МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ
КАФЕДРА НОРМАЛЬНОЙ ФИЗИОЛОГИИ

ЧАСТНАЯ ФИЗИОЛОГИЯ СЕРДЕЧНО-СОСУДИСТОЙ, ДЫХАТЕЛЬНОЙ И ПИЩЕВАРИТЕЛЬНОЙ СИСТЕМ И ВЫСШАЯ НЕРВНАЯ ДЕЯТЕЛЬНОСТЬ

SPECIAL PHYSIOLOGY OF CARDIOVASCULAR, RESPIRATORY AND DIGESTIVE SYSTEMS AND HIGHER NERVOUS ACTIVITY

Практикум для студентов, обучающихся по специальности «Стоматология»

Под редакцией Ю. В. Гайкович, В. А. Переверзева

Минск БГМУ 2024

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Ч-25

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ISBN 978-985-21-1600-8.

Представлены вопросы к практическим и итоговым занятиям по разделам курса физиологии: физиология кровообращения, физиология дыхания, физиология пищеварения и высшая нервная деятельность. Даны описания практических работ и протоколы их выполнения, необходимая дополнительная информация по темам занятий. Приведены задания для самостоятельной работы студентов, справочная информация.

Предназначен для студентов 2-го курса медицинского факультета иностранных учащихся, обучающихся по специальности «Стоматология» на английском языке.

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Online learning system: https://etest.bsmu.by/ → For English Medium Students → Dentistry → Normal Physiology (dent)

A list of examination questions can be found on the e-test in the "EXAM" section. The department reviews examination questions annually and upload them on the e-test at least two weeks before the exam.

№	TOPIC	Defended	Organization
PHYSIOLOGY OF CIRCULATION			III term (autumn): Practical classes — 17 (51 hours) Lectures — 10 (15 hours) The autumn term includes 2 colloquiums: – Session 25; – Session 31. **Session 35** is the final session of discipline course when you have to get the permission to exam.
Session 19	Hemodynamics. The main indices of the circulatory system. Microcirculation		
Session 20	Physiological properties and features of heart muscle		
Session 21	Cardiac cycle. Methods of heart function analysis		
Session 22	Regulation of the heart function. Mechanism of regulation of systemic arterial blood pressure		
PHYSIOLOGY OF RESPIRATION			
Session 23	External respiration. Gas exchange in the lungs and tissues		
Session 24	Transport of gases. Regulation of respiration		
Session 25	Colloquium. Concluding session on the sections "Physiology of circulation" and "Physiology of respiration"		
PHYSIOLOGY OF DIGESTION			
Session 26	Nutritional motivations. Digestion in oral cavity and in stomach		
Session 27	The role of liver in digestion. Digestion in the small and large intestines		
ENERGY BALANCE AND METABOLISM. PRINCIPLES OF HEALTHY NUTRITION			
Session 28	Energy balance and metabolism. Principles of healthy nutrition		
THERMOREGULATION			
Session 29	Physiology of thermoregulation		
PHYSIOLOGY OF EXCRETION			
Session 30	Physiology of excretion		
Session 31	Colloquium. Concluding session on the sections "Physiology of digestion", "Energy balance and metabolism. Principles of healthy nutrition", "Thermoregulation", "Physiology of excretion"		
PHYSIOLOGY OF SENSORY SYSTEMS			
Session 32	General physiology of sensory systems. Physiology of the visual system		

№	TOPIC	Defended	Organization
Session 33	Special physiology of sensory systems. Sensory function of mucous membranes and structural formations of the oral cavity		
INTEGRATIVE BRAIN ACTIVITY			
Session 34	Integrative functions of the brain. Innate and acquired adaptive forms of behavior. Memory		
Session 35	Physiological bases of psychological activity		

To get the permission for the exam, the following requirements have to be completed. Only lecturer can fill in this page.

In absence of this page you are NOT allowed to pass the exam until the reason is clarified!!!

Eligibility requirements	Execution status
The credit test was passed with positive mark in the spring term	
All of the absences (lectures and practical sessions) were reworked	
Each control test (35 total) was done	
The colloquiums were passed with positive mark in the autumn term	
The practical book for autumn term is completely done and defended	

Permission for the exam is given to _____

(Lecturers fill the name of student by themselves)

Permission for the exam is approved by _____

(Lecturer's name, signature, date)

Total rating for the both terms: _____

SECTION
"PHYSIOLOGY OF CIRCULATION"

SESSION 19 (1). HEMODYNAMICS. THE MAIN INDICIES OF THE CIRCULATORY SYSTEM. MICROCIRCULATION

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:	**LITERATURE**
1. General plan of circulatory system. 2. Hemodynamics. Functional classification of vessels. Factors that ensure the blood movement through the vessels. 3. The basic law of hemodynamics: the relationship between blood pressure, volume blood flow and peripheral resistance to blood flow. 4. Volume and linear blood flow in various parts of the vascular system, factors determining them. 5. The main properties of blood flow (blood pressure, blood flow velocity, resistance) in the arterial, microcirculatory and venous parts of the vascular system. 6. Blood pressure, its types and role. 7. Blood pressure in various parts of the vascular system. Factors determining the value of blood pressure (BP). 8. The concept of normal values of BP. 9. Capillary blood flow and its properties. Microcirculation and its role. Mechanisms of fluid and other substances exchange between blood and tissues. 10. Microcirculation in the oral cavity tissues. 11. Lymph formation, functions of lymph.	***Main*** 1. Lecture & E-learning materials. 2. *Moroz, V. M*. Physiology : Textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 293–376. ***Additional*** 1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 19. 2. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013. P. 462–471. 3. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021. 4. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 19.1. Safety Rules for Practical Lessons in the Disciple "Normal Physiology"

The teaching program at the Department of Normal Physiology envisages practical works performed by the students, mastering their practical skills of operating some electric devices, computer techniques, research equipment, laboratory dishes, chemical reagents and biological fluids.

In addition, students may be allowed to do research work in the laboratories of the Department during their out-of-classes hours.

General requirements:

1. The student should put on a lab coat (medical gown) before entering an academic room.
2. To assign the student on duty.

A student on duty should:

– observe the order, rules and requirements of safety provisions while working in practical rooms;

– receive the practical rooms key and various materials necessary for carrying out practical works — in the laboratory room **№ 131 (*103 temporary*)**;

– at the end of practical classes — switch off the water and lights and return the received materials into room **№ 131 (*103 temporary*)**.

Safety rules in operating electrical equipment.

Cases of electric trauma and fires may occur while working with electric equipment. They may be caused by:

– working with defective electric equipment (switches, sockets, etc.);

– absence of electric appliances grounding;

– breaking rule of operating electric devices;

– touching current-carrying elements with hands and metal objects.

In case of revealing a defect of the electric device or electric equipment it is necessary to inform the teacher about it.

While operating the electric equipment and electric devices it is strictly forbidden to:

– check the presence of electric voltage with fingers and touch current-carrying parts;

– operate ungrounded electric equipment and devices if not allowed by the device instruction;

– use defected electric equipment and electric wiring;

– leave an electric circuit under tension without supervision.

General rules of giving the first aid.

The first aid to victims should be given immediately and properly. It may affect the life, consequences of injuries, burns and poisonings. You'll get acquainted with specific rules of rendering it at clinical departments.

In case of serious injuries, burns due to electric trauma an ambulance should be called in (telephone number 103). If the injuries are mild, the victims should be given the first aid and directed to a medical care institution. It should be kept in mind that rendering aid to a person under electric current you shouldn't touch him with bare hands. First of all, the setting (device), which the victim touches, should be switched off or you should separate the victim from current-carrying parts using sticks, boards and other dry objects not conducting electric current or cut off wires by an axe with a dry axe handle.

*In all cases, you must call the duty laboratory assistant, who is in the room **№ 103** or a lecturer of the Department.*

Actions taken in case of fire.

In case of fire one should immediately switch off the power, call in the assistance (**room 103**) or lecturer and start extinguishing the fire. There are fire extinguishers in rooms **104**, **135** and **138**. For extinguishing the fire one can also use available fire hoses: unreel the hose and open the hydrant. The fire hydrants with hoses are at the end of the corridor next to room **136**, in the niche between rooms **139** and **140**, **133** and **132**, and opposite room **104**.

Directions for recording the Protocol:

After the completion of safety rules studying it is necessary to put your name and signature in the "Safety Register for students" in the computer class, room 104.

PROTOCOL

I have read and have been instructed by safety rules:

_____	_____	_____
Date	Student's signature	Student's name (completely and legibly)

<table>
<tr><td colspan="2">Work 19.2. TERMINOLOGY</td></tr>
<tr><td>Hemodynamics — _____</td><td>Blood pressure — _____</td></tr>
<tr><td>Factors ensuring the blood flow: _____</td><td>Pulse pressure — _____</td></tr>
<tr><td rowspan="2">Functional classification of blood vessels:
1) _____; 2) _____;
3) _____; 4) _____;
5) _____; 6) _____</td><td>Stroke volume — _____</td></tr>
<tr><td>Cardiac output — _____</td></tr>
<tr><td>Normal values of arterial pulse:</td><td>Normal values of BP: systolic — _____, diastolic — _____</td></tr>
<tr><td>Sphygmogram — _____</td><td>Microcirculation — _____</td></tr>
<tr><td>Anacrota — _____</td><td>Functions of lymphatic system: 1) _____;
2) _____; 3) _____</td></tr>
<tr><td>Dicrotic notch — _____</td><td>Lymph consists of: 1) _____; 2) _____;
3) _____; 4) _____; 5) _____</td></tr>
<tr><td>Self-check questions:
1. In what organs and tissues is the organ blood flow at rest proportional to their metabolic needs and where is it higher? Why?
2. How do you calculate mean hemodynamic pressure and pulse blood pressure? Indicate the normal values of them.
3. List the factors determining blood pressure.
4. Indicate the normal values of systolic and diastolic blood pressure.
5. What factors do the pulse filling and pulse tension depend on?
6. In what way deep inspiration and expiration do affect the venous return to the heart?
7. In what way will venous return change after veins' constriction or dilation? In what way will it affect stroke volume (SV)?
8. What is the basic reason of age-related systolic blood pressure increase?</td><td>9. What is the difference between the concepts of "pulse rate", "pulse wave propagation velocity" and "linear blood flow velocity"?
10. What kind of transport through a capillary wall is characteristic of O_2, CO_2, water, hydrophilic low-molecular substances; lipids; proteins?
11. Hydrostatic blood pressure in a capillary is 30 mm Hg, hydrostatic pressure of interstitial fluid is 2 mm Hg, colloid osmotic blood pressure is 25 mm Hg, colloid osmotic pressure of interstitial fluid is 2 mm Hg. Calculate the resulting pressure difference for filtration (or reabsorption) of fluid in the capillary.
12. List main factors that may result in interstitial edema.
13. What are the features and properties of the lymphatic capillaries?</td></tr>
</table>

Work 19.3. Arterial Pulse Examination Using the Palpation Method

Arterial pulse is a rhythmic artery wall oscillation due to the ejection of the systolic volume of blood from the heart into the arteries and changes of pressure there during the systole and diastole.

Accomplishment. Grasp the hand of the examined in the area of his wrist with your right hand so that your thumb is located on the back of the arm, and the rest of them — on its frontal lateral surface. Having felt the radial artery, press it with your three fingers to the underlying bone until you feel the pulse under your fingers. Assess the pulse by the following factors:

1. **Pulse rhythm**. It is determined by the duration of intervals between pulse waves. In a healthy person pulse waves follow one after the other at about regular intervals.

In norm there may occur ***respiratory arrhythmia*** when pulse increases on inspiration and decreases on expiration. Respiratory arrhythmia occurs more often in young people and persons with unstable autonomic nervous system.

2. **Pulse rate.** Pulse beats are counted during 20–30 sec and then calculated for 60 sec (1 min). The pulse rate at rest may vary in the range 60–90 beats/min. The increase of pulse rate over 90 beats/min is called *tachycardia*; its decrease under 60 beats/min is *bradycardia*.

3. **Pulse filling** (amplitude) is a subjective factor evaluated by the height of arterial wall elevation during palpation of pulse wave passing. Pulse filling depends on the *systolic blood volume, elasticity* of arterial walls and *circulating blood volume***.**

4. **Pulse tension** is a subjectively estimated factor assessed by the force of pressing sufficient for ceasing of pulsation distally from the site of pressure. Pulse tension depends on the *systolic arterial pressure* level. In normal BP pulse tension is assessed as moderate. The higher is the pressure the more difficult is to cease pulsation by pressing the artery, and in high BP the pulse becomes tense or hard. In low BP the artery is pressed easily, and the pulse is assessed as soft.

5. **Pulse wave velocity** is a subjective factor assessed by palpating the velocity of reaching the maximum oscillation amplitude by the arterial wall. The pulse velocity depends on the velocity of pressure increase in the arterial system during the systole that in turn depends on the *pulse pressure, stroke volume* and *artery resistance*. If during the systole a large volume of blood is ejected into the aorta and the pressure there increases rapidly, the maximum amplitude of artery extension is reached sooner. Such pulse is called rapid and occurs in insufficiency of aortal valves. When the pressure increases slowly, slow pulse is determined during the systole in the arterial system, and it is observed in stenosis of the artery.

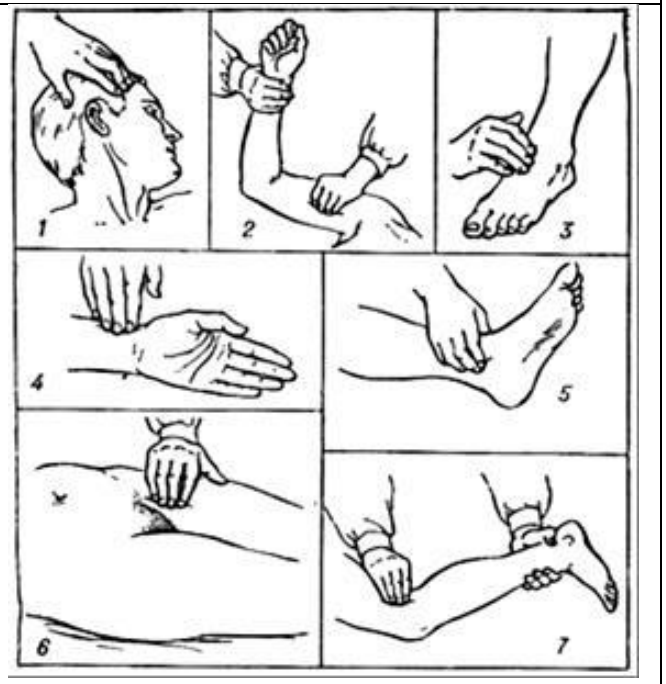


Fig. 19.1

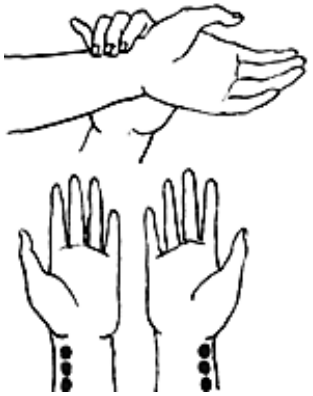


Fig. 19.2

Materials and equipment: a stop-watch.

Directions for recording the protocol:

1. Fill in the Table 19.1 with your pulse examination results.
2. Find minimum, maximum pulse rate and calculate pulse rate mean values for the students of your group.
3. Compare the results with the norm.

PROTOCOL

Table 19.1

Pulse property	Norm	Deviation variants	Obtained data
Rhythm	Rhythmic	Arhythmic	
Rate	60–90	infrequent (bradycardia, < 60), frequent (tachycardia, > 90)	
Filling	Good	Weak, thready pulse	
Tension	Moderate	Soft pulse, hard pulse	
Velocity	Normal	Rapid pulse, slow pulse	

Pulse rate in the group: minimum _____, maximum _____.

Conclusion: _____

Work 19.4. Arterial Pulse Assessment by Sphygmogram Analysis

Sphygmogram is a pulse tracing produced by a sphygmograph. A curve occurs on the tracing with each contraction.

Open the computer program on the main screen «**07_Heart Sounds**» → «**General Tutorials**» → «**Hemodynamics**» → «**Normal Left Heart Pressures and the Carotid Pulse**». Pay attention to the time relationships of the first and the second heart sounds and the basic elements of sphygmogram: *anacrota, catacrota, incisura and dicrotic notch.*

Fig. 19.3

Directions for recording the protocol:

1. Indicate *anacrota, catacrota, incisura and dicrotic notch* on the sphygmogram (Fig. 19.3).
2. Fill in the gaps in the text below related to the sphygmogram.

PROTOCOL

1. Blood pressure increases in the aorta and carotid artery. These changes are observed on the sphygmogram as _____.
2. The appearance of a dicrotic notch on the sphygmogram is caused by _____
_____

Work 19.5. Measurement of Arterial Blood Pressure in Humans by the Korotkov's Method

Blood pressure is an important indicator of the cardiovascular system state. Blood pressure measurements in humans can be performed by using various methods: auscultatory (Latin auscultatio — listening) **Korotkov's method**, oscillographic, ultrasound method etc.

Materials and equipment: Aneroid sphygmomanometer with a cuff for adults (130 × 270 mm), a phonendoscope, antiseptic.

Progress of work

Wipe the phonendoscope with antiseptic. To obtain reliable and reproducible BP values, BP measurement standards must be strictly adhered to:

– Explain the measurement procedure to the subject (patient) and take the measurement in a quiet room at a comfortable temperature after **a 5-minute rest**. In case of active physical or emotional load BP can be measured not earlier than after half an hour. Exclude food, caffeine (tea, coffee, cola, etc.) or smoking within half an hour. Timing of vasoactive medications should be considered. Avoid talking during the measurement.

– The tested person is usually seated in a chair, leaning back in a comfortable posture, hand resting loosely on the table with palm up, legs relaxed and not crossed, the bladder should be emptied;

– The tonometer cuff and phonendoscope head must not be placed on clothing. The rolled-up sleeve must not squeeze the shoulder tissue (Fig. 19.4);

– The size of the cuff should correspond to the size of the arm. The rubber balloon in the cuff should cover **at least 80 %** of the circumference of the upper arm.

– The lower edge of the cuff should be **2–3 cm higher** of the ulnar pit.

– The pulsing brachial artery to the site of its projection; the phonendoscope head is applied to the site of its projection.

– In the cuff the pressure is created by ~**30 mm Hg** higher than the expected pressure in the artery.

Performing blood pressure measurement:

– close the valve of the bulb and rapidly pressurize air until the pressure is about 30 mm Hg higher than the expected pressure in the artery, at which time the pulse on the radial artery should disappear; smoothly reduce the pressure at a rate of about 2 mm Hg per second and listen for vascular tones in the brachial artery, without the subject seeing the manometer scale;

– record the value at the appearance of the first Korotkoff tone — **the systolic pressure**;

– record the value the end of the loud last Korotkoff tone — **the diastolic pressure**.

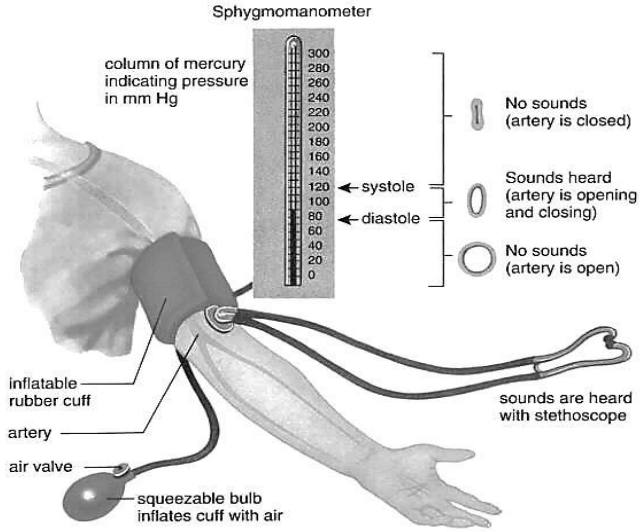


Fig. 19.4

Table 19.2

The normal values of arterial blood pressure in an adult person at rest

Normal	**100–139**	**60–89**
Category	**Pressure values (mm Hg)**	
	systolic	**diastolic**
High normal	130–139	85–89
Normal	120–129	80–84
Optimal	100–119	60–79

PROTOCOL

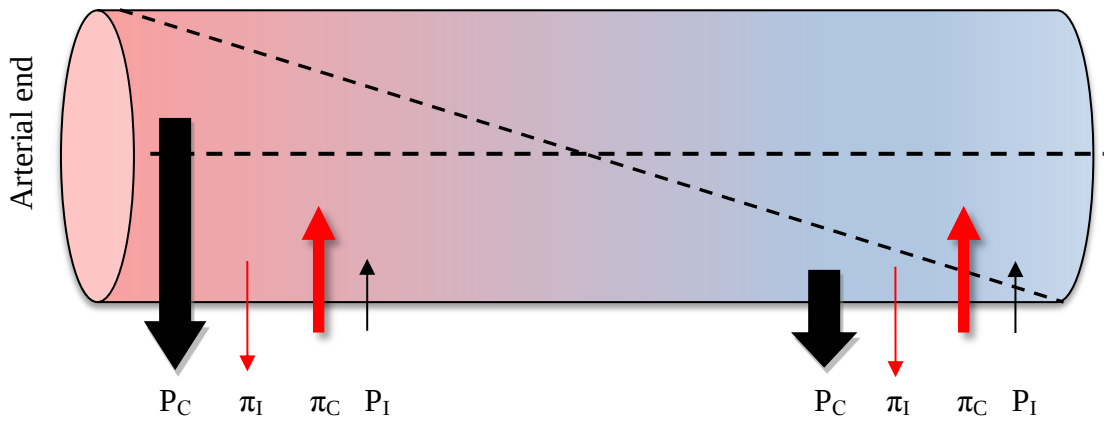
BP on the right hand	BP on the left hand
BPsys = _____ mmHg	BPsys = _____ mmHg
BPdia = _____ mmHg	BPdia = _____ mmHg

Conclusion: the blood pressure of the tested person has _____

(normal, hypotension — low BP, hypertension — high BP)

Work 19.6. STUDYING THE BLOOD FLOW IN MICROVASCULAR BED (MICROCURCULATION)

Using the e-learning materials & lectures, fill in the boxes.



NFP = Net Filtration Pressure

NFP = (_____ + _____) – (_____ + _____)
filtration reabsorption

P_C — hydrostatic pressure _____ (↑↓, ~constant) along the capillary

art: _____ mm Hg

ven: _____ mm Hg

π_I — oncotic pressure of interstitial fluid = _____ mm Hg

π_C — oncotic pressure _____ (↑↓, ~constant) along the capillary = _____ mm Hg

P_I — hydrostatic pressure of interstitial fluid = _____ mm Hg

1. The blood flow in arterioles is _____ than in venules.
2. Fill in the normal values:
Average liner blood flow in capillaries:_____;
Blood pressure in arterioles:_____;
Pressure in arteriole end of capillary:_____;
Pressure in venous end of capillary: _____;
Blood pressure in venules and veins: _____.
3. Write down the mechanism by which molecules and substances cross the vessel wall:

O_2 – _____
CO_2 – _____
H_2O – _____
glucose – _____
proteins – _____

THE PRACTICAL WORKS ARE DEFENDED

_____
Lecturer's signature

SESSION 20 (2). PHYSIOLOGICAL PROPERTIES AND FEATURES OF HEART MUSCLE

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. Functions of atria, ventricles and heart valves. The direction of blood flow in the heart.
2. Peculiarities of heart metabolism and blood supply at a relative rest and at exercise. The coronary blood supply.
3. The structure and functions of the heart conducting system. Structure, physiological properties and functions. Propagation of excitation through the heart conducting system. Automaticity gradient.
4. Mechanism of the heart automaticity. Action potential of pacemaker cells, its phases and ion mechanisms.
5. Contractile myocardium. Structure, physiologic properties and functions. Action potential of contractile myocardium cells, its phases and ion mechanisms.
6. Excitation-contraction coupling, the role of Ca^{2+} ions. Transmission of excitation through a contractile heart muscle cells.
7. Times relationships of excitation, excitability and contraction of myocardium. The concept of extrasystole.
8. Laws of the heart muscle contraction. The concepts of pre- and afterload.

LITERATURE

Main

1. Lecture & E-learning materials.
2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz [et al.] ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnitsia : Nova Knyha, 2016. P. 293–376.

Additional

1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 20.
2. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013. P. 471–486.
3. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
4. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 20.1. TERMINOLOGY

Sinus node (sinoatrial node — SA) — _____

Pacemaker cell — _____

AV node delay — _____

Contractile myocardium — _____

Self-check questions:

1. What substances are used by the heart muscle as substrates for oxidation at rest and at exercise?
2. Why does the heart muscle response to the stimulation according to "all-or-none" law? What is functional syncytium?
3. Why is the excitation from atria conducted to ventricles only through the atrioventricular node?
4. What phase of action potential of the conducting system cells underlies heart automaticity?

MAIN PROPERTIES OF HEART MUSCLE

Excitability, contractility, automaticity, conductivity

The excitation wave: Sinus node → atrioventricular node → His bundle → His bundle branches → Purkinje fibers → Contractile myocardium

Work 20.2. STUDYING THE HEART AUTOMATICITY AND IMPACT OF DIFFERENT SUBSTANCES

Heart automaticity is ability of the heart to generate electric impulses causing its contraction. It happens due to the work of autorhythmic or pacemaker cells. Depolarizations of the autorhythmic cells spread rapidly to adjacent contractile cells through gap junctions.

The ability to automaticity decreases along the conducting system from sinoatrial node (SA) to Purkinje fibers. SA node serves as the main pacemaker of the heart. The depolarization wave then spreads rapidly through a specialized conducting system of non-contractile autorhythmic fibers.

Progress of work

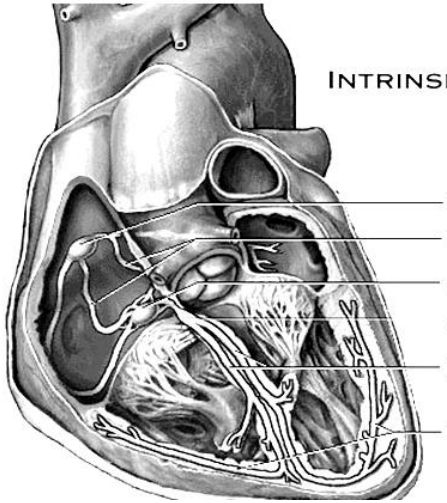
1. Attentively watch the video "Stannius Ligature on Frog's Heart".
2. Analyze the heart contraction in different ligature placements.
3. Make a conclusion based on video.

PROTOCOL

Results: After applying the Stannius ligature we observed _____
_____

Conclusion (localization of the main heart pacemaker): _____
_____

Fill in the boxes.



Frequency of AP

Answer the questions:

1) How the heart work will change if there is no connection between sinoatrial and atrioventricular node? _____
_____

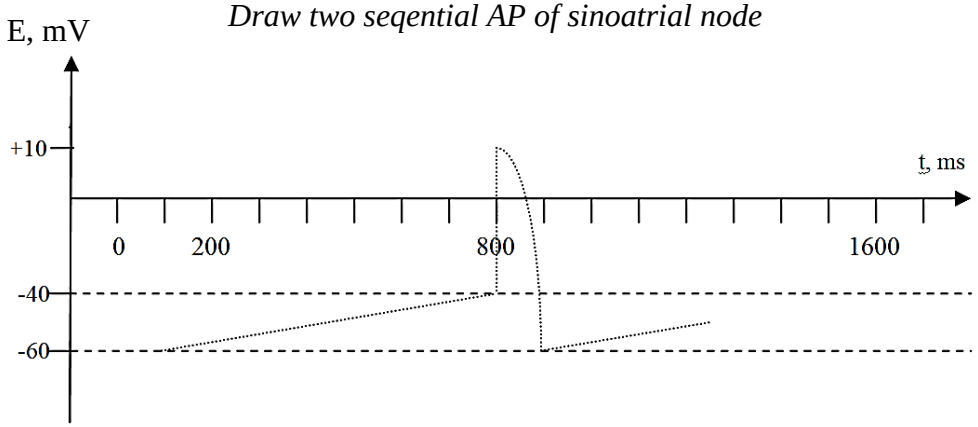
2) How the heart work will change if the bundle of His will be the main pacemaker of the heart? what if Purkinje fibers? _____
_____
_____
_____

Work 20.3. MECHANISMS OF ACTION POTENTIAL GENERATION OF SINOATRIAL NODE AND CONTRACTILE MYOCARDIUM

Based on E-learning materials, lectures, book and program **"8_12Lead"**:
Calculate the duration of cardiac cycle (DCC) with heart rate (HR) = 75 in minute:

DCC_{SA} = 60 / HR = _____ / _____ = _____ sec = _____ ms;

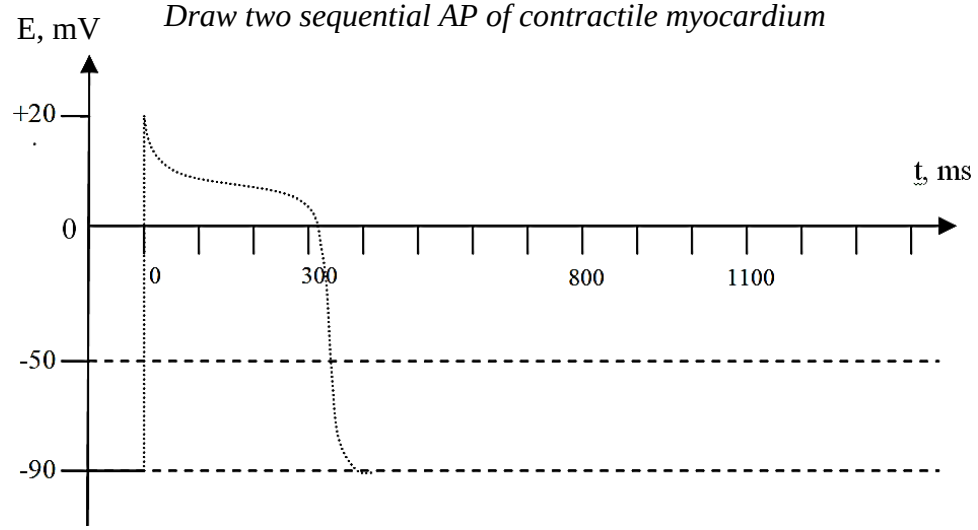
Draw two seqential AP of sinoatrial node



Ion mechanism of AP of SA-node

phase 4		gradual ____ (↑↓) of membrane permeability for ____ ions and increase for _____ ions
phase 0		influx flow of ____ and ____ ions through _____ channels
phase 3		closure of _____ channels and _____ (↑↓) of membrane permeability for _____ ions, flow of _____ ions _____ the cell

Draw two sequential AP of contractile myocardium



Ion mechanism of AP of contractile myocardium

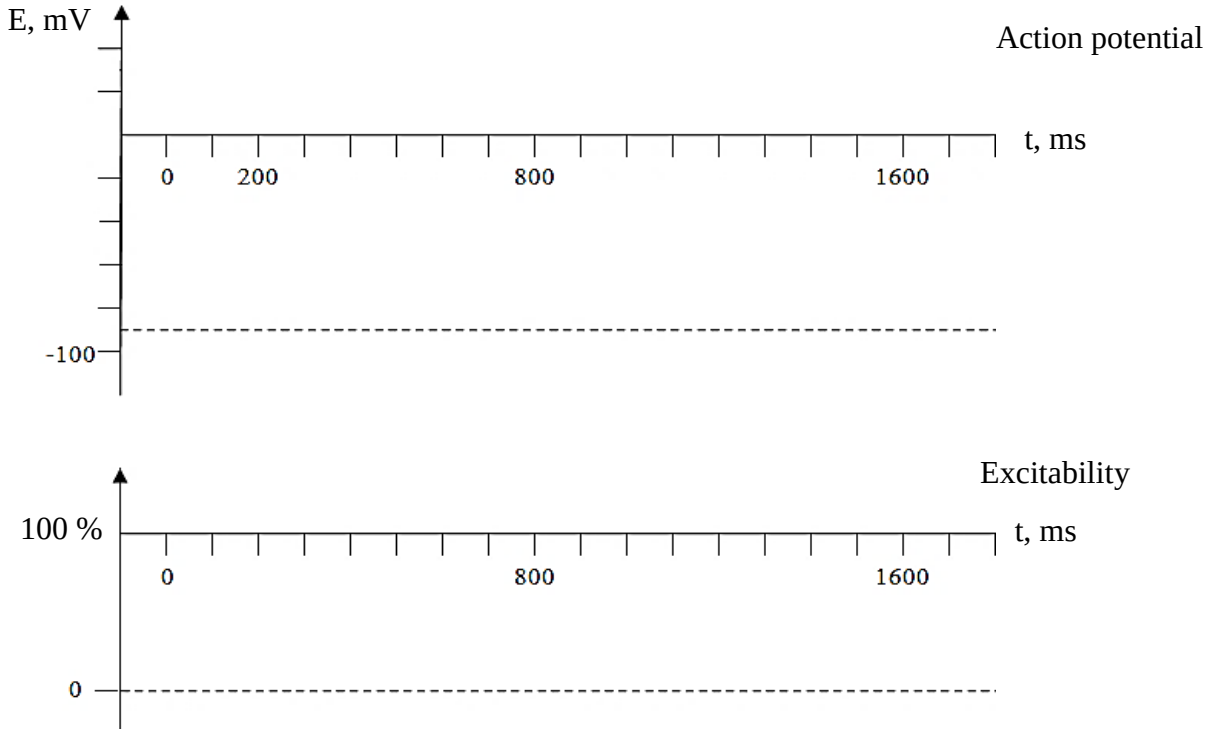
phase 0		mostly influx flow of _____ ions through _____ voltage-gated channels
phase 1		influx flow of _____ ions stops, outflux of _____ ions is prevailed, slowly increased influx flow of _____ ions
phase 2		outflux flow of _____ ions and influx flow of _____ ions is balanced
phase 3		inactivation of channels for _____, outflux of _____ ions is prevailed
phase 4 corresponds to the _____		

Work 20.4. STUDYING THE CHANGES OF EXCITABILITY DURING AP OF CONTRACTILE MYOCARDIUM

The refractory period is the time following an action potential during which a normal stimulus cannot trigger a second action potential. In cardiac muscle, the long action potential means the refractory period and the contraction end almost simultaneously. By the time a second action potential can take place, the myocardial cell has almost completely relaxed.

Progress of work

1. Draw synchronized recording of action potential of typical cardyomyocytes and changes of its excitability.
2. Indicate phases of action potential and changes of excitability.



Conclusion: the long refractory period helps to prevent tetanus in heart muscle. It is important because cardiac must _____ between contraction so the _____ *(atria/ventricles)* can fill with blood.

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SESSION 21 (3). CARDIAC CYCLE. METHODS OF HEART FUNCTION ANALYSIS

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. Cardiac cycle. Sequence of phases and periods of the cardiac cycle, their characteristic.
2. Position of valves, changes in pressure and blood volume in the heart chambers in different phases of the cardiac cycle.
3. Comparison of pump function of left and right atria.
4. Electrical activity of the heart. Electrocardiography (ECG). Origins of ECG components.
5. Plan of analysis and criteria of normal ECG data in II standard lead (duration of P, Q, R, S waves, PQ interval, QRS complex, ST segment). Evaluation of rhythm.
6. Modern methods of ECG analysis. Determination of extrasystoles (premature ventricular contractions).
7. Heart sounds, their origin. Principles of phonocardiography (PCG).
8. Polycardiography, synchronized recording of ECG and PCG.

LITERATURE

Main

1. Lecture & E-learning materials.
2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 293–376.

Additional

1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 21.
2. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013. P. 486–495.
3. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
4. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 21.1. TERMINOLOGY

Cardiac cycle — _____
_____

Electrocardiography (ECG) — _____
_____

End systolic volume _____ ml
End diastolic volume _____ ml
Stroke volume _____ ml

Einthoven's triangle — _____
_____

Ventricular pressures	Left ventricle	Right ventricle
End-systolic pressure	_____ mm Hg	_____ mm Hg
End-diastolic pressure	_____ mm Hg	_____ mm Hg

Standard 12 leads of ECG:
1) bipolar _____ leads;
2) augmented (unipolar) _____ leads;
3) chest leads _____ leads.

Work 21.2. Analysis of Cardiac Cycle at Rest and after Physical Activity

Each **cardiac cycle** has two phases: *diastole*, the time during which cardiac muscle relaxes, and *systole*, the time during which the muscle contracts. Because the atria and ventricles do not contract and relax at the same time, we discuss atrial and ventricular events separately.

Blood flows from an area of higher pressure to one of lower pressure, and contraction increases pressure while relaxation decreases pressure.

Progress of work

1. Using e-learning materials, lectures, textbook fill in the boxes in Fig. 21.1.
2. Make a conclusion.

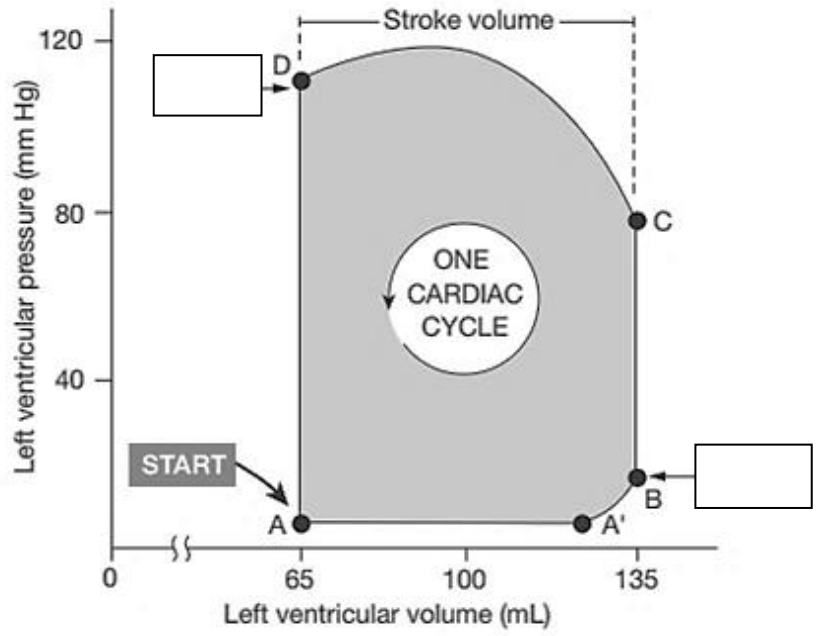


Fig. 21.1. One cardiac cycle

PROTOCOL

1. Fill in the table.

Table 21.1

Cardiac cycle

A`B	presystole, _____ sound
B	_____ valve is _____ *(closed/opened)*, _____ sound
BC	isovolumic _____ phase
C	_____ valve is _____ *(closed/opened)*
CD	isovolumic _____ phase
D	_____ valve is _____ *(closed/opened)*
DA	passive _____ and atrial _____
A	_____ valve is _____ *(closed/opened)*
AA`	_____ period, _____ sound

2. Calculate the duration of cardiac cycle based on arterial pulse measurement:
1) at rest;
2) after physical activity (make 10 squats).

DCC = 60 / arterial pulse rate

	Arterial pulse rate	Duration of cardiac cycle
At rest		
After physcial activity		

3. **Conclusion:** duration of one cardiac cycle equals _____ sec. After physical activity, the arterial pulse rate _____ (*increases/decreases*), so cardiac cycle becomes _____ (*shorter/longer*).

Work 21.3. RECORDING AND ANALYSIS OF ELECTROCARDIOGRAPHY (CALIBRATION, SPEED MOTION OF PAPER, HEART RATE)

Electrocardiogram is method showing the summed electrical activity generated by all cells of the heart. ECG records electric potential difference generated by electric field of heart during excitation. An ECG is recorded from one lead at a time. One electrode acts as the positive electrode of a lead, and a second electrode acts as the negative electrode of the lead.

Materials and equipment: electrocardiograph, antiseptic solution, gauze balls, electrically conductive paste or 3–5 % solution of NaCl.

Progress of work

1. Prepare the electrocardiograph console to work in accordance with the attached instructions.

2. During ECG recording the tested person has to be in lying position. To ensure better contact between electrodes and skin, it is needed to:

– degrease skin with antiseptic solution on skin surface for electrodes application;

– use soap solution on skin surface for electrodes application in case of high hairiness;

– put electrically conductive paste on electrodes to reduce the resistance between electrode and skin surface;

3. Apply electrodes on limbs based on standard colorful marking: **right hand — red; left hand — yellow; left leg — green; right leg — black (grounding electrode).** It helps to record *three standard lead (I, II, III)* and *three pseudounipolar leads (aVR, aVL, aVF).*

4. *Six unipolar leads* are formed while applying chest electrodes:

– V_1 and V_2 — fourth intercostal space;

– V_3 — midway between V_2 and V_4;

– V_4 — fifth intercostal space along left midclavicular line;

– V_5 and V_6 — at the level of V_4 on the anterior and middle left axillary lines.

5. Record the ECG in 12 standard leads. Record the calibration signal (1 mV = 10 mm). Standard paper speed reaches 50 or 25 mm/sec.

Draw ECG and indicate waves, segments and intervals.

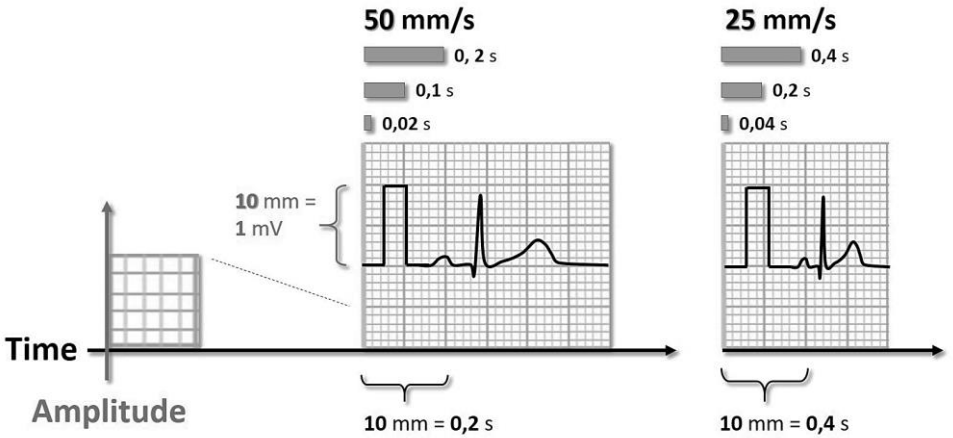


Fig. 21.2. Calibration signal amplitude & speed motion of paper

Work 21.3. RECORDING AND ANALYSIS OF ELECTROCARDIOGRAPHY (ECG) (CONTINUATION)

Instructions for recording the protocol:

1. Analyze the ECG recording in the II lead. **Remember! The sample has to be chosen by your lecturer!**
2. ECG analysis begins with an assessment of the correctness of its recording:
1. The presence of interference (if it is significant, then it is necessary to re-record the ECG)
2. Calibration signal amplitude (mV 1 = 10 mm, the allowed deviation ± 1 mm)
3. Speed (V) motion of paper during ECG registration.

RULE: 1 cell (1 mm) is ALWAYS equal to 0.1 mV

3. Make a conclusion based on obtained results.

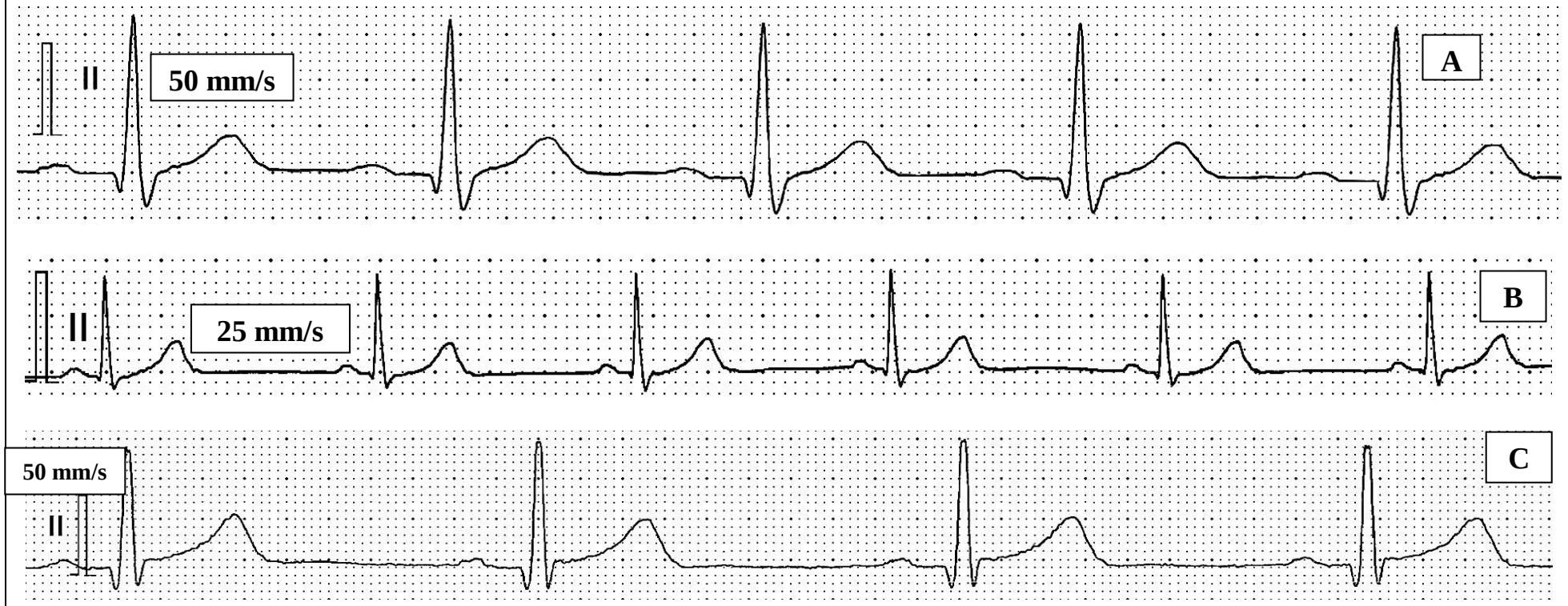


Fig. 21.3. Samples of ECG

Work 21.3. RECORDING AND ANALYSIS OF ELECTROCARDIOGRAPHY (ECG) (CONTINUATION)

1. Determination of origin heart rhythm

Sinus rhythm is observed in normal healthy organism of adult. It may be indicated based on **positive P waves** on ECG that have the same **shape** and preceding **before** QRS complexes. Duration of PQ intervals have to be the same and lasts ***0.12–0.20*** seconds.

identify the presence of P waves on ECG: _____;

describe their direction _____; duration of PQ _____ sec;

Conclusion: rhythm is _____

2. Determination of heart rate (HR)

Evaluation of HR is based on measurement of average RR interval that is consistent with duration of cardiac cycle (DCC). To calculate HR in correct rhythm, it is needed to 60 sec (1 min) divide by duration of RR (sec):

HR = 60 : DCC = 60 : RR (seconds)

HR in a healthy person at rest is ***60–90 beats*** per minute.

Calculate HR based on average RR duration and make a conclusion.

HR = 60 : _____ = _____ in 1 minute

Conclusion: _____

3. Determination of the nature of rhythm

Measure the length of 5–6 sequentially registered RR intervals. If the duration of these intervals are equal to or differences of adjacent intervals do not exceed 10 %, the rhythm is referred to as correct. Healthy young people have sinus respiratory arrhythmia, in which there is a periodic gradual shortening of the RR intervals on inspiration and lengthening of the interval RR on exhalation.

RR_1 = _____ sec; RR_2 = _____ sec; RR_5 = _____ sec;

RR_3 = _____ sec; RR_4 = _____ sec; RR_6 = _____ sec.

Conclusion: nature of the rhythm is _____ (*correct/incorrect*)

4. Analysis of conductivity

The sign of heart conductivity disturbance is an increase in the duration of ECG elements. To analyze heart conductivity, it is needed to calculate:

– duration of **wave P**, which identifies the time of excitation conduction through atria (***0.06–0.10 sec***)

– duration of **PQ interval** — the time of excitation conduction along atria, atrioventricular node, His bundle *[time of excitation conduction form atria to ventricles]* (***0.12–0.20 sec)***

– total duration of ventricular complex QRS [time of excitation conduction along ventricles] ***(0.06–0.1 sec)***.

Calculate the duration of wave P _____

PQ interval _____

QRS complex _____

Compare results with normal values and make a conclusion.

Conclusion: conductivity is _____ (*impaired or not*).

5. Evaluation of waves direction on ECG in II lead

waves _____ point upwards (positive)

waves _____ point downward (negative)

waves _____ are absent

6. Analysis of ST segment

ST segment deviation from the isoelectric line (baseline) is one of the main signs of myocardial ischemia. ST segment deviation upward (elevation) or downward (depression) does not exceed 1 mm.

Conclusion: ST segment deviation from the baseline is _____ mm. Signs of myocardial ischemia are _____ *(absent/presented).*

7. General conclusion on ECG results analysis

Rhythm is _____, _____, HR is _____ in min, conductivity is _____, signs of ischemia are _____.

Work 21.4. RECORDING AND ANALYSIS OF PHONOCARDIOGRAPHY (PCG)

Phonocardiography (PCG) — method of graphic recording of sounds (tones and noises) arising from the work of the heart.

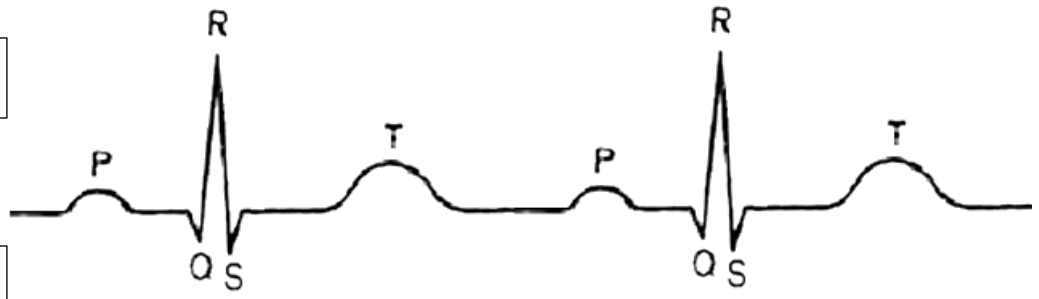
Progress of work

To record PCG, the room has to be isolated from any possible noise. PCG is recorded on one of the electrocardiograph channels using a microphone and phonocardiographic attachment synchronously with one of the ECG leads. The microphone is fixed on the chest of a patient in the area of apical tremor.

Instructions for recording the protocol:

1. Draw synchronous recording of ECG and PCG.
2. Make a conclusion about heart sounds.

ECG



PCG

Analysis of PCG:

1. Sounds are identified: _____, murmurs are identified: _____.
2. The origin of first heart sound (S1) is _____, its duration: _____ sec.
3. The origin of second heart sound (S2) is _____, its duration: _____ sec.

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

ADDITIONAL MATERIALS

Echocardiography is a method of studying morphological structures of the heart and vessels, changes in their linear dimensions in dynamics, allowing calculating the rate of these changes, including estimation of volumes of heart cavities in different phases of the cardiac cycle, as well as parameters of blood flow in heart cavities and vessels. Echocardiography is the most common method that allows reliable assessment of myocardial contractility.

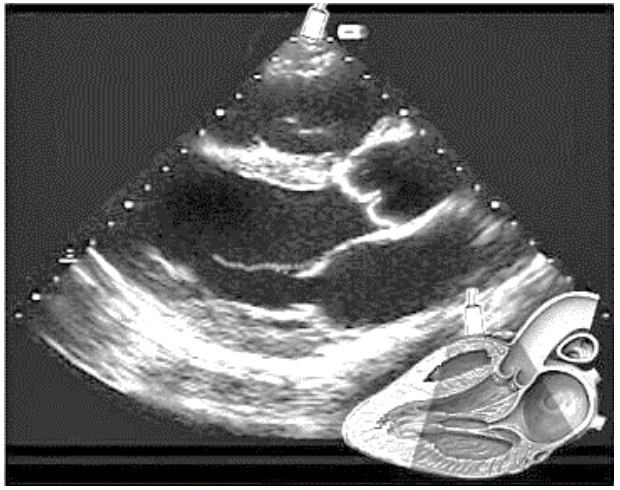
Echocardiographic examination is performed by means of short series of ultrasound waves sent by the transducer of the device, part of which, reflecting from the structures of the human body at different depths, returns in the opposite direction, is captured by the receiver of the transducer and processed in the form of electrical signals, forming an image of the heart structures (as well as colored blood flows in it — in Doppler modes of research) on the display of the device.

Echocardiographic study is carried out by sending a probe inside the body in certain areas, generated short series of ultrasonic waves by the device. Part of the ultrasonic waves passing through the body tissues is partially absorbed by them and reflected waves (e.g., from the surfaces of myocardium and blood, valves, and walls of blood vessels and blood wall) extend in the opposite direction to the body surface, and are captured by sensor receiver and converted into electrical signals. After computer analysis of these signals on the display screen, ultrasound image of the dynamics of processes taking place in the heart during the cardiac cycle is formed. According to the result of calculation of the distance between the working surface of the sensor and the surfaces of different tissues or density changes, a lot of visual and digital echocardiographic indicators of heart can be acquired.

Demonstration is performed using the computer program "**Heart Sounds**".

Open: ***Heart Sounds → General Tutorials → Introduction to Cardiac Imaging Modalities →Transthoracic Echocardiogram.*** The video image that appears shows a dynamic image of changes in the thickness of the interventricular septum, ventricular cavities, and the position of the mitral and aortic valve flaps on the left (B-mode). Press the "Labels" and "Play" buttons alternately to study the ultrasound image of the listed heart structures. On the image on the right (M-mode), analyze the changes in the thickness of the interventricular septum during systole and diastole of the heart.

Pay attention to the character of movements of the anterior and posterior mitral valve leaflets, note the smaller amplitude of movements of the posterior mitral valve leaflet and the opposite direction of these movements in comparison with the movements of the anterior leaflet.



SESSION 22 (4). REGULATION OF THE HEART FUNCTION. MECHANISMS OF REGULATION OF SYSTEMIC ARTERIAL BLOOD PRESSURE

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. The most important indices of the heart function (HR, SV, and contractility). Cardiac output, blood pressure and organ blood flow dependence on the heart function.
2. Intracardiac and extracardiac mechanisms of heart function regulation. Tone of nervous centers regulating heart function.
3. Humoral mechanisms of heart regulation: the effects of catecholamines, angiotensin II, electrolytes and metabolites.
4. Self-regulation of heart activity. Stroke and minute blood volume, their dependence on venous return value (Starling's law) and vascular resistance (Anrep's effect).
5. Humoral mechanisms of heart regulation: the influence of catecholamines, angiotensin II, electrolytes and metabolites.
6. Reflex regulation of cardiac activity. Characterization of the influence of parasympathetic and sympathetic parts of the autonomic nervous system and their chemical mediators on heart activity. Reflex changes in the heart activity, including during medical manipulations in the oral cavity.
7. Vascular tone, its types. Reflex regulation of vascular tone. Vasomotor center, its afferent and efferent connections.
8. Humoral regulation of blood circulation. Vasoconstricting and vasodilating endogenous substances.
9. Local mechanisms of blood circulation regulation. Influence of metabolic, myogenic mechanisms and factors secreted by the endothelium on the smooth muscle cells of the vascular wall.
10. Functional system maintaining the regulation of systemic arterial pressure. Physiological mechanisms of maintaining relative constancy of blood BP.

LITERATURE

Main

1. Lecture & E-learning materials.
2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 293–376.

Additional

1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 22.
2. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
3. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 22.1. TERMINOLOGY

Frank-Starling law — _____ _____	*Sympathetic* stimulation of pacemaker results in _____ heart rate. The catecholamines norepinephrine (from _____) and epinephrine (from _____) increase ion flow through both I_f and Ca^{2+} channels.
Anrep's effect — _____ _____	The *parasympathetic* neurotransmitter _____ slows heart rate. It activates _____ cholinergic receptors that change K^+ and Ca^{2+} flow in the pacemaker cell.

Work 22.2. Effect of Sympathetic and Parasympathetic Parts of ANS and its Neurotransmitters on Heart function

Using E-learning materials, lectures & textbook, fill in the Table 22.1.

Table 22.1

Heart innervation by ANS

Parasympathetic innervation	Sympathetic innervation
1. Localization of preganglionic neuron: _____	1. Localization of preganglionic neuron: _____
2. Neurotransmitter of preganglionic fibers: _____	2. Neurotransmitter of preganglionic fibers: _____
3. Type of receptors on membrane of ganglionic neuron: _____	3. Type of receptors on membrane of ganglionic neuron: _____
4. Neurotransmitter of postganglionic fibers: _____	4. Neurotransmitter of postganglionic fibers: _____
5. Mostly innervated myocardium structures: _____	5. Mostly innervated myocardium structures: _____
6. Type of cellular receptors in myocardium: _____	6. Type of cellular receptors in myocardium: _____
7. Intracellular mechanism of signal transmission: _____	7. Intracellular mechanism of signal transmission: _____
8. Main changes in cell due to stimulation of _____ receptors	8. Main changes in cell due to stimulation of _____ receptors
9. Influence on the main indices of heart work (*use ↑↓ to show changes*): HR: ____; contraction: ____; stroke volume: ____; excitation: ____; cardiac output: ____; conduction: ____.	9. Influence on the main indices of heart work (*use ↑↓ to show changes*): HR: ____; contraction: ____; stroke volume: ____; excitation: ____; cardiac output: ____; conduction: ____.

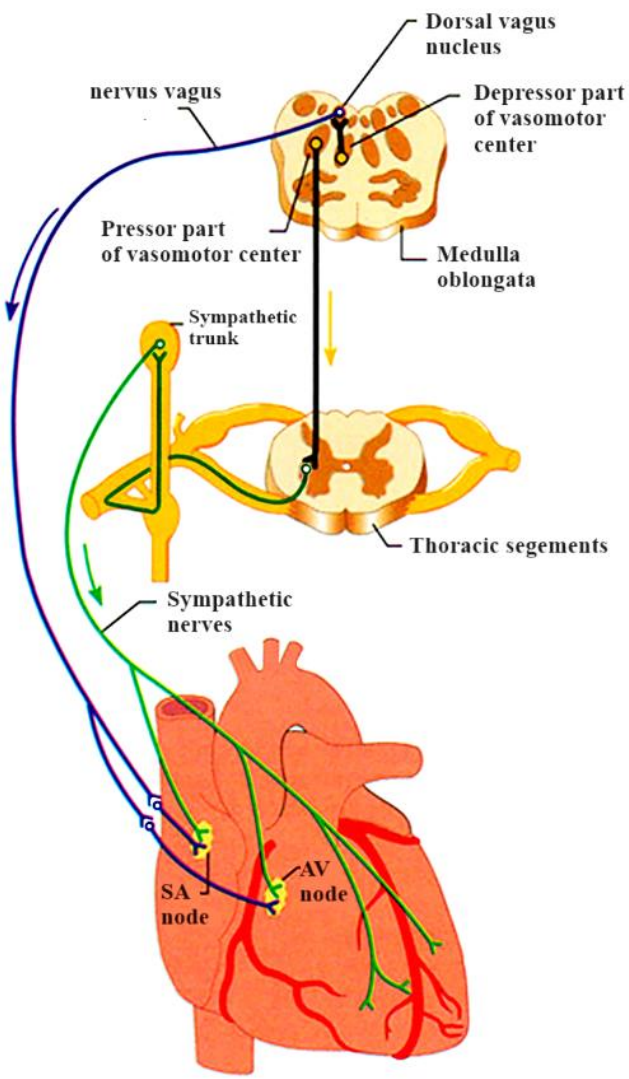


Fig. 22.1. Heart innervation by ANS

Work 22.3. FEATURES OF INNERVATION AND INFLUENCE OF SYMPATHETIC AND PARASYMPATHETIC PARTS OF ANS AND ITS NEUROTRANSMITTERS ON VASCULAR TONE

1. Using E-learning materials, lectures & textbook, fill in the Table 22.2.

Table 22.2

Vascular innervation by ANS

Parasympathetic innervation (some vascular areas)	Sympathetic innervation
1. Innervated vessels: _____	1. Innervated vessels: _____
2. Neurotransmitter of preganglionic fibers: _____	2. Neurotransmitter of preganglionic fibers: _____
3. Type of receptors on membrane of ganglionic neuron: _____	3. Type of receptors on membrane of ganglionic neuron: _____
4. Main neurotransmitter of postganglionic fibers: _____	4. Main neurotransmitter of postganglionic fibers: _____
5. Type of cellular receptors in endotheliocytes and smooth muscles cells of vessels: _____	5. Type of cellular receptors in smooth muscles cells of vessels: 1) _____; 2) _____
6. Intracellular mechanisms of signal transmission in stimulation of endotheliocytes: _____, direct stimulation of smooth muscle cells: _____.	6. Intracellular mechanisms of signal transmission: 1) _____; 2) _____
7. Changes of smooth muscle cells state in stimulation of M_3-cholinergic receptors of vascular endotheliocytes: _____.	7. Changes of smooth muscle cells state in stimulation of α_1-adrenoreceptors: _____; β_2-adrenoreceptors: _____.

2. *Fill in the boxes.*

Sources of Ca^{2+} for smooth muscle cells contraction: _____. Increase of smooth muscle cells plasma membrane permeability for Ca^{2+} ions result in _____ of the vessel tone, decrease — in _____. Opening of smooth muscle cells endoplasmic reticulum Ca^{2+} channels result in _____ of the vessel tone.

3. Describe signal transmission in activation of α1- and β2-adrenoreceptors of smooth muscle cells:

Noradrenaline + α1-adrenoreceptor → … _____

_____

_____

Adrenaline + β2-adrenoreceptor → … _____

_____

Work 22.4. Studying the Parameters of Arterial Blood Pressure During Postural (Orthostatic) Baroreflex

The autonomic nervous system (ANS) state may be observed by specific tests with changes of body position. Based on ANS reaction on new signal, the researcher may find the state of functional regulation system, its ability to maintain the constancy of internal environment in different situations. *Orthostatic test* helps to identify reaction, tone and reactivity of sympathetic part of ANS.

During transition of body from lying position to standing position, a significant volume of blood is deposited in the lower half of the body. It leads to decrease in venous return to the heart. As a result, pressure on the baroreceptors, located in carotid bodies, is reduced, and arterial blood pressure increases. The following processes occur reflexively:

1. Increase in peripheral resistance (contraction of arteriols through α_1-adrenoreceptors by noradrenaline).
2. Contraction of capacitive vessels (noradrenaline action on α_1-adreno-receptors of smooth muscles → contraction of venous and venuls).

To maintain the normal level of metabolism of tissues following reaction are developed to maintain cardiac output:

– increased **heart rate**;

– **BP_{sys}** does not change or decreased for 2–6 mm Hg; still lower than initial values.

– **BP_{dia}** increases for 6–10 mm Hg;

– **BP_{puls}** decreases, gradually increases because of increased

Materials and equipment: aneroid sphygmomanometer, stethoscope, stopwatch.

Progress of work

The tested person has to be in lying position during 4–6 minutes. After that, it is needed to measure heart rate (HR) with 1 minute interval and arterial BP. Than tested person has to stand up and stay still for 10 minutes. During this time, it is needed to measure their HR and BP in the ending 15 seconds of 1st, 5th and 10th minute. Observed data is recorded in protocol.

Result analysis

1) by changes of pulse and BP for first minute, the tone of sympathetic ANS is evaluated — autonomic control of activities;

2) parameters in 2–10 minutes describe process of restoration of tone of ANS due to changes of body position.

In normal people, the increase of pulse **for first minute** has to be no more than 6–24 beats per minute. Increased pulse less than 6 beats is a sign of insufficient tonus of sympathetic ANS; it means the tonus of parasympathetic ANS is more. Increased pulse more than 24 beats is a sign of excess tonus of sympathetic ANS. Based on results **for 10 minutes**, the type of reaction is identified:

1. *Physiological*: moderate increase in HR, moderate decrease in **BP_{sys}** and increase in **BP_{dia}**.
2. *Hyperdiastolic* hemodynamic: increase in **HR** more than 24 beats per minute, decrease in **BP_{sys}** more than 5 mm Hg, increase in **BP_{dia}** more than 5 mm Hg — increased tonus of sympathetic ANS.
3. *Hypodiastolic* hemodynamic: constant **HR** values or even decreased, **BP_{sys}** and **BP_{dia}** are strongly decreased (more than 20 mm Hg) — decreased tonus of sympathetic ANS.

PROTOCOL

Fill in the table. Use ↑↓ to identify changes. Make a conclusion.

Time	HR, per min	Changes	BP_{sys}, mm Hg	Changes	BP_{dia}, mm Hg	Changes
Initial		–		–		–
Standing position:						
1st min						
5th min						
10th min						

Conclusion: tone of sympathetic ANS is _____

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SECTION
"PHYSIOLOGY OF RESPIRATION"

SESSION 23 (5). EXTERNAL RESPIRATION. GAS EXCHANGE IN LUNGS AND TISSUES

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. Respiration. The role of the respiratory system in the body. Basic respiration stages.
2. Compliance of the lung and chest wall. Elastic recoil of the lungs. Surfactant functions.
3. Respiratory muscles, their innervation. Biomechanics of an inspiration and expiration.
4. Pressure in the pleural cavity, its origin and role in the mechanism of lung ventilation. The concept of pneumothorax.
5. Lung volumes and capacities. Spirometry, spirography. Spirogram analysis.
6. Gas exchange in the lungs. Composition of atmospheric, expired and alveolar air.
7. Gas exchange between alveoli and blood, blood and tissues. Partial pressure of O_2 and CO_2 in alveolar air and the gases tension in arterial and venous blood, in tissues and in cells.

LITERATURE

Main

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2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 437–490.

Additional

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2. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013. P. 569–593, 600–605.
3. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
4. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 23.1. TERMINOLOGY

Tidal volume (TV) — _____

Respiration rate (RR) — _____

Alveolar ventilation (AV) — _____

Minute ventilation (MV) — _____

Vital capacity (VC) — _____

Self-check questions:

1. What is the role of alveolar surface tension?
2. Explain the relationship between the lungs, the pleural membranes, the pleural fluid, and the thoracic cage.
3. What is pneumothorax? What is the mechanism of pneumothorax emergence?
4. Stabbing victim is brought to the emergency room with a knife wound between the ribs on the left side of his chest. What has probably happened to his left lung? To his right lung? Why does the left side of his rib cage seem larger than the right side?

Work 23.2. SPIROMETRY

Spirometry is a method of measurement of lung volumes and capacities. Only exhaled air volume can be measured with spirometer. Mostly air and water spirometers are used to make a measurement.

Materials and equipment: air spirometer, disposable or repeatedly sterilized mouth-pieces, sanitizer, gauze balls. Use specific nose clamp to prevent inhalation through nose.

1. Measurement of Vital Capacity.

One of the ways of calculating due vital capacity (DVC), is its determination using Harris–Benedict tables. On the basis of body mass, height and age the basal metabolic rate due value is taken from the tables. (p. 77, 79). Then it is multiplied by coefficient the following way:

for **men**: VC^{due} = BMR × **2.6** for **women**: VC^{due} = BMR × **2.2**.

Progress of work

Spirometer arrow has to point to zero. Put nose clamp on nose. After maximum inspiration, put spirometer into your mouth and make a maximum slow expiration. Repeat three times and record the best result.

Results

Sex ____ (m/f), age _____ (y.o.), height _____ (cm), weight _____ (kg).

VC = _____ ml. VC^{due} = (_____ + _____) x _____ = _____ ml

VC – VC^{due} = _____ ml, that is _____ % of VC^{due}.

Evaluate the measured VC comparing it with its due value. The difference between the measured VC and VC^{due} **should not exceed 20 %**.

Conclusion: _____

2. Effect of body posture on VC value.

Determine VC value in standing, sitting and lying position three times and use the best.

VC in standing = _____ ml

VC in sitting = _____ ml

VC in lying = _____ ml

Conclusion: _____

3. Effect of expiration velocity on VC value.

Determine VC in the examined, then forced VC (FVC). To determine FVC a *fast* maximally deep expiration is made after a maximal inspiration. In norm the difference between VC and FVC **does not exceed 300 ml**. The increase of this difference evidences the constriction (obstruction) of bronchi.

Results

VC = _____ ml, FVC = _____ ml, VC – FVC = _____ ml.

Conclusion: _____

4. Determination of the lungs volumes.

The examined must make 5 quiet expirations into the spirometer. To find a mean Tidal Volume (TV) the obtained total air volume is divided by 5. To determine an expiratory reserve volume (ERV) the examined, having made a quiet expiration, expires the residue of the air into the spirometer.

To find IRV it is necessary to extract the value of TV and ERV from VC.

Results

TV = _____ ml, _____ % (the norm is 300–800 ml; 15–20 % of VC

ERV = _____ ml, _____ % (the norm is 20–33 % of VC).

IRV = VC – TV – ERV = _____ ml, _____ % (the norm is 55–66 % of VC).

Conclusion: _____

Work 23.3. SPIROGRAPHY

Spirography is a method of graphic registration of inhaled and exhaled air volume.

Progress of work

To measure the most important indices of lung volumes and capacities, the calm respiration is recorded (Fig. 23.1). The tested person has to make maximum deep inhale and just after — maximum exhale. The obtained data is *vital capacity*. After that calm respiration is recorded again. In the end of test, the tests person makes maximum hyperventilation during 12–15 seconds. Obtained data helps to identify maximal voluntary ventilation (**MVV**).

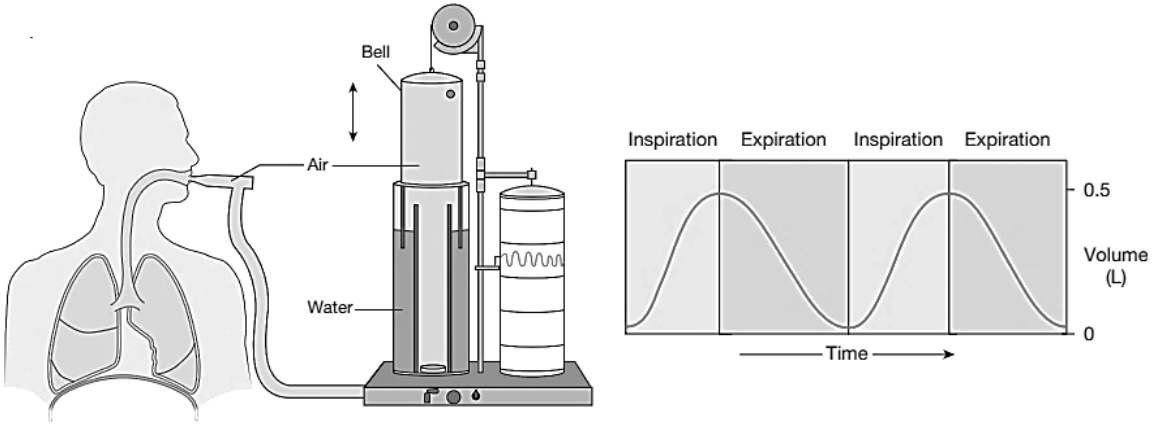
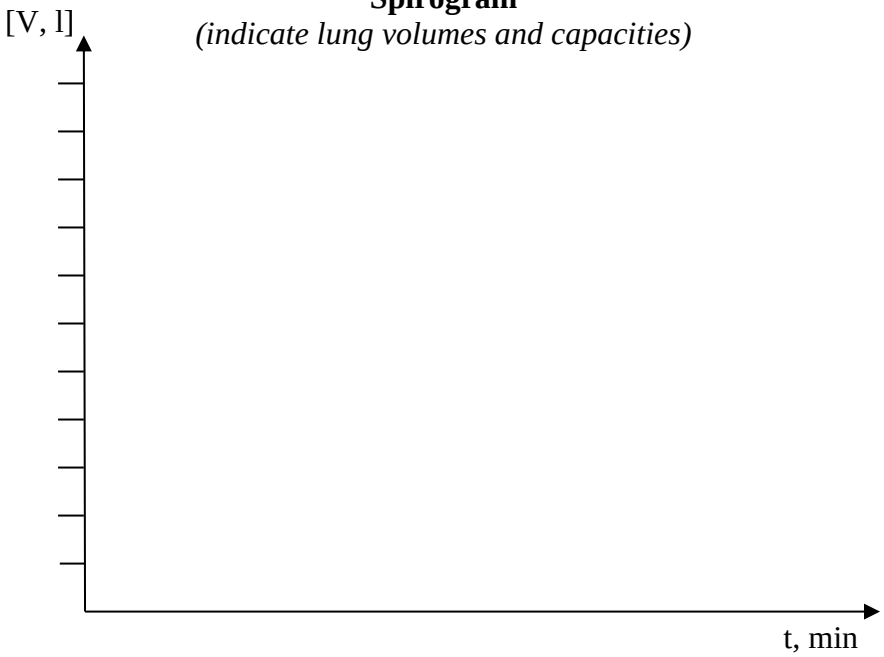


Fig. 23.1. Spirography

Spirogram

(indicate lung volumes and capacities)



1. Fill in the table.
2. Make a conclusion.

VC = TV + IRV + ERV = _____ + _____ + _____ = _____ ml.

MV = TV × RR = _____ × _____ = _____ l / min.

AV = (TV – dead space) × RR = (_____ – _____) × _____ = _____ l / min.

Table 23.1

Analysis of spirogram

Index	Measurement	Normal values
1. Respiration rate (RR)	12 / min	9–20 / min
2. Rhythm of respiration	rhythmic	rhythmic
3. Tidal volume (TV)	500 ml	300–800 ml
4. Inspiratory reserve volume (IRV)	1500 ml	55–66 % of VC
5. Expiratory reserve volume (ERV)	1200 ml	20–33 % of VC
6. Vital capacity (VC)	…….	3–7 l
7. Minute ventilation (MV)	…….	4–9 l/min
8. Alveolar ventilation (AV)	…….	80–65 % of MV

Conclusion: comparing with normal values, obtained data consider as _____, because _____
_____

Work 23.4. Pneumotachometry (Peakflowmetry)

Pneumotachometry or **peakflowmetry** is a technique for the flow volume velocity measurement on inspiration and expiration. The most common are peakflowmeters allows measuring the value of **peak expiratory flow (PEF)**.

The principle of the method is based on the measurement of the air pressure gradient on the different sides of the constriction in the peakflowmeter tube. This gradient is proportional to the value of the volume velocity of air movement.

Materials and equipment: peakflowmeter, sanitizer, individual mouse-pieces.

Progress of work

Peak expiratory flow in adults is 4–10 l/sec. To find the proper PEF, the measured properVC is multiplied by 1.25.

$$\mathbf{PEF^{due} = VC \times 1.25 = \_\_\_\_\_\ L/sec.}$$

The difference between due PEF value and real measured PEF must not exceed ±20 %.

Set the instrument switch to the "exhale" position. After a deep inhalation, the test person, tightly grasping the mouthpiece with lips, makes a maximum forced exhalation through the mouth. The result is determined by the maximum deviation of the pneumotachometer arrow (or slider displacement — in portable peakflowmeter).

To determine **peak inspiratory flow (PIF)**, set the device switch to the "inhale" position and after a deep exhalation, take a maximum forced breath through the tube.

Results

Peak Expiratory Flow		
Measured PEF	**Due PEF**	**% PEF of PEF^{due}**

Conclusion: _____

_____

Work 23.5. Studying the Parameters of External Respiration with Automatic Spirometer MAS-1

Automatic spirometers are increasingly being introduced into clinical practice, which allow performing both spirography and peakflowmetry, automatically calculating the due values of the measured indices, and assessing their quality and the dynamics of their changes during repeated testing.

Full names of main indices of external respiration and their abbreviations are presented in Table 23.2.

Table 23.2

Main indices of external respiration

Index	Units	Full name
VC	l	Vital Capacity
TV	l	Tidal Volume
MV	l/min	Minute Ventilation
ERV	l	Expiratory Reserve Volume
IRV	l	Inspiratory Reserve Volume
RR	l/min	Respiratory Rate
IC	l	Inspiratory Capacity (TV + IRV)
FVC	l	Forced Vital Capacity
FEV_1	l	Forced Expiratory Volume in 1 sec
FEV_1/FVC	%	Gaenslar index
FEV_1/VC	%	Index Tiffeneau (FEV_1 / VC × 100 %)
PEF	l/sec	Peak Expiratory Flow
PIF	l/sec	Peak Inspiratory Flow
MEF_{25}	l/sec	Maximum Expiratory Flow at 25 % of the FVC
MEF_{50}	l/sec	-------- ------- at 50 % of the FVC
MEF_{75}	l/sec	-------- ------- at 75 % of the FVC
$MEF_{25–75}$	l/sec	Mid-Expiratory Flow at 25 to 75 % of the FVC
$MEF_{75–85}$	l/sec	Forced End-Expiratory Flow at 75 to 85 % of the FVC
MVV	l/min	Maximal Voluntary Ventilation

Work 23.5. Studying the Parameters of External Respiration with Automatic Spirometer MAS-1 (Continuation)

Materials and equipment: spirometer MAS-1, mouthpieces, nasal clip with gauze napkin, disinfectant, absorbent cotton or clean rags, container for waste materials.

Progress of work

Place the mouthpiece over the measuring tube. The subject's head should be tilted slightly back so that the airway is as free as possible. Explain to the subject how to take the mouthpiece correctly. Explain to the subject how to perform the breathing maneuver. Close the subject's nasal airway using a nasal clip.

1. Vital capacity test (spirometry)

A spirogram is constructed from the results of the Vital Capacity Test (spirometry) to estimate TD, IRV, ERV and VC. A volume diagram is allows to easily assess the value of the obtained indicators.

2. Forced vital capacity test (pneumotachometry)

According to the results of this test, two curves are constructed: flow-volume loop, which reflects the dependence of inhalation (lower part of the curve) and exhalation (upper part) volume velocity on the volume of inhaled/exhaled air, and forced exhalation curve, which shows the dependence of the exhaled air volume on the exhalation time. Fig. 23.2 demonstrates "flow-volume" curve and forced vital capacity curve.

3. Maximal Voluntary Ventilation test (MVV)

After the end of measurement, ask tested person to put out the tube and put of nose clump.

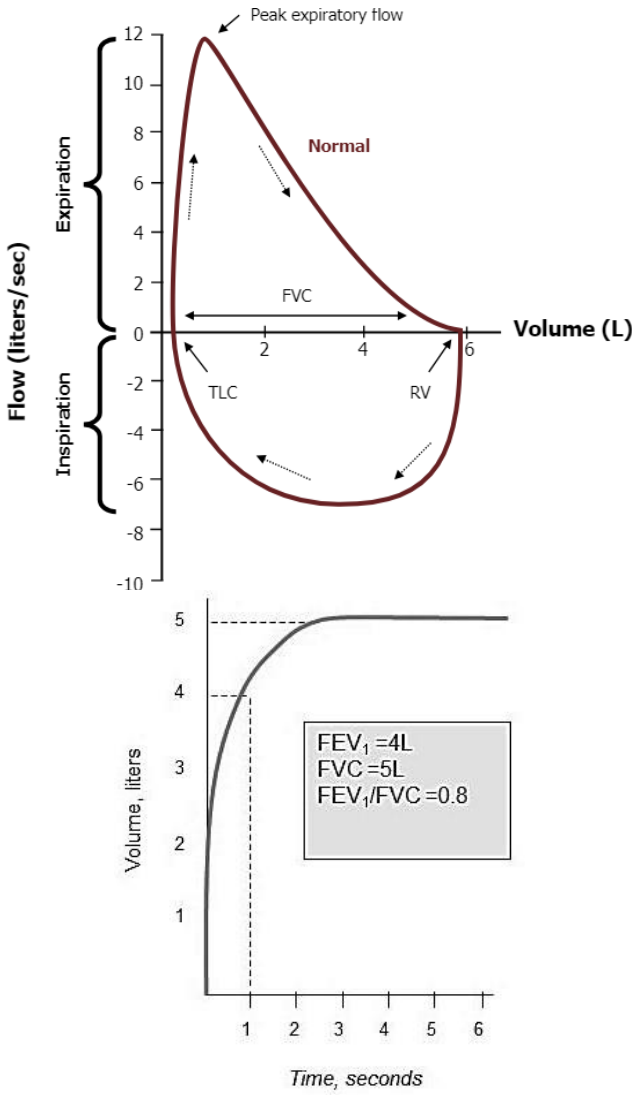


Fig. 23.2. "Flow-volume" curve and forced vital capacity curve

Work 23.5. Studying the Parameters of External Respiration with Automatic Spirometer MAS-1 (Continuation)

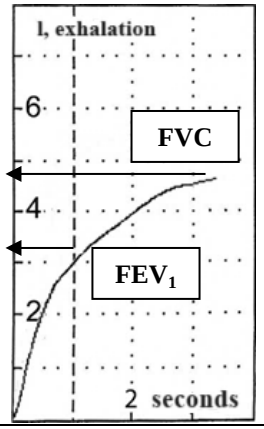
PROTOCOL

For analysis of external respiration functions, use the data in Table 23.3. Calculate FVC and FEV_1 based on graph in Table 23.3.

Table 23.3

Spirometry results

Index	Result		
	measured	proper	% of proper
FVC	……. L	5.25 L	…….
FEV_1	……. L	4.16 L	…….
FEV_1/FVC	…….%	70–85 %	…….
PEF	7.21 L/sec	9.47 L/sec	76
MEF_{25}	4.74 L/sec	8.21 L/sec	58
MEF_{50}	1.96 L/sec	5.27 L/sec	37
MEF_{75}	0.53 L/sec	2.03 L/sec	26
$MEF_{25–75}$	1.52 L/sec	4.26 L/sec	36
$MEF_{75–85}$	0.36 L/sec	1.00 L/sec	36



Based on data presented in Table 23.3. (PEF, MEF_{25}, MEF_{50}, MEF_{75}) draw the "flow-volume" curve: one drawing for measured data and one for due values.

Remember! In the beginning and in the ending of exhalation (0 % and 100 % of FVC), volume velocity is **0 L/sec**.

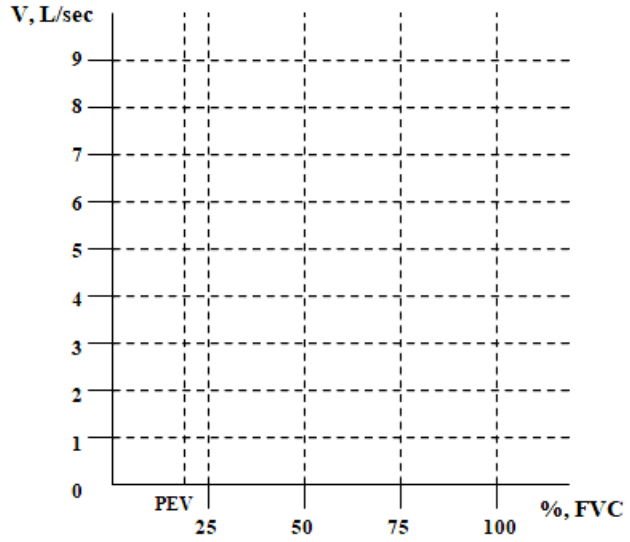
Conclusion: _____

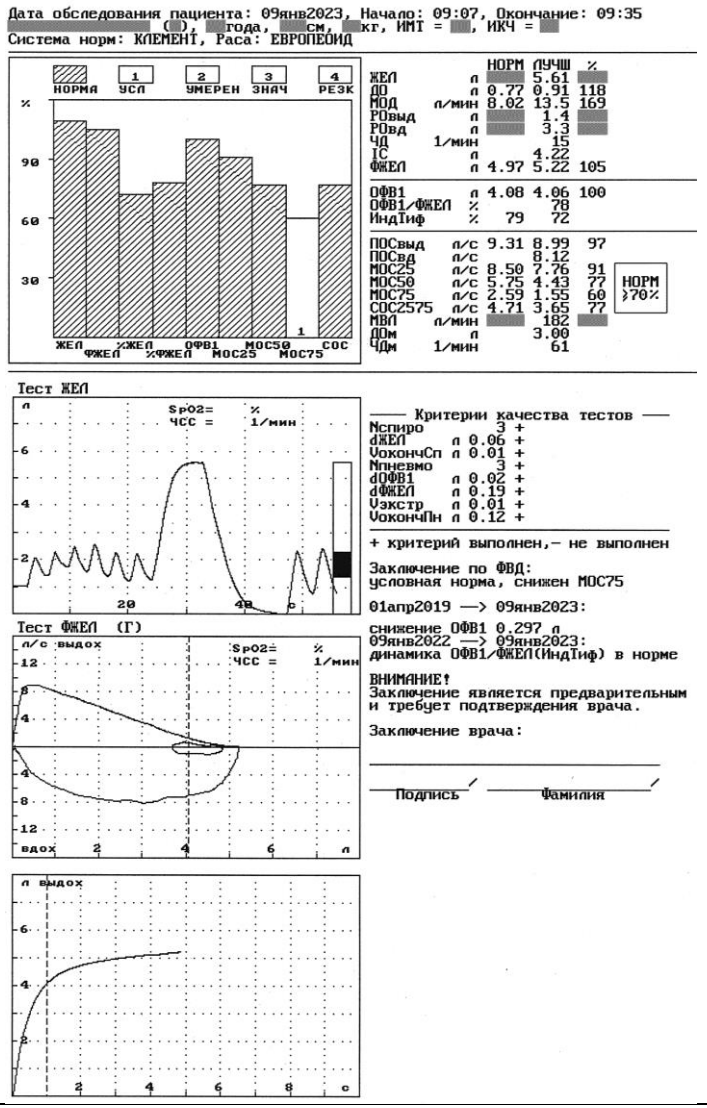
_____

_____

_____

"Flow-volume" curve





ADDITIONAL MATERIALS

THE CONCEPT OF BIOMECHANICS OF INHALATION AND EXHALATION BASED ON MODELS

The Donders' model (Fig. 23.3) is designed to demonstrate the role of mechanical factors in lung ventilation. In the classical experiment, model consists of a glass bell with rubber membrane of the bottom. There are animal's lungs inside the bell. They are connected through the trachea to a special cannula that is hermetically inserted into a plug at the top of the bell.

Through the cannula, lungs may communicate with the external environment. In presence of side branch, the pressure inside the bell can be measured. Rubber membrane is used to change the pressure and observe lungs' movements and pressure changes inside the bell.

Materials and equipment. Bunsen flask, a plug with a hole and a glass tube with a tightly fixed rubber ball, a 100–200 ml Janet syringe with a silicone tube, a vacuum manometer.

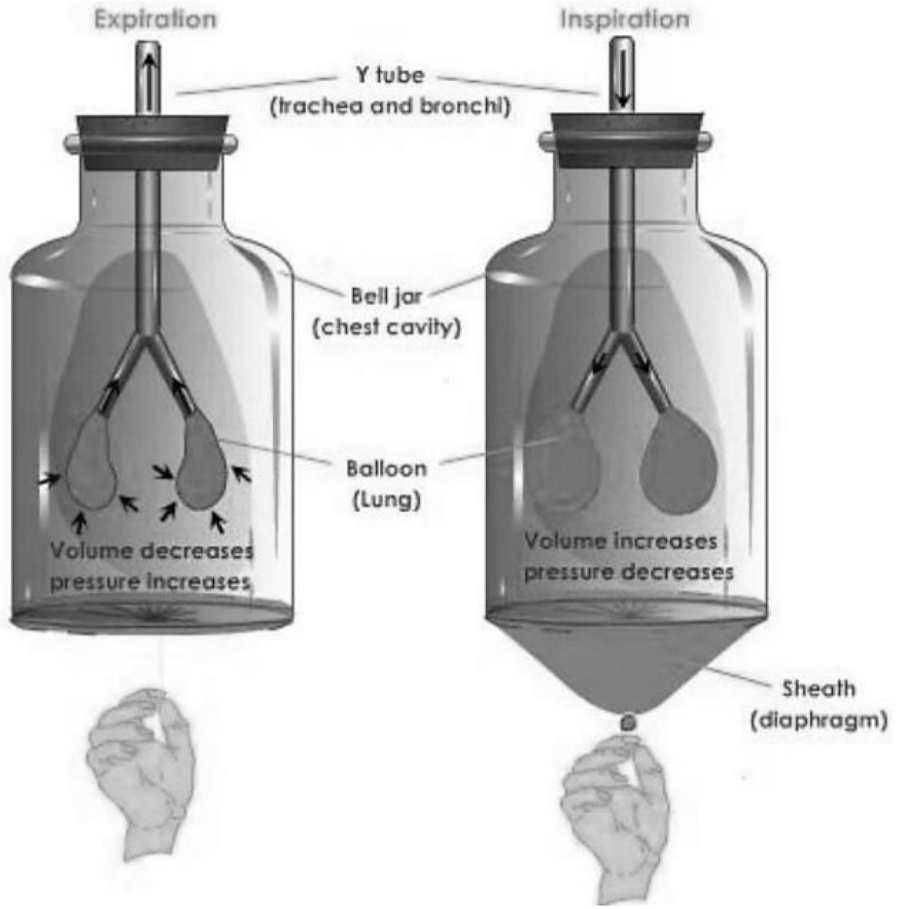


Fig. 23.3. The Donder's model

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SESSION 24 (6). TRANSPORT OF GASES IN BLOOD. REGULATION OF RESPIRATION

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. Transport of gases in blood. Transport forms of O_2 and CO_2.
2. Oxygen capacity of blood and O_2 utilization rate. Pulseoxymetry.
3. Oxyhemoglobin dissociation curve. Factors affecting the affinity of hemoglobin to O_2 and CO_2.
4. Respiratory center: structure and localization, its afferent and efferent connections.
5. Central and peripheral receptors of pH, CO_2 and O_2 in the body, their role. Factors stimulating respiratory center of medulla oblongata.
6. Receptors of the respiratory tract, lungs and respiratory muscles. Reflex reactions arising in response to the receptors irritation.
7. Neural and humoral mechanisms of regulation of respiration.
8. Hypoxia and its signs. Theoretical basics of cardiopulmonary resuscitation (CPR): first aid.
9. Functional system for maintaining relative constancy of respiratory constants of the internal environment of the body.

LITERATURE

Main

1. Lecture & E-learning materials
2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 437–490.

Additional

1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 24.
2. *Silverthorn, D. V.* Human physiology: An integrated approach / D. V. Silverthorn. 6th ed. 2013. P. 604–621, 626.
3. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.

Work 24.1. TERMINOLOGY

Oxygen capacity of blood — _____

Respiratory center — _____

Transport forms of O_2:

Transport forms of CO_2:

List structures included in respiratory center: _____

Oxyhemoglobin dissociation curve — _____

Respiratory alkalosis — _____

O_2 utilization coefficient (O_2 extraction ratio) — _____

Metabolic acidosis — _____

Systemic circulation

	Arterial blood	Venous blood
P_{O2}	100 mm Hg	≤ 40 mm Hg
P_{CO2}	40 mm Hg	≥ 46 mm Hg

$$CO_2 + H_2O \underset{}{\overset{\textit{Carbonic anhydrase}}{\rightleftharpoons}} \underbrace{H_2CO_3}_{\text{Carbonic acid}} \rightleftharpoons H^+ + HCO_3^-$$

↑P_{CO2} (hypercapnia) → ↓ pH (acidosis)
↓P_{CO2} (hypocapnia) → ↑ pH (alkalosis)

Work 24.2. STUDYING THE HEMOGLOBIN DISSOCIATION CURVE

Progress of work

1. Fill in the table of dependence of the degree of hemoglobin oxygen saturation depending on the value of partial pressure of oxygen in the blood.

pO_2, mm Hg	0	10	27	40	60	90	100
HbO_2 %							

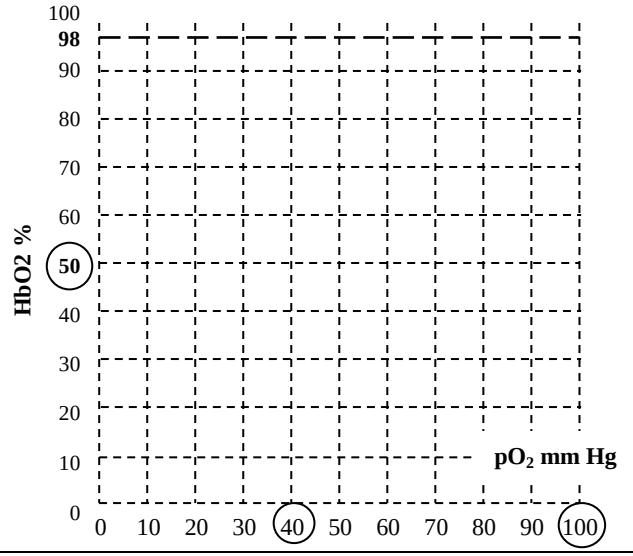
2. Graph the oxyhemoglobin dissociation curve based on the data in the table. Use *red color* for pO_2 of arterial blood, use *blue color* for O_2 of venous blood.

3. Draw a curve in red with a *shift to the right*, in blue with a *shift to the left*.

4. Calculate *coefficient of O_2 utilization or O_2 extraction ratio (O_2ER) for every drawn curve:*

$$O_2ER = \frac{O_2 \text{ content in arterial blood} - O_2 \text{ content in venous blood}}{O_2 \text{ content in arterial blood}}$$

$O_2ER_{standard}$ = _____ %; O_2ER_{right} = _____ %; O_2ER_{left} = _____ %



Work 24.3. ULSEOXYMETRY. STUDYING THE ROLE OF BREATH HOLDING ON HEMOGLOBIN OXYGENATION

Note: HbO_2 and SpO_2 are both terms for indicating hemoglobin oxygen saturation

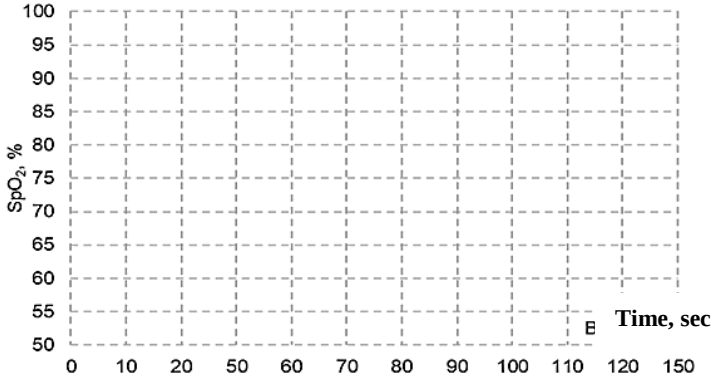
One important clinical indicator of the effectiveness of gas exchange in the lungs is the concentration of oxygen in arterial blood. **The pulse oximeter**, clips onto the skin and in seconds gives a digital reading of arterial hemoglobin saturation. The oximeter works by measuring light absorbance of the tissue at two wavelengths.

Progress of work

The study is carried out on healthy people. When conducting the test requires careful monitoring of the condition of the examined person. With a sharp increase or weakening of the pulse, the appearance of arrhythmia, pale or discoloration of the skin and lips, the test is stopped. Respiratory hold lasts 90 s. Blood saturation is recorded during the test and for one minute after the end of the breath hold.

Results

	Holding a breath								After holding			
Time, sec	0	10	20	50	60	70	80	90	100	110	120	150
SpO_2, %	96	96	95	92	88	82	76	68	60	85	92	94



Work 24.4. Effect of Increasing CO_2 in Alveolar Air on External Respiration

The computer program "**09_PhysioLogy**" is used for work.

Progress of work

Simulate the increase of alveolar air P_ACO_2 when its concentration in the inhaled air changes: set the indicator $FiCO_2$ % in the **INSPIRED GAS** section for 30–40 sec to 3 %, then to 4 % and 5 %.

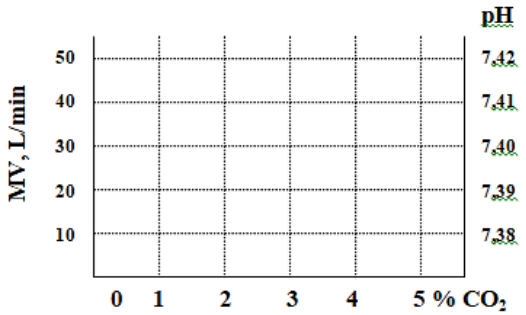
Table 24.1

Measurement results

Index	Content of CO_2 in inhaled air			
	0 %	**3 %**	**4 %**	**5 %**
P_ACO_2, mm Hg	36.5	37.2	38.8	39.4
$PaCO_2$, mm Hg	37	37.8	39.3	39.7
MV, L/min	**4.71**	**13.1**	**18.5**	**51.1**
RR, L/min	10	15	18	29
TV, L	0.62	1.02	1.20	1.93
pH	**7.41**	**7.40**	**7.39**	**7.38**

PROTOCOL

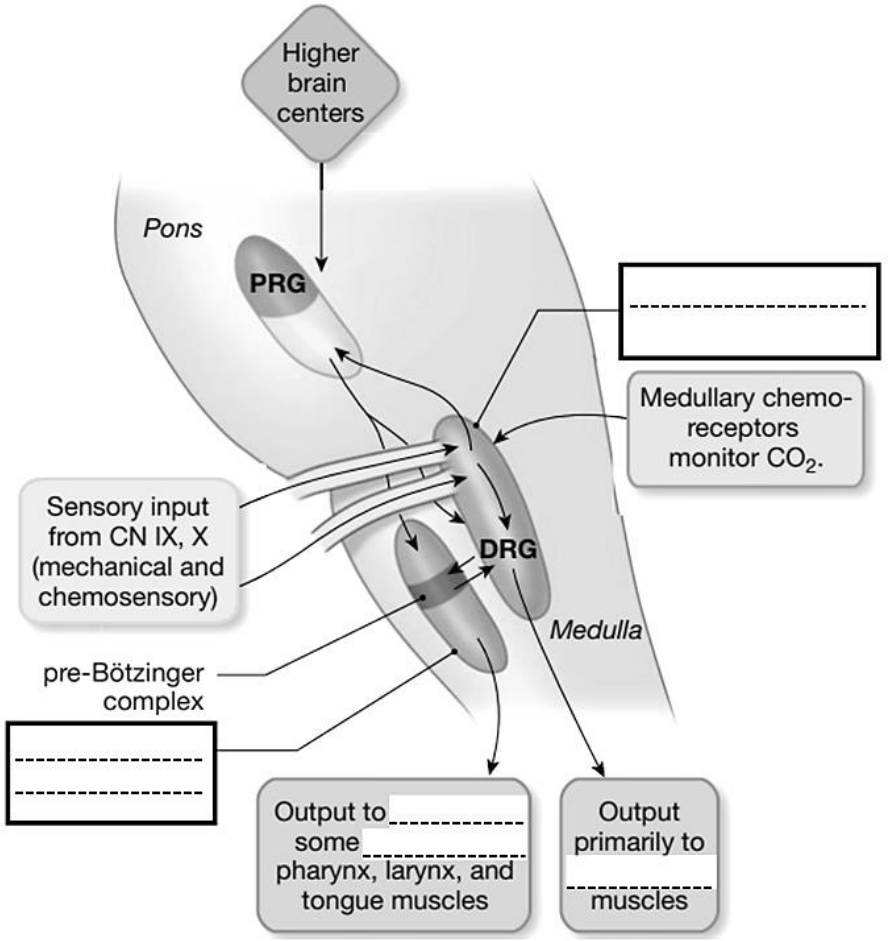
1. Using Table 24.1 draw graphs of MV and pH depending on CO_2 content in inhaled air.



2. **Conclusion:** increase in CO_2 content of the alveolar air result in _____ (↑↓) alveolar ventilation and _____ (↑↓) pH level.

Work 24.5. Model of Nerve Center Connections

Fill in the boxes, using E-learning materials & textbook.



THE PRACTICAL WORKS ARE DEFENDED

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Lecturer's signature

SESSION 25 (7). COLLOQUIUM. CONCLUDING SESSION ON THE SECTIONS "PHYSIOLOGY OF CIRCULATION" AND "PHYSIOLOGY OF RESPIRATION"

DATE OF CLASSES
«____» _____ 20___
day month year

THEORETICAL QUESTIONS:

1. Hemodynamics. Functional classification of vessels. Factors that ensure the blood movement through the vessels. The basic law of hemodynamics: the relationship between blood pressure, volumetric velocity of blood flow and peripheral resistance to blood flow.
2. Volumetric and linear velocity of blood flow in various parts of the vascular bed, factors determining them. The main properties of blood flow (blood pressure, blood flow velocity, resistance) in the arterial, microcirculatory and venous parts of the vascular bed.
3. Capillary blood flow and its properties. Microcirculation and its role. Mechanisms of fluid and other substances exchange between blood and tissues. Microcirculation in the oral cavity tissues. Lymph formation, functions of lymph.
4. Blood pressure, its types and role. Blood pressure in various parts of the vascular bed. Factors determining the value of blood pressure (BP). Changes in BP during medical manipulations in the oral cavity, with changes in the body position.
5. The concept of normal values of BP. Functional system that provides regulation of systemic arterial pressure.
6. Heart conduction system. Structure, physiological properties and functions. Current concepts of the substrate, origin and gradient of automaticity.
7. Contractile myocardium. Structure, physiologic properties and functions. Laws of cardiac contraction.
8. Action potentials of pacemaker cells and typical cardiomyocytes. Ratios of excitation, excitability and contraction of myocardium.
9. Cardiac cycle. Sequence of phases and periods of the cardiac cycle, their characteristic. Position of valves, changes in pressure and blood volume in the heart chambers in different phases of the cardiac cycle.
10. Electrical activity of the heart. Plan of analysis and criteria of normal ECG data in II standard lead. The concept of extrasystoles.
11. Heart sounds, their origin. Polycardiography, synchronized recording of ECG and PCG.
12. Self-regulation of heart activity. Stroke and minute blood volume, their dependence on venous return value (Starling's law) and vascular resistance (Anrep's effect).
13. Humoral mechanisms of heart regulation: the influence of catecholamines, angiotensin II, electrolytes and metabolites.
14. Reflex regulation of cardiac activity. Characterization of the influence of parasympathetic and sympathetic parts of the autonomic nervous system and their chemical mediators on heart activity. Reflex changes in the heart activity, including during medical manipulations in the oral cavity.
15. Vascular tone, its types. Reflex regulation of vascular tone. Vasomotor center, its afferent and efferent connections.
16. Humoral regulation of blood circulation. Vasoconstricting and vasodilating endogenous substances. Local mechanisms of blood circulation regulation. Influence of metabolic, myogenic mechanisms and factors secreted by the endothelium on the smooth muscle cells of the vascular wall.

LITERATURE

Main

1. Lectures & E-learning materials.
2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016.

Additional

1. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013.
2. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
3. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Structure of colloquium:

Step 1. Computer test

http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 25.

Grade to pass is 60 %!

Step 2. Oral conversation

17. Functional system maintaining the regulation of systemic arterial pressure. Physiological mechanisms of maintaining relative constancy of blood BP.
18. Respiration. The role of the respiratory system in the body. The main stages of breathing. Biomechanics of inhalation and exhalation.
19. Pressure in the pleural cavity, its origin and role in the mechanism of lung ventilation. Volumetric and flow rates of lung ventilation.
20. Gas exchange in the lungs. Composition of atmospheric, exhaled and alveolar air. Gas exchange between alveoli and blood, blood and tissues. Partial pressure of O_2 and CO_2 in alveolar air and the gases tension in arterial and venous blood, in tissues and in cells.
21. Transport of gases in blood. Transport forms of O_2 and CO_2. Factors affecting the affinity of hemoglobin for O_2 and CO_2. Oxygen-hemoglobin dissociation curve. Oxygen capacity of blood and O_2 utilization rate.
22. Respiratory center: structure and localization, its afferent and efferent connections.
23. Receptors of the respiratory tract, lungs and respiratory muscles. Reflex reactions arising in response to the receptors irritation. Regulation of the lumen of the respiratory tract. Receptors to pH, CO_2 and O_2 in the body, their localization, features of sensitivity and role in the regulation of breathing. The mechanism of the first breath of a newborn baby.

PRACTICAL QUESTIONS (SKILLS):
1. Properties of arterial pulse and assessment of its rhythmicity and frequency by palpation method.
2. Assessment of cardiac cycle duration at rest and at physical training. Physiological assessment of the obtained data.
3. Mechanism of generation of action potential of typical cardyomyocyte and atypical cardyomyocyte.
4. Assessment of cardiac cycle duration based on ECG.
5. Analysis of arterial pressure changes during conduction of orthostatic test.
6. Spirometry: determination of vital capacity (VC), due vital capacity (dVC), physiological assessment of obtained data. Assessment of spirogram.
7. Pulseoxymetry conduction and physiologic assessment of hemoglobin oxygen saturation curve. Calculation of oxygen capacity of blood.

Marks for computer test

The percentage of correct answers	**Mark for the quiz**
98 % – 100 %	9 points
82 % – 91 %	8 points
84 % – 91 %	7 points
76 % – 83 %	6 points
68 % – 75 %	5 points
60 % – 67 %	4 points
41 % – 59 %	3 points
21 % – 40 %	2 points
0 % – 20 %	1 point

Permission to pass the colloquium approved for _____
(Student name, Lecturer signature)

Test mark	Mark for oral part

The colloquium is passed_____
(Lecturer signature)

SECTION
"PHYSIOLOGY OF DIGESTION"

SESSION 26 (8). NUTRITIONAL MOTIVATIONS. DIGESTION IN ORAL CAVITY AND IN STOMACH

DATE OF CLASSES
«____» _____ 20___
day month year

<table>
<tr>
<td>BASIC QUESTIONS:
1. General characteristic of functional system of nutrition. Nutritional motivations. Appetite. Physiological mechanisms of hunger and satiety. Mechanisms of regulation of eating behavior.
2. Digestive and non-digestive functions of the digestive system. Types of digestion depending on peculiarities of hydrolases and its localization.
3. Digestion in the oral cavity. Mechanical and chemical digestion of food. Formation of bolus. The concept of masticatory digestion.
4. Functional characteristics of the mastication apparatus. The role of mastication and mimic muscles, various types of teeth and temporomandibular joints in the process of mechanical digestion of food in the oral cavity.
5. Hard tissues of the tooth. Enamel: structure, properties, functions, features of "nutrition". Enamel permeability for various substances.
6. Fluids of oral cavity: oral ("mixed saliva"), gingival, salivary glands. Functions and composition of oral fluid.
7. Protective function of oral fluid. Mechanisms and ways to protect teeth from caries.
8. Swallowing, its phases. Reflex regulation of swallowing. The knowledge of this mechanism for dentists. Functional relationship of the breathing, chewing and swallowing.
9. Digestion in stomach. Functions of stomach. Composition and properties of gastric juice.
10. Role of hydrochloric acid and gastric mucus. Mechanism of formation and secretion of hydrochloric acid. Nervous and humoral mechanisms of their regulation.
11. Phases and mechanisms of regulation of gastric gland secretion before and after a meal. Motor and evacuation functions of the stomach before and after a meal.</td>
<td>LITERATURE
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</tr>
<tr>
<td colspan="2">NORMAL VALUES OF DIGESTIVE SYSTEM</td>
</tr>
<tr>
<td>Daily secretion of saliva — 0.5–1.5 L
Saliva pH — 5.6–7.6</td>
<td>Daily secretion of gastric juice — 2.0–2.5 L
Volume of gastric juice in empty stomach ≤ 50 ml</td>
<td>pH of pure gastric juice — 1.0–1.8
pH of gastric juice after a meal ≥ 6.0</td>
</tr>
</table>

Work 26.1. SIALOMETRY

Methods for examining the composition and quantity of saliva are varied. One method of quantifying saliva is sialometry. The amount of secreted saliva helps in identifying the state of the salivary glands.

Saliva is collected after 1.5–2 hours after a meal or on an empty stomach. In order to avoid increased saliva secretion, patients should not consume food, chew gum, drink, brush teeth, smoke and so on. A calm environment where the patient is completely relaxed is necessary for saliva secretion.

This paper presents a simple technique for collecting saliva, stimulated and unstimulated.

Table 26.1 provides data on salivary flow rates in the presence and absence of stimulation.

Table 26.1

	Nonstimulated secretion of saliva	**Stimulated secretion of saliva**
Normosalivation	0.1–2.0 ml/min	0.5–6.0 ml/min
Hyposalivation	below 0.1 ml/min	below 0.5 ml/min
Hypersalivation	above 2.0 ml/min	above 6.0 ml/min

Materials and equipment: 4 graduated test tubes, 2 funnels, stopwatch, chewing gum (students bring their own).

1. Collection of mixed saliva (non-stimulated)

The patient sits quietly with the head down so as not to swallow saliva; lips and tongue must not be moved. Within 6 minutes, the patient should spit the salivary fluid into the provided container (glass, test tube). After the time has elapsed, the total amount of salivary fluid is converted for 1 minute into ml per minute.

Total amount of oral fluid for 6 minutes: _____ ml

Saliva flow rate = _____ / 6 min = _____ ml / min.

2. Collection of mixed saliva (stimulated)

The patient is asked to chew gum or use a piece of wax for 30 seconds. The accumulated saliva should then be swallowed. The patient then continues chewing the gum (wax) for 6 minutes while spitting saliva into the provided container (glass, test tube). After the time has elapsed, the total amount of salivary fluid is converted at 1 minute into ml per minute.

Total amount of oral fluid for 6 minutes: _____ ml

Saliva flow rate = _____ / 6 min = _____ ml / min.

Conclusion: the tested person has _____

(normo-, hypo-, hypersalivation)

Work 26.2. DETERMINATION OF pH OF ORAL CAVITY

In the oral fluid, the pH value can shift either acidic or alkaline. Changes in the acid-base state can lead to disturbances in the structure and function of oral tissues (e.g., demineralization of tooth enamel, formation of cavities, erosion of hard tissues, paradontitis, etc.).

Under normal conditions, the pH value is maintained autogenously. Its regulation involves saliva (buffer systems), plaque (acids), tartar (binding of hydrogen ions), gingival fluid, food components, etc. **The normal pH value of the oral fluid is 5.6–7.4.**

pH > 7.4 risk of tartar formation

pH < 6.2 Ca^{2+} and P deficiency, non-mineralization

Materials and equipment: test tubes with freshly collected saliva (see work 26.1), pH-meter.

Progress of work

Place the beaker with saliva on the pH-meter table so that the electrode of the pH-meter is immersed in the saliva. Take data of the device.

PROTOCOL

1. pH of oral fluid: stimulated _____;
   non-stimulated _____.
2. **Conclusion:** pH of oral fluid _____ *(in norm; ↑ > 7.4; ↓ < 6.2)*

Work 26.3. STARCH DIGESTION BY ENZYMES OF HUMAN SALIVA

The process chemical processing of food begins in the mouth under the action of enzymes of mixed saliva (α-amylase, lingual lipase, alkaline and acid phosphatases, kallikrein, nucleases, peroxidase). Sources of production of these enzymes are different: salivary glands, oral mucosa epithelial cells, microorganisms, emigrated leukocytes into the oral cavity. Under the influence of these enzymes, hydrolysis of carbohydrates, lipids, nucleic acids, cleavage of phosphate from organic compounds takes place.

Amylase is the predominant content (0.4–1.0 g/L) in human saliva. It is synthesized in a variety of salivary glands in the following volume:

parotid — 0.5–1.5 g/L;
submandibular — 0.1–0.5 g/L;
sublingual — 0.1–0.5 g/L.

Under the influence of α-amylase (ptyalin) the α-1,4-glycosidic linkages in the molecule of starch is broken down and hydrolysis products formed are maltose, maltotriose and α-dextrin. The enzymatic activity of α-amylase is manifested in a wide pH range (from 3.8 to 9.4), but the optimal activity is achieved at neutral pH.

Materials and equipment. 4 test tubes, funnel, pipette, tripod stand for the test tubes, water bath (thermostat to 37°), ice, starch paste (1 % aqueous solution), 5 % solution of Lugol's solution, 2 % HCl solution, distilled water, litmus paper.

Progress of work

Saliva (5–6 ml) is collected in a graduated tube using a funnel. Number 4 tubes, place them in a rack and add 1 ml of saliva to each tube. Test tube №2 is carefully heated on a spirit flame to boiling, tilted at an angle of 30–40° to the horizon, heated along its entire length and directed away from people. In test tube №3 add drop by drop, stirring, 2 % solution of HCl until the appearance of persistent red coloring of litmus paper.

Two tubes (№ 5 and № 6) have to be put on ice. Test tubes № 1–5 are carefully brought to 37–40 °C on a water bath, №6 stays at room temperature. Add 1 ml of 1 % solution of raw starch to tube № 4, and 1 ml of 1 % cooked starch to the other tubes (starch solutions are shaken before use).

Stir the contents of the tubes with a glass rod!

Test tubes № 1–5 are placed in a thermostat or water bath at 38 °C, № 6 — on ice.

After 30–40 min the contents of test tubes are examined for the presence of starch by adding 1–2 drops of Lugol's solution.

The contents of the tubes, in which starch is present, turn blue.

PROTOCOL

№	Tube content	t, °C	Color of tube after adding Lugol's solution	Presence of hydrolysis (+/–)
1	1 ml saliva + 1 ml boiled starch	38		
2	1 ml boiled saliva + 1 ml boiled starch	100 → 38		
3	1 ml of saliva + 0.5 % HCl solution + 1 ml of boiled starch	38		
4	1 ml saliva + 1 ml of raw starch	38		
5	1 ml defrosted saliva + 1 ml of boiled starch → in warmth	0 → 38		
6	1 ml defrosted saliva + 1 ml of boiled starch → on ice	0		

Conclusion: hydrolysis of starch occurs due to presence of _____ in saliva. After boiling the saliva and pH changes in acid, enzyme activity is _____. The raw starch is _____ by saliva enzymes, therefore vegetable food rich in starch requires _____ processing The cooling of saliva results in _____ *(increased/decreased)* activity of its enzymes, while restoration of optimal temperature_____ *(increases/decrease)* enzymes activity.

Work 26.4. STUDYING OF THE ENZYMATIC PROPERTIES OF GASTRIC JUICE

Gastric juice is a unique combination of hydrochloric acid (HCl), gastric lipase, and pepsin. Acidic gastric juice is found in all vertebrates, and its main function is to inactivate microorganisms. The phylogenetic preservation of this energy-consuming and, at times, hazardous function (acid-related diseases) reflects its biological importance.

Gastric juice comprises water, mucus, hydrochloric acid, pepsin, and intrinsic factor. Of these five components, pepsin is the principal enzyme involved in protein digestion

Materials and equipment: water bath or thermostat, spirit flame, rack with test tubes, glass-graph, tweezers, natural gastric juice, 4 ml of strained boiled egg white or fibrin, 5 % $NaHCO_3$ solution, 0.5 % HCl solution, pipettes, litmus paper, container for waste materials.

Progress of work

Four test tubes are numbered and poured into test tubes № 1–3 2 ml of gastric juice, in test tube № 4–2 ml of 0.5 % solution of HCl. After that, the contents of test tube number 2 carefully boiled on a spirit flame, and in test tube number 3 drop by drop add 5 % solution of $NaHCO_3$ (soda) to obtain a bluish staining of litmus paper (neutralization of acid). Test tubes are carefully heated in warm (37–40 °C) running water.

In all tubes add 0.5 ml of finely grated egg white and place them in a water bath or thermostat at 38 °C. After 30–40 min the tubes are removed from the thermostat and the change of protein pieces in all tubes is observed.

PROTOCOL

1. Fill in the table based on results.

№	Tube content	t, ^oC	State of fibrin
1	2 ml of gastric juice + 0.5 ml of egg white	38	
2	2 ml of boiled gastric juice + 0.5 ml of egg white	100 → 38	
3	2 ml of gastric juice + $NaHCO_3$ + 0.5 ml of egg white	38	
4	2 ml 0.5 % HCl + 0.5 ml of egg white	38	

2. Make a conclusion.

Conclusion: hydrolysis of proteins occurs in stomach due to presence of _____ and _____. In boiled gastric juice, there is denaturation of _____, so egg white is _____ *(digested or not)*, but it _____ because of presence of _____. Adding $NaHCO_3$ results in neutralization of _____ that _____ activation of pepsin. The egg white _____ *(swell or not)* and _____ *(digested or not)*.

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SESSION 27 (9). THE ROLE OF LIVER IN DIGESTION. DIGESTION IN THE SMALL AND LARGE INTESTINES

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. Digestion in the duodenum.
2. The role of the pancreas for digestion. Composition and properties of pancreatic juice. Phases of pancreatic secretion.
3. Liver role in digestion. Bile formation and bile secretion. The role of the gallbladder. Composition and properties of bile, its participation in digestive processes.
4. Recirculation of bile acids. Regulation of bile formation and biliary excretion on an empty stomach and after a meal.
5. Cavity and membrane hydrolysis of nutrients in the small intestine. Motor activity of the small intestine and its regulation.
6. Absorption of hydrolyzed products of fats, proteins and carbohydrates, vitamins and microelements in different parts of the digestive tract.
7. Digestion in the large intestine. Motility of the large intestine and its regulation.
8. Significance of large intestine microflora for the body. Features of digestion processes, synthesis and absorption in the large intestine.

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NORMAL VALUES OF DIGESTIVE SYSTEM

Liver bile	**Gallbladder bile**	**Pancreatic juice**	**Small intestine juice**	**Large intestine juice**
L = 0.5–1.2 l pH = 7.3–8.0	gallbladder volume — 50–80 ml pH = 5.6–7.5	L = 1.5–2.0 l pH = 7.8–8.4	L = up to 2.5 l pH = 7.2–8.6	L = 0.3–1.5 l pH = 8.5–9.0

Work 27.1. TERMINOLOGY

Bile — _____	Parietal digestion — _____
Gallbladder function is _____	Enteropeptidase — _____
Chyme — _____	The hepatic _____ vein delivers around _____ of the liver's blood supply and carries venous blood rich in _____.

Work 27.2. Assessment of Bile Impact on Fats State

One of bile important functions is emulsification of fats, formation of micelles and solubilization of lipids, which is achieved due to the presence of bile acids — *cholic* and *chenodeoxycholic* and their salts.

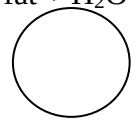
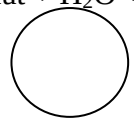
Materials and equipment: glass slides, glass sticks, bile, vegetable oil, distilled water, absorbent cotton, container for collecting waste material.

Progress of work

Take two glass slides, put 1–2 drops of water and vegetable oil on each slide. Add 2 drops of bile to a drop of water and oil on one of the slides. With a glass stick carefully mix first the drop without bile, then with bile, not allowing bile to get into the second drop.

PROTOCOL

Draw how a drop of fat is distributed in water and in the presence of bile and make a conclusion.

fat + H_2O	fat + H_2O + bile
	

Conclusion: the bile is needed for _____

Work 27.3. Parietal Digestion Analysis

The parietal digestion is carried out in the mucus layer between the microvillus of the small intestine and directly on their surface (in the glycocalyx).

Materials and equipment: section of rat small intestine in Ringer's solution, 2 test tubes, tripod, glass, glass and plastic sticks, thread, scissors, Ringer's solution, Lugol's solution, boiled starch solution, pipettes, water bath, absorbent cotton, antiseptic, container for collecting waste materials with disinfectant solution.

Progress of work

Label two test tubes. Pour 1 ml of Ringer's solution and cooked starch solution into both tubes. Using tweezers, place a section of small intestine on the stick. At the bottom, tie the intestine to the stick with a string and use tweezers to twist the intestine by pulling on the free edge. In the first test tube immerse the twisted section of rat small intestine tied to the stick with ligature.

Place both tubes in a water bath for **30 min at 38 °C**, at the end remove the intestine from the tube, and put 1–2 drops of Lugol's solution into both tubes.

PROTOCOL

1. After 30 min, in the tube with the intestine the color becomes _____. The other tube color is _____.
2. Hydrolysis of starch was in test tube _____. It happened due to _____ _____

Work 27.4. Analysis of Blood Plasma Activity

Determination of amylase activity in blood plasma has an important diagnostic value and is used in clinical practice to assess the function of the pancreas.

Materials and equipment: 2 test tubes, tripod, glass slide, glass sticks, rat blood plasma, 1 % solution of boiled starch, water bath, Ringer's and Lugol's solutions, absorbent cotton, container with disinfectant.

Progress of work

Label two test tubes. Pour 1 ml of 1 % solution of boiled starch into tubes with 1–2 ml of blood plasma and of Ringer's solution, mix the solution in each tube with a clean glass rod. Place both tubes in a water bath for ***30 min at 38 °C***. At the end add 1–2 drops of Lugol's solution to both tubes.

PROTOCOL

1. After 30 min, in the tube with plasma color becomes _____. The other tube color is _____ _____.
2. Hydrolysis of starch was in test tube _____. It happened due to _____.

Work 27.5. EFFECT OF NEUROTRANSMITTERS OF AUTONOMIC NERVOUS SYSTEM ON SMALL INTESTINE PERISTALSIS AND ANALYSIS OF NEUROTRANSMITTERS MECHANISM OF EXCITATION CONDUCTION ALONG SMOOTH MUSCLE OF INTESTINES

Nervous regulation of digestive functions is provided by digestive center with conditioned and unconditioned reflexes. Reflex closure can be at the *brain and spinal cord* levels OR at *peripheral ganglia of autonomic nervous system (extramural and intramural).*

Secretory and muscle cells of small intestine change level of functional activity depending on reflex intro- and exteroreceptor and humoral factors. Some chemical substances can change peristalsis of small intestine, because they activate local mechanism of regulation.

Progress of work

1. Open the file **«FINK»**.
2. Select **«Introduction»** → click **«Enter»** → **«Experiments»** → **«Nerve Stimulation»:**

Frequency Response

1A: normal activity of small intestine.

1B: F_5 — 25.0 Hz (stimulation) → Esc.

2A: **Atropine**, 2 μg/ml → Esc.

2B: **Propranolol**, 20 μg/ml → Esc.

2C: **Phentolamine**, 200 μg/ml → Esc.

Adrenergic Drugs

1C: Noradrenaline → Dose response → F_5 (54 μg/ml)

3. To log out from application, click on **«Quit» → «Q» → «Enter» → Alt + Tab**

Instructions for recording the protocol

1. Draw peristalsis of small intestine → **1A.**
2. Draw changes of peristalsis of small intestine after electrical stimulation of sympathetic nerve (25.0 Hz) → **1B**.
3. Draw changes of peristalsis of small intestine after injection of chemical substances and electrical stimulation:

atropine (2 μg/ml) → **2A**;

propranolol (20 μg/ml) → **2B**;

phentolamine (200 μg/ml) → **2C**.

4. Draw changes of peristalsis of small intestine after injection of chemical substances:

Noradrenaline (54 μg/ml) → **1C**.

5. Make a conclusion about the effect of sympathetic nerve stimulation on peristalsis of small intestine. Specify which neurotransmitter is released from postganglionic fibers of ANS and which type of receptors is located in the smooth muscles of small intestine.

PROTOCOL

1A (normal activity)	**1B (25.0 Hz)**	**1C (Noradrenaline)**
2A (Atropine)	**2B (Propranolol)**	**2C (Phentolamine)**

Conclusion: sympathetic nerve stimulation results in _____ the peristalsis of small intestine. Neurotransmitter of postganglionic fibers of ANS is _____. Type of receptors in smooth muscles of small intestine is _____.

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SECTION
"ENERGY BALANCE AND METABOLISM. PRINCIPLES OF HEALTHY NUTRITION"

SESSION 28 (10). METABOLISM AND ENERGY. PRINCIPLES OF HEALTHY NUTRITION

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. The concept of metabolism in the organism. Processes of anabolism and catabolism, their ratio in different functional states of the body.
2. Plastic and energy role of nutrients. The concept of daily need for nutrients. Essential substances for the organism.
3. Energy balance. Basal metabolic rate. Methods of energy expenditure (Basal metabolic rate) determination (direct and indirect calorimetry, calculation using tables and formulas).
4. Total metabolic rate, its components. Energy expenditure at variouslevels of working activity.
5. Body weight as an objective indicator of the coming and energy consumption. The concept of normal body weight and its regulation. Physiological basis of motor activity with excess body weight.
6. Nutrition. Basic principles of healthy nutrition. Nutrition standards depending on age, type of working activity and state of the organism. Daily needs in protein, fats, carbohydrates, dietary fiber, and water.
7. Principles of healthy nutrition, considering the need of prevention of dental caries ("culture of carbohydrate consumption", intake of hard food, etc.).
8. The role of calcium and phosphate in the body, their content in bone tissue and teeth. Balance of calcium and phosphate in the body and in bone tissue: age differences, mechanisms of regulation. Daily requirements for calcium, phosphate and fluoride.

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NORMAL VALUES OF HUMAN METABOLISM

Energy expenditure for basal metabolism	**Caloric coefficient**	
♂ — 1.00 kcal/g in hour ♀ — 0.9 kcal/g in hour	fats — 9 kcal protein — 4 kcal carbohydrates — 4 kcal	Protein daily need — 0.75–1.0 g/kg Ratio of proteins : fats : carbs — 1 : 1.2 : 4.6

Work 28.1. Assessment of Body Weight

Body mass (BM) is important index for analyzing physical development of human body. Expenditure of energy has to be equal to energy consumption to save stable BM. Increased BM is one of the risk factors of different diseases such as heart failure, endocrine disorders, cancer etc. Decreased BM is also dangerous because it can be a sign of some already started disorder.

Materials and equipment: wooden or metal stadiometer (vertical Board or rod with measuring marks and horizontal lath), lever or electronic scales.

Progress of work

1. Measure the height using the wooden or metal stadiometer.
2. Measure the weight using lever or electronic scales.
3. Calculate value of due BM (according different formulas) and compare with measured BM.

Formula 1:

DBM = Height (cm) – 100 (height ≤ 165 cm);

DBM = Height (cm) – 105 (height 166–175 cm);

DBM = Height (cm) – 110 (height ≥ 175 cm).

Formula 2:

DBM (f) = (Height (cm) – 152) × 0.9 + 48;

DBM (m) = (Height (cm) – 152) × 1.1 + 48.

Formula 3 (appendix D, page 80):

Body Mass Index = BM (kg) / Height^2 (m)

PROTOCOL

According formula 1, due body mass — _____ kg;

According formula 2, due body mass — _____ kg;

According formula 3, due body mass — _____ kg.

Conclusion: comparing measured and due values of body mass, BM is _____ *(increased/decreased/same).* If BMI is _____ (↑↓), so it is needed to _____.

Work 28.2. Calculation of the Basal Metabolic Rate Due Values by Tables and Formulas

Basal metabolic rate (BMR) is minimal energy expenditure for ensuring homeostasis in standard conditions.

Standard conditions:

1) The state of being awake (during sleep energy expenditures are reduced by 8–10 %);
2) The state of physical and emotional rest, in the lying position;
3) Fasting state, no less than 12–16 hours of taking a meal;
4) Thermoneutral conditions — about 20–22 °C.

Energy of BMR is used for renewal of cellular structures, maintaining the constant temperature, activity of internal organs, skeletal muscles tone, contraction of respiratory and cardiac muscle.

The daily amount of the basal metabolic rate is easy to calculate using formulas and tables, derived based on the results of a large number of studies of healthy people of different sex, age, body mass and growth.

In Table 28.1 calculation formulas are provided.

Table 28.1

Calculation formulas for human DBM depending on age, sex and body mass (BM) — formula 1

Age, years	Due body mass	
	Men	Women
0–3	60.9 × BM – 54	61.0 ×BM – 51
3–10	22.7 × BM + 495	22.5 ×BM + 499
10–18	17.5 × BM + 651	12.2 ×BM + 746
18–40	**1.0 × BM × 24** **15.5 × BM + 679**	**0.9 ×BM × 24** **14.7 ×BM + 496**
40–60	11.6 × BM + 879	8.7 ×BM + 829
Over 60	13.5 ×BM + 487	10.5 ×BM + 596

y

Work 28.3. Calculation of the Basal Metabolic Rate Due Values by Tables and Formulas (Continuation)

One of the most widely used method for calculating BMR is the **Duboi's method**. It is based on the law that body surface is directly connected with energy expenditure. Heat production per 1 m^2 of body surface depends on age and sex. The body surface area is found by the nomogram depending on body mass and height.

In Table 28.2 information about energy expenditure is provide.

Table 28.2

Expenditures for basal metabolism of healthy people depending on age and sex — formula 2

Age, years	Men, ккcal/m^2·hour	Women, kcal/m^2·hour
14–16	46.0	43.0
16–18	43.0	40.0
18–20	41.0	38.0
20–30	39.5	37.0
30–40	39.5	36.5
40–50	38.5	36.0

Another widely used method for calculating basal metabolic rate (BMR) is the method by **Harris–Benedict**. **Harris–Benedict** tables are the 2 types of tables — for men and for women. Each table consists of **A and B part** *(formula 3).*

– A part consists of information about energy consumption for body weight;

– B part consists of information about energy consumption for height and age.

The summation of A and B number is BMR.

Progress of work

1. Use measured height and weight form previous work 28.2.
2. Calculate BMR according three different methods.

PROTOCOL

1. Sex: _____ (male/female). Age: _____ y.o.
   Height: _____ cm. Weight: _____ kg.
2. According to Table 28.1 (formula 1),
   Due BMR= _____ = _____ kcal in day.
3. According to Table 28.2 (formula 2, p. 79),
   Energy expenditure (E) — _____ kcal/m^2 per hour
   Body surface (S) according to nomogram — _____ m^2.
   BMR = E × S × 24 = _____ = _____ kcal/day.
4. According to Harris–Benedict table (formula 3, appendix A, B; p. 77, 78),
   BMR = A + B = _____ = _____ kcal/day.

Conclusion: different methods allow calculate and analyze basal metabolic rate. The difference between each method is no more than _____ kcal.

Proper daily needs in nutrients			
Nutrients	**% of total energy consumption**	**E, kcal**	**Weight, g**
Proteins			
plant origin			
animal origin			
Fats			
saturated			
unsaturated			
Carbohydrates			
complex			
sugars			

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SECTION
“THERMOREGULATION”

SESSION 29 (11). PHYSIOLOGY OF THERMOREGULATION

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. Thermoregulation. The concept of homeothermia, poikilothermia and heterothermia.
2. Human body temperature and its daily fluctuations. Temperature of different skin areas and internal organs.
3. The concept of hypo- and hyperthermia, fever. Nervous and humoral mechanisms of thermoregulation.
4. Peripheral and central thermoreceptors. Thermoregulation centers. Functional system maintaining the constant temperature of the internal body environment.
5. Thermal diagnostics in dentistry. Determination of thresholds of heat and cold sensitive teeth. Changes in caries.
6. Heat production of the body. Sources of heat production in the body. Contractile and non-contractile thermogenesis. Metabolic processes in brown adipose tissue. Regulation of heat production processes.
7. Heat loss of the body. Heat transfer within the body. Physical processes and physiological mechanisms providing heat loss. Regulation of heat loss processes.

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4. *Ganong’s* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 29.1. TERMINOLOGY

Heat loss — _____

Heat production — _____

Heat loss types: 1) _____; 2) _____; 3) _____; 4) _____.

NORMAL VALUES

0.56–0.58 kcal is lost per 1 g (1 ml) of evaporated water
relative humidity level — 40–60 %
Set-point — **37.1 °C**
Axial temperature — **36 ± 0.9 °C** (35.1–36.9 °C)
Oral temperature — **35.5–37.5 °C**
Rectal temperature — **36.0–38.0 °C**

Work 29.2. Measurement of the Axillary Body Temperature

Body temperature is important parameter of human body. The temperature of deep tissues of the body remains constant while skin temperature is more variable.

Normal range of axillar temperature — **36 ± 0.9 °C** (from minimally 35.1 to 36.9 °C maximally during day). Temperature 37 °C or above is considered high (hyperthermia); 35 °C and below as subnormal (hypothermia).

The temperature is measured using a contact (mercury, electronic thermometers) or remote (infrared cameras) methods (Fig. 29.1).

Fig. 29.1. Different types of thermometer

Materials and equipment: electronic, non-mercury, infrared thermometers, antiseptic solution, gauze balls.

Progress of work

1. Observe thermometer: it has to be intact and undamaged. Switch on the electronic thermometer by pressing the button and wait for a beep. It is calibrated and ready for use, the symbol "L" will appear on the display.
2. Place the thermometer in the armpit and press it tightly shoulder. Armpit has to be dry because damp skin thermometer shows a lower temperature.
3. Record the data on display in 30 seconds, 1 min, 2 min, 5 min, 10 min. The second beep does not mean that thermometer finished the measurement.
4. Fill in the data in protocol.

PROTOCOL

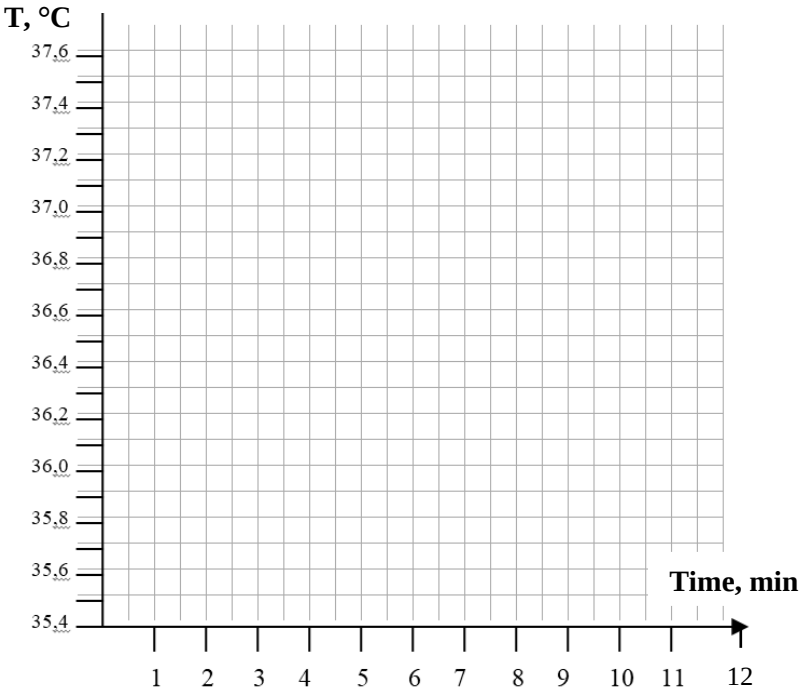
1. Fill in the Table 29.1.

Table 29.1

Measurement results

Time	30 sec	1 min	2 min	5 min	8 min	10 min	12 min
t °C							

2. Draw a graph based on Table 29.1.



3. Make a conclusion.

Conclusion: the axillar temperature of tested person is _____ °C. It is _____ *(hypothermia/ hypothermia/ normal temperature).* The duration of measurement has to be no less than _____ min.

Work 29.3. Assessment of Thermal Sensitivity of Teeth

Determination of heat sensitivity of teeth is one of the most effective ways to evaluate the dental pulp state. As irritants, a dentist can use ether, but cold and hot water is much easier to use. Technique is easy — applying the gauze ball soaked in water of different temperature to the tooth surface.

Indifferent zone (zone with no reaction) for incisors is **30 °C** (50–52 °C — reaction to coldness; 17–22 °C — reaction to warmness). The pain may occur outside the zone. Adequate threshold reaction is a sign of normal state of pulp. In case of inflammation in pulp the narrowing of zone appears; it may cause prolonged and strong pain. Teeth with necrotized pulp do not react to heat irritants.

Materials and equipment: 2 glasses, container with cold water, container with hot water, electronic thermometer, gauze balls.

Progress of work

1. Prepare solution with different temperature: 15, 20, 25, 30, 35, 40, 45, 50, 55 °C. Use thermometer to control the temperature.
2. After preparation of solution, put gauze ball in the water and place on the surface of incisors. Analyze the reaction.
3. Fill in the protocol.

PROTOCOL

1. The heat sensitivity of incisors is: for coldness — _____ °C; for warmness — _____ °C. Value of indifferent zone is _____ °C.
2. Conclusion: comparing with normal sensitivity of teeth, the tested person's sensitivity is _____ *(in norm/impaired)*, pulp state is _____ *(in norm/inflammation signs).*

Work 29.4. Nervous regulation of Heat Loss

Nervous regulation of heat loss is provided by several types of reaction.

Skin **vasodilation** develops due to decreased sympathetic influence. Warm blood from deep tissues brings warmth to the skin surface and increases skin temperature.

Skin **vasoconstriction** develops due to stop of blood flow through skin capillaries because arteriovenous anastomoses open between arterioles and venules. Blood does not enter the surface layers of the skin, and heat is effectively conserved in the body core.

Using E-learning materials & lecture, fill in the Table 29.2.

Table 29.2

Nervous regulation of heat loss

Organ	Smooth muscles of skin vessels	Thermoregulatory sweating glands
ANS part	Sympathetic	Parasympathetic
Neurotransmitter		
Type of receptor		
Physiological effect	1) contraction of smooth muscles 2) _____ heat loss 3) vaso_____	1) _____ secretion of sweating glands 2) _____ heat loss

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SECTION
"PHYSIOLOGY OF EXCRETION"

SESSION 30 (12). PHYSIOLOGY OF EXCRETION

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. Excretory system. Organs of excretion (kidneys, skin, lungs, digestive tract). Their participation in the maintenance of homeostasis.
2. Kidney. Excretory and non-excretory functions of the kidney.
3. Nephron as a structural and functional unit of the kidney. Renal blood flow, its features. Structure of the renal filter.
4. Mechanism of glomerular filtration. Effective filtration pressure and factors affecting it.
5. Formation of primary urine, its quantity and composition.
6. Mechanisms of tubular reabsorption in various parts of the nephron tubules and collecting ducts. Features and mechanisms of reabsorption and secretion of various substances in nephron. Countercurrent system of the renal medulla, its physiological role.
7. Mechanism of urine concentration. The role of urea.
8. Excretory secretion and synthesis in the kidney.
9. Kidney participation in the maintenance of acid-base state, osmotic pressure, ionic composition of blood, circulating blood volume, in the regulation of systemic blood flow, hematopoiesis, water-electrolyte balance.
10. Common urine analysis. General properties and basic principles of assessment.

LITERATURE

Main

1. Lecture & E-learning materials.
2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 587–634.

Additional

1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 30.
2. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013. P. 628–650.
3. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
4. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 30.1. TERMINOLOGY

The urinary system consists of:
1) _____; 2) _____;
3) _____; 4) _____.

Juxtaglomerular apparatus is _____

Filtration is movement from _____ to _____
Reabsorption is movement from _____ to _____
Secretion is movement from _____ to _____
Excretion is movement from to

Work 30.2. STRUCTURE OF NEPHRON MODEL

Using E-learning materials, lecture & textbook, fill in the boxes.

Description:
F — filtration
R — reabsorption
S — secretion
E — excretion

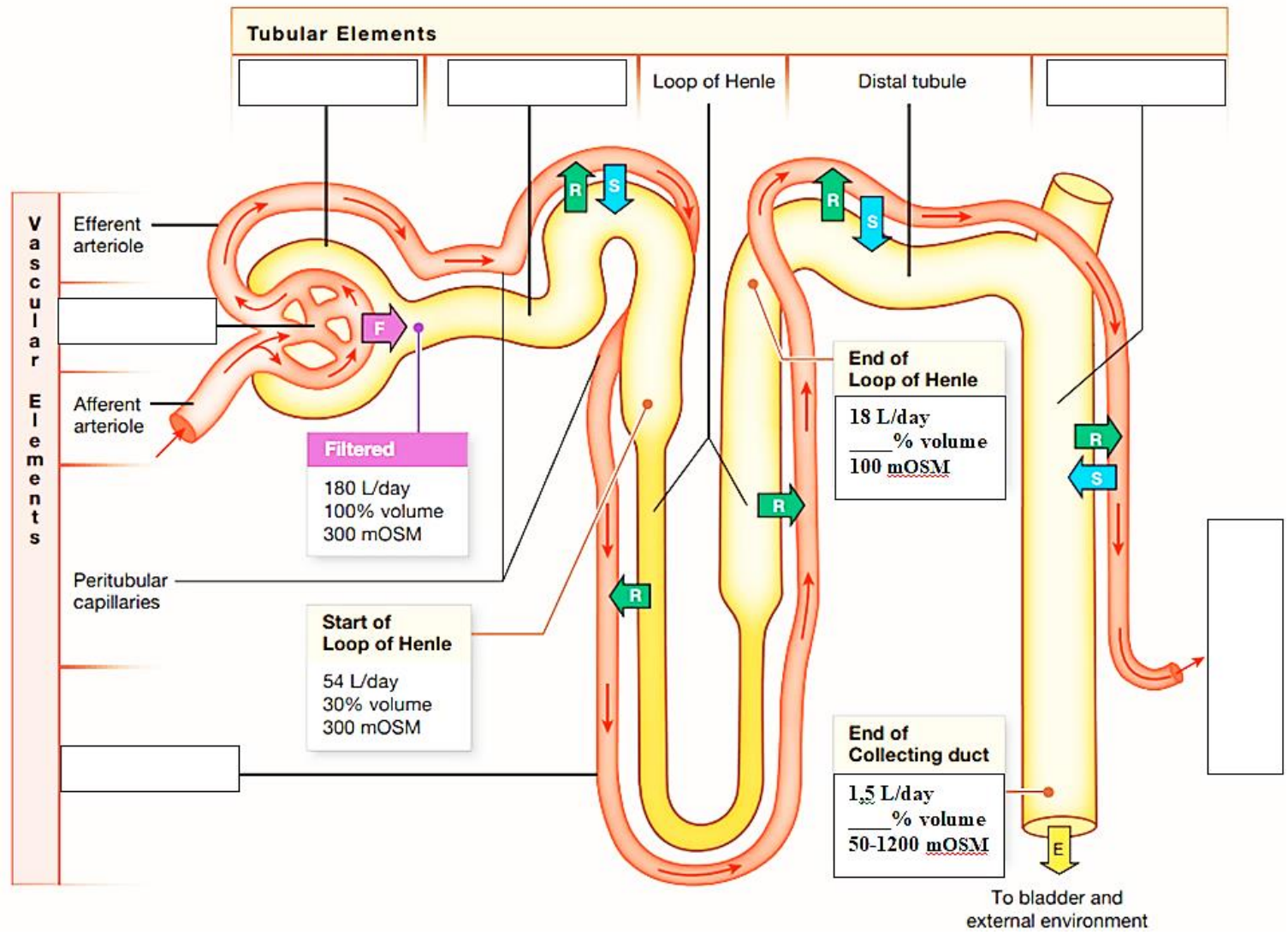


Fig. 30.1. Nephron model

Work 30.3. Performing a Common Urine Analysis Using the Express Method

An **express urine test** is the quickest way to test urine. This involves dipping a test strip with small square colored fields on it into the urine sample for a few seconds. After that you have to wait a little for the result to appear. Depending on the concentration of the particular substance you are testing for, the fields on the test strip change color. Then the resulting colors of the fields are compared with a color table. The color table can be found on the urine test package. It shows which colors indicate normal and abnormal values.

In a rapid urine test, a test strip is dipped into the urine and then compared with the colored fields on the packaging.

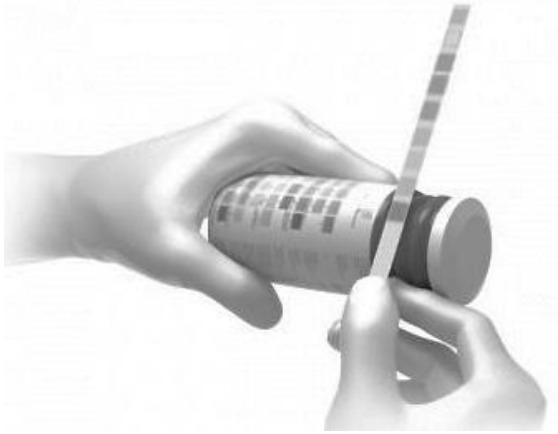


Fig. 30.2. An express urine test

To get an accurate result and avoid bacterial contamination, "clean" midstream urine is used. You take a sample of midstream urine by interrupting the flow of urine after a few seconds and then collecting this middle portion of the urine in a clean cup.

The urine cannot be kept in long time, because it can cause changing of its physical properties, and the destruction of cellular elements, bacteria reproduction. Almost all urinalysis is conducted no later than 1–1.5 hours after getting an urine sample.

Many substances are usually found only in certain amounts in urine, so higher or lower levels indicate a deviation from the norm.

You can determine whether the results are within the normal range by using the package insert or the color chart on the package. Tests measuring other things can help detect other problems.

Progress of work

Urinalysis involves determination of its color; transparency; reaction (pH); relative density (SG); presence and degree of concentration of protein and glucose; count of erythrocytes and leukocytes; count of epithelial cells of the urinary tract and the casts; salts and identification of bacteria.

The following substances can be checked using a rapid urine test:

– pH value (measure of the acidity of the urine)
– Protein (not usually found in urine)
– Sugar (glucose, not usually found in urine)
– Nitrite (not usually found in urine)
– Ketone (a metabolic product, not usually found in urine)
– Bilirubin (breakdown product of hemoglobin, not usually found in urine)
– Urobilinogen (breakdown product of bilirubin, not usually found in urine)
– Red blood cells (erythrocytes, not usually found in urine)
– White blood cells (leukocytes, not usually found in urine)

Instruction for recording the protocol

1. Perform a urinalysis:

Remove the test strip from the tube; take a plastic cup and serviette to the toilet. The test strip should be held in a couple of minutes in the test liquid and wet with serviette, then in the study laboratory attach the test strip to the tube under the corresponding indicator and the color and write down the received result in a table.

2. Fill in the Table 30.1.

3. Compare result and normal values. Make a conclusion.

PROTOCOL

Table 30.1

Urinalysis results

Parameter	Normal values	Obtained results	Conclusion
Color	Yellow		
pH	4.5–8.0		
Specific gravity (SG)	1.010–1.025		
Glucose (GLU)	None, not identified by this method		
Protein (PRO)	No traces		
Ketone bodies (KET)	None, not be detected by this method		
Bilirubin (BIL)	None		
Urobilinogen (UBG)	3.2 micromol/l (0.2 E.U./dl)		
White blood cells (WBC / LEU)	None (0–4 cel/mcl), not be detected by this method		
Occult blood (BLO)	None		

Conclusion. Parameters of urinalysis in the tested person: _____

_____

_____

Fig. 30.3. A tube for express urinalysis

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer’s signature

SESSION 31 (13). COLLOQUIUM. CONCLUDING SESSION ON THE SECTIONS "PHYSIOLOGY OF DIGESTION", "ENERGY BALANCE AND METABOLISM. PRINCIPLES OF HEALTHY NUTRITION", "THERMOREGULATION", "PHYSIOLOGY OF EXCRETION"

DATE OF CLASSES
«____» _____ 20___
day month year

THEORETICAL QUESTIONS:

1. Food motivations. Appetite. Physiological mechanisms of hunger and satiety. Mechanisms of regulation of eating behavior. Digestive and non-digestive functions of the digestive system. Types of digestion depending on the origin of hydrolases and localization of hydrolysis.
2. Digestion in the oral cavity. Mechanical and chemical digestion of food. Formation of food clump. The concept of masticatory digestion.
3. Functional characteristics of the mastication apparatus. The role of mastication and mimic muscles, various types of teeth and temporomandibular joints in the process of mechanical digestion of food in the oral cavity.
4. Hard tissues of the tooth. Enamel: structure, properties, functions, features of "nutrition". Enamel permeability for various substances.
5. Fluids of oral cavity: oral ("mixed saliva"), gingival, saliva salivary glands. Functions and composition of oral fluid.
6. Protective function of oral fluid. Mechanisms and ways to protect teeth from caries.
7. Swallowing, its phases. Reflex regulation of swallowing. The knowledge of this mechanism for dentists. Functional relationship of the breathing, chewing and swallowing.
8. Digestion in stomach. Functions of stomach. Composition and properties of gastric juice. Role of hydrochloric acid and gastric mucus. Mechanism of formation and secretion of hydrochloric acid. Nervous and humoral mechanisms of their regulation. Phases and mechanisms of regulation of gastric gland secretion before and after a meal. Motor and evacuation functions of the stomach before and after a meal.
9. Digestion in the duodenum. The role of the pancreas in digestion. Composition and properties of pancreatic juice. Phases of pancreatic secretion.
10. Liver role in digestion. Bile formation and bile secretion. The role of the gallbladder. Composition and properties of bile, its participation in digestive processes. Recirculation of bile acids. Regulation of bile formation and biliary excretion on an empty stomach and after a meal.
11. Cavity and membrane hydrolysis of nutrients in the small intestine. Motor activity of the small intestine and its regulation. Absorption of hydrolyzed products of fats, proteins and carbohydrates, vitamins and microelements in different parts of the digestive tract.

LITERATURE

Main

1. Lectures & E-learning materials.
2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016.

Additional

1. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013.
2. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
3. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

12. Digestion in the large intestine. Motility of the large intestine and its regulation. Significance of large intestine microflora for the body. Features of digestion processes, synthesis and absorption in the large intestine.
13. Metabolism of substances and energy in the body. Processes of anabolism and catabolism, their ratio in different functional states of the body. Maintenance and energetic role of nutrients. The concept of daily need for nutrients. Essential substances for the organism.
14. Energy balance. Basal metabolic rate. Energy expenditure of the body during various types of labor activity.
15. Nutrition. Physiological bases and principles of healthy nutrition. Nutrition standards depending on age, type of labor and body condition. Daily needs in protein, fats, carbohydrates, dietary fiber, and water. Principles of healthy nutrition, considering the need of prevention of dental caries ("culture of carbohydrate consumption", intake of hard food, etc.).
16. The role of calcium and phosphate in the body, their content in bone tissue and teeth. Balance of calcium and phosphate in the body and in bone tissue: age differences, mechanisms of regulation. Daily requirement for calcium, phosphate and fluoride.
17. Thermoregulation. The concept of homeothermia, poikilothermia and heterothermia. Human body temperature and its daily fluctuations. Temperature of different skin areas and internal organs. The concept of hypo- and hyperthermia, fever. Nervous and humoral mechanisms of thermoregulation.
18. Peripheral and central thermoreceptors. Thermoregulation centers. Functional system maintaining the constant temperature of the internal body environment.
19. Heat production of the body. Sources of heat production in the body. Contractile and non-contractile thermogenesis. Metabolic processes in brown adipose tissue. Regulation of heat production processes. Heat loss of the body. Heat transfer within the body. Physical processes and physiological mechanisms providing heat loss. Regulation of heat loss processes.
20. Excretory system. Organs of excretion (kidneys, skin, lungs, digestive tract). Their participation in the maintenance of homeostasis. Kidney. Excretory and non-excretory functions of the kidney.
21. Nephron as a structural and functional unit of the kidney. Renal blood flow, its features. Structure of the renal filter. Mechanism of glomerular filtration. Effective filtration pressure and factors affecting it. Formation of primary urine, its quantity and composition.
22. Mechanisms of tubular reabsorption in various parts of the nephron tubules and collecting ducts. Features and mechanisms of reabsorption and secretion of various substances in nephron. Countercurrent system of the renal medulla, its physiological role. Mechanism of urine concentration. The role of urea.
23. Excretory secretion and synthesis in the kidney. Kidney participation in the maintenance of acid-base state, osmotic pressure, ionic composition of blood, circulating blood volume, in the regulation of systemic blood flow, hematopoiesis, water-electrolyte balance.

Structure of colloquium:

Step 1. Computer test
http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 31.
Grade to pass is 60 %!

Step 2. Oral conversation

Marks for computer test

The percentage of correct answers	Mark for the quiz
98 % – 100 %	9 points
82 % – 91 %	8 points
84 % – 91 %	7 points
76 % – 83 %	6 points
68 % – 75 %	5 points
60 % – 67 %	4 points
41 % – 59 %	3 points
21 % – 40 %	2 points
0 % – 20 %	1 point

PRACTICAL QUESTIONS (SKILLS): 1. Sialometry conduction and physiological assessment of the obtained data. 2. Assessment of carbohydrate hydrolysis in different states (pH, t). 3. Assessment of bile impact on fats state. 4. Physiologic assessment of the composition and properties of terminal urine. Common urine analysis. 5. Measurement of axial body temperature using liquid and electronic thermometers: analysis of possible errors during performance. Physiological assessment of the obtained data. 6. Assessment of thermal sensitivity of teeth. 7. Measurement of body mass. Calculation of body mass index. Physiological assessment of the obtained data and formulation of scientifically based recommendations for the body weight correction.	

Permission to pass the colloquium approved for _____

(Student name, Lecturer signature)

Test mark	Mark for oral part

The colloquium is passed _____

(Lecturer signature)

SECTION
“PHYSIOLOGY OF SENSORY SYSTEMS”

SESSION 32 (14). GENERAL PHYSIOLOGY OF SENSORY SYSTEMS. PHYSIOLOGY OF THE VISUAL SYSTEM

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:	**LITERATURE**
1. The concept of sensory organs, analyzers, sensory systems. Classification of sensory systems. 2. General principles of the structure of sensory systems. Information processing in sensory systems. 3. Receptor part of the analyzer. Classification and functional properties of sensory receptors. Mechanisms of functioning of primary and secondary sensory receptors. Encoding of information about the quality and strength of the stimulus. 4. Analog and discrete coding in receptors. Adaptation of receptors. Classification of receptors according to their ability to adapt. 5. Visual system. Structure, functions. 6. Features of the structure and properties of the eye, providing the function of vision. 7. Optical media of the eye. Refraction and accommodation, the nearest and farthest point of clear vision in different age periods. 8. Visual acuity. The concept of emmetropia, myopia, hypermetropia, presbyopia and principles of their correction.	***Main*** 1. Lecture & E-learning materials. 2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 635–683. ***Additional*** 1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 32. 2. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013. P. 357–371. 3. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021. 4. *Ganong’s* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 32.1. TERMINOLOGY

Sensory system — _____	Analyzer consists of three parts: 1) _____; 2) _____; 3) _____.
Vision — _____	Emmetropia — _____
Optic tract — _____	Astigmatism — _____

Work 32.2. Assessment of Visual Acuity

Visual acuity is the ability to see clearly surrounding objects placed at various distances. Usually it is determined as the ability to identify separately two nearly located points (Fig. 32.1). It is clear that the higher is the distance to the points, the higher should be the distance between points to discriminate them. But the angle of vision remains constant.

Normal human eye is able to discriminate between two points placed under the angle of vision of about **1 minute of arc (1′).**

Parallel light rays pass through a flattened lens, and the focal point falls on the retina.

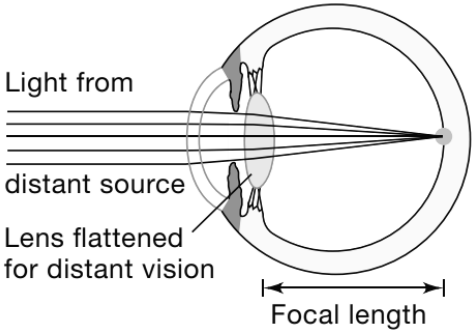


Fig. 32.1. Emmetropia

Progress of work

To evaluate visual acuity **the special tables** are used (Fig. 32.2). These tables contain the images (usually letters or pictures) of various sizes. The examined should stay at a distance of 5 meters with one eye covered with a shield. The examiner checks the ability to recognize letters from the table, starting from the biggest ones and passing to the smaller until the letters are not recognized clearly. The last correctly recognized line of letters is taken for the determination of visual acuity level. It is calculated by the formula.

$$V = d / D,$$

where V — visual acuity (visus); d — distance to the table (5 m); D — distance, from which a normal eye must clearly see letters of the given line (usually is indicated in the table to the left of every line).

Normal visual acuity is taken as 1.0.

In case the last line that examined clearly sees is the line which should be seen from 5 m, the visual acuity is 1.0 (5/5=1). If the last line clearly seen by a patient should be seen from 25 m, the visual acuity is therefore 5/25=0.2. The corresponding level of visual acuity (visus, v) is indicated in the table to the right of every line (v=0.1, v=0.2 and so on).

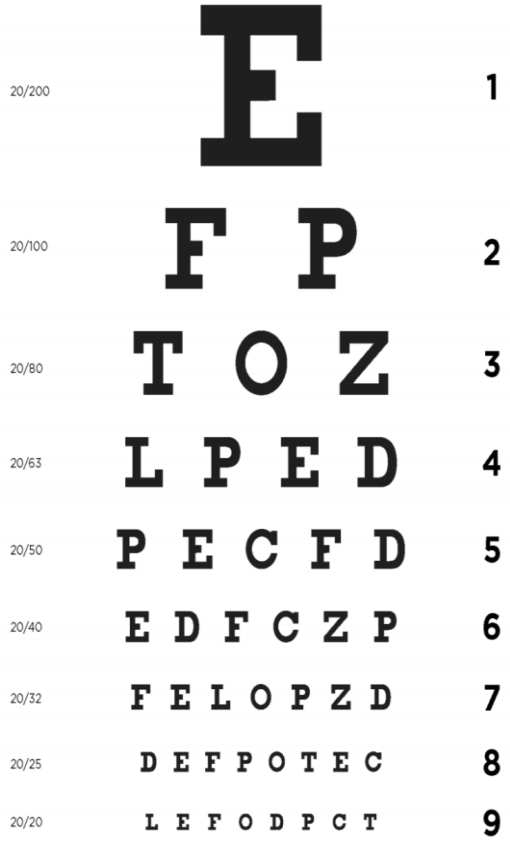


Fig. 32.2. Table for visual acuity

PROTOCOL

1. Evaluate visual acuity for both eyes:
   right eye — _____; left eye — _____.
2. Right eye visual acuity is _____ *(in norm/ increased/ decreased).*
3. Left eye visual acuity is _____ *(in norm/ increased/ decreased).*

Work 32.3. Determination of Visual Field Bounds (Perimetry)

Vision field is the space seen by a human eye, when the sight is fixed at one point. The value of visual field is not identical in different people and depends on the *functional state of the retina, depth of the eye-ball, sizes and forms of superciliary arches and the nose*.

There are color (chromatic) and colorless (achromatic) visual fields. Achromatic visual field is larger than the chromatic one, because rods are located predominantly on periphery of the retina.

For various colors visual field is not identical either: it is the greatest for yellow color and the narrowest for green color. Approximate limits of the achromatic visual field towards outside is 100°, towards inside and upwards — 60° and downwards — 65°.

Materials and equipment: Forster's perimeter, objects of various colors, a ruler, colored pencils.

Modern visual field assessment equipment is an analyzer that reads light emitters (Fig. 32.3). The analyzer displays stimuli of different sizes and intensities on a special screen, and the patient then reports their visibility in their field of vision. It counts the number of dots and then records them on an ophthalmic chart.

Fig. 32.3. Modern visual field assessment equipment

Progress of work

1. The study is performed using Forster's perimeter that is a stand-holder with a movable calibrated (in degrees) metal arch with divisions on a lateral side. The examined must seat with his back to light and put his chin on a rest of the stand-holder at the right (while examining the left eye) or at the left (while examining the right eye). Regulate the height of the rest so that the lower edge of the eye cavity was at the sight-plate level.

Fig. 32.4 shows the correct position of head to perimeter.

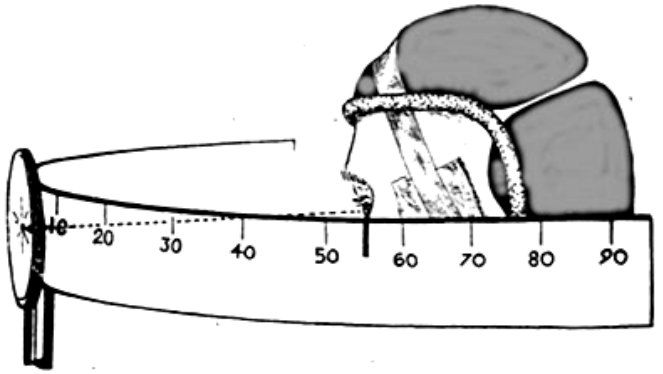


Fig. 32.4. Position of head during perimetry

2. During the whole experiment the sight of the examined stays fixed on a white point of the perimeter, the other eye is covered with a shield. Start the examination with a horizontal position of the perimeter. Slowly move the colorful object (a white square or a circle 5–10 mm in diameter) along the internal arch surface from 90° to 0°; the examined should point out the moment of appearing the object in the visual field and name its color. Repeat the study in a vertical and two oblique positions of the perimeter for objects of white, green and blue color.

Work 32.4. DETERMINATION OF VISUAL FIELD BOUNDS (PERIMETRY) (continuation)

PROTOCOL

1. Fill in the Table 32.1, identifying the angle of limits.

Table 32.1

Perimetry results

Direction	Limit of visual field for the right eye °. Color:			
	White	Yellow	Green	Red
180° (outwards)				
135° (outwards above)				
90° (upwards)				
45° (inwards above)				
0° (inwards)				
315° (inwards down)				
270° (downwards)				
225° (outwards down)				

2. Draw a curve identifying the limits of achromatic (white) and chromatic (colorful) vision. Compare the difference between achromatic and chromatic vision.

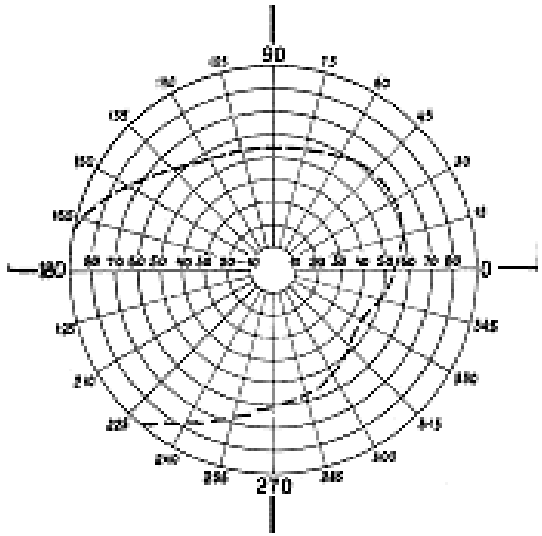


Fig. 32.5. Limits of visual fields

3. **Conclusion:** _____

Work 32.5. ASSESSMENT OF COLOR VISION

The human eye can discern both shades of black, white, grey colors and all colors and shades of the rainbow. However, there occur various disorders of color perception in some people. Complete color blindness occurs extremely rare. People with this form of color vision disorder see only various shades of grey. Partial color blindness occurs more often.

Studying color vision has a particular significance for people, whose profession requires good orientation in all colors.

Materials and equipment: polychromatic plates of E. B. Rabkin, a shield for covering one eye, a centimeter tape.

Progress of work

Every table should be set at the eye level of the examined at the distance of 1 m from him. The exposure duration of one and the same table is about 5 sec. Each eye is examined separately, the second eye being covered with a special shield.

PROTOCOL

1. The tested person identified _____ *(correctly/ non-correctly)* each number, letter, sign.

2. Conclusion: _____

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SESSION 33 (15). SPECIAL PHYSIOLOGY OF SENSORY SYSTEMS. SENSORY FUNCTION OF MUCOUS MEMBRANES AND STRUCTURAL FORMATIONS OF THE ORAL CAVITY

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. The auditory system. Peculiarities of the structure and properties of the sound-conducting apparatus. Functions of the outer and middle ear. Defense reflexes.
2. Sound-perceiving apparatus of the auditory system. Inner ear structures, their functions. Mechanism of hair cells excitation.
3. Mechanisms of sound perception and analysis. Frequency coding and sounds strength. Information transmission and processing in the conductive pathways and auditory system central parts. Auditory cortex.
4. The vestibular system, its functions. Peculiarities of the structure and properties of the receptor department.
5. Functions of vestibular receptors of the vestibule and semicircular ducts. Perception mechanism, body position and movement in space evaluation.
6. Transmission and processing of information in the conductive pathways and central parts of the vestibular system.
7. The olfactory system. Reception of odors. Conducting pathways and central parts of the olfactory system.
8. The taste system. Taste perception. Conducting pathways and central parts of the taste system. Perception and classification of tastes. The organism reactions to taste stimulation. Taste adaptation.
9. Biological significance of pain. Nociception. Features of pain sensitivity of dental hard tissues. Pain and antinociceptive systems. Neurochemical mechanisms of antinociception.

LITERATURE

The main

1. Lecture & E-learning materials.
2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 635–683.

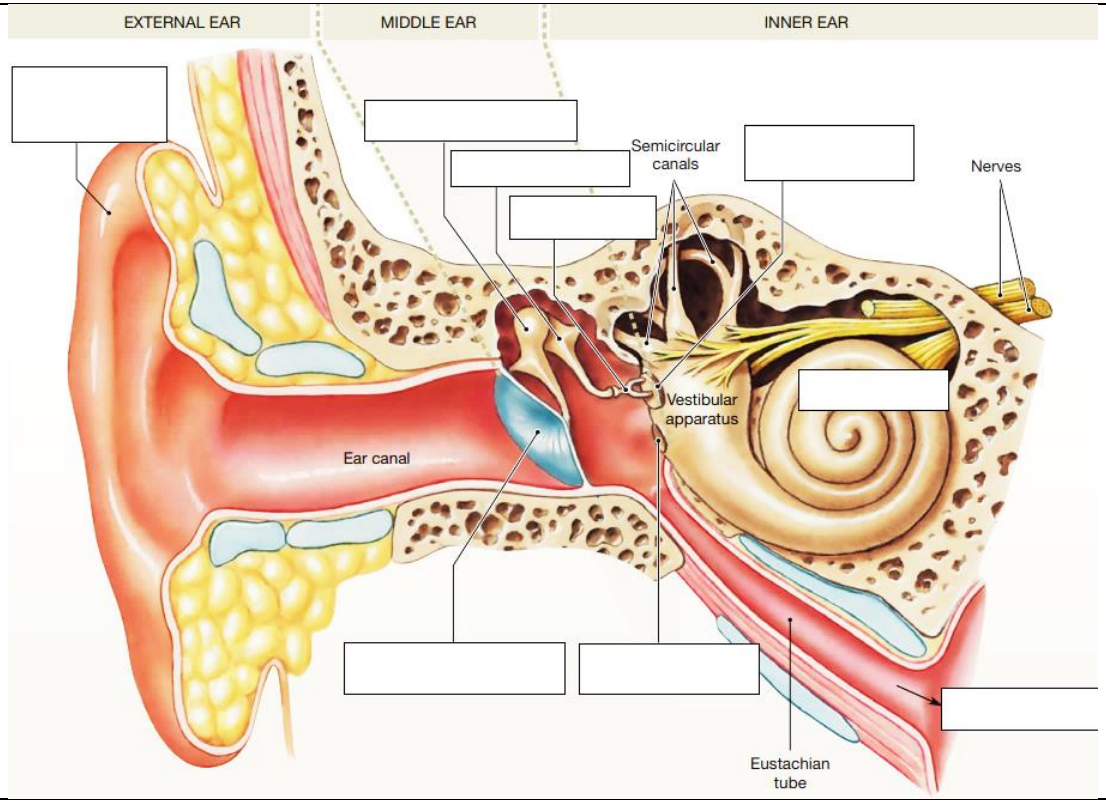
Additional

1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 33.
2. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013. P. 31–345, 346–356.
3. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.

Work 33.1. TERMINOLOGY

Sound is _____	The peripheral part of the vestibular system consists of: _____
Eardrum is _____	Linear acceleration is _____
Microphone potential is _____	Taste buds are _____

Work 33.2. Studying the Structures of Outer, Middle and inner Ear



Fill in the boxes and complete sentences.

1. Ear pinna _____ sound waves and directs in to the _____ auditory canal. This canal helps in maintaining temperature and _____ near the eardrum.
2. The eardrum is connected to the handle of _____, which is connected to the _____, which in turn is connected to the smallest ossicle, _____.
3. Eustachian tube connects middle ear with _____. The tube can be compressed during _____.
4. Passive changes of the eardrum tension occurs due to _____
_____
5. Active changes of the eardrum tension occurs due to _____
_____

Work 33.3. Studying Some Mechanisms of the Sound Source Direction

Determination of sound source is based on the two factors. Firstly, it is intensity of sound, or loudness. There are soft and loud sounds. Secondly, it is frequency of sound, or pitch. There are lower and higher sounds.

Materials and equipment: a camertone, a phonendoscope with tubes of different lengths.

Progress of work

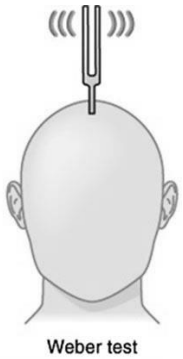
1. Tested person has to close their eyes. Then, they must determine the source of direction. Sound can be created by tapping (pencil over pencil) on the right and left sides, at front of and back of tested person.
2. Ask tested person insert the olives of phonendoscope in the ears. Repeat the experiment. Determine if tested person perceive the sound better at side with longer or shorter tube. Explain the difference.

PROTOCOL

1. Tested person determined direction _____ *(correctly/incorrectly)*
2. The sound is perceived better at _____ tube because _____
_____

Work 33.4. Studying of Bone and Air Conduction

Weber's Test



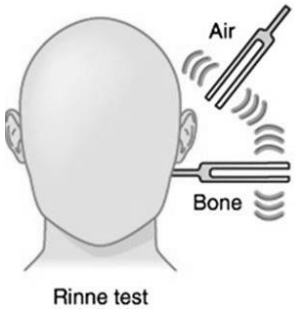
Sound can be conducted to the internal ear receptors by the way of usual air conduction (through the middle ear) and by bone conduction. Bone conduction is the transmission of sound waves directly to the internal ear involving into oscillations cranial bones (the temporal bone) and internal ear fluids, resulting in the oscillation of the basilar membrane and excitation of receptors.

Materials and equipment: a camertone, a stop-watch, cotton pads.

Progress of work

1. Apply the handle of the vibrating camertone to the top of the head in its middle line. Ask the examined if he hears by both ears the sound of the same intensity or it is heard better with one ear.
2. In the damage of the sound-perceiving apparatus lateralization of the sound is noted to the side of a healthy ear, in the damage of the sound-conducting apparatus the sound is lateralized to the side of the damaged (poorly hearing) ear.
3. Repeat the experiment covering the one auditory canal with cotton.

Rinne's test



The test is needed to compare the time of the air and bone conduction.

Materials and equipment: a camertone, a stop-watch, cotton pads.

Progress of work

1. Press the handle of the oscillating camertone to a mastoid bone at one side and measure the time till sound sensation disappears (the time of bone conduction).
2. Then bring the same camertone with its still vibrating branches closer to an external auditory canal and continue to count time. In norm the examined continue to hear sound of the camertone that is still oscillating because of the better sound conduction through the middle ear that amplifies sound.
3. The total time, during which the sound is heard, is the time of air conduction. In norm the time of air conduction is greater than that of bone conduction (*a positive Rinne's test*). When the sound-conducting apparatus is impaired, the time of air conduction does not exceed the time of bone conduction (*a negative Rinne's test*).

PROTOCOL

1. Weber's test:
   Sound intensity on the right and left sides is _____.
   After closing the canal: _____.
2. Rinne's test:

	Air conduction (s)	Bone conduction (s)
On the left		
On the right		

Air conduction _____ Bone conduction (=, <, >)

Table 33.1

Interpretation of results

Hearing loss	Weber localization	Rinne conduction
None	Midline	Air > bone
Sensorineural	Normal ear	Air > bone
Conductive	Affected ear	Bone > air

3. **Conclusion:** _____

Work 33.5. Studying the Dependence of Auditory Sensitivity on Sound Frequency (Audiometry)

The limits of sound frequencies perceived by humans are:

16–20 – 16 000–20 000 Hz

Sensitivity to sounds of different frequencies is very different. Sensitivity can be assessed by the value of the **threshold of hearing**: *minimal intensity* of sound of the certain frequency, causing the sensation of hearing.

Sound intensity is assessed by the sound pressure. Usually the logarithmic index is used, Sound Pressure Level, which is measured in **decibel, dB**. The less is the threshold, the higher is sensitivity.

Minimal thresholds and maximal sensitivity is found in the range of frequencies from **1000–4000 Hz that** corresponds to the frequencies of the speech. For lower or higher frequencies the thresholds increase (i.e. sensitivity decreases) dramatically

Materials and equipment: an audiometer, earphones.

Progress of work

Using the sound generator, determine thresholds of absolute auditory sensitivity (in decibels) for the left and right ear for the following frequencies.

Instructions for recording protocol:

1. Enter the data in a Table 33.1.
2. Results build the audiogram test subject (Fig. 33.1).
3. Make a conclusion.

PROTOCOL

Table 33.2

Sound sensitivity thresholds

Frequency	dB	Frequency	dB
150 Hz		4 000 Hz	
500 Hz		5 000 Hz	
1 000 Hz		8 000 Hz	
2 000 Hz		11 000 Hz	
3 000 Hz		15 000 Hz	

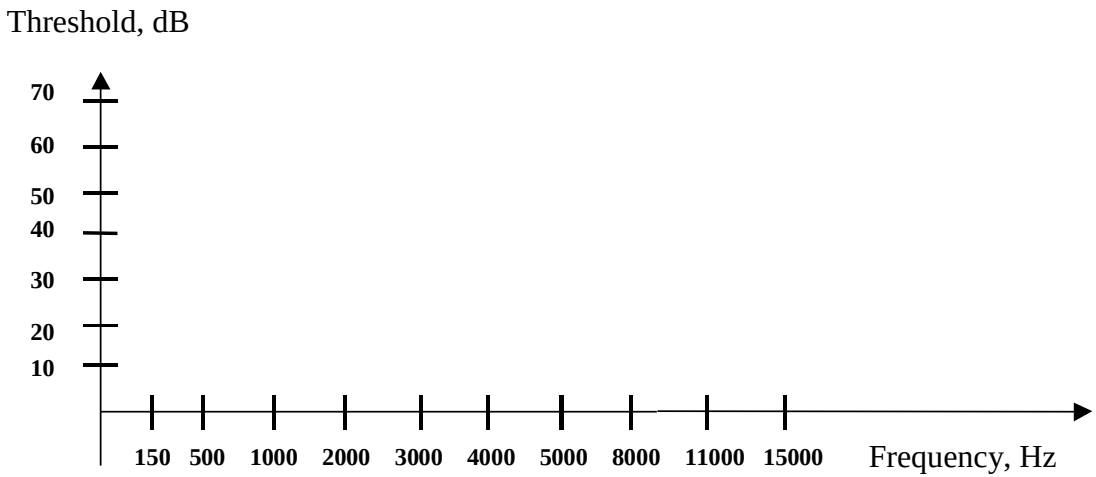


Fig. 33.1. Sound sensitivity thresholds

Conclusion: the minimal threshold of tested person equals _____ dB; the maximal threshold of tested person equals _____ dB.

Work 33.6. Studying of Tactile Sensitivity. Esthesiometry (Measurement of Spatial Thresholds)

Esthesiometry is the method of measuring **tactile sensitivity**. There is a spatial threshold that is determinded by the power threshold. Spatial threshold of tactile sensitivity is characterized by that least distance between two points of the skin, in simultaneous touching to which a sense of two touches occurs (Fig. 33.2). It characterizes the spatial discriminative ability of the skin.

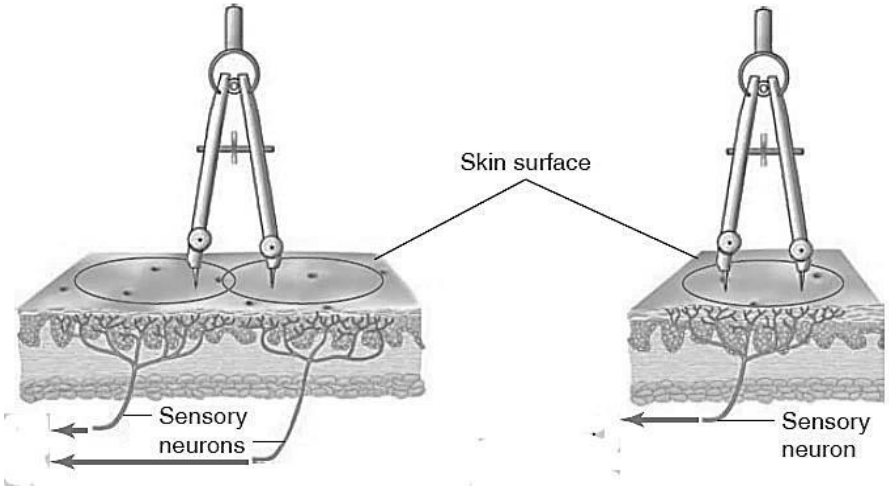


Fig. 33.2. Spatial sensitivity

Materials and equipment: an esthesiometer (Weber's compass).

Progress of work

1. The examined must seat with closed eyes. The esthesiometer with branches brought together maximally close is brought in touch with some regions of the skin. It is necessary to observe that both needles of the esthesiometer touched simultaneously and with identical pressure.

2. Touching is repeated with gradual increasing the distance between the esthesiometer branches (every time by 1 mm), and a minimum distance is found, when a sensation of two separate touching appears. This distance is a spatial threshold for the given region of the skin.

Directions for recording the protocol

1. Enter the spatial threshold for different skin surfaces in the Table 33.3.

2. Compare the spatial skin sensitivity thresholds. Explain the reasons of their differences.

PROTOCOL

Table 33.3

Spatial threshold

Skin surface	Spatial threshold (mm)
Internal side of forearm	
External side of forearm	
Tip of index finger	
Cheek	
Forehead	
Lips	

Conclusion:

1) The *minimal* spatial threshold equals _____ mm at _____.

2) The *maximal* spatial threshold equals _____ mm at _____.

3) Difference in spatial threshold is caused by _____
_____

Work 33.7. Studying the Taste Sensitivity and Rate of Taste Adaptation to Basic Taste Substances

Materials and equipment: solutions of common salt, sugar, citric acid and quinine, each solution in 5 concentrations: 1 %, 0.1 %, 0.01 % and 0.001 %.

Progress of work

1. The examined is given 2–3 ml of the solution of unknown to him substance with a pipette or in a test-tube starting with a minimal concentration.
2. Having kept the solution in the mouth for 20–30 sec (without swallowing), they must identify the taste of the solution. If the examined cannot identify the taste, they are given the solution of greater concentration of the substance — until they surely identifies the taste.
3. The solution concentration, at which the examined correctly defined the substance taste, is threshold. The less is this concentration the higher is sensitivity to this substance.
4. Explore the mechanisms of gustatory receptors and complement the scheme, using the lecture and computer classroom.

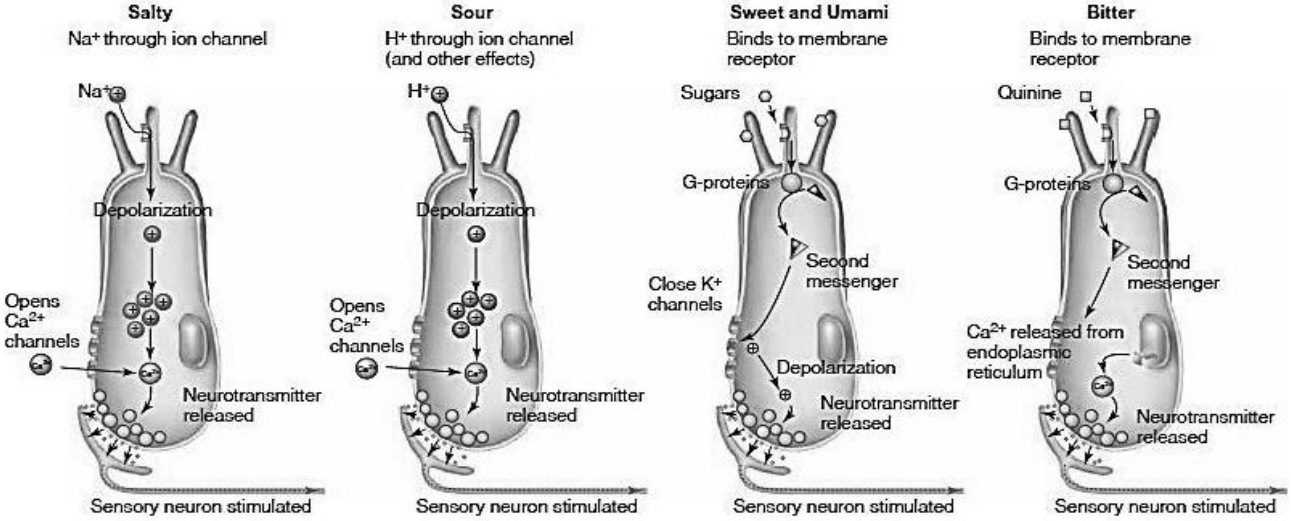


Fig. 33.3. Mechanisms of gustatory receptors

Directions for recording the protocol

1. Fill in the threshold sensitivity in the Table 33.4.
2. Compare the threshold and explain differences.

PROTOCOL

Table 33.4

Taste sensitivity threshold

Substance (taste)	Threshold (%)
Bitter (quinine)	
Sweet (sugar)	
Salty (salt)	
Sour (citric acid)	
Umami (glutamate)	

Conclusion:

1) The *minimal* threshold equals _____.
It is measured for _____ taste.
2) The *maximal* threshold equals _____.
It is measured for _____ taste.
3) The highest sensitivity is for _____ taste, because _____
_____.

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SECTION
"INTEGRATIVE BRAIN ACTIVITY"

SESSION 34 (16). INTEGRATIVE FUNCTIONS OF THE BRAIN. INNATE AND ACQUIRED ADAPTIVE FORMS OF BEHAVIOR. MEMORY

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. Innate forms of behavior (unconditioned reflexes and instincts). Classification, conditions for manifestation, biological role.
2. Acquired forms of behavior, their types (conditioned reflex, dynamic stereotype). Classical conditioned reflex: mechanism of formation.
3. Conditioned reflex as a form of animal and human adaptation to different conditions of existence.
4. Classification of conditioned reflexes. Mechanisms of formation and manifestation of conditioned reflexes.
5. Teaching of I. P. Pavlov about types of higher nervous activity of animals and humans, their classification and characteristic.
6. The concept of inhibition in the higher nervous activity. Types of inhibition.
7. Memory, its types and mechanisms. Attention and its role in memorizing and learning.

LITERATURE

Main

1. Lecture & E-learning materials.
2. *Moroz, V. M*. Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 684–722.

Additional

1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 34.
2. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
3. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 34.1. TERMINOLOGY

Higher nervous activity — _____ _____	The conditioned reflex — _____ _____
The unconditioned reflex — _____	The dynamic stereotype — _____
The instincts — _____ _____	Conditioned inhibition: 1) _____; 2) _____; 3) _____; 4) _____

Work 34.2. Assessment of the Associative Memory Volume

Semantic (**mediated** memory) is characterized by the presence of and independent, proactive use different means of memorization, storage and playback of information. During the research, it is important to identify, can the person install semantic relationship between requirements and own notes (drawings, symbols, signs).

All semantic relationship signs can be classified into five major types of:

concrete — concrete subjects;

plot oriented — visible objects, characters are combined in any situation, story or one character that performs any activity;

abstract — in the form of lines, not designed in any way;

sign-symbolic — as signs or symbols (geometric shapes, arrows, letters, numbers, etc.);

metaphorical — images in the form of a metaphors, fiction.

According to the results of the study can be to evaluate the development level of **associative** memory, as well as to the conclusion about the nature of the thought process a person depending on the most frequently used types of images.

Materials and equipment: pens.

Progress of work

1. Lecturer reads out 20 concepts.
2. The student in practical manual makes tagging (symbols or sketches), sketching, those associations that you cause.
3. The student has to name each symbol (all 20 concepts) in 30–60 minutes.
4. Examples you may find at page 81.

Directions for recording protocol:

1. Write down the mistakes.
2. Count the number of points — for each correctly identified symbol a person gets **1 point.**
3. Make a conclusion about the
4. Compare the results with the results of other persons and norm.

Normative data for the level of development of semantic (mediated) auditory memory:

20 points — very highly developed;

16–19 points — highly developed;

8–15 points — average developed;

4–7 points — low developed;

0–3 points — weak.

Way of thinking process depending on type of symbols:

1) Abstract and sign-symbolic types of drawings — high level of abstract-logical thinking.

2) Plot and metaphorical images make up a group of people with creative thinking.

3) A specific type of images you can suggest specific effective thinking.

PROTOCOL

1. Number of errors: _____. Total amount of points: _____.
2. **Conclusion:**

a) the level of development: _____ (very high, high, medium, low, very low):

b) way of thinking: _____ (abstract-logical, creative, specific type).

Work 34.3. Assessment of a Short-Term Auditory Memory Volume Using Letter and Digit Complexes in the Human

For the duration of the storage of information there are several types of memory. Memory, providing retention and playback of operational information, known as **short-term**. Its volume is approximately 7±2 units. The main characteristic of this type of memory is short. Storage of information in short-term memory lasts seconds, minutes.

To quickly determine the amount of short-term memory using alphabetic or numeric signal complexes. Set the maximum number of digital and alphabetical characters that person can master (at the hearing, or by looking at the scoreboard) from one presentation and playback.

Materials and equipment: tables with numeric or alphabetic signaling complexes, a watch with a second arrow.

Progress of work

1. Use two tables with signaling complexes of letters or numbers. Each table has 8 rows (Fig. 34.1); the shortest first series consists of 3 characters. Read signal complexes from the table, starting with the shortest, consisting of 3 elements (e.g. 9, 7, 2 or E, U, Y) with a speed of 3 character in 2 seconds.

2. After each set of do interval in 5–7 seconds. Person immediately repeats from memory heard complex in the same sequence. If a series of numbers (or letters) without errors, read next row, in which the number of items exceeds the one character (for example: 1, 4, 6, 8 or U, E, O, I).

3. After error (skip or replace a character or change their sequence playback) read a new set with the same number of elements, but now from another table. After the successful development of this complex name the following set with a large number of items. If the error occurred again, then the work should be complete.

4. Calculate the number of characters in the last set, signal playback correctly. This figure is an upper limit on the amount of short-term memory.

The average is **3–7 characters**.

PROTOCOL

9 7 2	6 4 1
1 4 5 6	2 7 3 5
3 9 3 1 8	8 5 9 4 3
4 7 6 2 8 5	7 6 5 2 9 4
3 1 5 6 2 9 7	1 5 3 8 7 9 6
3 8 3 9 1 2 7 4	2 9 6 8 1 3 5 7
7 6 4 5 8 3 1 2 9	3 4 2 8 6 5 1 2 9
2 1 6 4 3 8 9 5 7 3	4 7 9 5 3 8 8 2 1 5

A E O	U A E
E U I A	I E O Y
O U E A Y	E O A U E
E O I A U Y	O E Y E A U
I E U A E O I	E Y A U E I O
U A E Y O E A U	A U E Y O A E Y
A U E O Y A E I O	U E O A Y E U E A
E Y A E U O A E I Y	U E U O E Y A O E I

Fig. 34.1. Signaling complexes of letters and numbers

1. Number of correct named letters: _____.
2. Number of correct named digits: _____.
3. **Conclusion:** short-term memory volume is _____ (normal, decreased, increased).

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

SESSION 35 (17). PHYSIOLOGICAL BASES OF PSYCHOLOGICAL ACTIVITY

DATE OF CLASSES
«____» _____ 20___
day month year

BASIC QUESTIONS:

1. Sleep. Modern concepts of its role and mechanisms. Phases of sleep. Changes in somatic and autonomic functions of the organism during sleep and wakefulness.
2. Emotions: mechanisms of origin, role, manifestations. Emotional stress as a risk factor for health, the main manifestations of stress.
3. Modern ideas about the function's localization in the cortex of the brain cerebral hemispheres. Functions of parietal-temporal-occipital and frontal associative cortex.
4. Modern ideas about the functional asymmetry of the large hemispheres cortex in humans.
5. First and second signaling systems. Speech, its types and functions. Functional asymmetry of the large hemispheres cortex associated with the development of speech in humans.
6. Motivations: classification, mechanisms of emergence. The role of motivations in targeted behavior (the example of food-seeking behavior).
7. The concept of the architecture of an integral behavioral act from the position of the theory of functional systems (P. K. Anokhin).

LITERATURE

Main

1. Lecture.
2. *Moroz, V. M.* Physiology : textbook / V. M. Moroz ; ed. by V. M. Moroz, O. A. Shandra. 2nd ed. Vinnytsia : Nova Knyha, 2016. P. 635–683.

Additional

1. http://etest.bsmu.by – For English Medium Students – Dentistry – Normal Physiology (Dent) – Session 35.
2. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
3. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.

Work 35.1. TERMINOLOGY

Main sensory areas: 1) _____ 2) _____	Memory _____ _____
Functions of the prefrontal associative area: 1) _____; 2) _____; 3) _____; 4) _____; 5) _____;	Short-term memory is based on _____ such as 1) _____; 2) _____; 3) _____
Speech disorders develops as _____ _____. Speech disorder is referred to as _____	Long-term memory is based on _____ such as 1) _____; 2) _____; 3) _____

Work 35.2. Assessment of Latent Period of Simple and Complex Sensorimotor Reaction

Sensorimotor human reaction in response to a light stimulus is the simplest mental reaction. The latent period consists of signals conduction from the retina to the visual centers, processing and identification of visual stimulus, the conduction of the efferent signals from the sensory vision centers in the motor cortex centers to spinal cord and muscles.

The duration of the latent period is the extra time, associated with individual characteristics of mental processes.

The latent period of reaction to the light stimulus is about 180–200 msec.

In the life a man forced to distribute their attention between two or more activities. Performing two or more of the activities requires the distribution of attention. It increases the delay before response and increases the chance of erroneous actions.

Progress of work

1. Open computer program **"Eye test"**. Use keys to choose **"Reaction test"**.
2. You will see a light triangle on a dark screen, after that it will disappear in 2–3 seconds.
3. When it appears again, press **"Enter"** as quickly as possible. You will see the value of latent period on the screen. *It is your latent period for simple reaction.*
4. To perform complex reaction, you need to repeat the test. After the triangle disappears, you need start mental mathematic: for example, 200 – 7 = 193; 193 – 7 = = 186 etc.
5. When triangle appears again, press **"Enter"**. *You will find the latent period for complex reaction.*

PROTOCOL

Latent period of a simple sensorimotor reaction is _____ msec.

Latent period of a complex sensorimotor reaction is _____ msec**.**

Conclusion: the latent period of a complex sensorimotor reaction is _____ (more/less), because _____

Work 35.3. Assessment of Attention Indices Using a Correction Test

Attention is one of the main psychological processes, on characteristics of which depends the state of cognitive readiness for learning, successfulness of academic and professional activity.

Main characteristics of attention:

– stability — the ability to keep attention on one and the same, sufficiently high level during a long period of time;

– attention volume — is the number of objects or events that can be simultaneously in the sphere of attention of a person.

The study is performed using special correction tables — forms with rows of randomized Landolts' rings, letters, digits, figures, etc. The work offers a letter variant of tables.

Materials and equipment: a stop-watch, a pencil, standard correction tables with rows of small letters placed randomly without intervals.

Progress of work

The work is performed individually by every student. The time of procedure is 5 min. Standard correction tables contain 1600 signs.

1. On the signal, you should start looking carefully through each row from left to right, finding and crossing out the letter with which the row begins. The work is done for time with maximum speed and accuracy.
2. After every minute, at the command **"line"**, mark with a vertical line the place on the form where you were caught by this command.
3. The work is stopped at the command **"stop"** (mark the place where it ends).

Work 35.3. ASSESSMENT OF ATTENTION INDICES USING A CORRECTION TEST (CONTINUATION)

One "–" line marks divisions of 5 lines, two "– –" lines mark divisions of 10 lines. In the table, there are 40 rows in each column and 40 characters in each row. Total 1600 + 1600 = 3200 characters.

СХАВСХЕВИХНИСХНВХВКМНАИСЕМВХЕНАИСНПУКСОВ	ГИТВОГАЭШДАРСМИВАКМНЦГСОВРПАШКНСИТЛВОАРО
ВЕНХИВСНАВВСАВСАЕКМАХВКЕОРУМЛПНАВЫВАМПРИ	ЕХЮТГМИОУЕАВСКНМСИТВДЮБСЕГОВЧБЯЕБЮЫХЦТМА
НХСРОВНВОТКНЛМЧАМОЛТВНЛМИСМГУБВВНСМЛОТЛБ	НСМГУНЛМИНСМЛОТБВВХСРОВНВОТКНЛМЧАМОЛТВЛБ
ХАКИТОНВММБЛЧСХНГХАИХКМИНГСБЧХФИСБЛМОГНХ	БНЯЕХЮСМБДЮАПОРАОШУВПАЕВКЛВРАГБЕИМТОВЛФЕ
АХВСТМОНЕУБСТГАХЫЧНАТНВЛСМНГАХВВЛГМВЕМНМ -	АХВСТМОНЕУБСТГАХЫЧНАТНВЛСМНГАХВВЛГМВЕМНБ -
СОРНВУЛОНСМСЛНХЧССИОЛКОМГИСМВЛХТСИМНЕПСМ	КНАЕВПСМИМРЛЭЯБСМИКШВПОЛЭХУНВЕКПРВСМИТОР
УХРАОПНИСМИОТУХНГВЛБЯШГВИМТСНУХЛОГНЦСИМУ	УХРАОПНИСМИОТУХНГВЛБЯШГВИМТСНУХЛОГНЦСИМУ
ИКНГАЕПВОРСМИТУХЫЖБСИНУХТЯДЛАНТСИМХВУМОЛ	ВАПУЕКАЧМСИТВДЛМТИНФЭЧБГГКПБЯЕХЮЩАНСМВАТ
ББВАПМИСРОКНЕОЛЭТФОЕУБВОАЖМБНАОПМЮЭХЦШАМБ	УИМЕВАРПОТИМТИГОХЮБТИСМУЛОАНЕГИАУФВАСМИА
СИТНЫДАОРЕГСМИТАНЦХЭОАЛСЬМАЫЖЧТСНМКЕАВЭХ --	ИКНГАЕПВОРСМИТУХЫЖБСИНУХТЯДЛАНТСИМХВУМОЛ --
ВАПУЕКАЧМСИТВДЛМТИНФЭЧБГГКПБЯЕХЮЩАНСМВАТ	СИТНЫСМИТАНЦХЭОАЛСЬМАЫДАОРЕГЖЧТСНМКЕАВЭХ
ЕКНМСИТВДЮБСЕГОВЧБЯЕХЮТГМИОУЕАВСБЮЫХЦТМА	МНГАЕЛИЬЮМПВЕХФЛУЕАСМОЛВГОИБЧСМКЕНГОВМАЕ
МНГАЕЛИЬЮМПВЕХФЛУЕАСМОЛВГОИБЧСМКЕНГОВМАЕ	НГМИТГОЛХИНАПМТИНГОЛЭСВАИНРХВАЛЭЮМИНЕРПМ
ХВАМСИРНКЕГОМЛЭЮБСМИХВАНЕГЛХУЫМСОЛЭТЕТМГ	ХВАПРСМИТСФШВХАПКЕНУИТСОЛЭВАТИСРЕВШЛАОЭМ
НГМИТГОЛХИНАПМТИНГОЛЭСВАИНРХВАЛЭЮМИНЕРПМ -	СХАВИХНСХХНВЕВИСХВКМНАИСЕМВХЕНАИСНПУКСОВ -
АПРВМИСНКМГОАМИВТХИНВЕАПРОЛАИСЕНВХАЭВММА	ВОЛСМИАПНШУХЭВТСИАПАМНЕВРЛЕЧСАВКАИСМРАЕВ
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ТНГОРАМИСПАРВЭМТСАШНКТОВМНГАРМИСТЭХВМИМТ	ББВМИЕНКЛОВМАБХМКЕНГИТМАБЛОМНГЕОЭЛАВТММБМ
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ОРЕГСМИТАМКМАХВКЕОРУМФЭЧБГГКОРМГСММИИРША	ВАПНСИМОЛХЭВТОЕНГАМИСВДЛАРПНМГМИТСЮББВАХЭ
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СММИВПАЕАНКГАРОАИПТСМСВПАЕНУГКНРИМИМЕАТ	ББВАПМИСРОКНЕОЛЭТФОЕУБВОБЖМБНАОПМЮЭХЦШАМБ
ИТОСМШВАЕАУКГНВДЛАОПЭБТСИМПВАМБЛЧСМИВАЭХ	УКЕНАПМСИРВШОРОАПМУЕКНГТСОЭВКЕНВУАЕПИСФМ
ХВАПРСМИТСФШВХАПКЕНУИТСОЛЭВАТИСРЕВШЛАОЭМ	МТОНАПСМИВПРАОЭХШКНЕВАСМИФАВКЕНСИАРЕОТИВ
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ГОВРПАШКНСИТВОГАЭШДАРСМИВАКМНЦГСИТЛВОАРО	КХАПРСМИТОВПНАКМГОДЛАТСИВПАМКЕГНХЛОЫВАПК
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КНАЕВПСМИМРЛЭЯБСМИКШВПОЛЭХУНВЕКПРВСМИТОР	ХАКИТОНВММБЛЧСХНГХАИХКМИНГСБЧХФИСБЛМОГНХ
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ХКЕНИСМПВАМЧСИТВАРПОЛХГНКЕЭФЫВУКЕСИМАПХА	АУКШНМИСМАВОРИТБЭВОРАМНКГЛОМИСТЦЯХЭЛАОРС
ТОРВМСИПЕУКНВГЛОЭХФЦУЕМСИТМОАРПНЕКХНКШАГ --	ИМАКЕНВАЭОЛМТИСПЕАНВШГФХВПАРУЛОСИМТРОАХЕ --

PROTOCOL

1. Fill in the Table 35.1 with amount of character you find for every minute (**N**).
2. Fill in the table with amount of mistakes per minute (**n**).
3. Calculate **S** (attention productivity and stability) per each minute and per 5 minute.
4. Draw a graph with S calculations.

$$S = (0.5 \times N - 2.8 \times n) : t$$

* *t — time in seconds*

Assessment of results:

S – over 3.25 = 10 scores — attention productivity and stability *very high.*

S – 3.1–3.25 = 8–9 scores — attention productivity and stability *high*.

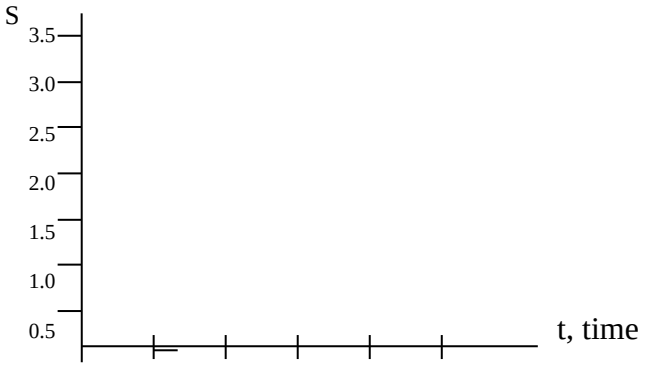
S – 2.5–3.0 = 4–7 scores — attention productivity and stability *medium.*

S – 1.5–2.49 = 2–3 score — attention productivity and stability *low*.

S – 0.0–1.49 = 0–1 score — attention productivity and stability *very low*.

Table 35.1

Minute	Amount of characters (N)	Amount of mistakes (n)	S
1st			
2nd			
3rd			
4th			
5th			
Total			



Conclusion: index of **attention productivity and stability (S)** for 5 minute in total equals _____ scores. S may _____ *(decrease/increase)* over time as attention and concentration are able to _____ *(dissipate/magnify).*

THE PRACTICAL WORKS ARE DEFENDED

_____

Lecturer's signature

LIST OF PRACTICAL SKILLS FOR EXAM

1. Measures to prevent infection with viral hepatitis and human immunodeficiency virus (HIV) during the blood and other biological materials analysis.
2. Physiological assessment of parameters in complete blood count obtained by using manual and semi-automatic methods of counting (red blood cells count, hematocrit, hemoglobin, color index and RBC indices, white blood cells count and leukocyte formula, platelet count, Panchenkov's ESR method).
3. Assessment of primary hemostasis indices (bandage test). Features of bleeding duration from the tooth cavity.
4. Assessment of result of blood typing in AB0 and Rh systems using standard sera and monoclonal antibodies.
5. Measurement and evaluation of height. Evaluation of endocrine system functions (height as index of endocrine axis hypothalamus-pituitary-liver).
6. Evaluation of endocrine system functions (comparison of muscle strength of men and women, axis hypothalamus-pituitary-sex glands).
7. Dynamometry (manual and standing) and physiological evaluation of the results.
8. Evaluation of dental formula of primary and permanent teeth.
9. Assessment of extracellular concentration of K+ and Na+ shifts on membrane potential values.
10. Possibility of pharmacological effect on process of signal transmission in synapses (example of neuro-muscular junction).
11. Features of innervation of skeletal and smooth muscles and impact of neurotransmitters.
12. Study of the main tendon reflexes on the example of the knee reflex (morphological basis [reflex arc]). Physiological assessment of the obtained data.
13. Comparison of mono- and polysynaptic reflexes.
14. Evaluation of EEG rhythms in different functional states of the CNS.
15. Assessment of tone and reactivity of sympathetic and parasympathetic parts of ANS by heart rate on the example of clinostatic and orthostatic reflexes. Necessity of knowledge of these reflexes for a dentist.
16. Measurement of arterial pressure values. Physiological assessment of obtained data.
17. Properties of arterial pulse and assessment of its rhythmicity and frequency by palpation method.
18. Mechanism of generation of action potential of typical cardyomyocyte and atypical cardyomyocyte.
19. Assessment of cardiac cycle duration based on ECG.
20. Analysis of arterial pressure changes during conduction of orthostatic test.
21. Spirometry: determination of vital capacity (VC), due vital capacity (dVC), physiological assessment of obtained data. Assessment of spirogram.
22. Pulseoxymetry conduction and physiologic assessment of hemoglobin oxygen saturation curve. Calculation of oxygen capacity of blood.
23. Sialometry conduction and physiological assessment of the obtained data.
24. Assessment of carbohydrate hydrolysis in different states (pH, t).
25. Assessment of bile impact on fats state.
26. Measurement of body mass. Calculation of body mass index. Physiological assessment of the obtained data and formulation of scientifically based recommendations for the body weight correction.
27. Measurement of axial body temperature using liquid and electronic thermometers: analysis of possible errors during performance. Physiological assessment of the obtained data.
28. Assessment of thermal sensitivity of teeth.
29. Physiologic assessment of the composition and properties of terminal urine. Common urine analysis.
30. Assessment of visual system functions (investigation of visual acuity).
31. Assessment of taste sensitivity thresholds.
32. Assessment of auditory sensory system functions: experiments of Weber and Rinne.
33. Assessment of a short-term auditory memory volume using letter and digit complexes in the human.
34. Assessment of attention indices using a correction test.

LITERATURE

Main

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3. *Fox, S. I.* Human Physiology / S. I. Fox. 14th ed. McGraw-Hill, 2015. 832 p.
4. *Hall. E. J.* Guyton and Hall textbook of Medical Physiology / E. J. Hall, M. E. Hall. 14th ed. Elsevier, 2021.
5. *Ganong's* Review of Medical Physiology / K. E. Barret [et al.]. 25th ed. McGraw-Hill Companies, Inc., 2016.
6. *Silverthorn, D. V.* Human physiology : an integrated approach / D. V. Silverthorn. 6th ed. 2013.

HARRIS–BENEDICT TABLES (MEN) 1 kcal = 4.1868 kJ

Table A

kg	kcal	kg	kcal	kg	kcal
15	272	**50**	754	**85**	1235
16 →	286	**51**	768	**86**	1249
17	300	**52**	782	**87**	1253
18	313	**53**	795	**88**	1277
19	327	**54**	809	**89**	1290
20	341	**55**	823	**90**	1304
21	355	**56**	837	**91**	1318
22	368	**57**	850	**92**	1332
23	382	**58**	864	**93**	1345
24	396	**59**	878	**94**	1359
25	410	**60**	892	**95**	1370
26	424	**61**	905	**96**	1387
27	438	**62**	919	**97**	1406
28	452	**63**	933	**98**	1414
29	465	**64**	947	**99**	1428
30	479	**65**	960	**100**	1442
31	498	**66**	974	**101**	1455
32	507	**67**	988	**102**	1469
33	520	**68**	1002	**103**	1483
34	534	**69**	1015	**104**	1497
35	548	**70**	1029	**105**	1510
36	562	**71**	1043	**106**	1524
37	575	**72**	1057	**107**	1538
38	589	**73**	1070	**108**	1552
39	603	**74**	1084	**109**	1565
40	617	**75**	1098	**110**	1579
41	630	**76**	1112	**111**	1593
42	644	**77**	1125	**112**	1607
43	658	**78**	1139	**113**	1620
44	672	**79**	1153	**114**	1634
45	685	**80**	1167	**115**	1648
46	699	**81**	1180	**116**	1662
47	713	**82**	1194	**117**	1675
48	727	**83**	1208	**118**	1689
49	740	**84**	1222	**119**	1703

Table B BMR = A + B

Height, cm	AGE, YEARS OLD													
	15 ↓	**17**	**19**	**21**	**23**	**25**	**27**	**29**	**31**	**33**	**35**	**37**	**39**	**41**
92	100	–	–	–	–	–	–	–	–	–	–	–	–	–
96 →	140	113	–	–		–	–	–	–	–	–	–	–	–
100	180	153	128	–	–	–	–	–	–	–	–	–	–	–
104	220	193	168	–	–	–	–	–	–	–	–	–	–	–
108	260	233	208	–	–	–	–	–	–	–	–	–	–	–
112	300	273	248	–	–	–	–	–	–	–	–	–	–	–
116	340	313	288	–	–	–	–	–	–	–	–	–	–	–
120	380	353	328	–	–	–	–	–	–	–	–	–	–	–
124	420	393	368	–	–	–	–	–	–	–	–	–	–	–
128	460	433	408	–	–	–	–	–	–	–	–	–	–	–
132	500	473	448	–	–	–		–	–	–	–	–	–	–
136	540	513	488	–	–	–	–	–	–	–	–	–	–	–
140	580	553	528	–	–	–	–	–	–	–	–	–	–	–
144	620	593	568	–	–	–	–	–	–	–	–	–	–	–
148	660	663	608	–	–	–	–	–	–	–	–	–	–	–
152	700	673	648	619	605	592	578	565	551	538	524	511	497	484
156	740	713	678	639	625	612	598	585	571	558	544	531	517	504
160	780	743	708	659	645	632	618	605	591	578	564	551	537	524
164	810	773	738	679	665	652	638	625	611	598	584	571	557	544
168	840	803	768	699	685	672	658	645	631	618	604	591	577	564
172	860	823	788	719	705	692	678	665	651	638	624	611	597	584
176	880	843	808	739	725	712	698	685	671	658	644	631	617	604
180	900	863	828	759	745	732	718	705	691	678	664	651	637	624
184	920	883	848	779	765	752	738	725	711	698	684	671	657	644
188	940	903	868	799	785	772	758	745	731	718	704	691	677	664
192	–	923	888	819	805	792	778	765	751	738	724	711	697	684
196	–	–	908	839	825	812	798	785	771	758	744	731	717	704
200	–	–	–	859	845	832	818	805	791	778	764	751	737	724

HARRIS–BENEDICT TABLES (WOMEN) 1 kcal = 4.1868 kJ

Table A

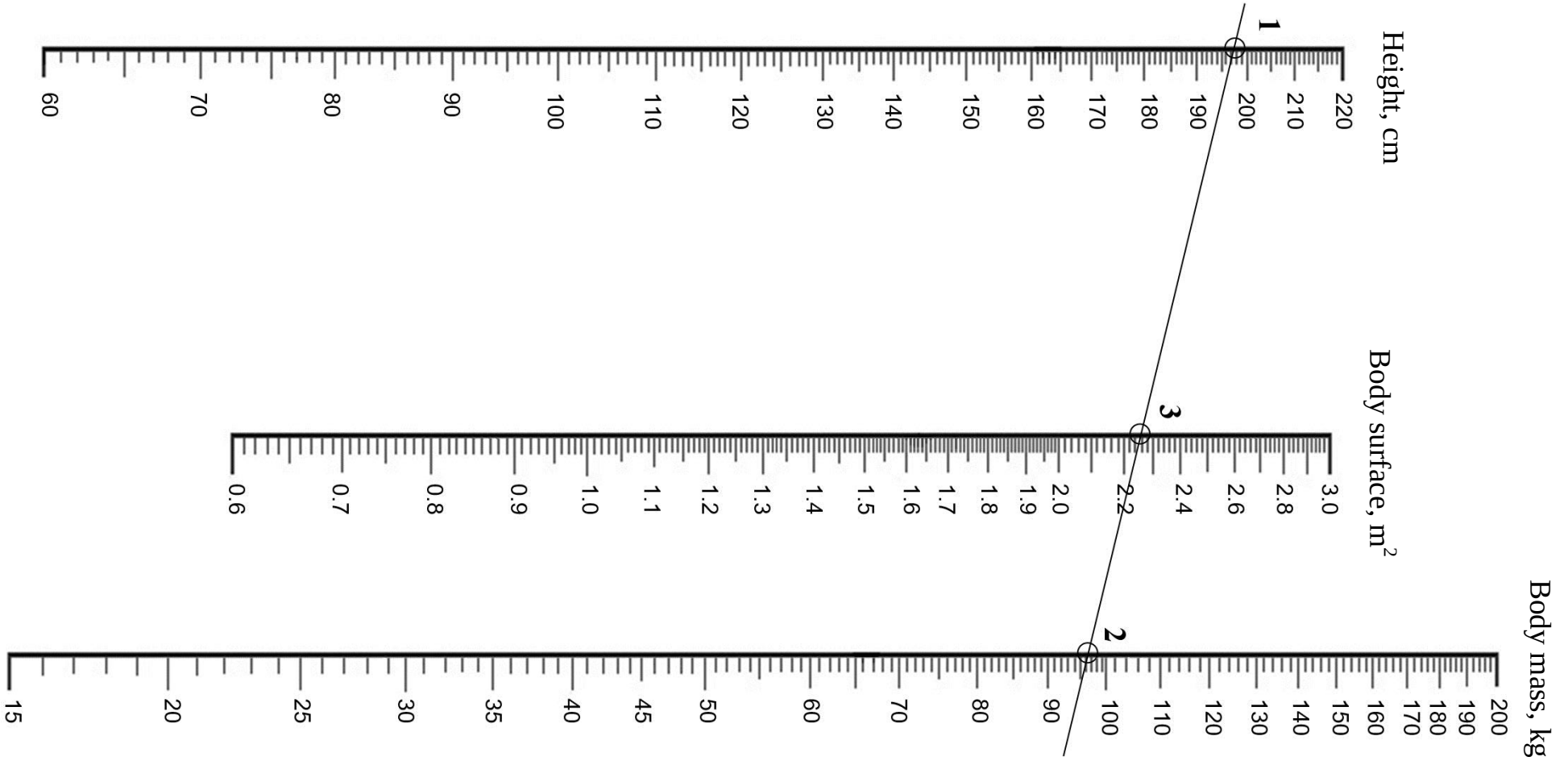
kg	kcal	kg	kcal	kg	kcal
8	731	**44**	1076	**79**	1411
9 →	741	**45**	1085	**80**	1420
10	751	**46**	1095	**81**	1430
12	760	**47**	1105	**82**	1439
13	779	**48**	1114	**83**	1449
14	789	**49**	1124	**84**	1458
15	798	**50**	1133	**85**	1468
16	808	**51**	1143	**86**	1478
17	818	**52**	1152	**87**	1487
18	827	**53**	1162	**88**	1497
19	837	**54**	1172	**89**	1506
20	846	**55**	1181	**90**	1516
21	856	**56**	1190	**91**	1525
22	865	**57**	1200	**92**	1535
23	875	**58**	1210	**93**	1544
24	885	**59**	1219	**94**	1554
25	894	**60**	1229	**95**	1564
26	984	**61**	1238	**96**	1573
27	913	**62**	1248	**97**	1583
28	923	**63**	1258	**98**	1592
29	932	**64**	1267	**99**	1602
30	942	**65**	1277	**100**	1611
31	952	**66**	1286	**101**	1621
32	961	**67**	1296	**102**	1631
33	971	**68**	1305	**103**	1640
34	980	**69**	1315	**104**	1650
35	990	**70**	1352	**105**	1650
36	999	**71**	1334	**106**	1669
37	1009	**72**	1344	**107**	1678
38	1019	**73**	1353	**108**	1688
39	1028	**74**	1363	**109**	1698
40	1038	**75**	1372	**110**	1707
41	1047	**76**	1382	**111**	1717
42	1057	**77**	1391	**112**	1725
43	1066	**78**	1401	**113**	1736

Table B BMR = A + B

Height,	AGE, YEARS OLD													
cm	**15** ↓	**17**	**19**	**21**	**23**	**25**	**27**	**29**	**31**	**33**	**35**	**37**	**39**	**41**
84	–	–	–	–	–	–	–	–	–	–	–	–	–	–
88 →	-43	–	–	–	–	–	–	–	–	–	–	–	–	–
92	-27	–	–	–	–	–	–	–	–	–	–	–	–	–
96	-11	-21	–	–	–	–	–	–	–	–	–	–	–	–
100	5	-5	-14	–	–	–	–	–	–	–	–	–	–	–
104	21	11	2	–	–	–	–	–	–	–	–	–	–	–
108	37	27	18	–	–	–	–	–	–	–	–	–	–	–
112	53	43	34	–	–	–	–	–	–	–	–	–	–	–
116	69	59	50	–	–	–	–	–	–	–	–	–	–	–
120	85	75	66	–	–	–	–	–	–	–	–	–	–	–
124	101	101	82	–	–	–	–	–	–	–	–	–	–	–
128	117	107	98	–	–	–	–	–	–	–	–	–	–	–
132	133	123	114	–	–	–	–	–	–	–	–	–	–	–
136	140	139	130	–	–	–	–	–	–	–	–	–	–	–
140	165	151	146	–	–	–	–	–	–	–	–	–	–	–
144	181	171	162	–	–	–	–	–	–	–	–	–	–	–
148	197	187	178	–	–	–	–	–	–	–	–	–	–	–
152	212	201	192	183	174	165	165	146	136	127	117	108	99	89
156	227	215	206	190	181	172	162	153	144	134	125	116	106	97
160	242	229	220	198	188	179	170	160	151	142	132	123	114	104
164	257	243	234	205	196	186	177	168	158	149	130	121	123	112
168	271	255	246	213	203	194	184	166	156	158	147	138	128	119
172	285	267	253	220	211	201	192	183	173	164	154	145	136	126
176	299	279	270	227	218	209	199	190	181	171	162	153	143	134
180	313	291	282	235	225	216	207	197	188	179	169	160	151	141
184	327	303	294	242	233	223	214	205	195	186	177	167	168	149
188	–	313	304	250	240	231	221	212	203	193	184	175	165	156
192	–	323	314	257	248	230	229	220	210	201	191	182	173	163

Appendix C

NOMOGRAM FOR DETERMINING BODY SURFACE



Appendix D

BODY MASS INDEX (BMI)

Body mass index (BMI) or Kettle index is calculated according to formula

$$\textbf{BMI = BM (kg) / Height}^2 \textbf{ (m)}$$

Body mass, BMI and risks for health

	Decreased BM	**Normal BM**	**Increased BM**	**Obesity**
BMI	**< 18.5**	**18.5–24.9**	**25.0–29.9**	**≥ 30.0**
Risk of diseases	Anemia, decreased immune function and increases chance of infections: lungs, kidneys, urinary tract; oncological diseases, osteoporosis and etc.	Minimal	Obesity, diabetes, atherosclerosis, arterial hypertension, heart ischemia, heart stroke and etc.	
General recommendations	Change diet, eating behavior and physical activity in the way to energy consumption with food exceeds expenditure	Save current eating behavior and physical activity level	Change diet, eating behavior and physical activity in the way to energy expenditure exceeds consumption with food	

Example concepts for work 34.2: *coastal, loss, sweet, barrel, peak, gentle animal, dog on the straw, sad, crunching ice, flight of the bee, a clear path, dusk, faithful companion, flame, dogs happy, evening call, light walking, lurch, destiny.*

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