vibration are presented in Diagram 3.

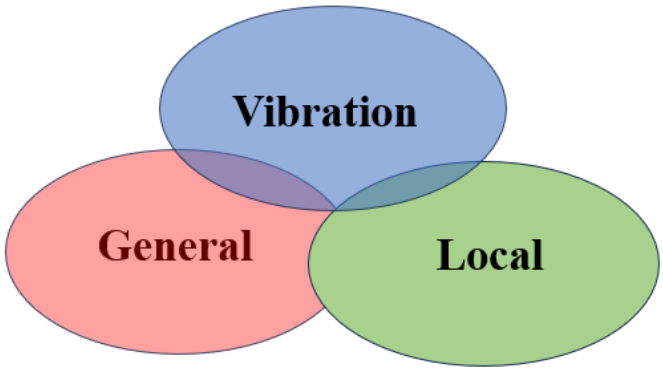


Diagram 3. Types of Vibration

Vibration occurs when a vibrating object makes contact with the human body, transmitting energy to the body's tissues. This interaction stimulates nerve receptors in various organs and tissues, triggering a reflex response. Prolonged and intense exposure to vibration can amplify these reflexes, resulting in alterations to the functional status of specific bodily systems.

Vibrations are categorized based on how they propagate through body tissues: whole-body vibration, which affects the entire body, and local (or segmental) vibration, which is restricted to specific areas. The amplitude of the vibrations plays a crucial role in determining how far they travel through the tissues; smaller amplitude vibrations tend to be absorbed by the body without causing damage.

In industrial settings, workers frequently encounter local vibration when using pneumatic tools or rotary drills. Conversely, whole-body vibration is more common among those operating heavy machinery such as vibration-compacting platforms, as well as in mining and agricultural equipment.

The clinical effects of both local and whole-body vibration can manifest as neurological disorders, injuries to the muscular and skeletal systems, metabolic issues, and other health concerns.Pathological changes in the body due to whole-body vibration are more diverse and are mainly expressed through disorders of the vestibular apparatus and the central nervous system.

Industrial environmental factors that enhance the harmful effects of vibration on the worker's body and create conditions for increased muscle workload include: heavy physical labor, high-intensity noise, unfavorable microclimatic conditions, etc.

The quantity that characterizes the **intensity of vibration** is called **vibration velocity**. It depends on the frequency and amplitude of oscillation and is expressed by the following formula:

$$\mathbf{V_{max} = 2\pi \times f \times a}$$

where:

Vmax – vibration velocity, cm/s;

f – frequency of oscillations, Hz;

a – amplitude of oscillations, cm.

Table 71.

Hygienic Standards for Local Vibration

Vibration Velocity	**Octave Bands with Geometric Mean Frequencies, Hz**							
	8	16	31,5	63	125	250	500	1000
m/s × 10^2	5,0	5,0	3,5	2,5	1,8	1,3	0,9	0,65
dB	120	120	117	114	111	108	105	102

The vibration velocity can be expressed in absolute units (m/s, cm/s, mm/s) or in relative units (dB). The zero level of velocity is taken as a vibration velocity of 5×10^5 mm/s, from which the measurement is taken.

The maximum permissible levels of general and local vibration differ. The phenomenon of resonance occurs as a result of the coincidence of the oscillatory movement frequencies of human tissues with the frequencies of external

vibrations. Such vibration has a stronger effect on the body. According to the resonance criterion, all types of vibration are divided into 5 classes (Table 72).

Table 72.

Hygienic Standards for Whole-Body Vibration

Vibration Class	Vibration Frequency, Hz	Vibration Characteristics
1	up to 5	Low-frequency, non-resonant
2	5–10	Resonant
3	10–30	Medium-frequency
4	30–50	Non-resonant
5	above 50	High-frequency

Measurement of Vibration

The vibration level is determined using a vibration measuring device — a **vibrometer** (see Fig. 61).

Figure 61. Vibrometer

Measurement of Vibration

Using a vibrometer (see Fig. 61), it is possible to measure various parameters of vibration such as **vibration acceleration**, **vibration velocity**, **vibration displacement**, and **vibration frequency**.

Vibrations of different frequencies have **varying effects on the human body**, which is why **weighting coefficients** are applied for specific frequency bands to better assess their impact.

Permissible limits of vibration are regulated by **sanitary standards and regulations**, ensuring occupational safety and protection of workers' health in environments with mechanical vibrations.

Vibration Measurement

The vibration level is determined using a vibration meter – a vibrometer (Fig. 61).

Fig. 61. Vibrometer

With this device, it is possible to measure various vibration parameters: vibration acceleration, vibration velocity, vibration displacement, and oscillation frequency.

Vibrations of different frequencies have varying effects on the human body; therefore, weighting coefficients are applied to specific frequency bands. Maximum permissible vibration levels are regulated by sanitary standards and norms.

Methods of Functional Research on the Effects of Vibration on the Human Body

The main methods used to study the effects of vibration on the human body include:

1. **Assessment of vibration sensitivity**
2. **Capillaroscopy**
3. **Skin temperature measurement**

1. Assessment of Vibration Sensitivity

This method is employed to identify early stages of functional disorders associated with exposure to vibration.

Special devices such as the IVCh-02 (Vibration Sensitivity Meter) are used to determine vibration sensitivity thresholds across different frequency ranges. The method is based on gradually increasing the amplitude of oscillatory movements and identifying the maximum amplitude at which the test subject begins to perceive the vibration.

The examination is performed multiple times at different vibration frequency characteristics. Typically, the measurement starts at 500 Hz, followed by 250, 125… down to 16 Hz.

The subject places their index finger on the vibrating platform of the device and holds a response button in the other hand. At a given frequency, the amplitude of vibration is gradually increased. Upon first perceiving the vibration, the subject

presses the response button. The test then continues at the next, lower frequency, and so on.

A key requirement is that the subject must not be able to observe the instrument panel during the test.

Vibration sensitivity is assessed both before and after vibration exposure. Normally, the threshold of vibration sensitivity increases after exposure due to fatigue of the vibration analyzers.

Prolonged exposure to vibration leads to a persistent decrease in vibration sensitivity, most pronounced at a frequency of 250 Hz.

2. Capillaroscopy

Capillaroscopic examination is performed using a special microscope with a reflected light illuminator and a clarifying liquid (cedar oil). The most suitable site for observing capillaries is the skin near the nail bed of the fourth finger on the left hand.

The examination focuses on capillary shape and width, as well as the characteristics of blood flow.

In healthy individuals, capillaries are usually arranged in neat rows with 2–3 gentle bends parallel to each other. Blood flow is fast and uniform. Under the influence of vibration, capillaries become more tortuous and deformed, indicating a state of spasm and atony. The arterial loop is significantly narrowed, while the venous branch is often dilated. Blood flow typically slows down.

3. Skin Temperature Measurement

Due to vascular spasms caused by vibration exposure, the skin surface temperature decreases.

Skin temperature is measured using an electric thermometer. During the measurement, the sensor of the electric thermometer is typically placed in contact with the palmar surface of the second or third finger of the right hand (most exposed to vibration during work with vibrating tools). Measurements are consistently conducted under identical environmental

temperature conditions (20°C) after the hand has rested under these conditions for at least 10 minutes.

Readings from the electric thermometer are compared to pre-exposure values.

This examination of vibration sensitivity is particularly useful for identifying early-stage functional impairments in workers.For this purpose, the ECO-2 Vibration Sensitivity Meter is used to determine vibration sensitivity thresholds across various frequency ranges.The maximum amplitude at which the subject begins to perceive vibration is established by gradually increasing vibration intensity.

Studies are conducted in several sessions at different frequency characteristics, beginning at 500 Hz, then 250, 125… down to 16 Hz.

Research Procedure:

During the test, the subject places their index finger on the vibrating platform of the device and holds a response button in the other hand.

At each frequency, the vibration amplitude of the platform is gradually increased.

The subject presses the response button at the first perception of vibration. The procedure is repeated at the next, lower frequency.

An important condition is that the subject must not observe the control panel of the device.

Vibration sensitivity is assessed before and after vibration exposure. Typically, after exposure, the threshold of vibration perception increases due to analyzer fatigue. Prolonged exposure to vibration results in a sustained decrease in vibration sensitivity, most prominent in the 250 Hz range.

Capillary Endoscopy

Capillary endoscopy is conducted using a special microscope equipped with a reflected light source and a clarifying solution (cedar oil).
The most appropriate site for examination is the skin near the nail bed of the fourth finger of the left hand. Exposure to vibration causes the capillaries to become more tortuous and deformed. Arterial loops are significantly constricted,

while venous branches are frequently dilated in the opposite direction. Blood flow is generally slowed.

Skin Temperature

Vibration exposure results in a decrease in skin surface temperature due to vasoconstriction.

Skin temperature is measured with an electric thermometer. The sensor is typically placed in contact with the palmar surface of the second or third finger of the right hand.

Measurements are consistently taken at an ambient temperature of 20°C, after the hand has been at rest for no less than 10 minutes. The readings are then compared to those obtained prior to vibration exposure.

HYGIENIC ASSESSMENT OF INDUSTRIAL POISON TOXICITY

Industrial poisons can cause not only occupational diseases but also temporarily compensated disorders, an increase in overall morbidity, and a decrease in the body's adaptive reserves to harmful environmental factors.

Main parameters of industrial poison toxicity:

- Indicators of the “dose-effect” relationship (toxicodynamics) – indicators of the level of poison toxicity
- Indicators of the “time-effect” relationship (toxicokinetics) – indicators of the movement of poisons in the body: rate of absorption, metabolism, and excretion

Classification of industrial poisons depends on the task at hand.

The **hazard class** of a substance is determined based on the **Maximum Allowable Concentration (MAC)** in the air of the working zone. **Maximum Allowable Concentration (MAC)** – the concentration which, during daily 8-hour work shifts and no more than 40 hours per week, throughout the entire working life, does not cause disease or health deviations.

There are **three stages** of hygienic standardization of chemical substances:

1. Justification of *tentative safe exposure levels* as a temporary hygienic standard.
2. Justification and approval of MAC based on toxicological experiments.
3. Adjustment of MAC based on workers' morbidity rates.

For some substances, **two MAC values** are established:

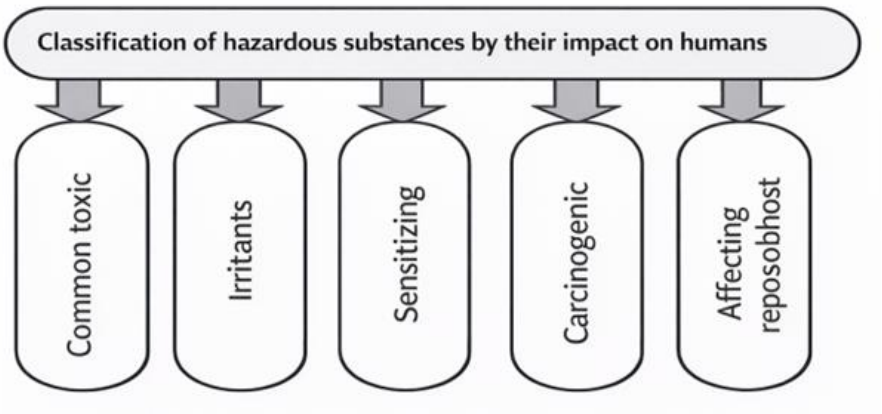
Maximum single-time concentration – the content of a substance in the worker's breathing zone averaged over a short sampling period.

Average shift concentration – the concentration averaged over an 8-hour work shift. This value more accurately reflects the air conditions at the workplace.

Industrial poisons may appear as gases, vapors, liquids, aerosols, solids, or mixtures. They enter the body via:

Inhalation route – through the respiratory organs (the most common and dangerous route), oral route – through the gastrointestinal tract, percutaneous route – through intact skin and mucous membranes (lipophilic poisons).

Harmful substances are also classified by the nature of their effect on the human body (see Scheme 4).

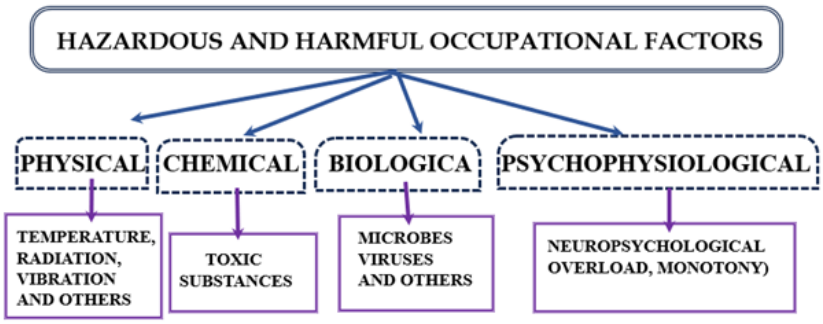


Scheme 4. Classification of Harmful Substances by Their Effects on the Human Body

Toxic industrial poisons exhibit **selective effects**, targeting specific organs or systems. They are classified as follows:

- **Neurotoxic agents**: e.g., organophosphorus insecticides, carbon monoxide
- **Respiratory system toxins**: e.g., silicon oxides, coal dust, sulfur compounds
- **Hepatotoxic agents** (affect the liver): e.g., phenols, hydrocarbons, aldehydes, xylene
- **Nephrotoxic agents** (affect the kidneys): e.g., oxalic acid, ethylene glycol, heavy metal compounds
- **Gastroenterotoxic agents**: e.g., strong acids and alkalis, heavy metal compounds
- **Hematotoxic agents** (affect the blood): e.g., aniline and its derivatives, toluene, benzene, nitrites
- **Allergens**: e.g., cobalt, chromium, nickel, formaldehyde
- **Teratogens** (cause developmental anomalies in embryos): e.g., certain halogenated hydrocarbons, cadmium
- **Mutagens** (cause genetic mutations): e.g., chromium, cadmium, lead, formaldehyde, nickel
- **Carcinogens** (cause cancer): e.g., hexavalent chromium, beryllium, arsenic, cadmium, nickel
- **Polytropic poisons** (affect multiple organs/systems simultaneously)

The **overall classification** of dangerous and harmful occupational factors affecting workers' health is presented in **Scheme 5**.



Scheme 5. Classification of Hazardous and Harmful Occupational Factors

Determination of Chemical Substances in the Workplace Air

Systematic monitoring of chemical compound concentrations in the air of production facilities provides an assessment of hygienic conditions.

Currently, **universal gas analyzers** are used for this purpose (see ***Fig. 62***).

Fig. 62. Gas analyzer for determining harmful substances in the workplace air.

In addition to industrial poisons, there are other negative factors that affect workers' health. The **combined effect** of these factors forms the basis for the **classification of working conditions**.

According to **hygienic classification principles**, working conditions are divided into **four classes**:

Class 1 – Optimal Working Conditions

In this category, the work environment not only safeguards the health of employees but also fosters high levels of productivity and overall well-being.

Class 2 – Acceptable (Permissible) Working Conditions

These conditions are defined by environmental and labor factors that remain within established hygienic limits. Any physiological changes experienced by workers are reversible during rest periods or before the next shift, ensuring no detrimental impact on their health or that of future generations in either the short or long term.

Class 3 – Harmful Working Conditions

This class is identified by the presence of industrial factors that surpass hygienic standards and can potentially harm the health of employees or their descendants.

Class 4 – Dangerous (Extreme) Working Conditions

Conditions in this category are characterized by elevated levels of hazardous factors in the workplace, which pose a significant risk of acute occupational illnesses, poisoning, injuries, or life-threatening scenarios during work hours **or as a consequence of the job.HYGIENIC ASSESSMENT OF WORKING CONDITIONS OF DOCTORS OF VARIOUS SPECIALTIES.**

Modern medical work is characterized by high intensity, significant intellectual and psychological stress. Often, a doctor's professional activity demands considerable physical effort, endurance, high work capacity, and increased concentration.

The introduction of modern technology and implementation of new procedures into the medical workflow increases both professional risk and the sanitary-hygienic requirements for doctors' working conditions.

The occupational hazards faced by doctors of various specializations can be classified into the following categories: mechanical, physical, chemical, biological, and psychogenic factors.

Mechanical factors include forced body postures and strain on specific muscle groups and organs. These are typical for surgeons and other doctors performing long-duration procedures.

Chemical factors are closely related to the variety of pharmaceutical and disinfecting agents used in practice. Doctors of all specialties are exposed to these substances.

Physical factors encompass radiation such as X-rays, lasers, ultraviolet rays; electromagnetic fields such as microwave (MW), ultra-high frequency (UHF), and high frequency (HF); as well as noise from medical equipment. These are common in the work of radiologists, surgeons, obstetricians-gynecologists, and others.

Biological factors include exposure to pathogenic viruses, bacteria, and fungi.

Psychogenic factors stem from high levels of emotional and nervous tension. These are particularly prevalent among psychiatrists, narcologists, and doctors working long shifts or overnight duties.

The **optimization of work and rest schedules**, along with the **creation of optimal microclimatic conditions**, are the primary methods of preventing the adverse effects of occupational hazards on the health of doctors.

Methods for Assessing the Professional Suitability of Doctors in Certain Specialties

It is well known that many factors affect a person's health, and one of the key ones is professional activity. Professional suitability implies not only successful mastery of a profession during training but also the continuous development of skills in the course of work.

Studies show that a lower level of professional suitability correlates with higher morbidity rates, increased incidence of neuroses, and more frequent workplace injuries.

Key criteria for determining the professional suitability of medical personnel include a set of **psychophysiological indicators**, which assess whether a person meets the professional requirements of a doctor. The object of a doctor's work is a sick human being. The clinical doctor's activity consists of three main stages:

1. Examination of the patient,
2. Establishing a precise diagnosis,
3. Conducting therapeutic interventions.

Medical work is among the most complex types of professional activity. A doctor's decisions affect not only the health but also the life of a patient. This high level of responsibility causes significant **neuropsychic stress**.

Additionally, medical professionals are at risk of **occupational exposure**. Doctors regularly come into contact with patients suffering from diseases transmitted via airborne droplets, direct contact, or bodily fluids. They are susceptible to occupational illnesses such as: tuberculosis, hepatitis, bronchial asthma, allergies to medications, dermatitis.

Other conditions including **malignant neoplasms**, **cardiovascular diseases**, and **mental disorders** are frequently leading causes of **disability among doctors**.

Main causes of occupational diseases include: violations of safety protocols, outdated or poorly maintained equipment, inadequate lighting, ventilation, and heating, improper work-rest schedules, poor enforcement of personal protective equipment use, inefficient technologies.

Given the high demands on physical and mental health, **professional selection** plays a crucial role in choosing the medical profession. **Absolute contraindications** for medical practice include: organic diseases of the central nervous system, epilepsy, mental disorders, severe neuroses.

When selecting **surgical specialties**, particular attention should be paid to the **musculoskeletal system** and **visual acuity**.

Professional selection for doctors must take into account a set of **psychophysiological functions**, including: nervous system flexibility (e.g., ability to shift attention), visual analyzer performance, precision of muscular effort, tactile sensitivity.

These functions can be assessed using **specialized methods**, and the results are recorded in a **psychophysiogram chart**, which supports comprehensive evaluation of professional fitness.

Methods for Studying Psychophysiological Functions: Devices and Equipment

Psychophysiological function assessments are conducted in a calm and controlled environment to ensure optimal testing conditions.

The following instruments are commonly used in such studies:

1. **Chronoreflexometer**: Measures the time interval between the presentation of a stimulus (light or sound) and the subject's motor response.
2. **KChSM-2 Device**: Comprises a measuring unit and a stimulus block that emits light flashes with variable frequencies to assess visual response thresholds.
3. **F. Galton's Line or Visual Estimation Ruler**: A 1000 mm ruler mounted on a stand with a central thin line. Graduations extend symmetrically from the center to both ends. Used to evaluate visual estimation accuracy.
4. **Hand Dynamometer DRP-120**: Features a dial gauge and a compression handle. For assessing muscular endurance, the device is adjusted to allow the needle to move freely.
5. **Mac-Worty Ruler**: Consists of two wooden rulers joined at an angle. The unit of measurement is the spacing between the ruler ribs, with 1 Mac-Worty unit equivalent to 0.9 mm. Used for spatial perception evaluation.

6. **V.Ya. Anfimov Correction Tables and Schulte-Platonov Tables**: A4 sheets with 30 rows of randomly arranged letters, each row containing 30 characters. Results are recorded using a special scoring table at the bottom of each sheet.

Comprehensive Methods for Studying Core Psychophysiological Functions

1. Assessment of Nervous Process Mobility

This method evaluates the speed of receiving and processing visual information in decision-making conditions. The subject is instructed to react quickly to **white and red lights** but **not to react** to a **green light**. Stimuli are repeated over **five series** using the stereotype: white and red = "go", green = "inhibit".

Procedure:

Calculate the difference in reaction time between the red stimulus presented before and after the green (inhibitory) stimulus for each of the five series.

If the post-inhibitory reaction is slower, the difference is marked as **"+"**.

If it is faster, the difference is marked as **"–"**.

The **average difference** is calculated across all five series.

A **negative average** indicates **high nervous mobility**, while a **positive** one indicates **low mobility**.

The **differentiation error index (A)** is calculated using:

$$A = \frac{n}{5} \times 100$$

Where **n** is the number of incorrect responses, and **5** is the total number of series.

2.Attention Switching Assessment

This test evaluates how quickly and accurately a person can switch attention between tasks using **three black-red Schulte-Platonov tables**:

Table A: Find and name black numbers from 1 to 25 in ascending order.

Table B: Find and name red numbers from 1 to 24 in descending order.

Table C: Alternating task — find and name black numbers in ascending and red numbers in descending order, stating the color out loud (e.g., "1-black, 24-red, 2-black, 23-red...").

The attention-switching score (T) is calculated as:

T=C−(A+B)T = C - (A + B)T=C−(A+B)

Where:

C = time to complete mixed table,

A = time for black ascending task,

B = time for red descending task.

3.Visual Analyzer Evaluation

The subject sits 50 cm from the center of the **visual estimation ruler**. A slider is moved from the center to a specific point on one side (e.g., 20 cm or 35 cm), and the subject must replicate that distance on the opposite side. After three practice trials, five formal measurements are taken for:

- **Underestimation errors** (moving from center outward),
- **Overestimation errors** (moving from edge inward).

  All errors are recorded. The **average error** is calculated without considering the sign by summing the total error and dividing by the number of trials (10).

4. Assessment of Muscle Effort Reproduction Accuracy

Using a **hand dynamometer**, the examiner determines **½ of the subject's maximal grip strength**. The subject is asked to reproduce this effort:

- **3 practice trials** with visual feedback,
- **3 test trials** without visual feedback.

The error in each attempt is recorded. The **average reproduction error** is calculated as:

Mean Error=Sum of all errors3\text{Mean Error} = \frac{\text{Sum of all errors}}{3}Mean Error=3Sum of all errors

This value reflects the **accuracy of muscle force reproduction**.

Example of a Case Study Solution

Case: Which type of dust has higher fibrogenic activity: One with 40% free silicon dioxide and particle size of 2 nm, or one with 10% free silicic acid and particle size of 0.1 nm?

Solution:

The dust containing **10% free silicic acid with a particle size of 0.1 nm** has greater **fibrogenic activity**, as its ultrafine particles can penetrate deep into the alveoli and remain there. In contrast, larger particles (e.g., 2 nm) are more likely to deposit in the upper respiratory tract and are cleared via mucus.

Situational Tasks

Task 1. In which room are the conditions worse?

A) Coal dust containing **10% free silicon dioxide**, with particle sizes ranging from **5 to 12 nm**, and a dust concentration of **9 mg/m³**.

B) Coal dust containing **15% free silicon dioxide**, with particle sizes ranging from **0.5 to 3 nm**, and a dust concentration of **8 mg/m³**.

Evaluation:

Although the dust concentration in option B is slightly lower (8 mg/m³ vs. 9 mg/m³), the **higher content of free crystalline silica** (15%) and **smaller particle size** (0,5–3 nm) significantly increase its **fibrogenic hazard** and ability to penetrate deep into the respiratory tract.

Conclusion: The conditions are more hazardous in **Room B**.

Task 2. An evaluation of the **work regimen** of female weavers during the **morning shift** was conducted. Under the current schedule, only a single **20-minute lunch break** was allowed, occurring **3,5 hours after the beginning of the shift**.

Below are the **changes in time** required to perform a single operation (eliminating a yarn break) and **physiological indicators**, with baseline values taken as **100%**.

Table 73. Change in time spent on performing a single operation

Indicators	**Working Hours**							
	1	2	3	4	5	6	7	8
Time to eliminate 1 break	100	99	102	102	103	113	108	111
Visual-motor reaction time	100	100	106	108,5	115	118	120	126
Arm endurance	100	92	84	78	65	44	48	44

Task:

1. Assess the change in the time spent on one operation during the shift.
2. Evaluate the changes in visual-motor reaction time and hand endurance during the shift.
3. Evaluate the changes in hand endurance during the shift.
4. Assess the current work schedule of the weavers.
5. Develop recommendations to reduce fatigue and improve the work capacity of the weavers.

Solve the problem:

During a one-and-a-half-hour operation, the surgeon spends 64% of the time in a forced standing position with the torso bent more than 30°. During the procedure, the surgeon must simultaneously monitor 5–8 objects. The energy expenditure during the operation was 4.9 kcal/min. The visual-motor reaction time after the operation increased by 52.4% compared to the baseline.

Self-check Questions:

1. What are the sources, routes of exposure, and nature of the harmful effects of industrial dust?
2. Noise and vibration-related occupational diseases: sources, nature of harmful effects, preventive measures.
3. What are the working conditions in agriculture: occupational hazards and their effects on the body?
4. What is the classification of industrial poisons?

5. What are the hygienic characteristics of the working conditions of healthcare professionals?

PART VII.

RADIATION HYGIENE

Sources and Properties of Ionizing Radiation

In 1895, German physicist Conrad Roentgen discovered the property of radioactivity. The rays emitted by uranium salts possessed penetrating ability through various substances. This radiation, which he called X-rays, caused the darkening of photographic plates. Thus, the method of radiography was first applied and named after C. Roentgen.

Sources of ionizing radiation are widely used in various fields of production and scientific research. Accordingly, more and more people come into contact with radioactive substances.

According to research, the atom has a structure consisting of a positively charged nucleus surrounded by negatively charged electrons. The charge of the electrons and the nucleus corresponds, which creates conditions for the atom's electrical neutrality. In turn, the atomic nucleus consists of positively charged protons and neutrons (nucleons), which determine the mass and charge of the atom.

Identical elements may have different numbers of neutrons in the nucleus, meaning they have different atomic weights but the same chemical properties. Such atoms, with different numbers of neutrons in the nucleus, are called **isotopes**, and this phenomenon is called **isotopy**. For example, uranium isotopes are denoted as 92U235 and 92U238, the latter containing three more neutrons.

Isotopes of many elements are unstable and thus attempt to transition to a stable and secure state.

Unstable or radioactive substances decay, and the rate of their decay — the number of radioactive nuclei decaying per unit of time — is called **activity**. As a result of decay, there is a constant decrease in the number of radioactive nuclei, accompanied by the appearance of daughter decay products.

For military purposes, and later for peaceful ones, fissile materials — artificial radioactive isotopes — were developed. Artificial radionuclides and sources of

radioactivity are used in various spheres of human activity, which significantly raises the issue of **radiation safety**.

Nature and Properties of Ionizing Radiation

Regardless of their different nature and origin, ionizing radiations (IR) are capable of ionizing atoms. Upon exposure, they break chemical bonds within molecules and cause adverse effects when impacting biological tissues or living organisms.

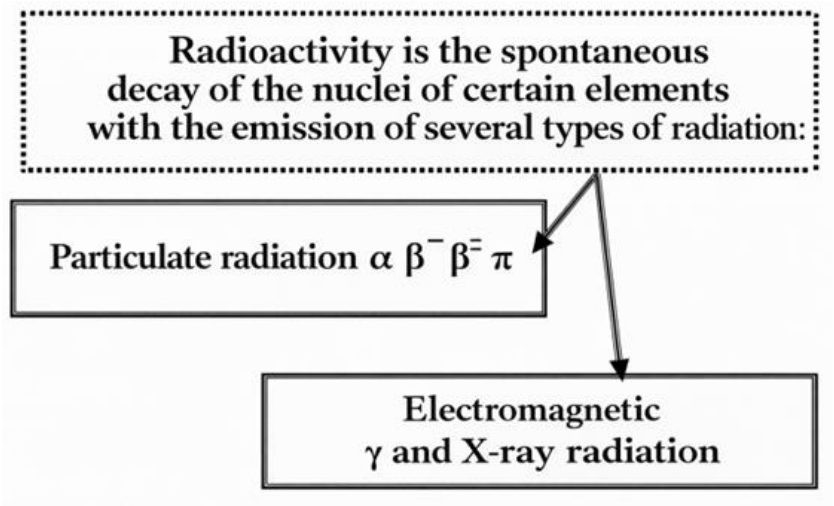


Fig. 63. Types of Ionizing Radiation.

There are two main types: **electromagnetic radiation**, such as **γ-radiation**, and **corpuscular (particle) radiation**, which includes particles like **α-particles** (positively charged), **β-particles** (negatively charged), and **neutrons (n)** — which carry **no charge** (Fig. 63).

Characteristics of α-, β-, and γ-radiation

α-radiation, α-particles are **positively charged helium nuclei** (Fig. 64, Table 74) and possess **high energy**.

Flux density of 50-70 ion pairs per 1 μm

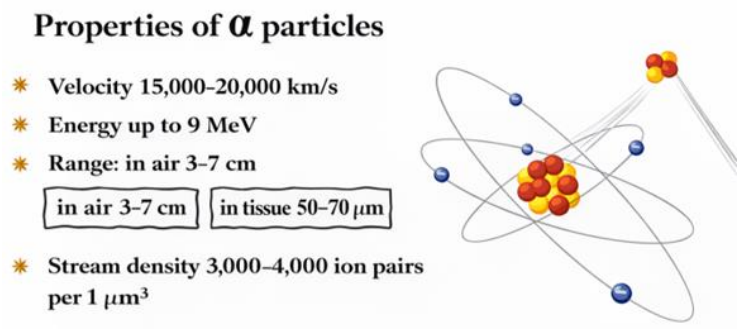


Fig. 64. Properties of α-Particles

Mechanism of substance ionization: To ionize an atom, approximately **30–35 eV** of energy is required. Meanwhile, an α-particle initially carries up to **5,000,000 eV** of energy. Therefore, it acts as a powerful source of ionization and can generate **over 100,000 ions** before transforming into a helium atom.

The **mass of an α-particle** is about **7,000 times greater than that of an electron**. It attracts electrons, pulling them from their orbits. In this process, the α-particle loses a small portion of its original energy, and the atom loses an electron, forming a **positively charged ion**.

The **velocity and kinetic energy** of the α-particle gradually deplete. Once the energy is expended, the α-particle **captures two electrons**, comes to a **resting state**, and **transforms into a helium atom**.

The **range of an α-particle in the air** is no more than **a few centimeters**. A **sheet of paper** is sufficient to block the particle. When entering **human tissue**, its **penetration depth is less than 0,7 mm**.

α-radiation cannot penetrate the skin even if it contacts **unprotected areas** of the body and **does not cause harm externally**.

However, **if it enters the body** through **inhalation, drinking water, or contaminated food**, it causes ionization **directly within tissues and organs**, potentially causing harm.

β-Radiation

During the decay of a nucleus into a **neutron and a proton**, an **electron is formed**.

The process of **emitting electrons from the atomic nucleus** is known as **β-radiation**.

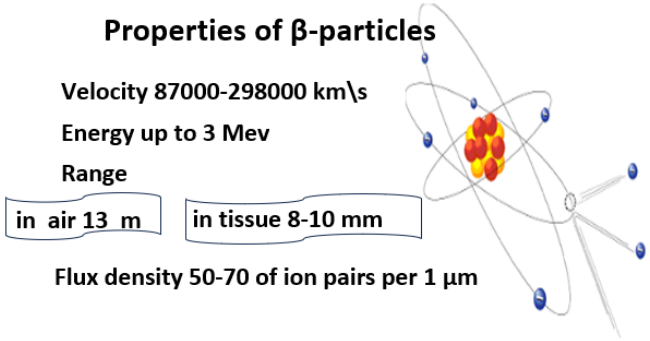


Fig. 65. Properties of β-particles

The resulting β-particle (Fig. 65, Table 74) from a stable chemical element knocks out one orbital electron. The atom, having lost the electron, transforms into a positively charged ion. The mass of a β-particle is 7,000 times less than that of an α-particle, but its penetrating ability is higher. Due to the small charge and mass, the ionization caused by a β-particle is also much lower. However, β-particles expend their energy over a longer path.The ability of a β-particle to penetrate varies and depends on its initial energy potential. Adequate protection of the body from external exposure to β-particles is provided by personal protective equipment and footwear.

More dangerous are β-particles when they **enter the body with food**.

γ-radiation

Photon radiation or electromagnetic radiation is called γ-radiation, i.e., it consists of γ-quanta emitted during nuclear reactions or particle annihilation. γ-radiation has a **high penetrating ability**, as it has a **very short wavelength** compared to, for example, light or radio waves. The energy of γ-radiation can be

high, and the **speed of propagation of γ-quanta is equal to the speed of light**.

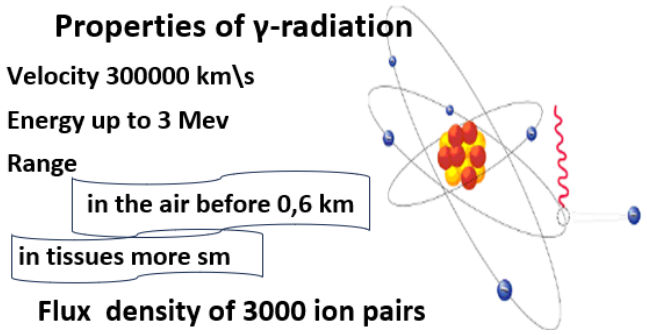


Fig. 66. Properties of γ-radiation

γ-radiation is produced (Fig. 66, Table 74) during nuclear reactions. γ-radiation differs from X-rays in frequency and electromagnetic wavelength, as well as in origin. γ-radiation has the ability to ionize atoms of matter. Upon penetration, it transfers energy to the electrons of the substance. γ-radiation has **no electric charge**, which is why its radiation energy decreases rapidly, meaning its **ionizing ability is much lower** than that of α- and β-radiation.

Due to its **very high penetrating ability**, it is more difficult to protect against γ-radiation compared to the effects of α- and β-particles. γ-radiation can **penetrate human tissues and organs**.

To reduce γ-radiation intensity by 50%, **1 cm of lead, 5 cm of concrete, or 10 cm of water** is used.

Table 74.

Indicators of Different Types of Radiation

Type of Radiation	**Nature of Radiation**	**Charge and Typical Energy Range**	**Ionizing Ability in Air per 1 cm**	**Penetrating Ability**	**Propagation Speed**
Alpha (α)	Helium nuclei	+2 / 4–6 MeV	Several tens of thousands of ion pairs	A few cm in air; a few microns in human	10,000–2,300 m/s (approx.)

Type of Radiation	Nature of Radiation	Charge and Typical Energy Range	Ionizing Ability in Air per 1 cm	Penetrating Ability	Propagation Speed
				tissue	
Beta (β)	Stream of electrons/ positrons	-1 / +1 / few keV to 3 MeV	About 100 ion pairs	Several meters in air; up to 1 cm in human tissue	~300,000 km/s (speed of light)
Gamma (γ)	Stream of photons	0 / same	Several ion pairs	Tens to hundreds of meters	Same (speed of light)
X-rays	Same (photon stream)	0 / 1 keV–1 MeV	Same	Same	Same
Neutrons	Nuclear particles	0 / around 2 MeV	Same	Same	

UNITS OF RADIOACTIVITY

In the International System of Units (SI), radioactivity is characterized by the **decay rate**, more precisely, by the number of **disintegration events per unit time**. The unit used is the **becquerel** (symbol: **Bq**, Russian: **Бк**), which represents one nuclear disintegration per second (1 Bq = 1 disintegration/s).

Another unit still in use is the **curie** (symbol: **Ci**, Russian: **Ки**), which also characterizes the rate of radioactive decay. One curie is defined as the number of decays per second in 1 gram of pure metallic radium, amounting to **$3{,}7 \times 10^{10}$ disintegrations per second**.

Activity of a Radioactive Substance

Radioactive decay is the spontaneous transformation of atomic nuclei. It is the probability that a nucleus decays per second. For example, only **$1{,}38 \times 10^{-11}$** of the total number of radium nuclei decay each second. If a substance contains

10^{13} radium nuclei, then approximately **138 nuclei** decay per second. Therefore, the decay constant of radium is **$1{,}38 \times 10^{-11}\ s^{-1}$**.

1 becquerel (Bq) = 1 disintegration per second.

1 curie (Ci) = **$3{,}7 \times 10^{10}$** disintegrations per second.

Curie is a non-SI unit: **1 Ci = $3{,}7 \times 10^{10}$ Bq.**

Units of Absorbed Dose

The **absorbed dose** of radiation is the energy transferred from ionizing radiation to the medium. This dose reflects the degree of exposure to radiation, not the radiation itself. Molecules in matter absorb radiation and become ionized; the **energy transferred** is called the **absorbed dose**.

The absorbed dose **D** is defined as the ratio of the differential energy **dW** absorbed by a substance to its mass **dm**:

$$D = \frac{dW}{dm}$$

In the SI system, the unit of absorbed dose is the **gray** (symbol: **Gy**, Russian: **Гр**), where:**1 Gy = 1 J/kg.**

A non-SI unit still in use is the **rad**:

- **1 rad = 0.01 Gy**
- **1 Gy = 100 rad**

Units of Equivalent Dose

Different types of radiation produce **different levels of biological damage** to tissues. To evaluate the **biological impact**, the concept of **equivalent dose** is used in radiation safety.

Each type of ionizing radiation has its own physical properties—velocity, energy, penetration depth, ionization capability—and therefore its own **level of hazard** to human health.

The **equivalent dose (H)** accounts for the **quality factor (K)** of each radiation type and is calculated as:

H=D×KH = D \times KH=D×K

This dose reflects the **potential health damage** caused by absorbed ionizing radiation. For prolonged exposure, the total equivalent dose is the sum of the products of absorbed doses from each type of radiation **Di** and their respective **quality factors Ki**: $$H=\sum_{i=1}^{n} D_i K_i$$

H=∑(Di×Ki)H = \sum (D_i \times K_i)H=∑(Di×Ki)

In the SI system, the unit of equivalent dose is the **sievert** (symbol: **Sv**, Russian: **Зв**):

- For **beta and gamma radiation**, **1 Sv = 1 Gy = 1 J/kg**
- **1 µSv = 1/1,000,000 Sv**

A non-SI unit still used is the **rem** (roentgen equivalent man), also referred to in Russian as **ber**:

- **1 rem = 0,01 Sv = 10 mSv**

Effective Equivalent Dose

Since the **radiation exposure** of the human body is **uneven**, and **different organs** have **different sensitivities**, there is a need to evaluate the overall health impact. This is done using the concept of **effective equivalent dose**, calculated as:

Heff=∑(Hi×Wi)H_{\text{eff}} = \sum (H_i \times W_i)Heff=∑(Hi×Wi)

Where:

- HiH_iHi is the average equivalent dose to the ***i-th*** organ or tissue.
- WiW_iWi is the **tissue weighting factor**, representing the relative damage of exposure to that organ compared to whole-body exposure at the same dose.

Examples of tissue weighting factors:

- **Gonads (reproductive organs)**: W=0,25W = 0,25W=0,25
- **Breast tissue**: W=0,15W = 0,15W=0,15
- **Red bone marrow**: W=0,03W = 0,03W=0,03
- **Bone tissue**: W=0,03W = 0,03W=0,03

- **Other tissues** (combined): W=0,30W = 0,30W=0,30

Exposure Dose

The **exposure dose** is an assessment of the **total amount of ionization** by ions of one sign created by ionizing radiation in a specific volume of air. This dose is calculated **only** in the case of **external radiation**, such as **X-rays or gamma radiation**.

In the **International System of Units (SI)**, the unit of exposure dose is the **coulomb per kilogram (C/kg)**, which refers to the **amount of electric charge** created in **1 kg of irradiated dry air**. An exposure dose of **1 C/kg** means the formation of such a number of **ion pairs** that the **total charge of one sign equals one coulomb**, which corresponds to **$6{,}24 \times 10^{18}$ ion pairs**.

A **non-SI unit** still commonly used is the **roentgen (R)**.

The exposure dose **X** is defined as the amount of **charged ions of one sign (dQ)** created in a given ionized mass **dm** of air, assuming all electrons and positrons remain within that mass: $X = \frac{dQ}{dm}$

Exposure dose is defined only for electromagnetic radiation with energies ranging from 1 keV to 3 MeV.

Conversion Between Exposure and Absorbed Dose

- **1 C/kg** of exposure dose corresponds to:
  - **33,8 Gy** absorbed dose in **air**
  - **37,2 Gy** absorbed dose in **biological tissue**
- **1 R (roentgen)** corresponds to:
  - **0,873 rad** in **air**
  - **0,96 rad** in **biological tissue**

Dose Rate Units

Gamma (γ) radiation creates a **dose rate** that depends on:

- The **decay parameters** of the radionuclide

- The **activity units**, i.e., the number of disintegrations and photon emissions

Each well-studied radionuclide has a specific **γ-constant**, which allows for calculating the **exposure dose rate**.

There are two types of **γ-constants**:

Differential γ-constant – represents the **gamma energy spectrum** of a radionuclide

Total γ-constant – represents the **complete isotropic gamma emission spectrum** of a source with activity **1 mCi**, expressed as **exposure dose rate in R/h**

The **γ-constant** can also be expressed in **non-SI units**:

Table 75

Gamma Constant for Some Radionuclides

Nuclide	**$T_{1/2}$ (Half-life)**	**Γ (R·cm² / μCi·h)**	**$Γ_{si}$ (μGy·m² / s·Bq)**
Na^{22}	2,602 years	11,85	78,02
Fe^{59}	45,1 days	6,177	40,67
Co^{57}	270,9 days	0,553	3,64
Co^{60}	5,272 years	12,85	8,.63
K^{35}	10,71 years	1,29	84,9
I^{131}	8,04 days	2,156	14,20
I^{133}	20,8 hours	3,36	2,06
Cs^{134}	2,062 years	8,724	57,44
$Cs^{137} + Ba^{137m}$	30,174 years (2,552 min)	3,242	21,33
Ra^{226}	1620 years	9,031	59,45

In SI units, the gamma constant is defined through the absorbed dose in air. It is important for all types of ionizing radiation, and its unit of measurement has a simple relationship with the non-SI unit: **1 Gy = 100 rad.**

Absorbed Dose Rate

The dose rate assesses the effect of ionizing radiation per unit of time.

- The **absorbed dose rate** is measured in **Gy/hour**,

- The **equivalent dose rate** is measured in **Sv/hour** or **µSv/hour**.
- **Gray per hour (Gy/h);**
- 1 Gy/h = 1 Sv/h = 100 R/h (for beta and gamma).
- **Sievert per hour (Sv/h);**
- 1 µSv/h = 1 µGy/h = 100 µR/h.
- **Roentgen per hour (R/h)**
- 1 µR/h = 1/1,000,000 R/h.

Effective dose (effective equivalent dose) — is an indicator used to assess the risk of long-term effects resulting from human exposure to radiation. When calculating this dose, it is necessary to consider the **radiosensitivity** of human organs and tissues. Therefore, the **equivalent dose** is the sum of the products of radiation exposure (dose) and the corresponding **tissue weighting factor**.

Units of measurement: joules per kilogram (J/kg), **sieverts (Sv)**, or **rems** (ber).

The **sum of doses received by a group of individuals**, corresponding to their individual effective doses, is called the **collective effective dose**. The unit of measurement used is **man-sievert (man·Sv)**.

Total collective effective dose — the collective effective dose that will be received by generations of people from a radiation source over the entire time of its existence.

Sources of ionizing radiation are used in medicine as methods for diagnostic examinations. Ionizing radiation sources used in medicine include:

I. Generators of ionizing radiation, open and sealed radionuclide sources. According to the degree of radiation hazard, **category III and IV** ionizing radiation sources include:

II. Computed tomography (CT) scanner.

III. Digital model X-ray diagnostic system.

IV. Fluorographic X-ray machine.

V. Dental X-ray machine.

VI. X-ray densitometer.

There are **open and sealed** types of radionuclide radiation sources.

Open Radionuclide Radiation Source (ORRS)

Its use allows radioactive material to enter the environment, which may result in contamination with radioactive substances. ORRS includes radioactive preparations in the form of liquids and gases, such as labeled compounds, radiopharmaceuticals, and others. ORRS are used in **contact radiation therapy**, where the preparations are absorbed by the body.

Open radionuclide sources, such as **Iodine-125 (I-125)**, are classified as **Category III radiation hazard sources** and are used in **radioimmunoassays** in clinical diagnostic laboratories.

In **radioisotope diagnostics**, the radioactive substance is not introduced into the human body but is added to biological samples from the patient, in which the radioactive isotopes are then detected.

Sealed Radionuclide Radiation Source (SRRS)

The radioactive material does not contaminate the environment because the design prevents its release. These sources are used in **contact**, **applicative**, **intracavitary**, and **external beam radiation therapy**.

Radiation Safety

Is ensured through a comprehensive set of measures, including:

- Organizational and legal support
- Development of engineering, technical, and sanitary-hygienic measures
- Educational and awareness-raising activities

ENSURING RADIATION SAFETY

The **Law of the Republic of Uzbekistan "On Radiation Safety"** and the **Sanitary Standards "Radiation Safety Norms (NRB-2006…)"** are aimed at creating conditions that **protect the life and health of people from the harmful effects of ionizing radiation**.

To ensure radiation safety, it is necessary to follow the following **principles**:

I. Principle of Regulation – not exceeding the permissible individual radiation doses for citizens from all sources of ionizing radiation (IR);

II. Principle of Justification – prohibit the use of IR sources in those types of activities where the benefit to individuals and society does not outweigh the risk of potential harm to people and the environment (exceeding natural background radiation);

III. Principle of Optimization – maintaining the lowest reasonably achievable level of individual radiation doses and the number of exposed individuals when using any source of IR.

Ionizing radiation affects the human body both through **external exposure** (e.g., X-rays and gamma rays) and **internal exposure** (e.g., alpha particles). When ionizing radiation enters the body through the **lungs**, **skin**, or **digestive organs**, internal irradiation occurs. This is more dangerous than external exposure because unprotected internal organs are constantly irradiated by the ionizing radiation source.

Water in the human body, under the influence of ionizing radiation, breaks down into various charged ions. Free radicals and oxidizing agents act on organic molecules in tissues, oxidizing and destroying them. This leads to **metabolic disturbances**.

Changes occur in the blood — the number of **red blood cells (erythrocytes)** decreases, the **composition of white blood cells (leukocytes)**, **platelets**, and **neutrophils** changes qualitatively. **Hematopoietic organs** (responsible for blood formation) are damaged, and the **immune system** becomes compromised, increasing the risk of **infectious diseases**.

Delayed effects, such as the development of **malignant tumors**, are also possible. A **lethal dose** of ionizing radiation is considered to be in the range of **2500–6000 mSv** (250–600 roentgen).

Radiation sensitivity varies between different organs and systems in the human body. Therefore, the **biological effect** of radiation directly depends on which organ is exposed.

Considering the biological effects and **radiation sensitivity** of different organs and systems, **hygienic standards** (dose limits) have been established for different population groups. (Figure 67, Table 76).

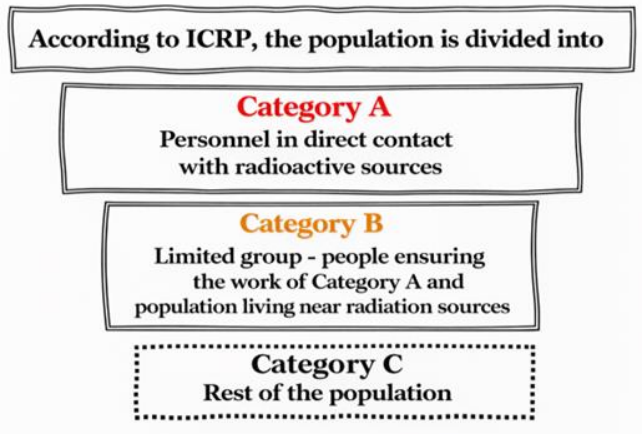


Figure 67. Groups of people by radioactive hazard.

Table 76. Basic

Main Dose Limit	**Limits of Dose**		
	A	B	C
Effective Dose	20 mSv/year average over any last 5 years, but no more than 50 mSv/year	5 mSv/year average over any last 5 years, but no more than 12,5 mSv/year	1 mSv/year average over any last 5 years, but no more than 5 mSv/year
Equivalent Dose per Year			
Lens of the eye	150 mSv	38 mSv	15 mSv
- Skin	500 mSv	125 mSv	50 mSv
- - Hands, Feet	500 mSv	125 mSv	50 mSv

Hygienic Regulation.

According to the Radiation Safety Standards of 2006:

1. **Personnel (Groups A and B):**

A. Persons directly working with ionizing radiation (effective dose < 1000 mSv over 50 years);

B. Persons working in adjacent rooms (effective dose < 250 mSv over 50 years).

2. **The entire population, including personnel outside the scope and conditions of their work activity** (effective dose < 70 mSv over 70 years).

Under standard conditions, the established dose limits are:

- For personnel: **20 mSv/year**
- For the general population: **1 mSv/year**

The effective dose of exposure from natural sources for personnel of all professions should not exceed **5 mSv/year**.

Three groups of organs with different radiation sensitivity are defined:

1. Gonads, red bone marrow, and the whole body during general irradiation.
2. Kidneys, liver, gastrointestinal tract, muscles, thyroid gland, and some other organs not belonging to groups 1 or 3.
3. Bone tissue, skin, hands, forearms, ankle joints, and feet.

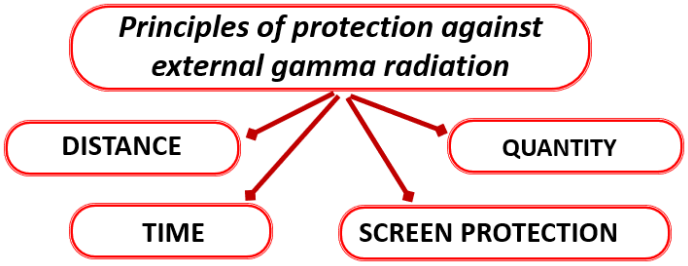


Figure 68. Principles of Protection Against Ionizing Radiation.

When working with sources of ionizing radiation (Figure 67), it is necessary to comply with radiation safety requirements.

Description of the principles of protection against ionizing radiation:

- **Protection by quantity:** The need to reduce the strength (power) of radiation sources.

- **Protection by time:** When working with ionizing radiation sources, it is necessary to reduce the contact time.
- **Protection by distance:** It is necessary to increase the distance between the ionizing radiation sources and the personnel's workplace.
- **Protection by shielding:** Installation or use of shields made from materials that absorb ionizing radiation.

Measures for personnel protection when working with ionizing radiation sources:

Use the basic protection principles (time and distance).

I. Technological measures:

- Automation;
- Remote control;
- Modernization and improvement of equipment used in radiology;
- Sealing (hermetization).

II. Planning measures;

III. Use of sanitary-technical devices, dosimetric control;

IV. Medical health control - periodic medical examinations;

V. Personal protective equipment.

When working with radioactive sources, the dose load is reduced by controlling the factors of time, distance, and radiation parameters. To reduce ionizing radiation exposure, the first two factors require preliminary planning, which is primarily solved through layout measures and relevant legal or regulatory acts in operating organizations. Shielding is a common method to reduce personnel exposure.

The main shielding materials used for protection against radiation are lead and tungsten. The most widely used, cheaper, and more accessible material for shield production is lead. Natural minerals are also used as part of construction materials, such as barite, which is added to plaster in X-ray rooms.

When working with open ionizing radiation sources, healthcare personnel must apply the above protection principles and prevent the incorporation of radioactive substances.

Requirements for the operating regime in radiology departments include preventing contamination of work surfaces, equipment, the external environment, and personnel working with radionuclides.

The main solution is planning measures and appropriate finishing of rooms with materials that do not absorb radioactive substances. Work with radioactive substances is conducted in special protective boxes equipped with exhaust isolated ventilation and subsequent decontamination. This involves decontamination of construction surfaces, equipment, apparatus, collection, and decontamination of radioactive waste. Decontamination of hands, skin, and clothing of workers is done in a sanitary checkpoint.

Personnel working with ionizing radiation sources must use personal protective equipment followed by sanitary processing and mandatory dosimetric control.

In rooms where open radioactive sources are used, it is forbidden to store clean personal clothes, food products, cigarettes and other tobacco products, cosmetics, or to use these items there.

To protect patients from ionizing radiation, the same protection principles already mentioned are applied.

With the widespread use of X-ray diagnostics, it is necessary to apply a complex of organizational and technical measures and scientific research to improve the conditions for using and operating modern X-ray equipment.

It is recommended to reduce the use of X-ray examinations wherever possible, especially strictly following the schedules for preventive examinations of workers, employees, and the population, controlling dose loads, increasing the qualifications of radiologists, replacing old equipment, and monitoring for malfunctions.

Calculation of Protection

The above-mentioned principles of protection follow from the physical dependence of the external radiation dose on the source activity and the exposure time; all these factors are inversely proportional to the square of the distance from the source:

$$D = \frac{Q \times t}{R^2}$$

where:

- DDD is the radiation dose,
- mmm is the source activity expressed in milligram-equivalents of radium (mg Ra eq),
- ttt is the exposure time in hours,
- RRR is the distance in centimeters from the source.

For closed-type ionizing radiation sources, the basic protection rules include shielding by quantity (source activity), time, distance, and shielding (screens).

When source activity is expressed in milligram-equivalents of radium, the formula becomes:

$$D = \frac{8{,}4 \times m \times t}{R^2}$$

where 8,4 is the dose rate (dose strength) created by 1 mg of radium at a distance of 1 cm.

Safe working conditions with ionizing radiation sources can be determined by incorporating the allowable effective equivalent dose for category A personnel (20 mSv/year or 2 rem/year, i.e., 0,04 rem/week), considering the distance rrr (usually measured in meters) from the worker to the source.

After transformation and simplification, the formula takes the form: **$t : kr^2 \geq 48$.**

Here, 48 is an abstract, dimensionless coefficient.

This formula can be used to calculate protection parameters:

1. **Protection by quantity (source activity):** $m = (48 \times r^2 \times k) : t$.
2. **Protection by time:** $t = (48 \times r^2 \times k) : m$.
3. **Protection by distance:** $r = \sqrt{(m \times t) : 48k}$.
4. **Protection by shielding (screening).**

Shield thickness for gamma radiation

The required thickness of a shield for gamma radiation depends on:

- The energy of the radiation,
- The specific activity of the source,
- The distance from the source to the workplace,
- The working time,
- The material the shield is made of.

The shield size to reduce the radiation dose to the allowable level is determined either:

1. Using tables (e.g., attenuation tables), or
2. By calculating the half-value layer (HVL), i.e., the thickness that reduces radiation by half.

Determination of the attenuation factor KKK: $K = \frac{mt}{48r^2}$

$K = \frac{P_x}{P_d}$ When using gamma installations, the attenuation coefficient is determined by the formula:where:

- P_x is the measured dose rate at the workplace,
- P_d is the permissible dose rate.

To determine the required shield thickness using tables, besides the value KKK, the radiation energy is needed. This can be found in a table of physical characteristics of individual isotopes (see Table 77).

Table 77.

Physical Characteristics of Radionuclides Used in Medicine:

Radioactive Substance	**Half-lif**	**Type of Radiation**	**Radiation Energy, MeV**	**Gamma Constant (mSv/(1m × GBq × h))**	**Half-Value Layer for Pb, cm**
Radium-226	1620 years	Alpha, beta, gamma	0,2-2,4	0,213	1,1
Cesium-137	30 years	Alpha, beta,	0,662	0,081	0,6

		gamma			
Iridium-192	74 days	Alpha, beta, gamma	0,136-1,06	0,120	0,3
Gold-198	2,7 days.	beta, gamma	0,412	0,064	0,3
Iodine-125	60 days	gamma	0,028;0,035	0,027	
Cobalt-60	5,27 years	beta, gamma	1,17;1,33	0,351	1,1

To protect against strong **β-radiation**, thick heavy layers of lead are used, while the generation of radiation is reduced by light materials such as polyethylene, plastics, paraffin, organic glass, or aluminum.

In contrast, to reduce the effect of **γ-radiation**, only heavy metals are used — for example, lead, steel, tungsten, cast iron, leaded glass, and even depleted uranium.

When necessary, parts of building structures can be used as shields — such as bricks, concrete, and barite concrete.

For absorbing **neutron radiation**, materials containing a large number of hydrogen atoms are required: water, paraffin, and concrete.

Lead has excellent protective properties and is often used as a reference to evaluate the shielding effectiveness of other materials.

Determination of Shield Thickness Based on Half-Value Layer Parameters

The value that reduces the radiation dose rate by half is called the **half-value layer (HVL)**. For radiation energy of 1 MeV, the calculated half-value layer thicknesses are: Lead — 1,3 cm, steel — 2,4 cm. concrete — 6.9 cm

For example, when using X-ray sources, a lead shield with a thickness of 1 mm is equivalent in shielding thickness to 12 cm of steel, 14 cm of barite concrete, 80 cm of concrete, or 80–110 cm of brick masonry.

Different materials are used for shielding depending on the penetrating power of the radiation.

If shields are made from other materials (concrete, iron, brick, water, cast iron), the protection can be recalculated based on density ratios (see Table 78).

Table 78.

Density of materials (g/cm³):

Material	Density (g/cm³)	Material	Density (g/cm³)
Aluminum	2,7	Lead	11,34
Iron	7,89	Cast iron	12
Brick	1,4 – 1,9	Water	1,0
Concrete	2,1 – 2,7	Air	0,00129

Recalculation of thickness depending on density: $\frac{d_1}{d_2} = \frac{P_1}{P_2}$

Where:

d1 is the thickness of the lead,

P1 is the density of the lead,

d2 and P2 are the thickness and density of the material used.

Calculation of protection against X-ray radiation

The attenuation coefficient (KKK) is determined by the formula:

К = I_a : (r^2 x DMD),

where:

Ia— standard anode current of the X-ray tube in mA;

r^2 — distance from the X-ray tube to the protection in meters;

DMD — dose rate at the working place, used in designing stationary protection (1,4 mR/h).

The thickness of the protective screen for attenuation of the primary X-ray beam is selected according to the table depending on the required attenuation coefficient and the voltage on the X-ray tube (Table 79).9**Table 79.**

Dependence of attenuation coefficient and voltage on the X-ray tube

Attenuation Coefficient	Voltage 100 kV	Voltage 125 kV	Voltage 150 kV
0,1	2,0 cm	2,3 cm	2,9 cm
0,15	2,2 cm	2,5 cm	3,0 cm
0,2	2,3 cm	2,6 cm	3,2 cm
0,3	2,5 cm	2,8 cm	3,4 cm
0,4	2,6 cm	2,9 cm	3,5 cm

Attenuation Coefficient	Voltage 100 kV	Voltage 125 kV	Voltage 150 kV
0,5	2,7 cm	3,0 cm	3,6 cm
1,0	3,0 cm	3,4 cm	4,0 cm
1,5	3,2 cm	3,6 cm	4,2 cm
2,0	3,3 cm	3,7 cm	4,3 cm
3,0	3,5 cm	3,9 cm	4,5 cm
4,0	3,6 cm	4,0 cm	4,7 cm

Protection Against Different Types of Ionizing Radiation

Protection Against α-Particles:

- Increasing the distance from the ionizing radiation source (IRS);
- Methods and measures preventing the ingress of beta radiation sources into the body, including the use of personal protective equipment (PPE).

Protection Against β-Radiation:

- Shields made from aluminum sheets several millimeters thick (which fully absorb β-particle flux);
- Methods and measures preventing the ingress of beta radiation sources into the body, including the use of personal protective equipment (PPE).

Protection Against γ-Radiation and X-Rays:

- Increasing the distance between the ionizing radiation source and the workplace;
- Reducing exposure time to the IRS;
- Using materials with high density (such as lead, iron, concrete, etc.) as shielding;
- Providing the population with protective structures (such as radiation shelters, basements, and the like);
- Personal protective equipment (PPE) to protect respiratory organs, skin, and mucous membranes;
- Dosimetric monitoring of the environment and food products.

Work with radionuclides is divided into two types: with sealed and unsealed radioactive sources.

Protection Against Ionizing Radiation from Sealed Sources

Sealed sources are any ionizing radiation sources designed such that radioactive substances cannot contaminate the air within the working area. In contrast, unsealed ionizing radiation sources may cause air contamination.

Therefore, specific requirements have been developed separately for the safe handling of sealed and unsealed ionizing radiation sources in industrial settings (see Figure 69).

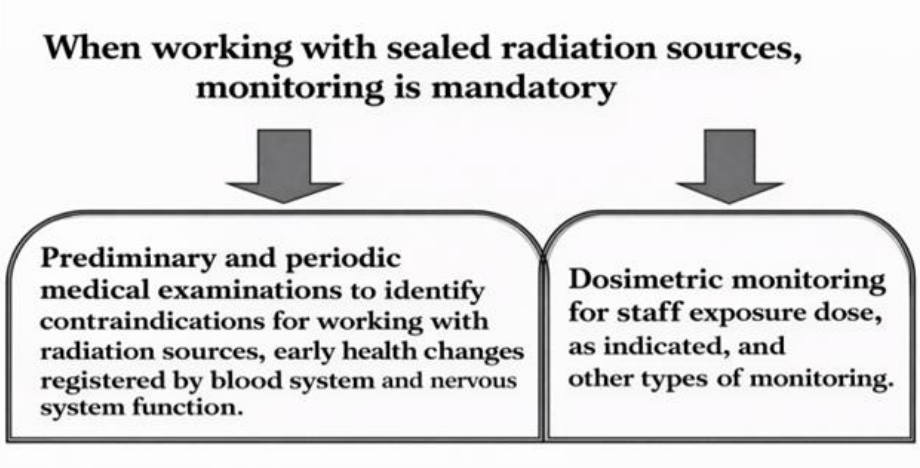


Figure 69. Safety Requirements for Working with Sealed Ionizing Radiation Sources

The reliability of radiation safety is determined by the calculation of the dose of exposure and the absorbed dose, as well as by appropriately selected protective measures. These measures, in turn, depend on the specific working conditions with ionizing radiation sources, the type of source, its activity, and the radiation flux density.

By understanding the law of propagation and the nature of the interaction of ionizing radiation with matter, adequate radiation safety can be ensured. It is well known that the dose of external exposure is proportional to the intensity of radiation and the duration of exposure. Moreover, based on the principles of ensuring radiation safety for sealed sources, the best practices are considered to be:

1. Reduction of the source strength to minimal values, since radiation loses energy when interacting with matter (protection by quantity);
2. Reduction of exposure time (time protection);
3. Increasing the distance between the source and the personnel's workplace, which results in more interactions of radiation with atoms and molecules of the surrounding environment at greater distances, thereby reducing the risk of exposure (distance protection);
4. Use of absorbing materials, with screen thickness depending on the radiation intensity (shielding protection).

Protection Against Unsealed Sources

Protection of personnel takes into account the possibility of both external and internal exposure, considering the potential intake of radioactive substances into the body via respiratory, digestive systems, or through the skin.

Practically the same protective principles (Figure 70) are applied as with sealed sources of radiation. However, particular attention is given to personal behavior requirements, such as prohibitions on smoking and eating in the working area. After work, mandatory decontamination of the skin is required, followed by contamination assessment via dosimetric control of protective clothing, special footwear, and skin.

At enterprises, safety control during work with ionizing radiation sources is conducted by a specialized unit—the Radiation Safety

Service.

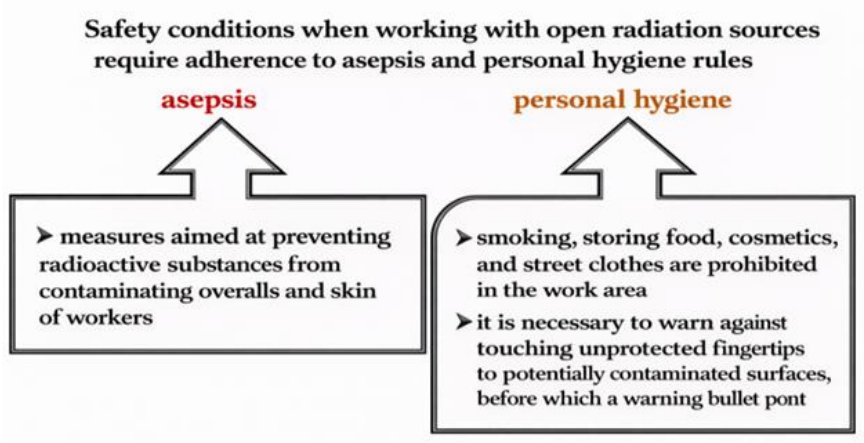


Figure 70. Safety Requirements for Working with Unsealed Ionizing Radiation Sources

Screens may have various designs: stationary, mobile, collapsible, or desktop.

Screens are applied depending on the type of ionizing radiation sources. For example, protection against neutron flux is implemented using three-layered screens:

The first layer consists of concrete, water, paraffin, plastics, or polyethylene.

The second layer consists of boron, graphite, or cadmium.

The third layer consists of concrete and lead.

According to their purpose, screens can be classified as:

1. Containers for storing sources.
2. Protective screens for equipment.
3. Mobile protective screens.
4. Protective screens as parts of building structures.
5. Personal protective equipment (PPE) screens protecting against external exposure such as aprons and gloves used when working with sealed sources.

Decontamination is the removal and neutralization (deactivation) of radioactive substances.

Decontamination from working surfaces, equipment, skin, and PPE can be carried out by:

- Mechanical methods (wiping, removing surface layers, using brushes or vacuum cleaners);
- Chemical methods.

Timely removal is necessary because, over time, the degree of fixation of radioactive substances on the skin increases. Skin can be effectively cleaned using soap and warm water.

PREVENTION OF HARMFUL EFFECTS OF IONIZING RADIATION WHEN WORKING WITH SEALED AND UNSEALED SOURCES

Room planning is carried out based on the principle of zoning, i.e., division into zones depending on the degree of potential radioactive contamination.

Architectural and Planning Measures

Maximum isolation of rooms is achieved through zoning. All rooms are divided into a contaminated (or working) zone and a clean zone.

Department Layout

Between the zones there are screens, a sanitary control point (sanitary checkpoint), and mandatory dosimetric monitoring. The distribution of rooms is planned considering workflow continuity — the movement paths of the sources (storage, packaging, operating rooms, etc.) should not intersect.

Fig. 71. Zoning of Premises for Work with Ionizing Radiation Sources (IRS)

Sanitary Protective Devices

Centralized water supply. Artificial ventilation — air inflow into the operators' zone and exhaust from the sources' zone.

Waste Disposal:

- Collection, temporary storage, and transportation to disposal sites by special transport (removal system);
- Municipal sewage system if waste activity complies with standards; special sewage systems for high-activity waste (which is removed);
- Room planning;
- Painting ceilings and walls with oil-based paint; floors covered with polyvinyl chloride construction materials, laid without joints;
- Rounding of corners in rooms;
- All engineering communications and wiring installed inside walls;
- Windows without frames, sashes, or window sills;
- Shield-type doors.

Layout of the X-ray Room

The purpose of the X-ray room is to examine patients using X-ray equipment. The layout of the radiology department ensures reliable protection of personnel and persons in adjacent rooms from X-ray radiation exposure. The X-ray room is not located above inpatient wards.

Main Structure of the Room:

- Procedure room;
- Control room;
- Photo laboratory;
- Changing room;
- Restroom.

Procedure Room: Designed for conducting examinations. The procedure room houses the equipment (radiation source) for the examination. Equipment is arranged to allow free access to workstations. Adjacent rooms must be shielded from X-ray radiation.

Control Room: The X-ray specialist's workstation is shielded from radiation, with remote control of the X-ray machine (control panel). A viewing window with X-ray protective glass is located between the control room and the procedure room.

Changing Rooms: For patient convenience.

Restroom: Provided near the procedure room where gastrointestinal tract examinations are performed.

Radiology Department

The radiology department is designated for conducting clinical studies of various functional and morphological disorders in organs and systems. It is preferable to locate the radiology department in a separate building or an annex isolated from the main hospital building.

The department includes premises for radioisotope diagnostics, remote radiation therapy, and handling of both sealed and unsealed radiation sources.

Radioisotope Diagnostics Department

Radioisotope diagnostics premises are planned on the first floor of the hospital, with a unidirectional workflow. The composition of rooms depends on the type of radiodiagnostic studies conducted. For scanning — a scanning room; for radiometric studies — a radiometric room.

Rooms are divided into blocks:

I. Radioisotope Support:

- Preparation rooms for radioactive sources;
- Rooms for receiving radiopharmaceuticals;
- Storage;

- Packaging;
- Washing;
- Sanitary-dosimetric airlock;
- Radioactive waste storage.

II. Radiodiagnostic Studies:

- Procedure rooms for intravenous administration of radiopharmaceuticals;
- Scintigraphy procedure rooms;
- Scanning and radiometry rooms (including radiography, radiocardiography, etc.);
- Rooms for radiometric studies of biological media, observation, and waiting areas.

III. Auxiliary Rooms:

- Staff room;
- Room for the head of the department;
- Storage for consumables;
- Staff hygiene room.

Remote Radiation Therapy Department

Consists of procedure rooms intended for therapeutic manipulations, including:

- Remote and intracavitary gamma therapy rooms;
- Remote and contact X-ray therapy rooms, etc.

Procedure rooms are separated by stationary shields for protection during operation of the radiation devices. The department includes a control room, a changing cabin, and a physician's room, with an airlock located between the control and procedure rooms.

Room for Receiving and Temporary Storage of Transport Containers for Radiation Sources

Auxiliary Rooms

Include a dressing room, room for manufacturing shaping devices, phantoms, boluses, and matrices.

Examples of architectural and planning solutions for medical facility rooms using radiation sources are illustrated in Figures 72 and 73.

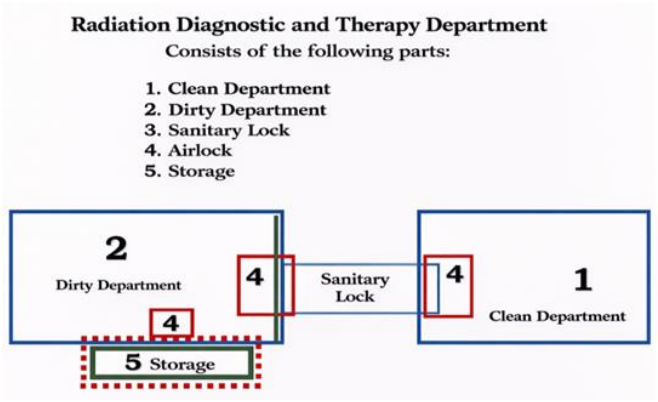


Fig. 72

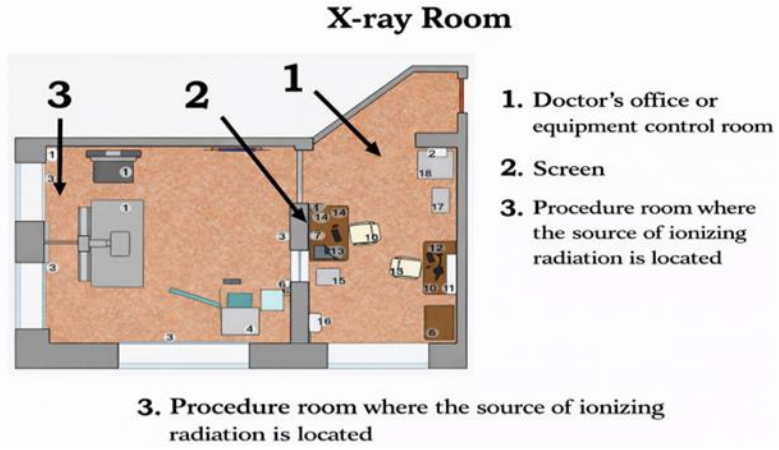


Fig. 73. Layout of the X-ray Room

An essential component of preventive measures when working with ionizing radiation sources (IRS) is the implementation of radiation monitoring, which includes:

- Assessment of the presence of radioactive gases and aerosols in the air of workplace zones within the facility;

- Monitoring the level of individual exposure of personnel in accordance with the nature of the tasks performed (analysis of external exposure, monitoring of radioactive substance content in the body or in specific critical organs);
- Monitoring emissions of radioactive substances into the atmosphere;
- Monitoring the quantity of radioactive substances in wastewater discharged into the sewage system;
- Oversight of the collection, removal, and decontamination of radioactive solid and liquid waste;
- Assessment of contamination levels of environmental objects outside the facility.

DETECTORS OF IONIZING RADIATION

The primary objective in controlling ionizing radiation is to identify the effects of the interaction between ionizing radiation and the sensitive element of the detection device, in which radiation effects manifest as signals convertible into a measurable output on a display device. Examples include weak electrical discharges, light emissions, coloration, thermal effects, and others.

The detection and recording of ionizing radiation is referred to as dosimetry, and the devices used are called dosimeters (Fig. 74).

Modern methods employed in dosimetry include:

- Photographic;
- Ionization;
- Chemical;
- Scintillation;
- Luminescent.

Fig. 74. Dosimetric Instruments.

Photographic Method.

One variant of the chemical method is the photographic method. The basis of this method lies in the reduction of metallic silver atoms from halide salts under the influence of radiation (Fig. 75).

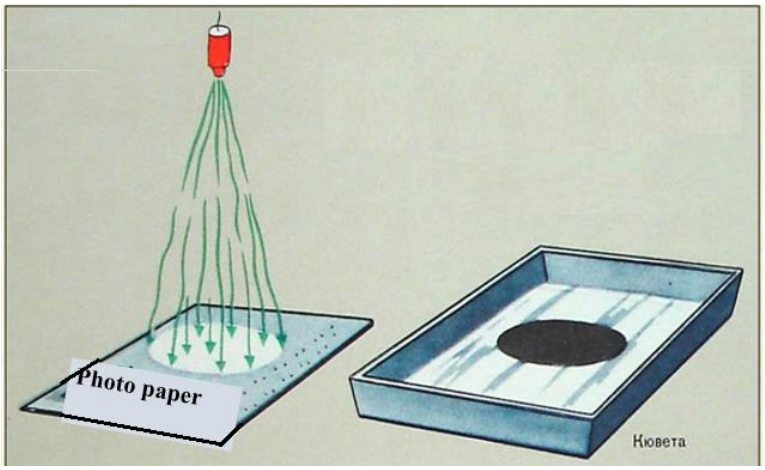


Fig. 75. Photographic Method.

Ionizing radiation affects the photographic material, initiating darkening. The level of film darkening is used to assess the properties of the radiation flux. For example, X-ray film acts as a detector, while the crystals of silver chloride or

silver bromide serve as the sensitive elements. The degree of film darkening is evaluated using densitometers or photometers, and by calculating the measured darkening volume, the radiation dose is determined. The density of the film darkening after development depends on the radiation dose. The Individual Radiation Monitoring System (IRM) is based on this method.

Ionization Method.

This method is based on the fact that ions formed in a gas-filled detector chamber by the action of ionizing radiation create an electrical discharge, which is registered as an ionization current by the device. The magnitude of the current is proportional to the intensity of the ionizing radiation (Fig. 76). Instruments relying on the appearance of ionization current in gases are used to measure particle flux densities. For example, dose rate and dose measurement counters (ionization chambers).

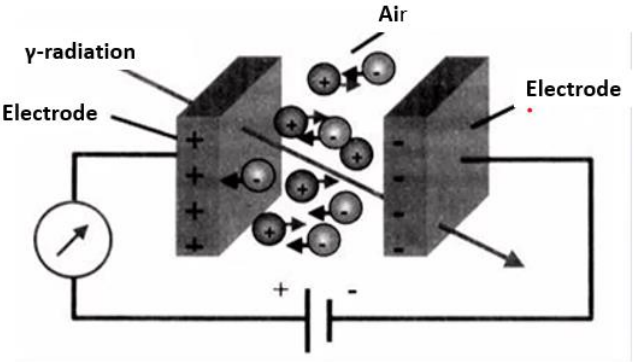


Fig. 76. Ionization Scheme in an Ionization Chamber.

Gas-discharge counters are a type of ionization method. The initially weak ionization is accelerated in an electric field to energies sufficient to repeatedly ionize the gas molecules in the detector. As a result, the number of generated ions increases significantly, making detection much easier.

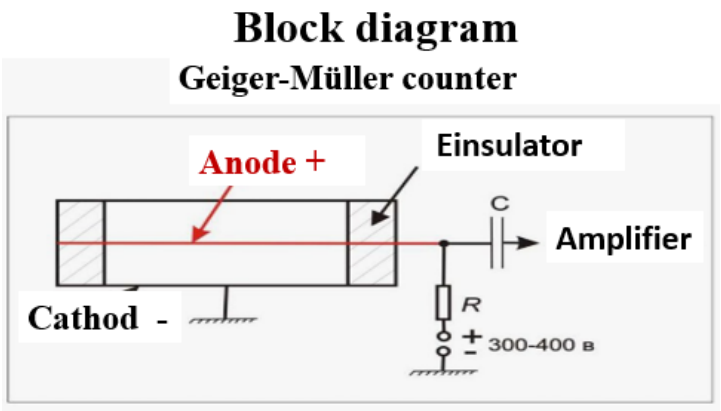


Fig. 77. Diagram of a Gas-Discharge Counter.

This is a Geiger-Müller counter (Fig. 77). It consists of a tube with one electrode formed by the outer wall and the other by a metal wire stretched along the central axis of the tube. The entire volume of the tube is filled with an inert gas (argon, neon), and to reduce avalanche discharge, vapors of ethyl alcohol or chlorine are added. Gas-discharge counters enable the detection of a strong signal, which simplifies the device's circuitry and ensures high sensitivity. The device is compact, making it convenient for use.

Scintillation Methods.

This method is based on detecting flashes of light generated when radiation interacts with certain organic and inorganic substances (anthracene, stilbene, zinc sulfide, etc.) (Fig. 78).

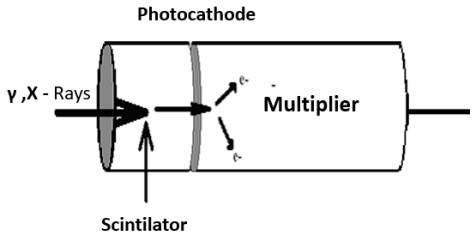


Fig. 78. Diagram of a Dosimeter with a Photomultiplier.

The photomultiplier registers the electrical current (photocurrent) whose magnitude is proportional to the intensity of the ionizing radiation. These

methods are employed in instruments designed for measuring photon and particle fluxes.

Luminescent Method.

The essence of this method lies in the fact that under the influence of ionizing radiation, certain solid-state insulators (crystals) undergo changes in their crystal lattice, which shifts the position of charge carriers. In some regions, charge trapping occurs; quantum transitions take place between certain energy levels, emitting or absorbing energy, resulting in luminescent excitation. This manifests as changes in optical properties or the ability to exhibit radiophotoluminescence—emission of light quanta induced by thermal excitation. The luminescence intensity is proportional to the radiation dose, making this method suitable for dose measurement.

Chemical Methods.

Ionizing radiation induces bursts of radiation-chemical reactions. This method is based on detecting such changes. When radiation acts on water, free radicals H+H^+H+ and OH−OH^-OH− are formed. The radiolysis products interact with dissolved substances, causing redox reactions.The ferrous sulfate dosimeter relies on the reaction:

$$\mathbf{Fe^{2+}+OH^{+}\rightarrow Fe^{3+}+OH^{-}},$$

The nitrate dosimeter operates via

$$\mathbf{NO_3^{-}+2H^{-}\rightarrow NO_2^{-}+H_2O.}$$

Organic solutions that change the color of films or glass are also used in chemical dosimetry. This method is applied for radiation level measurements.

Instruments Used for Radiometric and Dosimetric Control.

Radiation control includes:

1. Assessment of radiation dose received by personnel;
2. Determination of dose rates at workplaces;
3. Use of dosimeters that alert when radiation doses exceed permissible limits.

Instruments for radiometric and dosimetric control are classified into three groups:

1. Devices for individual monitoring and external dose assessment (e.g., S-KID-2, DK-02—ionization principle; IFK-2,3—photochemical principle; thermoluminescent dosimeters such as ILK);
2. Instruments to assess dose rates, including stationary and portable devices such as radiometers and intensimeters (e.g., Argun, RUP-1, Luch-A);
3. Alarm devices—stationary radiometers for monitoring radiation dose rates indoors, equipped with visual or audible alarms when limits are exceeded (e.g., USIT-1, USIT-2, USID-12).

Dosimeters-Radiometers.

These combined devices monitor both radiation dose and dose rate and also detect particle flux intensity on surfaces contaminated by radioactive substances. They are widely used in facilities handling radioactive materials and in emergency situations.

Spectrometers are used to determine the nature of ionizing radiation and estimate its energy.

Indicators are instruments that assist in detecting ionizing radiation (γ- and β-radiation), its levels, and provide approximate dose rate measurements. Such devices often have audible alarms and are convenient for inspecting buildings or conducting radiation reconnaissance.

All radiometric and dosimetric devices consist of a recorder and a detector to identify ionizing radiation presence on a display. Display types may be analog (needle) or digital. These instruments only register readings from the surface or volume where the sensor is located. Modern radiometers and dosimeters commonly employ ionization and scintillation detectors.

Fig. 79. Dose Rate Meter DP-5V.

The X-ray meter DP-5V (Fig. 79) is designed to determine the exposure dose rate of gamma radiation, as well as to detect surface contamination of objects by both gamma and beta radiation. The measurement range extends from 0.05 mR/h to 200 R/h.

Dosimeter DKГ-03Д "Grach" (Fig. 80).

This device is used for assessing the radiation environment. The radiation level is indicated not only by audible clicks, the frequency of which is proportional to the radiation dose rate, but also displayed numerically on the instrument's screen.

Fig. 80. Dosimeter DKG-03D "Grach".

Individual Dosimeter Kit ID-1 (Fig. 81)

Designed to measure absorbed doses of mixed gamma-neutron radiation in the range from 20 to 500 rad (0.2 – 5 Gy).

The kit includes:

- 10 dosimeters ID-1;

- Charger unit ZD-6;
- Carrying case with a stand for 10 slots;
- Technical documentation

Fig. 81. Dosimeter ID-1, (1) Kit DP-22V – 50 Dosimeters DKP-50A(2).

Dosimeter Kit DP-24 (DP-22V)

The DP-24 kit includes 5 dosimeters DKP-50A (Figure 81). This device is used to measure the exposure dose of gamma radiation using directly reading dosimeters DKP-50A. The measurement range of the dose rate is from 0.5 R/h to 200 R/h.

Dosimeter for dose rate measurement DRG 0-1

The dosimeter (Fig. 81) is used to measure the exposure dose rate of both continuous and pulsed X-ray or gamma radiation. It can be used in dosimetric laboratories of research institutions and industrial enterprises. The device is based on the scintillation method for measuring ionizing radiation.

Fig. 82. Dosimeter DRG 0-1, Individual TLD Dosimeter.

Personnel in X-ray radiology departments undergo individual dosimetric monitoring to control radiation doses. Currently, various types of individual dosimeters are widely used for this purpose.

TLD Dosimeter (Thermoluminescent Dosimeters).

The material from which these dosimeters are made (e.g., LiF) can store radiation energy, which is released as light photons when the dosimeter is heated. The intensity of the emitted light is directly proportional to the accumulated radiation dose. TLD dosimeters are small “tablets” or plates (Fig. 81) that are attached to the worker’s protective clothing. Each dosimeter has its own registration number.

IFKU Dosimeter (Improved Individual Photocontrol).

Used for measuring doses of various types of radiation (beta, gamma, X-ray, neutron; see Fig. 83). Photographic film is used to record the radiation.

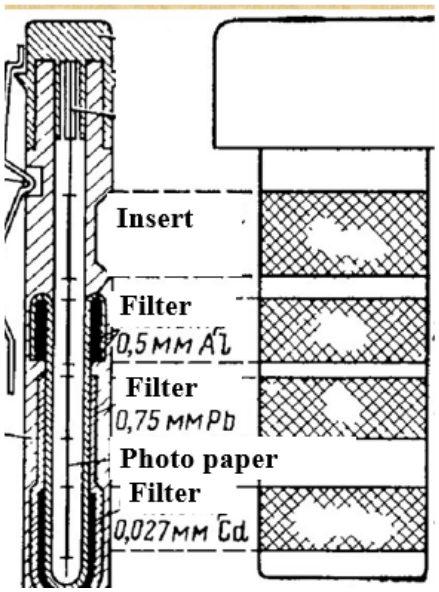


Fig. 83. IFKU Dosimeter

The presence of filters (aluminum, lead) screens different types of radiation, so the degree of darkening of various areas of the photographic film will differ; this allows assessment of the radiation dose.

Radiometric control in medical institutions is conducted when using open sources of ionizing radiation. When using open sources, contamination of radioactive substances on surfaces, workers' hands, clothing, and room air is possible. Under such conditions, there is a danger of incorporated radioactive substances entering the human body (corpus), which means there is a risk of both external and internal exposure.

To prevent internal exposure from incorporated radioactive substances in these departments, in addition to general and individual dosimetric control, it is necessary to monitor the contamination level of the air, work surfaces, hands, and clothing of personnel with radioactive substances. Such monitoring is systematically carried out by the Chief State Sanitary and Epidemiological Service (CGSEN) using radiometers.

All radiometers consist of a detecting and recording part. Geiger-Müller counters or scintillation detectors are used as the detecting part. Portable radiometers such as RUP (Universal Portable Radiometer) or UIM (Universal Medical Meter) are used for radiometric control. However, to ensure safe working conditions, a stationary radiometer-alarm should be installed in the department itself, for example, at the exit of the procedure room.

After completing procedures, the doctor or nurse measures the radiological cleanliness of hands and clothing using a radiometer set to a specified maximum permissible level of radioactive contamination. If this level is exceeded, a light signal (red indicator light) or sound alarm is triggered. In this case, the medical worker must return to the procedure room to repeat hand cleaning or change protective clothing.

Sanitary Examination of Environmental Objects for Radioactive Contamination

Radioactive substances used in medical institutions can contaminate environmental objects (air, clothing, equipment, wastewater), which creates the possibility of radioactive substances entering the human body and causing additional exposure.

Objects using ionizing ionizing radiation sources (IIS) are subjected to radiometric examination. During evaluation, it is necessary to determine the required level of protection for the organization and to carry out decontamination measures for the objects.

The determination of radioactive contamination levels in the environment is carried out according to Sanitary Norms and Regulations. The permissible concentration levels in environmental objects (PC) and permissible surface contamination levels (PSC) are presented in Table 80.

When calculating PC and PSC, the radiotoxicity of isotopes is taken into account, which depends on the isotope's half-life, type of radioactive decay (alpha, beta decay), rate of intake into the body and excretion, distribution within the body, etc. According to radiotoxicity, isotopes are divided into 5 groups (A, B, V, G, D).

Calculations of PC and PSC also consider that contamination of objects can cause both external exposure and internal intake of radioactive substances.

Table 80.

Permissible Concentrations of Certain Radioactive Isotopes

Изотоп	**Допустимая концентрация, Ки/л**	**в атмосферном воздухе**	**в воде**	**в воздухе рабочих помещений**
Натрий-24	4,9·10^12	12	2,8·10^8	1,4·10^10
Фосфор-32	2,4·10^12	12	1,9·10^8	7,2·10^11
Стронций-90	4,0·10^14	14	4,0·10^10	1,2·10^12
Йод-131	1,5·10^13	13	1,0·10^9	4,2·10^12
Радий-226	8,5·10^16	16	5,4·10^11	2,5·10^14
Неизвестные	1,0·10^17	17	3,0·10^11	4,0·10^16

Determination of Radioactive Contamination of Environmental Objects

Radioactivity is measured using instruments (Fig. 84). The samples under study are preliminarily concentrated (by evaporation, drying, incineration, etc.). Subsequently, the activity of the concentrate (ash) is determined on a radiometric setup with mandatory recalculation per unit of mass, volume, or area of the object under investigation.

Fig. 84. Radiometric Control Instrument.

Assignment for Students:

Situational Problems

1. A nurse in the radiology department prepares radiopharmaceuticals (RFP) daily for 1 hour (i.e., 6 hours per week) in a box that attenuates radiation by a factor of 6; the distance from the preparations to the nurse's body is 60 cm (0.6 m). What is the safe quantity of preparations that can be present at the workplace daily?

   Reference solution:

M=48×6×0,626=17 mg-equivalent of radium

2. Daily cleaning of the storage room is required, where radioisotopes with a total activity of 5000 mg-equivalent radium are stored in containers. The containers reduce gamma radiation from the sources by a factor of 100. The average distance from the source to the cleaning staff's body is 70 cm (0.7 m). For how long is cleaning the storage room considered safe?

   Reference solution:

t=48×100×0.725000=0.47 hours or 28 minutes per week, i.e., approximately 5 minutes per dayt

3.In designing a gamma therapy room, both the procedural gamma therapy room and an adjacent control panel room are planned. The radiation source is Co-60 with an activity of 5000 mg-equivalent radium. The wall between the procedural room and the control panel attenuates radiation by a factor of 100. The installation is operated daily for 3 hours, i.e., 18 hours per week. What should be the distance from the source to the control panel to ensure safe working conditions?

Reference solution:

g2=5000×18100×48=18.75 m2;g=4.33 mg

4.It is necessary to install a protective screen made of lead blocks for working 3 hours with a source of Au-198 with an activity of 600 mg-equivalent radium. The work is conducted at arm's length (approximately 70 cm, i.e., 0.7 m). What should be the thickness of the lead blocks for safe operation with the source?

Solution:

a) $k = (600 \times 3) : (48 \times 0{,}7^2) = 76$

b) The radiation energy of Au-198 is 0.412 MeV (see appendix)

c) According to the table, for k=76k = 76k=76 and radiation energy 0.412 MeV, the thickness of lead shielding should be 21 mm.

5. The anode current of the X-ray tube is 1 mA at a voltage of 100 kV. What should be the thickness of the lead protective screen for the radiologist's workplace located 1 m from the X-ray tube?

   Reference solution:

6. $K = I_a : r^2 \times DMD$ ДМД = $1 : 1^2 \times 1{,}4 = 1{,}4$

From the table, for K=1.5K = 1,5 K=1,5 and a voltage of 100 kV, the lead shielding thickness should be 3,2 mm.

SELF-STUDY QUESTIONS

1. In which units is radioactivity measured?
2. What is the nature and properties of β-radiation, including its ionizing and penetrating abilities?

3. What is the nature and properties of α-radiation, including its ionizing and penetrating abilities?
4. What is the nature and properties of X-ray and γ-radiation, including their ionizing and penetrating abilities?
5. Which materials are used for protection against ionizing radiation?
6. Characterize the phenomenon of radioactivity and the cause of nuclear decay.
7. What is radiation safety?
8. What are the main regulatory documents concerning radiation safety for the population of the Republic of Uzbekistan that you know?
9. Provide a characterization of the principles of protection against ionizing radiation.

TEST QUESTIONS.

Food hygiene

1. Daily human protein requirement (in g) per day:
а 15 – 20;
б 30 – 40;
в 50 – 70;
г 80 – 120. *
д 70 – 110
correct answer:4

2. The daily requirement of a person for carbohydrates (in g) per day:
а 50 – 80;
б 150 – 200;
в 350 – 400; *
г 500 – 700.
д 500 - 600
correct answer: 3

3. The ratio of protein, fat and carbohydrates in the diet of people engaged in heavy physical labor:
а 1: 0,8: 3;
б 1 : 1,3 : 6; *

в 1 : 1 : 4;
г 1 : 1 : 5.
д 1: 2 : 7
correct answer: 2

4. The main functional role of water-soluble vitamins:
а Caloric value.
б catalytic; *
в plastic surgery;
г energy system.
д security card
correct answer:2

5. Vitamin " C " is most often found in:
а In cabbage
б ; in carrots;
в in black currant;
г in rosehip. *
д in cucumbers
correct answer:4

6. Beriberi disease occurs when the body lacks the following vitamins:
а B1 (thiamine); *
б PP (nicotinic acid);
в D (calciferol);
г K (phylloquinone).
д B12 (zincobalamin)
correct answer:1

7. Food substances containing vitamins A, D, E, and K:
а Fats. *
б proteins.
в vitamins;
г mineral salts.
д Amino Acids
correct answer:1

8. Product that is the main source of phosphorus:
а Dried apricots, apricots;
б peas and beans.
в fish;
г beef liver, eggs.*
д vegetables
correct answer:4

9. The main biological role of carbohydrates:
а They are a source of energy. *
б they are structural elements of cells and tissues.
в play a protective role.
г they are a source of vitamins.
д I play a role in the formation of hormones
correct answer:1

10. Conditions that contribute to the breakdown of vitamin " C " in foods:
а A natural product.
б acidic environment.
в oxygen; *
г storage in an airtight container.
д Pressure
correct answer:3

Health care facilities ' hygiene

1. Windows, which premises (residential, hospital, educational) are recommended to be oriented south and east?
a. treatment rooms, bathrooms, doctors ' offices.
b. operating rooms, resuscitation rooms.
B. Main living quarters.*
g. hospital wards.*
d. study rooms. *
Correct answer:3,4,5

2. The production process in medical institutions may be associated with the risk of exposure to:
a. x-ray radiation. *
b. unfavorable microclimate.*
b. medicinal products. *
d. forced body position. *
D. using an ECG machine
Correct answer:1,2,3,4

3. What should be the ventilation in infectious diseases departments?
a. mechanical supply air.
b. supply and exhaust system with a predominance of inflow.
b. supply and exhaust system with a predominance of exhaust air.*
d. can be any, depending on the design features of the department building.
D. manual supply air

Correct answer:3

4. List the harmful occupational factors associated with the specifics of the work of medical personnel.

a. overstrain of individual organs and systems.*
b. prolonged forced body position.*
b. uncomfortable working position.*
d. nervous and emotional tension.*
d. vertical body position.
Correct answer:1,2,3,4

5. What are the occupational hazards associated with medical personnel?

but. with the peculiarities of the treatment technology.*
b. with the peculiarities of labor processes.*
b. with violation of the working regime.*
d. with insufficient facilities for doctors and medical staff.
d. with violation of hygienic conditions *
Correct answer:1,2,3,5

6. What occupational diseases of medical personnel are associated with the peculiarities of their work?

a. drug allergy.*
b. diseases of the musculoskeletal system.*
b. diseases of the cardiovascular system.
g. chronic inflammatory diseases of the gastrointestinal tract.
d. overwork.
Correct answer:1,2

7. In open source departments, medical personnel should be protected in the following areas:

but.respiratory and skin protection against radioactive substances.*
b. protection from external radiation.*
b. correct planning decision of the department.*
d. use of personal protective equipment.*
d. isolation of employees
Correct answer:1,2,3,4

8. Standards of illumination of workplaces in classrooms under fluorescent lighting:

a. not less than 100 lux
b. not less than 300 lux*
b. not less than 200 lux
d. not less than 400 lux
D. not less than 500 lux
Correct answer:2

9. Standards of illumination of workplaces in classrooms when using incandescent lamps:
a. not less than 50 lux
b. not less than 250 lux
b. not less than 150 lux *
d. not less than 400 lux
D. not less than 300 lux
Correct answer:3

10. Which hospital construction system is most preferable in the hot climate of Uzbekistan?
a. mixed*
b. centralized, in one multi-storey building.
B. pavilion for each department in a separate building
d. decentralized,
D. local
Correct answer:1

11. What lech.prof. are institutions usually located outside the city limits?
a. psychiatric, bone tuberculosis.*
b. infectious diseases
B. psychiatric and somatic disorders
G.tuberculosis
D. Medical and sanitary unit (MSH).
Correct answer:1

12. Which departments should have a separate admissions office
a. infectious diseases, maternity hospitals, and children's hospitals*
b. pulmonological, infectious diseases
b. surgical, children's, and infectious diseases
d. physical therapy, dental
D. neurological, infectious, oncological
Correct answer:1

13. Distance between building walls.
a. 2.5 m height of the opposing building*
b. 10 m
B.15 m
G.25 m
d. 20 m
Correct answer:1

Water hygiene

1. **What is the significance of water in human life?**
   A. Environmental management
   B. Physiological, epidemic, hygienic (sanitary-hygienic)*
   B. Transport services
   D. Sanitary and hygienic, ecological and health-improving services
   D. Economic, physiological, and transport services
   Correct answer: 2

2. **What diseases can be transmitted through water?**
   A. Typhoid fever*
   B. Typhus
   B. Tularemia*
   D. Hepatitis A*
   D. Hepatitis B
   Correct answer: 1, 3, 4

3. **Для Water-borne epidemics are characterized by:**
   A. Rapid growth of diseases*
   B. Slow decline in the number of diseases after isolation of the focus of infections
   B. Short standing of the curve at a high level*
   D. Association of the disease with the use of water from a particular source*
   D. Rapid decline*
   Correct answer: 1, 3, 4, 5

4. **What conditions contribute to the occurrence of fluorosis?**
   A. Increased fluoride content in water and food*
   B. Increased iodine content in water
   B. Reduced fluoride content in water and food
   D. Reduced iodine content in water and food
   D. Increased iodine content in food
   Correct answer: 1

5. **List the main symptoms of severe fluorosis**
   A. Speckling of enamel
   B. Speckling and cracking of enamel, brittleness of teeth*
   B. Restriction of joint mobility
   D. Plaque on the teeth
   D. Bleeding gums
   Correct answer: 2

6. **What endemic diseases are classified к as biogeochemical?**
   A. Endemic goiter*

B. Fluorosis*
B. Water-nitrate methemoglobinemia
G. Molybdenum gout*
D. Strontium rickets *
Correct answer: 1, 2, 4, 5

7. Specify the cause of water methemoglobinemia
A. increased content of nitro compounds in water*
B. Increased oxidizability of water
B. Reduced content of nitro compounds in water
D. reduced oxidizability of water
D. Increased fluoride content in water
Correct answer: 1

8. List ways to reduce water hunger on Earth
A. Creation of reservoirs*
B. Replenishment of underground water horizons with surface water*
B. Injection of industrial wastewater into deep underground reservoirs
D. Organization of recycled water supply in industrial enterprises*
D. Use of desalination of sea and ocean waters*
Right answer:1, 2, 4, 5

9. What sources of anthropogenic pollution of surface water bodies do you know?
A. Domestic wastewater*
B. Industrial effluents*
B. Storm drains*
G. Geochemical composition of water
D. Shipping*
Correct answer: 1, 2, 3, 5

10.Name indirect indicators of biogenic water pollution in reservoirs
A. Total water salinity
B. Content of ammonium salts, nitrites, and nitrates*
B. Fluorine and iodine concentrations
D. Water oxidizability*
D. Residual chlorine content
Correct answer: 2, 4

11.What is the difference between surface water and interplastic water?
A. Greater mineralization
B. High oxygen content*
B. Greater bacterial contamination*
D. A greater tendency to "bloom" *
D. Low oxygen content

Correct answer: 2, 3, 4

Occupational health and safety

1. **All harmful production factors are divided into:**
   a) Mechanical
   b) Physicalentities*
   c) Chemical*
   d) Biological*
   e) Factors of the labor process that characterize the severity of physical labor and its intensity *
   Correct answer: 2,3,4,5

2. **According to the prevailing effect, industrial poisons are divided into:**
   a) Low-toxic
   b) Neurotoxic and hematotoxic effects*
   c) Hepatotoxic and nephrotoxic effects*
   d) Substances affecting the respiratory system*
   e) Highly toxic
   Correct answer: 2,3,4

3. **According to the evaporation rate, all organic solvents are divided into:**
   a) Gaseous
   b) Highly volatile*
   c) Medium-volatile*
   d)Low-volatile*
   e) Vapors
   Correct answer: 2,3,4

4. **What is noise?**
   a)These are sounds that follow one another and have different intensities
   b) A harmonious combination of sounds
   c) Disharmonious sounds that are more common in the workplace
   d) It is a chaotic combination of sounds*
   e) These are melodic vibrations
   Correct answer: 4

5. **By pitch, sounds are divided into:**
   a) Ultrasounds*
   b) Human-audible sounds*

c)Megazooks
d) Infrasounds*
e) Millisounds
Correct answer: 1,2,4

6. **What does the biological effect of noise depend on?**
a)From amplitude and frequency
b) From the frequency*
c) From the wavelength
d) From the sound pressure level
e) From the noise source
Correct answer: 2

7. **What spectrum groups do industrial noises fall into?**
a) Ultra-high frequency
b) Mid-frequency*
c) High-frequency*
d) Low-frequency*
e)Infra-frequency ones.
Correct answer: 2,3,4

8. **What are the body's systems that are affected by prolonged exposure to noise?**
a)Musculoskeletal system-двигательный аппарат
b) The digestive system*
c) Respiratory system
d) The organ of hearing*
e) Nervous and cardiovascular system*
Correct answer: 2,4,5

9. **What are the main symptoms of "noise sickness"?**
a) Headache and stomach pain, palpitations and pain in the heart area
b) Memory loss, increased fatigue, loss of appetite*
c) Noise causes gastric dysfunction, decreased immunological reactivity*
d) Increased blood pressure, sleep disorders, headaches
e) Headaches, emotional instability, palpitations and pain in the heart, sleep disorders*
Correct answer: 2,3,5

10.In what units is the sound pressure level measured?

a) In Hertz
b) In decibels*
c) In backgrounds
d) In belakh*
e) in minutes
Correct answer: 2,4

11.How is the noise level normalized in production?

a) By overall sound level
b) By sound volume
c) By sound pressure levels in 8 octave bands*
d) By sound pressure level in 6-octave bands
e) by sound tempo
Correct answer: 3

Hygiene of children and adolescents

1. **"The main task of the subject of hygiene for children and adolescents"?**

a) to study the influence of environmental factors on the body of children and adolescents with the development of hygiene standards*
b) study the harmonious development of children and adolescents
c) develop sanitary norms and rules for the harmonious development of children
d) to preserve the health of the younger generation by creating preventive measures
e) study the physical development of children and adolescents
Correct answer: 1

2. **Founder of the Department of General Hygiene in Turkestan?**

a)V. P. Pinegin*
b)S. N. Babadzhanov
c) A. Z. Zakhidov
d) V. Moiseev
e) G. I. Bautin
Correct answer: 1

3. **How many child and adolescent health groups do you know?**

a) 5*
b) 2
c) 3
d) 4

e) 1
Correct answer: 1

4. **What children are included in the 1st health group?**
   a) practically healthy*
   b) healthy, butwith some morpho-functional changes
   c) children with reduced body function
   healthy, butwith some deviations in physical development.
   vitii
   d) children with chronic diseases in the compensation stage
   e) children with chronic diseases at the stage of sub-compensation
   Correct answer: 1

5. **What children are included in the 2nd health group?**
   a) healthy, butwith some morpho-functional changes*
   b) practically healthy
   c) healthy, butwith reduced body resistance
   d) children of normal physical development
   e) children with chronic diseases at the stage of compensation
   Correct answer: 1

6. **What children are included in the 3rd health group?**
   a) with chronic diseases in the compensation stage*
   b) with significant functional changes in the body
   c) healthy, butwith some morpho-functional changes
   d) practically healthy children
   e) with chronic diseases in the stage of subcompensation
   Correct answer: 1

7. **What is the baby's infancy?**
   a) 10 days-1 year*
   b) 1st day-1 year
   c) 7 days to 1 year
   d) from 1 birthday to 1 year
   e) from birth to 2 years of age
   Correct answer: 1

8. **Please indicate current methods for assessing the physical development of children and adolescents?**
   a) regression scale, complex estimation, centile method*
   b) anthropometric, dispensary, statistical analysis
   c) regression scale регрессии, dispensary, questionnaire
   d)sigmal deviation, questionnaire, statistical, complex
   e) anthropometric, соматоскопическийsomatoscopic, somatometric
   Correct answer: 1

9. What group should an overweight child study in?
a) preparatory*
b) the main one
c) special
d) additional information
e) according to the indications of the medical group
Correct answer: 1

10. If the child has chronic hepatitis in the subcompensation stage what health group will you assign him to?
а. in the 4th*
б. in the 1st
в. to the 2nd
г. to the 3rd
д. to the 5th
Correct answer: 1

11. What factor influences the child's body fatigue at school?
а. incorrect organization of the educational process and insufficient
б. class illumination*
в. school hours in 2 shifts
г. early learning
д. number of children in the class
е. long-term work experience
Correct answer: 1

12. Signs of student fatigue?
а. increasing the number of errors*
б. the appearance of a feeling of fatigue
в. reduced appetite and working capacity
г. changes in the autonomic nervous system
д. weakness, гtin pain, гdizziness
Correct answer: 1

13. Incorrect seating at the desk leads to the appearance of?
а. curvature of the spine, нvisual impairment, fatigue*
б. diseases of the gastrointestinal tract, curvature of the spine
в. respiratory diseases
г. diseases of the respiratory system, visual impairment
д. visual impairment, diseases of the cardiovascular system
Correct answer: 1

14. Indicators used to assess the physical development of children by the centile method;

a. height, body weight, chest circumference*
~~а.~~б. posture, height
~~б.~~в. leg shape, age
~~в.~~г. biological development
~~г.~~д. sexual development, age
Correct answer: 1

15.Indicators of physiometry:
a. VEL, muscle strength, deadlift*
б. body weight, height, chest circumference
в. chest circumference and shape, respiratory rate, height ,
г. muscle development
д. secondary sexual characteristics, immune status of the body
Correct answer: 1

16.Basic principles of organization of the educational process
a. age-appropriate mental and physical work возрасту
organization of the educational process, schedules, and changes. *
б. after each quarter-vacation
в. Sunday afternoon should be used for пребывания наoutdoor activities
г. individual approach to students in the organization of the educational process
д. continuous classes with 5-10-minute breaks
Correct answer: 1

17.School building construction system
a. centralized, block-sectional, pavilion*
б. decentralized, mixed
в. mixed or block version
г. pavilion, block, mixed
д. centralized, mixed
Correct answer: 1

18.What are the main measures you know to prevent myopia?
a. Sufficient illumination of the classroom, pcareful organization of the educational process, proper seating of students at the desk*
б. Organization of outdoor activities
в. Good microclimate of the room, sufficient illumination
г. Class 6 m depth,S of the room not less than 50 m2
д. selection of desks based on students ' height
Correct answer: 1

19.Ways to determine body fatigue?
a. chronoreflexometry Anfimov table*
б. chronotremometry, physiometry
в. by heart rate monitor

г. cardiography
д. радиометр Sizyakov radiometer
Correct answer: 1

20.Specify physical education groups?
а. basic, special, preparatory*
б. basic and additional features
в. all answers are incorrect
г. basic, physical imperfection, additional
д. basic, with a lag in physical development (height, weight)
Correct answer: 1

21.Key health indicators for children and adolescents:
а. physical development and morbidity*
б. physical development and performance level
в. morbidity and level of immunological reactivity
г. performance level and overall morbidity
д. general and infectious morbidity
Correct answer: 1

Radiation hygiene

1. Who draws up the radiation safety action plan in clinics and hospitals?
а. administration of polyclinics and hospitals.*
б. chief radiologist-radiologist
в. radiological department of the san. epid station.
г. Ministry of Health
д. project organization.оектная организация.
Correct answer: 1

2. Natural radiation background:
а. cosmic radiation, radiation from natural radioactive elements located in objects of the external environment.*
б. an electron, a photocell, and the phenomenon that occurs during their interaction.
в. radiation from plants, animals, water, and air.
г. radiation from minerals.
д. radiation from multi-storey buildings
Correct answer: 1

3. What is traffic rules?(maximum allowable dose).

a. this is a dose that is absorbed evenly for 50 years, but невызываетdoes not cause changes in the state of health.*
~~а.~~б. such a dose, which is absorbed by the body, does not cause changes.
~~б.~~в. absorbed dose of ionizing radiation.
~~в.~~г. the dose received by a professional in a year.
~~г.~~д. the dose received by the worker during the year.

Correct answer: 1

4. What is the TISS radiometer used for?

а. to measure the level of contamination of the skin of hands and workplaces.*
б. individual dosimeter
в. for measuring the dose of X-ray radiation
г. all answers are correct
д. measurements of individual doses received by the worker.

Correct answer: 1

5. Principles of protection when working with closed RV sources?

а. protection by time, distance, shielding, quantity.*
б. activities: planning, sanitary, technological, use of personal protective equipment.
в. dosimetric and medical monitoring
г. protection using different screens.
д. work in a special laboratory.

Correct answer: 1

6. Open sources radiation

а. radioactive isotopes in the form of powders and solutions*
б. radioactive isotopes with moderate toxicity
в. radioactive isotopes in the form of X-rays and gamma rays
г. radioactive isotopes with a short half-life of average betta radiation activity
д. radioactive isotopes in the form of neutron flux and gamma radiation

Correct answer: 1

7. What is the principle of defining classes for working with open RV?

а. by exposure dose of ionizing radiation*
б. by the number of RV's used in a year
в. relative radio toxicity of isotopes and their MACS at the workplace
г. by types of radioisotope use
д. by annual dosesreceived by workers

Correct answer: 1

8. Screens made to protect against beta radiation

а. aluminum, glass, plastic*
б. concrete
в. water, paraffin
г. lead, iron, and baritone concrete
д. wooden screens

Correct answer: 1

9. How to increase the dose loads of ionizing radiation?
is public exposure related to cancer incidence?

а. увеличивается проявлениеthe stochastic effect of the action increases
~~а.~~б. Radiation sources*
~~б.~~в. the number of os&2 increases
~~в.~~г. the number of chronic radiation injuries is increasing
~~г.~~д. due to the accumulation of radioactive substances in the body
~~д.~~е. the number of malignant neoplasms of the skin increases

Correct answer: 1

10. What material is used to make screens for protection against gamma and R radiation?

а. Cvinets, concrete, cast iron *
б. glass, plastic, aluminum
в. paraffin, graphite, polyethylene
г. water, paraffin
д. glass, wood

Correct answer: 1

11. Radioactive substances are used in the form of:

а. open and closed,*
б. in a combined form,
в. combined form,
г. closed, combined, or closed .
д. not applicable

Correct answer: 1

12. Which part of the lithosphere is characterized by a high content of naturally occurring radioactive elements?

а. rocks*
б. loess soils
в. loamy soils
г. chernozem soils
д. salt marsh

Correct answer: 1

13. What device can be used to determine the level of RV contamination in various areas?
surfaces?

а. with the TISS device *
б. RPN-1 or MRM-2 device
в. sedimentation method or KID-2 device
г. MRM-2 device
д. KID-2 device, IFKU

Correct answer: 1

14. What categories of exposed persons do you know?

а. Category A-personnel who have contact with the AI, category B-individuals from the staff, category C-population*
б. Category A-population, category B-personnel, category
в. B - Individuals from the staff

г. Category A-personnel, category B-individuals from the population, Category C-women under 30 years of age, category D-all
д. category of persons over 30 years of age
е. category of persons working with gamma and X-ray sources
Correct answer: 1

15. What are the long-term consequences of AI?
а. all answers are correct*
б. chronic radiation sickness, hair loss, skin peeling
в. leukemia, malignant neoplasms, cataracts
г. reduced life expectancy, radiation burns
д. all answers are incorrect
Correct answer: 1

16. What is the frequency of conducting medical examinations of those working with AI and the composition of the medical commission?
а. 1 time a year: therapist, neurologist, obstetrician-gynecologist*
б. 2 times a year: radiologist, dosimetrist, optometrist
в. monthly: dermatologist, gynecologist, optometrist
г. quarterly2
д. all answers are correct
Correct answer: 1

17. Protection principles when working with open DPS
а. planning measures, sealing of equipment,
б. use of special sanitary devices, individual*
в. protective equipment, personal hygiene
г. time, distance and shielding protection
д. dosimetric and medical monitoring
е. protection with different screens
ж. working in a special laboratory
Correct answer: 1

18. What does the biological effect of radiation on the body depend on?
а. depending on the absorbed dose, time of exposure, type of radiation*
б. from the category of exposed persons
в. depending on the absorbed dose, immunological status and age
г. depends on the amount of exposure dose and the state of the body
д. from a group of critical organs
Correct answer: 1

19. What biological chains do RV consistently follow? into the human body?
а. atmosphere-soil-plants-animals-people*
б. plant-soil-products-man.
в. human-soil-plant-food products
г. man-water-animal-soil.
д. water-plant-soil-man.
Correct answer: 1

20. Receiving part of MRM-2

а. spherical ionization chamber*
б. condenser ionization chamber
в. cassette
г. remote blocks
д. scintillation prefix

Correct answer: 1

21. The type of radiation with the lowest penetrating power

а. alpha radiation*
б. beta radiation
в. gamma radiation
г. neutron radiation
д. x-ray radiation

Correct answer: 1

22. Permissible exposure limit Ifor group I critical organs of category A persons

а. 5.0 rem / year*
б. 1.5 rem / year
в. 0.1 rem / year
г. 15 rem/ year
д. 0.5 rem / year

Correct answer: 1

Air hygiene

1. **Optimal temperature in residential areas in temperate climates:**
   a. 16-18 degrees
   b. 18-20 degrees*
   c. 20-22 degrees
   d 22-24 degrees
   D 24-26 degrees

   Correct answer: 2
2. **Heating is considered optimal:**
   but. furnace
   b. fireplace room
   central vodiane
   town central steam
   village panel view*

   Correct answer: 5
3. **Increased indoor air temperature negatively affects:**
   a. the digestive system*
   b. thermoregulation system*
   B. cardiovascular system*
   d. water-salt metabolism*
   d. musculoskeletal system

Correct answer: 1,2,3,4

4. **Low air temperatures may cause the following violations:**
   a. peripheral nervous system*
   b. thermoregulation, reducing heat
   transfer c. thermoregulation, increasing heat transfer*
   G. spring system*
   D. in the form of myositis, neuritis, and so on.*

   Correct answer:
   1,3,4,5

5. **For a hygienic assessment of room heating, it is necessary to carry out:**
   but. thermometry*
   b. B. psychrometry.
   anemometry
   of g. catathermometry
   D. barometry

   Correct answer: 1

6. **What type of heating is not recommended for residential buildings and children's institutions:**
   a. pechnoye
   b. fireplace room
   vodiane
   city Steam*
   d. radiant

   Correct answer: 4

7. **The value of a comfortable room temperature is affected by:**
   but. geographical latitude
   b. climate zone*
   B. physical properties of air
   g. characteristics of the building
   d. the degree of hardening of the body

   Correct answer: 2

8. **Standard indoor air temperature indicators depend on the climate zone because:**
   a. humans belong to homoyothermic biological species
   b. the degree of pigmentation of the skin determines the heat
   exchange in. the height above sea level
   varies. relative humidity affects heat
   exchange. radiative heat loss prevails*

   Correct answer: 5

9. **The thermal comfort of a person in a room depends on:**
   but. the nature of work*
   b. the level of illumination
   c. Age*
   year. Constitutions*
   d. heating efficiency*

Correct answer: 1,3,4,5

10. **What is the predominant heat transfer path in terms of thermal comfort in humans:**
    a. conduction
    b. convection
    in. Radiation*
    G. perspiration
    D. conduction, convection and perspiration

Correct answer: 3

11. **Prevention of overheating of the body is carried out by:**
    a. rational clothing and footwear*
    b. rational ventilation system*
    c. a rational work and rest regime*
    d. a rational drinking regime*
    d. increased muscle activity

Correct answer: 1,2,3,4

12. **Recommended types of heating in residential areas:**
    a. convector*
    b. vodiane*
    V. parovoe
    g. Air*
    d. radiant (panel)*

Correct answer: 1,2,4,5

13. **Medical (mercury) thermometer belongs to the following types:**
    a. ordinary
    b. maximum I. minimum*
    V. electrothermometer
    G. thermograph

Correct answer: 2

14. **Optimal relative humidity in residential areas:**
    a. 30-40%
    b. 30-60%*
    c. 40-50%
    d. 50-60%
    d. 60-70%

Correct answer: 2

15. **The relative humidity indicator is of physiological importance, not absolute, because:**
    a. relative humidity affects heat exchange, but absolute humidity does not
    b. absolute humidity is not an objective indicator
    c. relative humidity shows the percentage of air saturation with water vapor*
    d. barometric pressure does not affect the absolute, but changes the relative humidity indicator
    D. air humidity is determined relative to the speed of air movement

Correct answer: 3

16. **Microclimate conditions that cause the body to become supercooled faster:**
but. high humidity and high temperature
b. low humidity and high temperature
in. high humidity and low temperature*
d. low temperature and low humidity
d. high humidity and low atmospheric pressure

Correct answer: 3

LITERATURE

1. Iskandarov Sh.T., Khasanova M.I., Inagamova V.V., Ikramova M.I. *Guide to Practical Exercises in General Hygiene*. Tashkent, 2013.
2. Voronina N.V. *Hygiene. Educational-Methodical Complex.* Tashkent, 2023. – 146 p. Hygienic Classification of Working Conditions by Indicators of Harmfulness and Danger of Industrial Environmental Factors, Severity, and Intensity of the Labor Process. SanPiN RUz № 0141-03.
3. Hygienic Standards for Food Safety. SanPiN RUz № 0366-19.
4. Hygienic Requirements for the Safety of Toys (Games) for Children. SanPiN № 0354-18.
5. Hygienic Requirements for Food Safety. SanPiN RUz № 0283-10.
6. Hygienic Requirements for Educational Publications for General Secondary, Secondary Specialized, and Professional Education. SanPiN № 0359-18 / Sadyvakasov A.U.
7. Hygienic Requirements for the Organization of Full and Safe Nutrition in Preschool Educational Institutions of the Republic of Uzbekistan. SanPiN RUz № 0348-17.
8. Law “On Radiation Safety” № 120-II dated 31.08.2000.
9. Radiation Safety Standards NRB 2006 and Main Sanitary Rules for Ensuring Radiation Safety. SanPiN 0193-06.
10. Approval of Sanitary-Hygienic Requirements for Public Catering Enterprises. Resolution of the Service for Sanitary-Epidemiological

Welfare and Public Health of the Republic of Uzbekistan, № 14 dated 14.07.2022.

11. Definition and Assessment of Noise and Vibration Hazards in Working Conditions. SanPiN RUz № 0175-04.
12. Presidential Decree of the Republic of Uzbekistan № PP-4887 dated 10.11.2020 “On Additional Measures to Ensure Healthy Nutrition of the Population.”
13. Prevention of Nosocomial Infections. SanPiN № 0342-17.
14. Sanitary-Epidemiological Requirements for Conditions and Organization of Education in General Education Schools. SanPiN № 0341-16.
15. Sanitary-Hygienic Requirements for Maintenance, Arrangement, and Organization of the Regime of Work in Preschool Educational Institutions of the Republic of Uzbekistan. SanPiN № 0355-18.
16. Sanitary-Epidemiological Requirements for the Organization of Nutrition for Students in General Education Schools and Institutions of Secondary Specialized Professional Education. SanPiN RUz № 0288-10.
17. Sanitary Norms for Safety and Nutritional Value of Food Raw Materials and Food Products (with Supplement № 4). SanPiN RUz № 0138-03.
18. Sanitary Norms for Permissible Noise Levels at Workplaces. SanPiN RUz № 0325-16.
19. Sanitary Norms for General and Local Vibration at Workplaces. SanPiN RUz № 0122-01.
20. Sanitary Rules and Norms for Designing, Construction, and Operation of Medical and Preventive Institutions. SanPiN № 0020-22.
21. Sanitary Rules and Norms for Collection, Storage, and Disposal of Waste in Medical and Preventive Institutions of the Republic. SanPiN № 0317-1.
22. Sanitary Rules for the Arrangement, Equipment, Maintenance, and Operation of Computer Classrooms in Educational Institutions of the Republic of Uzbekistan. SanPiN № 0359-18.

23. Skurihin I.M. et al. (eds.) *Chemical Composition of Food Products. Vol. 1: Reference Tables of the Content of Major Nutrients and Energy Value of Food Products*. Moscow, 1987.
24. Physiological Norms of Nutrient and Energy Requirements by Gender, Age, and Professional Groups of the Population of the Republic of Uzbekistan for Maintaining Healthy Nutrition. SanPiN RUz № 0347-17.