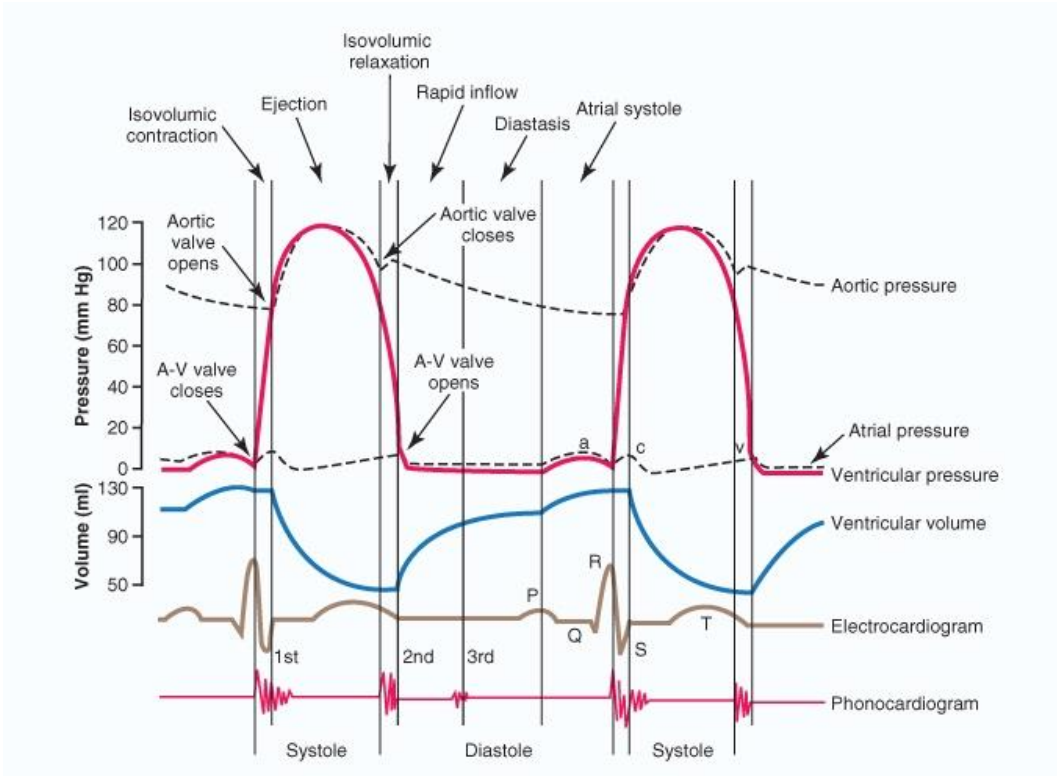
Practical works in physiology



Manual for practical studies and individual work for English-speaking students

221 "Stomatology"

Part 2

Edited by associate professor I.M.Karvatsky

Kyiv
«Книга-плюс»
2021

УДК 612 (075.8)
ББК 28.073я73
Ш 37

Recommended at the Academic Council of the Bogomolets National Medical University (the report №9 from 24.06.2019)

Authors:
A.V.Gumeniuk
I.M.Karvatsky
U.V.Konyk
N.V.Motorna
M.M.Mykula
K.V.Nesvitaylova
O.V.Skrypka
I.G.Strokina
K.V.Tarasova
O.O.Vinogradova-Anik

Group of translaters: O.F.Moroz, O.O.Vinogradova-Anik, I.G.Strokina.

Reviewers:
L.M.Shapoval, Doctor of Biology, Leading Research Associate, Bogomoletz Institute of Physiology National Academy of Science, Ukraine.
M.V.Kryshtal, Doctor of Medicine, Head of Patophysiology department of Bogomolets National Medical University, professor.

Practical works in physiology. Edited by I.M.Karvatsky. Manual for practical studies and individual work of stomatological faculty students. 2-th Vol. – Kyiv. Книга-плюс, 2021. V.2 – 184 p.

Department of Physiology

In the manual for practical training and individual work for students in physiology materials which will promote mastering of physiology by students of faculties of the higher medical educational institutions which study on credit-transfer system (ECTS) are submitted. These materials are developed on the basis of long-term pedagogical experience of the collective of Physiology department of National O.O.Bogomolez Medical University, and as experience of introduction of credit-modular system of the organisation of educational process. In the manual materials for principal kinds of individual work of students (IWS) are submitted, practical works which are carried out by students on practical training, and schemes of reports of practical training in which students have possibility to write down results of researches and other tasks are described. It will promote formation of abilities to analyze results of researches of functions of an organism and make conclusions on certain algorithm. This Manual is published in English for foreign students of medical high schools for whom English is a training language.

ISBN 978-966-7758-55-4

CONTENTS

INTRODUCTION

The practical works in physiology is the manual to a practical training and independent work of stomatological faculty students which study on credit-transfer system which is a component of Bolonsky process in the higher medical educational institutions.

The subject "Physiology" is structured on modules which provide realisation of ultimate goals of the subject which are formulated in educational-qualifying characteristics (EQC) and educational-professional programs (EPP) preparations of experts of medical faculties, and are confirmed by ME Ukraine.

The credit-modular system of the organisation of educational process induces students to regular studying of the subject because studying of each module comes to the end with the total control of the level of students` preparation, thus current progress is the important making certification of students for each module and the subject as a whole.

The manual is written on the basis of introduction of credit-modular system at National O.O.Bogomolez Medical University and the experience of collective of department.

Feature of the grant is that students will use it as a writing-book to a practical training where they will write down the results of research of functions, analyze these results and write down the conclusions, the established laws.

In a practical work themes of practical training and independent work of students (IWS) according to the curriculum and the subject program, and also the list of tasks to the total modular control are submitted.

The practical work in physiology is the subsequent development of those materials which are printed in the Grant in physiology edited by professor V.G.Shevchyuk. Vinnitsa: the NEW BOOK, 2005. - 576 p., but basic feature of this edition is its appointment - record of reports of researches on practical training and performance of tasks by students.

The practical work consists of four parts, in each of them materials which are a part of modules №1,2 are presented. Such division of the material is convenient for students because the practical work is simultaneously a ***writing-book*** to a practical training in physiology where not only the technique of carrying out concrete researches is described, but also the additional information, including inquiry one contains.

We hope that the practical work will be pleasant for students, and will promote their successful study.

Ighor Karvatsky.

Part 2.

ORGANIZATION OF STUDYING PROCESS FOR SUBJECT "PHYSIOLOGY" ACCORDING TO CREDIT-TRANSFER SYSTEM

Educational purpose of the subject

The end purposes of studying of the subject are defined in educational-professional programm (EPP) and studying programm in Physiology (2021):

- *Make conclusion about a state of physiological function of an organism, its systems and organs;*
- *Analyze age percularities of functions of an organism and their regulation;*
- *Analyze regulated parameters and make conclusions about mechanisms of nervous and humoral regulations of physiological functions of an organism and its systems;*
- *Analyze a state of human health under different conditions on the base of physiological criteria;*
- *Interpret mechanisms and regularities of functioning of excitable structures of an organism;*
- *Analyze a state of sensory processes and their role in vital activity;*
- *Explain physiological bases of a researched methods of organism`s functions;*
- *Explain mechanisms of interrative activity of an organism.*

The structure of the subject

The subject Physiology is divided into 2 parts, in each of them there are some semantic sections.

The structure of the subject for stomatological faculty

Part 1. "General physiology"

Semantic sections:

1. Introduction to physiology
2. Excitable structures
3. Biological regulation of functions of an organism
4. Physiology of sensory systems
5. Nervous regulation of motor functions
6. Nervous regulation of visceral functions
7. Humoral regulation of visceral functions

Part 2. "Visceral system`s physiology and higher integrative functions"

Semantic sections:

8. Blood system
9. Circulatory system
10. Breathing system
11. Digestive system
12. Energy exchange
13. Thermoregulation
14. Urinary system
15. Higher integrative functions of the nervous system

Modules and semantic modules are realised by all kinds of studies which are provided by the curriculum: at lectures, practical training, during individual work of students (CPC), the total

modular control. Practical training provides: a)research by students of functions in experiments on animals, isolated tissues, cells, models or on the basis of the experiements which have been recorded in video films, in computer programs and other educational technologies; b) research of functions of a healthy person; c) solving situational tasks (an estimation of parameters of functions, parameters of a homeostasis, mechanisms of regulation, etc.) which have an experimental or cliniko-physiological direction.

It is recommended to students on a practical training shortly to write down reports of the spent researches which form is submitted for each work in the manual which should be used by them as a writing-book to a practical training.

Mastering of each module of the subject comes to the end with the total modular control which is carried out on last control employment of the certain module.

PART 2. VISCERAL SYSTEM`S PHYSIOLOGY AND HIGHER INTEGRATIVE FUNCTIONS

Section 8. Blood system.

Practical study 1.

Blood system. Research of physics-chemical properties of blood

1.Theme urgency:

The blood is a mean of transport of the matters, gases to the cells of an organism and from them to the excretory organs; the functions of blood components are connected with told above.

Blood belongs to external environment of an organism with the lymph and extracellular liquid and so it has c**omponents taking part in homeostasis support.**

Any changes in an organism are reflected on the components of blood and its functions, and so studying of the system of blood is absolutely necessary for a doctor.

2.Educational aims

- *To treat concept of the blood system, mechanisms of its regulation on the basis of analysis of its parameters of a homeostasis: volume, acid-base equilibrium, osmotic pressure.*
- *To treat physiological regularities of functions of the blood system: respiratory, transport, protective.*
- *To explain physiological foundations of research techniques of functions of the blood system.*
- *To make conclusions about the state of physiological functions of an organism, which are carried out with the help of the blood system on the basis of quantitative and qualitative blood indices:hematocrit, blood sedimentation rate and osmotic resistance of erythrocytes.*
- *To analise the age changes of the quantitative and qualitative blood indices and their regulation.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Determination
Hematocrit	Hematocrit is percent volume of blood cells (first of all erythrocytes) in blood.
Osmotic resistance	Is the resistance of erythrocytes` membranes in the hypotonic solutions.
Hemolisis	Is a destruction of the erythrocytes` membrane as a result of which hemoglobin goes out of erythrocytes.
Blood Sedimentation Rate (BSR)	Is measured by the column of plasma over the erythrocytes which are sedimentated per hour (mm/hour) in the Panchenkov`s capillary.

3.2.*Theoretical questions*

1) Blood system and its function.
2) Blood volume in an organism, structure of blood, hematocrit.
3) Components of blood plasma, intercellular fluid and lymph. Proteins of plasma and their role in an organism.
4) Osmotic and oncotic pressure of blood. Role of the blood plasma components and their influence on blood indices.

5) pH of blood and physicochemical mechanisms of maintenance it on a fixed level.

3.3.*Practical works*

1) Determination of hematocrit.
2) Determination of osmotic resistance of erythrocytes.
3) Determination of blood sedimentation rate (BSR) by Panchenkon`s method.

4.Materials for self-control

4.1.Answer the question

1) Describe the content of the blood and the role of its components in the transport of matters.

2) Calculate how much plasma and blood cells contain in blood of a person if his body mass is 80 kg, hematocrit is 40%. Volume of circulated blood is normal. Estimate the results.

3) Describe the content of blood buffer systems, mark the chemical formulas of substances.

4) Calculate the value of the pressure of filtration which provides the liquid movement with the dissoluted substances from arterial end of capillary to intercellular liquid if hydrostatic pressure in the arterial end of capillary is 30 mm Hg., hydrostatic pressure in intercellular liquid is 8 mm Hg, oncotic pressure of blood plasma is normal, oncotic pressure of intercellular liquid contains only 60 % of oncotic pressure of blood plasma.

5) Calculate under what pressure the liquid from tissues will move to the venous end of capillary if hydrostatic pressure of intercellular liquid and oncotic one are 10 mm Hg, hydrostatic pressure of the venous end of capillary is 16 mm Hg, oncotic pressure of blood is normal.

6) Explain why the edema of tissues does not appear if it was stated that the liquid output from the arterial end of the capillary in norm is 25 % more than the liquid input into the venous end of the capillary.

7) Calculate the concentration of water solution of sodium chlorine which would have the same osmotic pressure as blood plasma if the concentration of the osmotic active particles in blood plasma (the osmolarity of plasma) is 300 mosmol/l.

8) Calculate what is sodium chlorine participation in the osmotic pressure of blood plasma if its osmolarity is 300 mosmol/l, sodium chlorine content in blood plasma is 7,5 g/l.

9) Calculate the concentration of glucose solution for the infusion not to make the disbalance of the normal osmotic pressure of blood plasma.

4.2.*Choose the right answer*

1. A person kept a diet without proteins for a long time, severaly limiting proteins in food. In the result of it there will be the diminishing in blood:
   A. pH
   B. osmotic pressure
   C. oncotic pressure
   D. glucose
   E. sodium

2. As a result of trauma a person left 1 liter of blood. 1 liter of 0,9 % NaCl solution was infused. The value of hematocrit will be:
   A. 50%
   B. 32%
   C. 40%
   D. 42%
   E. 55%

3. After having salt food a man always felts thirsty. What blood parameter change can it be connected with?
   A. P oncotic
   B. hematocrit
   C. P osmotic
   D. Sedimantation rate of erythrocytes.

4. 0,5 liters of isotonic glucose solution was infused into experimental animal. As a result of it the erythrocytes:
   A. swell
   B. are wrinkled
   C. do not change
   D. are hemolysated

5. At a woman`s blood analyses it was stated that: in a whole the concentration of osmotoc-active substanses is 321 mosm/l, including: sodium-140 mmol/l, glucose-15 mmol/l. The most probable is:
   A. hypoosmia, hyponatriemia, hypoglycemia
   B. hypoosmia, isonatriemia, hyperglycemia
   C. isoosmia, isonatriemia, hyperglycemia
   D. hyperosmia, hypernatriemia, hyperglycemia
   E. isoosmia, hyponatriemia, hyperglycemia

6. Define which of the following results (pH, HCO_3^- mmol/l, Pco_2 mm Hg) take place in a patient who smokes for many years and complains of a cough:
   A. 7,32, 30, 60
   B. 7,26, 24, 33
   C. 7,5, 16, 20
   D. 7,65, 15, 45
   E. 7,41, 10, 20

7. After long physical exercises sportman`s hematocrit made 50%. Such blood parameter is first of all the result of:
   A. Water loss with the sweat
   B. Increase the quantity of blood cells
   C. Increase the volume of circulated blood
   D. Decrease the diureis
   E. Increase the ptotein`s content in the blood

8. In a woman of 25 it was found in blood plasma: protein`s content is 95 g/l, albumino-globulinic coefficient is 1,2. It will lead to the increase: of
   A. oncotic pressure
   B. osmotic pressure
   C. sedimintation rate of erythrocytes
   D. pH
   E. volume of circulated blood

9. A man of 45 drank 2 liters of distallated water to remove his thirst. What changes in homeostatic parameters will appear:
   A. diminishing of blood osmotic pressure
   B. increasing of blood osmotic pressure
   C. diminishing of volume of circulated blood
   D. diminishing of oncotic blood pressure
   E. increasing of oncotic blood pressure

10. During a day and night a patient had vomitting and he had no opportunity to drink enough water. The most probable value of hematocrit will be:
   A. 48%
   B. 55%
   C. 40%
   D. 35%
   E. 42%

Protocol of practical study №1. __"_____"_____20_____

Work 1. Determination of hematocrit.

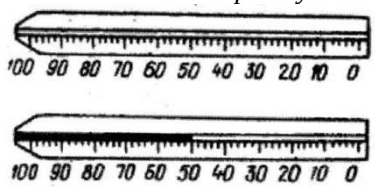
Hematocrit shows percent volume of blood cells (first of all erythrocytes) in blood. Distinguish arterial, venous and capillary hematocrit as volume of blood cells, (first of all erythrocytes), is unequal in different sections of blood circulation system. The lowest hematocrit is in arterial blood.

The purpose of the work:

To determine percent volume of blood cells(first of all erythrocytes) in blood of capillaries and to estimate it`s value.

To fullfil the work one needs: the capillary for hematocrit or micropipet, whizzer on 8000 rpm, plasticine, aqueous solution of Heparinum (with activity 5000 E/mls), a needle, 96 % alcohol, solution of Iodum in alcohol, cotton wool, pyriform rubber.

Hematocrit capillary



Fullfilment of the work.

Wash out graduated on 100 segmentations micropipet, with the solution of Heparinum, blow it by pyriform rubber, dry and fill it with blood at 7/8 lengths. Then plaster the hole of micropipet by the plasticine, centrifuge during 5 mines at 8000 rpm. Than determine percent of the blood cells in complete blood volume. This is hematocrit.

Results of the work.

Hematocrit is _____%.

C***onclutions:***

Hematocrit is_____

1) Is the volume percent of blood cells (first of all erythrocytes) in blood of capillaries normal? (to compare with the norm. What does the value of hematocrit testify about?)

2)What changes in blood system can the increase and decrease of hematocrit show?

Work 2. Determination of osmotic resistance of erythrocytes.

The resistance is an ability of erythrocytes to confront with destructive operation on blood of low osmotic pressure of an external environment, and also mechanical, temperature and other factors. Owing to such influences a hemolysis can appear - it is destruction of erythrocytes. For practical medicine it is important to spot an osmotic resistance, which characterizes physicochemical properties of erythrocytes, first of all elastance and density of their membranes, which are not equal for aged and young cells. The osmotic hemolysis of erythrocytes in norm has definite parameters, which very much variate at various disfunctions of red bone marrow.

Resistance of erythrocytes membrane is researched in hypotonic solutions of a sodium chloridum. In normal state hemolysis only of the least steady erythrocytes takes place at concentration 0,5-0,45 % of NaCl. (minimum resistance).

If the concentration becomes less hemolysis of more steady erythrocytes begins. Even the most steady erythrocytes are destroyed in 0,4-0,35% NaCl solution (maximum resistance). The

solution becomes limpid as a laky (so-called laky solution). The interval between upper and low limits of resistance is called as amplitude of resistance.

The purpose of the work:

To get aquainted with limit changes as to osmotic pressure of blood plasma in which erythrocytes membranes is still saved and to give an evaluation of stability and elastisity of the erythrocytes membrane.

To fullfil the work one needs:

7 Vidal`s test-tubes (or usual laboratory test-tubes), support for test-tubes, 0,5% solution of NaCl, distilled water, blood mixed with 5% solution of sodium chythrat , 3 droppers with equal holes.

Fullfilment of the work:

Using 0,5% solution of NaCl prepare series of delutions under the scheme:

Number of test- tube	Quantity of drops of 0,5% NaCl solution	Quantity of drops of distilled water	Received concentration of solution
1	25	-	0,5 %
2	24	1	0,48 %
3	22	3	0,44 %
4	20	5	0,40 %
5	18	7	0,36 %
6	16	9	0,32 %
7	14	11	0,28 %

Add on one drop of a tinned blood in each test-tube. Contents of the test-tubes cautiously intermix before even colouring and keep 1 hour in a support. In one hour, without shaking contents of test-tubes see, where the destruction of the erythrocytes membrane / a hemolysis / is watched. Estimate the state of blood on a degree of colouring of solution NaCl, which seats above caked erythrocytes in test-tubes.

Results of the work.

1) The beginning of hemolisis of erythrocytes took place in hypotonic solution of sodium chlorine with the concentration_____%, it corralates with the minimum resistance of erythrocytes.

2) The complete hemolisis of erythrocytes took place in hypotonic solution of sodium chlorine with the concentration_____%, it corralates with maximum resistance of erythrocytes.

Conclutions*:(compare values with the limits of norm. What does it testity about?)*

Work 3. Determination of blood sedimentation rate (BSR) on Panchenkon`s method.

Blood is at the same time really colloidal solution and suspension. The particles of substances suspensed in liquid are subjected to the action of opposite forces. On one side it`s force of gravity causing sedimentation of particles. On the other side it`s power of diffusion causing the mixture of particles. It is known that the rate of sedimentation of a particle is directly proportional to a quadrate of its radius and difference of density of suspensed substance and dissolvent and also is inversely proportional of viscosity of a dissolvent. The electric charge of particles that are in solution have great significance.

Blood cells are suspensed in colloidal solution of blood plasma and proofly bound with them by charges, will subside in the stabilized blood at the expense of intensifying their sintering. Thus the blood will be divided into 2 layers: upper - plasma and inferior -cells.

Interrelation of cholesterol and lecithine in plasma, contents of cholic pigments and cholic acids, change of viscosity, pH, the properties of erythrocytes, quantity of a haemoglobin etc. influence on BSR (sedimentation rate of erythrocytes).

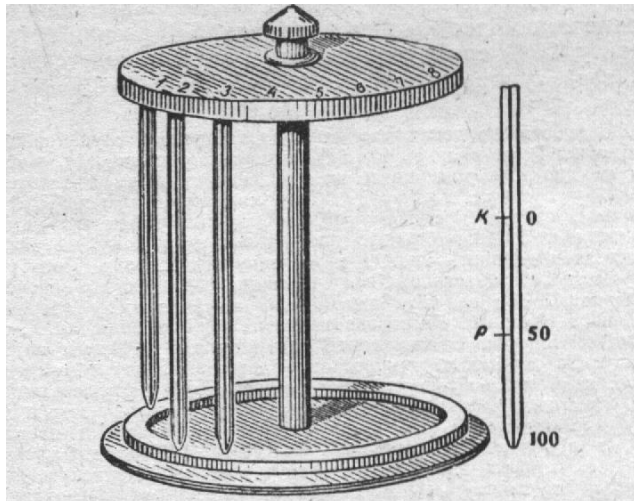
As the main factors, which BSR depends on, one considers qualitative and quantitative changes of proteins in plasma. So, the augmentation of quantity of high molecular proteins (globulins) gives in rise BSR, and decrease of their concentration and the augmentation of a contents of Albuminums gives in its lowering.

BSR yields some idea about an interrelation between proteins of plasma and their electrostatic interaction with erythrocytes of blood.

The purpose of the work:

To define BSR. To look through principles of the determination of BSR. To give a common assessment of an interrelation between albumens and globulins in blood plasma.

To fullfil the work one needs: Panchenkov`s apparatus, support with test-tube, a needle, a watch, 5% solution of sodium cythrat, 96% etyl alcohol, 2% solution of Iodum in etyl alcohol, cotton wool, pyriform rubber.



Мал. 7. Апарат Панченкова з піпетками

The Panchenkov`s apparatus with pipettes

Fullfilment of the work:

Intermix blood of the donor, mixed with 5% solution of sodium cythrat in correlation 4:1 and collect it to the mark K with the help of a pyriform rubber. Take cautiously the capillary out of the test-tube, take away the blood from the pipette`s tip and squeeze the pipette`s tip in a rubber gasket, which is present in the Panchenkov`s apparatus . Only after that it is possible to remove a pyriform rubber from the capillary. The top of the capillary also should be carefully consolidated in the apparatus. In 30 mins and 1 h. determine the level of subsidence erythrocytes in the capillary.

Results of the work.

BSR is _____mm per hour.

Conclutions (mark, is the determinated BSR normal? What does it testity about?)

Protocol revised_____
(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P. 302-307, 311-312, 323-325.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 54-64, 74-75.

FOR NOTES

Practical study 2.

Studying of he number of erythrocytes and hemoglobin's level in blood. Defensive functions of blood. Hemostasis

1.Urgency of the theme:

The main function of erythrocytes and hemoglobin, which contains in them, is the participation in the transport of gases (O_2 and CO_2) with blood. But the functions of erythrocytes are not limitted with it. Having greate biological activity, the erythrocytes` membrane plays the significant role in the transport of the many substances absorbeted on the erythrocytes, namely: different substrates, nutritious substances, metabolites, biological active substances, ions and others.

Hemoglobin of erythrocytes is a buffer system and takes part in pH regulation of blood. In the clinic it is nessecary to define the quantity of erythrocytes and hemoglobin content and estimate these parameters. Their changes can be observed in healthy people in different physiological states of an organism.

To estimate the received results right it is important to know the nervous and humoral mechanisms of supporting the quantity of erythrocytes and hemoglobin in blood at a certain level during different adaptative reactions of an organism.

Blood fulfils defensive function: hemostasis and immunity. Knowledge of physiological mechanisms of blood coagulation is necessary to understand its violations and in the case of bleeding to normolize it or to restore mechanisms for supporting liquid state of blood in vessels.

The system of coagulation is the main system to protect the organism from bleeding when damaging vessels. The system of coagulation consists of the factors which promote coagulation (coagulants) and contradict it (anticoagulants). They are substances which differ by their chemical properties and mechanisms of action (ions, carbonhydrates, proteins etc). The principle of feedback connection lies in the base of their interraction. Thus, the increased quantity or activity of coagulants obligatory causes the changes in the content of anticoagulants` system which in turn causes the liquid state of blood support. On one hand thrombocytes, erythrocytes and leucocytes and on the other hand proteins and ions of internal environment supply blood coagulation. They contain the factors of coagulation or they are these factors themselves, take part in their transport or regulate blood coagulation.

It is important that in norm the system of coagulation makes the permanent control for microcirculatory vessels` permeability. In case of increased tissue`s activity (physical work, increased secretion etc) when their permeability increased, the temporary microfibrine nets are formed which prevent from going proteins and blood cells out of the vessels. There is connection between coagulants and anticoagulants or otherwise between the factors which promote coagulants and contradict it because this fibrine net must be temporary.

Besides, in norm thrombocytes regulate not only capillars` permeability but partically take part in trophyc of endothelium of vessels` walls and take part in immunity reactions. Thus, in normal conditions the functions of blood coagulation`s system are directed to homeostasis support, and in the case of vessels` damage – to the stop of bleeding. In practice the research of blood coagulation is one of the most difficult procedures in blood research in general. It is connected not only with the capacity of blood to coagulate but with those changes in its content that appear just after blood goes out of the vessels. These are the changes of coagulants` activity, the factors of fibrinolisis, ruining of thrombocytes, the increase or decrease activity of proteases which are the factors of coagulation. Therefore it is necessary to begin the research of blood coagulation just after taking blood for testing and make it quickly. Only certain tests (IV and V phases of coagulation, retraction of thromb, fibrinolisis) can be made some time later. In such cases blood stabilization also differ from the usual one.

Blood taken for testing is poured not into usual glass test-tubes but into special covered with silicone or single plastic test-tubes. In hematological clinics the research of blood coagulation are made by unificated technique.

2.Educational purposes:

- *To treat concept of the system of erythron.*
- *To apply knowledge of a constitution, functions, quantity of erythrocytes and hemoglobin in blood, regulation of the erythropoesis to the assessment of: parameters and state of red blood; role of erythrocytes in adaptative reactions of an organism.*
- *To explain physiological foundations of research techniques of functions of the blood system: functions of erythrocytes and quantity of hemoglobin.*
- *To make conclusions about the state of physiological functions of an organism, which are carried out with the help of the blood system on the basis of quantitative and qualitative blood indices: quantity of erythrocytes, hemoglobin, colour parameter of blood.*
- *To interpret physiological regularity of functions for maintenance liquid state of blood and hemostasis development (vessel-thrombocytic and coagulative) when damaging blood vessels.*
- *To explain physiological foundations of function`s research of the blood system: duration of bleeding, blood coagulation time.*
- *To make conclusions about the state of physiological functions of an organism on the base of: quantities of thrombocytes, blood coagulation time, duration of bleeding.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Erythrone	This is subsystem of blood which contains the totality of erythrocytes of circulating and deponating blood, organs of blood formation and the structures where the blasting of old and defective erythrocytes is carried out and also the regulatory mechanisms. This subsystem provides the supporting of quantity of erythrocytes as a means of oxygen transport in accodance to the adaptative reaction of an organism.
Hemoglobin F (HbF) – fetal hemoglobin	This is atype of hemoglobin which contains in fetal`s erythrocytes and in the protein part of which there are 2 alpha and 2 gamma-aminoacid ($\alpha_2\gamma_2$) chains.
Hemoglobin A (HbA) – adalt hemoglobin	This is a type of hemoglobin which contains in the erythrocytes of a man after his birth and in the protein part of which there are 2 alpha and 2 beta-aminoacid ($\alpha_2\beta_2$) chains.
Oxigemoglobine	This is unstable hemoglobin combination with oxygen – HbO_2.
Desoxihemoglobin	This is hemoglobin which is not combined with oxygen - Hb.
Methemoglobin	This is oxidative form of hemoglobin MeHb.
Carbohemoglobin	This is unstable derivation of hemoglobin with carbon dioxide - $HbCO_2$.
Carboxihemoglobin	This is stable derivation of hemoglobin with carbon monoxide (CO) – HbCO.

Color parameter/color index (CP) or CI	Relative parameter which charactirizes the saturation of erythrocytes with hemoglobin in comparison with the normal saturation of erthrocytes with hemoglobin.
Hypochromic erythrocytes	Erythrocytes which are saturated with hemoglobin less than in norm.
Hyperchromic erythrocytes	Erythrocytes which are saturated with hemoglobin more than in norm.
Oxigen blood capacity (OBC)	This is a volum of oxigen which is in 1 liter (0,1 liter) of blood under the condition of 100% saturation of hemoglobin with oxigen.
Hemostasis	It is the stop of bleeding when damaging vessels .
Types of hemostasis	Vessels`-thrombocytic hemostasis and coagulative one (coagulation).
Coagulation	It is the change of aggregate state of blood which takes place during coagulation.
Coagulants	The factors of coagulation, they cause coagulation.
Anticoagulants	They contradict to coagulation at different stages of coagulation.
Fibrinolisis	It is the process of thromb dissolution.
Fibrinolisins	They cause the thromb dissolution.

3.2.*Theoretical questions*

1) Erythrocytes, their quantity, constitution and functions.
2) Hemoglobin, its physiological role. Methods of determination of hemoglobin. Derivants of a hemoglobin, their characteristics.
3) Conception of erythron.
4) Regulation of quantity of erythrocytes in circulating blood.
5) Hemostasis, its types.
6) Thrombocytes, their quantity, functions, physiological role.
7) Vessels-thrombocytic hemostasis, its role and physiological significance.
8) Coagulative hemostasis, its phases, mechanisms, physiological significance.
9) Modern notions about the main factors taking part in coagulative hemostasis – coagulants. Antigoagulants, their types, mechanism of action, physiological significance.
10) Plasmins and fibrinolisis, its mechanisms, significance.
11) The role of vessel`s wall in regulation of hemostasis and fibrinolysis.
12) The regulation of coagulation. Mechanisms of maintenance of liquid state of blood. Blood cells formation and its regulation.
13) Physiological base of hemostasis`s research.
14) Age changes in the system of hemostasis. Age changes in the system of blood.
15) Extravessel liquids of an organism, their role in providing cells` life activity of an organism.

3.3.*Practical works*

1) Scoring of quantity of erythrocytes in blood.
2) Colorimetric method of quantitative determination of hemoglobin rate in blood.
3) Calculation of a colour parameter (color index).
4) Determination of a cristal of hemin and hemoglobin.
5) Determination of common blood coagulation time
6) Research of thromb retraction

7) Research of fibrinolysis processes.

4.Materials for self-control

4.1.*Answer the question*

1) Name the main priciples of basal methods to determine hemoglobin level.

2) Determine, how much oxigen hemoglobin can join if body mass of a patient is 75 kg. hemoglobin content in blood is normal.

3) The quantity of erythrocytes is $2.5 * 10^{12}$/l, hemoglobin is 160 g/l. The color parameter is 1.3. Estimate the parameters. What do they testity about?

4) Everyday rabbit`s blood was taken to research in the quantity of 2.5 ml. In 10 days the quantity of hemoglobin and erythrocytes increased. Explain, why.

5) Calculate the oxigen blood capacity if the quantity of hemoglobin in investigated blood is 120 g/l. Make conclusions.

6) There is a lack of K vitamine in an organism. How and why will the blood coagulation change?

7) The time of blood coagulation makes 4 min. The blood was taken from vien and mixed with the solution of sodium citrate. How and why will the time of blood coagulation change?

8) On the base of heparin injection into blood the common blood coagulation time reaches 7 min. What does it testify about?

9) The quantity of globulins diminishes significantly in blood. How and why will the speed of blood coagulation change in these conditions.

10) The quantity of therombocytes in blood makes 160*109/liter. What does it testify about? How will it act on blood coagulation?

4.2.*Choose the right answer*

1. Training in barocamera with reduced content of oxigen in air is necessary for pilots. As a result of it the increased quantity of erythrocytes and hemoglobin in blood appears in 2 weeks, which testitfies about the stimulation of erythropoesis by erythropoetins. The erythropoetins` formation increases under the appearance of

A. hypertonia
B. hypercapnia

C. hypoxemia
D. hyperosmia
E. hypervolumia

2. With the appearance of strong oxidizers in blood in erythrocytes one of the following substances is formed first of all:
A. carbohemoglobin
B. carboxihemoglobin
C. oxihemoglobin
D. methemoglobin
E. desoxihemoglobin

3. A man was poisoned with carbon monoxide and lossed consciousness. It happened in the result of formation of:
A. oxigemoglobine
B. carbohemoglobin
C. carboxihemoglobin
D. desoxihemoglobin
E. methemoglobin

4. The oxigen blood capacity in fetus at the end of pregnancy before birth increases first of all due to the fact that in erythrocytes there are more:
A. methemoglobin
B. carbohemoglobin
C. hemoglobin A
D. hemoglobin F
E. hemoglobin S

5. In a woman with body mass 70 kg blood quantity is 4.9 liters; hematocrite is 32%, the quantity of erythrocytes is $3.0 \cdot 10^{12}$ /l, hemoglobin is 105 g/l, color parameter is 1.0, the minimum osmotic resistance of erythrocytes is 0.38%NaCl; the maximum osmotic resistance of erythrocytes is 0.34%NaCl. Such blood analises testifies first of all about:
A. the water excess in the organism
B. the lack of water in the organism
C. osmotic hemolisis of erythrocytes
D. chemical hemolisis of erythrocytes
E. the lack of iron in blood plasma

6. In a woman`s blood analises it was found: hematocrite – 34%, hemoglobin – 90g/l, erythrocytes – $3.5 \cdot 10^{12}$ /l, color parameter – 0.77, reticulocytes – 1%, SRE– 10 mm/hour. The reasons for erythropoesis violation the most probable can be the lack of :
A. albumens
B. globulins
C. C vitamine
D. iron
E. folic acid

7. In a man`s blood analisis it was found: hematocrite – 38%, hemoglobin – 120 g/l, erythrocytes – $3.0 \cdot 10^{12}$ /l, color parameter – 1.2, BSR – 8 mm/hour. The reasons of such alalisis the most probable can be the lack of:
A. albumens
B. globulins
C. C vitamine
D. iron
E. vitamine B_{12}

8. In a man of 35 with body mass 80 kg the volume of circulated blood is 5.6 liters, hemoglobin content is 130 g/l. Such parameters testity about:
A. the volum of circulated blood is less than normal
B. the volum of circulated blood is more than normal
C. hemoglobin content is less than normal
D. hemoglobin content is more than normal
E. hemoglobin content is normal

9. The volum of oxigen transported in solutable form by 1000 ml of arterial blood plasma if pO_2 = 100 mm Hg will be:
A. 10 ml
B. 20 ml
C. 30 ml
D. 40 ml
E. 50 ml

10. In a woman`s blood analises it was found: hemoglobin content – 100 g/l, erythrocytes – $3.0 \cdot 10^{12}$/l. The oxigen blood capacity is equal to:
A. 134 ml
B. 100 ml
C. 200 ml
D. 1,34 ml
E. 3,0 ml

11. In a man of 40 with weight of 80 kg, during the stress common blood coagulation time makes 2 min., which is first of all the result of the action on coagulation:
A. Catecholamines
B. cortisol
C. aldosterone
D. somatotropin
E. Vasopressin

12. After the violation of microvessels the content of thromboxan A_2 in blood was increased which led to the diminishing of

time bleeding during the development first of all:

A. revearsible aggregation of thrombocytes
B. adhesion of thrombocytes
C. unrevearsible aggfregation of thrombocytes
D. hemocoagulation
E. thromb`s retraction

13. In a girl of 10 the absence of X factor was stated in blood which led to the prolonged bleeding with the vessels` damage as a result of hemostasis violation directly during the formation of:

A. prothrombinase
B. thrombin
C. fibrin
D. thrombostenin
E. plasmin

14. In a youth of 16 after the desease the protein`s synthetic function of liver is diminished as a result of lack of K vitamine. It leads first of all, to violation of:

A. blood coagulation
B. blood segimentation rate
C. anticoagulants formation
D. erythropoetins formation
E. blood oncotic pressure

15. The content of ATP/ADP was considerably diminished in blood cells which was accompanied with the increase of time of bleeding as a result of hemostasis violation directly during the development of:

A. revearsible aggregation of thrombocytes
B. unrevearsible aggregation of thrombocytes
C. adhesion of thrombocytes
D. hemocoagulation
E. thromb`s retraction

16. In a boy of 4 the absence of УIII factor was stated in blood which leds to the prolonged bleeding when damaging vessels as a result of hemostasis violation just during the formation of:

A. blood prothrombinase
B. tissue prothrombinase
C. thrombin
D. fibrin
E. thrombostenin

17. Blood was put into a test-tube. It was stated that blood coagulation time made 6 min. After the thromb formation the test-tube was put into thermostate for 24 hours and in 24 hours the thromb destroying was stated as a result of direct activation of:

A. plasmins
B. kinins
C. kallikreins
D. Heparin
E. antithrombins

18. The common blood coagulation time makes 5 minutes. Prothrombine index makes 100%. With these parameters the duration of the I phase of coagulative hemostasis makes:

A. 5 minutes
B. 15 minutes
C. 5 seconds
D. 15 seconds
E. 2 minutes

19. In a man the quantity of thrombocytes in peripheric blood makes $150 \cdot 10^9$/liter, it is stated the diminishing of Von Willebrand factor content. What time of bleeding (Duka`s test) will make with these parameters:

A.10 minutes
B. 4 minutes
C.3 minutes
D. 2 minutes
E. 1 minute

20. The common blood coagulation time makes 5 minutes, prothrombine index – 100%, prothrombine`s content in blood plasma – 0,15 g/l. With these parameters the duration of II phase of coagulative hemostasis makes:

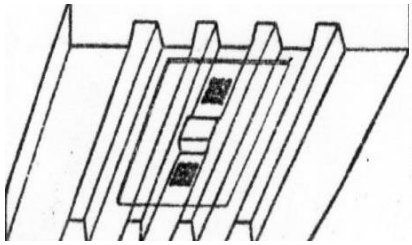
A. 5 seconds
B. 20 seconds
C. 1 minute
D. 2 minutes
E. 10 minutes

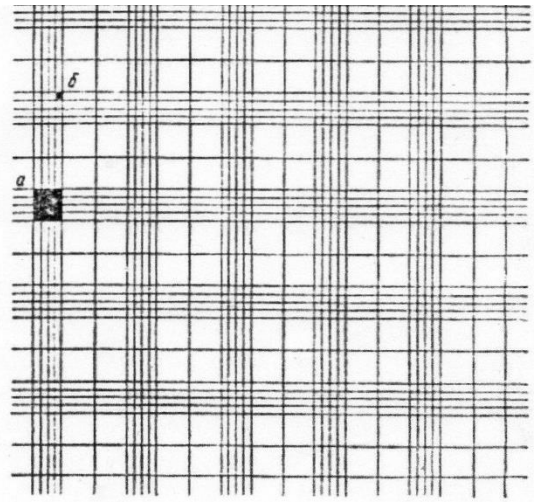
Protocol of practical study №2. __”_____”_____20___

Work 1. Scoring of quantity of erythrocytes in blood.

The erythrocytes are scored with the help of Gorayev`s cytometer under a microscope. The grid of a cytometer consists of 225 major quadrates, from which 25 are divided on 16 small

ones. The side of one small quadrate equals 1/20 mm, square - 1/400 мм^2, height of the camera (distance from the floor up to glass) - 1/10 mm. Thus, volume of the camera above small square compounds 1/400 мм^3 (1/4000 * 1/10).

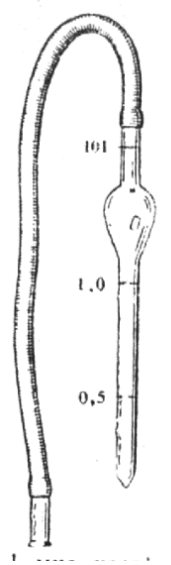




Picture 1 **Picture 2**

Gorayev`s cytometer (1, 2). The grid of a cytometer (2)
А -major box, б -small box

Blood for scoring erythrocytes is thinned in special mixers - capillary pipettes with dilating as an ampula. There are marks 0,5 and 101 on the mixer for erythrocytes. The mark 0,5 shows, what part of volume of all mixer holds the given column of the capillar, filled blood. This volume contains 1/200 parts of complete volume of the mixer. Thus, the blood is thinned in 200 times.



The mixer for erythrocytes

It is possible to thin blood in 200 times also by other methods. For example: to pour 4 ml 5 % of solution of sodium of Citras in the tube and to add there 20 mkl of blood with the help of a micropipette. It is necessary to wash twice a micropipette by the given solution, for all blood to get into the tube.

The purpose of the work is to meet a principle of scoring of quantity of erythrocytes in a Gorayev`s cytometer, to calculate erythrocytes with the help of this method, to estimate the quantity of erythrocytes, which are contained in peripheric blood researched.

To fullfil the work one needs a microscope, gaffer, Gorayev`s cytometer, glass, a mixer for red blood, tube, 3 % solution of Sodium chloridum, a needle, 96 % alcohol, 2 % solution of Iodum in alcohol, cotton, rubber pear, 5 % solution of a sodium of Citras, a micropipette of capacity 20 mkl.

Fullfilment of the work. Put glass of Gorayev`s cytometer under a lens of a microscope and watch a net of the camera on major and small augmentation. Cover the cytometer by the glass. Put on a rubber pear on an upper foramen of the mixer (mixing pipette). Pour 1-1,5 ml 3 % of solution of a sodium chloridum in the working tube. Load the end of the mixer in tube with researched blood and collect blood up to a mark 0,5. If more blood is taken, remove an excess of blood with the help of a dry cotton plug, touching to a spont. Load the end of the mixer in 3 % solution of sodium chloridum, which is in the working tube, and with the help of a rubber pear collect it to a mixing pipette till the checkmark 101. Thus, the blood will be thined in 200 times.

Shaking the mixer cautiously, intermix solution of blood in its ampula. There is a small red thing for this purpose. Blow off on cotton the first two drops of solution, which go from the capillar of a mixing pipette, place into the camera the following drops from ampullary solution. For this purpose put the point of a mixing pipette at the edge of the cytometer near the glass and push easyly on the pear. The solution will go under the glass into the cytometer and will fill it in. Wait for 1-2 minutes till erythrocytes have subsided on the bottom of the cytometer.

Find a net of the cytometer at small augmentation of a microscope. Translate the microscope on major augmentation and begin scoring erythrocytes in 5 major quadrates, which are divided on small. It is best to count erythrocytes in major quadrates, which seat on a diagonal a field of vision. It is necessary to remember the Burcer`s rule during scoring erythrocytes: to count in small quadrates those cells, which seat in the middle of a quadrate of the net, and also on its upper and left sides. It is necessary not to count twice erythrocytes, which are on the sides of the nearest quadrates

Calculate quantity of erythrocytes in 1mkl of blood under the formula:

$$X = \frac{a * 4000 * 200}{80}$$

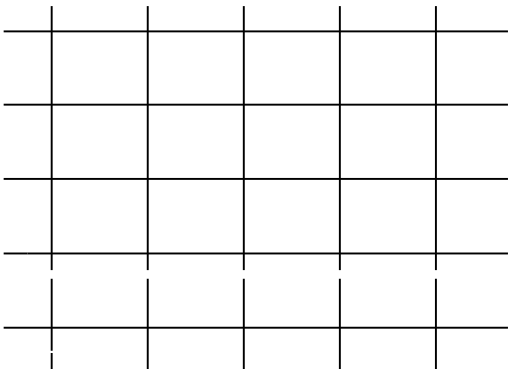
Where X - quantity of erythrocytes in 1 mkl; a - quantity of erythrocytes in 80 small boxes; 80 - quantity of calculated small boxes (5*16 = 80); 200 degrees of delution of blood; 4000-factors, which gives result in volume 1mkl of blood, as volume of small quadrate makes 1/400 mkl.

Practically determine quantity of erythrocytes in 80 small quadrates, the obtained parameter multiply on 10 000. For quantifying erythrocytes on C1 - T (tera) in 1 l - obtained digit multiply on 10^6.

Map the process of calculation in the protocol. The quantity of erythrocytes in 1 liter of blood should be indicated after final calculation.

Rresults of the work.

One small box*:*



The quantity of erythrocytes in 80 small boxes is __

___The quantity of erythrocytes in 1 liter of blood is__

Conclutions: (Is the quantity of erythrocytes in researched blood normal?)

Work 2. Colorimetric method of quantitative determination of hemoglobin rate in blood.

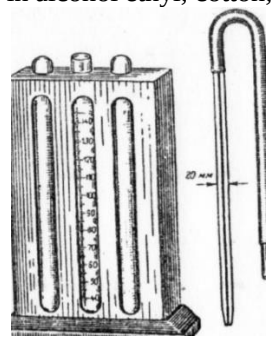
The quantifying of hemoglobin in blood is obligatory in examination of any person - both healthy, and sick.

The Sahli`s method is applied most often in quantifying hemoglobin in blood. It is based on matching of colour of researched solution of blood with a standard. This method of quantifying hemoglobin yields results within 10 %. Such mistake arises in connection with the technique of determination and possible subjective errors in colour test. However, this method is simple and convenient. The most precise methods of determination of hemoglobin concentration are those that are based on determination of its quantity on the base of determination of contents of those materials, which are available in hemoglobin (for example, Fe^{2+} or O_2 at complete oxygenation of a molecula of hemoglobin).

The Sahli`s hemometer consists of a mount with 3 tubes. There is 1 % solution of chlorohydroxyhematinin inside soldered tubes. The average tube has segmentation from 0 up to 23 g/%. This is absolute quantity of hemoglobin in 100 mls of blood.

The purpose of the work.: to get acquainted with the method of quantitative determination of hemoglobin on the Sahli`s method. To spot and to estimate quantity of hemoglobin in blood of a researched.

To fullfil the work one needs: Sahli`s hemometer, micropipette of capacity 20 mkl, glass rod, eyedropper, 0,1 % solution of Acidum hydrochloricum, distillated water, needle, 96 % alcohol ethyl, 2 % solution of Iodum in alcohol ethyl, cotton, rubber pear.



The Sahli`s hemometer with pipette

Fullfilment of the work Pour 0,1 % solution of Acidum hydrochloricum up to the inferior mark with the help of a micropipette into the middle tube of a hemometer. Collect 20 mkl of blood with the help of a micropipette and rubber pear. Wipe off the end of the capillar with cotton and, having loaded it in 0,1 % solution of Acidum hydrochloricum on the bottom of the tube of a hemometer, cautiously, for the foam not to appear, blow out blood and water the capillar twice with this solution. Keep a hemometer 4-5 mins. During this time the acid, having destroyed the shell of erythrocytes, will convert hemoglobin in chlorohydroxyhematinin, which has brown

colour. Add distillated water in drops in the average tube as long as the colour of solution in the average tube, will become such, as in standard tubes. Fix a level of solution in the average tube. It will be the value, which characterizes quantity of hemoglobin in blood in absolute units. The hemometer contains in standard solutions 167 g/l of hemoglobin.

Recommendations for writing results of the work. Calculate quantity of hemoglobin in researched blood. Give results in absolute units.

Examples of calculation.

The hemometer has segmentation in absolute units of hemoglobin. Result - 15 g of %

Calculation: 15 g of %∗10 = 150 g/l.

Results of the work:

The quantity of hemoglobin in researched blood is_____g/l

Conclusions: *(Is quantity of hemoglobin in a researched blood normal? What does it testity about?)*

Work 3. Calculation of colour parameter.

5 indexes of red blood are calculated in hematological clinic: a colour parameter, average hemoglobin content in erythrocyte, average concentration of hemoglobin in erythrocyte, average volume of erythrocyte, average diameter of erythrocyte. The determination of a colour parameter should be obligatory in common clinical analysis.

The value of this parameter displays relativity content of hemoglobin in erythrocytes. The colour parameter is in limits 0,85-1,15 at a normal saturation of erythrocytes with hemoglobin. The increase or decrease it bears to violation of a saturation of erythrocytes by hemoglobin. It is possible to use a nomogram for calculation of a colour parameter of blood.

The purpose of the work. To determine and estimate erythrocytes`s saturation by hemoglobine.

Fullfilment of the work Calculate a colour parameter (CP) having determinated quantity of erythrocytes in 1 mkl of blood and quantity of hemoglobin.

If the quantity of hemoglobin is determined in gram-percents, CP calculate under the formula:

$$\text{The CP} = \frac{\text{Quantity Hb (g/l)} * 3}{\text{Quantity erythrocytes} * 100}$$

For example, if the quantity of hemoglobin makes 140 g/l, erythrocytes – $4{,}2 * 10^{12}$, so

$$\text{The CP} = \frac{140 * 3}{4{,}2 * 100} = 1{,}0$$

Results of the work:

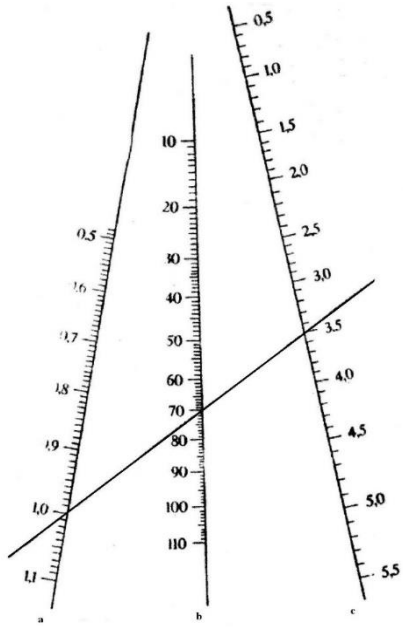
Calculate a colour parameter on the base of datas of previous works.

CP =

Conclusions: *(estimate the value of CP and mark what is the saturation of erythrocytes by hemoglobin? What does it testify about*).

Give total characteristic of parameters of red blood on the base of data obtained at fulfilment of works 1,2,3.

It is possible to determine CP on the nomogram.



The nomogram for color parameter determination: a- scale for color parameter; b – scale percent content of a hemoglobin by the Saly1s method; c - quantity of erythrocyters in 1 mkl of blood

Work 4. Determination with chips of hemin and hemoglobin.

The constitution of hem in hemoglobin molecula is identical for all mammalian, and the globin has specific specificity and manifold frames in borders of one sort. Tap manifold bonds of hemoglobin at qualitative test in blood, solutions, on subjects. It is possible to determine, what sort of animal or human blood belongs to.

The purpose of the work.

To determine, if there is blood in a slide and to whom it belongs to.

To fullfil the work one needs: researched fluid or a microscope slide with the dried drug, a microscope, gaffer, glass, a spirit-lamp, matches, eyedroppers, ice acetic acid, Chloroformium, balm.

Fullfilment of the work Obtaining of chips of hemin and hemoglobin.

1. Add small chip of Sodium chloridum to the drop, dried on a microscope slide, stir 1 drop of an ice acetic acid and wait, while the odour of an acid will disappear (it is possible to preheat glass on fire). After that drug is put into the glass and at major augmentation search under a microscope for chips of hemin.

2. One superimposes a drop of balm dissolved with Chloroformium on a microscope slide. One puts into it a drop which is 5-10 times less than researched solution and covers it with glass at once. Preheat on fire for 1-2 min.

3. Watch by a microscope. If there is blood in solution, there should be chips of a hemoglobin in a drug.

Results of the work:

*The chips of hemine have the form*_____

*The chips of hemoglobin have the form*_____

(To drow chips of hemin and hemoglobin. To pay attention to their colour and form).

Conclusions: *(mark, was there blood in a researched slide; was there animal blood or human blood in the drug?)*

Work 5. Determination of common blood coagulation time

The purpose of the work: to determine common blood coagulation time and to estimate it.

To fulfil the work one needs: a microscope glass, a glass hook, watch, needle, 96 % alcohol, 2 % solution of Iodum in alcohol, cotton wool.

Fulfilment of the work. To take blood from a rat`s tail and to drop this blood on a microscope glass, simultaneously to note time. Pulling out the contents of a drop with the hook within an interval 20-30 min (hook should be kept upright), wait, while the thin transparent strand of a fibrin will be pulled behind the hook. Again note the time and consider this moment as the beginning of coagulation. Then, also having loaded a hook in a drop of blood to draw out contents of a drop horizontally on glass within the same interval. As soon as the thromb is pulled behind a hook, note time, which responds the terminal of the process of coagulation.

Results of the work.

Blood coagulation begins through _____ minutes.

Blood coagulation ends (thromb formation) through _____minutes.

The conclusions: The common blood coagulation time is ____ . It testifies about_____.

Work 6. Research of thromb retraction

The violation of retraction of a thromb arises in case of lowering activity of retractozime (thrombostenin), which is contained in thrombocytes.

The purpose of the work:

1) To master the method of quantitative determination of a degree of retraction.
2) To determine and to estimate thromb retraction.

To fulfil the work one needs: the measuring tube with a fuse and drain, filled with coagulated blood of a rabbit, a support, a thermostat.

Fulfilment of the work. To determine thromb retraction you should use the measuring tube, filled with a rabbit`s blood. The blood has been issued from an arteria directly into the tube. The tube is stopped up with a fuse with drain and is put into the thermostat for 1 h with the temperature 37 C^{o}.

Take out the tube from the thermostat. Mark, how much blood is present in it. Take out the tube with the drain and thromb, which has been derivated on it. Determine how much Serum remained in the tube.

Results of the work. To describe sort and form of a thromb, this has been taken out of the tube. To calculate in percentage quantity of Serum, which has remained, outgoing from total amount of blood.

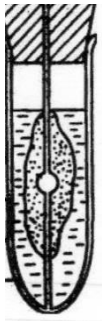
Blood volume in test-tube is_____ml.

Serum volume is_____ ml.

Thromb retraction is_____%.

Conclutions: determine whether the retraction of the thromb is normal? What does it testify about?

The test-tube for the determination of thromb retraction



Work 7. Research of fibrinolysis processes

Fibrinolysis – is a process of thromb`s dissolution, which depends on the activity of its factors and can be completed in a period from several minutes up to several hours. But when the activity of fibrinolytic enzymes is very great, blood coagulation can not take place at all. This work is fulfilled with the purpose of having only ideas about the activity of plasmin (fibrinolytic) system.

The work can be done in the form of demonstrating the results of animals' blood samples different in time.

The purpose of the work: observe thromb dissolution in the tube.

To fulfil the work one needs: a support, a tube with animal blood, water heater with the thermometer, a test tube or pipette with checkmarks on 0,01 ml.

Fulfilment of the work. Prepare water heater to the temperature 38^{o} C. Put the test tube filled by fresh blood in it (1 ml of blood) and support the temperature in it at alevel mentioned before. Tilt the tube through each 10 minutes, taking out from a heater. Criteria for the beginning of a fibrinolysis will be decrease of a thromb and colouring of Serum, which level variates during an obliquity of the tube. Spot quantity of fibrinolysis blood in 30 minutes and 1 h after the beginning of research with the help of a measuring tube or a pipette.

Results of the work.

1) To describe changes, which have taken place in the tube during observations;
2) To point quantity of fibrinolysated blood.

Conclusions: What does fibrinolysated blood differs from fresh stabilized? Fibrinolisis of thromb testifies about the appearance _____in blood.

Protocol revised_____
(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.307-351.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 64-85.

FOR NOTES

Practical study 3.

Defensive functions of blood. Immunity. Physiology of leukocytes. Blood types

1.Urgency of the theme:

Blood fulfils defensive function. It is an important factor of immunity. It is caused by the presence of leukocytes in blood, antibodies which inactivate microorganisms and their poisons, ruin strange proteins. The increase of the activity of the defensive factors takes place during digestion, psychological stress, physical activity etc.

A future doctor has to estimate the quantitive changes of leukocytes and leukocytic formula, the functional possiblities of different types of leukocytes, the mechanisms of increasing or decreasing their quantity.

For successful blood transfusion from a donor to a recipient every doctor must know the main blood groups and must be able to determine blood group in AB0 and CDE systems.

In hematological clinic one makes not only the calculation but a description of all white blood cells (leukogramm), calculation and description of the cell received during the punction of the red bone marrow (mielogramm) and lymphatic nodes (lymphoadenogramm).

2.Educational purposes:

- *To apply knowledge of a structure, types and functions of leukocytes; regulations of leukopoiesis for estimation the parameters of white blood (quantity of leukocytes, leukocytic formula) and functional state of an organism and defensive function of blood.*
- *To interpret the principles of fulfilment of all tests before blood transfusion.*
- *To explain physiological base of methods for blood grouping in ABO and CDE systems.*
- *Make the conclusions about the state of physiological functions of an organism on the base of quantity of leukocytes and leukocytic formula.*
- *To analyse age changes of leukocytes` quantity, their functions and regulatory mechanisms.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
AB0	Blood group. It contains agglutinogens (antigens) A and B, agglutinins (antibodies) α and β.
СДЕ	Blood group which contains more than 40 antigens. The main is D antigen.
Tholyclon anti-A	They are specific immunoglobulins or antibodies, agglutinins which act against A antigens of AB0 system. They are formed by monoclonic B-lymphocytes in mice.
Tholyclon anti-B	They are specific immunoglobulins or antibodies, agglutinins which act against B antigens of AB0 system. They are formed by monoclonic B-lymphocytes in mice.
Standart erythrocytes A	Human erythrocytes of A (II) group which contain only A antigens.
Standart erythrocytes B	Human erythrocytes of B (III) group which contain only B antigens.

3.2.*Theoretical questions*

1) Leukocytes, their quantity, types. Regulation of leukopoesis. The notion about leucicytosis and leukopenia. Physiological leukocytoses.

2) Leukocytic formula. The functions of different types of leukocytes. Regulation of leukocytes` quantity. The notion about immunity, its types.
3) Physiological characteristics of the group systems AB0 and CDE (rhesus) and others. The significance of grouping in rhesus system at blood transfusion and pregnancy.
4) The methods of blood grouping. Physiological base for blood transfusion. The tests applied before blood transfusion. The conditions for blood compatibility of a donor and a recipient. Blood-substituted solutions.

3.3.*Practical works*

1) Blood grouping in the AB0 system on the base of agglutination test with the help of tholyclons.

4. Materials for self-control

4.1. Answer the question

1) Estimate the blood analisis: leukocytes`s quantity is $7\text{-}10^9$/l; leukocytic formula: neutrophils — 55%, eosinophils — 18 %, lymphocytes — 22 %., monocytes — 5 %. What do these parameters testify about?

2) Determine whether this leukocytosis is absolute or relative (physiological) if the quantity of leukocytes is $10 - 10^9$/ l, neutrophils — 60 %, lymphocytes — 40 %.

3) In a sportman the quantity of leukocytes before physical exercises was $4\text{-}10^9$/l, after exercises — $6\text{-}10^9$/l. Are these quantative changes normal and what do they testify about?

4) A recipient has Bα (III) blood type. Blood has no antigens of СДЕ system. What antigens and antibodies content from the named above systems are permissible in donor`s blood which is to be trasfused to the patient?

5) Recipient has 0αβ (I) blood type. There are rhesus antigens and antigens of M and MNSs systems. What antigens and antibodies must not be present in donor`s blood which is to be transfused to a patient?

6) There are no CDE antigens in the blood of a pregnant woman, but they are in the blood of fetus. Can rhesus conflict appear in this case? If it can, then why?

4.2.Choose the right answer:

1. During the determination of the blood group in AB0 system it was stated that there was agglutination of blood with tcholyclone anti-A and there was no agglutination of blood and tcholyclone anti B. There was agglutination with the mixing of blood plasma and standart erythrocytes A; there was no agglutination with the mixing of blood plasma and standart erythrocytes B. What blood group is it?

A. A β(II)
B. Bα (III)
C. AB $_o$(IV)
D. 0 αβ (I)
E. Blood group can not be determined.

2. A patient needs hemotranfusion. Which test from the abligatory will you fulfil the last?
A. Bioassey.
B. Individual serological test on group compatibility
C. Donor`s Blood typing determination in the CDE system
D.Blood group determination of the donor in the AB0 system
E. Blood group determination of the recipient in the AB0 system.

3. During the determination of blood types it was stated that there was agglutination of researched blood with the standart serums 0αβ (I), Aβ (II), B α(III) of blood types. It permits to propose IV blood type. For the final conclusion about the blood type it is necessary to fulfil the test with:
A. 0,9%NaCl
B. standart serum of AB $_{O}$ (IV) blood type
C. recipient`s plasma
D. anti-rhesus serum
E. tcholyclons

4. As a result of bleeding the blood transfusion became necessary for a woman with the previous blood type determination. There was agglutination between erythrocytes and standart serums of 0αβ (I), Aβ(II) blood types, and there was no aglutination between erythrocytes and the standart serum of α (III) group. Researched blood belong to:
A. 0αβ (I)
B. A β(II)
C. Bα (III)
D. AB $_{O}$(IV)

5. In the blood analises of a youth of 23 who consulted a doctor with body temperature increasing to 37,8ºC for 3 days in was stated that: erythrocytes $4.5*10^{12}$/l, hemoglobine-160 g/l, leukocytes -$12*10^{9}$/l, morphonuclear neutrophils - 65%, basophils - 0,5%, eosinophiles - 0,5%, monocytes - 8%, lymphocytes - 20%. Such parameters testity first of all about the stimulation
A. Erythropoesis
B. Monocytopoesis
C. Lymphopoesis
D. Granolocytopoesis,
E. Immunogenesis

6. A Rhesus-negative woman is pregnant. It is the first pregnancy. Is rhesus-conflict in the woman possible if the father of the child is rhesus-positive (Rh+)?
A. It is impossible during the pregnancy
B. Appears obligatory during pregnancy
C. It is possible when placent barrier is damaged.
D. Appears obligatory during the birth
E. It is impossible during the first pregnancy

7. In the hemanalisis of a patient it was stated: leukocytes 10 x 10 9/l. Leukocitic formula is without changes. Most probably it testifies about that:
A. A patient didn`t sleep
B. A patient had breakfast
C. inflammation takes place.
D. lymphopenia takes place
E. A patient drank water before the analisis.

8. There was agglutination between erythrocytes of the reaserched blood and tcholyclone anti-B. It testifies about:
A. the presence of B antigens on erythrocytes` membrane of the researched blood.
B. blood group is Bα (III)
C. blood group is AB $_{o}$(IV)
D. the presence of A agglutinogens on the erythroytes` membrane of the researched blood.
E. the presence of β agglutinins in the researched blood.

9. There was agglutination as a result of mixing of plasma and standart erythrocytes A. It testifies about:
A. the presence of α agglutinins in blood plasma of the researched blood.
B. the presence of β agglutinins in blood plasma of the researched blood.
C. the presence of A agglutinogens on the erythrocytes` membrane.
D. blood type is A β(II)
E. the presence of B agglutinogens on the erythrocytes`s membrane

10. During the blood type determination in AB0 system there was agglutination of the researched blood with the tcholyclone anti-A. What blood type is it?
A. A β(II)
B. Bα (III)
C. AB $_{o}$(IV)

D. 0 αβ (I)

E. It is impossible to determine the blood type

Protocol of practical study №3. "____"_____20___

Work 1. Blood grouping in the AB0 system on the base of agglutination test with the help of tholyclons

The same principle is used in any system for determination of blood groups: provide conditions for realization of agglutination test of erythrocytes in medium of standard isohaemoglutynating serums or tholyclons, which have a high titre of antibodies to researched antigens of erythrocytes. Standard serum is plasma of donors of different blood groups, cleared in factory conditions, which does not contain Fibrinogen and has high concentration of antibodies to one or several antigens of one certain blood group.

The tholyclins anti-A and anti-B represent powder, which contains specific immunoglobulins, that are antibodies, aglutinins, which react against group antigens A and B. These antibodies are derivated by monoclonic B-lymphocytes of mice with introduction to their organism antigens (A or B) by the way of malignant specific cells.

Tholyclons are antibodies only of one specificity. It means, that they make reaction only to one antigen, that is do not cause nonspecific polyagglutination of erythrocytes. These their properties provide advantage before standard serums, which are hardly cleaned from other antibodies and therefore nonspecific reactions with antigens of researched blood are possible.

The purpose of the work:

To determine blood group in the AB0 system.

To fulfil the work one needs:

A white porcelain plate, 7 marked pipettes, 2 microscope glasses, a pencil for glass, blood and plasma of an examined person, closed volums with solutions of tholyclons anti-A and anti-B, standard erythrocytes II (A) and III (B), isoosmotic solution of sodium chloridum.

Fulfilment of the work.

Divide the dry porcelain plate into 4 sectors with the pencil for glass. Make inscriptions "anti-A", "anti-B", " the standard A ", " the standard B ". With the help of marked pipettes in turn drop one drop (0,1 ml) of the tholyclons anti-A and anti-B on the surface of the plate to the definite sector. Observe that there were no drops to nabouring sectors. Make the drop plane (not less than 1,5-2 cm in a diameter) with the same pipette.

With the help of a glass stick place one drop of the researched blood on the first dry microscope glass. With the corners of the second dry microscope glass bring a part of blood (0,01ml) to both drops of tholyclons . The corners of glass for different tholyclons should be different. Mix the blood immeadiately with the drop of tholyclons with this corner of microscope glass. The proportion of blood and tholyclon should be 1:10 (the mixed drop has weak - pink colouring). Carry out the observation of reation shaking the plate during 2,5 minutes.

Estimation of the results and control.

1. There is no agglutination either with tholyclon anti-A, or with tholyclon anti-B. So, it is possible to assume, that the researched erythrocytes do not contain antigens A and B, and it is the blood I group (0, α, β). For confirmation it is necessary to carry out the control on presence aglutinins α and β in this blood.

For carrying out the control it is necessary with the help of the marked pipette to drop on parts of the plate with inscriptions " the standard A " and " the standard B " one drop of plasma of the researched person. Make the drops plane (diameter 1,5-2 cm). Place a drop of standard erythrocytes of group II (A) on the first microscope glass. With the corner of the second microscope glass bring a part of blood to the drop of plasma, which is in the sector " the standard A". The proportion of blood and plasma should be1:10. In the same way mix standard erythrocytes of group III (B) with researched plasma in the sector " the standard B ". If there is

agglutination in both drops of plasma, it is possible to say with confidence, that the researched blood is the blood of I group (0, α, β) and contains aglutinins α and β.

2. The agglutination has taken place only with tholyclons anti-A. So, it is possible to assume, that the researched blood, namely, it`s erythrocytes, contain only antigen A and it is blood of II group (A, β). For confirmation it is necessary to carry out the control with the purpose of detection aglutinins in plasma of the researched person.

For carrying out the control with the help of the marked pipette it is necessary to drop 1 drop of plasma on the plate into the sectors " the standard B " and " the standard A " . Mix plasma and standard erythrocytes II (A) and III (B) by the procedure described above. If the agglutination takes place in the sector " the standard B " and it is absence in the sector " the standard A ", it testifies that in plasma there is aglutinins β and no aglutinins α. So, it is possible to say, that the blood belongs to II group (A, β).

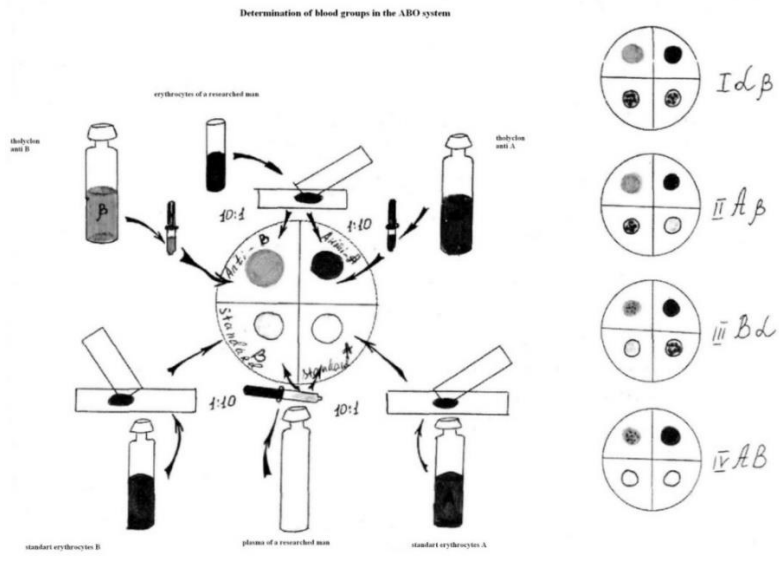
3. The agglutination was held only with tholyclon anti-B. So, it is possible to assume, that the researched erythrocytes contain only antigen B and it is the blood of III group (B, α). For confirmation it is necessary to carry out the same control, as in the previous cases. If the agglutination has taken place in the sector " the standard A " and has not taken place in the sector " the standard B ", it is possible to state, that the researched blood belongs to III group (B, α).

4. The agglutination of erythrocytes is watched in both drops with tholyclons. So, it is possible to assume, that the researched erythrocytes contain antigens - A and B, and it is the blood of IV group (AB-). For confirmation the control is also obligatory which is spent by the procedure described above.

If agglutination of standard erythrocytes is not in both drops of the mixture with researched plasma, it will mean, that the plasma does not contain antibodies α and β. So, the researched blood is the blood of IV group (AB-).

When carrying out the tests it is necessary to remember, that all phenomena, which take place in drops more than for 2,5 minutes from the moment of mixing, will not be connected with specific agglutination, which is determined in research, and can have different reasons.

The false agglutination of erythrocytes can occur, when they are collected in monetary columns. This agglutination can be easily distinguished from the real one if to add 1-2 drops of isoosmotic solution of sodium chloridum to 1 drop of mixture. In this case false agglutination will disappear.



Blood group	erythrocytes reaction with tholyclons		plasma reaction with standart erythrocytes	
	anti-A	anti-B	Standart.A	Standart.B
I	-	-	+	+
II	+	-	-	+
III	-	+	+	-
IV	+	+	-	-

Results of the work

Describe in the form of the offered table results of agglutination with tholyclons anti-A and anti-B, and also results of the control.

Reaction of erythrocytes of researched blood with tholyclons		Reaction of plasma of the researched person with standart erythrocytes		Reseached blood is the blood of group:
anti-A	anti-B	Standart A	Standart B	

Conclutions:

To write conclutions you are to answer:

What does presence/absence of agglutination of researched blood with tholyclon anti-A testify about?

What does presence/absence of agglutination of researched blood with tholyclon anti-B testify about?

What does presence/absence of agglutination of researched blood plasma with standart erythrocytes A testify about?

What does presence/absence of agglutination of researched blood plasma with standart erythrocytes B testify about?

What blood group in AB0 system does the researched blood belong to?

Researched blood belongs to _____group.

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P. 319-351.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 64-68, 75-82.

FOR NOTES

Section 9. Blood circulation system.

Practical study 4.

The system of blood circulation. Studying of physiological properties of heart muscle

1.Urgency of the theme:

Optimal blood supplement of organs and tissues is a necessary condition for their normal activity. It is acheived due to the system of blood circulation. Frequency and rhythm of heart contraction, consequence and synchronity, force and speed of its part`s contraction characterize heart`s work as a pump, and depend on properties of heart muscle. The properties of heart muscle are the following: automatia, excitability, conductivity, contractivity, refractority. The knowleges about molecularic and ionic mechanisms of this properties of heart mucle are necessary for future physisian to normolize damaged heart`s function.

2.Educational purposes:

- *To explain the structure of the system of blood circulation, it`s importance for organism`s activity.*
- *To interpret electrophysiological peculiarities of atypical and typical cardiocyties.*
- *To explain the importance of physiological properties of myocardium (automatia, excitability, conductivity, contractivity, refractority) to provide the pump`s function of the heart.*
- *To fulfill Stannius`s experiment, to write down the results, to make well-grounded conclusions.*

3.The task for independent work at preparation for practical study

3.1. The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study

Term	Definition
Automatia (automatism) of the atypical myocardium`s cells	Capacity to generate action potential without strange irritant. (Automatically)
Pacemaker of the heart	Heart`s structure in the rhythm of which the ventricles contract.
The main pacemaker of the heart	Heart`s structure in the rhythm of which the ventricles contract **in norm.** It is sino-atrial node
Latency pacemakers	Structures of conductive system, which can be pacemakers in some conditions. They are: atrio-ventrical node, Hiss bundle, Purkinje fibers.

3.2.Theoretical questions

1) The structure and importance of the system of blood circulation.
2) Physiological properties and functions of heart muscle.
3) Automatia of the heart. The modern conceptions about the base, nature and gradient of automatia. Action potential of the cells of sino-atrial node.
4) Excitation transmission in the heart.
5) Excitation of heart muscle. Action potential of typical cardiomyocytes. Cooperation between excitation and contraction in the cardiomiocytes.
6) Changes of excitability during the excitation.

3.3.Practical works

1) Analises of the conductive system of the heart (Stannius`s experiment). .

4.Materials for self-control

4.1. Answer the question

1) What phase is specific for action potential of pacemaker? What are the mechanisms of its formation?

2) What phase is specific for action potential of typical cardiomyocytes? What are the mechanisms of its formation?

3) Peculiarities of excitation and contraction cooperation in cardiomyocytes.

4) What peculiarities of changes in excitation prevent titanic contraction?

5) Explain, why the heart submitted to the law "all-or-non".

4.2.Choose the right answer:

1.The specific phase for action potential of pacemaker is the phase of slow diastolic depolarization.What ions entrance into cells causes this phase development?

A. Sodium
B. Potassium
C. Calcium
D. Calcium and sodium
E. chlorine

2. The specific phase for action potential of typical cardiomyocytes is the phase of slow repolarization (plateau).What ions entrance into cells causes this phase development?

A. Sodium
B. Potassium
C. Calcium
D. Calcium and sodium
E. chlorine

3. The patient gets the drug which blocks slow calcium channels. What changes in heart activity does it result in?

A. Force of contraction decreases
B. Frequency of contraction decreases
C. Force and frequency of contraction decreases
D. Force of contraction increases
E. Frequency of contraction increases

4.In the experiment on animal`s isolated heart one of the heart`s structures was local frozen, it causes temporal heart stop. After this the heart restores contraction with the frequency twice less than initial. What structure was frozen?

A. Sino-atrial node
B. Atrio-ventrical node
C. Hiss bundle (Atrio-ventrical bundle)
D. Branches of atrio-ventrical bundle
E. Purkinje fibers

5.Isolated cardiocytes are researched in the experiment. Their resting potential is – 90 mV, amplitude of action potential is 120 mV, duration of action potential is 300 ms. What structures were they taken from?

A. Ventricles
B. Sino-atrial node
C. Atrio-ventrical node
D. Hiss bundle (atrio-ventricle bundle)
E. Pukkinje fibers

6.Stopped isolated heart is stimulated by two electrical impulses with the equal parameters with the interval 200 ms between them. First impulse causes heart`s contraction, the other does not. The reason of this is the fact that the other impulse:

A. Is subthreshold force
B. Is subthreshold duration
C. Is subthreshold speed of force increasing

D. Acts during absolute refractority
E. Acts during relative refractority

7. In what structure of heart`s conductive system the speed of excitation transmission is 0,02-0,05 m/s?

A. Sino-atrial node
B. Atrio-ventrical node
C. Hiss bundle (atrio-ventrical bundle)
D. Branches of atrio-ventrical bundle
E. Purkinje fibers

8.Isolated heart of a rat is perfused by solution without calcium ions. What changes in heart activity does it result in?

A. Frequency of contraction decreases
B. Force and frequency decreases
C. Heart stops
D. There won`t be any changes

9. Acetilholine increases potassium permeability of myocardium cells membrane interacting with M-cholinoreceptors. What changes in heart activity will it result in?

A. There won`t be any changes
B. Force contraction increases
C. Frequency and force contraction increases
D. Frequency of contraction increases
E. Frequency of contraction decreases

10. Frequency of heart contraction in a man is 35 per minute. What is the heart`s pacemaker?

A. Sino-atrial node
B. Atrio-ventrical node
C. Hiss bundle (atrio-ventrical bundle)
D. Branches of atrio-ventrical bundle
E. Purkinje fibers

Protocol of practical study №4. "____"_____20___

Work 1. The research of the conductive system of the heart (Stannius`s experiment)

Automatia is one of the properties of atypical muscle fibres which form the conductive system of the heart. In the heart of a frog sino-atrial node located in the venous sine and ayrio-ventrical node located on the border between atria and ventricles consist of atypical cardiomyocytes. Hiss bundle (atrio-ventricle bundle) begins with antrio-ventricle node which contacts with cardiomyocytes through Purkinje fibres.

The purpose of the work: To determine where the pacemaker of the frog`s heart is located. Be sure that there are other centres of automatia in the frog`s heart. Be sure that there is a gradient of automatia in the heat.

For work it is necessary to have: a set of tools for preparation, plank for preparation, support with a hook, Engelman`s lever, kimograph, serfine (a little metallic clutch), studs, pipette, Pinger solution, tweezeds, threads, a frog.

Fulfillment of the work.

Decapitate a frog, destroy a spinal cord. Cut the thorax and take awey and cut pericardium.

After that the atriums, ventricle, the bulb of aorta and both arcs of aorta are seen. In order to see the venous sine it is necessary to put the heart carefully aside. During the experiment the heart is constantly washed with Ringer solution.

The top of the heart is caught with serfine during the diastole. The heart is hung with a thread which is tied to serfine, the pellicle of pericardium between the venous sine and the back surface of the heart is cut. The thread is pushed through the hole of the short shoulder of the Engelman`s lever closer to the axe of rotation. The thread is drawn in such a way that the heart would be placed vertically, and the lever would be placed horyzontally during the diastole. The thread is fastened in the hole of lever.

A pencil fastened on the lever must be placed so that to touch the surface of kimofraph. Regulate the system of registration in such a way that the line on kimograph would be written during all period of movement at heart contraction and lever`s movement.

One writes mechanocardiogramm, calculates the friquency of contraction of different parts of frog`s heart (the venous sine, atriums, ventricle). With the help of the tweezeds the thread is led through the arcs of aorta and the venous sine. Tie a knot and tighten the ligature between the

venous sine and atriums – it is I ligature by Stannius. Observe the contraction of every part of the frog`s heart. Calculate the frequency of contraction of every part. After that without taking off the I ligature, it is necessary to put the II ligature along atrio-ventrical sulcus and to tie.

Observe the contraction of the parts of the heart, calculate the frequency of contraction of each of them. Write down the mechanocardiogramm.

Results of the work:

The parts of the heart	***The frequency of contraction***		
	control	***After I ligature***	***After II ligature***
Venous sine			
atriums			
ventricle			

Conclutions:

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.362-360, 385-402.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 87-99.

FOR NOTES

Practical study *5.*

Registration and analyses of electrocardiogram. Studying of the pump`s function of the heart

1.Urgency of the theme:

The knoledges of mechanisms of ECG formation and capacity to make analyses of this line is necessary for a future doctor because it permits to determine the heart`s pacemake, esmimate the consequence and speed of excitation distribution, rhythm and frequency of action potential generation by the pacemaker.

The state of blood circulation in the organism depends on heart`s activity as a pump. Therefore its very important for a doctor to be able to demine and estimate the pump`s function of the heart.

2.Educational purposes:

- *Explain the physiological bases of electrocardiogramm.*
- *Interpret the formation of ECG elements from the vector`s theory points of view.*
- *On the base of ECG`s analyses in the standard leads from extremities to be able to detemine:*
  - *What structure is the heart`s pacemaker;*
  - *Is the speed of excitation transmission along the heart`s structures normal;*
  - *Is the orientation and value of the main moment heart`s vector in frontal square normal;*
  - *The position of electrical axe of the heart. .*
- *Estimate the pump`s function of the heart on the base of cardiac output and cardiac index analyses.*
- *Explain the structure of cardiac cycle for the pump`s function of the heart.*
- *Explain the age percularities of the pump`s function of the heart.*
- *Explain the physiological base of methods research of the pump`s function of the heart.*
- *Estimate the state of heart valves on the base of phonocardiogramm analyses.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Electrocardiographia	It is a method of graphic registration of potential difference which appears between different points of the body surface as a result of electrical activity of the heart.
Electrical activity of the heart	It is the process of excitation appearance and its redistritution along heart`s structures
electrocardiogramm (ECG)	It is projection of the summary vector of electrical moving force of electrical field (EMF) on the axes of the leads. This projection is registrated during its changes in time.
Standard leads from extremities (I,II,III)	It is bipolar method of ECG registration in which the both active electrodes are placed on extremities. The potential difference is registrated between two extremities: I lead – “right arm-left arm”; II lead – “right arm-left leg”; III lead – “left arm – left leg”.
Inforced leads from extremities (aVR, aVL, aVF)	It is unipolar method of ECG registration in which the potential difference is registrated between one of extremities where the active electrode is placed (right arm aVR, left arm – aVL, left leg -aVF) and indifirent electrod. It makes ability to inforce potential difference on 50%.

Chest leads ($V_1 – V_6$)	It is unipolar method of ECG registration in which the potential difference is registrated between 2 points of chest cage where the active electrodes are placed ($V_1 – V_6$), and indifirent electrode
The moment heart`s vector	It is summary momemt vector of the electromoving force which appears as a result of electrical activity of the heart. The last causes potential difference between 2 points of body surface and can appear in some moment of cardiac cycle in some square and characterizes direction and value of electrical moving force.
The main heart`s vector	It is a maximum moment vector of the heart which appears during cardiac cycle and characterizes the direction and value of the electrical moving force in frontal square.
The electrical axe of the heart	It is the line which characterizes the main heart`s vector position in frontal square
Einthoven`s triangle	It is equilateral triangle formed with lines connecting points of electrodes. The electrodes are placed on extremities in standard leads.
Axe of the lead	It is imaginative line connecting 2 electrods
Cardiac cycle	It is cyclic contraction (systole) and relaxation (diastole) of the different parts of the heart which is repeated cyclically
Cardiac output or the minute blood volume	It is blood volume which is pushed out by each ventricle into vessels per 1 minute.
Cardiac index	It is cardiac output per 1 square meter of body surface
Stroke volume output	It is blood volume which is pushed out by each ventricle into vessels for 1 systole.
End-diastolic volume	It is blood volume in each ventricle at the end of their diastole.
End-systolic volume	It is blood volume which is left in each ventricle after their systole.
Phonocardiogramm	It is graphycal registration of heart sounds
Sphygmogramm	It is graphycal registration of vibration of arterial vessels` wall which arises due to strike wave distribution along arterias during the systole of left ventricle.
Arterial pulse	It is vibration of arterial vessel wall which arises due to strike wave distribution along arterias during the systole of left ventricle.
echocardiogragy	It is an ultrasound method of movement registration of ventricles` wall, partition and valves during cardiac cycle.

3.2.*Theoretical questions*

1) Electrophysiological bases of electrocardiographia.
2) Dynamic of depolarization and repolarization in the heart.
3) Electrocardiographic leads. Characteristics of normal electrocardiogram.
4) Vector theory of ECG fpormation.
5) Electrical axe of the heart, its determination and position.
6) The role of heart in hemodynamic.
7) The changes in pressure and blood volume in the heart`s chambers during cardiac cycle. Catheterization of heart`s chambers.
8) The valves` role in hemodynamic. The heart sounds, their origin and registration methods. Phonocardiogramm analyses.

9) Arterial pulse, methods of its registration . sphygmogramm analyses.
10) Cardiac output and stroke volume output. Cardiac cycle.

3.3.*Practical works*

1) ECG analyses and registration in a man.
2) Determination of the electrical axe of the heart.
3) Registration and analyses of phonocardiogramm.
4) Registration of central pulse.

4.Materials for self-control

4.1. Answer the question

1) During the preparation for ECG registration the electrodes were mistakenly changed places on the right and left arm. What changes in ECG in the I standard lead will it cause to and why?

2) Why is the direction of ECG waves in aVR always opposite to that in the I and II standard leads from extremities?

3) Why is the wave of atrium repolarization absent on ECG?

4) The duration of *R-R* interval is 1.33 s. What structure is the heart`s pacemeker?

5) The duration of QRS complex is 0.15 s (in norm — to 0.1 s). What does it testify about?

6) The oxygen content in arterial blood of a man makes 190 ml/l, in venous — 90 ml/l. oxygen utilization by an organism equals 1200 ml/min. Calculate cardiac output of a man. What functional state of an organism does this value correspond to?

7) With what pressure in left ventricle does the isometric contraction in a man finish, if it is known that his arterial pressure is 120/70 mm Hg. (16/7,9 k P)?

8) Cardiac output of a man is 6,3 l/min in the state of a rest, body surface —1,8 m2. Calculate cardiac index, estimate its value..

9) It was stated that the cardiac cycle is 0,8 s, the phase of isometric contraction — 0,08 s, the ejection period — 0,33 s. Estimate values of these parameters. In what cases can it change in such a way?

4.1.Choose the right answer

1. In the analyses of ECG it is necessary to estimate the speed of excitation transmission along heart`s structures. For that it is necessary to estimate:

A. direction of waves
B. amplitude of waves
C. direction and amplitude of waves
D. duration of waves and intervals

E. the position of electrical axe of the heart

2.In the analyses of ECG it was stated that the duration of R-R interval makes 0.5 s. What is the frequency of heart contraction per minute?

A. 60
B. 80
C. 100
D. 120
E. 140

3. How are the electrodes placed at ECG registration in the second standard lead on extremities by Einthoven?

A. Right arm (-) – left arm (+)
B. Left arm (-) – left leg (+)
C. Right arm (+) – left leg (-)
D. Left arm (+) – left leg (-)
E. Right arm (-) – left leg (+)

4. In ECG analyses it was stated that the direction, amplitude and duration of P wave in all leads is normal.. True is the conclusion that in the atria there is normal process of:

A. excitation
B. depolarization
C. repolarization
D. contraction
E. relaxation

5. In ECG analyses it was stated that the duration of P-Q interval makes 0.15 s (in norm 0,12 – 0,20 s) at the normal duration of P wave. True is the conclusion that normal is the speed of conduction of excitation along:

A. atria
B. atria-ventrical node
C. sino-atrial node
D. Hiss bandle
E. ventricles

6.In ECG analyses it was stated that the amplitude of T wave in all leads is normal It means that normal is:

A. the value of summary moment vector
B. orientation of summary momemt vector
C. the speed of ventricles repolarization
D. the position of electrical axe of the heart
E. the processes of ventricles repolarization

7. The positive wave is registrated in some ECG lead if the projection of summary moment vector of electrical moving force of electrical field of the heart:

A. Has enough value
B. Has enough duration
C. Gets positive half on axe of the lead
D. Gets negative half on axe of the lead
E. Is parallel to axe of the lead

8. It is necessary to estimate the speed of depolarization by ventricles` miocardium. For that it is necessary to determine the duration of:

A. P wave
B. P-Q interval
C. QRS complex
D. Q-T interval
E. R-R interval

9. In ECG analyses it was stated that the value of α angle is 55°. It means that electrical axe of the heart has the following position:

A. horizontal
B. vertical
C. declined to the left
D. declined to the right
E. normal

10. To dermine on the base of ECG analyses the heart` pacemaker as a rule it is enough to calculate:

A. Direction of R wave
B. Direction of waves of QRS complex
C. Duration of P-Q interval
D. Duration of Q-T interval
E. Duration of R-R

11. In a healthy man the pressure in heart cavities and large arteries was measured with a help of a probe. Where is the probe if during the heart cycle the pressure changes from 0 to 8 mm Hg?

A. Left atrium
B. Left ventricle
C. Right ventricle
D. aorta
E. atria

12. Cardiac output equals 3500 ml, stroke volume output – 70 ml. What is the frequency of heart contractions?

A. 50 per minute
B. 60 per minute
C. 70 per minute
D. 80 per minute
E. 90 per minute

13. Between what phases (periods) of cardiac cycle do atrio-ventricle valves open?

A. Between asinchronic and isometric contraction
B. Between isometric contraction and rapid ejection
C. Between phase of slow ejection and protodiastolic period
D. Between protodiastolic period and phase of isometric relaxation
E. Between isometric relaxation and rapid filling

14. Between what phases (periods) of cardiac cycle do semilunar valves close?
A. Between asinchronic and isometric contraction
B. Between isometric contraction and rapid ejection
C. Between phase of slow ejection and protodiastolic period
D. Between protodiastolic period and phase of isometric relaxation
E. Between isometric relaxation and rapid filling

15. In polycardiogramm they measured the distance between maximum oscillasions of I sound of phonocardiogramm and "c" point (the beginning of anactotism) of sphygmogramm and calculate corresponding time interval. What phases (period) duration of cardiac cycle was determined?
A. Phase of asinchronic contraction
B. Phase of isometric contraction
C. Ejection period
D. Tention period
E. Protodiastolic period

16. In the analyses of phonocardiogramm it was stated that the duration of the I sound equals 0.10 s (normal value – till 0.14 s). True is the conclusion that a man has normal state of:
A. Pump`s function of the heart
B. Contractive capacities of miocardium
C. Valves of the heart
D. Semilunar valves
E. Atrio-ventricle valves

17. In a man sphygmogramm of central pulse was registrated. Its amplitude is redused and waves are smoothed out. The reason of such changes are violations of:
A. Pump`s function of the heart
B. Contractive capacities of miocardium
C. State of heart`s valves
D. Elasticity of venous vessels
E. Elastisity of arterial vessels

18. A man with the body surface of 2 m^2 has cardiac output 5 l. What is the cardiac index in this man in l/min on 1 m^2:
A. 10,0
B. 7,5
C. 5,0
D. 2,5
E. 1,0

19. During what phase of cardiac cycle does the pressure in ventricles achieve the biggest value?
A. Asinchronic contraction
B. Isometric contraction
C. Tension period
D. Rapid ejection
E. Slow ejection

20. At the phasic analyses of heart activity of a man it was stated that duration of cardiac cycle is 0.8 s, duration of isometric contraction phase is 0.05 s, duration of ejection period is 0.3 s. True is the conclusion that a man has violation in:
A. Pump`s function of the heart
B. Contractive capacity of miocardium
C. State of heart`s valves
D. Cardiac output
E. Stroke volume output

Protocol of practical study №5. "____"_____20___

Work 1. ECG analyses and registration in a man.

The purpose of the work: To registrate ECG in standard inforced unipolar leads from extremities and chest leads. On the base of its analyses make conclusions about heart`s automatia (what structure is the heart`s pacemaker, how rhythmycally it generates action potentials), the dynamic and velocity of excitation destribution in heart.

For work it is necessary to have: electrocardiograph.

Fulfillment of the work. A patient undressed till the waist lies on the back on the sofa. For ECG registration from extremities electrodes are placed on the left and right wrists and on left leg in accordance to markers marked on the panal of device. One more electrode is placed on the right leg to grounding of the patient. At ECG registration in the standard

leads from extremities the electrodes are placed in the following way: I lead — "left arm (+) and right arm (—)"; II lead — "left leg (+) and right arm" (—); III lead — "left leg (+) and left arm (—)".

Signs « + » and «—» show with what pole of electrocardiograph the electrode is connected.

At ECG registration in inforced unipolar leads from extremities the active positive (+) electrode is placed on one of the extremity (aVR— right arm; aVL —left arm; aVF — left leg), and the united electrode is used as a negative (—), which is created by the way of connection of two other extremities through additional resistance.

At ECG registration in chest leads the active positive (+) electrode is placed in certain points on the thorax surface and the united electrode which created due to connection of 3 extremity through additional resistances is negative (—). They are marked with letter V. The place of active electrode location: V_1— the fourth intercost (between ribs) on the right side of breast-bone; V_2—the fourth intercost (between ribs) on the left side of breast-bone; V_3—between V_2 and V_4; V_4 — the fifth intercost on the left middle-breast-bone line; V_5 — left front arm-pits line; V_6 — left middle arm-pits line. The electrodes V_5 and V_6 are placed on the same horizontal level as the electrode V_4.

Skin must be worked up with 96 % ethanol solution in the points of leads or with 20 % soup solution, paint the electrodes with paste or place a cheese cloth packing under the electrode which is wetted with the isotonic solution of sodium chlorine. Regulate amplification in such a way that pen`s incline on 10 mm corresponds to 1 mV. Turn on the movement of band of device and write down the calibrated signal.

A patient has to relax, lie quiet during the registration and breath in a perfunctory manner. It is necessary to write down some cardiac cycles in every lead and begin to analyze ECG. For this purpose it is necessary to mark the waves in all leads and pay attention to their direction.

Simplified algorhythm for ECG analyses:

1)Determine the heart`s pacemaker, the frequency of heart contraction, rhythm.

For pacemaker determination it is necessary to watch the consequence of positive atria P waves and ventricle`s QRS complex in standard leads which are registrated if the sino-atrial node is the heart`s pacemaker.

It is possible to determine heart`s pacemaker if to calculate frequency of heart contractions on the base of R-R interval.

For the characteristics the rhythm of action potentials generation of heart`s pacemaker it is necessary to determine the duration of some consequent R-R intervals and determine them. The rhythm is consided to be normal if the registrated duration of R-R intervals differs from average not more than on 10%.

It is necessary to remember that

Sino-atrial node is the main heart`s pacemaker if:

- QRS complex follows after every P wave

- P wave precedes every QRS complex

- P wave is positive in I,II and III standard leads.

The frequency of heart contraction is 60-100 per minute

less than 60 heart beats per 1 minute – bradicardia

more than 100 heart beats per 1 minute – tahicardia

the rhythm is normal *if the dispertion of R-R durations not more than 10%.*

2) Determination of waves and intervals duration. *One determines duration of P-Q, QRS, Q-T, R-R intervals and duration of P and T waves,* compares them with proper values and makes the conclusions about the speed of excitation destribution in heart.

The speed of band movement of electrocardiograph makes – 50 mm/s, so the band moves 1 mm for 0,02 s. To determine the waves duration one calculates the quantity of mm from the

beginning to the end of a wave and multiplies this number on 0,02 s. it is necessary to do the same to determine intervals.

It is necessary to remember that

Normal interval P-Q =0.12-0.20 s
Normal interval QRS =0.6-0.10 s
Normal interval Q-T is less or equal
to a half of R-R interval at normal
frequancy of heart contraction.
Normal P wave = 0.07-0.10 s
Normal T wave=0.1 – 0.25

3) determination of waves direction and amplitude. One determine amplitude ECG waves in standard leads, determines it with proper values.

Waves amplitude is measured from isoline in mm. If the inclines vertically on ECG at calibration makes 10 mm per 1 mV, then the decline on 1 mm makes 0.1 mV.

It is necessary to remember that in the second standard lead

Normal amplidude of P wave makes 0.5-2.5 mm or 0.05-0.25 mV (not more than 1/6-1/9 of amplitude of R wave in standard leads)

Normal amplidude of Q wave makes 0-3 or 0-0.3 mV

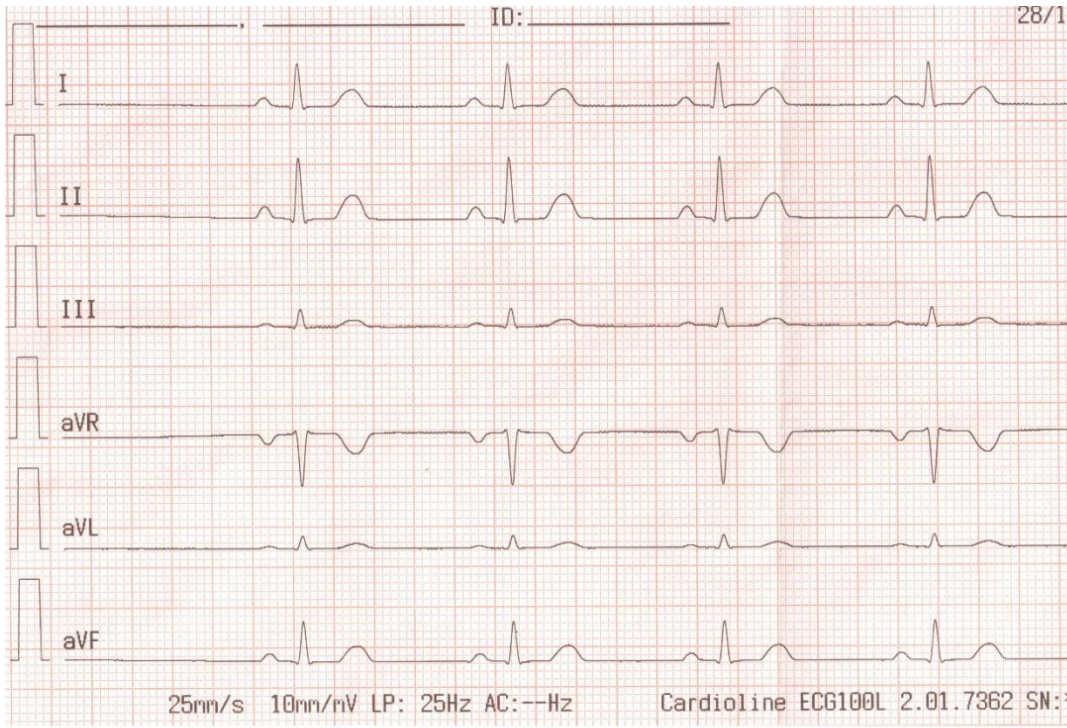
Normal amplidude of R wave makes 6-24 or 0.6-2.4 mV

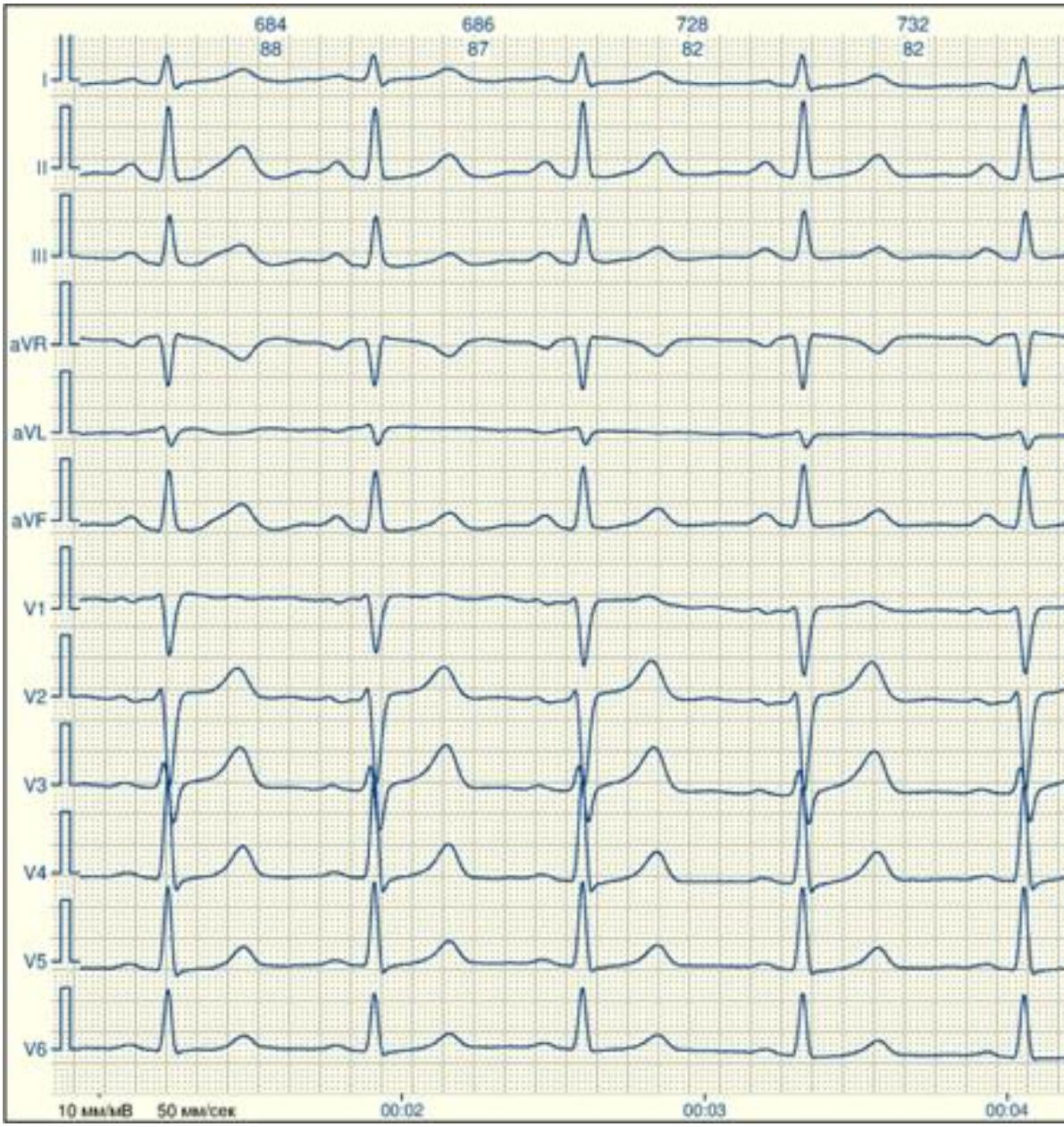
Normal amplidude of S wave makes 0-6 or 0-0.6 mV

Normal amplidude of T wave makes 3-5 or 0.3-0.5 mV (not more than 1/3-1/4 of R wave amplitude in standard leads)

Results of the work.

Clip ECG into the protocol, written in different leads.





Duration of ECG waves and intervals	proper	received	Estimation (normal, less or more then normal)
P			
P-Q			
QRS			
T			
Q-T			
R-R			

Amplitude of ECG waves			
P	-		-
Q	-		-
R	-		-
S	-		-
T			
Direction of ECG waves			
P	-		-
Q	-		-
R			
S			
T			
Frequency of heart contraction	-		-

Conclusion:

1) the heart`s pacemaker is _____,because

_____

The frequency of heart contraction _____, rhythm _____

2) _____duration of P wave testifies about_____

_____

_____duration of P-Q interval testifies about_____
_____duration of QRS interval testifies about_____

_____duration of T wave testifies about_____

_____duration of Q-T interval testifies about_____

3)_____amplitude of _____waves testifies about

_____

4)_____direction of _____ waves testifies

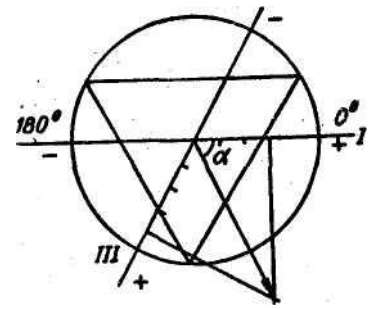
about_____

Work 2. Determination the position of electrical axe of the heart

The electrical axe of the heart characterizes the direction of ventricles` depolarization. It is average resultative QRS vector. Its position is defined by the value of α angle, made by the line of I standard lead and bisector of angle formed by crossing of projections of I and III

standard leads. There are the following variants of axe position: 1) normal when α angle makes from +30 to +69°; 2) vertical — α angle equals 70-90°; 3) horizontal — α angle makes from 0 to +29°; 4) incline of the axe to the right — α angle equals from +91 to +180°; 5) incline of the axe to the left — α angle makes from 0 to -90°.

In norm the electrical axe of the heart lies in the sector from 0 to 90°. It only sometimes comes behind these borders. As a rule the electrical axe coinsides with the anatomical one.

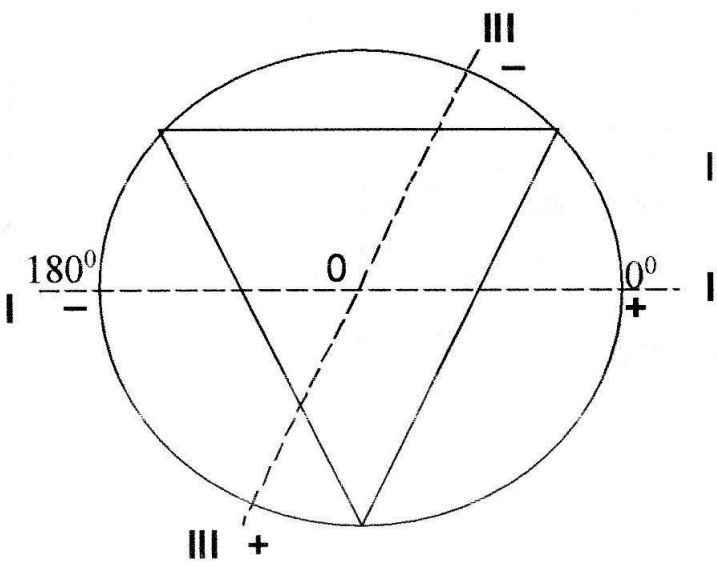


Determination the α angle i angle and the position of the electrical heart axe is shown on the scheme.

The purpose of the work: define the position of the electrical heart axe and estimate it.

The work fulfillment. The value of α angle which characterizises the position of the electrical axe can be defined graphycally. To do it it is necessary to draw the isosceles triangle the sides of which are the lines of standard leads. This is Einthoven`s triangle. Place this triangle into the circle. Draw the lines parallel to I and III standard leads through the centre. Using ECG find algebral sum of wase of QRS complex in I and III leads and put segments which correspond to found sums (considering the sign) on the lines painted through the centre. Draw the perpendicular at the ends of segments to the lines of I and III leads. Draw the line from the centre of the circle to the point of perpendicular`s crossing. This line corresponds to the position of the electrical heart axe. With the help of a protractor define the value of α angle located between the electrical heart axe and the line of the I lead in Einthoven`s triangle.

Results of the work:



I lead
the sum of waves of QRS complex:

III lead
the sum of waves of QRS complex:

Angle α =_____

Conclusion:

1) the position of the electrical axe of the heart_____

Work 1. Registration and analyses of phonocardiogramm.

Phonocardiogramm (PCG) is a method of graphyc registration of heart sounds and murmurs.

The heart work is accompanied by acoustic phenomena which are named heart sounds. There are two main sounds in the cardiac cycle: I — systolic takes place during ventricles systole; II — diastolic during the ventricles diastole. Compounds of the I sound are sounds which appear as a result of the following phenomena: a) closing and vibration of atrio-ventricle valves; b) tension of tendon fibres; c) tension of venricles muscles; d) tension and vibration of large arteries walls at the beginning of blood ejection. The second sound is caused by closing and tension of semilunar valves of aorta and lung`s artery. Besides main sounds which are registrated constantly there are additional III and IV sounds. The third one takes place during rapid filling phase of ventricles and is caused by rapid stretching of its walls. The fourth sound appears during the atria systole and is connected with ventricles walls vibrations which are the result of blood expulsion to them.

PCG is added by auscultation of heart sounds. It permits to estimate objectively the duration of heart sounds and murmurs which occur as a result of pathology.

The studying of heart sounds and murmur has a great clinical meaning because it gives the possibility to estimate the state of heart valves and conditions for blood movement from one chamber to another and to large vessels.

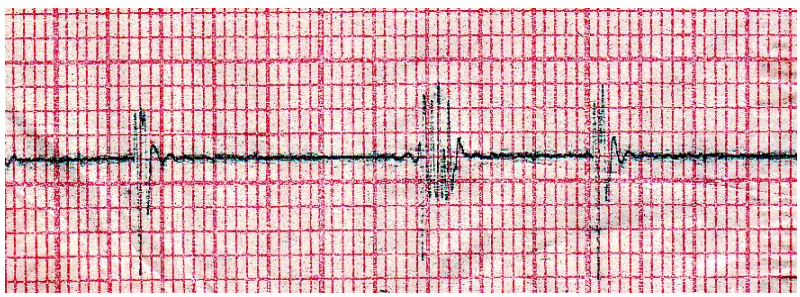
The purpose of the work: determine whether the heart sounds are normal; estimate the state of the heart valves and conditions for blood movement through the heart.

For work one needs: phonocardiograph, electrocardiograph, gauze packings, 10 % sodium chlorine solution.

Work fulfillment. For heart sounds registration phonocardiograph is used, in the content of which there is registrator-microphone and intensifier. PCG is registrated with the help of electrocardiograph. For this purpose one connects the device to electrocardiograph: to socket I of the device one insets the wire of electrocardiograph from the right hand, to socket II — from the left hand, and socket III — is grounded. Hand of electrocardiograph lead is in the position I (first lead). Electrocardiograph is grounded and stitched on. inforcement is regulated, the speed of band movement is stated 50 mm/s.

A researched person lies on the sofa. In the part of heart apex (heart`s push) a microphone is placed and picked up connecting it with phonocardiograph. The most practical meaning at PCG registration has the channel with auscultative characteristics of frequencies: the III and IV tones are registrated on the low-frequency channel , and high-frequency murmurs are registrated on high-frequency channel. The PCG registration is carried out in conditions of breath hold on expiration. Modern multy-channels devices for system of blood circulation research permit to registrate PCG without additional phonocardiographs.

Results of the work. Clip PCG into protocol. Mark I and II heart sound on it, calculate their duration. Mark on PCG and calculate the duration of systolic and diastolic pauses. Pay attention on the fact that at PCG registration on auscultative channel the straight line without oscillations corresponds to pauses; systolic pause is shorter than diastolic.

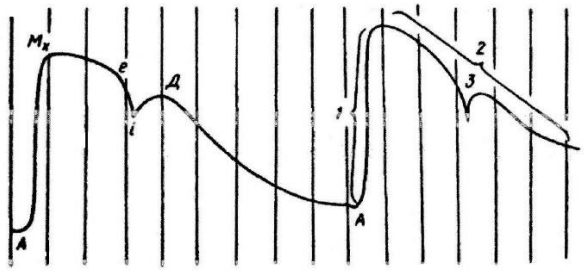


Conclusions: *answer the questions: Are there murmurs? Arethe heart sounds clean? Is the state of valves normal or not? Why do you think so? Mark the part of PCG which testifies about the state of valves. What are the conditions for blood movement through the heart?*

Work 2. Registration of central pulse.

Rythmical vibration of arterial walls caused by the work of the heart is called arterial pulse. The pulse of carotic and subclavian arteries is called central.

The method of graphyc registration of arteries` pulse vibrations is named sphygmography and registrated curve - sphygmogramm(SPG).



Sphygmogramm of central pulse: A-Mx – e - the systolic part; e-i-D-A – the diastolic part; 1 – anacrotism; 2 – catacrotism; 3- dicrotic lifting

The purpose of the work: *1)* acquaint with the method of sphygmography; 2) determine the main phases of sphygmogramm of central pulse, analyse its origin. 3) Determine the amplitude of anacrotism, the speed of its development. 4) On the base of the third purpose estimate the pump`s function of the heart (indirect estimation of pump`s function); 5) on the base of the second purposes and the third one estimate the elastisity of large arterias.

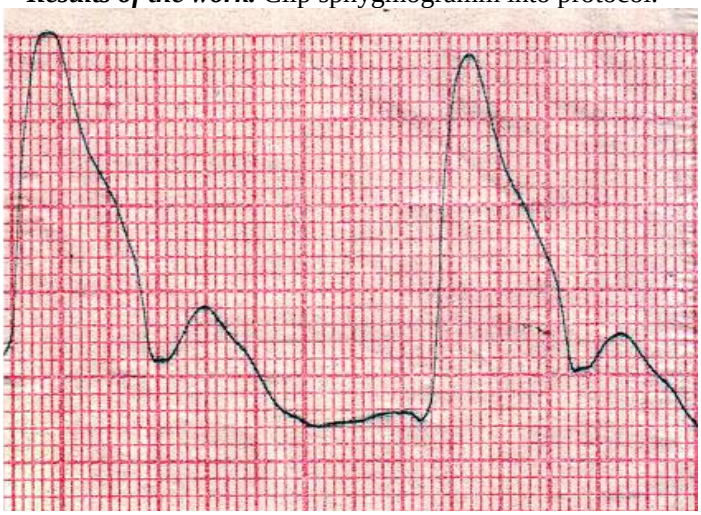
For work one needs: sphygmograph, polycardiograph.

Work fulfillmemt. One connects sphygmograph with polycardiograph, grounds it, turns on. Comutator of leads is in the I position — first lead. The speed of band movement — 50 mm/s. A researched person lies on the sofa. One determines palpatorally the place of pulsation of the common carotic artery. One place tightly the register on this place but not squeezes artery, connects the register with sphygmograph and write down the curve. One makes analyses of sphygmogramm.

The curve reflects the pressure changes in aorta and percularities of its ejection from left ventricle during systole.

The normal sphygmogramm of central pulse consists of systolic part (A — Mx — e) and diastolic one (e — i — Д — A). Systolic wave begins with sharp rise which caused by pressure increases in artery during the phase of rapid ejection of blood from left ventricle. This rise of curve is called anacrotism *(1).* After reaching the top (Mx) the curve descends which is connected with the phase of slow ejection. This descending is called catacrotism *(2).* «e» point corresponds to the end of ejection. The curve continues to descend forming inthzizure, the lower point of which (*i)* is formed simultaneously with the II heart sound of PCG that is the closing of semilunar valves. Blood strike on closed valves as a result of it the removed wave is formed. It is reflected on sphygmogramm as repeated rise *(3)* —discotic rise.

Results of the work. Clip sphygmogramm into protocol.



1)Anacrotism has sharp rise and practically take place simultaneously with the phase of _____of cardiac cycle; the beginnig of catacrotism takes place simultaneously with the phase of _____of cardiac cycle;

Dicrotic rise is caused by_____

2) The duration of ejection period (time from the beginning of anacrotism to "e" point of catacrotism which takes place simultaneously with II heart sound of PCG) is _____s.

Conclusions:

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P. 352-384, 402-420.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P.99-106.

FOR NOTES

Practical study *6.*

Studying of regulation of heart`s activity

1.Urgency of the theme:

The main parameter of blood circulation and heart as a pump activity is cardiac output (Q), which changes from 5 to 30 liter/min depending on organism`s needs of an adult person. Blood quantity which is pushed out of each ventricle into vessels per minute (Q) depends on stroke volume output and frequency of heart contraction (n).

Q = stroke volume output * n.

Regulation of heart activity is the providing of cardiac output corresponding to organism`s needs on the acount of changes of stroke volume output and frequency of heart contraction.

2.Educational purposes:

- *Analyse the changes of regulated parameters of heart activity as a pump under the action of regulatory mechanisms (miogenic, nervous, humoral, local and central).*
- *Explain the regulatory mechanisms of pump`s function of the heart.*
- *Explain the changes of the pump`s function of the heart under the action of regulatory mechanisms at different adoptative reactions of an organism.*
- *Analyse the age percularities of heart activity regulatory mechanisms.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Miogenic regulation	It is a type of local intracardiac regulation of heart contraction force due to the increase of acto-miosine cross-bridges quantity during contraction
Inotropic effect	It is action on the force of heart contraction
Chronotropic effect	It is action on the frequency of heart contraction
Dromotropic effect	It is action on the speed of excitation transmission in the heart
Batmotropic effect	It is action on excitability of miocard`s structure.
bradicardia	It is diminishing of the frequency of heart contraction – less than 60 per minute.
tahicardia	It is increase of the frequency of heart contraction more than 100 per minute
Beforeloading of the heart	It is degree of miocytes`s stretching before the contraction during the ventricles` filling with blood.
Afterloading of the heart	It is resistance which is necessary to overcome at contraction of ventricles`s miocard during pushing blood out the ventricles into aorta or lung artery

3.2.*Theoretical questions*

1) Miogenic regulation of heart activity. Chronoinotropic dependance.
2) Autonomic nerves action on heart`s activity.
3) Reflex regulation of heart`s activity.
4) Hormones`s role in regulation of heart activity.
5) Dependance of heart activity on ionic content of blood.

3.3.*Practical works*

1) Research of reflex actions on heart activity in a human. (Danini-Ashner`s reflex)
2) Research of adrenaline and acetilholine action *in situ* on heart activity in a frog.
3) Research of physical loading action on heart activity in a man.

4.Materials for self-control

4.1.Answer the question:

1) How and why will electrocardiogramm in a man change after athropine sulphate injection?

2) Why does not isolated heart of mammals contract in the solution which has not calcium ions?

3) How will the character of dog`s heart activity change on the irritation of sympathetic nerves which innervate it after the injection of α-adrenergic block?

4) During the surgical operation manipulations in the part of reflex zones in thorax or abdominal cavities can cause reflex heart stop. What nerve transmits information to heart? How to prevent these changes in heart activity?

5) Why does the increase of frequency of heart contraction till 200 per minute cause the diminishing of cardiac output?

4.2.Choose the right answer:

1.Vagus nerves decrease the frequency of heart contraction. The main mechanism in this effect development is activation of the following channels in cardiomyocytes` membrane:

A. sodium
B. potassium
C. calcium
D. calcium and sodium
E. chlorine

2.Sympathetic nerves increase the frequency of heart contraction.The main mechanism in this effect development is activation of the following channels in cardiomyocytes` membrane:

A. calcium and sodium
B. potassium
C. calcium
D. sodium
E. chlorine

3.Sympathetic nerves increase the force of heart contraction. The main mechanism in this effect development is activation of the following channels in cardiomyocytes` membrane:

A. sodium
B. potassium
C. calcium
D. calcium and sodium
E. chlorine

4. Sympathetic nerves increase the force and frequency of heart contraction. What cytoreceptors can be blocked to prevent the sympathetic effects told above?

A. α-adrenergic receptors
B. β-adrenergic receptors
C. α- and β-adrenergic receptors
D. H-cholinergic receptors
E. M-cholinergic receptors

5.Parasympathetic nerves diminish the frequency of heart contraction. What cytoreceptors can be blocked to prevent the parasympathetic effects told above?

A. α-adrenergic receptors
B. β-adrenergic receptors
C. α- and β-adrenergic receptors

D. H-cholinergic receptors
E. M-cholinergic receptors

6. A man was intravenously injected with calcium chlorine. What changes in heart activity will it cause?
A. Diminishing the frequency of heart contraction
B. Diminishing the force of heart contraction
C.Increasing the frequency of heart contraction
D. Increasing the force of heart contraction
E. Increasing the force and frequency of heart contraction

7. Isolated mammal`s heart is perfused by solution with high content of calcium chlorine which led to heart stop in diastole. What changes in cardiomyocytes were the reason of it?
A. Increasing the potassium permeability
B. diminishing the potassium permeability
C. stable prolonged hyperpolarization of membrane
D. stable prolonged depolarization of membrane
E. diminishing of threshold of depolarization

8. in the experiment on isolated stopped mammal`s heart the increase of heart`s stimulation by electrical impulses in 2 times were not accompanied by the diminishing of stroke volume output and cardiac output increased in 2 times. Which of the following mechanisms realization was the reason of it?
A. Frank-Starling low
B. Anrep`s effect
C. Boudich effect
D. Sympathetic reflexes
E. Parasympathetic reflexes

9. In the experiment on mammal`s isolated heart the increase of perfusate input to right atria led to the increase of the force of left ventricle contraction. Which of the following mechanisms realization was the reason of it?
A. Sympathetic reflexes
B. Parasympathetic reflexes
C. Local reflexes
D. Frank-Starling low
E. Anrep`s effect

10. A student-shirker suddenly met a dean which led to increase of the force and frequency of heart contraction. Which of the following mechanisms realization was the reason of such changes in heart activity?
A. Conditional sympathetic reflexes
B. Conditional parasympathitic reflexes
C. Unconditional parasympathetic reflexes
D. Unconditional sympathetic reflexes
E. Unconditional local reflexes

Protocol of practical study №6. "____"__.___20___

Work 1. Research of reflex actions on heart activity in a human. (Danini-Ashner`s reflex).

The purpose of the work: define the character of reflex influences on man`s heart activity under the pressing on eye balls.

The work fulfilment. A student who will make the research has to wash his hands before the work. Determine heart rate per 30 seconds before the research. After it the investigated student closes his eyes. The investigator presses on the eye balls with his I and II fingers during 20 seconds.The pain sensations are not to arise at the pressing! Simultaneously with the pressing the other student determines heart rate for 30-40 seconds. If there were no changes in heart rate the research has to be repeated increasing the force of pressure on eye balls.

Results of the work:

*The initial frequency of heart contraction per 1 minute makes*_____

*After pressing on eye balls the frequency of heart contraction per 1 minute makes*_____

Conclusions:

1) *Reflex _____ of the frequency of heart contractions which appeared at the pressing on eye balls is the consequent of action on the heart pacemaker of the*

_____

2) *The scheme of Danini-Ashner`s reflex arch:*

Work 2. Research of adrenaline and acetilholine action in situ on heart activity in a frog.

The purpose of the work: to study the character and mechanisms of the action of adrenaline, acetilcholine, calcium ions and potassium ions on heart activity

For work one needs: *a* studying film.

The work fulfillment. To watch a studying film.

Results of the work*: to draw the diagramms showing the action of adrenaline, acetilcholine, calcium ions and potassium ions on heart activity.*

Conclusions: in conclusions explain the mechanisms of such changes in heart activity.

Work 3. Research of physical loading action on heart activity in a man.

The purpose of the work: define the character of reflex influences on man`s heart activity under the physical loading.

For work one needs: watch

The work fulfillment. calculate the heart rate in the state of the rest, fulfill standart physical loading and calculate the heart rate again

Results of the work:

The initial frequency of heart contraction per 1 minute makes_____

After physical loading the frequency of heart contraction per 1 minute makes_____

Conclusions:

1 Reflex _____ of the frequency of heart contractions which appeared as a result of physical loading is the consequent of action on the heart pacemaker of the

_____

2) The scheme of sympathetic reflex arch:

Protocol revised_____
(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.358-359, 380-384, 399-402, 421-441.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P.120-130.

FOR NOTES

Practical study 7.

The role of vessels in hemodynamic. The research of arterial pressure in a human

1.Urgency of the theme:

Understanding the laws of hemodynamic permits a doctor to state the reasons of blood circulation`s violations and to find the ways for their normalization.

Arterial pressure is an integrative parameter of hemodynamic, the support of which in the borders of physiological values is one of the conditions to take away the factors of risks of patological changes development in blood circulation.

2.Educational purposes:

- *To explain the main regularities of hemodynanic and interpret its parameters (the volume and linear speed of blood flow, blood pressure, the total peripheral vascular resistance).*
- *To interpret the role of different types of vessels in blood circulation.*
- *To analyze the age percularities of blood circulation.*
- *To explain the physiological bases of the researched methods of blood circulation`s parameters.*
- *To measure and interpret the value of arterial pressure of a man..*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Systolic pressure	It is the most blood pressure in arterial vessels during ventricles` systole
Diastolic pressure	It is the least blood pressure in arterial vessels during ventricles`s diastole
Sphygmic pressure	It is the difference between systolic and diastolic pressure
Average pressure	It is average value of pressure in arterial vessels during cardiac cycle. Its value is equal to the sum of diastolic pressure and 1/3 of sphygmic pressure
Vessels of compression chamber	It is aorta and arteries with large diameter which decrease the force of hydrodynamic strike during blood ejection from heart due to elastisity of their vessels` walls.
Precapillary resistable vessels	They are arteries with little diameter and arterioles which have the most resistance and change it regulating blood flow to capillaries.
Vessels of exchange	They are capillaries through the walls of which the exchange of water and sunstances is carried out due to pressure gradient between both sides of capillary wall.
Postcapillary resistable vessels	They are venules which change their resistance regulating blood flow from capillaries.
Capacity vessels	They are the veins which have the least resistance and the most capacity for expansibility and blood deponating

3.2.*Theoretical questions*

1) The functional structure of different parts of vessels and their role in hemodynamic.
2) The factors which provide blood movement by vessels, its movement in one direction and continuity.

3) The changes of vessels resistance, blood pressure and the velocity of blood flow in different parts of vessels` system.
4) The changes of blood viscocity in different parts of vessels.
5) Arterial and blood pressure, the methods of registration, factors which act on their value.

3.3.*Practical works*

1) The measuring of arterial blood in a man.
2) The observation on blood flow in the vessels of swim web of a frog`s pad.

4.Materials for self-control

4.1.Answer the question:

1) The heart pushes into aorta 5 liters of blood per 1 minutes. How much blood passes through capillaries and veins cava?

2) What part of vessels`s system makes the most resistance to the blood flow?

3) The level of blood pressure in a man in the first research makes 115/70 mm Hg (15,3/9,3 kPa), in the second —180/75 mm Hg (24/10 kPa), in the third — 120/95 mm Hg (16/12,7 kPa). What factors can cause the marked changes of blood pressure?

4) Determine the velocity of pulse wave distribution in a man of 25 if the distance between gauges of sphygmograph makes 50 sm and the time of "peripheric" pulse lating makes 0,09 s? From what factors does the velocity of arterial pulse distribution depend on?

***4.2.Choose the right answer*:**

1. Cardiac output in a man makes 5 liters. What is the volume speed of blood flow through lungs` vessels in this man?
   A. 5 liter
   B. 4 liter
   C. 3 liter
   D. 2,5 liter
   E. 2 liter

2. Which of the following vessels provides uninterrupted blood flow inspite of the fact that heart pushed out blood with separate portions?
   A. Vassels of compression chamber (amortizating)
   B. Precapillary resistable vessels
   C. Vessels of exchange
   D. Postcapillary resistable vessels
   E. Capacity vessels

3. Systemic arterial pressure in a man makes 160/80 mm Hg. Which of the following is the main reason of such changes of pressure?
   A. The increase of the pump function of left part of heart
   B. The increase of the pump function of right part of heart
   C. The increase of common peripherial resistance
   D. The increase of volume of circulated blood
   E. The decrease of elasticity of amortizating vessels (the vessels of compression chamber)

4. Systemic arterial pressure in a man makes 130/100 mm Hg. Which of the following is the main reason of such change of pressure?
   A. The increase of the pump function of left part of heart
   B. The increase of the pump function of right part of heart
   C. The increase of common peripherial resistance
   D. The increase of volume of circulated blood
   E. The decrease of elasticity of amortizating vessels (the vessels of compression chamber)

5.Systemic arterial pressure in a man makes 80/60 mm Hg. Which of the following is the main reason of such change of pressure?

A. The decrease of the pump function of left part of heart
B. The decrease of the pump function of right part of heart
C. The decrease of common peripherial resistance
D. The decrease of volume of circulated blood
E. The decrease of elasticity of amortizating vessels (the vessels of compression chamber)

6. In a man the central venous pressure makes 10 mm Hg. In can be consequence of decrease:

A. the pump function of left part of heart
B. the pump function of right part of heart
C. common peripherial resistance
D. volume of circulated blood
E. elasticity of amortizating vessels (the vessels of compression chamber)

7. In a man the increase of the tone of systemic arterioles happened. The consequence of it will be the increase:

A. Volume of circulated blood
B. Central venous pressure
C. Peripheral venous pressure
D. Common peripheral resistance
E. Filtrational pressure in capillaries

8. Central venous pressure is increased in a man. It leads to the increase of water movement:

A. From intersticium(intercellular liquid) to capillaries
B. From capillaries to intersticium
C. From intersticium to cells
D. From cells to intersticium
E. There will not be any changes in water movement

9. The linear speed of blood movement in capillaries is the least because capillaries have:

A. The least lenght
B. The least radius
C. The most thin wall
D. The largest square of cross-section
E. Large resistance

10. Which of the following factors makes the most action on resistance to blood movement in a separate vessel?

A. radius
B. lenght
C. viscosity of blood
D. sickness of wall
E. linear speed of blood movement

Protocol of practical study №7. "____"_____20___

Work 1. Measuring of the arterial pressure in a man.

The value of arterial pressure is one of the constant parameters of an organism, it testifies about the heart work and tone of vessels. Auscultative technique of blood pressure measuaring by Korotkov is based on audition of sounds appearing at grasp of vessel with a cuff and laminaric blood flow stop in narrowed part. This tecnique permits to measure both systolic and diastolic pressure.

The purpose of the work: Determine the value of arterial pressure, analize received results.

For work one needs: mercurial manometer, phonendoskope.

The work fulfilment:. A patient sets down sideways near a table. His hand is put on a table. A cuff is put on a bare shoulder of the hand so that it fits close but does not squeeze tissues. Measurings are made in such a way: a) screw up valve of rubber and palpatory determine the place of clear pulsation of arteria of elbow bend; b) put phonendoskope on this place; c) with the help of rubber gradually increase pressure in the cuff till complete squeezing of the artery; d) after it slowly open valve, gradually decrease the pressure in cuff, and look at an arrow of manometer. The value on manometer`s skale at the moment of the first sound appearance corresponds the value of systolic pressure.

The value of manometer at the moment of sharp muffle or dissapearance of sounds in artery at the further decrease of presure in the cuff corresponds the value of diastolic pressure.

The difference between systolic and diastolic pressure makes sphygmic pressure.

Results of the work:

1) The systolic pressure makes_____mm Hg.
2) The diastolic pressure makes_____ mm Hg.
3)The sphygmic pressure makes _____ mm Hg.
4) The average arterial pressure makes_____ mm Hg.
Conclusions:

Work 2. Observation of the blood movement in vessels of a swim web of a frog`s pad.

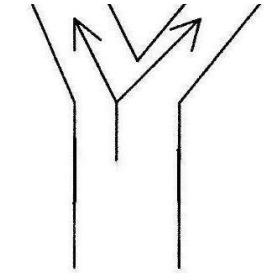
This observation with the help of microscope permits to deterime some percularities of the linear speed of blood flow in vessels of swim web of a frog`s pad. This speed (V) is calculated by the formula: V = Q **:** S, where Q— the volume speed of blood flow, S — the square of summary cross-section of vessels. The least linear speed is in capillaries because on their level the square of summary cross-section is the largest.

The purpose of the work: to observe the speed of blood movement in different vessels.

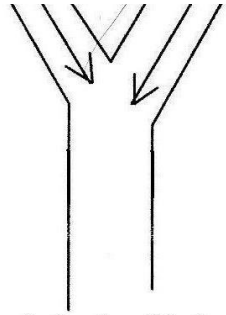
For work one needs: a frog, a microscope, 10 % etanole, a set of tools, preparating desk.

The work fulfilment: A frog must be narcotizated by putting it into 10 % etanole for 10 min (till complete disappearing reflex reaction on the irritation — a prick with a pin). After that one puts the frog on preparating desk, fixes with pins a stretched swim web between II and III fingers of back extremity. Students observe blood movement in vessels first under little, then under large increasing.

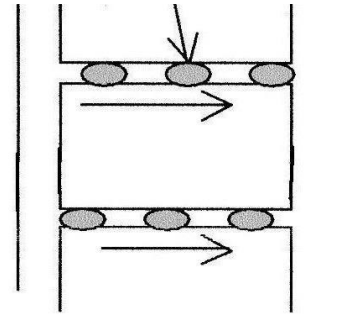
Results of the work:



the direction of blood flow in arterioles



the direction of blood flow in venules



blood movement in capillaries:

erythrocytes move just one after another

Conclusions:

The largest speed of blood flow is _____
The least speed of blood flow is _____
Explain the resons of observed results

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.442-465.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P.130-146.

FOR NOTES

Practical study 8.

Studying of hemodynamics regulation

1.Urgency of the theme:

Adoptation of blood circulation to organism`s needs is carried out due to closely connected intetrelations between local and central regulatory mechanisms. The system of regulatory mechanisms provides some accordance between stroke volume output, resistance and capacity of vessels and volume of circulated blood. Due to it the optimal conditions for blood supply of organs and tissues in accordance to their state – rest or physical load is supported.

2.Educational purposes:

- *Interpret the changes of regulated parameters of the system of blood circulation under the action of regulatory mechanisms.*
- *Explain the changes in regulated parameters of the system of blood circulation at different adoptative reactions of an organism (ortostatic test, physical exercises).*
- *Estimate the state of regulatory mechanisms of the system of blood circulation on the base of changes in regulated parameters of the blood circulation system at ortostatic functional test, physical exercises.*

3.The task for independent work at preparation for practical study

4.1. The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study

Term	Definition
Hemodynamic centre	It is the centre of regulation of blood circulation
Pressoric reflexes	They are visceral reflexes which provide the increase of systemic arterial pressure due to the increase of stroke volume output and the increase of blood vessels` resistance. These reflexes are carried out with the participation of sympath-adrenal system.
Depressoric reflexes	They are visceral reflexes which provide the decrease of systemic arterial pressure with the participation of parasympathetic vagus fibres, due to it stroke volume output decreases; and due to the inhibition of sympatho-adrenal system which leads to the decrease of resistance of blood vessels.
Ortostatic functional test	It gives possibility to reveal the mechanisms of regulation of systemic blood circulation at the changes of body position from horizontal to vertical one.
vasoconstrictors	They are the factors which contract blood vessels
vasodilators	They are factors which dilate blood vessels
Active hyperemia	It is the local increase of blood flow of an organ or tissue at the increase their metabolic activity

3.2.*Theoretical questions*

1) Hemodynamic centre, its structure, pressoric and depressoric reflexes (own and cooperative).
2) Humoral regulatory mechanisms of blood circulation.
3) Analysis of peripheral and central parts of the system of blood pressure self-regulation.
4) Regulation of blood circulation during physical exercises, other adoptative reactions of an organism.

3.2.*Practical works*

1) The research of muscles` activity action on blood circulation.
2) The research of body position changes on blood circulation.

4.Materials for self-control

4.1.Answer the question:

1) How and why will frequency of heart contraction, blood pressure, cardiac output and tone of capacity vessels be changed at emotional stress?

2) In a narcotizated cat the systemic arterial pressure (average) makes 112 mm Hg (14,9 kPa), heart rate — 185 per 1 minute. How will these parameters change at isolated pressure increase in sinocarotid zone to 180 mm Hg (24 kPa) and at the decrease it to 60 mm Hg. (8 kPa)? What reflexes will cause these changes?

3) How will heart work and arterial pressure change at the increase of CO_2 and milk acid content in blood? What are the mechanisms of these changes?

4) During physical excersise heart rate increased from 70 to 160 per 1 minute, systolic pressure — from 115 (15,3 kPa) to 185 mm Hg (24,7 kPa), cardiac output — in 4 times. At the same time the vessels of functioning capillaries are greatly dilated. What is the mechanism of arterial pressure increase, changes of other hemodynamic parameters?

5) A man fixed in a special device, first is put from horizontal position to vertical one, with his head up, and then from horizontal to vertical with his head down. How and why will the tone of arterial and venous vessels, heart rate, cardiac output change? What adoptative meaning do these changes have?

***4.2.Choose the right answer*:**

1. A man fulfils physical exercises. Which of the following reflexes will be realized as a result of it?
   A. Own pressoric reflex
   B. Own depressoric reflex
   C. cooperative pressoric reflexes
   D. cooperative depressoric reflex

2.A man fulfils physical exercises. Which of the following changes will be obvious at normal reaction of the system of blood circulation on physical exercises?
   A. Systemic vasodilation of resistable vessels
   B. Systemic vasodilation of capacity vessels
   C. Vasdilation in working muscles
   D. The decrease of the volume of circulated blood
   E. The decrease of stroke volume output

3. In initial state the reaction of the system of blood circulation on physical exercises is normotonic. After introduction of membrane cytoreceptors` block the frequency of heart contraction after physical exercises increased on 100%, systolic pressure – on 5 mm Hg, diastolic pressure decreased twice. What receptors were blocked in a man?
   A. α-adrenergic receptors
   B. β-adrenergic receptors
   C. α- and β-adrenergic receptors
   D. M-cholinergic receptors
   E. H-cholinergic receptors

4. There are reflex changes of blood circulation at fulfilment of the straight

ortostatic probe (change the position from horizontal to vertical). What receptor do these reflex changes begin with?

A. Volumoreceptors of atria
B. Volumoreceptors of viens
C. Chemoreceptors of vessels
D. Baroreceptors of vessels
E. Proprioreceptors

5.There are reflex changes of blood circulation at fulfilment of physical exercises. What receptor do these reflex changes begin with?

A. Chemoreceptors of vessels
B. Baroreceptors of vessels
C. Volumoreceptors of atria
D. Volumoreceptors of viens
E. Proprioreceptors

6. The change of body position from horizontal to vertical one at normal state of regulatory mechanisms of blood circulation leads to the increase of diastolic pressure. The reason of it is the following reflex changes of the executive organs:

A. Vasoconstriction of capacity vessels
B. Vasoconstriction of resistable vessels
C. The increase of pump`s function of left part of heart
D. The increase of pump`s function of right part of heart
E. The increase the frequency of heart contraction

7. The brain transection between hindbrain and midbrain was done in animal in the experiment. What changes of arterial pressure did it cause?

A. The increase of systolic pressure
B. The decrease of diastolic pressure
C. The decrease of systolic pressure
D. The decrease of diastolic pressure
E. It did not cause the essensial changes of arterial pressure

8. Test with physical exercises in a man is made. The inverstigated takes M-cholinergic blockcs. The last will lead to the less degree of increase of one of the following parameters .

A. Stroke volume output
B. Frequency of heart contractions
C. Tone of resistable arterial vessels
D. Tone of venous capacity vessels
E. Volume of circulated blood

9. Intravenous injection of noradrenaline solution in the experiment on an animal will lead to the tone increase of one of the following structures:

A. Pressoric part
B. Depressoric part
C. Nucleus dorsalis nervi vagi
D. Depressoric part and nucleus dorsalis nervi vagi
E. Pressoric part and nucleus dorsalis nervi vagi

10. A man makes maximum breath hold, it leads to the tone increase of one of the following structures:

A. Pressoric part
B. Pressoric part and nucleus dorsalis nervi vagi
C. Nucleus dorsalis nervi vagi
D. Depressoric part
E. Depressoric part and nucleus dorsalis nervi vagi

Protocol of practical study №8. "____"_____20___

Work 1. The research of the influence of muscle work on blood circulation.

The system of blood circulation is a conductive link in complicated system of oxygen transport from external environment to working muscles. A human organism can fulfil physical excersises for a long time due to the increase of the functioning of the system of blood circulation. The increase of cardiac output, which supports increased energetic emission during physical activity can be possible only thanks to coordinational work of heart and vessels.

The purpose of the work: research the reaction of the system of blood circulation on blood redistribution during physical excersises.

For work one needs: a sphygmotonometer, a stop-watch. The research is made on a man.

The work fulfilment. One measures systolic and diastolic pressure, heart rate every 10 seconds during 1 minute in an inverstigated man. After it an investigated fulfils the standard physical excersises

– 20 squattings during 30 seconds. Just after finishing excersises the arterial pressure and heart rate are measured per 10 s during every minute of the rest till the moment when heart rate per 1 minute becomes equal to one in the state of the rest. This time arterial pressure is measured once more.

Results of the work:

Heart rate per 10 seconds	*In the state of the rest*	*After standard physical exercises*		
		First minute	*Second minute*	*Third minute*
1.				
2.				
3.				
4.				
5.				
6.				
The sum per 1 minute				
Arterial pressure in mm Hg: systolic/diastolic				

1) the frequency of heart contractions after physical exercise per first minute increased on _____%,

Normalization took place on_____ minute.

2) Systolic pressure during the first minute after physical exercises increased on _____%, its normalization took place on _____minute.

3) Diastolic pressure on the first minute after physical exercises_____%, its normalization took place on _____minute.

conclusions: (estimate the dynamic of the changes of hemodymamic parameters caused by physical exercises, explain the mechanisms of regulation of blood circulation during physical exercises).

Work 2. The research of body position changes on blood circulation

Ortostatic test permits to make an estimation of a functional state of blood circulation therefore it is widly used in clinical practice.

The purpose of the work:: research the reaction of heart-vessels system on blood redistribution at body position change.

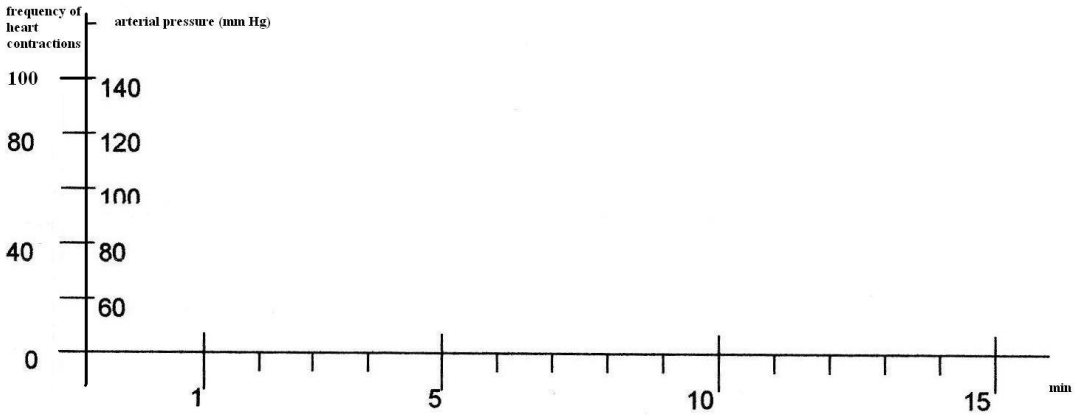
For work one needs: *a* sphygmotonometer, a stop-watch.

The work fulfilment. Before the beginning of the research an investigated person has to lie on his back during 5 minutes. After it one measures arterial pressure three times and calculates pulse rate. By request an investigated stands up and is standing during 5 minutes. Just after standing up arterial pressure and pulse rate is measured in him. Measurings are

repeated every minute. After 5 minutes an investigated lies once more and one continues to measure arterial pressure and pulse rate.

Results of the work:

Researched parameters	*Horizontal body position - lying*	*Vertical body position - standing*	*Horizontal body position - lying*
Frequency of heart contractions per minute			
1.			
2.			
3.			
4.			
5.			
Arterial pressure: systolic/diastolic			
1.			
2.			
3.			
4.			
5.			



The diagramm of the dynamic of parameters (pulse rate,systolic and diastolic pressure) when body position changes from horizontal on vertical and again on horizontal.

Conclusions: *(estimate the changes of pulse rate and arterial pressure,* explain the mechanisms of the changes of blood circulation at ortostatic test).

Protocol revised_____
(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.486-518.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P.146-166.

FOR NOTES

Section 10. Breathing system.

Practical study 9.

The system of respiration. Breathing

1.Urgency of the theme:

Breathing is a the complex of physiological processes which constantly take place in an organism and provide the processes of gas exchange - oxygen consumptions and carbon dioxide releasing, because metabolic processes in an organism are carried out mainly with participation of oxygen – aerobic.

The system of respiration provides the permanent gas exchange between an organism and environment. Thus, as a result of breathing such level of pO_2, pCO_2 and pH in arterial blood is supported, which provides metabolic processes in the cells.

Breathing of a human is provided by co-operation of organs of respiration, blood circulation, blood and regulatory mechanisms.

Breathing consists of 5 basic processes (stages):

The first stage is external breathing (gas exchange between environment and lungs, or pulmonary ventilation);

The second stage is gas diffusion through aerohematic barrier (gas exchange between alveolar air and blood);

The third stage is gas transport by blood (oxygen from lungs to the cells and carbon dioxide in opposite direction).

The fourth stage is gas diffusion between capillary blood and tissues.

The fifth stage is tissue respiration. This stage of respiration is studied by biochemistry.

The significance of gas exchange is in the oxygen supply for oxidazing processes as a result of which macroegic matters are decayed with energy releasing hidden in them, and excretion of products of metabolism — carbon dioxide and water.

Breathing is the first stage of respiration and it is gas exchange between an environment and lungs with the purpose of maintenance of permanent oxygen and carbon dioxide partial pressures in alveoli and providing permanent gas exchange between them and blood. As a result of that the satiation of blood by oxygen, or oxygenation is arrived and acid-basic equilibrum of blood is supported due to the elimination of carbon dioxide surplus from an organism .

The knowledges of the mechanisms of the basic stages of respiration, its regulation, physiological constants of the breathing, mechanisms of inspiration and expiration, the acquaintance with the methods of research and estimation of the breathing indexes is necessary for a doctor of any speciality, because the violation of the functions of this system can take place and the task for a doctor is to normalize them.

2.Educational *purposes*

- *Iinterpret the concept "the system of respiration" and explain the stages of respiration*
- *Explain the mechanisms of biomechanics of inspiration and expiration, the function of respiratory passageways, the nature and role of elastic recoil of lungs and surfactants.*
- *Make conclusion about the state of breathing on the basis of analysis of static and dynamic parameters of breathing (vital lungs capacity and its component volumes, minute respiratory volume, minute alveolar ventilation, maximum lungs ventilation, breathing reserve, others).*
- *Make conclusion about the resistance of respiratory passageways on the basis of results of pneumotahometria.*
- *Explain the age-old percularities of breathing process.*
- *Explain physiological bases of spirometery, spirography, pneumotahometria.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Respiration	It is gas exchange between cells of an organism and environment
Breathing	It is a process of gas exchange between alveoli and environment
Elactic recoil of lungs	It is the force due to which lungs try to get minimum volume. It is caused by the following factors: 1) the surface tension of molecules of liquid which coves the internal alveolar surface (2/3 of all force); 2) resiliensy of alveolar wall tissue due to presence of elastic fibres in them; 3) the tone of bronchial muscles
Surfactants	These matters are derivatives from phospholipids and apoprotein which are secreted by alveolocytes of II type, cover the internal alveolar surface and decrease the surface tension in alveoli due to which they don`t compress completely.
Respiratory distress-syndrom in newborns (RDSSN)	It is characterized by surfactant deficite in a baby due to which the lungs have increased tendention to compression on expiration.
Pneumotorax	It occurs at the damage of germeticy of preural cavity when the pressure around the lungs becomes atmospheric and lungs compress completely.
Pleural pressure	It is the pressure in the pleural cavity which is negative relatively to atmospheric one and makes (-5 sm of water after expiration or before the inspiration and –7.5 sm of water on inspiration or before the expiration)
Transpulmonary pressure	It is pressure gradient between alveolar and pleural
Compliance of lungs (C)	It is the quantity measure of lungs` resiliency – lungs` capacity to stretch with changing of lungs` volume. (ΔV) due to the change of transpulmonary pressure (ΔP): $C = \Delta V \backslash \Delta P$
Tidal volume (TD)	It is volume of air which enters lungs or goes out of the lungs at quiet breathing.
Inspiratory reserve volume (IRV)	It is maximum volume of air which one can inspires after the quiet inspiration.
Expiratory reserve volume (ERV)	It is maximum volume of air which one can expires after the quiet expiration.
Residual volume (RV)	It is volume of air which is left in the lungs after the maximum expiration
Anatomical dead space	It is the volume of air which is in the respiratory passageways and which dosn`t take part in gas exchange (about 150 ml).
Physiological dead space	It is the volume of air which dosn`t take part in gas exchange, it can be more than anatomical dead space if there is no gas exchange in some alveoli.
Vital lungs capacity (VLC)	It is the sum of air volumes (tidal volume, inspiratory reserve volume and expiratory reserve volume). It is the volume of air which can be expired at maximum expiration after maximum inspiration.

Total lungs capacity (TLC)	It is the sum of all air volumes which are in the lungs after the maximum inspiration, namely – the sum of tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume.
Functional residual capacity of lungs (FRCL)	It is the sum of air volumes which are in the lungs after quiet expiration, namely – the sum of expiratory reserve volume and residual volume.
Inspiratory capacity	It is the sum of tidal volume and inspiratory reserve volume
Minute lungs ventilation (MLV)	It is the quantity of air which passes through the lungs per 1 minute at quiet breathing.
Minute alveolar ventilation (MAV)	It is the quantity of air which passes through alveoli per 1 minute at quiet breathing.
Maximum lungs ventilation (MLV)	It is the quantity of air which passes through the lungs at maximum deepness and frequency of breathing.
Breathing reserve (BR)	It is difference between maximum lungs ventilation and minute respiratory volume
Spirometry	It is a method for lungs` volumes and capacities measuring
Spirography	It is a method of grafic registration of lungs` volumes and capacities.
Pneumotahometry	It is a method of measuring of volume speed of air stream which passses through respiratory passageways and lungs, its value can give a possibility to determine the resistance of respiratory passegeways.

3.2.*Theoretical questions*

1) Conception about the system of respiration. The stages of respiration. Its significance for an organism.
2) Breathing. Its significance.
3) The mechanisms of inspiration and expiration. The role of respiratory muscles at quiet and forced breathing. Preural pressure.
4) Lungs volumes and capacities. Methods of their determination.
5) Lungs and alveolar ventilation. Methods of determination of minute ventilation. “Dead space”, its significance.
6) Maximum lungs ventilation, breathing reserve, their calculation.

3.3.*Practical works*

1) Spirography.
2) Pneumotahometry.

4.Materials for self-control

441.Answer the question:

1) Why is it better to breath through nose but not through mouth?

2) What will happen with breathing if cucare-like substance is injected into an animal?

3) How can one measure the pressure in pleural cavity and prove that it is negative?

4) Make quiet expiration. How much air will be left in your lungs? How is this air called? What volumes is it consist of?

5) Make maximum possible deep inspiration, hold the breath for a moment. Call air volumes which are in the lungs.

6) How to expel one lung from the prosess of breathing?

***5.2.Choose the right answer*:**

1. The loss of lungs` capacity for expanding can be displayed by:
   A. The diminishing of vital lungs capacity
   B. The increase of residual volume
   C. The diminishing of total lungs capacity
   D. The diminishing of expiratory reserve volume.

2. The increase of tidal volume (if breath frequency, anatomical dead space, ventilational-perfusional coefficient don`t change) will most of all effect on the increase of:
   A. Ventilated dead space
   B. Functional residual capacity
   C. Inspiratory capacity
   D. Alveolar ventilation
   E. Alveolar pCO_2

3. The lack of surfactants in a newborn baby with a distress syndrome leads to:
   A. The increase of lungs complience
   B. Stabilization of alveolar volume
   C. The increase of elastic recoil of lungs
   D. The diminishing of the force of filtration in lungs capillars
   E. The diminishing of ΔPO_2 alveola – arterial blood

4. The most resistance to air steam during the breathing make
   A. Mouth and gullet
   B. Trachea and large bronchi
   C. Bronchi with middle diameter
   D. Bronchioles with diameter less than 2 mm
   E. alveoli

5. The increase of functional residual capacity was stated in a man. The most possible reason of it is:
   A. the diminishing if lungs complience
   B. the increase of resistance of respiratory passegeways
   C. the diminishing of thoracic cage volume
   D. the diminishing of vital lungs capacity
   E.the diminishing of total lungs capacity

6. In a man there is the diminishing of complience of lungs (the elasticity is diminished due to fibrosis appearance). His tidal volume makes 350 ml, minute alveolar ventilation – 4.8 l/min, and breath frequency per 1 minute makes:
   A. 14
   B. 16
   C. 18
   D. 20
   E. 24

7. Anatomical dead space will be diminished with:
   A. the diminishing of tidal volume
   B. the diminishing of alveolar ventilation
   C. the increase of vital lungs capacity
   D. tracheostomia

8. The surface tension in alveola with the diameter 0.0075 sm makes 15 din/sm, and alveolar pressure is 4 sm of water. In another alveola with diameter 0.0150 sm the surface tension is 30 din/sm, so the alveolar pressure in another alveola according to Laplas`s law makes:
   A. 1 sm of water
   B. 2 sm of water
   C. 3 sm of water.
   D. 4 sm of water.
   E. 6 sm of water.

9. In a man Rainolds`s number was calculated for trachea with diameter 3 sm and was stated that it testifies about turbulent air stream as its value made

A. <500
B. <1000
C. <1500
D. <2000
E. >2000

10. Pleural pressure makes – 1029 sm of water, alveolar one makes 1034 sm of water, atmospheric pressure makes 1034 sm of water. Such values take place:

A. During inspiration
B. At the end of inspiration
C. During expiration
D. At the end of expiration
E. Before inspiration and expiration

Protocol of practical study №9. "____"_____20___

Work 1. Spirography.

Spirography is grafic registration of rhythm, frequency, deepness of breathing, lungs and ventilational volumes. The research can be fulfilled with the help of spirographs of different constructions at the breathing with pure oxygen, air or air-oxygen mix during 10-12 minutes.

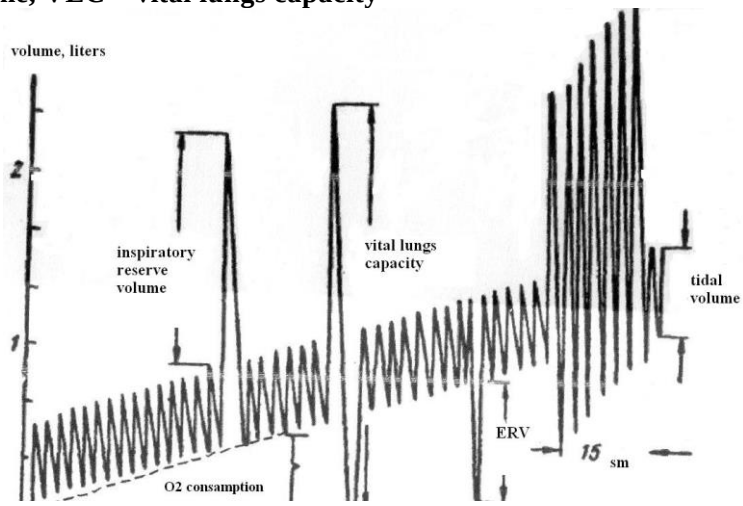
In the case if the device of close system is used and its sack is filled with oxygen in can be used instead of spirometabolograph which is the device with the help of which basal metabolic rate can be determined on the base of oxygen up-take during some time.

The principle of its work is the following. The device is the closed system which consists of spirometer, absorber for carbone dioxide (lime), sack with oxygen, valve with tap, rubber tubes.

The sack is filled with oxygen. Respiratory passegeways of the investigated person is connected hermetically to breathing system with the help of mouthpiece, forming closed system device-lungs. Then he breathes with oxygen. Expired air passing through absorber is liberated from CO_2 and comes into the sack again. Spirogramm is regisrated. When using oxygen its volume in spirograph is decreased and the spirogramm inclines up from the initial isoline.

Knowing the speed of cassette`s movement (3.5 sm per minute) and that 3 sm corresponds to consumption of 1 liter oxygen, one can determine oxygen consumption per 1 minute

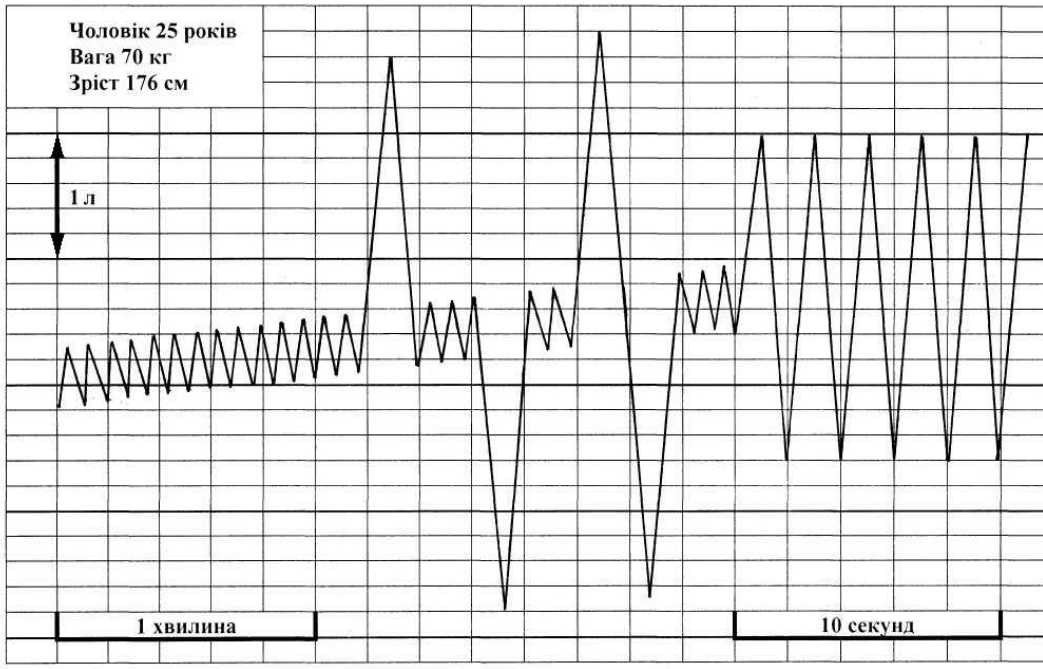
The spirogramm on which it is shown how to determine lungs volumes and capacities: TV – tidal volume, IRV – inspiratory reserve volume, ERV – expiratory reserve volume, VLC – vital lungs capacity



All lungs volumes are calculated by spirogramm taking into consideration that 5 boxes make 1 liter of oxygen, therefore 1 box makes 200 ml of oxygen.

The purpose of the work: to determine and estimate the values of static and dynamic indexes of breathing, on the base of them estimate the functional reserves of breathing and the realization of functional reserves.

The work fulfilment. Students analyze spirogramms of different investigated persons and determine by spirogramm: tidal volume, inspiratory reserve volume, expiratory reserve volume, vital lungs capacity, the frequency of breathing (respiratory movements); minute resiratory volume: MRV = TV x Frequency of breathing; minute alveolar ventilation: MAV = (TV – anatomical dead space) x frequency of breathing (anatomical dead space is consided to be 150 ml), maximum lungs ventilation: MLV =TV forced. x frequency of breathing forced (tidal volume forced is at the maximum deep breathing, frequency of breathing forced is at maximum frequent breathing); breathing reserve (BR): BR = MLV – MRV. *Physiological proper value* of these indexes can be determined using the Harris-Benedict`s tables 2, 4 (see "Appendix"). Use tables 1, 3 (see "Appendix"), first calculating the standart basal metabolic rate using the tables.



Results of the work.:

Breathing indexes	Received values	Proper values	% of deviation of received value from the proper one (+ or -)
Vital lungs capacity			
Tidal volume			
Inspiratory reserve volume			
Expiratory reserve volume			
Minute respiratory volume			
Minute alveolar ventilation of the lungs			
Maximum lungs ventilation			
Breathing reserve			

Conclusions: (write down whether the received results correspond to proper values, mark what every value testifies about taking into consideration the factors which it depends on (functional reserves of breathing and their realization); estimate the state of breathing in the state of rest and probable physical exercises)

Work 2. Pneumotahometry

The method of pneumotahometry is determination of the speed of air stream during inspiration and expiration.

Pneumotahometer consists of differential manometer which permits to display the difference between air streams on both sides of diaphragm. With the help of value of air stream velocity one can suppose some violation which causes obstacles on the way of inspired or expired air. With the increase of respiratory passegeways resistance the velocity of air stream decreases per time unit.

In norm at quiet breathing the speed of air stream makes 500—600 ml/s, during forced inspiration — 6000—8000 ml/s, during forced expiration — 4000—6000 ml/s.

The purpose of the work*:* determine and estimate the value of air stream velocity in an investigated person.

For work one neeeds*:* pneumotahometer, sterile mouthpiece.

The work fulfilment*.* Put sterile mouthpiece on the tube of device. Put the switch on the corresponding act of inspiration or expiration and watch the scale marking the maximum incline of the arrow.

Results of the work:

	The velocity of air stream (ml/s)	
	inspiration	***expiration***
Quiet breathing		
Forced breathing		

Conclusions: *(*estimate the received values, mark the state of respiratory passegeways resistance to air stream.)

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.519-548.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 168-180.

FOR NOTES

Practical study 10.

Studying of gas diffusion in lungs, gas transport with blood

1.Urgency of the theme:

Oxygen diffusion from alveoli into blood and CO_2 diffusion from blood into alveoli are passive processes which characterize II stage of respiration. The speed of gas diffusion through membrane which consists of alveolar, vessel and blood cells and layers of different substances dividing and covering them depends on many factors. The main among them are partial pressures gradient, thickness of diffusing membrane, surface of diffusion and gas properties.

One can`t watch directly for the function of diffusion membrane in a man because all the methods of diffusion determination are based on detecting its results that is gas quantity determination in venous and arterial blood, their comparison and also the determination of common oxygen consumption and CO_2 releasing by an organism according to the indexes of breathing. It is necessary for estimation this stage of respiration.

2.Educational purposes:

- *Make conclusions about the state of gas exchange on the base of parameters` alalyses which characterize gas diffusion through respiratory membrane, gas transport by blood, gas diffusion between blood and tissues according to the methabolism level.*
- *Explain the dependance between hemoglobine saturation by oxygen and oxygen partial pressure; action of some factors such as CO_2 tension, H+ ions concentration, temperature and 2,3–dyphosphoglycerate (DPG) concentration on the curve of hemoglobine dissosiation.*
- *Explain physiological bases of methods of gas exchange determination.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Respiratory membrane or alveolar-capillaric membrane or aerohematic barrior	They are structures through which gas exchange is realized between alveoli and blood of lung`s capillars: alveolar epithelium of I type (0.2 microns), basal membrane of alveolocytes (0.1 microns), endothelium of capillar (0.2 microns), average thickness about 0.5 microns.
The speed of gas transport thruogh alveolar-capillaric membrane or the speed of diffusion (Vg)	It is the gas volume which passes through alveolar-capillaric membrane per 1 minute with diffusion according to the Fick`s low.
Diffusing Capacity of the respiratory membrane (DCRM)	It is the gas volume which passes through alveolar-capillaric membrane per 1 minute with partial pressure gradient 1 mm Hg
The curve of hemoglobine saturation by oxygen	It is dependence of hemoglobine saturation with oxygen - $\%HbO_2$ depending on oxygen tension (partial pressure) in blood.
Hypercapnia	Increased partial pressure of CO_2 in arterial blood more than normal values – more than 40 mm Hg
Hypocapnia	Decreased partial pressure of CO_2 in arterial blood less than normal values – less than 40 mm Hg

3.2.*Theoretical questions*

1) Diffusion and gas transport as stages of respiration.

2) The content of athmospheric, expired and alveolar air. Partial pressures of gases.
3) Blood gases, methods of research. Partial pressures (tension) of gases in arterial and venous blood.
4) Oxygen binding and its transport with blood. Oxygen blood capacity. Curve of hemoglobine saturation and factors acting on it.
5) Gas diffusion in lungs. Diffusing Capacity of the respiratory membrane and factors acting on it.
6) CO_2 transport with blood.

3.3.*Practical works*

1) Determination of oxygen consumption per 1 minute with the help of spirograph.

4.Materials for self-control

4.1.Answer the question:

1) Base the expediency of blood transfusion in a man who was poisoned with carbone monoxide.

2) What factors increase oxyhemoglobine dissosiation?

3) Determine the oxygen blood capacity, if the absolute content of hemoglobine in blood makes 110 g/l. Is this value physiological?

4) Name the forms of CO_2 transport with blood.

5) How is the oxygen transported?

6) Calculate the partial pressure of oxygen in alveolar air if its content makes 15 %, athmospheric pressure makes 740 mm Hg (99 k Pa). Compare it with physiological values.

7) Calculate the coefficient of oxygen utilization, if O_2 content in arterial blood makes 19 %, and in the venous one — 13 % Estimate these parameters.

***4.2.Choose the right answer*:**

1. In a mountain-climber during the adaptation to high mountaining the oxygen blood capacity increased due to the increase of
   A. Alveolar ventilation
   B. Tidal volume
   C. Breath frequency
   D. hypercapnia
   E. erythropoesis

2. During hyperventilation lasting 10 seconds one of the following factors will be diminished
   A. alveolar ventilation
   B. tidal volume
   C. oxyhemoglobine dissosiation
   D. PO_2 of arterial blood
   E. pH of arterial blood

3. Determine the resistance of lung`s vessels under the condition that the avarage value of arterial pressure in lung`s artery makes 12 mm Hg., in left atria = 5 mm Hg., cardiac output = 5 l/min. The resistanse of lung`s vessels will be
   A. 1,0
   B. 1,4
   C. 1,8
   D. 2,4

4. Oxygen partial pressure in venous blood is increased and differs little from that in arterial blood under the conditions:
   A. Poisoning with carbone monoxide
   B. Poisoning with cianids
   C. Diminishing the quantity of hemoglobine
   D. Diminishing of blood circulation
   E. Physical loading

5. Under the physical loading diffusing lungs capacity to oxygen increased most probably thanks to the increase of:
   A. Alveolar ventilation
   B. Maximal lungs ventilation
   C. pO_2 gradient on the border alveolus – lung`s capillar
   D. diffusing surface
   E. coefficient of diffusion

6. If in the expiriment on an animal one blocks blood circulation completely causing the embolia, it will results in:
   A. diminishing ventilation-perfusion coefficient in left lung to 0
   B. ventilational-perfusional coefficient in both lungs will be equal
   C. pO_2 diminishing in arterial blood
   D. pO_2 in alveoli of left lung = pO_2 of inspired air

7. During the short time work the appearance of oxygen debt and replacement of the curve of hemoglobine saturation to the right was found in a man due to the increase of :
   A. alveolar ventilation
   B. potassium ions concentration
   C. hypocapnia
   D. 2,3 DPG concentration in erythrocytes
   E. Methobolism intensivity

8. In comparison with upper parts of lungs in their lower parts there is:
   A. pO_2 increase in lung`s capillars
   B. pCO_2 increase in lung`s capillars
   C. increase of ventilation-perfusion coefficient
   D. equal ventilation-perfusion coefficient

9. in the expiriment on an animal one caused the obstruction of one bronch after which pO_2 in lung`s capillars of this part will
   A. be equal to pO_2 of athmosphere
   B. be equal to pO_2 of venous blood
   C. be equal to normal pO_2 in arterial blood
   D. be less than pO_2 in venous blood
   E. be more than in expired air

10. In a child hypoxemia was called by
   A. blood shunting from the left half of the heart to the right
   B. blood shunting from the right half of the heart to the left
   C. increase of lung`s blood circulation
   D. increase of residual volume
   E. diminishing of the coefficient of diffusion

Protocol of practical study №10. "____"_____20___

Work 1. Determination of oxygen consumption per 1 minute with the help of spirograph.

The purpose of the work: to determine oxygen consumption in the state of rest and after physical loading. To mark what the value and dynamic of oxygen consumption testifies about..

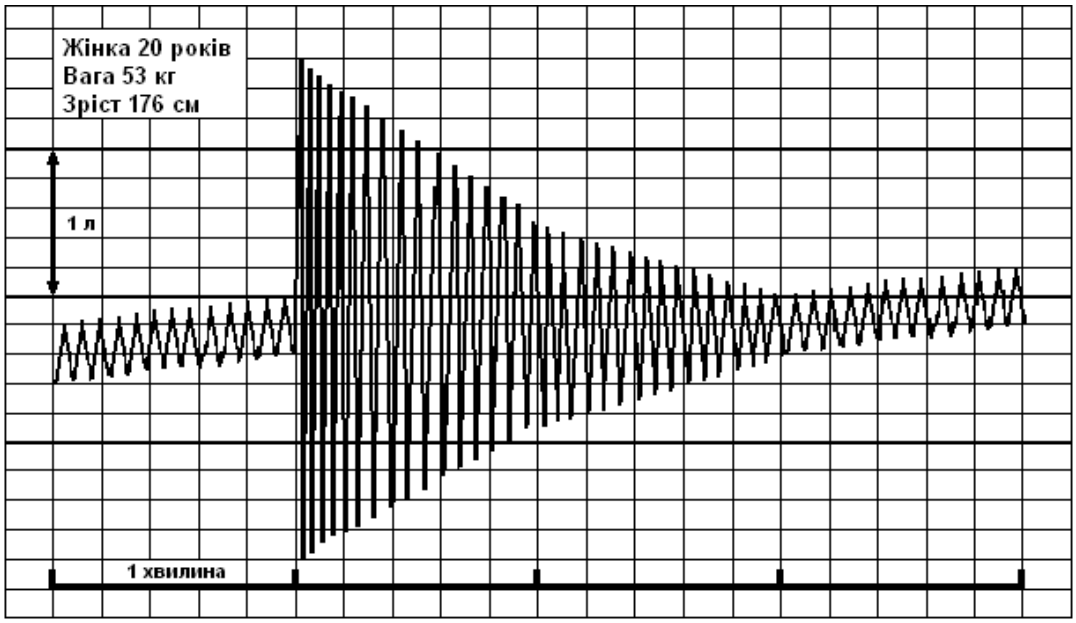
For work one needs: spirograph, oxygen chamber, sodium line, sterile mouthpiece, recording drum, floating drum,counterbalancing weight, serviette.

Work fulfilment. *C*onnect hermetically respiratory passageways to the device with the help of mouthpiece, forming closed system device-lungs. During 1 minute in the state of the rest one writes down spirogramm. When using oxygen the spirogramm inclines up from the initial isoline. Knowing that curve incline from the "0" line on 30 mm up corresponds to consumption of 1 liter oxygen, one can determine oxygen consumption per 1 minute.

Then one quckly closes the tap of the device, the investigated person takes mouthpiece out of the mouth and makes 20 squattings for 30 seconds. Just after the squattings he joins to the device through the mouthpiece again. One writes down the spirogramm after physical loading for 3 minutes till oxygen consumption restoration as in the state of rest. After finishing the research one calculates oxygen consumption in the state of rest and after physical loading for every minute of restoration till the spirogramm will become as in the state of rest.

A student receives spirogramm and determines oxygen utilization according to the curve incline from "0" level for 1 minute in the state of rest and every minute of restoration to normalization of the value which was in the state of rest.

Results of the work. Write down the quantity of oxygen (Vo_2 l/min.) which was used in the state of the rest and after physical loading.



Oxygen consumption	In the state of the rest	After physical loading		
		1 min.	2 min	3 min
Vo_2 l/min.				

Conclusion. (write how much more O_2 was used after physical loading; in what time the oxygen consumption in the period of restoration became the same as in the state of rest what it testifies about. Mark, how and due to what factors diffusing lungs capacity changed in connection with physical loading.

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.549-566.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 180-196.

FOR NOTES

Practical study 11.

Regulation of respiration

1.*Urgency of the theme*:

Regulation of respiration in wide meaning is adaptation of respiration to changing needs of an organism. The speech is not only about the level of metabolism, but also about changes in gas content of external envirounment, emotions, irritation of different receptors etc.

The main physyological result of regulation of respiration is supporting the optimal partial pressures of respiratory gases in blood and tissues according to the intensivity of metabolism.

A doctor offen comes across the situations when it is necessary to help a patient quickly and professionally in cases of respiration violations.

A doctor can need knoledges of regulatory mechanisms of respiration at giving help to a woman in childbirth, drowned men or poisoned with carbon monoxide. The knoledges can be helpful during stay in the mountains, at the fire etc.

2.Educational *purposes*:

- *Explain the mechanisms of respiratory rythmogenesis regulation, parameters of gas homeostasis on the base of analyses of physiological criteria every of the stages of respiration, the functions of executive organs of the system which privide the processes of respiration.*
- *Make the conclusions about the state of respiratory processes regulation on the base of analyses of parameters of breathing at standart physical loading and tests with breath hold.*
- *Analyse the regulated parameters which characterize the state of gas exchange and make conclusions about the mechanisms of respiration process regulation in a man under different conditions.*
- *Explain the perculatities of regulation of respiration in the age aspect.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Pneumotaxic centre	The stucture which comes to the content of the local respiratory centre, is located in pons, inhibits inspiration due to inhibition of inspiratory neurons of dorsal respiratory group (DRG)
Dorsal respiratory group of neurons (DRG)	It is the structure of local respiratory centre, is located dorsally in medulla oblongata, provides rythmogenesis of inspiratory neurons due to this the inspiration is made.
Ventral respiratory group of neurons (VRG)	It is the structure of local respiratory centre, is located ventrally in medulla oblongata, contains inspiratory and expiratory neurons, is not active in the state of rest, is activated by DRG at forced breathing.
Apneustic centre	It is the structure of local respiratory centre, is located in the lower part of pons and can activate DRG.
Eupnoe	Normal depth and frequency of breathibg
Hypernoe	Increased depth of breathing
Hyponoe	Decreased depth of breathing
Tahipnoe	Increased frequency of breathing
Bradipnoe	Decreased frequency of breathing

Dispnoe	Violation in depth and frequency of breathing, short breath
Hypoventilation	The value of alveolar ventilation is less than metobolic needs which leads to pCO_2 increase in arterial blood.
hyperventilation	The value of alveolar ventilation is more than metobolic needs which leads to pCO_2 decrease in arterial blood

3.2.*Theoretical questions*

1) Regulation of respiration. Regulatory mechanisms.
2) Respiratory centre, its location and functions. Autonomy of the respiratory centre.
3) Vagus role in regulation of respiration. Gering-Brayer reflex.
4) The role of large hemispheres in regulation of respiration.
5) Regulation of respiration at low oxygen content and high level of CO_2 in athmospheric air.
6) Regulation of respiration during exercise.
7) Defensive reflexes of respiratory system.

3.3.*Practical works*

1) Tests with maximal breath hold.
2) Spirographia in the state of rest and after exercises.

4.Materials for self-control

4.1.Answer the question:

1) What will happen with the respiration if vagus nerves of an animal are cut?

2) Which of the following factors promote the increase of ventilation during moderate exercises: a) reflexes from proprioreceptors of extremities; b) the increase of body temperature; c) diminishing the level of PO_2 in arterial blood; d) the increase of PCO_2 level in arterial blood?

3) Where are the iiritant receptors located? What reflex is observed during their irritation?

4) Why must not divers-amators fill their ballons with pure oxygen?

5) What is happening with a man`s respiration at one-side pneumotorax?

6) What is dispnoe? In what cases can it be?

7) With what receptors does the Gering-Brayer reflex begin?

8) How will bending and unbending legs of a man by another person influence on the respiration of a man who lies?

***4.2.Choose the right answer*:**

1. After spinal cord violation on the level of 6-th vertebra in a man there will be:

A. Normal breathing
B. Diaphragmal breathing

C. Breathing with the intercostal mucles` participation
D. slow deep breathing
E. stop of breathing

2. After brain stem transection between pons and medulla oblongata in an animal there will be:
A. normal breathing
B. Diaphragmal breathing
C. Breathing with the intercostal mucles` participation
D. slow deep breathing
E.stop of breathing

3.After brain stem transection between hindbrain and mesemcephalon in an animal there will be:
A. normal breathing
B. Diaphragmal breathing
C. Breathing with the intercostal mucles` participation
D. slow deep breathing
E. absence of breathing

4.After brain stem transection between medulla oblongata and spinal cord in an animal there will be:
A. normal breathing
B. Diaphragmal breathing
C. Breathing with the intercostal mucles` participation
D. slow deep breathing
E. absence of breathing

5. After transection of both vagus nerves in an animal there will be:
A. normal breathing
B. Diaphragmal breathing
C. Breathing with the intercostal mucles` participation
D. slow deep breathing
E. absence of breathing

6. Hypercapnia most of all increases lungs ventilation directly activating:
A. carotid chemoreceptors
B. aortic chemoreceptors
C. aortic baroreceptors
D. central chemoreceptors
E. irritant receptors

7. Hypoxemia causes hyperventilation directly acting on:
A. central chemoreceptors
B. carotid chemoreceptors
C. irritant receptors
D. J-receptors
E. Receptors from lungs vessels

8. In a man after beta-2-blocks introdution short breath appeared – the frequency of breathing increased, it was first of all the consequence of:
A. bronchospasm
B. hypertension
C. hypocapnia
D. alcalosis
E. hyperoxia

9. In a man after prolonged diarea pH of arterial blood – 7,25, pCO_2 of arterial blood – 30 mm Hg, arterial pressure –100/80 mm Hg. The decrease of pCO_2 in arterial blood is first of all the result of:
A. hyperventilation with alcalosis
B. hyperventilation with acidosis
C. hyperventilation with hypoxemia
D. hypovolumia with diarea
E. hypotensia as a result of diarea

10. When being in high mountains at the hight 1000 m above sea level the increase of lungs ventilation in a man takes place first of all as a result of:
A. hypercapnia
B. hypoxemia
C. acidosis
D. hypotension
E. alcalosis

Protocol of practical study №11. "____"_____20___

Work 1. Tests with maximal breath hold.

The purpose of the work: state the maximum keeping the respiration at different tests (Shtange`s, Gench`s etc.) and analyse the factors acting on the duration of breath hold.

For work one needs: stop-watch or a watch with a second hand.

The work fulfilment. Shtange`s test is a test with maximum hold on inspiration.

After deep inspiration (but not maximum deep) keep the respiration as long as you can closing the nose. Fix the time of the beginning of keeping and the duration of keeping. Write down the result. The next test can be made in 5 minutes.

Gentch`s test is a test with maximum keeping on expiration.

Quietly expire and mark the time of the beginning of breath holding. Don`t breath as long as you can. Determine the duration of holding. Write down the result. In 5 minutes make the next test.

The test with maximum breath holding after deep inspiration which is made after hyperventilation.

During several seconds make hyperventilation (breath deeply and frequently), after which make a deep inspiration and hold the breath, fix the duration of holding.

Results of the work:

The tests with maximum breath holding	Duration of breath holding in seconds
1. Shtange`s test with maximum hold on inspiration	
2.Gentch`s test with maximum keeping on expiration.	
3.The test with maximum breath holding after deep inspiration which is made after hyperventilation	

Conclusions: (base why period duration of breath hold is different in all 3 tests, compare the values with normal; compare the duration of breath hold in the same test in different people. Base why the duration is different in different people in the same test)

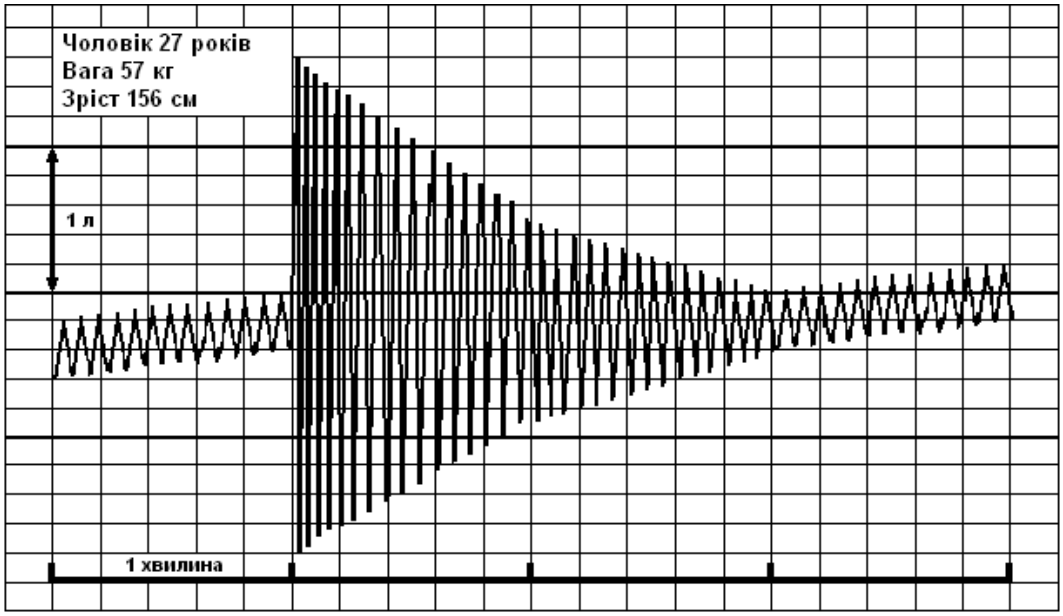
Work 2. Spirographia in the state of rest and after exercise.

The purpose of the work*:* determine how the oxygen consumption, frequency, depth of breathing and lungs ventilation will change during muscle work, analyse the mechanism of these changes.

For work one needs stop-watch or a watch with a second hand.

Work fulfilment. With the help of spirograph write down the spirogramm in the state of rest, during short exercises (20 squatting) and after it. During the squatting don`t write down the spirogramm. Just after the squatting take mouthpiece into the mouth and switch on the device on writing. Spend the experiment till the character of spirogramm will have the same look as in the state of rest.

Determine the quantity of used oxygen – VO_2 l/min. , tidal volume, frequency of respiratory movements, minute lungs ventilation in the state of rest and just after exercises per 1, 2, 3 and 4 minutes. Analyse the received results.



The results of the work:

Researched parameters	In the state of rest	After exercises			
		First minute	Second minute	Thired minute	Forth minute
VO_2 l/min					
Tidal volume					
Frequency of respiratory movements					
Minute lungs ventilation (minute respiratory volume) in l/min					

Conclusions (write down, how the breath and oxygen comsumption changed in connection with exercises and what such a dynamic testifies about)

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.567-578.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.

2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 196-216.

FOR NOTES

Section 11. Digestive system.

Practical study 12.

The system of digestion. Digestion in oral cavity. The role of taste and smell sensory systems in digestive process

1.Urgency of the theme:

In doctor`s professional activity the knowledge of physiology of the digestive system is needed very much in order to fulfil prophylaxis, diagnostics and treatment of deseases related to the disfunctions this system.

Sharp and chronic experiments are used in the investigations for the study of secretory, moving and absorbtion functions of digestion in different parts of digestive channel. Modern medicine owns many methods of research. Among them there is endoscopy, biopsy, radionuclid diagnostics, physiologycal, biochemical, immunological, roentgenologic methods, ultrasound research, pH-metry, computer tomography, videocapsules and many other methods.

The analyses of research results permit the students to master the physiological bases of methods and estimate corresponding functions of digestive system.

Digestion in oral cavity gives the notion of oral cavity significance as initial part of the digestive channel for the process of digestion. The initial analysis of matters which enter organism begins in this part, reflex signalling to the organs of the digestive system from the receptors of mucouses shells, mechanic and chemical tooling of food absorbtion of some matters begins. Valuable treatment of food in the mouth is a guarantor of normal function of all digestive channel of a healthy man.

2.Educational purposes:

- *Interpret the concept of the system of digestion and regulatory mechanisms of its physiological functions (secretory, moving, absorbtion) on the basis of parameters analysis of food matters hydrolysis and their tooling.*
- *Make conclusions about the role of the taste sensory system in determination of food fitness for the use on the basis of determination and estimation of taste sensitiveness threshold , taste fields of tongue. Explain physiological bases of research methods.*
- *Make conclusions about the processes of digestion in oral cavity on the basis of criteria analysis of the state of food mechanical treatment, composition of saliva and degree of food matter hydrolysis, its protective functions and regulation of salivation.*
- *Explain the physiological bases of research methods of moving and secretory functions of oral cavity organs.*
- *Explain the age-old features of the state of moving and secretory functions of oral cavity and mechanisms of their regulation.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Chyme	It is totality of matters which are in the content of food after its mechanical and chemical treatment.
Mastication	It is reflex moving of low jaw relatively to the upper one due to muscles contraction, the result of it is food reducing to fragments.

Swallowing	It is reflex movement of food lump stage by stage from the oral cavity to stomach.
Anticaries properties of saliva	It is the totality of factors and properties of saliva which provide antibacterial action, cleaning oral cavity and others, the result of which is saving of teeth structure.

3.2.*Theoretical questions*

1) General characteristics of the system.of digestion
2) Significance of oral cavity as the initial part of the system of digestion.
3) Taste sensory system, its structure, methods of research, functions and significance.
4) General description of secretory cells, mechanism of salivary glands secretion, phases of secretory cycle.
5) Content and properties of saliva. Influence of irritation`s properties on the quantity and content of saliva.
6) Regulation of salivary glands activity. The significance of parasympathetic and sympathetic innervation.
7) Mechanical treatment of food in the oral cavity.
8) Swallowing, phases and mechanisms of regulation.

3.3.*Practical works*

1) Determination of threshold of taste sensitiveness.
2) Research of the tongue`s tastes fields.
3) Research of saliva properties and regulation of salivation.

4.Materials for self-control

4.1.*Answer the question*

1) What is the significance of oral cavity for the process of digestion?

2) The man `s mucus shell of tongue was worked up by an anaestatic device, in particular dicaine. How will perception of food change here? Why?

3) What is the role of saliva in the process of digestion?

4) How is it possible to get saliva from parotid gland?

5) What is the difference between the saliva made by the irritation of parasympathetic and sympathetic nerves (quantity and quality content)?

6) What is the role of electrolytes which are in saliva?

7) How will the secretion of salivary glands change in the case of increase of adrenalin hydrochloride concentration in blood?

8) What factors influence on the quantity of saliva, that is secreted during a meal?

4.2.*Choose the right answer*

1. The end saliva is hypoosmatic relative to primary one because in the epithelium of salivatory glands ducts there is diminishing of:
   A. Sodium reabsorbtion
   B. Water reabsorbtion
   C. Potassium secretion
   D. Chlorine secretion
   E. Bicarbonates secretion

2. In a dog with the fistule of salivatory gland one received the saliva in which potassium ions concentration was more than in blood plasma. The reason of this is the increase of:
   A. Potassium secretion in acinuses
   B. Potassium secretion in ducts
   C. Permeability of acinuses` cells
   D. Permeability of ducts` cells
   E. Water reabsorbtion in ducts

3. In a dog with the fistule of parotic salivatory gland at irritation of efferent IX pair of cranian nerves in was stated that the saliva was almost isoosmotic relative to blood plasma. It became due to the increase of:
   A. Saliva quantity in acinuses
   B. The speed of saliva movement in ducts
   C. Salts secretion
   D. Proteins secretion
   E. Callicrein secretion

4. In a dog with the fistule of salivatory gland after aldosterone injection the concentration one of the following matters increased:
   A. sodium
   B. chlorine
   C. potassium
   D. bicarbonates
   E. hydrogen

5. In a lecturer during delivering the lecture the mouth became dry because the salivation was diminished due to the action on salivatory glands one of the following factors:
   A. dehydrotation
   B. hyperosmia
   C. cortisol
   D. parasympathetic nerves
   E. sympathetic nerves

6. In a child the ulcers on micus shell of oral cavity were found. In the analysis of blood plasma and saliva it was stated the diminishing of some substance concentration the lack of which caused all told above. The most probably it is the lack of:
   A. calcium
   B. α-amilase
   C. lysocyme
   D. bicarbonates
   E. phosphates

7. The increase of saliva secretion in a dog with fistule of salivatory gland was stated at the irritation of efferent parasympathetic fibres after athropine injection. The increase of salivation was the result of formation and action of:
   A. Vasoactive interstinal peptide
   B. Bradikinin
   C. cortisole
   D. serotonine
   E. prostaglandins

8. After spraying oral cavity with anaestetic (lidocain) it is difficult for a man to swallow. The reason of this is the absence of information from receptors, as a result of which first of all is inhibited:
   A. Oral phase of swallowing
   B. Pharinx phase of swallowing
   C. Oesophagus phase of swallowing
   D. Swallowing coordination

9. After spraying oral cavity with lidocain and food usage there is diminishing of:
   A. Bowel juice secretion
   B. Pancreatic juice secretion
   C. Motility of stomach
   D. Motility of small interstine
   E. Absorbtion in bowel

10. At M-chalinergic receptors activation salivation increases due to the formation of one of the following second messengers formation:
   A. cAMP
   B. cGMP
   C. IP_3
   D. Prostaglandins
   E. NO

Protocol of practical study №12. "____"_____20___

Work 1. Determination of the threshold of taste sensitivity.

The purpose of the work: to define and interpret the thresholds of taste sensitivity to different substances.

To fulfil the work one needs: 0,001%; 0,1% and 1% solutions of saccharose; 0,01%; 0,05%; 0,2% and 1% solution of sodium chloride, distilled water, flasks, test tubes.

Fulfilment of the work: In the flasks A_1, A_2, A_3, A_4 and B_1, B_2, B_3, B_4 there are water solutions of saccharose and sodium chloride in increasing concentrations. Pour into the test tube 2-3 ml of solutions from the flask A_1, rinse the mouth with distilled water and then by the explored solution. Make attempt to define taste of substance. If it was not successful, rinse the mouth with distilled water again and repeat the experiment with solution of greater concentration. Repeat with the content of flasks B_1, B_2, B_3, B_4. Between tests it is necessary to take break for 2-3 minutes.

Results of the work.

Minimum concentration of solution of substances, which gives the certain taste feeling, allows to set the threshold of sensitiveness to this substances.

*The feeling of salt appeared at testing the solution from the flask*_____

*The feeling of sweet appeared at testing the solution from the flask*_____

Conclusions:

1)The threshold of taste sensitivity to salt corresponds to concentration of solution _____

2) The threshold of taste sensitivity to sweet corresponds to concentration of saharose`s solution _____

*3) The value of taste sensitivity threshold depends on*_____

Work 2. Research of the tongue`s taste fields.

The purpose of the work: research the topography of taste sensitivity of tongue.

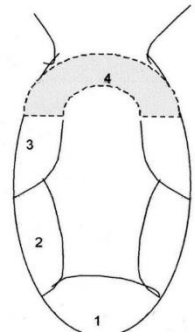
To fulfil the work one needs: 40% solution of saccharose, 2% solution of lemon acid, 20% solution of sodium chloride, 1% solution of chlorhydroxyquinine (prepare solution with the fresh distilled water), sterilized glass sticks, distilled water , test tubes.

Fulfilment of the work. For determination of sensitivity of different areas of tongue one rinses the mouth with water, and a researcher moistures the tip of glass stick by the certain solution, consequently touching its tip, middle part, lateral surfaces and radix of tongue An investigated person tells about the taste feeling. After every experiment one washes the mouth with distilled water. An interval between separate experiments must be over 2 minutes.

Results of the work:

In protocols draw the topography of the taste fields of tongue.

The topography of taste fields of tongue



1 – tip of tongue
2 and 3 - lateral surfaces
4 - radix of tongue

Conclusions: (name the types of taste sensitivity and topography of taste receptors of tongue, which perceive sour, salt, bitter, sweet substances)

Work 3. Research of saliva properties.

The purpose of the work: to make sure in a presence α-amylase and maltase in saliva.

To fulfil the work one needs: 4 test tubes, solution of the starched paste, 1% solution of iodine alcohol, Feling`s reagent, a pipette, a thermostat, distilled water, saliva.

Fulfilment of the work. Collect into the test tube 2,5 ml of saliva. Number other 3 test tubes. Pour 1 ml of distilled water into the first from the numbered test tubes, for 1 ml of saliva into the second and the third test-tubes. Add for 1 ml of starched paste into every test tube. Put into the thermostat for 20 minutes. (temperature 37^0C).

Then add 1 drop of 1% solution of iodine alcohol into the first and second test tubes, and Feling`s reagent into the third one (boil the content of this test tube holding it above the fire from youself!)

Results of the work

In addition of 1% solution of iodine alcohol to the liquid, containing starch, the last one becames blue-violet coloured.

The products of dextrans` disintegration- monosugas give the reddish colouring.

Mono- and dysugas at boiling with the Feling`s reagent give sediment with cuprous, that has reddish colouring.

The content of test tubes	Reaction with iodine	Feling`s reaction
1. starch and water	colour	-
2. starch and saliva	colour	-
3. starch and saliva	-	The colour of sediment

In conclusion *write*, what dark blue colouring in the first test tube testifies about, its absence in the second test tube, appearance of reddish sediment in the third test tube, difference in painted tests in different people

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.579-592.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 217-229.

FOR NOTES

Practical study 13.

Studying of digestion in stomach

1.Urgency of the theme:

Food stays in stomach for a few hours. It is mixed there with gastric juice which is produced by gastric glands. Under the action of gastric juice enzymes the hydrolysis of proteins begins, which considerably increases the action of proteolytic enzymes in the subsequent departments of digestive channel. The mass is mixed and is gradually moved from cardiac to the pyloric department due to the redution of stomach muscles. The secretory function of gastric glands and moving function of stomach is regulated.

The doctor of any speciality ought to know deeply secretory and moving functions of stomach , to be able to choose the adequate methods of research and to estimate their results.

It is necessary to know the mechanisms of the nervous and humoral regulation for normalization of stomach functions, as they provide adaptation of stomach to the quantity and quality of food. Thus, a future doctor has to master them well for understanding prophylaxis, diagnostics, pathogenesis and treatment of enough frequent stomach diseases.

2.Educational purposes:

- *To make conclusions about the state of digestion in stomach on the basis of analysis of the secretory function of gastric glands(secretions of chlorohydratic acid, enzymes, mucus) and moving functions of stomach and their regulation.*
- *To analyse the age-old features of secretory and moving functions of stomach and their regulation.*
- *To explain physiological mechanisms of modern methods of secretory and moving functions of stomach research.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Cephalic phase of gastric secretion	It is gastric juice secretion which is carried out due to unconditional reflexes under the receptors of oral cavity irritation and also due to conditional reflexes under the conditional irritant action which was supported with food.
gastric phase of gastric juice secretion	It is gastric juice secretion which is carried out due to unconditional reflexes under the stomach receptors irritation (vago-vagal reflexes) and due to the action of humaral factors – hormones which are secreted by stomach cells.
interstinal phase of gastric juice secretion	It is gastic secretion which is carried out due to unconditional reflexes from interstine receptors and hormones which are secreted by interstinal cell.
imaginated feeding	It is a chronic experimental method of investigation of the role of oral cavity receptors`s irritation in gastric stomach secretion regulation, which was proposed by Pavlov I.P. After oesophagotomia (oesophagus transsection the ends of which were taken out on the neck) food can`t reach the stomach but under the irritation of oral cavity receptors during having meal the gastric juice was secreted with reflex.

3.2.*Theoretical questions*

1) Stomach significance as the depot of food.
2) Secretory structures of stomach.
3) Methods of research of stomach secretory functions
4) Composition and properties of gastric juice, its significance.
5) Mechanisms of gastric juice. secretion
6) Cephalic phase of gastric secretion.
7) Gastric phase of secretion.
8) Intestinal phase of secretory function of stomach. Inhibition of stomach secretion
9) Gastric secretion in reply to different food substances.
10) Moving function of stomach, its significance, mechanisms and regulation.
11) Chyme transition from stomach into duodenum.

3.3.*Practical works*

1) Research of acid-production of gastric glands by the intragastral pH-metry method
2) Determination of proteolitic activity of gastric juice by Mett`s method
3) Analysis of experiments`s results which confirm existence of gastric secretion phases
4) Research of stomach moving function in a man

4. Materials for self-control

45.1. Answer the question

1) A patient has low acidity of gastric juice. How will it infuence on the digestion in stomach? Why?

2) What influences on pepsinogen, causing its transformation to an active form? What substances does pepsin influence on?

3) What experimental methods is it possible to prove the presence of cephalic phase of stomach secretion by?

4) What changes in the secretion of gastric juice will take place after vagothomia?

5) How to know, if the operation of «little stomach» is done by the method of I.P.Pavlov or by R.Gadenhein?

6) How will the secretion of gastric juice change after the resection of pilorus? Why?

7) What changes in the secretion of gastric juice will take place after introduction of HCl solution into the duodenum?

8) There is an increase of secretion of gastric juice at introduction of histamine or insulin to the sick . What mechanisms stimulate a secretion in these cases?

9) What types of receptors are there on the membranes of parietal cells?

10) What substances are there in broth, fish soup, decoctions of green-stuffs which stimulate the secretion of stomach?

4.2.Choose the right answer:

1. After gastrin injection into blood the secretion of stomach juice increased, pH in stomach cavity made 1,2. After blockage H_2-histaminergic receptors and gastrin injection pH increased to 4. It testifies that HCl secretion by stomach glands after gastrin injection is the result of direct stimulation of the function of:
   A. D-cells
   B. S-cells
   C. ECL-cells
   D. Chief cells
   E. Mucocytes

2. In 40 min after using unfat food which contains proteins the fat acids emulsion was introduced through a probe into duodenum during 10 minutes. The consequence of this became:
   A. Accelaration of chyme evacuation from stomach
   B. The increase of motilin secretion
   C. The increase of frequency of pylorus contraction
   D. Diminishing of cholecystokinin secretion
   E. Relaxation of proximal part of stomach

3. On an empty stomach the periodic contraction of caudal part of stomach and evacuation of stomach content to duodenum is carried out due to periodic secretion of:
   A. Gastrin
   B. HCl
   C. Histamine
   D. Motiline
   E. Cholecystokinin

4. After introduction of hypertonic salt solution into duodenum the speed of chyme evacuation from stomach diminished due to:
   A. Vago-vagal reflexes
   B. Sympathetic reflexes
   C. Metasympathetic reflexes
   D. Cholecystolinine secretion
   E. Secretin secretion

5. In the experiments on dogs with “little stomach” after Pavlov I.P. in was found that after eating meat the quantity of stomach juice increased in one hour and becomes maximum in an hour. Maximum secretion is reached due to:
   A. Conditional reflexes on the smell of food
   B. Unconditional parasympathetic reflexes
   C. Metasympathetic reflexes
   D. Sympathetic reflexes
   E. Stimulation of gastrin secretion

6. Glucose introduction into duodenum inhibits gastric juice secretion due to the releasing of one of the hormones:
   A. Somatostatin
   B. Insuline
   C. Glucagone
   D. Stomach-inhibiting peptide
   E. Vasointerstinal peptide

7. After having meal there was no “receptive relaxation” of stomach. The reason of it is:
   A. Parasympathetic stimulation
   B. Sympathetic stimulation
   C. Metasympathetic stimulation
   D. vagotomia
   E. gastrin injection

8. When having hypersecretion of HCl by parietal cells it is advisable to choose the preparate with prolonged action which blockes :
   A. M-cholinercgic receptors
   B. H_2 histaminergic receptors
   C. Gastrinergic receptors
   D. Hydrogen-potassium pump
   E. Sodium-potassium pump

9. A women of 60 after the fracture of radius bone used aspirin for a long time with the aim of aneastesia, it led to violation of stomach mucosa and stomach ulcer appearance because aspirine caused:
   A. HCl hypesecretion
   B. Gastrin releasing

C. Histamine releasing
D. Blockage of prostaglandins formation
E. Blockage of somatostatin formation.

10. The speed of chyme evacuation from stomach into duodenum will be quickened due to the increase of:

A. Cholecystokinin concentration in blood
B. Secretin concentration in blood
C. The frequency of antral part contraction
D. The frequency of pylorus contraction
E. The frequency of migrative complex

Protocol of practical study №13. "___"_____20___

Work 1. Research of acid-production of gastric glands by the intragastral pH-metry method

The usual methods of stomach secretion research such as fractional aspirated probing is not used in many countries almost 20 years because it has serious defects and doesn`t permit estimate acid-productive function of stomach glands. The aspiration of stomach juice is not physiological at probing. The part of stomach juice is lost through pyloric channel. The aspiration of stomach juice increases its secretion. The procedure is not comfortable for a patient. The results don`t reflect the real state of gastic secretion.

Day and night or prolonged (during 6-8 hours) intragastral pH-metry with the usage of the thinnest probes permits to estimate acid-productive function.

The purpose of the work: estimate pH in the cavity of stomach body during basal phase of secretion and after its stimulation with histamine, on the base of pH data estimate the acid-productive function of stomach, the function of parietal cells and mechanisms of their regulation.

For work one needs: data of pH – metry in the cavity of a stomach body during basal secretion and after its stimulation with histimine.

The work fulfilment: Analize the results of pH-metry in stomach cavity during basal secretion and after its stimulation with histimine.

The results of the work:

The scale of functional intervals:
pH 7,00-8,50 (FI pH 0 – anacidity)
pH 3,60-6,99 (FI pH 1 – hypoacidity expressed)
pH 2,30-3,59 (FI pH 2 - hypoacidity moderate)
pH 1,60-2,29 (FI pH 3 - normacidity)
pH 1,30-1,59 (FI pH 4 – hyperacidity moderate)
pH 0,86-1,29 (FI pH 5 - hyperacidity expressed)

1) One determines maximum stomach acidity searching the maximum acid point (value) and suitable functional interval to which this point belongs. Estimate the acidity in accordance with functional interval.

2) One determines the size of maximum stomach acidity zone depending on the square of stomach mucosa on which the certain maximum acidity belonging to the certain functional interval is determined. Calculate the quantity of points belonging to the suitable functional interval (see 1), then calculate the percentage. Acidity can be:

minimum (to 25% of general quantity of pH points (measuring)
selective (26-50%)
absolute (51-75%)
subtotal (76-99%)
total (100%)

Vinnitza`s National Medical University by Pirogov M.I.
Gastroenterological labolatory

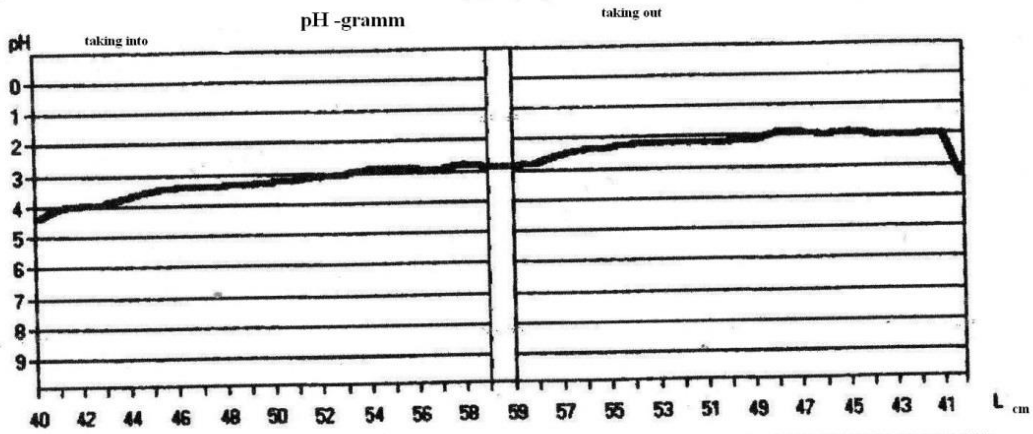
Intragastral pH-metry

Date: 14.06.2004 N 000866

S.N.P.: M.M.M. sex: female hight : 169 cm mass : 69
birthday: 05.08.1972

registration (cm) - begining: 40, end :59 step: 1 cm
imprint: without medicins

pH -gramm

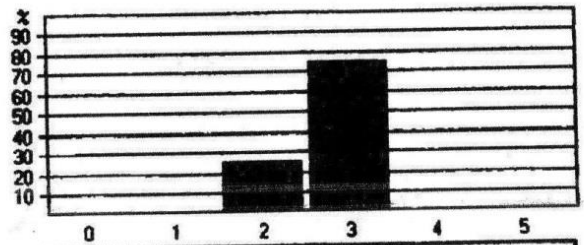


N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
L cm	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	-	-	-	-
pH↓	4,36	4,04	3,96	3,88	3,72	3,48	3,40	3,40	3,32	3,32	3,24	3,16	3,08	3,00	2,84	2,84	2,84	2,92	2,76	2,84	-	-	-	-
N	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
L cm	-	-	-	-	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
pH↑	-	-	-	-	3,32	1,96	1,96	2,04	1,96	1,88	1,96	1,88	1,88	2,12	2,12	2,20	2,20	2,20	2,20	2,28	2,36	2,52	2,76	2,84

analysis of pH-gramm

pH	min	max	Δ	V_L	X	σ	m_x	Me	Mo
	1,88	3,32	1,44	0,024	2,23	0,37	0,06	2,16	2,08

pH functional intervals	↑	
	n	%
5 (0,86-1,29)	0	0,00
4 (1,30-1,59)	0	0,00
3 (1,60-2,29)	15	75,00
2 (2,30-3,59)	5	25,00
1 (3,60-6,99)	0	0,00
0 (7,00-8,50)	0	0,00



Main conclusion: absolute normacidity

Additional conclusion:

Conclusions:(estimate the acid-productive function of the stomach according to 1 and 2)
What does it testify about?

Work 2. Determination of proteolitic activity of gastric juice by Mett`s method

The purpose of the work: to state the presence of pepsins` enzymes in stomach juice and their proteolitic activity, estimate the function of chief cells and the mechanisms of their regulation.

For work one needs: Mett`s sticks, stomach juice, thermostat, rulers.

Work fulfilment: Raw egg-white becomes white at boiling in glass tubes with diameter 1-2 mm. These tubes of 2-3 sm long are put into test tubes with gastric juice, then are placed into the thermostat for 4 hours at the temperature 37°C.

Under the action of pepsin the egg-white is overcooked on both ends of the glass tube. On empty stomach the size of overcooking makes 3 mm, on the high point of secretion – 7 mm on both sides of the tube

Results of the work:

On the high point of stomach juice secretion the size of overcooked egg-white in Mett`s sticks on the both ends makes _____mm

Conclusions: (estimate the results, mark what they testify about)

Work 3. Analysis of experiments`s results which confirm existence of gastric secretion phases

The purpose of the work: analize stomach juice secretion during different phases.

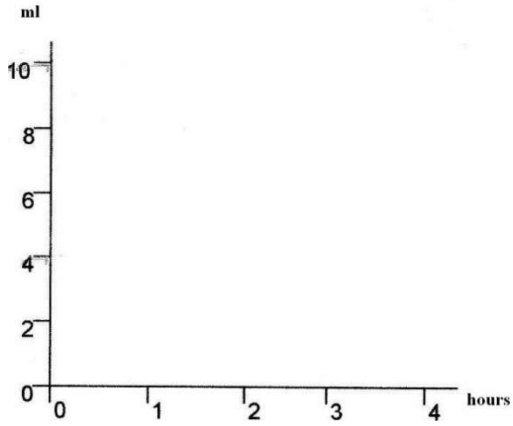
For work one needs: data of stomach secretion research in the experiment on dogs during imaginary feeding, when putting food through fistule, and also in normal conditions.

Work fulfilment. On the base of these data the students draw the curves of secretion in normal conditions, during cephalic and gastric phases and the "synthetic" curve in their protocols, vertically – the quantity of juice in ml, horizontally – the time in hours.

200 g meat is given to eat (by Higin)		**150 g of meat is put into stomach through the fistule (by Lobasov)**		**Imaginary feeding (by Lobasov)**		**The sum of 2 last expiriments**
The quantity of juice in sm^3	Digestive force in mm	The quantity of juice in sm^3	Digestive force in mm	The quantity of juice in sm^3	Digestive force in mm	The quantity of juice in sm^3
12,4	5,43	5,0	2,5	7,7	6,4	12,7
13,5	3,63	7,8	2,75	4,5	5,8	12,3
7,5	3,5	6,4	3,75	0,6	5,75	7,0
4,2	3,12	5,0	3,75	-	-	5,0

Results of the work:

The diagramms of dinamics of secretion in the experiment on dogs.



Conclusions: (compare the curve of dinamic of the secretion at normal feeding with "synthetic" curve which is the consequance of sums 1) the quantity of juice which is released during imaginary feeding; 2) the quantity of juice which is secreted after putting the food into stomach; mark the main phases of secretion on the base of fulfiled experiment).

Work 4. Research of stomach moving function in a man by radiogramms and regisrational curves of muscles contraction.

The purpose of the work: to state the type of stomach motility, the nature of their appearance and physiological significance of moving activity.

For work one needs: mechanogramms of dog`s stomach, a serie of radiogramms of human stomach, negatoscope or the source of light.

Work fulfilment: a) Students describe the regisrational curves of stomach contraction at their regisration by baloon-graphical method, analize the periodicy of stomach motility and percularities of stomach motility in the period between digestions. **In conclusions** mark physiological significance of hungry motility and the mechanisms of its appearance.

b) using the serie of radiogramm students describe the movement of baric contrast matter about the stomach, make the conclusions about the type of moving activity which supplies the movement of contrast matter.

Results of the work:

Hungry motility of dog`s stomach:

Radiogramms serie of human stomach in frontal (1-4) and side surfaces (5,6)

Conclusions: (explain the mechanisms of the periodic character of stomach motility, mark the connection of normal state of stomach motility with its digestive function)

Protocol revised_____
(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.593-615.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P.229-248.

FOR NOTES

Practical study 14.

Studying of digestion in bowels

1.Urgency of the theme:

Duonedum is one of the most important parts of alimentary channel. It is explained by, firstly, the ducts of two largest digestive glands – pancreas and liver enter here. Secondly, the significant quantity of interstitial hormones are formed in its mucus shell. They are secretin, cholecystokinin, gastric-inhibiting peptide, vasoactive interstinal peptide, motilin, enteroglucagon and others. Thirdly, numeral reflexes begin from this zone, these reflex realization act on upperplaced and lowerplaced parts of alimentary channel. Forthly, neurohumoral regulatory mechanisms with the help of feedback connections coordinate the secretory and moving functions of many organs belonging to the system of digestion.

There are three associated processes in small interstine and large interstine, namely: motive function, the final hydrolysis of nutritives in the cavity of small interstine and on its surfaces, and also absorbtion of products of hydrolysis into blood and lymph.

In clinical practice there are a lot of patients with violations of this system organs, therefore a doctor has to analize deeply pathological changes which occur in an organism and give qualificated help.

2.Educational purposes:

- *To make conclusions about the state of digestive processes in duodenum on the basis of analysis of pancreas`s secretory function (quantity and composition of pancreatic juice), liver`s secretory function (bile secretion and excretion), and products of hydrolysis of albumens, fats, carbonhydratess which appeared under enzymes action .*
- *To analyze the age-old features of pancreas`s secretory function, bile secretion and its excretion into duonum and regulatory mechanisms.*
- *To explain physiological bases of modern methods of research of pancreas`s secretory function, bile secretions and its excretion into duodenum.*
- *To make conclusions about the state of digestive processes in small interstine and large interstine, on the basis of analysis of the state of membranous and cavitary digestion, composition of intestinal juice and final products of albumens, fats, carbonhydratess hydrolysis which appeared under the action of enzymes.*
- *To explain the mechanisms of moving function of small interstine and large interstine and their regulation.*
- *To explain the mechanisms of bowels`s secretory function regulation*
- *To interpret the state of absorbtion processes in bowels and to explain its mechanisms.*
- *To analyse the age-old features of secretory and moving function of bowels and mechanisms of their regulation.*
- *To explain physiologycal bases of modern researched methods of secretory and moving function of bowels.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Proenzymes	Idle form of enzymes
Enterokinase	It is enzyme of bowel juice – enteropeptidaze, which activates pro-enzyme *tripsinogen* transforming it into active enzyme *tripsin* in bowel cavity.

Cephalic phase of pancreatic secretion	It is the phase of pancreatic secretion which is carried out due to unconditional reflexes at oral cavity receptors irritation and also due to conditional reflexes on conditional irritants, the action of which was supported with food.
Gastric phase of pancreatic secretion	It is pancreatic juice secretion which is carried out due to unconditional reflexes at stomach receptors irritation ("vago-vagal reflexes) and humoral factors action – hormones which are secreted by stomach cells, in particular gastrin, which stimulates mainly enzymes`s secretion by acini cells.
Interstenal phase of pancreatic secretion	It is pancreatic juice secretion which is carried out due unconditional reflexes from interstine receptors and hormones which are secreted by bowel cells, in particular, secretin, cholecystokinin-pancreozymin.
Cavitary digestion	It is the hydrolisis of nutritives – proteins, lipids and carbonhydrates which is carried out under the action of enzymes of digestive juices in the bowel`s cavity.
Membranous digestion	It is hydrolisis of oligoshugars, little peptids, lipids on the surface of membrane of enterocytes` microvilli which is connected with the absorbtion of the products of hydrolisis into blood and lymph.
Basal electrical rhythm (BER)	It is spontaneus electrical activity of the myocytes of digestive channel (except oesophagus and proximal part of stomach) which results in changes of membrane potential from –65 mV to – 46 mV on the base of which action potentials can be generated. The frequency of BER in stomach makes 4/min., in diudenum – 12 /min, in distal part of ileum – 8/min, in large interstine: from 9/min in caecum , to 16/min in colon sigmoideum.
Migrative moving complex (MMC)	It is pacemakers` activity of myocytes which leads to the contraction of digestive channel`s muscles in between-digestion period in direction from stomach to distal part of ileum every 90 minutes, it is hungry contractions.

3.2. ***Theoretical questions***

1) The research methods of pancreas`s external secretory function.
2) Composition of pancreatic juice and significance of its component parts.
3) Regulation of pancreatic secretion.
4) Analysis of pancreatic secretion curves in reply to the different food matters.
5) Research methods of bile formation and bile excretion.
6) Composition of bile and its significance for digestion.
7) Regulation of bile formation and bile excretion.
8) The researched methods of moving functions of small interstine and large interstine.
9) Types of small interstine and large interstine movements. Regulation of moving function. Researched methods of secretory function of small interstine. Types of digestion in it (cavitary and membranous) .
10) Composition and properties of intestinal juice. Regulation of its secretion.
11) Absorbtion in small interstine (methods of research, mechanisms, percularities of absorbtion of different substances, its regulation) .
12) Significance of large interstine for the process of digestion.

3.3.*Practical works*

1) Research of pancreatic juice action on albumens, fats and carbonhydrates.
2) Research of cavitary and membranous digestion.

4. Materials for self-control

4.1. *Answer the question*

1) To what matters are albuments, fats and carbonhydratess hydrolased under the action of enzymes of pancreatic juice?

2) What matters activate trypsinogen and chemotrypsinogen?

3) At excrement`s research the drops of undigested albumen, starch, neutral fat were found. How is it possible to explain?

4) How does a sulfate of atropine influence on the secretory function of pancreas? Why?

5) What matters stimulate the secrection of cholecystokinin - pancreozymin?

6) Why is the proteolitic activity of the pancreatic juice, which is secreted into duodenum and is got with the help of canula brought into a duct, different?

7) How will the pancreatic enzymes` activity change in the case of the prolonged reception of food rich on albumens?

8) What processes in small interstine will obturation with the stone of common bile duct influence on?

9) Name the basic enzymes of small interstine juice.

10) What is the role of membranous digestion and how does it differ from cavitary one?

11) What type of transport provides absorbtion of amino- acid and monosugars?

12) Why do they recommend to take food containing cellulose for strengthening small interstine motility?

13) How does the irritation of sympathetic nerve innervating small interstine influence on its motility?

14) How will the small interstine motility change in the case of decline of bile secretion?

15) Will there be the small interstine motility after vagothomia?.

16) A dog with the fistula done after the method of Tiry-Well is fed. Will there be the secretion of the isolated loop of small interstine? How to make it appear?

4.2.Choose the right answer:

1. The maximum quantity of stomach juice is secreted during the second hour after food. Pancreatic juice secretion has the same dynamic. The probable regulatory mechanism of maximum pancreatic juice secretion is secretory cells` stimulation by one of the following hormones:
   A. Gastrin
   B. secretin
   C. histamine
   D. pancreozymin
   E. acetilholine

2. In a patient after resection of 50 sm of ileum undigested fats in excrements were found (steatorea). The reason of it was the lack of one of the following enzymes in digestive juices, namely:
   A. pancreatic lipase
   B. pancreatic co-lipase
   C. hydrocarbonates
   D. bile acids
   E. bile pigments

3. For the pancreatic secretion diminishing a patient was recommended during 3 days not to use:
   A. proteins
   B. lipids
   C. carbonhydrates
   D. vegetables
   E. Any food

4. In the experiments on dogs it was stated that after using milk the quantity of pancreatic juice during 2 hours is significantly less than during the third hour. This less secretion during the first two hours is the result of diminishing of secretion of one of the hormones in these conditions:
   A. Cholecystokinin
   B. Gastrin
   C. Secretin
   D. Glucagon
   E. Somatostatin

5. During the experiment it was stated the diminishing of chemotripsinogen secretion by acini cells of pancreas:
   A. During cephalic phase
   B. After vagotomia
   C. During interstine phase
   D. Under the action of inhibitor of tripsin
   E. After glucose using

6. Hydrocarbonates` secretion with bile was increased after introduction into blood one of the following hormones:
   A. Gastrin
   B. Cholecystokinin
   C. Secretin
   D. Somatostatin
   E. Glucagon

7. With the diminishing of pancreatic secretion speed in the pancreatic juice content there becomes more :
   A. Sodium chlorine
   B. Potassium chlorine
   C. Hydrocarbonates
   D. Calcium ions
   E. Water

8. After amino acids introduction into duodenum the concentration one of the following hormones increases, namely:
   A. Gastrin
   B. Secretin
   C. Cholecystokinin
   D. Glucagon
   E. Insulin

9. During cephalic phase of pancreatic secretion the digestive force of pancreatic

juice increased due to acini cells stimulation mainly by:

A. Sympathetic nerves
B. Parasympathetic nerves
C. Metasympathetic system
D. Gastrin
E. Cholecystokinin

10. Bile salts` formation from bile acids provides:

A. Their solutability in water
B. Lipase activation by them
C. Bile secretion stimulation
D. Their precipitation
E. Motility activation

11. In a man of 50 diarea appears every time after using milk. It is a result of the lack of one of ennzyme which take part in membranous digestion, namely:

A. Peptidase
B. Lipase
C. Amilase
D. Maltase
E. Lactase

12. After ileum`s resection in a man the quantity of erythrocytes and hemoglobine decreased, the colour index made 1.25. The reason of the said above is the stop of absorbtion of:

A. Iron
B. K vitamine
C. C vitamine
D. B_{12} vitamine
E. Aminoacids

13. After introduction of sodium-potassium ATP-ase`s inhibitors it was stated that it didn`t act on absorbtion in small interstine one of the products of hydrolysis, namely:

A. Dypeptides
B. Tripeptids
C. Saccharose,
D. Fructose
E. Alanin

14.Lipids are transported from small interstine`s epithelium into blood by the way of:

A. Mycells
B. Chylomicrones
C. Triglycerids
D. Fat acids
E. Monoglycerids

15. Aldosterone was injected into blood. As a result of it there is the increase of some matter`s absorbtion by the way of secondary transport, namely:

A. A vitamine
B. E vitamine
C. D vitamine
D. Fructose
E. Glucose

16. Papathyrin was injected into blood. As a result of it some ions` absorbtion was undirectly increased in small interstine, namely:

A. Sodium
B. Potassium
C. Calcium
D. Magnesium
E. Chlorine

17. Toxins of choleraic vibrio cause water loss through alimentary channel (choleraic diarea) because in small interstine they stimulate the primary secretion of ions:

A. Sodium
B. Potassium
C. Calcium
D. Chlorine
E. Phosphates

18. After surgical operation on digestive channel the motility of small and large interstine stopped as a result of activation of:

A. Metasympathetic system
B. Parasympathetic system
C. Sympathetic system
D. The increase of neurotensin concentration
E. The decrease of motilin concentration

19. After leptins` introdution into rats` blood the diminishing of hypothalamic nuclei activity was registrated, namely:

A. Lateral
B. Ventromedial
C. Supraoptical
D. Paraventrical
E. Back

20. At the stretching of the ileum`s distal part with chyme the stomach content evacuation to duodenum is diminished due to:

A. Metasympathetic reflex
B. Parasympathetic reflex
C. Sympathetic reflex
D. neurotensin
E. chlolecystokinin

Protocol of practical study №14. "___"_____20___

Work 1. Research of pancreatic juice action on albumens, fats and carbonhydrates.

Pancreatic juice contains a wide spectrum of proteolitic, lipolitic and amylolitic enzymes. Pancreas`s secretory function insufficiency substantially influences on breaking up and assimilation of food matters.

In dependance with food contents enzymic composition of juice changes. At the prolonged nutrition by food with high content of carbonhydrates there is adaptation of pancreas to this food and there will be more active amylolitic enzymes in juice. In the case of the prolonged nutrition by food with high content of albumens proteolitic enzymes will prevail, and at the increase of fats in the ration the lipolitic enzymes will prevail. A gland adopts to the changes in food.

The purpose of the work.: to determine the action of pancreatic juice on albumens, fats and carbonhydratess; estimate the presense of amilaze, lipase and protease in gastric juice.

To fulfill the work one needs: thermostat, test tubes, pipettes with a pear-form rubber, 0,1 % solution of casein, prepared on a 0,1% solution of hydrocarbonate sodium , 2% alcoline solution of trybutirin, 0,1 % solution of starch, 0,5 % solution of iodine, 5 % solution of acetic acid in 50 % ethyl alcohol, 0,2 % solution of neytralrot in 60 % ethyl alcohol, pancreatic juice in proportion 1 : 200, 1 : 400 and 1 : 800 (instead of pancreatic juice it is possible to use enzymic drug of «Festalum» type; first dilution — 2 pills on 1 liter of the distilled water).

Fulfilment of the work. . Into test tubes № 1-3 pour in 1 ml solution of casein, into test tubes № 4—6 — 1 ml solution of trybutirin, into test tubes № 7—9 — 1 ml solution of starch.

Add in 1 ml of pancreatic juice in proportion 1 : 200, or 1 : 400, or 1 : 800 into all three groups of test tubes. Put test tubes into a thermostat on 20 min. at the temperature 37 °C.

Then add in 7—8 drops 5 % solution of acetic acid into test tubes № 1-3 (in the case of presence of albumen a turbid circle will appear there), in 1 drop of solution of neytralrot into test tubes № 4—6 (this indicator has the yellow colouring in a alcol envirounment, and pink - in acidic environment). Add in 1 drop 0,5 % of iodine solution into test tubes № 7-9 (in the presence of dextrines it gives the violet colouring). The degree of dilution of pancreatic juice characterizes its activity and coinsides to the quantity of conditional enzymic units in 1 ml.

Results of the work:

Number of test-tube, substrate, indicator	Pancreatic juice dilution, The presence of hydrolisis (+) or the absence of hydrolisis (-) substrate		
	1/200	1/400	1/800
№1-3. casein + 5% of acetic acid	fall:	fall:	fall:
№4-6.trybutirin + 0,2% solution of neytralrot	color:	color:	color:
№7-9.solution of starch 0,1% + 0,5% iodine	color:	color:	color:

Conclusions:to write, what the change of colouring of indicators testifies about; what is the activity of juice (to express in conditional units).

Work 2. Research of cavitary and membranous digestion.

The purpose of the work.: to make sure that due to the surface of mycrofibres of enterocytes the speed of hydrolysis of nutritives is considerably multiplied in small interstine.

To fulfill the work one needs: test tubes, juice of pancreas, 0,1 % solution of starch, solution of Feling, a segment of bowel, thermostat.

Fulfillment of the work. Pour for a 1 ml juice of pancreas in 2 test tubes, place the segment of small interstine in one of them. Add in every test tube for 1 ml 0,1 % solution of starch and put them into a thermostat at a temperature 38 °C for 15 min.

Fulfil the Feling`s reaction. Add in every test tube for 15 drops of reagent of Feling and put to boil. In a few minutes compare the degree of fall of cuprous oxide. The intensive yellow-red color of liquid testifies about the hydrolysis of starch.

Results of the work.

Number and content of test tube	Feling`s reaction (coloring, the presence of fall of cuprus oxide)
1. pancreatic juice + 0,1% starch solution	fall: color:
2. pancreatic juice + 0,1% starch solution + fragment of small interstine	fall: color:

In conclusion to mark , where the hydrolysis of starch is more intensive, in a test tube with the segment of bowel or without it it and why.

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.616-652.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 248-272.

FOR NOTES

Section 12. Energy exchange. Section 13. Thermoregulation.

Practical study 15.

Studying of energetic metabolism and metabolic rate. Thermoregulation

1.Urgency of the theme:

An exchange of matters and energy is a complex of biochemical and connected with them power processes which are the basis of vital functions of living organism.

An organism is an open thermodynamics system, which due to metabolic processes provides formations of macroergic connections, energy of which is used for realization of physiological functions.

Energetic wastes of an organism per time unit characterize metabolism`s intensity.

The first law of thermodynamics, according to which energy does not appear and does not disappear, but only transfer from one form into another, concerns living organisms too. Consequently there is a power balance between a receiption and wastes of energy. Energy sources are basic nutritives which enter organism with food. If the balance between received and wasted energy is kept, body mass stays constant.

Maintenance of balance between heat production and heat emission in an organism is the basis of temperature constancy (homoiotermia).

Heat appears in the process of metabolism and its quantity as more as more intensivity is metabolism.

A human being belongs to homoiptermic organisms, therefore its body temperature remains constant at large fluctuations of envirounment temperature.

The temperature of a man`s body is one of the homeostatic parameters and is an important indicator of an organism state. Therefore it is very important to understand the meaning of termogenesis and isotermia of a man`s body for his living activity.

2.Educational purposes

- *Make conclusion about metabolism intensity on the basis of analysis of energetic wastes which characterize basal metabolic rate.*
- *Make conclusions about day and night energy wastes of people of different professions and accordance of their food rations to the energy wastes .*
- *Analyse the age changes of energy wastes of an organism and their regulation.*
- *Explain physiological bases of methods of direct and indirect calorimetry.*
- *Analyse the state of termoregulation of a man under different conditions (depending on physiological state of an organism and temperature of body nuclear and processes of thermogenesis and heat emission).*
- *Analyse the age percularities of a man`s termoregulation.*
- *Explain physiological methods of termoregulation research.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Determination
Basal metabolic rate (BMR)	It is minimum energy wastes of an organism during day and night. It is determined in standard conditions: in the morning after awakening, on an empty stomach, lyings, in emotional rest, at the temperature of comfort.
Respiratory coefficient or respiratory ratio (RC or RR)	It is ratio between the volume of carbon dioxide (VCO2) which is released from an organism to the volume of used oxygen (VO2)

Calorical equivalent of oxygen (CEO_2):	It is an amount of energy which appears in an organism at the consumption of 1 liter of oxygen at oxidization of certain nutritives.
Gomoiotermia	It is maintenance of body temperature constancy of an organism under the changes of environment temperature.
Poykilotermia	It is dependence of an organism`s body temperature on the temperature of external environment – body temperature changes in accordance to environment temperature.
Temperature of body nuclear	It is a temperature of deep parts of a body, which is supported as a constant in homoiotermic organisms.
Temperature of body shell	It is a temperature of superficial layer of a body (skins) and extremities, which changes under the change of environment temperature in homoiotermic organisms.
Body temperatures (or temperature of body nuclear)	It characterizes balance between the processes of heat production and heat emission in an organism.
Comfort temperature	It is an environment temperature at which the least termoregulation takes place in a thermoneutral area.
Thermoneutral area	It is a range of environment temperatures, when equilibrium between heat production and heat emission is reached only due to vasculomotor reactions.
Perspiration	It is water evaporation from the surface of lungs, mucus shells, skin. It makes about 600 ml per 24 hours and depends on the temperature gradient and humidity of environment.

3.2.*Theoretical questions*

1) Organism as an open thermodynamics system. Sources and ways of energy wastes.
2) Methods of determination of energetic metabolism of an organism. Direct calorimetry.
3) Indirect calorimetry. Respiratory coefficient (respiratory ratio) and its value.
4) Basal metabolic rate. Factors which influence on a basal metabolic rate.
5) Working metabolic rate.
6) Regulation of metabolism intensity.
7) The significance of homoiotermia for the vital activity of a man.
8) Temperature of different parts of a body.
9) Periodic fluctuations of the body temperature.
10) Body temperature as a balance of heat production and heat emission.
11) Heat production and its regulation.
12) Ways of heat emission in different conditions.
13) Heat emission and its regulation.

3.3.*Practical works*

1) Determination of basal metabolic rate with the help of oxispirograph.
2) Determination of energy wastes in the state of relative rest and during muscular work with the help of oxispirograph.
3) Research of heat radiation from the surface of a body.

4.Materials for self-control

4.1.Answer the question

1) Basal metabolic rate in a man of 27 years old (hight 180 sm, body mass 82 kg) makes 2000 kcal. Estimate these parameter.

2) Determine standart basal metabolic rate in a man of 28 years old with body mass 70 kg and hight 176 sm. Use Harris-Benedict`s tables with body mass and body surface. Compare the received results and make the conclusions.

3) For a woman of 26 years old with body mass 60 kg and hight 164 sm in the conditions of basal metabolic rate the minute respiratory volume makes 6 liters, in expired air there is 16,3 % O_2 and 3,7 % CO_2. Define the value of basal metabolic rate, estimate results and make conclusion.

4) Define energy wastes of a man per 1 minute., if for this time 250 ml of O_2 was consumped and 240 ml of CO_2 was released.

4.2.Choose the right answer

1. It was stated that during the fulfilment of prolonged exercises in a sportman the respiratory coefficient (ratio) makes 0.7. It takes place during physical exercise mainly due to oxidazing of:
   A. proteins
   B. carbonhydrates
   C. lipidas
   D. lactate
   E. piruvate

2. In a student after standart physical exercise one dermined the respiratory coefficient (ratio) during the first minutes of the restoration. Respiratory coefficient made 1.2.. The reason of such value of respiratory coefficient is:
   A. oxidazing of carbonhydrates
   B. oxidazing of proteins
   C. oxidazing of lipids
   D. exclusion of supplanting CO_2 from bicarbonates
   E. oxyhemoglobine dissosiation

3. It was stated that during physical exercises in an investigated person in average 1 liter of CO_2 was released during 1 minute as a result of metabolic processes. The quantity of used oxygen was the same. The told above testities about:
   A. hypercapnia
   B. hypoxemia
   C. oxidazing of carbonhydrates
   D. oxidazing of lipids
   E. oxidazing of proteins

4. In a woman after using protein food there were the increase of:
   A. metabolism`s intensivity
   B. respiratory coefficient (ratio)
   C. calorical equivalent of O_2
   D. oxygen blood capacity
   E. % of hemoglobine

5. By the method of straight calorimetria it was stated that 15.7 kDj of energy as heat was released at 1 gramm of glusose oxidazing. How much kDj of energy will release at oxidazing of the same mass of glucose to the same products in an organism:
   A. 15,7
   B. 17,2
   C. 29,7
   D. 38,9

6. A patient consulted a doctor with the complaint on permanent thirst and diuresis increase. In the blood analyses the increase of glusose concentration was found. Oxygen consumption made 0.3 liter per minute, carbone dioxide releasing – 0,21 liter. These changes testify about:
   A. oxidazing of glucose
   B. oxidazing of lioids
   C. oxidazing of proteins
   D. anaerobic metabolism
   E. hyperventilation

7. At a patient examination bradicardia, adynamia, memory`s getting worth, the diminishing of basal metabolic rate on 20% was stated. All these testify about the decrease concentration in blood
   A. cateholamines
   B. adreno-corticothropine
   C. aldosterone
   D. tiroxine
   E. somatothropine

8. During the flu the usage of aspirin leads to temporaly decreasing of body temperature thanks to blockage of pirogens formation

which increase the level of temperature set point of hypothalamus, namely:

A. prostaglandin E_2
B. cytokins
C. adrenaline
D. serotonine
E. adrenocorticothropine

9. Adaptation to the high temperature is accompanied by the increase of sweat secretion and in the connection with this by the increase in blood one of the following hormones:

A. tiroxine
B. aldosterone
C. adrenaline
D. calcitonin
E. insuline

10. In winter wearing close shoes leads to rapid cooling of feet. The reason of this is the diminishing first of all:

A. blood circulation
B. sweating
C. radiation
D. adrenaline
E. tiroxine

Protocol of practical study №15. "_____"_____20_____

Work 1. Determination of basal metabolic rate with the help of oxispirograph.

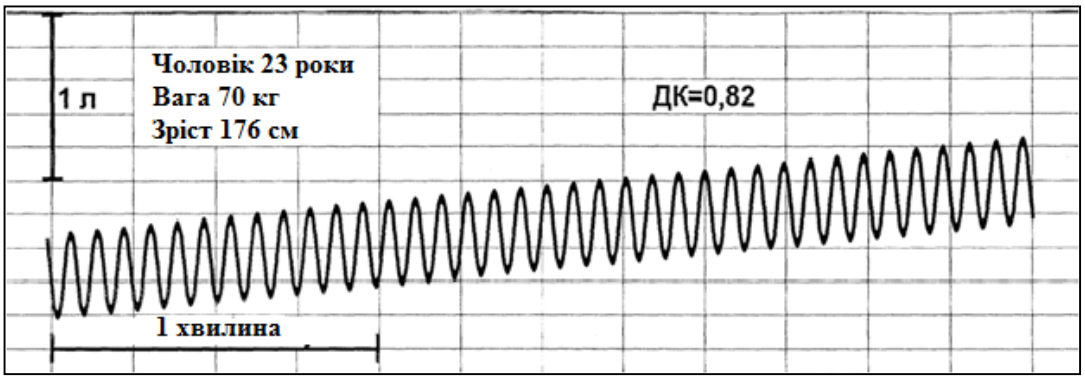
Purpose of the work: define and estimate the indexes of basal metabolic rate of a man, analyse factors which influence on them; estimate metabolism intensivity.

For work one needs: spirogram, written in in standard conditions of basal metabolic rate determination

Work fulfilment. Determine the amount of consumped O_2 per 1 min depending on the degree of spirogram inclination per 1 minute. Respiratory coefficient (RC) in the state of rest makes 0.82. Using tables find CEO_2 according to the value of RC. Then determine basal metabolic rate by the formula: BMR = VO2 x CEO_2 x 1440**,** where VO2 is the quantity of consumped oxygen per 1 minute in liters; CEO_2 is calorical equivalent of oxygen in kcal/liter; 1440 is an amount of minutes in 24 hours.

Find the proper physiology value of BMR (standard basal metabolic rate) by Harris-Benedict`s tables for investigated person, compare it with the received result.

Results:



BMR =

Standard BMR =

Diviation between received BMR and standard BMR = _____%

Conclusions: (to estimate BMR and define, what its value testifies about)

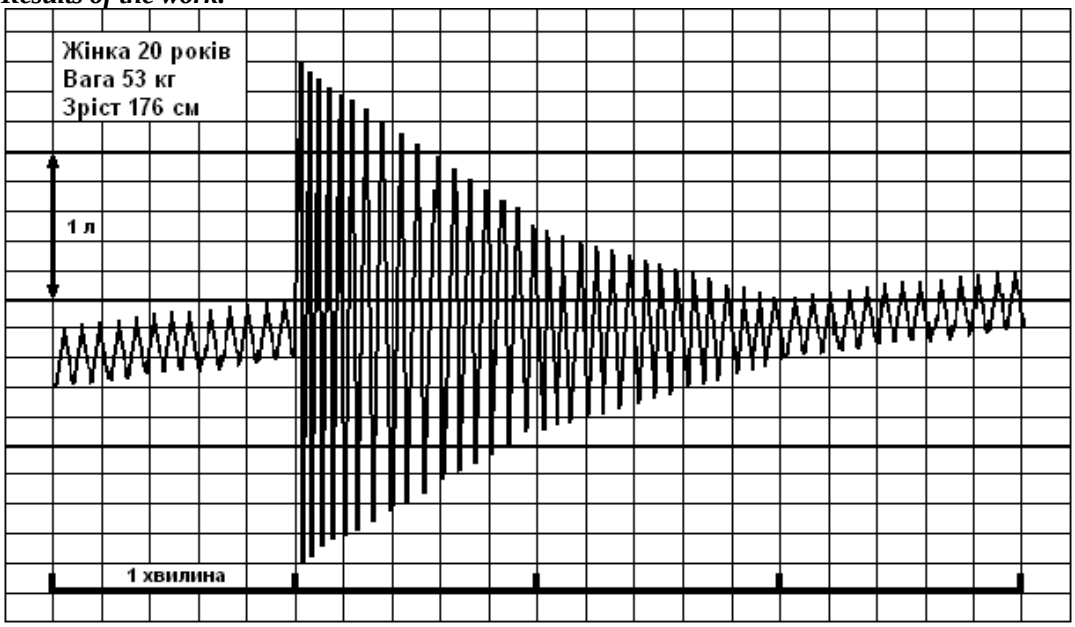
Work 2. Determination of energy wastes in the state of relative rest and during muscular work with the help of oxispirograph.

Purpose of the work : define the energy wastes in the state of relative rest and after muscle work and analyse the reasons and mechanisms of the increase of energy wastes in these conditions.

For work one needs: spirograms, written in in the state of rest and after the physical loading (the 20 squat per after 30 s).

Work fulfilment. Determine the quantity of consumped oxygen per 1 min by the spirogram (VO2) in the state of relative rest and per first minute after physical loading. RC in the state of rest is 0.82, after physical loading — 0.87. Determine CEO_2 by the value of RC and calculate energy wastes per 1 minute of the rest and per 1 minute after physical loading.

Results of the work:



Researched parameters	***In the state of rest***	***Per the first minute of restoration***
VO_2 l/min.		
RC	0.82	0.87
CEO_2 kcal/liter		
Energy wastes: kcal/min		

Conclusions: (analyse, how the energy wastes changed due to the physical loading, what it testifies about)

Work 3. Research of heat radiation from the body surface.

An organism gives 60—66 % heat to the environment by the radiation (infra-red rays). Consequently, as a rule, a body warms air. To make sure in it, it is possible to use highly sensitive devices, in particular, volt-ampermeter F-116 (or other device with the same characteristics). A sensor is a special warm-meter which consists of few thousand thermocouples and made as a coin (one side it «hot», second «cold» — depending on the side from the part which radiates warm). The more warm, for example, palm or the more close it is near the sensor, the more arrow deviates. If to put an obstacle (screen) on the way of radiation between a palm and sensor the arrow goes back to a zero.

This experiment testities about the fact that our body gives the heat by the way of radiation.

Purpose of the work: to make sure, that our body radiates heat.

For work one needs: volt-ampermeter F-116, sensor, warm-meter, screen.

Work fulfilment. Insert an electric plug into the wall outlet of the electric system, to include the device and let it warm up during 3—5 min. To set a switch in position «tension» and the desired sensitiveness. Gradually approaching hand to the sensor, to observe the arrow`s deviation. Approaching hand to the other side of the sensor, to observe the arrow`s deviation in this case. It is possible to appoach simultaneously two hands to the sensor which will be accompanied by the considerable declining of arrow.

Results of the work:

1) At approaching of hands to the sensor we observe _____

Conclusions: (mark, what arrow`s deviation testifies about at hand approaching to the sensor)

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P. 653-690.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.1, P. 279-290; 309-335.

FOR NOTES

Section 14. Excretory system

Practical study *16.*

Studying of the mechanisms of urine formation. Studying of kidney`s participation in the homeostasis support

1.Urgency of the theme:

The system of excretion provides the support of internal environment constancy of an organism by the way of excretion of metabolism`s products, and also other matters, if they are unnecessary or harmful for an organism.

Violation of excretory system`s activity and especially the kidneys as the main excretory organs causes considerable changes in an organism. The exception of kidneys functions for a short time is accompanied by accumulation of matters in blood, which contain nitrogen (such, as urea), that can entail death.

Kidneys functionate in an organism as effective homoeostatic organs. Due to regulatory mechanisms they functionate in different conditions, due to which the constancy of internal environment of an organism is supported. The knowledges and understanding of regulatory mechanisms of liquid volume in blood plasma, its osmotic pressure, the concentration of separate electrolytes, acid-base equilibrium are necessary for a doctor, because he often has to influence on these mechanisms in clinical practice with the purpose of homoeostasis normalization.

2.Educational purposes:

- *To interpret the concept of the excretory system, regulatory mechanisms of homeostasis with its participation on the basis of analysis of homoeostasis constants.*
- *To explain physiologycal bases of clearance determination for estimation of the urine formation processes in nephrons.*
- *To make conclusions about the mechanisms of urine formation in kidneys on the basis of analysis of parameters of clearance, which characterize glomerular filtration rate, secretion and reabsorbtion of substances and water in different departments of nephron.*
- *To analyse the age-old features of urine formation on the basis of the proper values, which characterize the processes of filtration, reabsorbtion, secretion..*
- *To explain the mechanisms of homoeostasis regulation with kidneys` participation on the basis of homoeostatic constants analysis: volume of circulatory blood, ions concentration, osmotic pressure, acid-base equilibrium.*
- *To analyse the state of the excretory system of a man, in particular kidneys`s function on the basis of quantitative and qualitive content of urine, its relative density in dynamics depending on the food and water regime.*
- *To analyse the regulated parameters of homoeostasis and to make conclusions about their regulatory mechanisms with kidneys` participation.*
- *To analyse the age-old features of the excretory system`s functions and their regulatory mechanisms.*

3.The task for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Primary urine	It is ultrafiltrate of blood plasma which enters nephrone`s capsule and has the same content as blood plasma except proteins which are not filtrated.
End urine	It is urine which enter the excretory ways from collecting tubules of nephrone and is the consequence of processes

	which take place in nephrone – filtration, reabsorbtion and secretion
Clearance	It is the volume of blood plasma which is being cleaned from the certain matter during blood movement through a kidney per 1 minute
Isoosmia	It is the constancy of osmotic pressure of the internal environment of an organism
Isoionia	It is the constancy of ions concentration in the internal environment of an organism
Isovolumia	It is the constancy of the volume of circulated blood
Diuretics	Diuretics increase the urine formation

3.2.*Theoretical questions*

1) The system of excretion, its functions and significance for an organism.
2) Kidneys as the main organs of the excretory system.
3) Functional morphology of nephrone and its functions. Peculiarities of renal blood flow.
4) Glomerular filtration, its mechanisms.
5) Tubular reabsorbtion, its mechanisms. Osmotic concentration and breeding of urine.
6) Sec**r**etion in tubulis, its mechanisms and role in excretion processes.
7) Methods of kidney excretory function research. Concept about clearence.
8) Kidneys` participation in the regulation of the constancy of blood osmotic pressure (isoosmia).
9) Kidneys` participation in the regulation of fluid-electrolits exchange and the constancy of ions concentration (isoionia).
10) Kidneys` participation in the regulation of the constancy of acid-base equilibrum of blood.
11) Physiological bases of the action of diuretics.

3.3.Practical works

1) Research of urine formation processes in the isolated rabbit`s kidney. (video-film).
2) Research of glomerular filtration rate (GFR).
3) Research of tubular reabsorbtion.
4) Research of tubular secretion.
5) Research of renal blood flow and blood plasma flow.
6) The research of the osmoregulatory function of the kidneys.

4.Materials for self-control

4.1.*Answer the question:*

1) Compare content of blood plasma and primary urine and make the conclusion.

2) Calculate net filtration pressure in kidneys in norm in a man.

3) After the blood loss its pressure in the capillaries of kidney glomerules diminished from 70 to 60 mm Hg. How and why will diuresis change? What meaning do these changes have?

4) What is the mechanism of diuresis increase at hyperglycaemia?

5) Estimate the following parameters of blood analises: pH=7,2; Posm=7,6 athmosphere (5700 mm Hg, or 762 kPa), Ponk=27 mm Hg.

6) How and why will diuresis and osmolarity of urine change after the surplus usage of water?

7) Explain, why usage of food rich with albumens requires the increase of liquid in the ration.

8) Explain, why it is impossible to satisfy thirst by sea water.

9) How and why will diuresis change in the case of salts reabsorbtion inhibition?

10) How and why will diuresis change in the case of insufficient aldosterone secretion?

11) In clinical practice the inhibitors of carbonhydres are used to increase diuresis. Explain the mechanism of their diuretic effect.

12) After the delete of both adrenal glands an animal perishes during a few days as a result of violation of electrolyte balance. Explain the mechanism of these violations.

4.2.*Choose the right answer:*

1. hydrostatic pressure in glomerular capillaries makes 55 mm Hg, the oncotic pressure of blood plasma – 30 mm Hg, glucose concentration in blood plasma - 15 mmol/liter, 24-hours` diuresis makes 2,5 liters. The increase of diuresis is the result of diminishing:

A. Glomerular filtration rate
B. Isoosmotic water reabsorbtion
C. Oncotic pressure of blood plasma
D. Tubular secretion
E. Net filtrational pressure

2. Clearance of inuline makes 110 ml / min at a woman with body surface 1.73 m^3. It testifies about the normal speed of:

A. Glomerular filtration (glomerular filtration rate)
B. Tubular secretion
C. Tubular reabsorbtion
D. Renal blood flow
E. Renal blood plasma flow

3. pH of arterial blood - 7,4; primary urine – 7,4; final urine– 5,8. the decrease of final urine pH is the consequence of secretion in nephrone`s tubules one of the following matters:

A. potassium
B. iodine
C. uric acid
D. hydrogen
E. creatinin

4. In the experiment it was stated that blood pressure in glomerular capillaries makes 47 mm Hg, the pressure of primary urine in Bowman`s capsule – 10 mm Hg, the oncotic pressure of primary urine – 0 mm Hg. Determine, at what value of oncotic pressure of blood plasma (in mm Hg) the glomerular filtration will stop

A. 57 .
B. 47
C. 37
D. 27
E. 10.

5. The clearance of inulin on the standart body man`s surface makes 125 ml/min. Glucose concentration in blood makes 4,5 mmol/liter, glucosuria takes place, the diuresis is increased. The most probable reason of it is violation of the functions of:

A. Glomerulars
B. Proximal tubules
C. Descending limb of the loop of Henle
D. Ascending limb of the loop of Henle
E. Distal tubules

6. Glucose reabsorbtion is carried out by the way of secondary active transport in one of the following parts of nephrone:

A. Proximal tubules
B. Descending limb of the loop of Henle
C. Ascending limb of the loop of Henle
D. Distal tubules
E. Collecting ducts

7. Into Bowman`s capcule 125 ml of blood plasma was filtrated per 1 min, 1ml of final urine was formed. Mark in what part of nephrone 2/3 part of filtrated water is reabsorbed according to the osmotic gradient:

A. Collecting ducts
B. Descending limb of the loop of Henle
C. Ascending limb of the loop of Henle
D. Proximal tubules
E. Distal tubules

8. Antibiotic penicillin was prescribed to a patient. Mark in what part of nephrone its secretion from organism will take place:

A. Proximal tubules
B. Descending limb of the loop of Henle
C. Ascending limb of the loop of Henle
D. Distal tubules
E. Collecting tubules

9. In the experiment the processes of energy formation were blocked in the epithelium of nephrone`s tubules, as a result of which diuresis increased in 4 times. The most probable reason of diuresis increases is the primary diminishing of reabsorbtion of:

A. potassium
B. sodium
C. calcium
D. glucose
E. phosphates

10. In the research of lowmolecular matter`s excretion by the kidneys it was stated that its clearance is more than the clearance of inuline. What processes in nephrone cause the excretion of this matter:

A. glomerular filtration
B. secretion in tubules
C. secretion in collecting ducts
D. secretion in the loop of Henle
E. glomerular filtration and tubular reabsorbtion

11. In the experimant on an animal its suprooptical nuclei of hypothalamus was ruined which led to day-night diuresis increase. Which of the following processes in the kidneys was the most violated as a result

of it?

A. Glomerular filtration
B. Water reabsorbtion in proximal tubules
C. Water reabsorbtion in distal tubules and collecting ducts
D. Water reabsorbtion in the loop of Henle
E. Secretion of osmoactive substances

12. Atria filling with blood was increased in the experiment. It led to the diminishing of Na^+ and water reabsorbtion in kidney`s tubules. What hormone`s increased secretion caused this result ?

A. Aldosterone
B. Vasopressin
C. natriuretic
D. renin
E. angiotensin II

13. After usage of salt food the quantity of urine decreased significantly. What hormone`s increased secretion led to diuresis decrease?

A. Aldosterone
B. natriuretic
C. angiotensin II
D. renin
E. vasopressin

14. In a man a vomiting led to dehydration of an organism. What hormone`s increased secretion provides water keeping in an organism under these condition first of all ?

A. aldosterone
B. vasopressin
C. calcotonin
D. natriuretic
E. aldosterone

15. A patient complains on stable increase of arterial pressure and oedemas. During the examination the constriction of kidney`s artery was stated. What systems`s activation caused the hypertension appearance?

A. Sympatho-adrenal
B. Hypothalamo-hypophysal
C. Renin-angiotensin`s
D. sympathetic
E. parasympathetic

16. In a men adaptated to a high temperature, the increased sweating is not accompanied by the loss of large amount of sodium chlorine with sweat due to the action of one of the following hormones:

A. aldosterone
B. cortisol
C. vasopressin
D. typoxin
E. natriuretic

17. Potassium ions concentration is increased in blood plasma which is accompanied with the increase of this ion in distal parts of nephrone. This also will lead to the diminishing one of the following ions secretion in the same part of nephrone

A. ammonia
B. calcium ions
C. magnesium ions
D. sodium ions
E. hydrogen ions

18. In a man the osmotic concentration of blood plasma is 350 mosmol/liter. It causes first of all the increased secretion one of the following hormones:

A. vasopressin
B. aldosterone
C. cortisol
D. adrenalin
E. calcitonin

19. In a man as a result of loss of 1,5 liters of blood the diuresis sharply diminished. What hoemone`s increased secretion caused such changes in diuresis first of all?

A. parathormone
B. cortisol
C. vasopressin
D. oxitocin
E. natriuretic

20. To escape high mountain desease (respiratory alcalosis) a man was injected with acetazolamid which blocks enzyme carbonhydrase in epithelium of proximal tubules of nephrone, after this diuresis increases, which is the consequence of:

A. diminishing of Na+ reabsorbtion
B. the increase of K^+ secretion
C. the increase of NH_3 secretion
D. diminishing of HCO_3^- reabsorbtion
E. diminishing of H_2PO_4 reabsorbtion

Protocol of practical study № 16. "___"_____20___

Work 1. Research of urine formation processes in the isolated rabbit`s kidney.

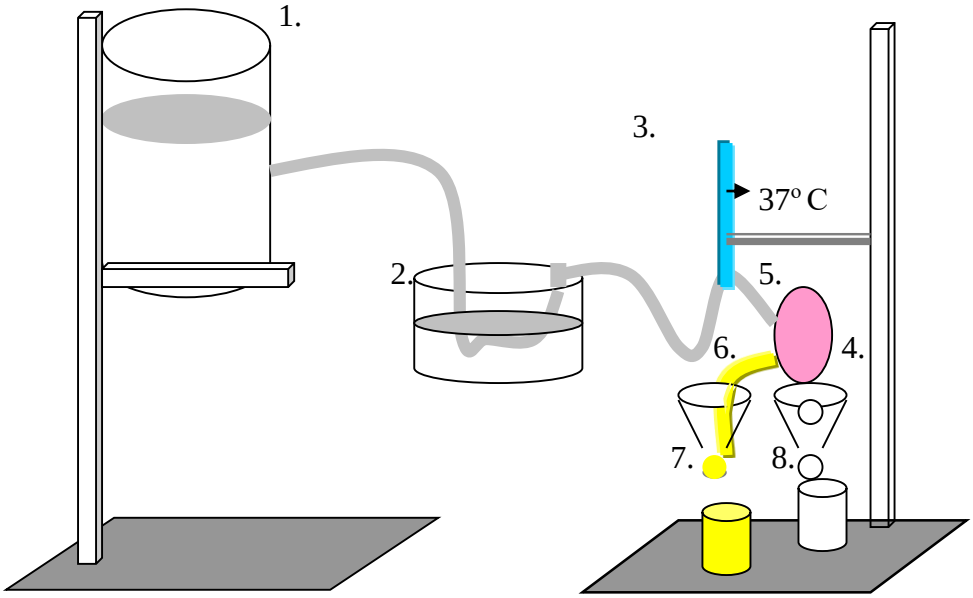
Purpose of the work: to state and analyse the mechanisms of the following factors having influence on the speed of urine formation:

a) the value of hydrostatical pressure in the kidney artery; b) the value of oncotic pressure in the perfusate; c) the increase of glucose concentration in the perfusate; d) the injection of adrenalin solution into the kidney artery.

To fulfil the work one needs: a set of surgical instruments, system for isolated kidney perfusion, Ringer-Lok solution, polyglukin or dry plasma, 40 % glucose solution, adrenalin hydrochloride, syringes, an experimental animal (rabbit).

Fulfilment of the work: An animal is under narcosis. One cuts quickly animal`s abdominal region and separates the kidney artery, kidney veins and ureter on considerable distance. After that one cuts out the kidney together with the separated vessels and ureter and put them into Ringer-Lok solution, where they are washed from blood. A canula is entered into the kidney artery. Through the system of tubes the canula is connected with the pressure vessel and one begins the perfusion of the isolated kidney with Ringen-Lok solution. Solution must be warmed up to the temperature of 37° C and be saturated by oxygen. The ureter is laid to the edge of watering-can, where the formed urine enters. To determine the speed of urine formation it is necessary to count up the quantity of urine drops, which appear per minute. The kidney is held above the second watering-can, where solution, that follows from venous vessels, enters, and in the same way the amount of drops of solution per minute is counted up.

The set for isolated kidney perfusion is shown in the scheme 1.



Pic. 1. The scheme of set for isolated kidney perfusion.

1— the pressure vessel; 2 — the vessel for warming up the solution; 3—termometer; 4—the isolated kidney; *5* — the kidney artery; 6—the ureter; 7 — the urine which comes from the ureter, *8.*— the solution, that comes out from the kidney.

After initial indexes determination (the amount of urine drops from ureter and Ringer-Lok solution from the venous vessels of the kidney per minute) the following factors influencing on them are researched:

a) the value of liquid pressure in the kidney artery (the perfusion pressure is multiplied or diminished by changing the level of location of pressure vessel in relation to the level of kidney location);

b) the value of oncotic pressure in perfusate (oncotic pressure is multiplied by injection of 2-3 ml polyglucine solution into perfunic solution near-by the canula with a syringe);

c) the increase of glucose concentration in the perfusate (2-3 ml of 40% glucose solution is injected into the perfusate near-by the canula);

d) injection of adrenalin hydrochloride into the kidney artery (0,5- 1 ml solution of adrenalin hydrochloride in concentration 1:1000 is injected into the perfusate near-by the canula)

It is necessary to determine the amount of drops of remaining urine and the amount of drops of solution, that comes out from venous vessels in each of the researches.

Results of the work.

Stages of research	**The quantity of drops per minute**	
	Final urine	**Perfusate, that comes out from the kidney viens**
1.The research of influenceof hydrostatic pressure value in the kidney artery: • -initial indexes • -after the increase of the perfusate pressure (Ph) in the kidney artery		
2 The research of influence of oncotic pressure value in the perfusate : • -initial indexes • -after the injection of 2-3 ml of polyclukine solution (into perfusate), which increases the oncotic pressure in the perfusate		
3.The research of influence of glucose concentration increase in perfusate: • -initial indexes • -after injection of 2-3 ml of 40% glucose solution into perfusate;		
4.The research of influence of adrenalin solution injection into perfusate: • -initial indexes • -after injection of adrenalin hydrochloride solution into perfusate in concentration 1: 1000		

Conclusions: (to note the reasons and to analyse the mechanisms of the change of final urine amount.)

1)

2)

3)

4)

Work 2. Research of glomerular filtration rate (GFR).

GFR is determined on the base of filtrate`s volume, which comes to the initial part of nephrons of both kidneys per 1 minute. The method is based on clearance determination.

The clearance is the speed of plasma cleaning from this matter per 1 minute during its passing through the kidneys.

For GFR determination the untoxic matters are used, which are not connected with blood plasma proteins and which freely pass through the membrane pores by the way of filtration and are neither reabsorbated no secreteted. Such matters are inuline, endogenous kreatinine and others.

GFR is measured in ml per minute on the 1,73 m^2 surface of the body, and in number it corresponds to the clearance of the matter from which plasma is cleared up only by filtration. Consequently, it is possible to apply such formula:

$$Cin = \frac{Uin}{Pin} \cdot V$$

where Cin is clearance of inuline, or GFR; Pin is inuline`s concentration in blood plasma; Uin is inuline`s concentration in urine; V is amount of urine (ml/min).

The average value of GFR for men makes 125 ml/min; for women-110 ml/min. It diminishes with the age and is counted by the formula:

Cin = 163,2 - 0,96 **.** age (in years).

Purpose of the work: to define and to estimate glomerular filtration rate.

To fulfil the work one needs: nomogramm or the table for the determination of the square of a body surface.

Fulfilment of the work: to calculate GFR on the base of the results of determination of inuline concentration or endogenous kreatinine in blood and urine and urine amount.

Task 1. Calculate GFR for a man of 35 years old (hight 175 sm, weight 72 kg), if after inuline injection its concentration in blood plasma makes 0,04 mmol/l, in urine - 0,85 mmol/l. The minute diuresis makes 5 ml/min.

Task 2. Calculate GFR for a man of 40 years old (hight 178 sm, weight 75 kg), if after inuline injection its concentration in blood plasma makes 0,044 mmol/l, in urine - 0,72 mmol/l. The minute diuresis makes 4 ml/min.

Task 3. Calculate GFR for a woman of 34 years old (hight 160 sm, weight 54 kg), if after inuline injection its concentration in blood plasma makes 0,05 mmol/l, in urine - 0,76 mmol/l. The minute diuresis makes 3,3 ml/min.

Task 4. Calculate GFR for a man of 38 years old (hight 180 sm, weight 78 kg), if after endogenous kreatinine injection its concentration in blood plasma makes 0,21 mmol/l, in urine - 12,6 mmol/l. The minute diuresis makes 1 ml/min.

Results:

Conclusions: (give estimation to the indexe and define, what it testifies about).

Work 3. Research of tubular reabsorbtion.

Tubular reabsorbtion value is determined by the way of determination the difference between their quantity in primary and eventual urine.

The water tubular value reabsorbtion (R H_2O) is determined by the way of determination of difference between glomerular filtration rate (Cin) and the quantity of eventual urine and is expressed in percents in relation to GFR:

$$\mathbf{R\ H_2O = \frac{Cin - V}{Cin} 100\ \%,}$$

The value of reabsorbtion is 98-99 % in ordinary conditions. To estimate the function of proximal tubules one determines the value of maximum glucose reabsorbtion (Tmg) increasing its concentration in blood plasma till the level that considerably exceeds the threshold.

$$\mathbf{Tmg = Cin \bullet Pg - Ug \bullet V,}$$

where Cin is GFR; Pg is glucose concentration in blood plasma; Ug is glucose concentration in urine; V is the amount of urine which was excreted per 1 minute.(minute diuresis). The average value of Tmg for men makes 34,7 mmol/l on 1,73 m^2 of body surface. At the age over 40 years old the Tmg is diminished on 7% every 10 years of life.

The purpose of the work: to define and to estimate the indexes of tubular reabsorbtion.

To fulfil the work one needs: nomogramm or the table for the determination of the square of a body surface.

Fulfilment of the work:

Task 1. Define R H_2O for a man of 30 years old (hight 170 sm, weight 65 kg), if the concentration of endogenous kreatinine in blood plasma makes 0,21 mmol/l, in urine - 10,7 mmol/l. The minute diuresis makes 1 ml/min.

Task 2. Define the index of maximum glucose reabsorbtion for a woman of 40 years old (hight 165 sm, weight 65 kg), if the GFR makes 100ml/min, glucose concentration in blood plasma makes 22,2 mmol/l, in urine - 111 mmol/l. The minute diuresis makes 5 ml/min.

Task 3. Calculate the maximum glucose reabsorbtion for a man of 40 years old (hight 178 sm, weight 80 kg), if his GFR makes 15ml/min, glucose concentration in blood plasma makes 19,4 mmol/l, in urine - 94,4 mmol/l. The minute diuresis makes 5,5 ml/min.

Result of the work:

Conclusions: give estimation to the index and define, what it testifies about.

Work 4. Research of tubular secretion.

The value of maximum tubular secretion is determined by the way of determination of the difference between the quantity of matter in primary and eventual urine.

$$\mathbf{Tm = V \,.\, U — C \bullet P \,.\, \mathit{a},}$$

where Tm is the index of maximum tubular secretion of matter; P is its concentration in blood plasma; U is its concentration in urine; C is glomerular filtration rate; V- the amount of urine; the part of the matter, which is contained in plasma and is not connected with plasma proteins.

To estimate functional ability of proximal tubules to secrete the matters by the way of secretion one determines the secretion of paraaminohypuric acid (PAH), either diotrast or preparations of penicilinic group and others.

The maximum secretion of PAH (Tm PAH) is determined under the condition of the increase of its concentration in blood plasma at which the maximum secretion in the proximal tubules takes place.

$$\mathbf{Tm\ PAH = Upah \bullet V - Cin \bullet Ppah \bullet \mathit{a}}$$

where a - 0,8.

The average maximum tubular secretion of PAH is 6,78±1,37 (mmol/min), or 79,9± 6,7 ml/min on 1,73 m^2 of body surface.

The purpose of the work: to define the value of maximum tubular secretion of the matter and to estimate it.

To fulfil the work one needs: nomogramm or the table for the determination of the square of a body surface.

area of body surface determination.

Fulfilment of the work:

Task 1. Define the value of maximum tubular secretion of PAH for a woman of 48 years old (hight 167 sm, weight 65 kg), if it is known that PAH concentration in blood plasma makes 2,06 mmol/l, in urine - 115 mmol/l. The minute diuresis makes 4 ml/min, the value of glomerular filtration rate makes 100 ml/min.

Task 2. After injection of diotrast its concentration in blood plasma makes 15,8 mmol/l, in urine - 392,4 mmol/l, iodine concentration in plasma does not depend on the level of albumens - 0,73. Calculate the maximum iodine secretion for a man, whose area of body surface makes 1,73 m^2, the value of glomerular filtration rate makes 120 ml/min, the amount of urine makes 3 ml/min.

Results of the work:

Conclusions: give estimation to the index and define, what it testifies about.

Work 5. Research of renal blood flow and blood plasma flow.

Clinical methods of determination of renal blood flow and blood plasma flow are based on the PAH clearance determination, because of the low concentration of this matter blood plasma is practically fully cleaned from it during one passing through the kidney.

$$C_{PAH} = \frac{U_{PAH}}{P_{PAH}} \cdot V$$

The average speed of renal blood plasma flow makes 720 ml/min for men, for women it makes 660 ml/min on 1,73 m^2 of body surface.

The speed of effective renal blood plasma flow depending on the age of a patient is calculated by the formula:

840,0-6,44 **.** age (in years).

The purpose of the work: define renal blood flow and renal blood plasma flow.

Fulfilment of the work:

Task 1. Define the speed of effective renal blood flow and renal blood plasma flow for a man of 42 years old (hight 175 sm, weight 78 kg), if PAH concentration in blood plasma makes 0,115 mmol/l, in urine - 120,09 mmol/l. the amount of urine makes 3,5 ml/min, the hematocrit is 50%.

Task 2. Define the speed of effective renal blood flow for a woman of 50 years old (hight 165 sm, weight 70 kg), if PAH concentration in blood plasma makes 0,103 mmol/l, in urine - 18,82 mmol/l, the amount of urine makes 3 ml/min.

Results of the work:

Conclusions: give estimation to the index and define, what it testifies about.

Work 1. The research of osmoregulatory function of kidneys.

Purpose of the work: to estimate the kidneys` capacity for urine concentration and dilution in the conditions of ordinary food and also in the case of surplus and limited water receipt into an organism. To make conclusions about the regulatory mechanisms of kidneys activity to support homeostasis.

To fulfil the work one needs: results of urine research by Zymnizky and Folgard.

Fulfilment of the work:

Using results of urine quantity and relative density in tests by Zymnizky and Folgard one analizes how the urine quantity and its relative density in collected porsions depend on surplus or limited water receiption into an organism.

The test by Zymnizky: is carried out in the conditions of ordinary food. The patient`s urine is collected by separate portions every 3 hour during day and night. In every of 8 portions one determines the amount of urine and its relative density or osmolarity. In a norm a day-night diuresis is 65-75 % of used liquid amounts, it is 1.5-1.8 liters. 2/3 of all day-night urine is excreted during a day (from 6.00 to 18.00) and its relative density and amount considerably differ in separate portions, the relative density is changed from 1.012 to 1.025 during day-night. In night porsions the quantity of urine is less, the relative density is more.

Folgard test on dilution. In the morning on empty stomach a patient is given 1500 ml warm water during 30 mitunes and every 30 minutes 7 portions of urine are collected. One determines its amount and relative density in every portion. In a norm 1500 ml water is excreted with urine for 4 hours, the maximum of excretion is in the 2 - 3 hour. Thus the relative density of urine goes down to 1.001-1.003.

Folgard test on concentration. A patient gets dry food rich with albumens. One collects 5 portions of urine every 2 hour. One determines the amount and relative density of it. In a norm the amount of urine in a portion diminishes to 40- 60 ml, 250-350 ml of urine is excreted for the period of research. The relative density in its separate portions achieves 1.028-1.035.

Results of the work:

(write down the results of Zymnizky and Folgard tests, determine the quantity of urine which was being excreted during the research, the borders of deviations of relative density and quantity in day and night portions, compare it with the norm in these conditions).

1. A. Results of urine research by Zimnitsky

№ of urine portion	***Time of collection of urine***	***Urine amount in ml***	***Relative density of urine***
1	6.00-9.00 o`clock	270,0	1,012
2	9.00-12.00 o`clock	220,0	1,014
3	12.00-15.00 o`clock	210,0	1,016
4	15.00-18.00 o`clock	200,0	1,013
5	18.00-21.00 o`clock	180,0	1,017
6	21.00-24.00 o`clock	120,0	1,025
7	24.00-3.00 o`clock	80,0	1,024
8	3.00-6.00 o`clock	120,0	1,020
	Day-night diuresis		
	Day diuresis		
	Night diuresis		

Conclusions: analyse the researched results, to estimate the kidneys` capacity for urine concentration and dilution in the conditions of ordinary food.; on their base eastimate kidneys` function and mechanisms of homeostasis regulation with the kidneys participation (during day and night)

1. B. Results of urine research by Zimnitsky

№ of urine portion	***Time of collection of urine***	***Urine amount in ml***	***Relative density of urine***
1	6.00-9.00 o`clock	350,0	1,010
2	9.00-12.00 o`clock	400,0	1,010
3	12.00-15.00 o`clock	330,0	1,012
4	15.00-18.00 o`clock	370,0	1,011
5	18.00-21.00 o`clock	380,0	1,012
6	21.00-24.00 o`clock	390,0	1,011
7	24.00-3.00 o`clock	380,0	1,011
8	3.00-6.00 o`clock	380,0	1,011
	Day-night diuresis		
	Day diuresis		
	Night diuresis		

Conclusions: analyse the researched results, to estimate the kidneys` capacity for urine concentration and dilution in the conditions of ordinary food.; on their base eastimate kidneys` function and mechanisms of homeostasis regulation with the kidneys participation (during day and night)

2. Results of urine research by Folgardt (on dilution)

№ of urine portion	***Time of collection of urine***	***Urine amount in ml***	***Relative density of urine***
1	7.30-8.00 o`clock	200,0	1,003
2	8.00-8.30 o`clock	300,0	1,002
3	8.30-9.00 o`clock	300,0	1,001
4	9.00-9.30o`clock	200,0	1,005
5	9.30-10.00 o`clock	180,0	1,009
6	10.00-10.30 o`clock	150,0	1,016
7	10.30-11.00 o`clock	190,0	1,015
	The general amount of excreted urine		

Conclusions: analyse the researched results, on their base eastimate kidneys` function and mechanisms of homeostasis regulation with the kidneys participation under the conditions of surplus water receiption into an organism, draw the scheme of regulatory contur of isoosmia regulation in these conditions.

3. Results of urine research by Folgardt (on concentration)

№ of urine portion	*Time of collection of urine*	*Urine amount in ml*	*Relative density of urine*
1	12.00 o`clock	120,0	1,016
2	14.00 o`clock	80,0	1,022
3	16.00 o`clock	40,0	1,029
4	18.00 o`clock	60,0	1,030
5	20.00 o`clock	50,0	1,035
	The general amount of excreted urine		

Conclusions: analyse the researched results, on their base eastimate kidneys` function and mechanisms of homeostasis regulation with the kidneys participation under the conditions of limited water receiption into an organism, draw the scheme of regulatory contur of isoosmia regulation in these conditions.

The table for the determination of the square of a body surface under the hight (in sm) and body mass (in kg) (DuBois`s tables)

Body mass (kg) / *hight (sm)*	**50**	**55**	**60**	**65**	**70**	**75**	**80**
190	*1,70*	*1,77*	*1,84*	*1,90*	*1,96*	*2,02*	*2,08*
185	*1,67*	*1,74*	*1,80*	*1,86*	*1,92*	*1,98*	*2,04*
180	*1,64*	*1,71*	*1,77*	*1,83*	*1,89*	*1,95*	*2,00*
175	*1,61*	*1,67*	*1,73*	*1,79*	*1,85*	*1,91*	*1,96*
170	*1,57*	*1,63*	*1,69*	*1,76*	*1,81*	*1,86*	*1,91*
165	*1,54*	*1,60*	*1,66*	*1,72*	*1,78*	*1,83*	*1,88*
160	*1,50*	*1,56*	*1,62*	*1,68*	*1,73*	*1,78*	*1,83*
155	*1,46*	*1,52*	*1,58*	*1,64*	*1,69*	*1,74*	*1,79*
150	*1,42*	*1,48*	*1,54*	*1,60*	*1,65*	*1,70*	*1,75*

Protocol revised_____

(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.690-750.

Additional

1. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2016. – 750 p.
2. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.2, P.335-349.

FOR NOTES

Section 15. Higher integrative functions of the nervous system.

Practical study 17.

Physiological base of behavior. Research of the role of motivations and emotions in behavior reactions. The research of conditional reflexes formation and inhibition. The state of jaw-face part and behavior of a person

1.Theme urgency:

This theme oulines the mechanisms of co-operation of organism as single unit with the external environment and dedicated to the physiological mechanisms of the acquired behaviour and memory. Such mechanisms belong to the higher|excelsior| integrative functions of the nervous system. Within these functions first of all the work of brain is studied, becouse it is the background of|footwall| of the certain|definite| perception of reality and different|diverse| forms|shape| and aspects of behavior|conduct| are. The basis of biological behavior|conduct| is motivational excitation|excilation| (the certain integrative state|figure| of the brain|definite|) in which the internal|inlying| needs of the organism are interpreted|what|. Information about satisfaction/of dissatisfaction|displeasure| of urgent problem during realization of certain|definite| behavioral act pass to|by| the respective brain centers|heartland| via feedback channel. Concrete matters of processes|Carbro| in CNS from the beginning and to the end of behavioral act determines the certain|definite| form|shape| of behavior|conduct| (in particular, localization of the excited motivational centers|heartland| of brain, heredity/ acquisition of the behavioral program|programme| which will be realized, degree of involvement of the limbic structures and monoaminergic systems of brain, which|what| are responsible for the emotional component|reductant| of behavior|conduct|, and others like that). Mastering of general|common| regularities and specification of mechanisms of the nervous providing|ADM| of behavior|conduct| has an indisputable value|meaning| for professional activity of doctor|physician| of any|some| profile. The most significant basis of behaviour|conduct| which is formed in the process of the personal|private| experience|tentative| of the individual, obtained during|for| life, there are pavlovian (conditioned) reflexes. Thus, the leading mechanisms of such behaviour|conduct| are|appear| the mechanisms of formation and inhibition of conditioned reflexes, which|what| are descirbed in the topic|object-matter|. Neurogenic background of conditioned reflex is|appear| temporal connection between sensory centers|heartland|, which|what| perceive an indifferent irritant that acquired an signal value|meaning|, and the central|center| neuronal|neurocyte| representation of certain|definite| unconditioned reflex. This temporal connection is a kind of psychical memory, and, as well as other its types can be of brief or protracted|prolonged| character|nature|. It allows|settles| to correlate the mechanisms of conditioned reflex formation with the general|common| mechanisms of memory. Concrete content of the processes|Carbro|, which take place at forming of the acquired conditionally-reflex|reflectory| behaviour|conduct| and at the input|payment|, storing|economy|, reconstruction and forgetting of information, determines the degree of complication of behaviour|conduct| and kind of memory. Mastering of this information has an important value|meaning| for forming of inergrative principle of treatment|treating| in the professional activity of doctor|physician| of any|some| profile, for the realized observance of professional ethics

2.Educational purposes:

- *To know: basic types of a inharitant behavior; basic forms of the acquired behaviour and physiological bases of attention.*
- *To acquire the abilities: to explain the mechanisms of origin of biological needs and motivations, specify their meaning and role in forming of different inharitant and aquired forms of behavior, directed to the maintenance of homoeostasis; to analyse the structure of integral behavioral act as the determined functional system and to explain the value of feed-*

back in termination of behavioral act (in tasks and creative situations); to explain the role of emotions in perception of reality and behavioral reactions on the basis of classic physiology conceptions of emotions (Anokhin P.K., Symonov P.V.); to analyse the different aspects of mechanisms of formation of emotions and emotional behavior (in tasks and creative situations); to analyse the types of conditioned reflexes and their inhibition and explain their role in forming of the acquired forms of behaviour; to explain conditions and mechanisms of generation, maintenance and suppresion of conditioned reflexes (in the tasks and creativ situations); to interpret the mechanisms of formation of temporal connection as the morpho-functional basis of conditionally-reflex activity in accordance with modern conceptions of psychical memory; to analyse the neurodynamic, cellular and molecular mechanisms of memory (in the tasks and creativ situations).

- *To familiarize with the method of the evoked potentials registration in the brain cortex in response to the sensory irritants and to aquire skills of determination of general functional state in accordance with the type of EEG-rhythm which is registered for a man; detremination of biorhythms role in forming of the different functional states; of making of conditioned reflex, determination of its kind and forming mechanism in accordance with the terms of experimental research; research of the memory parameters, determination of kind and mechanisms of memory which was investigated.*

3.Approximate pattern for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Higher nervous activity (HNA)	It is activity of brain cortex and nearest subcortex, which provides organism interactions with an external environment for achievement of adaptive reaction of organism (on determination of pavlov P.I.)
Behavior	It the purposeful organism interaction with an external environment for providing of the adaptive reaction which must satisfy the certain internal needs
Internal biological needs	It is the state of the organism, which is characterized by a lack or excess of something in the organism, which is manifested as a deviation of homoeostatic parameters that can be renewed only due to organism interaction with the external environment
Motivations	It is aspiring, motive to the actions of organism, that is sent to the search of the signs in external environment, which are necessary for satisfaction of internal need of the organism
Afferent synthesis	It is the first stage of behavioral reaction after Anokhin P.K., which includes analysis and processing of afferent signals about the presence of dominant motivation, afferent signaling about the state of external environment and starting stimuli on the basis of memory
Acceptor of the result of action	It is the neuron cluster that keeps information about the parameters of the final results of behavior - satisfactions of internal needs and compares them via reafference with those parameters, that were obtained at the certain results of the organism actions.
Instincts	It is the inherent complicated forms of biological behavior, which are realized according to the fixed, determined by a specific genotype programs that have chain character

Emotions	It is the state of organism, which can accompany perception of reality and behavior, and for which the typical are: 1) bright subjective experiencing which reflect individual attitude toward a certain situation, including the behavioral reaction /of perception of reality and behavior is modulated by subjective, brightly presented at sensory level attitude toward this reality/ 2) changes of the visceral systems of organism, that are biologically sent to satisfaction of internal needs of organism 3) external displays as motive reactions (characteristic posture, mimicry, gesticulation, step and others like that), which also assist in satisfaction of internal needs of organism.
Monoaminergic brain syster	The groups of neurons which begin in the brain stem, set contacts by monoamines transmitters, that include norepinephrine, epinephrine, dopamine and serotonin, innervate practically all brain departments and substantially determine emotional perception of reality, motive and biorhythmic activity of the organism (in particular, noradrenergic (adrenergic) systems acts as the centers of pleasure, positive emotions, wakefullness and stimulation of sexual behavior, the dopaminergic system is the initiator of motive activity and also applies on the role of centers of wakefullness; with the serotoninergic system are connected the inhibition of general activity, sexual activity and change of the state of wakefulness to the sleep, and also prevention of depression)
Unassociated behaviour	It stimulus-dependent behaviour forming of which takes place mostly on the early stages of life and it is unconnected with the result of behavioural actions is acquired; to the this type of behaviour belong habitouation, immitation, sumational reflex, imprinting
Associated behaviour	Is the acquired behaviour, forming of which is determined by the results of contact with reality which gives associative effect-dependent character (is arised in the older age) to it; the type of such behaviour comprises associations - effect-dependent conditioned reflexes.
Conditioned reflexes	Are the individual acquired systemic adaptive reactions, which arise on the basis of temporal connection formation (mainly in a cortex) between the sensory centers of conditional (alarm) irritant and cortical neuron representatition of unconditioned reflex which brings to forming of conditionally-reflex adaptive reaction of individual.
Dynamic stereotype	Chain conditionally-reflex reaction, which is caused under effect of any signal (conditioned irritant) from the complex of signals which operated together during certain period time , through small time intervals in a certain sequence and with a certain unconditioned reinforcement of each of them. At forming of dynamic stereotype each of such signals acquires the ability to start all chain of reflex reactions from the beginning to the end, instead of that reflex for which this signal is responsible actually.
Memory	It is ability of structures to perceive information, keep it and recall; important determinant of "memory" concept is

	maintenance of information about the irritant after stopping of its action.
Attention	It concentrating of consciousness on the real (external) or ideal (internal) object, or on content of activity at a simultaneous distraction from other objects.

3.2.*Theoretical questions*

1) The term "behavior" and "higher nervous activity".
2) Biological needs and motivations : physiology mechanisms of origin, classification, physiology role.
3) Functional model of behavioral act after conception of Anokhin P.K.. A value of feed-back in realization of the "quantum" of behavior. The idea about a successive and hierarchical quantum.
4) Types of behavior. Innate behavior: varieties and physiology mechanisms.
5) Emotional behavior as variety of the innate one. Theories of origin and physiology mechanisms of emotions. Role of the limbic system in forming of emotional manifestations: visceral and somatic components of emotions. Functions of emotions.
6) Biorhythmical bases of behavior.
7) Conditioned reflex as leading mechanism of the acquired behaviour|conduct|. Types of conditioned reflexes and rule of their making. The concept of dynamic stereotype and other forms|shape| of the acquired behaviour|conduct|.
8) Suppression of conditioned reflexes: types|sort|, physiology role
9) Modern conceptions about the mechanism of temporal connection formation as morpho-functional| basis|founding| of conditioned reflex and variety of memory.
10) Physiological mechanisms of memory. Types of memory and its damage.
11) Physiological bases|founding| of attention|attn.|.

3.3.*Practical works*

1) Electroencephalograms analysis.
2) Investigation of the emotional tension influence on the indexes|metric| of the cardiovascular system.
3) Research|work-up| of of conditioned reflexes formation in nimals(video film).
4) Research|work-up| of of protective conditioned wink [opticofacial] reflex formation in man
5) Research|work-up| of memory

4.Materials for individual work and self-control

4.1. *Answer the question*

1) Describe the behavior of domestic animal, which was without a meal for a long time. *(Explain, at what conditions the deveation of homoeostatic parameters is determined as internal biological needs.Specify, due to which internal resources the maintenance of homoeostatic parameters was performed in these circumstances. Draw a picture that explains the mechanism of origin of motivational excitation and behavior.Specify, where motivational centers are located in these circumstances and what factors cause their mobilization. Name the general properties of all types of motivation and define main differences between them. Give description to that behavior which must take place in these circumstances (aquired or innate, type of reflex/of instinct).*

2) On the basis of the structure of integral behavioral act (after Anokhin P.K.) compare the behavior of two students, one of whom when the bell was ringing , remained in a line in the buffet, and the other student who leaved the buffet run to the class. *(Draw a chart which explains the structure of integral behavioral act. Analyse the stages of afferent synthesis and decision-making for students, define the differences).*

3) Characterise the emotional state of the predator which carries out a fury attack on a victim. *(Define localization of the centers of the noted behaviorSpecify the somatic and autonomic displays of such emotional stateMark, what brain transmitters play a leading role in such behaviorTo name the functions of emotions in this case).*

4) Describe the physiology mechanisms and displays in the man who sees the dreams. *(Detremine the type of sleep which is developed. Define, what centers of brain are activated in these circumstances and what is the state of brain neurons activity. Give the description of its evident and EGG manifestationTo define the stage of sleep, in which a man can see dreams).*

5) How to aquire useful habits and get rid from the harmful ones for domestic animals, for example, for a dog? *(To explain from the physiological point of view the mechanisms. What type of the acquired behaviour should be producedTo give the concrete example of algorithm of making of such behaviour, using physiological terminology. To explain, what stages such studies must pass throughTo define morphofunctional basis of the developed behaviour).*

6) Conditioned reflex had been formed in a dog, but it wasn`t tested during some monthes. What reaction will be to the conditional irritant? (Determine the reaction and base your meaning using the conception about temporaly links. Determine the types and sense of conditional reflexes inhibition. Explain, why such a reaction can`t be caused by extinction of conditional reflex).

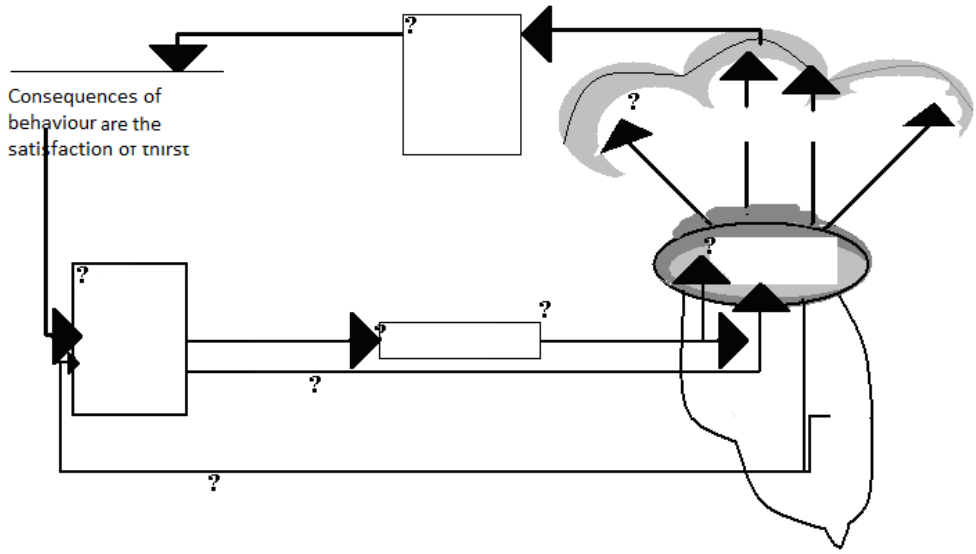
7) For a dog a sound of the metronome of 60/min is applied as a conditional irritant, that was reinforced by meal, in opposite sound of the metronome 120/min was not reinforced by feeding. What must be the consequences? *(To draw the chart of reflex arc of conditioned reflex which will arise in response to conditional stimulus, which was supported by a meal. To explain a reaction on a conditional irritant, which was not supported by a meal, using physiological terminology).*

8) The pupil repeated the homework after the teacher, and in a few minutes forgot it because his attention was atracted by air serpent through the window. Why did not a student remember a task? (*To define the type of memory which wre activated in the pupil, when he repeated a taskTo explain the mechanisms of maintenance of information and forgetting at such type of memory)*.

4.2.*Solve the tasks individually*

1. Choose the suitable sequence of the processes which takes place in an experimental animal with the destroyed hypothalamo-cortical connections and which hasn`t been fed for a long time.
   1) the integrative state of brain isn`t formed. This integrative state is motivational excitation and it appears in such a case at the presence of internal biological homeostatic need and it provides the interaction between an organism and envirounment.
   2) the glucose concentration, amino-acids and lipids concentrations in blood decreases.
   3) the behavior reaction to restore the stable concentrations of glucose, amino-acids and lipids doesn`t take place.
   4) such a type of behavior belongs to natural drive-reflex which is a part of vital food instinct
   5) The lack of internal resours to restore homeostasis provokes the afferent signalozation to activate stem and diencephalic structures with mobilization of ventrolateral hypothalamic nuclei.
   6) Glycogenolis and glyconeogenesis are inforced due to the increased production of glucagon and other hormones capable for the same effects (adrenaline, glucocorticoids, somatotropine and others)
   7) The excitation of the centre of hanger isn`t distributed to the corresponding areas of the cortex of large hemispheres.

2. Mark all elements in the following chart and concretize them in accordance with the consequences of behavior act. Name the mechanism shown in this chart.



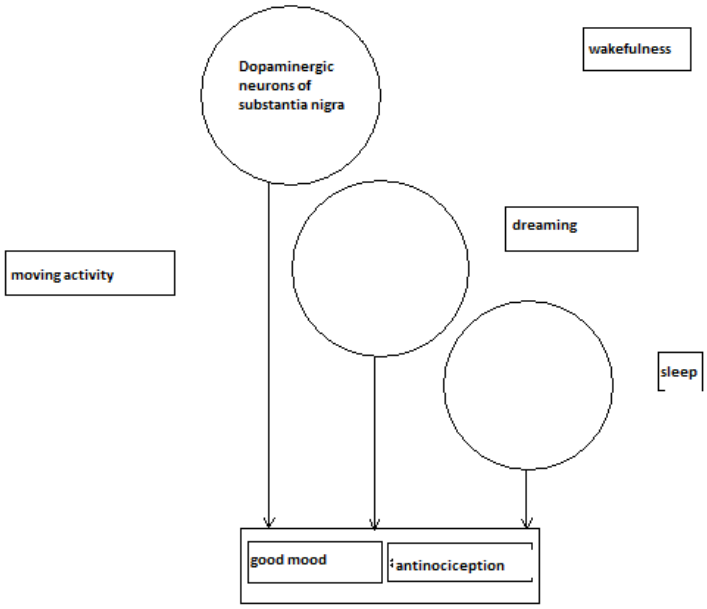
3. Choose the structure or structures (column B) for the displays represented in the column A. The damage of the structures (B) causes the appropriate display (A).

A 1.anxiety and trustfull submission an animal which was wild and aggressive in the past animal
2.refusal of food in unfed animal
3.insomnia
4.permanent search of food (hyperphagia)
5 dissapearance of paradoxal stage of sleep
6.food blindless, hyperactivity
7.perment sleep
8.oppression of sexual behavior
9.depression
10. complications in arbitrary movements realization

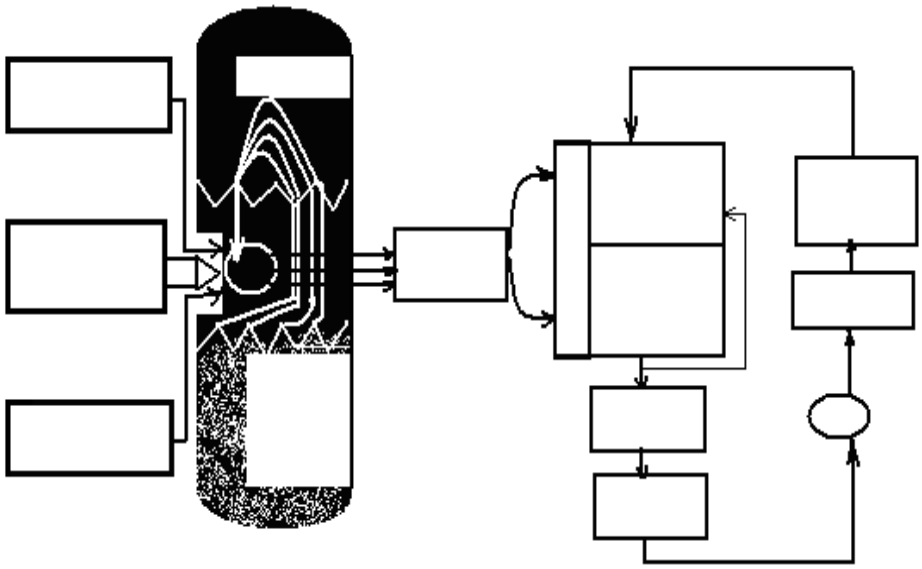
B 1.ventromedial nucleus of hypothalamus
2. blue spot of pons
3. substansia nigra of midbrain
4.reticular formation of brain stem
5.nuclei Raphe of medulla oblongata
6.ventomedial nucleus of hypothalamus
7.amygdala

8.precentral gyrus of the cortex of large hemispheres
9.premotor cortex
10. basal parts of forebrain (preoptic area)

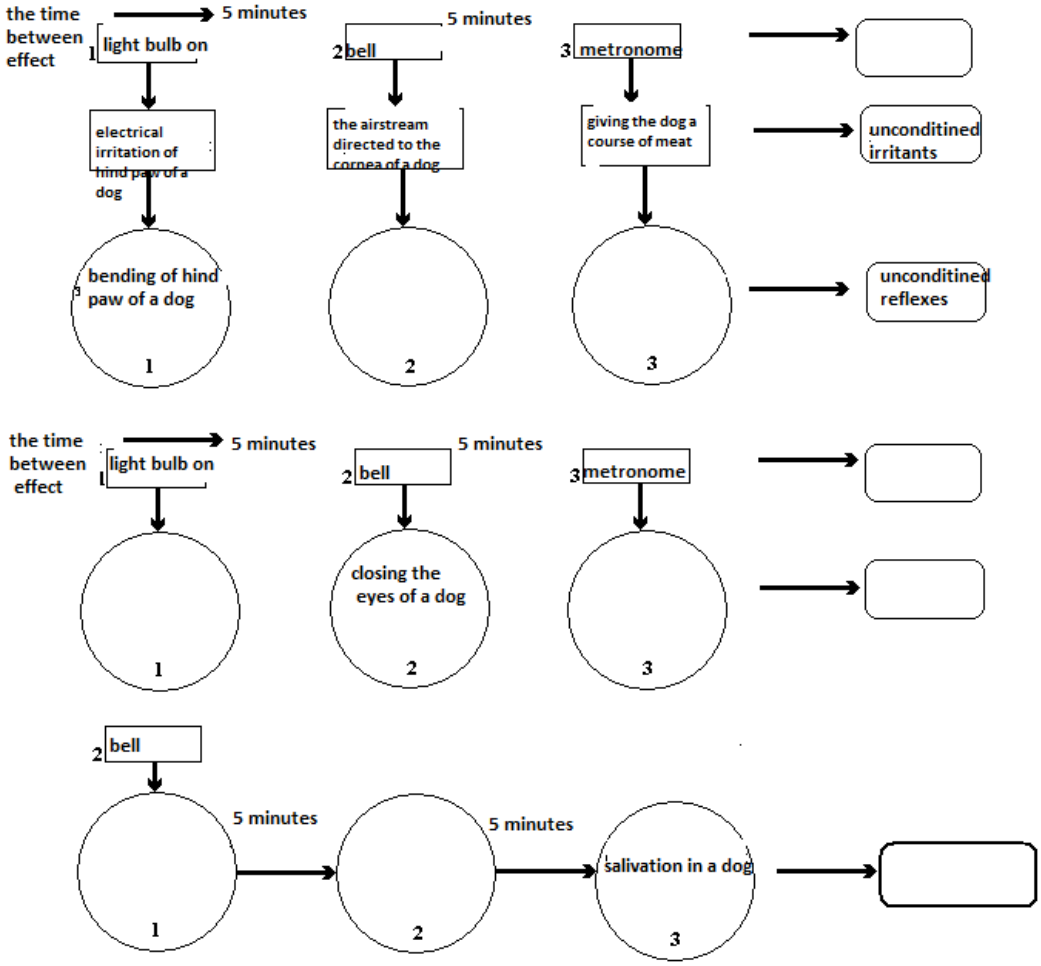
4. Concretize all elements in the chart and show the corresponding connections between the source of monoamines and the display of their action.



5. During the brake two students decided to bay cola in the student`s buffet. But there wasn`t cola in the buffet and besides the time of lecture was approaching. One student decided to drink water from the kettle of his acquainted laboratory assistant. The other one ran into the street and bought cola in the kiosk at last. A) Mark all elements in the following chart. B) Explain, what this chart namely shows. C) Show in the chart the consequence which was the similar for the behavior act of both students by the reason of absence of cola in buffet. D) Mark the elements in which the further behavior of the student became different.



6. Concretize all elements of the chart. Explain biological advisability of the mechanism which is formed at the end of the experiment.



7. In an experimental animal with bilateral extriction of thalamical lateral geniculate bodies the conditional salivatory reflex was formed in response to: 1) turning on the light, 2) the bell, 3) the voice command. A) Draw reflex arches of the reflexes under the conditions mentioned above.

8. Two monozygotic twins Karina and Marina by names began to be leant to read non-simultaneously: Karina at the age of 5 years, Marina at the age of 10. At the age of 6 years Karina already have read books for children fluently by Marina at the age of 12 could hardly read. A) Mark, what mechanism of studying (or acquired behavior) was actualized in Karina but wasn`t carried out in Marina. B) Explain? Why.

9. For the situation A choose the appropriate type of inhibition B which is carried out or opposite isn`t carried out in the situations below.

A.	**B**
1. A teacher confused students` surnames which look alike	1. External unconditional inhibitin
2. A sportsman took a false start	2.conditinal brake
3. Conditional salivation in a dog which had been formed in response to the turning on the lighter stopped when the phone rang.	3. differentiantion
4. At the research of memory mechanisms a student didn`t obey the teacher`s directive and not having waited for a command began to fulfill a task.	4.internal unconditional inhibition
5. A doctor never confused his home keys with the office ones though they were very similar.	5. fading brake
6. A fellow doesn`t get acquaintance with girls in red because the girl who threw him wore red.	6. trace brake
7. Conditional salivatory reflex in a dog which had been formed on the bell stopped at the electrical irritation of its front paw	7. beyong maximal inhibition
8. A student continued to write a lecture in spite of the sudden entrance into the auditory the students who were late	8. late inhibition
9. Conditional salivatory reflex in a dog in response to the command «eat!" stopped when the owner shouted it laudly.	9. internal conditional brake
10.A student stopped to prepare for the lessons in physiology because how much effort he did not make he got "2" in any case.	10. permanent inhibition
11. A doctor didn`t attend conferences when his lady-boss left her mobile at home because then she also forgot to check up the attendance.	11. fading
12. A girl doesn`t buy food in a market because one day she had poisoned with cucumbers bought at a market	12. external conditional inhibition

10. For the displays shown in the column (A) choose the structure or the system (column B) which disorders causes the appropriate display:

A 1. Inforced proactive inhibition at information perception
2.the violation of transformation of short memory into long memory
3. the violation of corresponding words reproduction (amnestic aphasia)
4. disappearance of visual sensory memory
5. rigidity behavior, stubbornness due to disordes in forgetting mechanisms
6. violation of face memory and capacity for their recognition (prosopagnosia)
7. disappearance of auditory sensory memory
8. disappearance of tactile sensory memory
9. violation of capacity to get any new skills (conditional reflexes)

B 1.hyppocampus

2. parietal –temporal assosiating cortex

3. the system RNA-protein

4. thalamical medial geniculate bodies
5. basal border between occipital and temporal cortex
6. mediabasal complex of thalamus

7.prefrontal associating cortex

8. calcarine sulcus of occipital cortex
9. postcentral gyrus

4.3.*Choose correct answer*

1.In the rat the irritation of ventro-medial hypothalamic nuclei by electric current an cause the reaction of "washing", cleaning of the muzzle by paws, because in these nuclei the located centers:

A. of the motion
B. of the hunger
C. emotional
D. satiation
E. of the sense of smell

2.Thw student had a goal to prepare to the exam and at first he refused to go with his friends to the party. Then changed mind and went after friends, and in a few seconds however turned back. Define what stage of behavior in any way was not completed for a student:

A. afferent synthesis
B. decision-making
C. creation of the program of action
D. efferent excitation
E. reafferernce

3. Irritation of certain hypothalamic nuclei in animals resulted in aggressive behavior. It was the consequence of the activation of the following centers:

A.motor
B.sensory
C.associative
D.motivational
E.emotional

4.Birds, what wintered in warm countries, in spring come back to those territories, where they brood. Such behavior belongs to:

A.unconditioned drive reflexes
B.instincts on the basis of ultradiann biorhythms
C.instincts on the basis of infradiann biorhythms
D.vital instincts
E.paternal instincts

5.The cat wa without meal a few days, as a result he had dominant motivation in:

A.medial nuclei of hypothalamus
B.limbic nuclei of thalamus
C.lateral nuclei of hypothalamus
D.associative nuclei of thalamus
E. pemotor cortex

6. For men in critical situations is typical that behavioral reaction is more aggressive, than that for women, due to the increase of concentration of hormones :

A.androgens
B. adrenalin
C.dopamine
D. serotonin
E.gonadotropins

7.Thw blockade of D2-dopamonergic receptors in the striopallidar system is associated with depression. Thus, dopamin is able to improve a mood by an action on:

A.the caudate nucleus
B. amygdalar nuclei
C.unspecificthalamic nuclei
D.red nucleus
E.reclined nucleus

8.When a favourite football command loses, for fans are typical the pupils broadening together with the increasing of the heart rate due to activating of the system :

A.pituitary-adrenal
B.sympatho-adrenal
C.serotoninergic
D.histaminergic
E.limbic

9.The passenger, who was in a hurry to catch the train, saw that the train is swiftly moved away. The state of this man more closer to:

A.the affect
B.ES-1
C.stenic the negative emotion
D.ES-3
E.ES-4

10.Extirpation of the amygdalas for wild monkeys makes their behavior quiet, calm, because these structures take part in forming:

A.emotions of fury
B.motor activity
C.aggressive behavior
D.adequate social behaviorE.certain level of anxiety

11.One from the methods of fight against alcoholism consists in making of conditioned vomiting reflex on the alcohol: the comsumption of the small dose of alcohol is supported after some time by introduction of vomiting drugs. Define the level of locking of conditionally-reflex connections.

A. vomiting center of the medulla
B. brain cortex
D diencephalon
C mesencephalon
E metencephalon

12.During the sporting relay race the sportsman of one of the teams accidentally passed relay stick to the sportsman of the other team. What type of the conditional inhibition is damaged in this sportsman?

A. delayed inhibition
B differentiation
C conditional brake
D trace inhibition
E. fade inhibition

13.Під time of relay race from swimming the second swimmer jumped from a stand into the water till the first one has touched to the wall of pool. What type of the conditional inhibition is impaired in the second swimmer?

A. delayed inhibition
B differentiation
C conditional brake
D trace inhibition
E. fades inhibition

14.Conditioned salivatory reflex on a sound of the metronome was evoked in a dog. What type does this conditioned reflex belong to?

A classic artificial alimentary
B classic natural alimentary
C classic natural protective
D classic natural inhibitive
E imitational natural alimentary

15. At research of memory a shining object was shown to the man on an instant. Another 150 msec he kept it in memory. Maintenance of information in the CNS was provided by a process:

A. of excitation of sensory visual cortex
B. irradiation of excitation in the CNS
C. reverberation of excitation in the circular chains of neurons
D. a concentration of excitation in the CNS
E. multiplication of excitation

16.While researching of memory, during a few seconds a peson was shown determined amount of geometrical figures, whereupon he had to recreate them without a book. What type of memory was investigated?

A. sensory
B. primary
C. secondary
D. tertiary
E. brief

17. Conditioned reflex of avoidance of pain irritation on a sound of metronome was developed in the rat: after turning on the metronome electrical current was applied on the metallic floor of a cage a current rat could avoid the pain reinforcement only by jumping out on the special wooden support that was performed by the animal. What type of conditioned reflexes does this reflex belong to?

A classic artificial protective
B instrumental artificial protective
C imitation artificial protective
D instrumental natural protective
E imitation natural protective

18.To get the university student should take the bus №69. If an empty bus arrives to the stop, he take it, if overcrowded - no. What type of inhibition of conditioned reflexes is decribed?

A. delayed inhibition
B differentiation
C conditional brake
D trace inhibition
E. fades inhibition

19.The student loves sweet cheeses, but hates the prunes While bying cheeses, he never stops the choice on cheeses with prunes. What type of inhibition of conditioned reflexes is developed in the student?

A. delayed inhibition
B differentiation
C conditional brake
D trace inhibition
E. fades inhibition

20. To get the university student should take the trolleybus №5. If the trolleybus №arrives, he does not take it. What type of inhibition of conditioned reflexes does speech go about?

A. delayed inhibition
B. differentiation
C. conditional brake
D. trace inhibition
E. fades inhibition

Protocol of practical study № 17. "____"_____20___

Work 1. Analysis of electroencephalograms

Aim of work : 1) to familiarize with the method of electro-encephalography and types of EEG activity in the different functional states of the organism; to aquire the ability to determine the general physiology state of man in accordance with a rhythm which is registered on EEG.

For work needed: standards of the electroencephalograms registered in the different functional states.

Plan of work: 1) EEG record is made on a multichannel electro-encephalograph. The inspected in comfort conditions in the screened chamber, is sitting in the arm-chair. By means of rubber helmet on his head electrodes which connect with a device are fixed. After adjusting of the device EEG is recorded in the conditions that are necessary for forming of the certain physiology state of the man (calm, active wakefullness, physiologic or hypnotic sleep, perception of sensory irritants, and others like that).

Basic physiological rhythms of EEG:

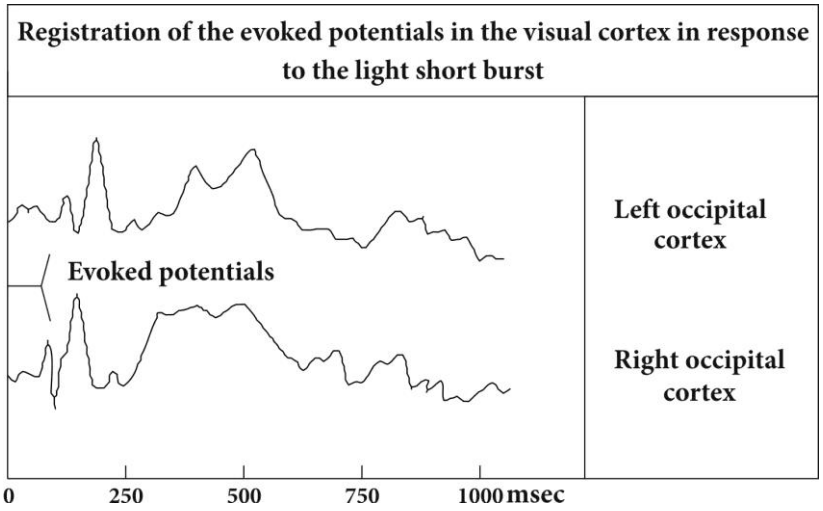
1) Quiet wakefullness - alfa-rhythm with the frequency 8-13 Hertzs, amplitude of 50-100 μV. Registered at the closed eyes, relaxed musculature, in absence of emotional tension and active intellection. In typical cases mostly present in occipital, parietal (rollandic alfa-rhythm), occipito-temporal, parietal-occipital areas of the cortex.

2) Active wakefullness - beta-rhythm with the frequency more 13 Hertzs, amplitude up to 20-25 μV. Is registered at the opened eyes, under the action of different, (e.g. ligh) stimuli, active intellection, emotional tension. In typical cases is mostly presented in the frontal and central parietal areas of the brain hemispheres.

3) Superficial sleep (narcosis, hypoxia) - τ-rhythm (or θ-rhythm) with the frequency 4-8 Hertzs, amplitude of 100-150 μV.

4) Deep sleep (narcosis, hypoxia) - Δrhythm (or δ-rhythm) with the frequency 0,5-3,5 Hertzs, amplitude of 250-300 μV.

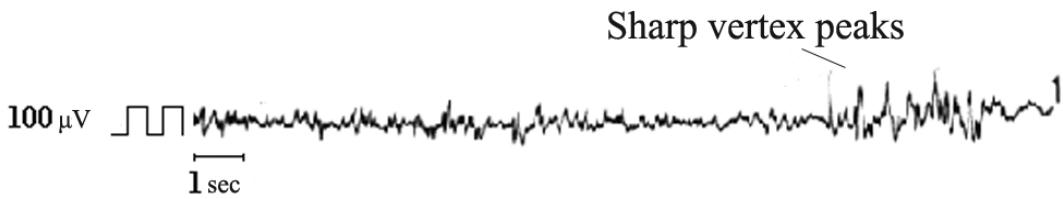
In response to the action of brief sensory irritants of certain modality (light, voice and so on) in the corresponding areas of brain cortex there are specific answers - evoked potentials which allow to analyse perception and processing of sensory signals the certain areas of cortex.



2) A. In the given electroencephalograms analyse the amplitude (A) and frequency (ν) of waves, taking into account notes making on them. In conclusions: to mark, what physiologic state was a man in while registratingh EEG (B); to describe the defined state of the patient (C).

Results:

1)



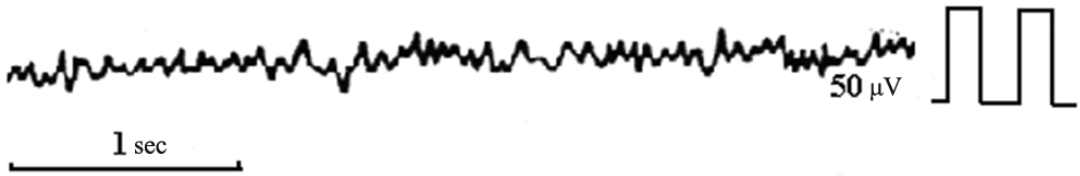
A. A= **v=**

Conclusions:

B.

C._____

2)



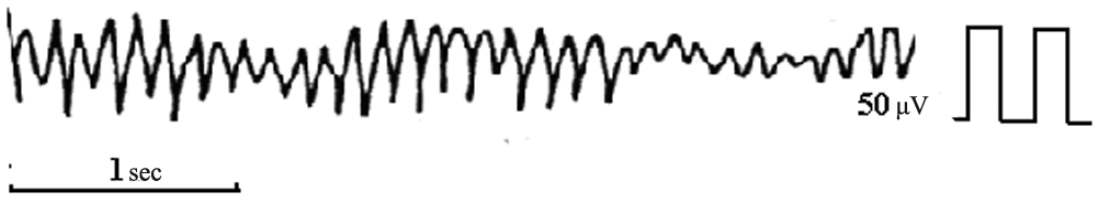
A. A= **v=**

Conclusions:

B.

C._____

3)



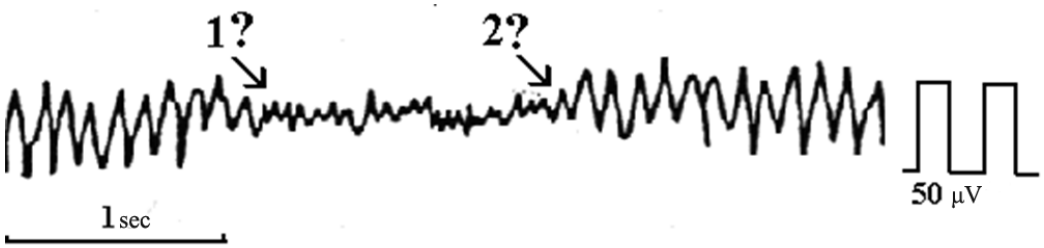
A. A= **v=**

Conclusions:

B.

C._____

4)



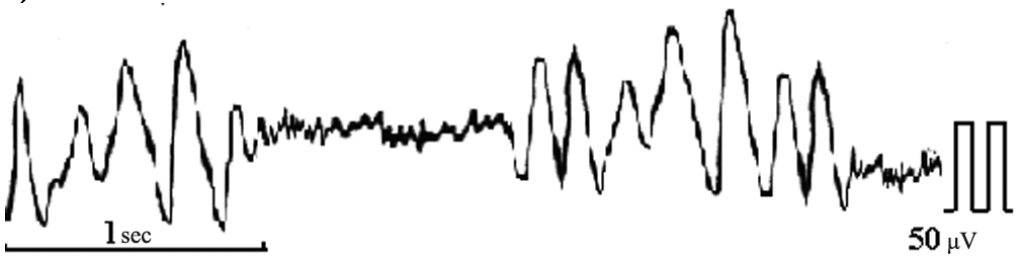
A. A= **ν=**

Conclusions:

B.

C._____

5)



A. A= **ν=**

Conclusions:

B.

C._____

Work 2. Research of influence of emotional excitation on the indexes of the cardiovascular system

Emotional excitation is designed as a result of realization of mathematical actions in the conditions of time deficit.

Aim of work :1) to determine the change of the frequency of the heart rate (HR) during emotional tension caused by the time deficit and explain its mechanism. 2) Explain the reason of this state (emotions which were caused by time deficit). 3) Estimate the changes of brain capacity for work after emotional tension and explain the mechanisms of such changes.

For work needed: stop-watch.

Plan of work: Brigades containing 2 students (one - inspected, second is a researcher which determines HR) start to work. Firstly the index is measured and written down in the resting state and then - after the task finishing. Tasks should be performed twicely: for the first time in quiet conditions (speed of stowage is arbitrary), for the second time - in the conditions of the time deficit (not less than 40 stowages per 1 min).

Concrete task is following: on the sheet of paper write down 2 numbers (one under the second), and the inspected folds them and writes down a sum alongside with an overhead number (if sum more than 10, then the number of ten is dropped, and units write only). An overhead number is carried in a bottom row. Then fold new two numbers and write down the same way.

For example, 5 7 2 9 1 0 1 1 2 3 5

2 5 7 2 9 1 0 1 1 2 3 et cetera

Speed of work is 40 stowages per 1 min

Results:

Terms of work implementation	***HR (beats per 1 min)***		***Amount of stowages***
	before task implementation	***after task implementation***	
At arbitrary speed of actions			
In the conditions of the limited time			

Conclusions: in conclusions answer such questions:
1) How and why did the HR change in the process of the research?
2) What emotional state does it testify to?
3) What conditions acoording with the theory of Symonov P.B. result in the origin of emotions?
4) What mechanisms, related to the emotional state, are capable to influence on Ie, Ee,· Te?
4) What function (role) is played by emotions in the conditions of the time limit ont he need satisfaction?

Estimate the changes of brain capacity for work after emotional tension and explain the mechanisms of such changes

Work 3. Formation of protective conditioned reflex of "avoidance" in the rat (or video film)

Aim of work: 1) to determine the type of conditioned reflex (reflexes)

2) to name condition which cause the formation of aquired conditioned reflex (formation of conditioned reflexes according to the film)

3) to define a main difference between conditioned reflexes which were evoked in animals (according to the film)

For work needed: rats, special chamber with metallic floor, electtrical stimulator, device for a voice signal.

Plan of work. To set the electric chain for the key-in of electric current through the floor of the chamber. To put the rat (or a few rats) in the chamber. To observe its behaviour in new circumstances. At first apply a pain irritant only, locking the chain of electric current, and to watch a reaction of the rat - as soon as it will jump on the wooden support (or will escape through opening in other section of cage, where an electric current does not operate) to break contact. To repeat several times with an interval 1-2 min Then to connect voice and electric irritants: at first to include a voice signal, and through 5 sec electric current. After 5 sec of their joined action turn off a sound. As soon as a rat will jump on the wooden support, break the chain of electric current. Repeat until a rat will jump out on support during the action of voice signal without an electric irritation.

Results: describe behaviour of the rat (or animals in the film) during all stages of experiment

Conclusions:

Work 4. The research of preventive conditional blinking reflex formation in a man

The purpose of the work: to analyze the mechanisms of formation and disappearance of temporaly links between the cortical sensory centres to bell action and the centres of blinking reflex in the large hemispheres of brain cortex.

For work one needs: electrical bell, special glasses with rubber for the direction of airstream to cornea.

Work fulfillment An investigated *is put a special glasses and the airstream is directed to the cornea with the pressing of rubber. But the bell had to ring before airstream. The experiment have to be done before the investigated blinks in response to bell. The quantity of combination between conditional and unconditional irritants which is necessary for conditional blinking reflex formation have to be registrated.*

Results of the work. To describe shortly the process of conditional preventive blinking reflex formation in response to a bell, marking the quantity of combinations between conditional and unconditional irritants which was necessary for formation this conditional reflex.

Conclusions: to show in the chart in conclusions **1)**the mechanisms of temporaly links formation between cortical sensory centres for the bell perception and the centres of blinking reflex in the large hemispheres of brain cortex **2)** the mechanism of this reflex reproduction after its formation **3)** identify the type of this reflex by the main classification of conditional reflexes **4)** determine the mechanism of this conditional reflex disappearance at the end of the lesson

Work 5. Research of memory

The process of memorizing is investigated by determination of volume of the involuntary memorizing, direct visual, auditory and other types of memory. The storage of that which was mastered is estimated by means of comparison of volume of memory right after perception of material and through the different intervals of time after it.

A volume of direct memory is the higher quantity of separate elements (geometrical figures, letters, numbers, syllables, words and other) which a man can recall without twisting after one presentation of these elements in the written or oral form.

A.Determination of volume of direct memory on geometrical figures.

Aim of work : to set and estimate the volume of the direct memory on geometrical figures.
to determine the type and explain the mechanisms of the investigated memory

For work necessary: images of 9 geometrical figures on the sheet of paper.

Plan of work. Explain what it is necessary to do: "During 18 sec you will look at 9 geometrical figures, whereupon during 1,5 min you must recreate them in protocol without twisting and on the same place". Experiment is conducted 3 times with an interval 3-5 min. For completion collate the rightness of recreation: a researcher demonstrates a sheet, and the inspected mark a sign "plus" those figures, represented correctly, and by a sign "minus" - those that are recreated wrong or not on the correct place.

The volume of memory is estimated by a formula:

$$MV = \frac{G - E - M}{G} \times 100\%,$$

MV — volume of memory; G - the total amount of figures in three experiments; E - amount of errors (incorrect depicted figures); M - amount of the omited figures (unfilled places). Norm - 62 %.

Results:

Volume of memory =

The volume of the memory on geometrical figures is equal to _____%, that is_____

Conclusions:

B. Determination of direct memory volume on numbers.

Aim of work : to set and estimate the volume of the direct memory on numbers..
to determine the type and explain the mechanisms of the investigated memory
For work necessary images of numbers - 10 rows including 12 numbers in each row**.**

Plan of work. To explain, how to do the work: You will be read the rows of numbers, beginning from the shortest. After 2-3 sec after the reading of a row there will be a command "Write", and you must in protocol represent numbers in the same order". In every row there is one more number, comparatively with the previous. The longest row has 12 numbers. An experiment is repeated 2-3 times with the interval 5-7 min. Results are collated the same way as in previous experiement. By a sign "plus" is marked row in which all elements are recreated correctly. Rows which are recalled not fully or with errors whether not in the given sequence of elements, mark a sign "minus".

The volume of memory is estimated by the formula:

MV = A+ m/n,

where MV is a volume of memory; A is an amount of elements of those rows, that were recalled correctly in all experiments; m is an amount of the correctly recreated rows in which the amount of elements is larger that A; n is an amount of experiments (2-3). For example, in 3 experiments (n = 3) rows are correctly recreated with the amount of elements 8, and in 2 rows are correctly recreated with 9 elements. Then MV = 8 and 2/3. Norm: 7±2.

Results: MV=

The volume of the memory on numbers is equal to_____
Conclusions:

Protocol revised_____
(date, Preceptor's signature)

The literature

Basic

1. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.

Additional

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P. 823-832, 863-883.
2. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2015. – 750 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.2, P. 329-353, 355-357, 360-364.
4. Fox I. Human Pysiology. 8th Edition. By the McGraw-Hill Companies, USA, - 2004. - 727 p.
5. Vander et alls. Human Pysiology. 9th Edition. - 2004.-245-266

FOR NOTES

Practical study 18.

The studying of HNA of human and typological properties of nervous system

1.Urgency of the theme:

From ancient times in medical science the aim was to find leading properties after which it is possible to distinguish the basic types of people personality. Among the numerous standards of such tests of the past most known is the typology of the Ancient-Greek doctor Hippocrates, Ancient-Roman doctor Halen, German psychiatrist E.Kretshmer, American doctor G.Sheldone. This tradition is actual in present times when the list of typology standards is substantially broadened due to findings of physicians and psychologists. But two to the typology of Pavlov I.P., who created at the beginning of 20 century, in this row were and remain unsurpassed. One advantage of them - types of HNA, which are determined on properties of the nervous system, - in the objective physiology tests of types selection. Exactly it, and also the hardly regulated methodology of determination of such properties gives to this typology its objectivity, which does not characterise many psychological conceptions in this field. Thoroughness of the second typology - types of HNA after prevailing/equilibrum of the signal systems consists in the genius foresight of the functional asymmetry of large hemispheres that was discovered considerably later. This theme reveals concrete meaning of Pavlov's conception in relation to the types of HNA, classic methodology of their determination, modern contributions in an idea about the types of HNA and methods of their study. Within the framework of this topic in pavlovian and modern terms the differences of people are discussed according to their advantages of vivid or abstract perception of the world, the mechanisms of abstract thought in basis of which a language lies. Physiology bases, functions of language and basic types of its violations are studied. Mastering of this information has an important value for forming of intergative principle and individual approach in treatment or other professional activity of doctor of any profile, for realization of professional selection, for the realized observance of professional ethics.

2.Educational purposes:

- ***To know:*** *the substantive points of leading standards of typology of Hippocrates, Pavlov I.P., G.Isenk and criteria of determination of personality properties; methods of determination of HNA types after Pavlov I.P.*
- ***To aquire abilities:*** *to analyse properties of the nervous system and determine on their basis the type HNA after Pavlov I.P, to compare the HNA with the type of temperament after Hippocrates (solving of regulated tasks and creatively improvised situations); to conduct the comparative analysis of criteria and methods of determination of HNA and temperament after different psychological conceptions; to analyse correlation of level of functioning of the signal systems and interpret the results of analysis in accordance with modern ideas about functional asymmetry of large hemispheres; physiology bases of verbal thought (regulated tasks and creatively improvised situations).*
- ***To aquire the skills of determination of:*** *properties of the nervous system, which determine type of HNA by means of physiology methods of research; HNA types depending on the level of functioning of the signal systems by means of physiology methodology of testing.*

3.Approximate pattern for independent work at preparation for practical study

3.1.*The list of the basic terms, parameters, characteristics which a student should acquire at preparation for practical study*

Term	Definition
Type of higher nervous activity or type of the nervous system	It is a fixed amount of certain properties of the nervous system, which determine the personal features of behavioral reactions

Temperament (from Latin temperamentum is certain correlation of parts, proportionality)	It is fixed combination of psychodynamic properties of personality which constantly appears in his behavior and activity, regardless of their content, aims and reasons, and makes organic basis of these displays
Signaling systems	The ways of regulation of behavior of living beings in the environment, properties of which travel to the CNS as signals which are perceived directly by the sensory systems of an animals and humans (1th signaling system), or by means of language and other abstract signals for a man (2th signaling system).
Aphasia	Loss of language.

3.2.*Theoretical questions*

1) Main positions of pavlovian conception about the types of HNA and criteria of their determination. Methods of study of properties of nervous processes which determine type of the HNA.
2) Nowadays opinions about temperament, main constituents of temperament, displays. Comparative description of criteria of key properties of personality on the different standards of their typology (to the typology of Hippocrates, Pavlov I.P., G. Isenk, informative exchange and others like that)
3) Signaling system as basis of perception of reality and behavior. Types of the signaling systems and types of correlation of their rate of functioning after Pavlov I.P. Forming of second signaling system in ontogenesis.
4) Modern concepts about functional asymmetry of brain; relative distribution of functions in the hemispheres of cerebrum for people with a leading right and left arm. Essence of the concept of "dominant hemisphere".
5) Physiological bases of verbal thinking . Centers of language. Functions of language. Essence and types of aphasia.

3.3.*Practical works*

1) Determination of functional mobility of nervous processes by means of ПНН3-01.
2) Determination of the force and mobility of nervous processes by means of proof-reading method.
3) Determination of HNA dependance on the level of functioning of the signaling systems by means of testing.
4) Determination the personal properties with the help of G.Isenk test /individual work/.

4.Materials for individual work and self-control

4.1.*Answer the question:*

1) Is it possible to bring up for a child the strong balanced and mobile type of higher nervous activity? *(To name the noted type of HNA after Pavlov and compare it with corresponding temperament after Hippocrates. To explain, whether the listed qualities are aquired during live, why exactly).*

2) Is it possible, watching behavior of man, to define the type of his higher nervous activity? *(To define, on what criteria determine type HNA. To mark the methods of determination of these criteria-properties. To explain, whether the methods of finding out of character of such properties belong to the methods of actualization of certain behavioral displays).*

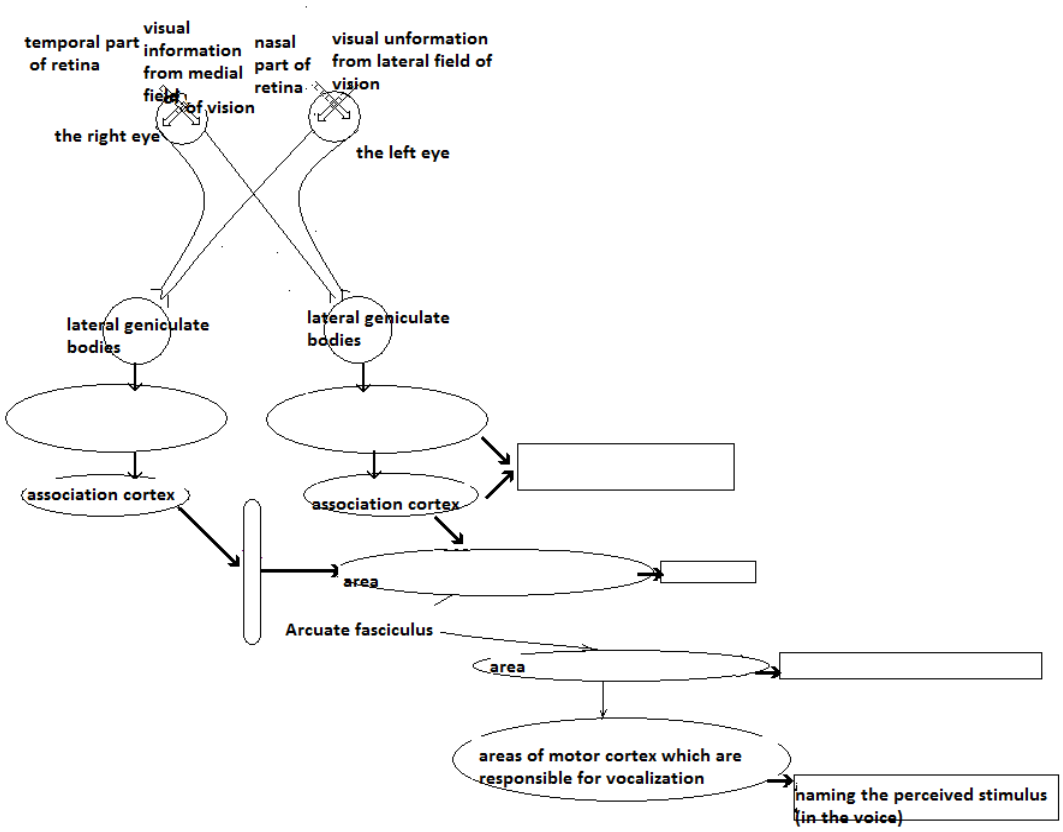
3) In a man a certain type HNA coincides with the quiet one. What does it testify to? What methods and by which features can it be defined? *(To describe the noted type of the HNA after Pavlov and to define its analogue in the typology of Hippocrates. To specify, what results should be revealed by research methods which were used to determine this type).*

4) A man has impaired right parencephalon. Define the possible consequences of it. *(To specify the functions of right and left hemispheres in man with the leading right or left hand. To define the consequences of the injury of right hemisphere. To define whether it will affect verbal function, what exactly. To define the basic centers of language and their location).*

5) If a child in early age was deprived by socializingwith people, will he be able to speak? *(To define whether there is a necessity for socializing with people for the formation of language. To define whether the language mastering is possible in such cases and whether it depends on age of returning in human communication).*

4.2.*Solve the tasks individually*

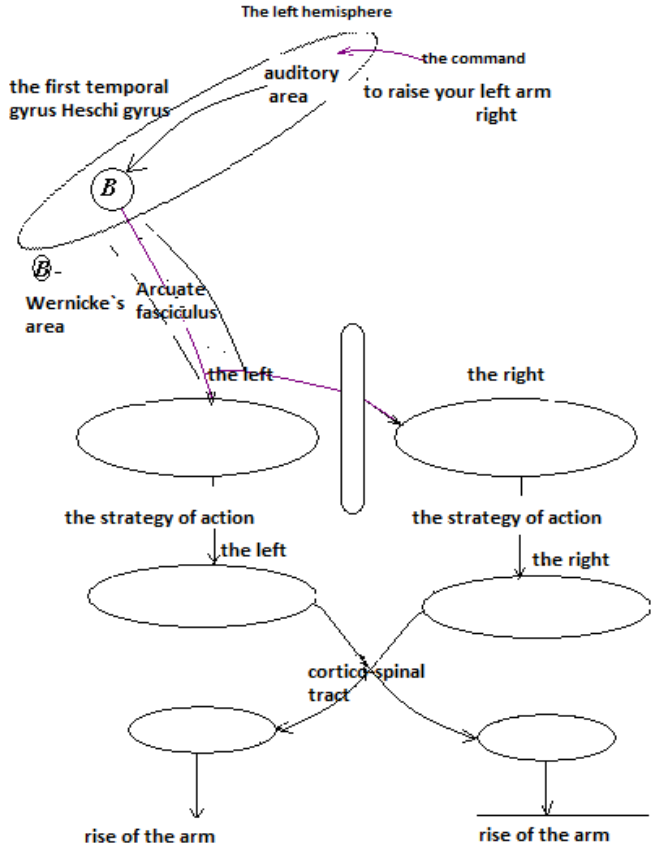
1. A) Concretize in the chart the elements which aren`t designated in accordance with the traditional designations, functional use and localization. B) Explain, if the speed of vocalization formation of seen from the left visual fields differe from the seen from the right visual field. C) Explain, why.



2. Complete the marked disorders (A) with the correcponding brain structures (B) the damage of which causes such desordes.

A 1.Depression, inclination to "disastrous" ideas, increased EEG activity of the right hemisphere of brain cortex.	**B** 1. **The right hemisphere of brain cortex**
2.Lost ability to write(agraphia)	2. the part of secondary motor centre on the medial surface of the left hemisphere.
3.Lost ability to understand speach (sensory aphasia)	3. occipital cortex before calcarine sulcus
4.Manic euphoria or vice versa, indifference to activity increased EEG activity of the left hemisphere of brain cortex.	4. temporal gyrus
5.Lost ability to calculate (acalculia)	5. frontal gypus
6.Lost ability to read to oneself and in voice (alexia)	6. the left hemisphere of brain cortex
7.Lost ability to speak and to read in voice (motor aphasia)	7. parietal –temporal associating cortex

3. A) Concretize the elements which are not designated in the chart in accordance with their functional use and localization. B) Explain, if the command fulfillment will be influenced under the damage of 1)Broca`s centres 2) the left precentral gypus C) Explain namely how and why.



4. A student who usually has high capacity for work and fulfilles succesfully long loading offen gets on bus 7a though she needs bus 7. Delete the unnecessary items and choose the optimal consequence at the determination of HNA type by Pavlov and its correlation with Hippocrates`s types.

1. the student is a choleric person by Pavlov
2.the processes of excitation and inhibition are unbalanced in the student
3. the student is a phlegmatic person
4.low capacity for differenciation shows weak inhibition
5. thus by Pavlov`s criteria the student belongs to unrestrained type
6.the student has strong excitation, the information about her high capacity for work and endurance testifies about it.
7. it characterizes her as strong and unrrestrainted
8. the student has high mobility of of the nervous processes
9. the student has low mobility of the nervous processes
10. it isn`t determined the mobility of such a type by Pavlov.
11. this HNA type corresponds to choleric temperament by Hippocrates

5. Phlegmatic temperament was stated in a student in the psychological study by Eysenk. But at the lesson in physiology it was stated that her type corresponds to choleric one. A) Mark and

compare the criteria of type determination by Pavlov and by Eysenk. B) Explain the probable reasons of the differences of allosions on Hippocrates`s types.

4.3.*Choose correct answer*:

1.A man with strong, inert and balanced type HNA after Pavlov has such temperament after Hippocrates:
- A. sanguine person
- B. temperamental person
- C. phlegmatic person
- D. melancholic person
- E. other

2.It was noticed, when a nervous disorder arose in people, forced to hide from close relatives their heavy disease. What types of temperaments after Hippocrates are being yield to such disturbances:
- A. melancholic persons and temperamental persons
- B. melancholic persons and sanguine person
- C. melancholic persons and phlegmatic persons
- D. temperamental persons and sanguine person
- E. temperamental persons and phlegmatic persons

3.A patient has injured frontal lobe of the left hemisphere, where language center of Broka is localized. What violations of language will be observed for this man? He will not be able:
- A. to understand the meaning of words
- B. to read
- C. to talk
- D. to understand words and talk
- E. to read and talk

4.Specific feature of higher nervous activity of man is a presence of:
- A. cerebral cortex
- B. temporal connections
- C. sensory systems
- D. I signaling systems
- E. II signaling system

5.Five years old child after a craniocerebral trauma lost the ability to talk for a some time, but long time after this ability was recovered. What hemisphere was damaged and due to what property of the infant CNS in a language became possible?
- A. left hemisphere, plasticity
- B. right hemisphere, plasticity
- C. left hemisphere, mobility
- D. right hemisphere, mobility
- E. both hemispheres, plasticity

6.The patient has damaged the temporal lobe of the left hemisphere, where the center of language of Vernike is located. What violations of language are here observed? A man is not able:
- A. to understand words
- B. to read
- C. to talk
- D. to read and talk
- E. to write and talk

7.In a man the strong, mobile and balanced type of higher nervous activity after Pavlov was defined. What it is temperament after Hippocrates:
- A. sanguine person
- B. temperamental person
- C. phlegmatic person
- D. melancholic person
- E. other

8. Weak type of the HNA for a man after Pavlov has such temperament after Hippocrates:
- A. sanguine person
- B. temperamental person
- C. phlegmatic person
- D. melancholic person
- E. other

Protocol of practical study № 18. "____"_____20___

Work 1. Determination of functional mobility of nervous processes by means of ПНН3-01.

A method consists in that the inspected receives the light irritations of different color (conditional irritants) and must react on them by pressing on the corresponding keys (conditioned motor reaction). Frequency of irritations is regulated by a device automatically

depending on speed and exactness of reaction. The index of functional mobility of nervous processes will be an amount of irritations on which the inspected will react after 2 min

Aim of work :1.To estimate functional mobility of nervous processes in inspected students; 2.To define, which type of HNA coincides the high mobility, low mobility and what HNA type mobility can not determined for

For work needed: ПНН3-01, stop-watch.

Plan of work. The inspected sits down before the screen of device and gets instruction: light irritants - red, green or yellow circles will appear on the screen. When a red circle is appeared, it is necessary quickly to press and release the right button, green circle - left, yellow - not to press. The rate of irritations will increase gradually. Try not to displace attention on errors , try as longer as possible to retain a maximal rate". Conduct training during 20-30 sec and then begin research - push the button "Starting" and simultaneously turn off a stop-watch. Through 2 min to shut down. Write down data.

Results.

Number of the inspected	Amount of the accepted signals after 2 min	An estimation is in points on a 10-ball scale
1.		
2.		
3.		

<152 – 1 point
153-165 – 2
166-175 – 3
176-183 – 4
184-193 – 5
194-202 – 6
203-212 – 7
213-222 – 8
223-230 – 9
>230 – 10

Conclusions:

Work 2. Determination of force and mobility of nervous processes by means of proof-reading method.

In experiment the table of Anfimov are used. They are 8 letters printed to the standard .sheet of paper in an arbitrary sequence - together 1600. The inspected must delete (conditioned motor reaction) a certain letter (conditional irritant). Work lasts 5 min, and must be performed in maximal rate. The index of mobility-lability of nervous processes will be an amount of signs which the inspected revised after 5 min, and forces of nervous processes are a change of the labour productivity (amounts of signs, revised after 30 sec, and errors had done).

Aim of work : to define force of excitation, the force of inhibition and the mobility of nervous processes.

For work needed: tables of Anfimov, stop-watch.

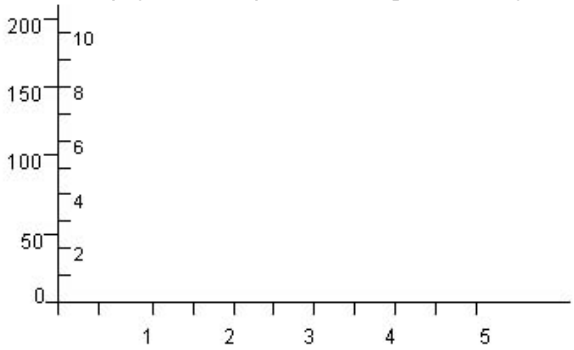
Plan of work. All students of group perform this work simultaneously. Each student gets a table, fills questionnaire data. Farther instructing is conducted: "Now you will get a task and simultaneously after a command will begin to do it, trying to do it maximally quickly and exactly. Letters are necessary to be looked over consistently in every line in direction from left to right. Every 30 sec after a signal you will sign by vertical that place of table, where you are looking through. Duration of experiment - 5 min". Then students inscribe a task which declares teacher above a table. It can be simple task (for example, to delete the letter of "в"), or a bit more difficult (to delete the letter of "в" and underline the letter of "а"), or even more difficult.

After it a teacher gives a command "Begin" and simultaneously turn on the stop-watch. Through every 30 sec he gives a signal and students put a vertical line in that place, where they are looking through for the moment. After completion of work students check up quality

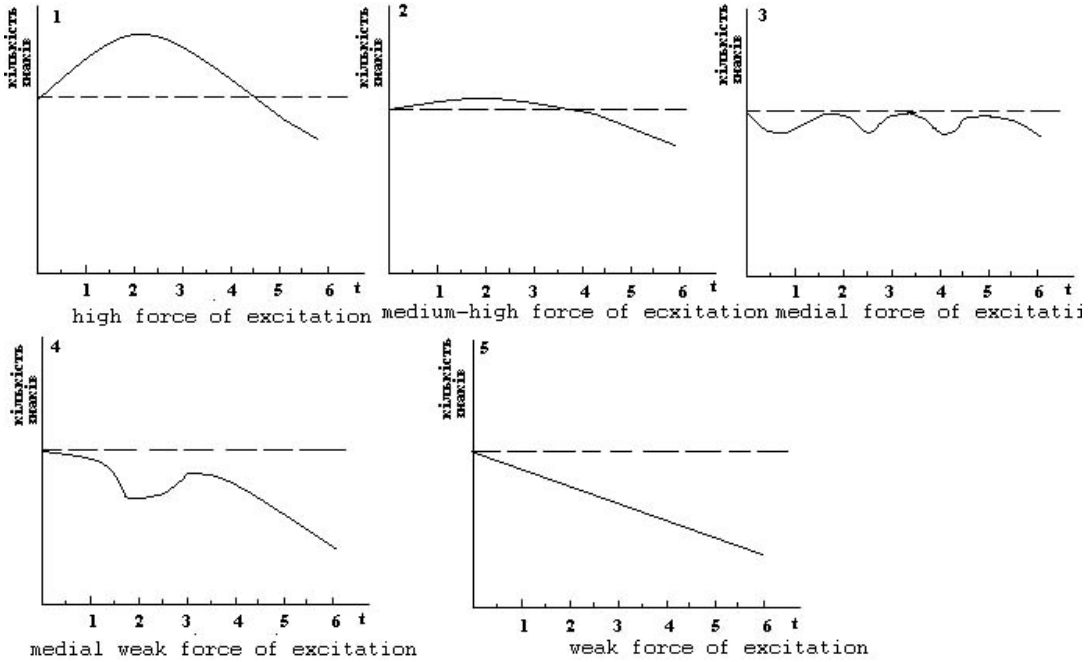
of work, or interchange forms. Count up the amount of the revised signs and errors for each 30 sec and for all period of work.

Results.

1) *Amount of the revised signs for 5 min* _____,
2) *Amount of errors*
3) *Chart of dynamics of the labour productivity :*



Criteria of estimation of force of excitation according to the dynamics of the productivity of work (without the account of errors)



Conclusions:

1) Mobility(lability) of nervous processes _____amount of signs after 5 min. Compare to the maximal and minimum amount of signs, revised for 5 min by other investigated students.

2) Forces of nervous processes according to the dynamics of the labour productivity_____

Work 3. Determination of artistic and mental types of personality by testing.

Defining the artistic and mental types of man is possible by means of tests in basis of which lies ability of man to expose the general signs of row of objects and summarize them on these signs .

Aim of work : to define belonging of investigated person to the artistic or mental types .

For work are needed: sets of words for classification of concepts.

Plan of work. At first give explanation to the test: "On a board I will write down 9 words. you must divide them into 3 groups for 3 words according to their general signs". Then write down the words of one set on a board, and students write them in protocol in 3 columns for 3 words in each. It is desirable to repeat a test with other set of words.

Possible methods of grouping of words in 3 columns: I - based on the external signs of objects; II - on purpose of objects, by their abstract properties; III - it is unregulated words grouping.

Results.

Methods of grouping of words in 3 columns:

1.

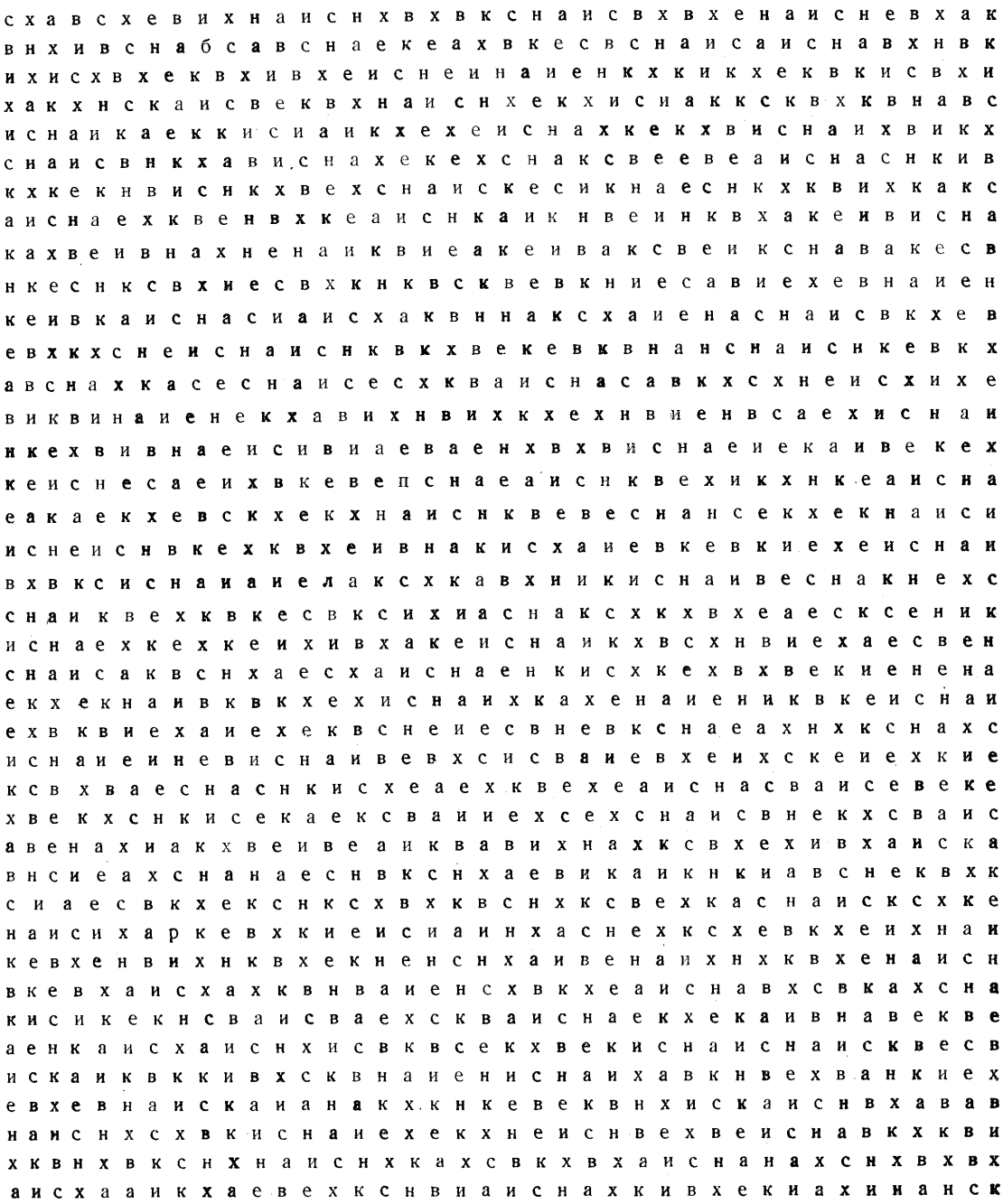
2.

Conclusions: (to determine, what mental type cause the performed classification of concepts, what type after Pavlov, if grouping of words after I method testifies to conception thinking that is usual for artistic type , after II - about abstract thinking, characteristic for a mental type. If both methods are used, means the middle type of mentation in inspected).

Таблица Анфимова

Подчеркнуть

Фамилия	1-ое задание	Возраст
Дата	2-ое задание	Специальность
Образование	Имя	Условия исследования



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Work 4. Determination of the personal properties with the help of G.Isenk test /individual work/.

Questionnaire or Isenk test contains 56 questions which characterizes the personality by two scales - extro-introversion and neurotism (emotionally-strong-willed persistence - instability). According to Isenk conception extro-introvertion together with neurotisn creates two main measurements of personality. These properties of temperament are to be considered not as contradiction but as uninterrupted scale between two poles of excessivly expressed property.

The purpose of the work: to make testing with the help of Isenk questionnaire and to determine the properties of temperament.

For work one needs: Isenk test, pictures with the Isenk circle, the keys to Isenk scale.

The course of the work. A researcher reads consequently the questions from Isenk test and write down into the protocol the number of a question and an answer to it ("yes" or "no"). After that he compares his answers with the answers containing in the "key to the Isenk scale". One marks the sigh "plus" if the answers coincide and the sigh "minus" if they don`t coincide. The check is carried out separately in accordance with the scales "Untruth", "Extro-introversion" and "Neurotism". The test result can`t be trusted if more than 50 % of answers coincide scale "Untruth". Than one calculates the quantity of scores in each scale and received results are marked in corresponding axes of Isenk circle: "Neutotism" in horizontal scale and "Extro-introversion" in vertical one. Cross perpendiculars which were done to the received points will give the point in the circle square. The distance from the centre testifies about the degree of deviation of corresponding temperament`s property from the middle value.

Results of the work:

1) The answer to the questions – "yes" or "no"

1	8	15	22	29	36	43	50
2	9	16	23	30	37	44	51
3	10	17	24	31	38	45	52
4	11	18	25	32	39	46	53
5	12	19	26	33	40	47	54
6	13	20	27	34	41	48	55
7	14	21	28	35	42	49	56

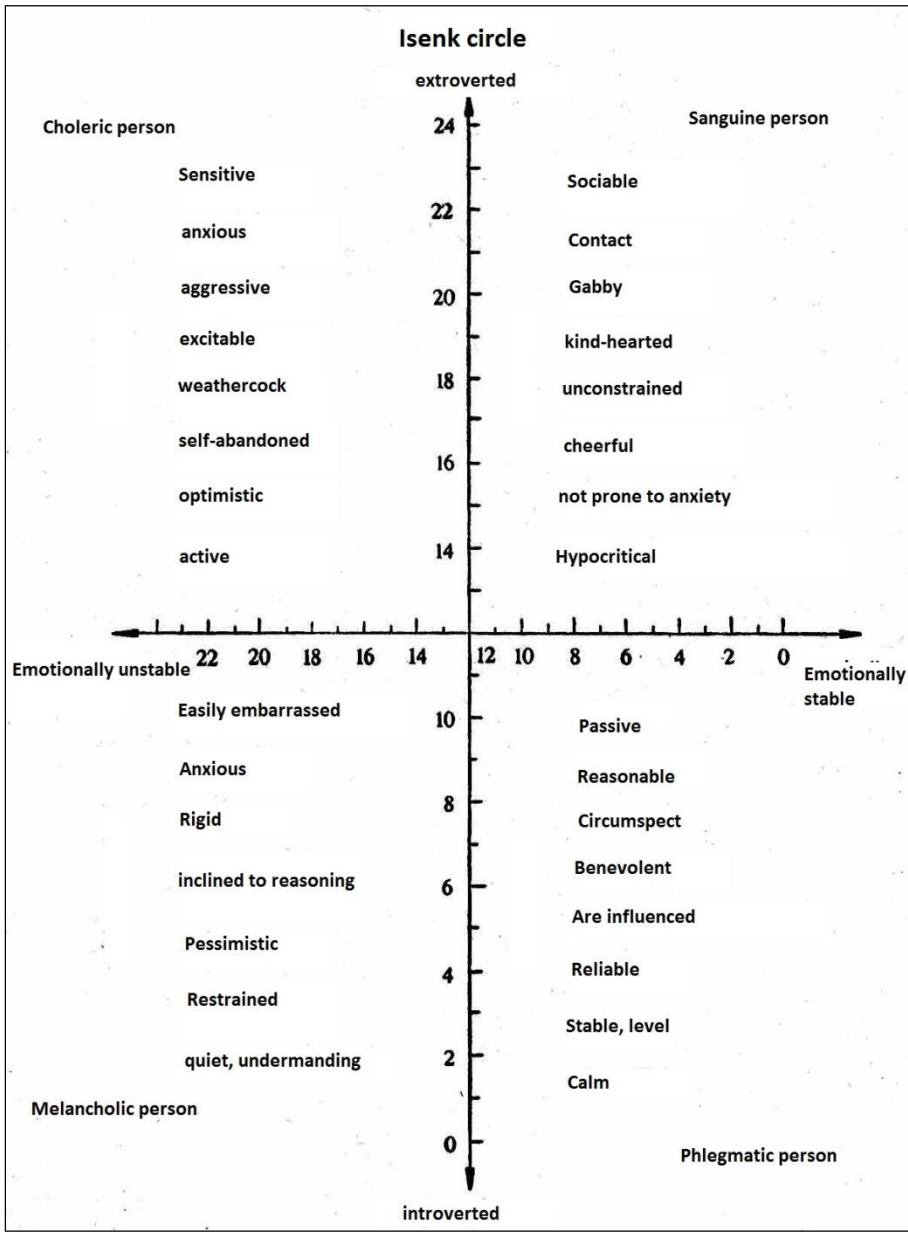
2) Answers comparison with the key to Isenk scale (the coincided answers are marked with plus and summarized):

Extro-introversion (the quantity of pluses)	Neurotism (the quantity of pluses)

3) The results represented in Isenk circle in accordance with the table:

Extroversion	**0-2 super-introvert**	**3-6 introvert**	**7 -10 potential introvert**	**11-14 ambivert**	**15-18 potential extrovert**	**19-24 extrovert**
Neutotism	**0-2 super-concordant**	**3- 6 concordant**	**7-10 potential concordant**	**11-14 normosthenic**	**15-18 potential discordant**	**19-24 discordant**

Conclusions: the report about the temperament by Isenk/Hyppocrates.



Protocol revised_____

(date, Preceptor's signature)

Addition to the work 4.

Isenk tast

1. Do you offen seek fot new impressions?
2. Do you offen feel that you need friends who would understand you and can console and cheer up?
3. Do you consider yourself a carefree person?
4. Is it very diffecult for you to refuse from your intentions?
5. Do you think over your plans leisurely, wait before to begin to act?
6. Do you always keep your promises even when it is not profitable for you?
7. Does mood elevation or recession offen happen with you?
8. Do you always speak and act fast and without hesitation?
9. Have you ever had a feeling that you are lack-all though there were no serious grounds for this?
10. Can you agree almost to everything to make a bet?
11. Are you embarrassed when you want to speak to an attractive stranger?
12. Does it sometimes happen that getting angry you don`t control yourself?
13. Does it offen happen that you act under the influence of momentary mood?
14. Do you offen worry about you shouldn`t have done or have spoken?
15. Do you prefer reading books to meeting with people?
16. Is it true that you are easy to be offended?
17. Do you like to be in a company?
18. Have you ever had such thoughts that you would not want anyone to know about it?
19. Is it true that you sometimes are full of energy and you do everything tiptop but sometime you are quite flabby ?
20. Are you inclined to have less friends but especially close to you?
21. Do you sometimes dream?
22. Do you reply in the same way when you are scolded?
23. Are you offen tormented by the feeling of wine?
24. Are all your habits good and desirable?
25. Are you able to give vent to feelings and have fun in the company?
26. Can one say about you that your nerves are offen going up?
27. Are you condidered to be lively and cheerful person?
28. After you have done something do you offen return to it mentally considering that you would do it better?
29. Are you previously in companies?
30. Does it happen that you spread rumors?
31. Does it happen you don`t sleep because of different thoughts?
32. If you want to know something is it better for your to read in books about it than to ask your friends?
33. Do you offen have palpitation?
34. Do you like a work demanding attention concentration?
35. Have you had shivering attacks?
36. Will you always express common opinion if you knew that all you should say would never be known to anybody?
37. Is it unpleasant for you to be in a company where people mock one over another?
38. Are you irritable?
39. Do you like a work which needs rapid reaction?
40. Is it true that you offen do not give rest for your thoughts of various troubles which would be though everything ended well?
41. Are you slow and unhurried in movements?
42. Have you ever been late for a work or an appointment?
43. Do you offen have terrible dreams?

44. Is it true that you like to talk so much that you have never refused the chance to talk with a stranger?
45. Are you suffering form any pain?
46. Should you feel unhappy if you couldn`t meet many of your friends or familiar persons for a long time?
47. Do you consider yourself a nervous person?
48. Are there such persons among your acquaintances which you don`t like?
49. Can you say about yourself that you are a self-confident person?
50. Is it easy to offend you if to criticize your personal disadvantages or disadvantages in your work?
51. Do you think that it is very difficult to get a real pleasure from a party?
52. Do you worry that you are worse in something than others?
53. Is it difficult for you to make the recovery into a boring company?
54. Does it sometimes happen that you are talking about the thing which you don`t understand at all?
55. Do you like to make a fun over somebody?
56. Are you suffering from insomnia?

The keys to Isenk scale

Extraversion	Neurotism	Untruth
1 yes	2 yes	6 yes
3 yes	4 yes	12 no
5 no	7 yes	18 no
8 yes	9 yes	24 yes
10 yes	11 yes	30 no
13 yes	14 yes	36 yes
15 no	16 yes	42 no
17 yes	19 yes	48 no
20 no	21 yes	54 no
22 yes	23 yes	
25 yes	26 yes	
27 yes	28 yes	
29 no	31 yes	
32no	33 yes	
34 no	35 yes	
37 no	38 yes	
39 yes	40 yes	
41 no	43 yes	
44 yes	45 yes	
46 yes	47 yes	
49 yes	50 yes	
51 no	52 yes	
53 yes	55 yes	
56 yes		

The literature

Basic

1. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.

Additional

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011, P.833-847.

2. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2015. – 750 p.
3. E.B. Babsky, B.I. Khodorov, G.I.. Kositsky, A.A.Zubkov Human physiology. Mir Publishers Moscow, 1975, V.2, V.2, P. 353-355, 365-376.

FOR NOTES

FOR NOTES

Control lesson 19.

Practical skills in Visceral systems` physiology and higher integrative functions

1.Educational aims:

The control of mastering module №2 "Visceral systems` physiology and higher integrative functions" in accordance to concrete aims of the current modules №8-15 permits to display student`s successfulness in the realization of the following end aims of the discipline:

- *To make conclusions about the state of the physiological functions of an organism, its systems and organs*
- *To analyse the age percularities of an organism`s functions and their regulation.*
- *To analyse the regulated parameters and make conclusions about the mechanisms of nervous and humoral regulation of the physiological functions of an organism and its systems*
- *To analyse the state of man`s health in different conditions on the base of physiological criteria*
- *To explain physiological base of the researched methods of organism`s functions*
- *To explain the mechanisms of integrative activity of an organism.*

2.The basal level of preparation

Students have practical skills from the previous studying disciplines:

The previous disciplines	Received skills
Human anatomy	*To analyze the information about structure of a human body, its systems, organs and tissues*
Histology, cytology, embryology	*To interpret microscopic and submicroscopic structures of the cells*
Medical biology	*To explain the regularities of the vital activity of a human organism on molecular-biological and cell levels*
Medical and biological physic	*To treat the general physical and biophysical regularities lying in the base of a human vital activity*
Physiology (Part 1: "General physiology")	*To interpret mechanisms and regularities of functioning of the excitable structures of an organism* *To analyse the state of sensory processes to privide the life activity of a man*

3.The task for independent work during the preparation for the control lesson

3.1.*Theoretical questions*

Semantic module 8. The system of blood

1. General characteristics of the system of blood. Blood components and its functions. The notion about hemostasis.
2. Electrolits of blood plasma. Osmotic pressure of blood and its regulation.
3. Ptoteins of blood plasma, their functional significance. Sedimentation rate of erythrocytes (SRE).
4. Oncotic blood pressure and its role.
5. Acid-base equilibrum of blood, the role of blood buffer systems to support its constancy.
6. Erythrocytes, their functions. Regulation of erythropoesis.
7. Types of hemoglobine and its derivants, their physiological significance.
8. Leucocytes, their functions. Regulation of leucopoesis. Physiological leucocytosis.
9. Thrombocytes, their physiological role.
10. Vessels-thrombocytic hemostasis, its mechanisms and physiological significance.
11. Coagulative hemostasis, its mechanisms and physiological significance.
12. Coagulants, anticoagulants, factors of fibrinolisis, their physiological significance.

13. Physiological characteristics of AB0 system. The conditions for blood compartability of donor and recipient. The tests before blood transfusion. Physiological characteristics of blood rhesus-system (CDE).
14. The significance of blood grouping in rhesus system at blood transfusion and pregnancy.

Semantic module 9. The system of blood circulation

1. General characteristics of the system of blood circulation. Factors which provide the blood movement in vessels, its movement in one direction and without interruptions.
2. Heart automatia. Gradient of automatia. Stannius`s experiment.
3. Action potential of atypical cardiomyocytes of sino-atrial node, the mechanisms of origin, its physioligical role.
4. The conductive system of the heart. The consequence and velocity of excitation transmission in the heart.
5. The action potential of typical cardiomyocytes of the ventricles, mechanisms of origin, its physiological role. Correlation in time the action potential and the single contraction of miocardium.
6. Refractority periods during the action of typical cardiomyocytes development, their significance.
7. Excitation-contraction coupling in miocardium. The mechanisms of miocardium`s contraction and relaxation.
8. Vector theory of ECG formation. ECG leads, the origin of ECG waves, segments and intervals.
9. Cardiac cycle, its phases, their physiological role.
10. The role of the heart`s valves. The heart sounds, mechanisms of their origin, phonocardiogragy, its analyses.
11. Arterial pulse, its origin. Sphygmogramm, its analyses.
12. The miogenic mechanisms of heart activity regulation.
13. The character and mechanisms of sympathetic nerves action on the heart activity. The role of sympathetic reflexes in regulation of heart activity.
14. The character and mechanisms of parasympathetic nerves action on the heart activity. The role of parasympathetic reflexes in regulation of heart activity.
15. Humoral regulation of heart activity. Dependence of heart activity on ionic content of blood.
16. The percularities of structure and functions of different blood vessels. The main low of hemodynamic.
17. The significance of blood viscosity for blood circulation.
18. The volume and linear speed of blood movement in different parts of the system of blood circulation. The factors which act on its value.
19. Blood pressure and its changes in different parts of the system of blood circulation.
20. Arterial pressure and the factors which act on its value. The methods of arterial pressure registration.
21. Blood circulation in capillars. The mechanisms of liquid exchange between blood and tissues.
22. Blood circulation in viens, the action of gravitation on it. The factors which act on the value of vien`s pressure.
23. The tone of arterioles and venules, its sugnificance. The action of vasomotor nerves on vessels` tone.
24. Miogenic and humoral regulation of vessels` tone. The role of substanses which are secreted by vessels` endothelium in vessels` tone regulation.
25. Hemodynamic center. Reflex regulation of vessels` tone. Pressoric and depressoric reflexes.
26. Reflex regulation of blood circulation at the changes of body position in the space. (ortostatic probe).
27. Regulation of blood circulation at muscle work.
28. Percularities of blood circulation in brain vessels and its regulation.
29. Percularities of blood circulation in heart vessels and its regulation.
30. Percularities of lung` blood circulation and its regulation.
31. Mechanisms of lymph formation. The lymph movement in the vessels.

Semantic module 10. The system of respiration

1. General characteristics of the system of respiration. The main stages of respiration. Biomechanic of inspiration and expiration.
2. Elastic recoil of lungs, negative intrapleural pressure.
3. Breathing. The parameters of breathing and their estimation.
4. Anatomical and physiological dead space, its physiological role.
5. Gas diffusion in lungs. Dissusing lings capacity and factors which it depends on.
6. Oxygen transport by blood. Oxygen blood capacity.
7. The curve of hemoglobine saturation and factors acting on its replacement.
8. Carbone dioxide transport by blood. Erythrocytes` role in carbone dioxide transport.
9. Physiological role of respiratory passegeways, its diameter regulation.
10. Respiratory center, its structure, regulation of the rhythm of breathing.
11. The mechanism of first inspiration of a newborn baby.
12. The role of receptors of lungs stretching and vagus afferent fibres in regulation of respiration.
13. The role of central and peripheric chemoreceptors in regulation of respiration.
14. The compotents of blood which stimulate breathing.
15. Regulation of respiration under physical exercises.

Semantic module 11. The system of digestion

1. General charasteristics of the system of digestion. Digestion in oral cavity. Mastication, swallowing.
2. Composition of saliva, its role in digestion.
3. Mechanisms of saliva formation, primary and secondarysaliva.
4. Regulation of saliva secretion. Influence of irritant`s properties on the quantityand quality of saliva.
5. Methods of research of secretory function of man`s stomach. Compositionand propertiesof gastric juice. Mechanisms of hydrochloric acid secretion.
6. "Cephalic" phase of gastric secretion regulation.
7. Neurohumoral ("gastric" and "intestinal") phase of gastric secretion regulation. Enteral stimulators and inhibitors of gastric secretion.
8. Nervous and humoral mechanisms of gastric secretion inhibition.
9. Moving function of stomach and its regulation. Mechanisms of gastric content transition into duodenum.
10. Methods of research of pancreatic juice secretion of a man. Composition and properties of pancreatic juice.
11. Phases of pancreas`s secretory function regulation.
12. Methods of research of bile excretion of a man. Composition and properties of bile.
13. Regulation of bile formation and bile excretion. Mechanisms of bile excretion into duodenum.
14. Composition and properties of intestinal juice. Regulation of its secretion. Cavitary and membraneus digestion.
15. Absorbtion in alimentary channel. Mechanisms of sodium ions, water, carbonhydratess, albumens, fats absorbtion.
16. Moving function of bowels, types of contraction, their regulation.
17. Physiology mechanisms of hunger and satisfaction. The role of leptins.

Semantic module 12. Energetic metabolism

1. Sources and ways of energy usage in a human organisn.
2. Methods of determination of energy wastes of a human organism. Respiratory coefficient (respiratory ratio)
3. Basal metabolic rate and conditions for its determination, factors which influence on its value.
4. Working metabolic rate, the significance of its determination.

Semantic module 13.Thermoregulation

1. Body temperature and its day-night deviations.
2. Physiological significance of homoiotermia. The center of thermoregulation, thermoreceptors.
3. Heart production in an organism and its regulation.
4. Heat emission in an organism and its regulation.

5. The regulation of the constancy of body temperature at different environment temperature.
6. Physiological base of adaptation to the cold

Semantic module 14. The system of excretion

1. General characteristics of the system of excretion. Kidneys` role in excretory processes. Percularities of renal blood flow.
2. Mechanisms of urine formation. Glomerular filtration and factors it depends on.
3. Tubular reabsorbtion and secretion in nephrone, its physiological mechanisms.
4. Countercurrent multiplayer of the nephrone, its physiological mechanisms and role.
5. Regulation of sodium ions and water reabsorbtion in the tubules of nephrone.
6. Kidneys participation in isoosmia support. The mechanism of thurst.
7. Kidneys participation in isovolumia support.
8. Kidneys` participation in the regulation of the constancy of acid-base equilibrum of blood.
9. Urine excretion and its regulation.

Semantic section 15. Higher integrative functions of the nervous system

- ***Physiologycal bases of behavior***

1. Biological forms of behaviour. Inborn forms of behaviour. Instincts, their physiological role.
2. Aquired forms of behaviour. Conditions for formation of conditional reflexes , their differences from unconditional ones.
3. Memory, types and mechanisms of formation.
4. Needs and motivations, their role in behaviour formation.
5. Emotions, mechanisms of formation, biological and information theory of emotions, biological role.
6. Age features of behavior of children and elderly people.

- ***Percularities of the human higher nervous activity***

1. Brain neocortical functions and the human higher nervous activity..
2. Biological and informational theories of emotions, their role in behaviour formation.
3. Functional assimetry of cortex of large hemisphears, its integrative function.
4. Speech, its functions, physiological base of formation.
5. Thinking. Development of abstract thinking of a man. Brain structures` role in the thinking process.
6. Types of higher nervous activity . Temperament and character.
7. Sleeping, its types, phases, cortical electrical activity, physiological mechanisms.
8. Age aspects of higher nervous activity of a man.

- ***Physiological bases of labor activity and sports***

1. Physiological bases of human working activity.
2. Percularities of physical and mental work. Optimal regimes of work.
3. Physiological mechanisms of tiredness. Active rest and its mechanisms.
4. Age changes of capacity for work in a man.
5. Physiological bases of sport. The principles of optimal regimes for training.
6. Sleeping, its types, phases, cortical electrical activity, physiological mechanisms.

3.2.*Practical skills*

1. Determine hemoglobine content in blood by Sahli`s method, estimate the results.
2. Determine the group of researched blood in AB0 system, make the conclusions.
3. Calculate colour parameter (color index). Make the conclusions
4. Determine hematocrit, make the conclusions.
5. Define the level of arterial pressure of a researched person, make the conclusion.
6. Define the direction and amplitude of the ECG waves in the II standart lead. Make the conclusions.
7. On the base of ECG analyses calculate the duration of P-Q interval. Make the conclusions.
8. On the base of ECG analyses calculate the duration of Q-T interval. Make the conclusions.
9. On the base of ECG analyses calculate the duration of QRS interval. Make the conclusions
10. On the base of ECG analyses define what structure is the pacemaker of heart. Argumantate your conclusion.

11. Calculate by spirogram tidal volume, vital lungs capacity. Make the conclusions.
12. Calculate by spirogram inspiratory reserve volume and expiratory reserve volume. Make the conclusions.
13. Calculate by spirogram minute respiratory volume. Make the conclusion.
14. Calculate by spirogram maximum lungs ventilation. Make the conclusion.
15. Calculate by spirogram breathing reserve. Make the conclusions.
16. Determine by spirogram oxygen utilization in the state of rest and during first minute after exercises. Make the conclusions.
17. Determine by spirogram oxygen utilization in the state of rest and during 3 minutes after exercises. Make the conclusions.
18. Fulfill the tests with the maximum breath hold. Make the analyses of the results.
19. Determine basal metabolic rate with the help of spirogramm, which has been registrated in standart conditions, make the conclusion.
20. How and why will saliva secretion change after atropine injection to the man?
21. Estimate the secretory function of a man`s stomach.
22. Why do they recommend a milk diet at the increase of gastric juice acidity?
23. How and why will the secretion of pancreatic juice change with the diminishing of gastric juice acidity?
24. How will the diminishing of bilious acids content in a bile be reflected on the process of digestion? Why?
25. Offer the facilities to increase the moving function of bowels. Give their physiology argumentation.
26. How and why will quantity and composition of gastric and pancreatic juices change at the receipt of fats into duodenum?
27. How and why will quantityand composition of gastric and pancreatic juices change at the receiptof cabbage juice intothe stomach?
28. Determine glomerular filtration rate (GFR), make the conclusion.
29. Determine the value of water reabsorbtion in nephrone. Make the conclusion.
30. Estimate the results of kidneys` function by Zymnytsky test. Make the conclusion.
31. Evaluate the state of the body during exercise in terms of function.
32. Draw diagrams explaining the formation of biological forms of behavior and interpret the mechanisms of each of its stages, the role of emotions in behavior.
33. Assess and interpret the results of studies characterizing the types of HNA of a person.
34. To estimate the state of an organism under the physical loading using the functional parameters.

5.The regulations of control lesson

The duration of a control lesson is 2 academical hours.

The control of student`s level of preparation during the control lesson is spend according to the following regulations:

1) Computer`s test control (during 45 minutes: consists of fulfillment of 60 tests in which a student has to chose only one right answer).

2) During the left time a student decides situational tasks, draws the diagramms, grafs and counturs of regulation, other integrative tasks in which the student can display abilities to analyze and to interpret preposed situational tasks and to make right based conclusions.

Some integrated situational tasks are proposed to a student, which permits to display the successful mastering of module №1. The check up of studying tasks is fulfilled by a teacher during the control lesson as far as they fulfilled by a student. The tasks are standartizated and are directed on the control of end aims of discipline during the semantic modules studying.

Protocol of control lesson № 19. "____"_____20___

Computer`s test control:

Solve the tasks:

Protocol revised_____
(date, Preceptor's signature)

The literature

Basic

1. V.M.Moroz, O.A.Shandra, R.S.Vastyanov, M.V.Yoltukhivsky, O.D.Omelchenko. Physiology. Vinnytsia: NOVA KNYHA PUBLISHERS, 2011. – 912 p.

Additional

1. Guyton and Hall Textbook of medical physiology. John E. Hall, 13th ed. Elsevier Inc. 2016. – 1168 p.
2. Ganong's Review of Medical Physiology 25th ed. McGraw-Hill Education. 2015. – 750 p.
3. Human Physiology. Fox I., 8th edition. By the McGraw-Hill Companies, USA, 2004. – 727 p.
4. Human Physiology: The Mechanism of Body Function. Vander et alls, 9th edition, 2004. – 800 p.
5. Human Physiology. E.B.Babsky, B.I.Khodorov, G.I.Kositsky, A.A.Zubkov, Mir Publishers Moscow, 1975. – V.1, P. 64-68, 75-82; 146-166; 168-248; 256-290; 309-359.

FOR NOTES

APPENDIX

Table 1

Proper basal metabolic rate in ***youthes*** and ***men***
a) quantity of kilocalories according to weight (number A) (by Harris-Benedict)

weight	Kilo-calories	weight	Kilo-calories	weight	Kilo-calories	weight	Kilo-calories	weight	Kilo-calories
50	754	62	918	74	1084	86	1249	98	1414
51	768	63	933	75	1098	87	1263	99	1428
52	782	64	947	76	1112	88	1277	100	1442
53	795	65	960	77	1125	89	1290	101	1455
54	809	66	975	78	1139	90	1304	102	1469
55	823	67	988	79	1153	91	1318	103	1483
56	837	68	1002	80	1167	92	1332	104	1497
57	850	69	1015	81	1180	93	1345	105	1510
58	864	70	1029	82	1194	94	1459	106	1524
59	878	71	1043	83	1208	95	1373	107	1538
60	892	72	1057	84	1222	96	1387	108	1552
61	905	73	1070	85	1235	97	1400	109	1565

b) quantity of kilocalories accordance to height and age for ***men*** 16-28 years old (number B)

height	age (years old)												
In cm	16	17	18	19	20	21	22	23	24	25	26	27	28
156	725	713	698	678	661	639	632	625	618	612	605	598	591
160	761	743	726	708	690	659	652	645	638	632	625	618	611
164	794	773	775	738	721	679	672	665	658	652	645	638	631
168	820	803	785	768	745	699	692	685	678	672	665	658	651
172	840	828	806	788	760	719	712	705	698	692	685	678	671
176	860	843	825	808	788	739	732	725	718	712	705	698	691
180	880	863	845	828	809	759	752	745	739	732	725	718	711
184	903	883	865	848	830	779	772	765	758	752	745	738	731
188	920	903	885	868	850	799	792	785	779	772	765	758	751
192	940	923	906	888	871	819	812	805	799	792	785	778	771

Basal metabolic rate (Kilocalories/24 hours) = number A + number B

Table 2

Proper values of lungs volumes and capacities
which are determined of basal metabolic rate in ***men***

Basal metabolic rate (Kilocalories/24 h)	Lungs volumes and capacities, ml							
	Minute respiratory volume	Minute alveolar ventilation	Oxygen consumption per 1 minute	Maximum lungs ventilation	Breathing reserve	Vital lungs capacity	Inspiratory-expiratory reserve volume	Tidal volume
1350	4772	2863	191	61425	56653	3614	1544	422
1360	4805	2883	192	61880	57075	3640	1556	424
1370	4842	2905	194	62335	57493	3666	1567	428
1380	4877	2926	195	62790	57913	3692	1578	432
1390	4915	2949	197	63245	58330	3718	1590	434
1400	4950	2970	198	63700	58750	3744	1601	438
1410	4985	2991	199	64155	59170	3770	1613	440
1420	5020	3012	201	64610	59590	3796	1624	444
1430	5050	3033	202	65065	60010	3822	1635	448
1440	5090	3054	204	65520	60430	3848	1647	450
1450	5125	3075	205	65975	60850	3874	1658	454
1460	5162	3097	206	66430	61268	3900	1670	456
1470	5197	3118	208	66885	61688	3926	1681	460
1480	5232	3139	209	67340	62108	3952	1693	462

1490	5257	3154	210	67795	62538	3978	1704	466
1500	5325	3195	212	68250	62925	4004	1716	467
1510	5337	3212	213	68705	63368	4030	1727	472
1520	5372	3223	215	69160	63778	4056	1738	476
1530	5410	3246	216	69515	64105	4082	1750	478
1540	5445	3267	218	70070	64625	4108	1761	482
1550	5480	3288	219	70425	64945	4134	1773	484
1560	5515	3309	221	70780	65265	4160	1784	488
1570	5550	3330	222	71435	65885	4186	1796	490
1580	5595	3351	223	71890	66305	4212	1807	494
1590	5620	3372	225	72345	66725	4238	1818	498
1600	5657	3395	226	72800	67143	4264	1830	500
1610	5692	3415	228	73255	67563	4290	1841	504
1620	5727	3436	229	73710	67983	4316	1853	506
1630	5762	3457	230	74165	68403	4342	1864	510
1640	5797	3478	232	74620	68823	4368	1876	512
1650	5832	3499	232	75075	69234	4394	1887	516
1660	5867	3520	235	75530	69663	4420	1899	518
1670	5905	3543	236	75985	70080	4446	1910	522
1680	5935	3571	237	76440	70505	4472	1921	526
1690	5975	3585	239	76895	70920	4498	1933	528
1700	6010	3606	240	77350	71340	4524	1944	532
1710	6045	3627	242	77805	71760	4550	1956	534
1720	6080	3648	243	78260	72180	4576	1967	538
1730	6115	3669	245	78715	72600	4602	1979	540
1740	6152	3691	246	79170	73018	4628	1990	544
1750	6187	3712	247	79725	73538	4654	2002	546
1760	6225	3735	249	80080	73855	4576	2013	550
1770	6257	3754	250	80535	74278	4602	2024	554
1780	6292	3775	252	80990	74698	4628	2036	556
1790	6327	3796	253	81445	75118	4654	2047	560
1800	6362	3817	254	81900	75538	4680	2059	562
1810	6400	3840	256	82355	75955	4706	2070	566
1820	6435	3861	257	82810	76375	4732	2082	568
1830	6470	3882	259	83265	76795	4758	2093	572
1840	6505	3903	260	83755	76250	4787	2104	576
1850	6540	3924	262	84175	77635	4810	2116	578
1860	6575	3945	263	84630	78055	4836	2127	582
1870	6610	3966	264	85085	78475	5862	2139	584
1880	6647	3988	266	85610	78993	4888	2150	588
1890	6690	4014	268	85995	79305	4914	2162	590
1900	6717	4030	269	86450	79733	4940	2173	594
1910	6751	4051	270	86905	80163	4966	2185	596
1920	7687	4072	271	87360	80573	4992	2196	600
1930	6822	4093	273	87815	80993	5018	2207	604
1940	6857	4114	274	88270	81413	5044	2219	606
1950	6895	4137	276	88725	81830	5070	2231	608
1960	6930	4158	277	89180	82250	5096	2242	612
1970	6965	4179	279	89635	82670	5122	2254	614
1980	7000	4200	280	90090	83090	5148	2265	618
1990	7035	4221	281	90545	83510	5174	2276	622

Table 3

Proper basal metabolic rate in ***young girls*** and ***women***

a) quantity of kilocalories according to weight (number A) (by Harris-Benedict)

weight	Kilo-calories	weight	Kilo-calories	weight	Kilo-calories	weight	Kilo-calories
50	1133	60	1229	70	1325	80	1420
51	1143	61	1238	71	1331	81	1430
52	1152	62	1248	72	1344	82	1439
53	1162	63	1258	73	1353	83	1449
54	1172	64	1267	74	1363	84	1458
55	1181	65	1277	75	1372	85	1468
56	1191	66	1286	76	1382	86	1478
57	1200	67	1296	77	1391	87	1487
58	1210	68	1305	78	1401	88	1497
59	1219	69	1315	79	1411	89	1506

b) quantity of kilicalories accordance to height and age for ***women*** 16-28 years old (number B)

height	age (years old)												
In cm	16	17	18	19	20	21	22	23	24	25	26	27	28
148	206	201	197	192	188	178	170	167	161	156	152	147	142
152	221	215	210	206	298	283	178	174	169	164	160	155	150
156	235	229	224	220	209	190	186	181	176	172	167	162	158
160	250	243	239	234	219	198	193	188	184	179	174	170	165
164	263	255	250	246	229	205	200	196	191	186	182	177	172
168	276	267	263	258	239	213	208	203	199	194	189	184	180
172	289	279	274	270	249	220	215	211	206	201	197	192	187
176	302	291	287	282	259	227	223	218	213	209	204	199	195
180	315	303	298	294	268	235	230	225	221	216	211	207	202
184	318	313	309	304	277	242	237	233	228	223	219	214	209

Basal metabolic rate (Kilocalories/24 hours) = number A + number B

Table 4

Proper values of lungs volumes and capacities
which are determined of basal metabolic rate in ***women***

Basal metabolic rate (Kilocalories/24h)	Lungs volumes and capacities, ml							
	Minute respiratory volume	Minute alveolar ventilation	Oxygen consumption per 1 minute	Maximum lungs ventilation	Breathing reserve	Vital lungs capacity	Inspiratory-expiratory reserve volume	Tidal volume
1200	4242	2345	170	48300	44058	2760	1214	332
1210	4277	2566	171	48685	44408	2783	1224	335
1220	4312	2587	172	49105	44793	2806	1234	338
1230	4347	2608	174	49490	45143	2829	1244	341
1240	4382	2629	175	49910	45528	2852	1254	344
1250	4420	2652	176	50295	45875	2875	1265	346
1260	4455	2673	178	50715	46260	2898	1275	348
1270	4490	2694	179	51100	46610	2921	1285	351
1280	4525	2715	181	51520	46995	2944	1295	354
1290	4560	2736	182	51905	47345	2967	1305	357
1300	4595	2757	184	52325	47750	2990	1315	360
1310	4630	2771	185	52710	48080	3013	1325	363
1320	4667	2800	186	53130	48463	3036	1335	366
1330	4700	2820	187	53480	48780	3056	1344	368
1340	4737	2842	189	53935	49198	3082	1356	370
1350	4772	2863	191	54320	49548	3105	1366	373
1360	4805	2883	192	54740	49935	3128	1381	377
1370	4842	2905	194	55125	50283	3151	1385	379

1380	4877	2926	195	55545	50668	3174	1396	382
1390	4915	2949	197	55930	51015	3197	1406	385
1400	4950	2970	198	56350	51400	3220	1416	388
1410	4985	2991	199	56735	51750	3213	1426	391
1420	5020	3012	201	57155	52135	3266	1437	394
1430	5055	3033	202	57540	52485	3289	1446	396
1440	5090	3054	204	57960	52870	3312	1457	398
1450	5125	3075	205	58345	53220	3335	1467	401
1460	5162	3097	206	58765	53603	3558	1477	404
1470	5197	3118	208	59150	53953	3381	1487	407
1480	5232	3139	209	59570	54338	3404	1497	410
1490	5257	3154	210	59955	54698	3427	1507	413
1500	5300	3180	212	60375	55050	3450	1518	415
1510	5337	3212	213	60760	55403	3473	1528	417
1520	5372	3223	215	61180	55808	3498	1538	420
1530	5410	3246	216	61565	56153	3519	1548	423
1540	5445	3267	218	61985	56540	3542	1558	426
1550	5480	3288	219	62370	56890	3565	1568	429
1560	5515	3309	221	62790	57275	3588	1578	432
1570	5550	3330	222	63175	57625	3611	1588	435
1580	5585	3351	223	63595	58010	3634	1598	437
1590	5620	3372	225	63980	58360	3657	1609	439
1600	5657	3394	226	64400	58743	3680	1619	442
1610	5692	3415	228	64785	59093	3703	1629	445
1620	5721	3436	229	65205	59478	3726	1639	448
1630	5762	3457	230	65590	59828	3749	1649	451
1640	5797	3478	232	66010	60213	3772	1659	454
1650	5832	3499	233	66395	60563	3795	1669	457
1660	5867	3520	235	66815	60948	3818	1679	460
1670	5905	3543	236	67200	61295	3841	1690	462
1680	5935	3571	237	67620	61685	3864	1700	464
1690	5975	3586	239	68005	62030	3887	1710	467
1700	6010	3605	240	68425	62415	3910	1720	470
1710	6045	3627	242	68810	62765	3933	1730	473
1720	6080	3648	243	69230	63150	3956	1740	476
1730	6115	3669	245	69615	63500	3979	1750	478
1740	6152	3691	246	70035	63883	4002	1761	480
1750	6187	3712	247	70420	64233	4025	1771	483
1760	6225	3735	249	70840	64615	4048	1781	486
1770	6257	3764	250	71225	64968	4071	1791	488
1780	6292	3775	252	71645	65353	4094	1801	491
1790	6327	3796	253	72030	65703	4117	1811	495
1800	6362	3817	254	72450	66088	4140	1821	498
1810	6400	3840	256	72835	66435	4163	1831	501
1820	6435	3861	257	73255	66820	4186	1841	504
1830	6470	3882	259	73640	67140	4209	1851	506
1840	6505	3903	260	74060	67555	4234	1862	508
1850	6540	3924	262	74445	67905	4255	1872	511
1860	6575	3945	263	74865	68290	4278	1882	514
1870	6610	3966	264	75255	68640	4301	1892	517
1880	6647	3988	266	75670	69023	4324	1902	520
1890	6690	4014	268	76055	69365	4347	1912	523
1900	6717	4030	269	76475	69758	4370	1922	526

Table 5

Value of caloric equivalent of 1 liter oxygen
at different value of respiratory coefficient (ratio)

Respiratory coefficient (ratio	Caloric equivalent of oxygen	Respiratory coefficient (ratio	Caloric equivalent of oxygen
0,70	4,686	0,86	4,875
0,71	4,690	0,87	4,887
0,72	4,702	0,88	4,900
0,73	4,714	0,89	4,912
0,74	4,727	0,90	4,924
0,75	4,739	0,91	4,936
0,76	4,752	0,92	4,948
0,77	4,764	0,93	4,960
0,78	4,776	0,94	4,973
0,79	4,789	0,95	4,985
0,80	4,801	0,96	4,997
0,81	4,813	0,97	5,010
0,82	4,825	0,98	5,022
0,83	4,838	0,99	5,034
0,84	4,850	1,00	5,047
0,85	4,863		

Table 6

Table for body surface determination (m^2)
using the parameters of height and weight
(by DuBois`s method)

height (cm)	Weight (Kg)						
	50	55	60	65	70	75	80
190	1,70	1,77	1,84	1,90	1,96	2,02	2,08
185	1,67	1,74	1,80	1,86	1,92	1,98	2,04
180	1,64	1,71	1,77	1,83	1,89	1,95	2,00
175	1,61	1,67	1,73	1,79	1,85	1,91	1,96
170	1,57	1,63	1,69	1,76	1,81	1,86	1,91
165	1,54	1,60	1,66	1,72	1,78	1,83	1,88
160	1,50	1,56	1,62	1,68	1,73	1,78	1,83
155	1,46	1,52	1,58	1,64	1,69	1,74	1,79
150	1,42	1,48	1,54	1,60	1,65	1,70	1,75

Table 7

Normal values of stomach secretion parameters

Parameter	On empty stomach	Basal secretion	Submaximum dose of histamine (0,008 mg/Kg)
Volume of stomach juice ml/hour	0-50	50-100	100-140
PH	1,4-1,3	1,4-2,0	1,1-1,2
General acidity mmol/l	0-40	28-48	78-98
Content of free HCl mmol/l	0-20	20-40	70-90
Debit -hour HCl mmol/l	-	1,5-5,5	8-14
Debit-hour of free HCl mmol/l	-	1-4	6,5-12
Volume of acid component ml/hour	до 21	21-51	68-90
Volume of main component mL/hour	до 29	29-49	30-50
Digestive force by Mett, mm	3	3-6	3-8

Table 8

Digestive enzymes of alimentary channel

Secretory glands	**Enzymes (ible form+ its activators)**	**Substrate of hydrolisis**	**Products of hydrolisis**
Salivatory glands	α-amylase (Cl^{-})	starch	dextrins, maltotriose and i maltose
Tongue glands	lingual lipase	Triglycerides	Fatty acids and 1,2 diacylglycerol
Stomach glands	Pepsins (pepsinogen + HCl)	Proteins and polypeptides	polypeptides
	Gastric lipase	Triglycerides	Fatty acids and glycerol
Pancreas - acini cells	trypsin (trypsinogen + enterokinase)	Proteins and polypeptides	Amino acids
	chymotrypsin (chymotrypsinogen + trypsin)	Proteins and polypeptides	Amino acids
	Carboxypeptidases A, B (procarboxypeptidases A,B + trypsin)	Proteins and polypeptides	Amino acids
	elastase (proelastase + trypsin)	elastin	Amino acids
	pancreatic lipase	Triglycerides	Monoglycerids and fatty acids
	colipase (procolipase + trypsin)	Drops of fats	Helps to action of active sites of lipase
	Cholesterol esterase	ethers of cholesterol	cholesterol
	pancreatic α-amylase (Cl^{-})	starch	dextrins, maltotrioses and maltoses

	ribonuclease	RNA	nucleotides
	Deoxyribonuclease	DNA	nucleotides
	phospholipase A_2 (prophospholipase A_2 + trypsin)	Phospholipids	Fatty acids, lysophospholipids
Mucus shell of small interstine	enterokinase	trypsinogen	trypsin
	aminopeptidase	polypeptides	Amino acids
	carboxypeptidase	polypeptides	Amino acids
	endopeptidases	polypeptides	Hydrolysis in the middle of peptide
	dipeptidases	dipeptides	Two amino acids
	maltase	maltose, maltotriose, α-dextrins	glucose
	lactase	lactose	Galactase and glucose
	Sucrase	sucrose, maltotriose and maltose	Fructose and glucose
	α-dextrinase	α-dextrins, maltose, maltotriose	glucose
	Trehalase	trehalose	glucose
	nuclease	Nucleic acids	Pentoses and purin and pyrimidine bases

FOR NOTES

Educational edition

Alla V. Gumeniuk, Ph.D.
Ighor M. Karvatsky, Ph.D.
Uliana V. Konyk, Ph.D.
Oleksandra A. Mozjeitova, Ph.D.
Natalia V. Motorna, Ph.D.
Mykola M. Mykula, Ph.D.
Klaudia V. Nesvitaylova, Ph.D.
Iryna G. Strokina, Ph.D.
Kateryna V. Tarasova, Ph.D.
Olena O. Vinogradova-Anik, Ph.D.

Translated by I.G.Strokina, Ph.D., O.O.Vinogradova-Anik, Ph.D.

Practical works in physiology

Manual for practical studies and individual work of stomatological faculty students

Edited by associate professor **I.M.Karvatsky**

Комп'ютерна верстка та дизайн – *І.М.Карвацький*

Practical works in physiology. Edited by I.M.Karvatsky. Manual for practical studies and individual work of stomatological faculty students. 2-th Vol. – Kyiv. Книга-плюс, 2021. V.2 – 184 p.

Формат 70×100/16. Папір офсетний. Друк офсетний. Ум. друк. арк. 15,3.
Підписано до друку 29.03.2021 р. Зам. №19-124. Наклад 100