МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ

УЧРЕЖДЕНИЕ ОБРАЗОВАНИЯ
«ГОМЕЛЬСКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ»

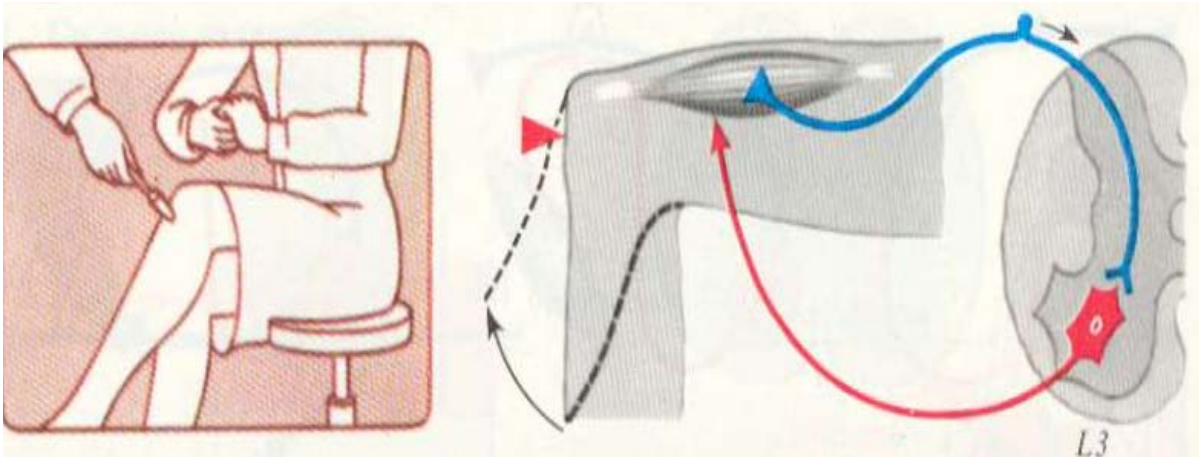
Кафедра нормальной физиологии

РУКОВОДСТВО К ПРАКТИЧЕСКИМ ЗАНЯТИЯМ ПО НОРМАЛЬНОЙ ФИЗИОЛОГИИ

Учебно-методическое пособие
для студентов 2 курса
факультета по подготовке специалистов для зарубежных стран,
обучающихся на английском языке,
учреждений высшего медицинского образования

TEACHING AID FOR PRACTICAL CLASSES ON NORMAL PHYSIOLOGY

The educational methodological text-book
for 2th year English medium medical students
of the Faculty of General Medicine
for overseas students of medical university



Гомель
ГомГМУ
2018

УДК 612 (072) (076.5)
ББК 28.707.3я 73
Р 85

Авторы:
В. А. Мельник, Ю. И. Брель, С. Н. Мельник, Я. И. Фащенко

Рецензенты:
кандидат биологических наук, доцент,
заведующий кафедрой нормальной физиологии
Витебского государственного ордена Дружбы народов
медицинского университета
С.С. Лазуко;
кандидат биологических наук, доцент,
доцент кафедры зоологии, физиологии и генетики
Гомельского государственного университета им. Ф. Скорины
Д. Н. Дроздов

Под редакцией В. А. Мельника

Р 85 **Руководство к практическим занятиям по нормальной физиологии:** учеб.-метод. пособие для студентов 2 курса факультета по подготовке специалистов для зарубежных стран, обучающихся на английском языке, учреждений высшего медицинского образования = Teaching aid for practical classes on normal physiology: the educational methodological text-book for 2th year English medium medical students of the Faculty of General Medicine for overseas students of medical university / В. А. Мельник [и др.] / под ред. В. А. Мельника; пер. на англ. яз. Ю. И. Брель, С. Н. Мельник, В. А. Мельника. — Гомель: ГомГМУ, 2018. — 108 с.

ISBN 985-985-588-084-5

Представлены лабораторные работы по физиологии крови, физиологии возбудимых тканей, общей и частной физиологии центральной нервной системы, физиологии дыхания, сердечно-сосудистой системы, пищеварения, физиологии обмена веществ и энергии, терморегуляции, физиологии выделения, сенсорных систем и высшей нервной деятельности, необходимые для проведения практических занятий по данным разделам нормальной физиологии. Изучение методик лабораторных работ, включенных в пособие, позволит закрепить полученные теоретические знания и освоить некоторые важные клинико-диагностические методы исследования.

Предназначено для студентов 2 курса факультета по подготовке специалистов для зарубежных стран, обучающихся на английском языке, учреждений высшего медицинского образования.

Утверждено и рекомендовано к изданию научно-методическим советом учреждения образования «Гомельский государственный медицинский университет» 20 июня 2018 г., протокол № 4.

УДК 612 (072) (076.5)
ББК 28.707.3я 73

ISBN 978-985-588-084-5

INTRODUCTION

The present methodological tutorial has been developed to conduct laboratory classes in Normal Physiology for English medium students of the Faculty of General Medicine for Overseas Students. The content of the tutorial meets the Normal Physiology Program for students of higher medical schools approved by the Ministry of Health of the Republic of Belarus.

Teaching Normal Physiology to overseas students puts forward certain difficulties due to the absence of special references in English adapted for the curriculum in Normal Physiology. Hence, one of the main concerns for the Department staff was the development of an English-language tutorial in Normal Physiology.

The practical tutorial contains laboratory tasks in the physiology of blood, cardio-vascular system, respiration, digestion, metabolism and energies, thermoregulation, excretion, physiology of nervous system, sensory systems, higher nervous activity necessary for practical classes in these areas of Normal Physiology. The study of the laboratory task techniques included into the guidance makes it possible to improve the theoretical knowledge obtained and to learn the issues of the clinical diagnostic methods of inspection. In the end of each section there are main constants expressed in the International system of physical units.

ВВЕДЕНИЕ

Методическое пособие предназначается для проведения лабораторных работ по нормальной физиологии на английском языке со студентами факультета по подготовке специалистов для зарубежных стран. Материал пособия соответствует Программе по нормальной физиологии для студентов высших медицинских учебных заведений, утвержденной Министерством здравоохранения Республики Беларусь.

При организации учебного процесса по нормальной физиологии со студентами факультета по подготовке специалистов для зарубежных стран, обучающихся на английском языке одной из трудностей является отсутствие учебно-методической литературы, адаптированной к учебной программе по нормальной физиологии. Поэтому одной из важнейших задач, стоящих перед преподавателями кафедры, явилось составление и перевод на английский язык данного пособия.

В методическом пособии представлены лабораторные работы по физиологии крови, физиологии возбудимых тканей, общей и частной физиологии ЦНС, физиологии дыхания, сердечно-сосудистой системы, пищеварения, физиологии обмена веществ и энергии, терморегуляции, физиологии выделения, сенсорных систем и высшей нервной деятельности необходимые для проведения практических занятий по данным разделам нормальной физиологии. Изучение методик лабораторных работ включенных в пособие позволит закрепить полученные теоретические знания и освоить некоторые важные клинико-диагностические методы исследования. В конце каждого раздела приведены основные константы, выраженные в Международной системе физических единиц.

INSTRUCTIONS ON SAFETY RULES

INSTRUCTION № 1

Safety rules for students who work in a laboratory at the department of normal physiology

General requirements

1.1. Put on the white gown before coming into the building.

1.2. Each student is expected to work only at his working place. Walking to another place without teacher's permission is not permitted.

Before starting to work

2.1. Keep your working places clean from reactants glassware and devices you are not using at the moment or other things.

2.2. In the beginning of each lesson a teacher briefly instructs the students about safety rules while working with substance, a preparation, a device. The instruction is registered in a book.

During work

3.1. All tools for general use (scales, microscopes, devices for definition of melting temperature, boiling and filtering at low pressure, etc.) are taken separately.

3.2. Silence, order and cleanness should remain while working; do not be in a hurry or make a mess.

3.3. Visitors from outside, doing other things rather than work, or chatting are strongly prohibited.

3.4. Students cannot work in the laboratory if unattended by a teacher or an assistant; no unscheduled work is allowed in a lab without prior permission of a teacher.

3.5. Any experiments not connected with the purpose of a lesson are strongly prohibited in the lab.

3.6. Proceed to work only after having received safety instructions and teacher's permission.

3.7. before starting to work, it is necessary:

— to understand the technique of work;

— to ensure the device has been mounted or fixed properly.

3.8. Substances obtained during experiment should be kept in corresponding lab glassware with labels or clear notes made with wax pencil.

Upon termination of work

4.1. At the end of work it is necessary:

— to switch off water, gas, electricity;

— remove all reactants, clean glassware, devices;

— bring dirty glassware to the washing room.

4.2. All tools for general use (scales, microscopes, etc.) to be removed to cases or boxes.

4.3. Poisonous substances spilled on the floor or table are neutralized and removed under guidance of a teacher according to the rules.

In emergency conditions

5.1. In case of fire call fire brigade immediately by phone “101”.

5.2. Tell the commandant about the fire.

5.3. Start extinguishing the fire with fire extinguishers.

INSTRUCTION № 2

First aid at electric shock

Saving of those exposed to electric shock in most cases depends on how quickly and correctly the contact with an electricity source is terminated and safety measures are performed. Delay of first aid may cause death of an affected person.

If a victim person is in contact with an electric current, first release him from the electric current exposure AS SOON AS POSSIBLE. Initially switch off the device contacting the person from the electricity source. Mind the following:

a) if a person is standing at height, after switching off the electricity he may fall down. Make sure it is safe for him to fall down;

b) after switching off the electricity the lights may go out either. Make sure you have an alternative source of light (lamp, candle, torch, etc.);

Mind the following when separating a person from subjects under current:

a) at low voltage — DO NOT use metal objects to remove the current from the person;

b) USE ONLY dry piece of woods or other objects not conducting electricity to release the person from the current. You can touch only dry parts of his clothes and only in those places where it does not contact his body (e.g. lower end of a skirt);

c) at high voltage — put on galoshes, gloves and use bar or pincers.

If to release the person from the current as described is not possible, ground wires instantly according to general rules of safety measures. First aid depends on a person state after his release from the current. To evaluate his condition immediately do the following:

a) put him down on his back on a hard surface;

b) check if he is breathing or not;

c) find the pulse on the radial artery or wrist;

d) find out the size of his pupil (narrow or wide); wide pupil indicates poor blood supply of the brain.

If the person is in consciousness but had fainted before or was exposed to the current for a long time, sent him to a doctor.

If the person has lost his consciousness and his breathing is heavy or spastic, make him an artificial respiration. At the same time call for a doctor. Only doctor has the right to certify death of a person.

INSTRUCTION № 3

First aid rules

General rules

The first aid should be performed immediately and correctly as life and consequence of injuries, burns and poisonings depend on this.

In case of serious injury, burn or a poisoning call up for an ambulance immediately. With smaller injury after first aid has been made, the person is sent to the aid station or a clinics.

Keep the substance which has caused poisoning, before the doctor's coming.

In all cases an affected person must be provided with rest and fresh air (place him in a room with fresh air).

First aid at injuries

Different kinds of injuries during lab work may be caused by an explosion at work with glassware, improper use of instruments and in other cases.

First aid at wounds: wash up your hands with soap or treat it with alcohol. Examine the wound for the presence of foreign bodies (splinters of glass, scrap of clothes, papers, etc.) and remove them with forceps once detected. Clean the edges of the wound with a swab moistened with alcohol or clean water in the direction from the edges to outside of the wound. Then smear the edges (without touching the wound!) with iodine or a brilliant green. The wound can be treated with 3 % solution of hydrogen. Apply a bandage afterwards.

First aid at burns

Chemical burns. Chemical burns are caused by acids and alkalis, some metals at their burning, oxides and peroxides.

First aid: at burns of skin — wash off the liquid with water, neutralization of acids with weak solutions of soda (sodium bicarbonate), alkalis — with weak acids solutions (citric, acetic) with subsequent rinsing under running water and application of a bandage.

At burns of eyes: washing of eyes with weak flush of water from an undine.

First aid at affection by acids and alkalis

General actions:

1. Remove substances from skin with a tampon or shake them down, eyes must be rinsed intensively with water.

2. Wash the substance off the skin with water.

3. Neutralize the residues of substances with 2–3 % solutions of sodium bicarbonate (in case of acids) and boric acid (in case of alkalis) by applying of a

moistened tampon onto the affected area for 5 minutes, and in case of eyes — by washing them with solution with subsequent rinsing with water.

4. After neutralization affected areas of skin (chemical burn) are moistened with alcohol and oiled with glycerin, as with eyes — wash them up with water and instill albucid.

Removal of substances from stomach: 2–3 times gastric lavage with water (drink 4–5 glasses of warm water, then induce vomiting by pressing the root of the tongue with finger). To neutralize drink 1 % solution of citric or acetic acid if swallowed alkalis, or dead-burned magnesia if swallowed acids.

Do not use sodium bicarbonate to neutralize of acids in stomach!

Gastric lavage can be combined with intake of an activated coal (1 tablet per each 10 kilos of weight). To reduce pain after gastric lavage you can drink water with ice, eat ice-cream, or apply ice on a belly.

Note: NO gastric lavage can be done as described above if patient has lost consciousness, and also if swallowed acids and alkalis in concentration close to 100 %. In this case drink only water in order to reduce the concentration of the substance in the stomach before a doctor's coming.

INSTRUCTION № 4
Fire safety

1. Medical officers and students should know fire danger of laboratory rooms and substances used in them strictly follow fire safety rules when working with them. It is strongly prohibited to store together substances which mutual chemical reaction can cause fire or explosion.

2. All work connected with extraction of toxic substances, flammable, explosive vapour or gas should be made only in draft hoods.

3. Before starting a new lesson, a teacher makes the fire instructions fixed in register.

4. DO NOT leave workplace, burners or other heating devices unattended.

5. All members of staff and students should know location of fire extinguishers and be able to use them.

6. Store overalls in special places only.

7. In laboratory you CAN NOT:

— block up gangways and places with fire extinguishers;

— dry flammable objects on heating devices;

— clean spilled flammables at active burners and electric heating devices;

— store in working rooms any substances with unknown fire-dangerous properties.

8. To prevent fire and accidents in rooms when working with dangerous substances, flammables, gases, and also at work at evening and night shifts, at least two people must be in a room.

9. Once finishing the working day, the person in charge is to check up all devices and tools, gas and water taps, switch off the knife-switch and ventila-

tion, and also remove from laboratory room residues flammables, substances and reactants.

10. Laboratories for work with explosives must be located in an isolated part of a building.

11. No work may be done in a draft hood if materials and equipment not related to the performed work are kept in it.

12. Working tables and draft hood designed for work with open fire and fire-dangerous and explosive substances, should be fully covered with fireproof material, and at work with acids and alkalis — anticorrosive material and to have welts.

INSTRUCTION № 5
safety measures at work with electrical appliances

General requirements

During all work it is necessary to be careful. Failing to keep to the safety rules or inappropriate use of appliances may cause electric shock.

Before beginning of work

1. No work can be performed with any appliance unless grounded.

2. Wires should always be serviceable, branches or connections of wires must be properly isolated.

3. Heating devices should be mounted on fire-resistant supports.

During work

1. Repair equipment, sockets, switches, change bulbs only once main power supply is off.

2. DO NOT touch bared wire due to electric shock hazard.

At the end of work

1. Disconnect the plug from the socket by holding the plug itself, not by pulling the wire.

2. When leaving the room, switch off all electrical appliances.

Emergency situations

When an appliance fail to operate properly, disconnect it from the power supply and ask for a qualified technician to repair it.

INSTRUCTION № 6
safety measures at work with alcohol flammables

1. Before activating a spirit-lamp, make sure whether its case is serviceable, the wick is at proper height and the spirit-lamp is dry.

2. You cannot move the spirit-lamp to other place or us it to burn another spirit-lamp.

3. To turn off the spirit-lamp by placing a cap on the fire. Do not blow out the fire.

4. Only ethyl alcohol can be used in spirit-lamps; do not use gasoline or other flammables with spirit-lamps.

5. Briquettes (tablets, bars) of dry fuel can sometimes be used for heating. Light it only on ceramic plate and put out by placing a cap on it. Briquettes still suitable for use are stored in a draft hood.

INSTRUCTION № 7

by safety measures at work with laboratory glassware and ampoules

General requirements

Sharp splinters of glass may cause cuts, and touching hot glass may cause burns.

Before work

All vessels with chemical substances must be clearly labelled.

During work

1. Mind the following rules when working with glassware:

— Glass tubules of small diameter can be broken only after their cutting with special knifes for glass, hands must be protected with a towel;

2. Do not leave the working device unattended.

3. When heating up liquid, hold the vessel with a special holder so that the opening would be directed outside the worker.

4. When transferring vessels with hot liquid, hold them with two hands: one — at the bottom, another — at the top. Use the towel to prevent hands from burnning.

5. Use the funnel to transfuse liquids.

6. All manipulations with ampoules before their opening are to be carried out in a draft hood. In this case use eye protectors.

In emergency conditions

If injuries occur while working with chemical glassware and ampoules first aid must be provided to the affected person.

1. PHYSIOLOGY OF BLOOD

Lab. work 1.1. Blood sampling method from a finger

When sampling blood one should remember its possible infection with AIDS, hepatitis B and associated high infection risk to which laboratory staff is subjected during clinical investigation. In this respect when making an analysis it is necessary to follow regulations of AIDS prevention in medical staff involved in blood sampling and its examination.

Purpose of work: to learn the technique of blood sampling from a finger.

Necessary material: sterile scarificator, alcohol, cotton wool, iodine, diethyl ether. Object of research — a person.

Course of work

1. A patient should sit opposite to a staff-person sampling blood with his hand (better left) on the table.
2. Blood is sampled from the 4^{th} finger since its synovial vagina is isolated preventing expansion of inflammatory process in case it gets into wrist.
3. Finger skin of the is disinfected and degreased with alcohol-ether.
4. Open package with disposable scarificators at the side opposite to the piercing tip.
5. Pierce the skin in the center of the finger-pad (one time only!), piercing tip immersed in full into the finger-pad.
6. The first drop of blood is swept clean with dry cotton wool, the finger is carefully wiped (skin should be dry).
7. The following drop of blood should have convex meniscus and not spread on the finger, from these and subsequent drops blood is taken for the analysis.
8. After blood sampling the pierced place is treated with alcohol or iodine.

Lab. work 1.2. Fresh blood sample under the microscope

Blood consists of liquid part — plasma and cells weighed in it (uniform elements): erythrocytes (red blood cells), leucocytes (white blood cells) and thrombocytes (platelets).

Purpose of work: to study features of fresh blood preparation.

Necessary materials: drop of fresh blood, a microscope, slides and cover slips, sterile scarificator, cotton wool, alcohol, diethyl ether, iodine.

Course of work

To look erythrocytes under the microscope, place the drop of blood on one of the sides of a slide, then cover it with cover slip, select field for observation with not thick layer of blood. Field of vision is occupied with erythrocytes located most often as «monetary columns». Make a drawing, write down a conclusion of the regular location of erythrocytes in the fresh blood sample.

Lab. work 1.3. Measurement of hematocrit number

Hematocrit number is a percent-marked relation of the uniform elements volume to the volume of the whole blood.

$$Ht = \frac{V\ of\ uniform\ elements}{V\ of\ blood} \times 100\% .$$

There are several techniques of hematocrit number detection. All of them are based on centrifugation of blood prevented from coagulation and placed into the capillary, and measuring of blood columns and the sedimented erythrocytes.

Purpose of work: to learn the technique of hematocrit number measurement and to determine its index in the examined blood.

Necessary materials: hematocrit capillary, centrifuge, cotton wool, alcohol, iodine. Object of research — a person.

Course of work

Pierce a finger by the known technique. Fill in hematocrit capillary at not less than 2/3 of its volume. Seal up the ends of the tubule with plasticine and place into the centrifuge (not less than two capillars in opposite cells). Rotate the cover to close the centrifuge tightly. When centrifugation is over, measure the blood column in the tubule with a ruler. Measure the erythrocytes column in mm, calculate percentage relation. Take the length of blood column as 100 %, length of erythrocytes column as X. The obtained value of X % corresponds to the parameter of hematocrit of blood. To convert the %-marked hematocrit into the international units system, multiply the obtained value by 0,01. Draw the hematocrit capillary.

In conclusion compare the obtained parameter of hematocrit with the norm.

Lab. work 1.4. Measurement of erythrocytes amount

Purpose of work: to learn the technique and to count the amount of erythrocytes in the examined blood.

Necessary materials: microscope, erythrocytometer (Gorjaev's count chamber), melangeur for erythrocytes, 3 % solution of sodium chloride, cover slips, adjustable pipette, tubes, sterile scarificator, cotton wool, alcohol, diethyl ether, iodine. Object of research — a person.

Course of work

Before the work it is necessary to examine the count chamber under the microscope, to detect small squares and big squares of a frame (one big square consists of 16 small) (figure 1.1). Gorjaev's count chamber should be preliminary prepared by rubbing a cover slip to lateral extended edges of the chamber till color (Newtonian) rings similar to gasoline stains in a pool appear. Place the tip of the melangeur (with red bead at widening) for erythrocytes into the drop of the fresh blood sampled from the finger, and collect blood up to mark

0,5 watching for air bubbles not to get inside the capillary. Instantly, till the blood is not coagulated, immerse the tip of the melangeur into 3 % solution of sodium chloride and collect it to the mark of 101, i. e. dissolve blood in 200 times. Then, take the filled melangeur, close its both ends with the 1st and the 3rd fingers and shake it for 1 minute. Once the blood has been mixed carefully, remove preliminary 1–2 drops of it and place a small droplet onto the frame of the Gorjaev's count chamber.

If necessary, the same dilution can be made in other way. For example, 0,02 ml of blood is mixed with 4 ml of the 3 % NaCl in a tube. The content of the tube in this case is carefully mixed.

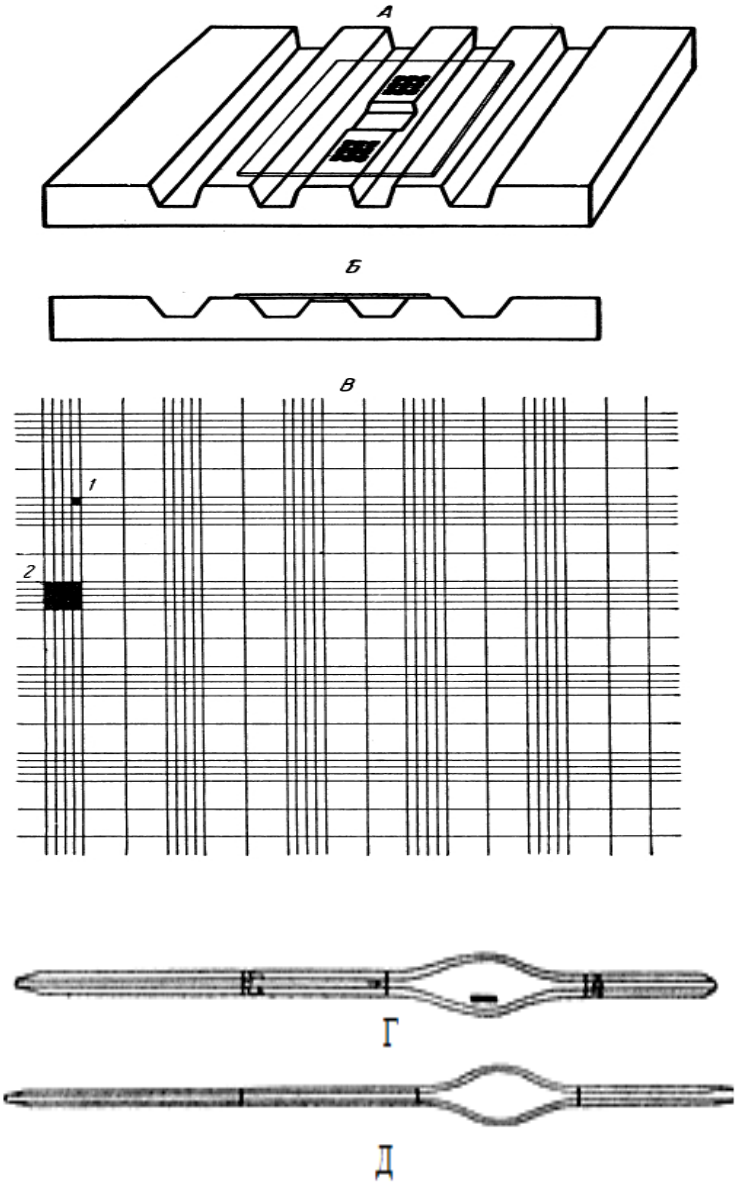


Figure 1.1 — Devices for counting of blood uniform elements:
Gorjaev's count chamber (A — top view, B — lateral view),
frame of Gorjaev's count chamber (C),
melangeur for erythrocytes (D) and leucocytes (E) count

After filling the chamber, place it under a microscope and start counting. Calculation of erythrocytes is more convenient at large magnification. Count erythrocytes in 5 large squares located in different places of the chamber, for example, diagonally. To prevent double count of cells laying on the border of the two small squares, apply the Egorov's rule: the small square includes all erythrocytes which are located inside the square, as well as on its upper and left sides.

Equation for calculation of erythrocytes amount in 1 mm^3 of blood:

$$N = \frac{A \times 4000 \times 200}{80},$$

where: N — number of erythrocytes;

A — number of erythrocytes in 80 small squares (or in 5 big);

4000 — multiplier for calculation of the erythrocytes content in 1 mm^3 of blood;

200 — dilution degree of erythrocytes.

To convert the received amount of erythrocytes into the international units system, multiply the calculated amount of erythrocytes by 10^6 and express as N x 10^{12}/l (tera per liter). Make a drawing of Gorjaev's count chamber with small and big squares.

In conclusion compare the obtained amount of erythrocytes in the examined blood with the norm.

Lab. work 1.5. Measurement of hemoglobin amount in blood by Sali method

Measurement of hemoglobin content in blood is made by colorimetric methods, one of which (Sali hematin method) is based on the formation of steady solution of brown color at interaction of hemoglobin with the hydrochloric acid. The principle of the colorimetric method is that if the examined solution is diluted to the color similar to that of the standard solution, concentration of soluted substances in both solutions will be identical, and amounts of substance will correlate as their volumes. Standard solution contains 167 g/l of hemoglobin.

Purpose of work: to learn technique of hemoglobin measurement and to detect the amount of hemoglobin in the examined blood.

Necessary materials: Sali hemometer, capillary with mark 0,02 ml, 0,1 normality (n) solution of the hydrochloric acid, distilled water, fresh blood, pipette, glass rod, sterile injection needle, cotton wool, alcohol, iodine, diethyl ether, sterile scarificator. Object of research — a person.

Course of work

Pour in 0,1 n solution of hydrochloric acid into the middle tube of the hemometer to the low ring mark. Take blood from a finger into capillary as usual (figure 1.2) without air bubbles up to the mark.

Surplus of blood can be removed from the capillary by applying cotton wool or filter paper to the tip of the capillary. Blow out the blood onto the bot-

tom of a tube from the capillary so that the top layer of the acid remained uncolored. Not taking out capillary, wash it with the solution of hydrochloric acid from the top layer of the hemometer tube. Then, mix the content of the tube with the glass rod and leave it in the hemometer for 5–10 minutes. This time is necessary for complete transformation of hemoglobin into hydrochloride hematin.

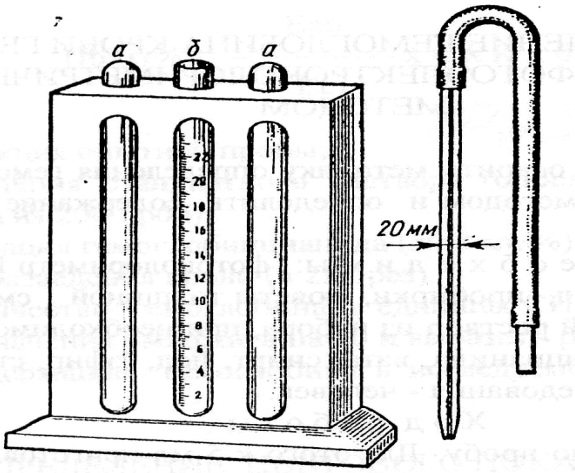


Figure 1.2 — Sali hemoglobinometer and capillary (explanation in the text)

Then add distilled water, one drop at a time, to the contents of the tube, continue mixing solution with the glass rod until the color of the obtained solution becomes identical with that of the standard solution of lateral ampules of hemometer. Digit marked at the lower boundary of the meniscus of the obtained solution indicates hemoglobin amount in the examined blood in grams-percent (g %).

To convert the received amount of hemoglobin into the international units system, multiply measured amount of hemoglobin in g % by 10.

Make a drawing of hemometer and the capillary.

In conclusion compare the obtained amount of hemoglobin in the examined blood with the norm.

Lab. work 1.6. Measurement of hemoglobin amount by hemoglobin-cyanide (photoelectrocolorimetric) method

Purpose of work: to learn the definition technique of hemoglobin of blood by hemoglobincyanide method and to determine the amount of hemoglobin in the examined blood.

Necessary materials: photocolorimeter, 0,02 ml and 5,0 ml pipettes, tubes, cuvette of 1 cm depth, prepared transforming solution, standard of solution of hemoglobincyanide (if necessary), cotton wool, alcohol, iodine, diethyl ether, sterile scarificator. Object of research — a person.

Course of work

Prepare test solution. For this purpose, add 0,02 ml of finger blood to 5 ml of the prepared transforming solution. Dilution of blood in this case will make

251. Mix the obtained solution carefully, let it stand for 5–10 minutes, then place it to the photocolorimeter cuvette.

Prepare cuvette with transforming solution. For this, measure 5 ml of the transforming solution and place it to the similar cuvette (as described above).

Measure as described in the instruction manual of the device with the help of the laboratory assistant. Measure the amount of hemoglobin not less than 3 times, then calculate arithmetic mean.

Concentration of hemoglobin in the examined blood to make with formula:

$$Hb(g/\%) = \frac{Etest}{Est} \times C \times K \times 0{,}001,$$

where: E_{test} — extinction of a test sample;

E_{st} — extinction of the standard solution (determined unitary for one set of 200 samples);

C — concentration of hemoglobincyanide (59,8 mg /%);

K — degree of blood dilution (in 251 times).

Convert the obtained amount of hemoglobin into the international units system: multiply the measured amount of hemoglobin by 10 and express the result in g/l. Write down the results in the table 1.1.

Table 1.1 — Results of hemoglobin measurement by photoelectrocolorimetric method

Parameters	Values			Mean value	Extinction of the standard solution Est
№ of sample	1	2	3		
Extinction of the test sample Etest					
Amount of hemoglobin Hb (g/%) (by formula)		Amount of hemoglobin in international units system (× 10 g/l)			

In conclusion compare the obtained amount of hemoglobin in the examined blood with the norm.

Lab. work 1.7 Calculation of erythrocyte indices

For the characteristic of erythron state in clinical laboratory diagnostics different indices are used which allow to evaluate the ratio between such parameters as amount of erythrocytes, hemoglobin, hematocrit.

CI (color index) reflects the average content of hemoglobin in an erythrocyte. Normal color index values: 0,86–1,05.

MCV (mean corpuscular volume) **—** the average volume of an erythrocyte, it is expressed in femtoliters (fl). MCV is calculated by the majority of hematological analyzers, due to direct dependence of electric impulse amplitude from cell volume. Devices automatically register the volume of each erythrocyte, thus, MCV value represents the average size of volume of all measured erythrocytes. Normal MCV values: 80–100 fl.

MCV is an important indicator in differential diagnostics of anemias. On the basis of MCV anemias are divided into normocytic, microcytic and macrocytic.

MCH (mean corpuscular hemoglobin) — the average content of hemoglobin in an erythrocyte, reflects the mass of hemoglobin in a single erythrocyte in absolute units — picograms (1 pg = 10^{-12}g). Normal MCH values: 27–31 pg.

On the basis of MCH anemias are divided into normochromic, hypochromic and hyperchromic. Decrease of MCH is observed at iron deficiency anemias, hemoglobinopathies; increase — at macrocytic, and, especially, megaloblastic anemias.

MCHC (mean corpuscular hemoglobin concentration) — the average concentration of hemoglobin in an erythrocyte. It is expressed in % (normal values 30–38 %) or in g/dl (normal values 30–38 g/dl).

The difference between MCH and MCHC is that MCHC doesn't depend on cellular volume and shows concentration of hemoglobin in one erythrocyte, that is the ratio of hemoglobin content to cell volume. MCHC is directly connected with synthesis of hemoglobin and reflects erythrocyte saturation by hemoglobin therefore it is sensitive test at disorders of haemoglobin formation.

Purpose of work: to calculate erythrocyte indices.

Necessary materials: data of erythrocytes and hemoglobin amount in blood received in the laboratory works 3.1, 3.2, nomogram (Figure 3.4).

Course of work

The amount of erythrocytes and hemoglobin in blood is determined in the examined person. Calculate the color index with the formula:

$$CI = \frac{Hb(g/l) \times 3}{A},$$

where:

Hb — hemoglobin amount, g/l:

A — amount of erythrocytes in 1 microliter (first three digits).

Color index can be determined by the nomogram (figure 3.4).

Calculate mean corpuscular volume:

$$MCV = \frac{hematocrit\ (\%) \times 10}{amount\ of\ erythrocytes\ \ in\ \ millions\ in\ 1\,mm^3}$$

Normal MCV values are 80–100 fl.

Calculate mean corpuscular hemoglobin:

$$MCH = \frac{hemoglobin\ (g/l)}{amount\ of\ erythrocytes \times 10^{12}}$$

Normal MCH values are 27–31 pg.

Calculate mean corpuscular hemoglobin concentration:

$$MCHC = \frac{hemoglobin\ (g/l)}{hematocrit\ (\%)} \times 10$$

MCHC is expressed in % (normal values 30–38%) or in g/dl (normal values range 30–38 g/dl).

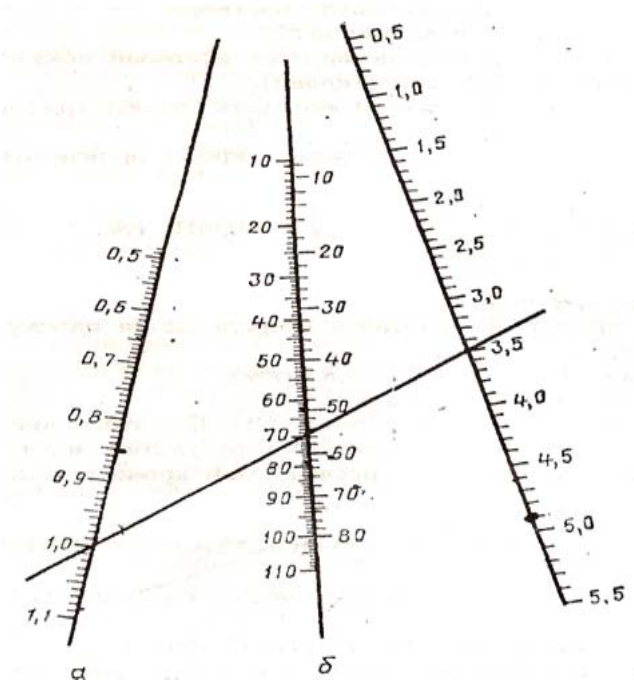


Figure 3.4 — Nomogram for determination of color index:
a — the scale of color index values, b — the scale of hemoglobin percentage amount by Sali, c — the amount of erythrocytes in 1 microliter

Lab. work 1.8. Blood groups determination

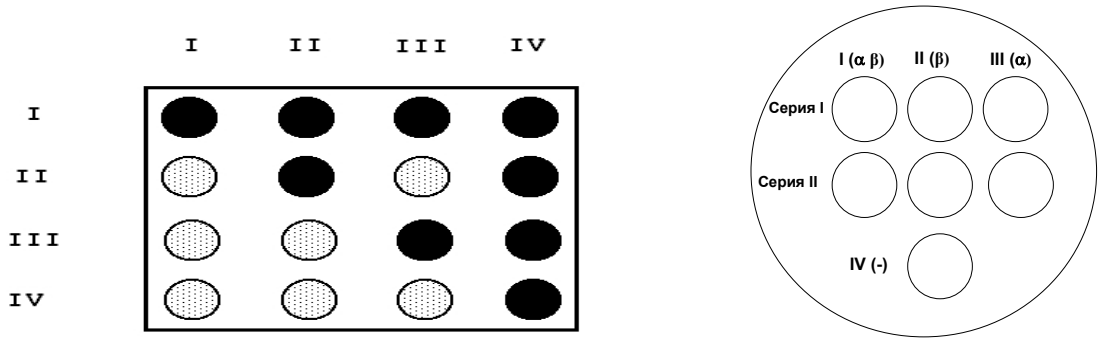
Blood groups determination is the detection of the contents of agglutinogens (A and B) on the membrane of erythrocytes and agglutinins (α and β) in blood plasma.

Purpose of work: to learn technique of blood groups determination and to determine blood group (blood type) of the examined person.

Necessary materials: slide, glass rods, standard serums of I, II, III groups, cotton wool, alcohol, iodine, diethyl ether, sterile scarificator. Object of research — a person.

Course of work

Place the slide on a white sheet of paper and put (without mixing) drops of standard serum of I, II and III groups one by one. Place small drops of finger blood (approximately 1/3 of the drop of serum) on the slide close to the drops of standard serum. Carefully mix each pair of serum and blood drops with dry clean glass rod (different rod for each pair!) until the fusion is of regular color.



A B

Figure 1.4 — A — Scheme of blood groups determination,
black circles — absence of agglutination, grey circles – presence of agglutination, B — the slide for blood groups definition

The agglutination reaction will happen in 1–5 minutes (figure 1.4). If agglutination presents, the drop becomes transparent and erythrocytes stick together as nubbins.

1. Absence of agglutination in each of the three mixed drops of serum refers the examined blood to 0 (I) group.

2. If agglutination occurred in drops of serums of I and III groups, the examined blood belongs to A (II) group.

3. If agglutination occurred in drops of serums of I and II groups, the examined blood belongs to B (III) group.

4. At presence of agglutination in drops of serums of I, II and III groups, the examined blood belongs to AB (IY) group.

Write down the results of blood group determination in the table 1.2.

Table 1.2 — Results of blood groups test

Name of an examined person	The group of serum				Result (blood group)
	I (α,β)	II (β)	III (α)	IV (0)	
	Presence or absence of agglutination (marked as + or –)				
1.					
2.					
3.					

In conclusion specify blood group.

Lab. work 1.9. Determination of rhesus-factor (Rh) of blood

Membrane of erythrocytes of 85 % of people, apart from agglutinogens A and B, has a special antigen called rhesus-factor (Rh). When transfusing rhesus-positive (Rh^+) blood to a rhesus-negative (Rh^-) recipient, antibodies to the Rh-factor of donor are developed the latter. At the repeated transfusion of the rhesus-positive blood these antibodies induce agglutination of erythrocytes of donor resulting in pathologic state.

Purpose of work: to learn the technique of determination of Rh-factor and to detemine Rh-factor of the examined blood.

Necessary materials: standard antirhesus serum and control serum (antirhesus of antibodies free), slide, glass rod, blood samples, cotton wool, alcohol, iodine, diethyl ether, sterile scarificator. Object of research — a person.

Course of work

Place one drop of standard antirhesus serum on one side of slide and place a drop of test blood — on the another side (the size of the drop should be half that of a drop of serum). Then mix drop of blood with drop of standard antirhesus serum with clean dry glass rod thus making one general drop. If the examined blood is rhesus-positive, agglutination of erythrocytes will be observed. If the examined blood is rhesus-negative, agglutination of erythrocytes will not be observed.

Write down the results of Rh-factor determination in the table 1.3.

Table 1.3 — Results of rhesus-factor (Rh) determination

Name of an examined person	Presence or absence of agglutination (marked as + or –) with standard antirhesus serum	Result rhesus-factor (Rh)
1.		
2.		
3.		

In conclusion note Rh-factor of the examined blood.

Lab. work 1.10. Measurement of leucocytes amount

Leucocytes are cell elements directly participating in immune-protective reactions. Unlike erythrocytes, they have nuclei and can leave blood channel and move independently.

Purpose of work: to learn technique and to count the amount of leucocytes in the examined blood.

Necessary materials: microscope, Gorjaev's count chamber, melangeur for leucocytes, 5 % solution of acetic acid with methylene-blue, cover slips, regulated pipette, tubes, cotton wool, alcohol, iodine, diethyl ether, sterile scarificator. Object of research — a person.

Course of work

Prepare the Gorjaev’s chamber as described earlier (Lab. work 1.4.).

Place the tip of the melangeur (with white bead at widening) for leukocytes into the drop of the fresh blood taken from the finger, and collect blood up to mark 0,5 watching without air bubbles and instantly, till the blood is not coagulated, immerse the tip of the melangeur into solution of acetic acid stained with methylene-blue. Collect the acetic acid solution to the mark 11, i. e. dissolve

blood in 20 times. Then, take the filled melangeur, close its both ends with the 1st and the 3rd fingers and shake it for 1 minute. Once the blood has been mixed carefully, remove preliminary 1–2 drops of it and place a small droplet onto the frame of the Gorjaev's count chamber. If the drop is too large, liquid can get onto the lateral sides of the chamber and the liquid layer above the frame will be more than 0,1 mm and further calculations will be wrong. In this case rinse the chamber carefully under the distilled water, dry it and fill in again. Soluted blood in melangeur should be mixed once again.

If necessary, the same dilution can be made in other way. For example, 0,1 ml of blood is mixed with 2,0 ml of the 5 % acetic acid in a tube. The content of the tube in this case is carefully mixed.

Having filled in the chamber, place it under the microscope and start calculation. Leucocytes are much easier to count with small magnification. Perform counting in 25 big squares that compounds 400 small squares. Use the Egorov's rule when counting.

Formula for calculation of the amount of leucocytes in 1 mm^3 of blood:

$$N = \frac{B \times 4000 \times 20}{400},$$

where: N — number of leucocytes;

B — number of leucocytes in 25 big (400 small) squares;

4000 — multiplier to get the contents of leucocytes in 1 microliter of blood;

400 — number of small squares in 25 big squares;

20 — degree of dilution of blood.

To convert the received amount of leucocytes into the international units system, multiply the calculated amount of leucocytes by 10^6 and express in $N \times 10^9$/l (giga per liter).

In conclusion compare the obtained amount of leucocytes in the examined blood with the norm.

Lab. work 1.11. Measurement of blood coagulation time by Althousen

There is a number of methods for measuring of blood coagulation time the use of which leads to different data. Normal parameters of blood coagulation time when using this method are 5–6 minutes at room temperature.

Purpose of work: to learn technique and to measure blood coagulation time by Althousen.

Necessary materials: stop-watch, sterile scarificator, alcohol, cotton wool, iodine, diethyl ether, slide. Object of research — a person.

Course of work

Warm up slide in your hand to the body temperature and put on it 2–3 drops of finger blood by known technique. Move the scarificator through the

blood each half minute till first thread of fibrin reaches for the needle. Hold the glass either on your palm or on gauze. Repeat the procedure with a cold slide.

In conclusion compare the received results with the norm.

Lab. work 1.12. Measurement of erythrocyte sedimentation rate (ESR) by T. P. Panchenkov

Blood protected from coagulation with sodium citrate divides at sedimentation into the upper light layer (plasma) and the lower red layer (erythrocytes).

Purpose of work: to learn the technique of ESR measurement and to determine its value in the examined blood.

Necessary materials: Panchenkov's device, 5 % solution of sodium citrate, sterile scarificator, clock glass or other vessel for blending, cotton wool, alcohol, iodine. Object of research — a person.

Course of work

With the Panchenkov's device capillary (figure 1.5) take 5 % solution of sodium citrate up to mark P and place it on the clock glass. Pierce the finger and take blood up to mark K. Blow out the contents on the clock glass into the solution of sodium citrate.

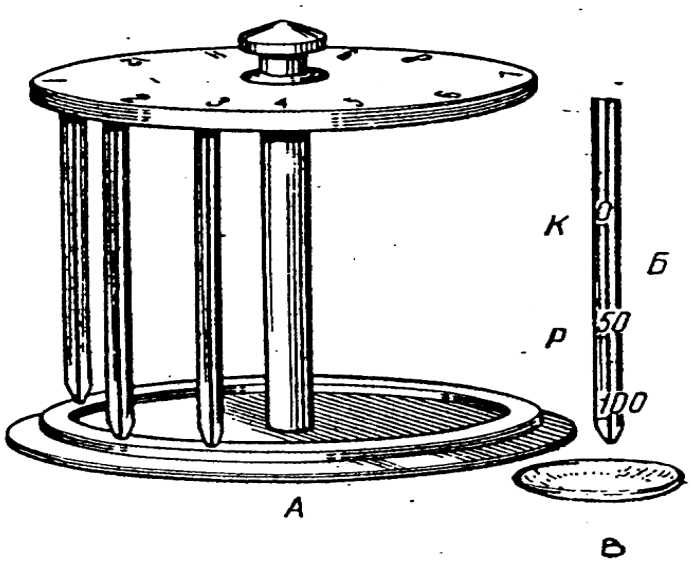


Figure 1.5 — Panchenkov's device for ESR measurement:
A — general view, B — capillary, C — clock glass

On a laboratory class, it's enough to take blood from a vial which already contains an anticoagulant, and place a capillary in the Panchenkov's device.

Take blood up to the "K" mark. Place firmly the lower end of the capillary into the lower rubber strip of the Panchenkov's device and then insert the upper end into above rubber strip.

Note the time and in one hour sharply measure height of the column of plasma. Write down the ESR value in mm/hour.

Compare the received parameters of ESR with norm.

Lab. work 1.13. Examination of various kinds of hemolysis

Destruction of erythrocytes with release of hemoglobin into the blood plasma is called hemolysis. Hemolyzed blood is transparent and has specific red color («varnish blood»).

Purpose of work: to learn technique and study various kinds of hemolysis.

Necessary materials: stand with five tubes, pipettes, saline solution, distilled water, 5 % solution of ammonia, 0,1 % solution of HCI, citrated blood, cotton wool, alcohol, iodine, diethyl ether, sterile scarificator. Object of research — a person.

Course of work

Put 5 tubes into stand, each containing 2–3 drops of blood. In the first and the fifth tubes add 3 ml of saline solution, in the second — 3 ml of the distilled water, in third — 3 ml of 0,1 % of HCl solution, in the fourth — 3 ml of 5 % solution of ammonia. Freeze soluted blood in the fifth tube in a fridge. Then take the tube out and warm contents up in hot water.

Examine all tubes, compare results. It is necessary to evaluate presence or absence of hemolysis. Write down the results in the table 1.4.

Table 1.4 — Examination of various kinds of hemolysis

№ of a tube	1	2	3	4	5
Tubes contents	blood + saline solution	blood + distilled water	blood+0,1 % HCl	blood + 5 % ammonia solution	blood + saline solution (freezing and thawing)
The presence or absence of hemolysis					
Kind of hemolysis					

In conclusion note observed kinds of hemolysis.

Lab. work 1.14. Examination of osmotic resistance of erythrocytes

The osmotic resistance of erythrocytes is an ability of erythrocytes to resist the decreased osmotic pressure; it depends on the properties of erythrocytes membrane.

Purpose of work: to learn technique and to evaluate the limits of osmotic resistance of erythrocytes.

Necessary materials: stand with 8 tubes, solutions of NaCl of descending concentration from 0,85 up to 0,3 %, donor's blood, pipettes, cotton wool, alcohol, iodine, diethyl ether, sterile scarificator. Object of research — a person.

Course of work

Consecutively number the tubes and place them into stand. With the pipette pour in 3 ml of solution of NaCl in the order indicated in table 1.2. Then add 3–

4 drops of blood with pipette into each tube. Check for results in 5 minutes — presence or absence of hemolysis. The obtained data must be presented in the table 1.5.

Write down in which of the tubes and at what concentration of NaCl solution first signs of hemolysis are marked (blood becomes clear), at what concentration blood is fully hemolyzed.

Table 1.5 — Osmotic resistance of erythrocytes

№ of a tube	Concentration of NaCl, %							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	0,85	0,70	0,60	0,50	0,45	0,40	0,35	0,30
Presence or absence hemolysis, partial hemolysis **(+; −; ±)**								

Measure the upper and the lower limits of the erythrocytes resistance and in conclusion compare the data to the norm.

THE BASIC CONSTANTS OF BLOOD SYSTEM

Parameter	Values
Amount of blood: in adults	4,5–6 l (6–8 % of body weight)
in newborns	15 % of body weight
Hematocrit (m)	0,42–0,52
(f)	0,37–0,47
Blood: deposited	45–50 %
circulating	50–55 %
Volume of blood plasma	approx. 3 l
Structure of blood plasma:	
Water	90–92 %
Solid residual	8–10 %
General protein	65–85 g/l
Albumins	35–55 g/l
Globulins	20–35 g/l
Fibrinogen	2–4 g/l
Urea	2,5–8,3 millimole/l
Bilirubin	3,4–20,5 mcmole/l
Glucose (whole blood)	3,30–5,55 millimole/l
(plasma)	3,30–6,10 millimole/l
Cholesterol	3,0–6,2 millimole/l
Triglycerides	0,55–1,65 millimole/l
Inorganic substances	0,9 %
Osmotic pressure	7,6–8,1 atm
Oncotic pressure	0,03–0,04 atm
Viscosity of blood in adults	5
in newborns	10,0–14,8

Parameter	Values
Relative density: in adults	1,050–1,060
in newborns	1,060–1,080
pH of arterial bloods	7,40
venous	7,35
pH borders compatible with life	7,0–7,8
Amount of erythrocytes: (m)	4,5–5,1 $\times 10^{12}$ /l (tera per litre)
(f)	3,7–4,7 $\times 10^{12}$ /l (tera per litre)
Erythrocytes: diameter thickness volume	7,2–7,7 microns 2,2 microns 76—96 micrometer^3 (femtoliter)
General surface of all erythrocytes	3800 m^2
Structure of erythrocytes:	
water	60 %
dry residual	40 % (90 % of it - Hb)
lifetime of erythrocyte	120–130 days
Amount of hemoglobin (m)	130–160 g/l
(f)	120–140 g/l
Types of Hb:	HbP appears in 7–12 weeks of antenatal period HbF — in 9 week of antenatal period HbA — before birth and in adults
The amount of Hb per erythrocyte	27–31 picogram
Concentration of Hb in erythrocyte	30–38 %
Color index: adults	0,85–1,05
newborns	0,9–1,3
Osmotic resistance of erythrocytes: Min	0,46–0,48 % solution of NaCI
Max	0,32–0,34 % solution of NaCI
Erythrocyte sedimentation rate (m)	1–10 mm / hr
(f)	2–15 mm / hr
Neonatal	1–2 mm / hr
Leucocytes: amount in adults	4–9 $\times 10^9$ /l (giga per litre)
in newborns	15–20 $\times 10^9$ /l (giga per litre)
The leukocytic formula (%): Neutrophils:	
myelocytes	0
metamyelocytes	0
stab neutrophil	1–6
segmentonuclear	47–72
Eosinophils	0,5–5
Basophils	0–1
Lymphocytes	19–37
Monocytes	2–11
Index of regeneration (shift to the left)	0,05–0,1
Amount of thrombocytes	150–450 $\times 10^9$/l (giga per litre)

Parameter	Values
Lifetime of thrombocyte	5–11 days
Blood coagulation time (by Lee-White)	5–7 min
Lymph:	
pH	7,35–9,0
Relative density	1,012–1,023
Proteins	20 g/l

2. PHYSIOLOGY OF EXCITABLE TISSUES

At the complex analysis of health and physical development of a person the measurement of his physical working capacity (PWC) is one of the most informative parameters. The advantage of the given parameter in comparison with others consists that it in complex reflects physical development of the person, functional state and interrelation between his functional and physiological systems (cardio-respiratory, neuromuscular, endocrine, etc.) and power ability of an organism.

PWC is calculated by the parameter of PWC_{170}, determined by the step-test or veloergometry which reflects the power of work a person can do at a pulse rate 170 beat/minutes.

Lab. work 2.1. PWC measurement by step-test method

Purpose of work: to learn the technique of PWC measurement by step-test method and to detect its value in a person.

Necessary material: height adjusted step, metronome, stop-watch. Object of research — a person.

Course of work

At first the person approves the order of instep on step and descents from it under rhythm of metronome. With the first impact of metronome on step instep the left leg, with the second — right, with the third — the left leg descents on floor, with the fourth — right.

Set the step to 30 centimeters height. Calculate power of the first and the second exercise with the formula:

$$N = 1{,}20 \times P \times h \times n,$$

where: N — power of work, kgm/minute;

P — body weight of the person, kg;

h — height of step, m;

n — number of ascents onto the step per minute

1,20 — the coefficient which considers the work at descent from the step (for children it is 1,33).

The person with the body weight of 65–70 kg performs the first exercise for 3 minutes with the frequency of 15 ascents per minutes (at the metronome's

frequency of 60 strokes per minute). Once the exercise is over, count the person's pulse rate (P_1) during the first 10 seconds. After 3 minute's break the person performs the second exercise multiplied, in comparison with first one, in 2 times (30 ascents on the step at the metronome's frequency of 120 strokes per minute). Count the pulse rate again (P_2).

Calculate PWC with Karpman's formula:

$$PWC_{170} = N_1 + (N_2 - N_1) \times \frac{170 - P_1}{P_2 - P_1},$$

where: N_1 and N_2 — power of the first and the second loads (kgm/min);

P_1 and P_2 — pulse rate at the end of the first and the second exercises (beat/min).

In conclusion compare the data obtained with the norm using the table 2.1.

Table 2.1 — PWC evaluation of an adult person

Evaluation	PWC_{170}, kgm/min		PWC_{170} for 1 kg of body weight, кgm/min	
	Men	Women	Men	Women
Above average	1200	750	17,0	12,0
Average	1000–1200	650–750	15,0–17,0	10,0–12,0
Below average	1000	650	15,0	10,0

Lab. work 2.2. Dynamometry. Measuring of human power

One of parameters of physical development of an organism is muscle power. The power of a person is evaluated by dynamometry method (hand and torso) which allows to measure the maximal muscle power, power parameter, level of work capacity of muscles and the parameter of its diminution.

1. Hand dynamometry

Purpose of work: to learn the technique of hand dynamometry. To measure muscle power of hand, power parameter, level of work capacity of muscles and parameter of its diminution in the person.

Necessary material: hand dynamometer, stop-watch. Object of research — a person.

Course of work

a) Measurement of the maximal muscle strength.

Measuring of the maximal muscle strength is made in standing position. The person takes the dynamometer into his right hand and stretches it under the right angle towards the body, another hand is down relaxed. The dynamometer is pressed three times with the maximal force without jerk, first with the right, then with the left hand. The largest indication of the dynamometer's arrow shows the maximal strength of hand muscles.

b) Measurement of muscle power parameter (MP). To calculate the MP, use the data of the previous measuring.

MP is calculated with the formula:

$$MP = \frac{MSH}{BW} \times 100,$$

where: MSH — muscle strength of hand (kg);
BW — body weight (kg).

A satisfactory parameter of muscle power of the hand is for:

- Women — 50 units.
- Men — 55 units.

c) Measurement of the working capacity level of muscles (WCLM).

The person makes 10 maximal efforts as above with the frequency of 1 time per 5 sec. Calculate the average level of working capacity of hand muscles with the formula:

$$WCLM = (f_1 + f_2 + f_{3...} + f_n) / n,$$

where: WCLM — level of work capacity of muscles;
f_1, f_2, etc. — dynamometer indications (kg) at separate muscles efforts;
n — number of attempts.

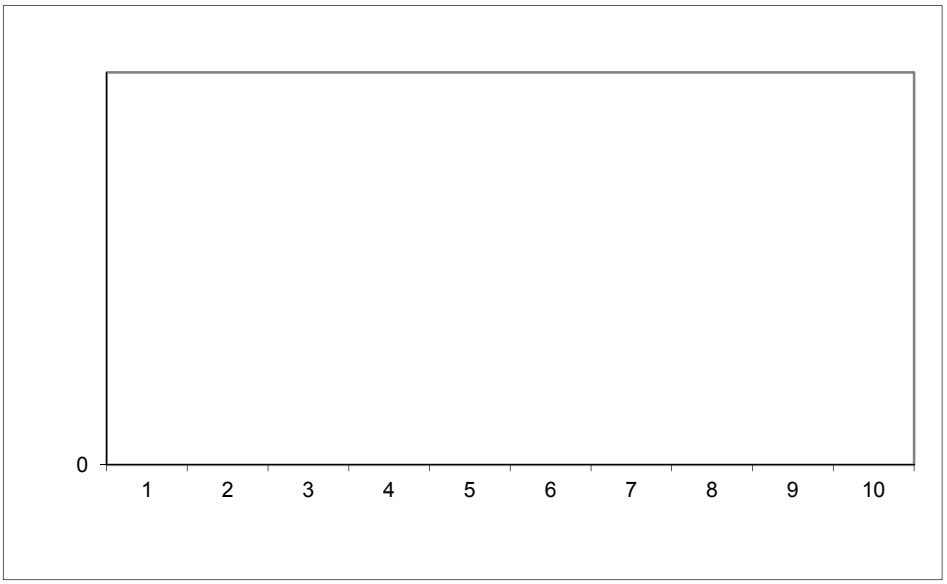


Figure 2.1 — Dynamics of changes of the power persistence level during 10 muscular efforts.
Y axis — muscles power (kg); X axis — consequence of muscular efforts (n)

In conclusions evaluate muscle power of the person. Using results of 10 muscular efforts draw a diagram which demonstrates the decrease of the working capacity of muscles: mark numbers of muscular efforts on X axis, and dynamometer's indications for each effort on the Y axis (Fig. 3). Compare the results of several persons.

d) Measurement of the parameter of working capacity decrease.

Calculate the latter with the formula using the previous data:

$$S = [(f_1 - f_{min})/f_{max}] \times 100,$$

where S — parameter of the working capacity decrease;

f_1 — initial muscular power volume

f_{min}— the minimal muscular power;

f_{max} — the maximal muscular power.

Write down the results in the table 2.2.

Table 2.2 — The results of hand dynamometry

	Muscle strength (kg)	Parameter of muscle power (unit)	Average level of working capacity (WCLM)	The parameter of working capacity decrease (S)
Right hand				
Left hand				

2. Torso dynamometry

Torso dynamometry allows to assess the power of extensor muscles of the back.

Purpose of work: to learn the technique of torso dynamometry and to measure the power of back muscle of the person.

Necessary material: torso dynamometer. Object of research — a person.

Course of work

The person stands on leg support. The hook of the dynamometer is connected to the support through the connecting rod depending on the body height. The person must keep legs straight in knees and lean his body to approximately 30° from vertical. To measure the torso power, the person tends to straight the body upright and, therefore, pulls the handle upwards with all his might.

The exercise is made 3 times and the maximal size (kg) is used. To assess the torso power, calculate the ratio of the extensors muscle power of the back to the body weight of the person.

Results:

The power of muscles-extensors of back, _____ kg

Torso force is more than body weight of the person in _____ times.

A satisfactory parameter of the power of muscles — extensors of back is the parameter of the torso power which exceeds the body weight:

For men — in 2 times;

For women — in 1,5 times.

In conclusion compare the received data with the norm.

Lab. work 2.3. Veloergometry. Measurement of physical work capacities by PWC_{170} test

Purpose of work: to learn the technique of the measurement of physical work capacities with a veloergometry method by PWC_{170} test and to measure its size in the person.

Necessary material: veloergometer, stop-watch, medical scales. Object of research — a person.

Course of work

Count the pulse rate of the person at rest in sitting position. Then during 5 minutes he makes the first exercise (N_1), the value of which depends on his body weight (table 2.3).

Table 2.3 — Power of the first exercise depending on the body weight of the person

Body weight, kg	Power, кgm/min	Notes
59 and less	300	To convert кgm/min into watts, divide кgm/min parameter by 6,12
60–64	400	
65–69	500	
70–74	600	
75–79	700	
80 and more	800	

Convert the power of the load in Watts found in the Table into nanometers and enter it on the veloergometer's panel:

1,6–10 watt
4,0–25 watt
8,0–50 watt
12–75 watt
16–100 watt
20–125 watt
24–150 watt
28–175 watt
32–200 watt
48–300 watt
64–400 watt

The frequency of pedals rotation is tachometer-controlled and is kept constant at 60 RPM. Count the pulse rate (BPM) — P_1 — during the last 30 seconds of the exercise. After 3 minutes' break the person does the second exercise (N_2), also for 5 min. The power of the second exercise depends on the size of the first one (P_1) and the heart rate (HR) after the first exercise (table 2.4). Count the pulse rate again during the last 30 seconds (BPM).

Table 2.4 — Power of the second exercise depending on HR during first exercise

Power of work at the first exercise, кgm/min	Power of work at the second exercise, *кgm/min*				
	HR during first exercise, *beat/min*				
	80–89	90–99	100–109	110–119	120–129
400	1100	1000	900	800	700
500	1200	1100	1000	900	800
600	1300	1200	1100	1000	900
700	1400	1300	1200	1100	1000
800	1500	1400	1300	1200	1100

After both exercises are over, calculate the physical work capacity with the formula:

$$PWC_{170} = N_1 + (N_2 - N_1) \times \frac{170 - Ð_1}{Ð_2 - Ð_1},$$

where: PWC_{170} — power of exercise, кgm/min;

N_1 and N_2 — power of the first and the second exercise (kgm/min).

P_1 and P_2 — pulse rate at the end of the first and the second exercise (beat/min).

Compare the received data with the norm in table 2.5.

Table 2.5 — Assessment of physical work capacities of an adult

Assessment	PWC_{170}, kgm/min		PWC_{170} for 1 kg of body weight, кgm/min	
	Men	Women	Men	Women
Above average	1200	750	17,0	12,0
Average	1000–1200	650–750	15,0–17,0	10,0–12,0
Below average	1000	650	15,0	10,0

Draw a conclusion about physical work capacities of the person.

Virtual experiments on the topic "Physiology of excitable tissues"

1. Influence of irritant force on amplitude of muscle contraction. Influence of temperature on muscular excitability and contractility.
2. Study of influence of stimulation frequency on contractility of skeletal muscles.
3. Study of role of a neuromuscular synapse in development of tiredness of a skeletal muscle.
4. Resting membrane potential.
5. Action membrane potential.

3. PHYSIOLOGY OF NERVOUS SYSTEM

Lab. work 3.1. Examination of redistributing vascular reactions of the organism by rheovasography method

Fluctuations of blood filling of organs and parts of the body are closely connected with the heart activity and with the state of somatic and vegetative nervous systems. The method of rheography allows to assess peripheral blood-flow and redistributing vascular reactions under various influences.

Rheography is a noninvasive method used to study the dynamics of pulse blood filling of organs and parts of the body. It is based on the graphic registra-

tion of their total electric resistance to alternating current of high frequency. Blood has the greatest electrical conductivity in comparison with all other body tissues. When the blood filling of arterial vessels increases during systole of ventricles, the electrical conductivity of separate parts of the body is increased and, on the contrary, after passing of a pulse wave is reduced. A curve of pulse fluctuations of electric resistance is registered by sensor electrodes and is called the impedance plethysmogram or rheogram. It is possible to register the rheogram of extremities (a peripheral rheogram), brain (rheoencephalogram), heart, etc. By the shape of rheogram blood circulation in vessels of the examined area is evaluated.

Purpose of work: to learn the technique of rheography and to study peripheral redistributing vascular reactions in the person under various conditions.

Necessary material: rheograph «Impecard», the instruction manual, ice pack, hot-water bag. Object of research — a person.

Course of work

After turning on of rheograph «Impecard» and loading of the program it is necessary to perform the registration of a new patient and to choose the technique "rheography of the upper extremities" and localization "wrist". The examined person is in a sitting position on a chair, in a quiet state.

Rheograph electrodes consist of current and potential electrodes and are applied by couples. Four paired electrodes (two on each extremity) are used. Electrodes are placed on a wrist and around the basis of fingers. The distance between electrodes in each couple should be about 2 cm. In case of the increased dryness of skin it is necessary to moisturize the patient's skin under electrodes with physical solution. In addition the general electrode is placed on any free part of the body.

After imposing of electrodes rheogram is recorded in each of below-mentioned conditions:

1. The person is sitting, his hand relaxed on the table.
2. Lift the hand with sensors up and record the rheogram instantly.
3. After the amplitude of rheogram is restored in 1–1,5 min, put the hand with the sensors down at maximum (towards the floor). Record the rheogram.
4. After the amplitude of rheogram is restored in 1–1,5 min, place the ice pack to the internal surface of the forearm. Register changes of rheogram in 2–3 min.
5. Apply hot-water bag on the internal surface of the forearm, write down record the rheogram in 2–3 minutes.

After recording of rheograms the system carries out their automatic processing and calculations of parameters for the left and right extremities.

Compare rheograms recorded at various conditions according to rheogram parameters.

The rheographic index (RI) — reflects the level of an arterial blood filling of the examined area.

The peripheral resistance index (PRI) — reflects the size of peripheral vascular resistance, i.e. the condition of tonus of small vessels.

The venous outflow (VO) — reflects the conditions of blood return from the venous system. Normal values of VO for the rheogram recorded at wrist area makes from 0 to 0,3. Increasing of VO values indicates decrease of tonus of veins or insufficient force of myocardium diastolic activity and, therefore, difficulty of venous outflow.

Gradation limits of rheogram parameters (for the wrist area) are given in the table 2.6.

Table 2.6 — Gradation limits of rheogram parameters (for the wrist area)

Rheogram parameter	Decreased	Normal	Increased
RI	RI < 0,065	RI > 0,065	—
PRI	PRI < 0,30	0,30 < PRI < 0,50	0,50 < PRI
VO	—	0 < VO < 0,3	VO > 0,3

Write down the parameters of rheograms recorded at various conditions and their interpretation in the table 2.7.

Table 2.7 — The comparative characteristic of rheograms and changes of blood filling at various conditions

The condition of rheogram recording	Values of rheogram parameters			Blood filling characteristics
	RI	PRI	VO	
The hand at horizontal position				
The hand is lifted up				
The hand is down				
Action of cold				
Action of heat				

Note the dependence of blood filling of the examined part of body on the temperature and other influences. In conclusion give explanations to the observed changes on rheograms.

Lab. work 3.2. Examination of reflex reactions of the person

Responses of the nervous system to various irritations proceed by reflex principle. The irritation induces a signal which goes by afferents to the nerve centers at various levels of the central nervous system. Here signals are analysed and the appropriate reaction is synthesized.

Spinal cord localizes a lot of nerve centers of the reflexes which regulate both somatic and vegetative functions. The simplest of them are tendon reflexes and myotatic reflexes.

Reflex reactions of the person are widely used in diagnostics.

Affection of certain reflexes can reflect the localization of a pathological process in the spinal cord; hypo- or hyper- excitability of nerve centers can be diagnosed. Clinical symptom of it is the difference between reflexes of the right and the left sides of the spinal cord.

Purpose of work: to learn the technique of the examination of reflex reactions of the person.

Necessary material: reflex hammer**.** Object of research — a person**.**

Course of work

McCarthy's supraorbital reflex

Strike easily with the hammer on the external margin of the superciliary arch. The person is to close eyelids.

Reflex of upper extremity extension

The assistant stands by the person drawing his arm up to the horizontal level. With his left hand he supports the arm of the person by the elbow so that the forearm hanged down at right angle. At easy stroke with the hammer on the elbow joint the forearm is extended.

Reflex of flexion of upper extremity (ulnar bone)

The assistant places his left palm under the elbow of the person, supporting thus his forearm in semiflexed position. Strike the tendon of the biceps, watch the flexion of the elbow joint.

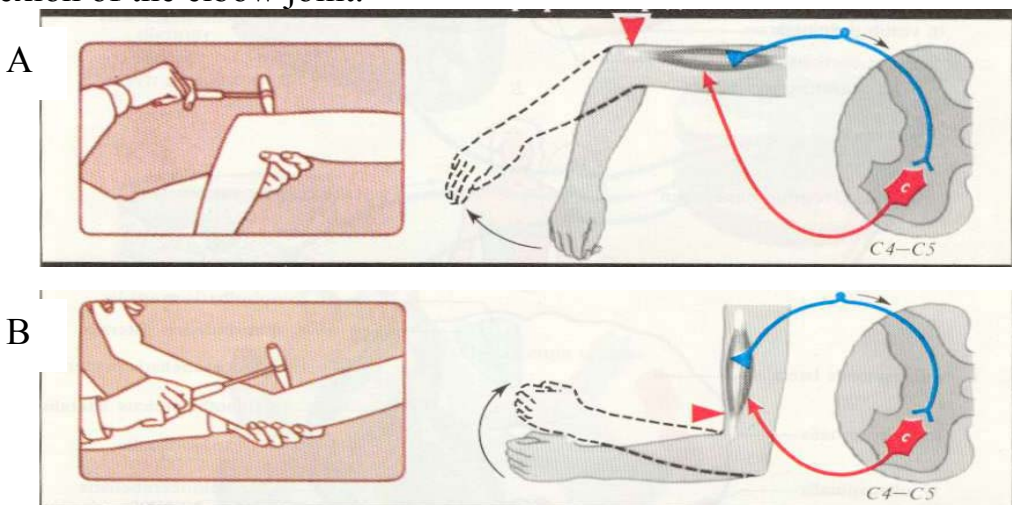


Figure 3.1 — A — Reflex of flexion of upper extremity,
B — Reflex of upper extremity extension

Knee reflex

The person sits on chair, his legs one on another. The assistant strikes the tendon of quadriceps of a leg somewhat lower of patella. There is an extension of the leg at knee-joint.

Achilles reflex

The person stands in his knees on a chair, his feet hang down freely from the chair. Strike the Achilles' tendon. The plantar flexion of foot is observed.

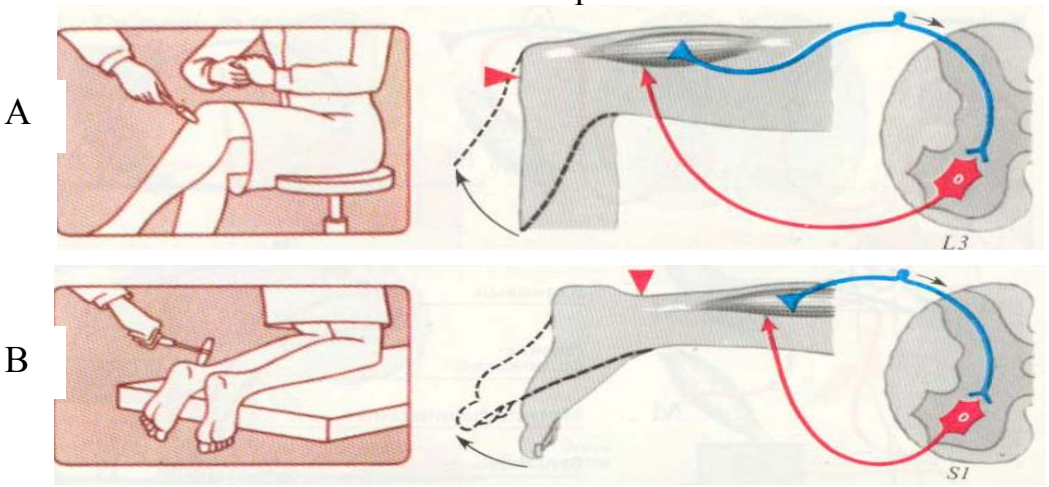


Figure 3.2 —A — Knee reflex, B — Achilles reflex

Iris contraction reflex

The pupil promotes sharp image of subjects on the retina by passing only central beams. Change of its size is caused by muscular system of the iris, thus stream of light falling into eye is regulated.

In norm at the bright light the pupil narrows, at darkening — dilates. Iris contraction reflex is used in clinics to diagnose the diseases of nervous system.

Consensual reaction of a pupil to light

The person sits faced to light and closes one eye with the hand. The assistant watches the pupil of the opened eye which narrows at light. Simultaneously, the pupil of the closed eye is narrowing.

In conclusions specify results of observations.

Lab. work 3.3. Evaluation of the state and the reactivity of vegetative nervous system by method of cardiointervalography

Examination of states of regulator mechanisms is the most important for the assessment of the adaptation of an organism to the influence of the environment, and early detection of pre-clinical forms of pathology. In this plan it is important to evaluate the state of the vegetative nervous system (VNS) and its reactivity. The initial vegetative tone (IVT) and vegetative reactivity (VR) are evaluated by cardiointervalography (CIG) with the use of an orthostatic sign (OS) which allows, by the parameters of cardiac rhythm, to estimate state of adaptive mechanisms of the whole organism.

Purpose of work: to learn the technique of CIG and to determine IVT and VR of the person. Object of research — a person.

Necessary material: electrocardiograph, couch, saline solution, gauze napkins, stop-watch, millimetric ruler.

Course of work

The test is made 1,5–2,0 hours after food reception. The person is made the ECG with 10–15 minutes intervals in one of 3 classical leads (usually the 2nd), not less than 100 cardiac cycles in lying position, and then not less than 100 — after changing into standing position. Paper speed is 25 mm/sec. With the help of the ruler measure R-R intervals in mm and convert them into seconds.

After the duration of each R-R interval is detected, make mathematical processing of the cardiointervalography.

The following parameters are calculated:

Mo — (mode, sec) — most frequently met interval;

AMo — (amplitude of mode) — number of the intervals conforming to the mode in percents to the general number of cardiac cycles. It characterizes the state of sympathetic influences.

ΔX — (variational excursion) — difference between maximal and minimal values of R-R in the given range of cardiac cycles. It characterizes vagus influence on the cardiac rhythm.

IS_1 (index of stress) — parameter of stress of compensatory mechanisms of the organism, calculated with the formula:

$$IS = \frac{AMo}{2 \times Mo(\text{sec}) \times \Delta X(\text{sec})} \text{ unit.}$$

By the IS_1 size determine IVT (see constants of VNS).

By CIG parameters written down IS_2 calculated in standing position (similar method), which is necessary for the calculation of R. M. Baevsky's index (IS_B):

$$IS_B = \frac{IS_2}{IS_1}$$

Write down the results in the table 2.8.

Table 2.8 — Cardiointervalography parameters

Parameter	The value of the parameter	
	in lying position	in standing position
Mo (mode, sec)		
AMo (amplitude of mode)		
ΔX (variational excursion)		
IS (index of stress)		
Baevsky's index (ISB)		

Determine the variant of initial vegetative tone (IVT) and the vegetative reactivity (VR) regarding IS_1 and IS_2 values and using the tables 2.9 and 2.10.

Table 2.9 — Evaluation of initial vegetative tone (IVT)

Indexes of stress (IS1)	Initial vegetative tone
< 30	vagotonia
30–90	eutonia (normtonia)
90–160	sympathicotonia
> 160	hypersympathicotonia

Table 2.10 — R. M. Baevsky's indexes (IS_B) for evaluation of vegetative reactivity

IS1 at rest, unit	Vegetative reactivity		
	Normal	Hypersympathicotonia	Asympathicotonia
Less than 30	1–3	> 3	< 1
30–60	1–2,5	> 2,5	< 1
61–90	09–1,8	> 1,8	< 0,9
91–160 and more	0,7–1,5	> 1,5	< 0,7

In conclusion note the state and the reactivity of the VNS of the person.

Lab. work 3.4. Evaluation of vegetative tonus by Kerdo index

The index of Kerdo allows to evaluate the state of vegetative nervous system by parameters, which characterize the state of cardiovascular system — arterial pressure (AP) and heart rate (HR).

Purpose of work: to evaluate vegetative tonus in the individual.

Necessary material: tonometer, phonendoscope, stop-watch. Object of research — a person.

Course of work

For the correct registration of parameters the individual should sit relaxed on a chair. It is necessary to measure his diastolic pressure and pulse on the left hand.

Kerdo index is calculated with the formula:

$$VIK = \left(1 - \frac{DP}{HR}\right) \cdot 100$$

where VIK — Kerdo vegetative index, %
DP — diastolic pressure, mm Hg;
HR — heart rate per minute.

Evaluation of the results:

VIK from –10 to +10 % (normotonia)
VIK more then +10 % (sympathicotonia)
VIK less then –10 % (vagotonia)

In the conclusion note the vegetative tonus of the person.

Virtual experiments on the topic "Physiology of nervous system"

1. Determination of the excitability threshold and demonstration of the phenomenon of temporal summation.
2. Determination of the effect of anesthetic substances and low temperature on action potential.
3. Determination of conduction velocity and the way it depends on axon diameter and on the presence or absence of myelin.
4. Central inhibition.
5. Peripheral inhibition.
6. The laws of radiation of reflexes (Pfluger's laws).

4. PHYSIOLOGY OF ENDOCRINE GLANDS

Questions for preparation of reports

1. Concept about endocrine glands. Hormones, their chemical structure and properties. Principles of interrelations (direct and feedback) in endocrine system. Transport of hormones blood. Mechanisms reception hormones and their action on cell-target.
2. Hormones of adenohypophysis and their physiological role. Regulation of function of adenohypophysis. Role of hypothalamic factors. Effects hypo- and hyperproduction of separate hormones of adenohypophysis.
3. Hormones of intermediate and posterior lobes of hypophysis and their physiological role. Role of hypothalamus in regulation of function of neurohypophysis.
4. Thyroid gland, its structural organization. Iodinated hormones (T_3 and T_4), their biosynthesis, transport by blood, physiological role.
5. Hypo- and hyperthyroid states. Cretinism, myxedema. Basedow's disease. Physiological hyperfunction of thyroid gland. Endemic goiter and its prophylaxis.
6. Calcitonin, cells its forming, chemical structure of hormone and physiological role.
7. Regulation of function of thyroid gland. Methods of diagnostics of functional state of thyroid gland.
8. Hormone of parathyroid gland and its role in regulation of metabolism of Ca and P. Regulation of function of parathyroid gland. Hypo- and hyperparathyroidism.
9. Role of hormones cortical layer of adrenal gland in regulation of functions of an organism.
10. Hormones of medullary layer of adrenal gland and their physiological role.
11. Endocrine function of pancreas and its role in regulation of metabolism. Regulation of function of pancreas. Adrenal diabetes.
12. Sex glands. Androgens and them physiological role. Estrogen and their physiological role. Hormone of yellow body progesterone, its physiological role. Hormones of placenta.

Lab. work 4.1. Evaluation of human height

Human height is one of the main characteristics of physical development. Growth is an integrated parameter of genetic, hormonal, tissue and external influences on bones and other tissues of the organism. The genetic program of growth is realized through the humoral endocrine system including all known hormones (thyroid hormones, insulin, calcium regulating hormones, sex hormones and hormones of adrenal glands), but hypothalamus-hypophysis regulation of growth which central link is somatotropin has the special value.

Somatotropin (STG) — the main hormone which stimulates linear growth. STG promotes growth of bones in length, growth and differentiation of internal organs and development of muscular tissue. The main effects of STG on bone tissue consist in stimulation of cartilage growth, protein synthesis and induction of cells mitosis. Growth stimulating effects of STG are mediated by insulin-like growth factors (somatomedins) which are synthesized under the influence of STG, mainly, in a liver and kidneys. Linear human height is finished with closing of growth zones under the influence of sexual hormones.

The simplest and available method of somatotropic function evaluation is anthropometrical, namely, the human height assessment in comparison with the predicted growth calculated on the basis of average height of his parents.

The measured height of the adult has to coincide with the predicted height or deviate from the calculated height no more than on 2 SD (standard deviations), namely, ±10 cm to the calculated height. The deviation of the measured height more than on 2 SD from the calculated height indicates pathologically high or low human height.

Purpose of work: to calculate predicted human height.

Necessary material: height meter. Object of research — a person.

Course of work

Measurement of height is made in a standing position. In order to avoid measurement errors and for receiving exact results it is necessary to observe some rules. The examined person should stand without footwear (in thin socks) in the correct position: hands on seams; heels together; heels, breeches and shovels are pressed to a board of a height meter. The head is in "the plane of Frankfurt", i.e. the inferior edge of an eye and external acoustical duct have to be on one horizontal line. Measurements are carried out at expiration. Level of a height meter is lowered on the head of examined person without much pressing, but at the same time, considering indumentum development.

Predicted height of a person (PHP) is calculated with the formula:

a) for men PHP = (father's height + mother's height + 13 cm) : 2

b) for women PHP = (father's height + mother's height – 13 cm) : 2

In the conclusion note the measured height and calculated predicted height and evaluate the deviation between them.

Lab. work 4.2. Identification of persons with high risk of diabetes mellitus by questionnaire method

The group of risk for carbohydrate exchange disorders consists of people with the hereditary predisposition, excess body weight and an inactive way of life, and also persons who had the disorder of tolerance (stability) to glucose in the period of acute diseases. The changed tolerance to glucose is a positive test with glucose load at normal glucose concentration in blood on an empty stomach. Earlier identification of such persons is important for clinic.

Purpose of work: to evaluate high risk of diabetes mellitus in a person by questionnaire method.

Necessary material: questionnaire, calculator. Object of research — a person.

Course of work

Answer the questions. Evaluate the answer using an estimated scale. Answering a question, note the number of your answer.

Questionnaire

Age, years _____. Sex (m, f) _____. Height, cm _____. Body weight, kg____			
Question	Answer	Estimated scale	
		men	women
1. Do you fill constant dryness in a mouth?	Yes No	1,62 0	2,07 0
2. Do you have constant thirst which is not connected with the use of salty food, hot weather, etc.?	Yes No	1,26 0	1,89 0
3. Do you have the increased appetite?	Yes No	0,78 0	0,85 0
4. Do you have constant weakness?	Yes No	0,69 0	0,94 0
5. Do you have skin itch?	Yes No	0,96 0	1,36 0
6. Do you have now or did you have pustulous diseases of skin?	Yes No	0,82 0	0,38 0
7. Do you have a need for drinking water between a breakfast, a dinner and a supper?	Usually no 1–2 glasses a day To 1 l a day More than 1 l a day	-0,49 -0,30 0,73 0,67	-0,99 -0,71 1,43 1,43
8. How did your body weight change within the last year ?	Didn't change Increased Decreased	-0,65 0,13 1,3	-0,56 0,33 1,5
9. Who from your close relatives (alive or dead) had diabetes mellitus?	Nobody I don't know Parents (father, mother) Grandmother, grandfather Brother, sister Uncle, aunt	-0,31 -0,03 -0,28 -0,54 0,38 1,08	-0,02 -0,72 -0,16 -2,26 1,53 -0,26
10. May you do without sweets?	Yes No	0,42 0,19	0,25 0,51
11. The actual body weight in comparison with "ideal" (growth in centimeters minus 100)	11–20 kg less than "ideal" 21 kg less and more Ranging from-10 to +10 kg 11–20 kg more than "ideal" 21 kg more and more	-0,57 1,07 -0,71 0,37 2,2	-1,87 0,9 -0,59 0,12 1,81

Calculate the total assessment of answers by summarizing positive and negative estimated points. If the total assessment of the test makes 3 points and more, the probability of diabetic disorder of carbohydrate exchange is rather high; the examinee belongs to group of risk and it needs to be subjected to laboratory examination.

In the conclusion note the calculated total assessment of the test and evaluate the risk of diabetes mellitus.

Lab. work 4.3. Influence of thermal procedures on the activity of medullary layer of adrenal glands

Cromophilic cells of medullary layer of adrenal glands produce catecholamines adrenaline and noradrenaline which are excreted into blood. Their secretion at rest is insignificant. It rises in the conditions activating sympathetic nervous system.

The various stimuli acting on different receptors (baroreceptors, thermoreceptors) are capable to increase the secretion. Increase of catecholamine concentration in blood leads to increase of arterial pressure (AP) and heart rate (HR). In norm the thermal impact on a waist leads to insignificant increase of these indicators. At hyperfunction of medullary layer of adrenal glands heat application on lumbar area causes sharp rising of systolic pressure — to 200–300 mm Hg and higher.

Purpose of work: to study influence of thermal procedures on functions of medullary layer of adrenal glands.

Necessary material: tonometer, stop watch, hot-water bottle. Object of research — a person.

Course of work

1. Measure the arterial pressure on both hands By Korotkov's method and count the pulse.

2. Put a hot-water bottle with hot water (80–90 °) wrapped up by a towel to a waist in the field of adrenal glands projection.

3. After 5 minutes of warming up again measure AP and count HR.

In the conclusion note the haemodynamic parameters (AP on right and left hands, HR) before and after carrying out thermal procedure and evaluate the activity of medullary layer of adrenal glands.

Lab. work 4.4. Analysis of conception scale at menstrual cycles of various duration

The rhythmic method of contraception is based on presumable detection of time of an ovulation which is observed at the majority of women on the 14th day of a menstrual cycle, and on abstention from the sexual relations during the period of possible conception (from the 10th to the 14th day of a 28-days' menstrual cycle).

At the correct application and the regular cycle efficiency of this method is about 90 %.

Purpose of work: to determine probable days of conception by the menstrual cycle.

Necessary material: standard scale of conceptions. Object of research — a person.

Course of work

Using a scale (figure 4.1), determine probable days of conception by your menstrual cycle.

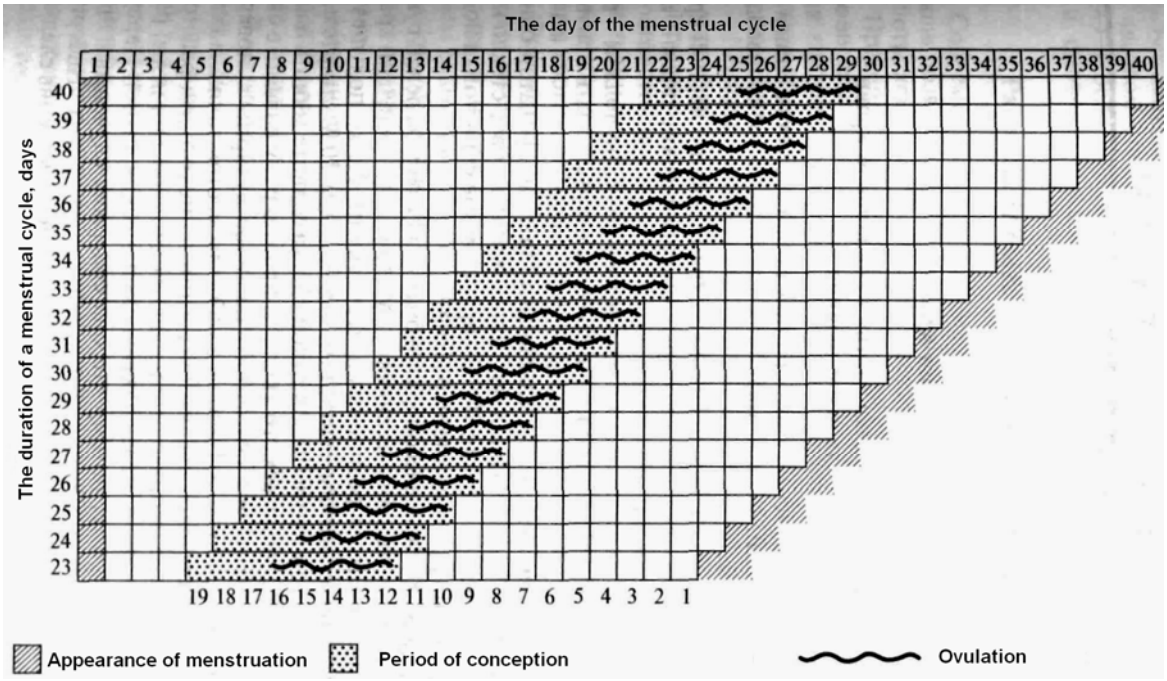


Figure 4.1 — Scale of determination of probable conception days by the menstrual cycle

In the conclusion note the duration of the menstrual cycle and the probable days of conception.

Virtual experiments on the topic "Physiology of endocrine glands"

1. Influence of thyroxin, thyrotropin and propylthiouracil on metabolism.
2. Influence of insulin and alloxan on glucose level in blood.

5. PHYSIOLOGY OF RESPIRATION

Lab. work 5.1. Spirometry

Spirometry — the method of measurement of vital capacity of lungs and its composing volumes.

Purpose of work: to learn the technique and to measure vital capacity of lungs (VCL) and it's composing volumes.

Necessary material: water or dry spirometer, nasal clamp, alcohol, cotton wool. Object of research — a person.

Course of work

The mouthpiece of the spirometer (figure 5.1.) should be wiped with cotton wool moistened with alcohol. After the maximum inhalation in the standing position, the individual should make a maximum deep exhalation into the spirometer and determine the vital capacity of lungs (VCL) on the spirometer scale. Measure the VCL for several times and calculate the average value.

Figure 5.1 — Spirometer

According to the nomogram (Fig. 5.2), calculate the due VCL (DVCL).

Breathe out several times (5–7) into the spirometer as usual. Measure tidal (respiratory) volume of air (TV) by dividing indications of the spirometer by the number of expirations into the spirometer.

To measure the expiratory reserve volume (ERV) make forced breathe out into the spirometer after you have made usual breathe out. Repeat measuring several times and calculate the average.

To calculate the inspiratory reserve volume (IRV), subtract the sum of tidal volume and expiratory reserve volume from VCL.

Indirect methods are used to determine the residual air volume (RV). Normally, the residual volume is 25–30 % of the value of the VCL.

Votchal's test. Normally, the difference between the values of VCL measured at the usual expiratory rate and at the maximum fast expiration does not exceed 300 ml. An increase in this difference indicates a narrowing (obstruction) of the small bronchi.

The results of the work must be included in the table 5.1 and compared with norm.

Table 5.1 — Parameters of the external respiration

Registered parameters	Result		Norm
	air spirometer	spirometer MAC-1	
VCL, l $_{standing}$			3,5–5,0
DVCL, l (by nomogram, figure 5.2)		—	—
TV, l			0,3–0,9
IRV, l			1,5–2,0
ERV, l			1,0–1,5
RV, l			1,0–1,5
Votchal's test, ml		—	0,3
RMV, (l/min)	—		to 7
RR, breaths per minute	—		12–18
FVCL, l Forced vital capacity			
FEV1 Forced expiratory volume in 1 second (Tiffno index)	—		3,0 liters per second (70–80 % of VCL)
MVV (MVL), l/min	—		120–170

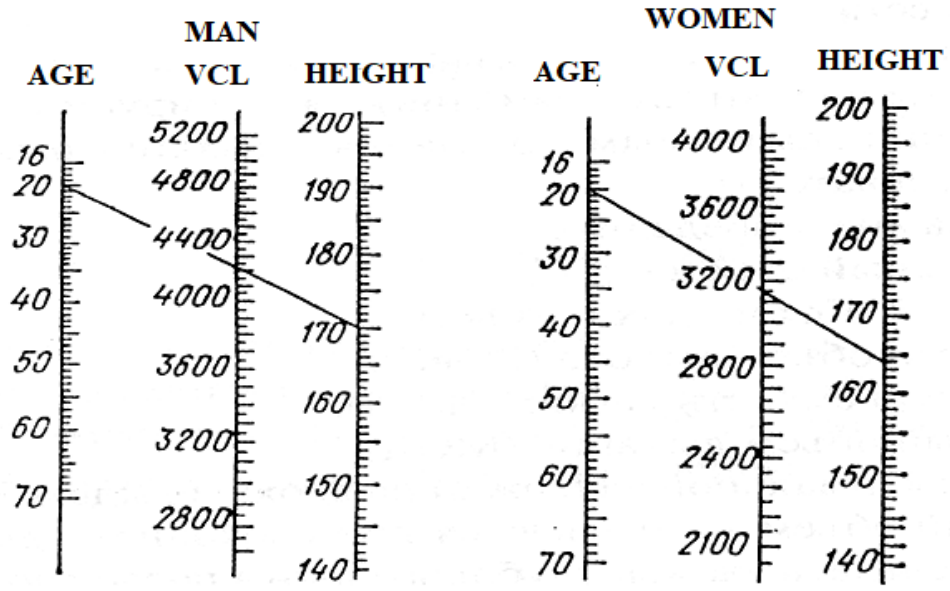


Figure 5.2 — Nomogram for evaluation of due size of the VCL

Write down VCL, FVCL, DVCL, parameter of Votchel's test and compare results with norm.

Lab. work 5.2. Spirography

It is possible to measure in detail and more precisely all capacities and volumes of lung with the help of a spirograph.

Purpose of work: to learn the technique of graphic registration of external respiration parameters.

Necessary material: spirograph, disinfected nasal clamp and mouthpiece. Object of research — a person.

Course of work

Prepare the device for work. Place the device in the position suitable for the individual. Attach the device to the individual through the mouthpiece. Apply nasal clamp. Let the individual to get used to breathe through the mouthpiece.

Register spirogram (figure 5.3) at tape speed 50 mm/min. Individual is to make various respiratory motions by the request of the assistant.

Measure on the spirogram:

a) Tital (respiratory) volume (TV);

b) Inspiratory reserve volume (IRV);

c) Expiratory reserve volume (ERV);

d) Vital capacity of lungs (VCL);

e) Respiratory minute volume (RMV);

The tidal volume is registered at quiet breathing. To measure IRV, make record of deep inspiration after quiet inspiration. To measure ERV, make record of deep expiration after quiet expiration.

To measure VCL, the individual should breathe deeply in, and then deeply breathe out.

After finishing to record pulmonary volumes, record the spirogram at tape speed of 1200 mm/min and calculate the following parameters:

1) Duration of quiet inspiration and expiration (t of inspiration and t of expiration); by the received data considering TV calculate respiratory minute volume (RMV).

2) Forced expiratory volume (FEV) (measure the volume of deep and fast expiration for 1 sec).

3) Maximal voluntary ventilation (MVV) or maximal ventilation of lungs, (MVL) (respiration with the maximal frequency and amplitude, write down 3–4 cycles).

Calculate all lung volumes, based on that 1 mm of record (in height) corresponds to 40 ml of air. Calculate time characteristics of parameters of respiration, considering tape speed of 50 mm/min (1 mm = 1,2 sec) and 1200 mm/min (1 mm = 0,05 sec).

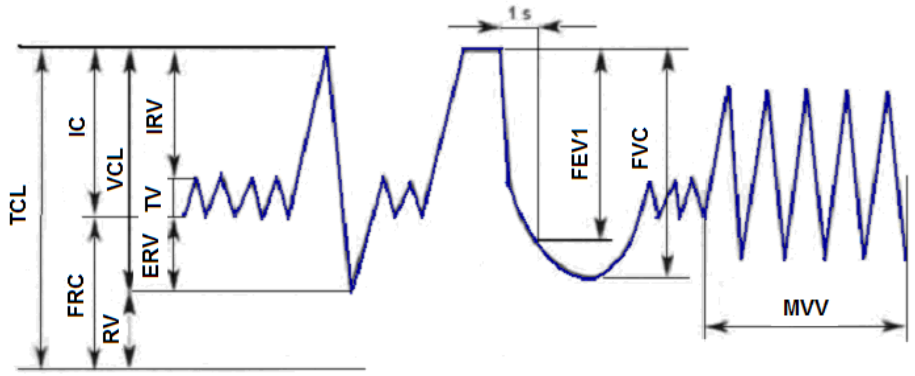


Figure 5.3 — Spirogram

Write down the obtained results into the table 5.2.

Table 5.2 — Spirography results

Recorded parameters	Result
Tidal volume, l	
Inspiration reserve volume, l	
Expiration reserve volume, l	
Vital capacity of lungs, l	
Respiratory minute volume, l/min	
Forced expiratory volume in 1 second	
Maximal voluntary ventilation, l/min	
Time of quiet inspiration, sec	
Time of quiet expiration, sec	

Draw conclusion on the state of external respiration of the individual.

Lab. work 5.3. Evaluation of functional state of respiratory system and cardiovascular system by Skibinskaya's index

Skibinskaya's index allows to estimate functional state of the organism by the two systems: system of respiration and cardiovascular system. It is the method of self-control.

Purpose of work: to estimate functional state of respiratory and cardiovascular systems by Skibinskaya's index.

Necessary material: the spirometer, stop-watch. Object of research — a person.

Course of work

First, calculate pulse and respiration rate. Then measure VCL by making 2–3 measurings and put down the largest result with the help of the spirometer. After 5–10 minutes' rest measure respiration rate for one minute, make deep breathe in and out, then deep breathe in and hold it for 1 time (measure in seconds).

Skibinskaya's index is calculate with the formula:

$$SI = \frac{VCL \times DBH(\text{sec})}{100 \times HR},$$

where: VCL — vital capacity of lungs, is expressed in milliliters;

DBH — duration of breath-holding;

HR — heart rate.

Trained people's respiration after its breath-holding should not become frequent, since the appeared oxygen deficiency is compensated due deepening of breathing.

Using the obtained VCL data, pulse rates and time of breath-holding calculate Skibinsk**ay**a's index with the formula and compare it with the data of table 5.3.

Table 5.3 — Evaluation of results of Skibinskaya's index measurement

Size of Skibinsk's index	Result
5	very bad
5–10	unsatisfactorily
10–30	satisfactory
30–60	good
60 and more	excellent

Make a conclusion on the functional state of respiratory and cardiovascular systems.

Lab. work 5.4. Functional test with breath-holding (Genche's and Stange's tests)

Breath-holding time is individual in each person. It depends on state of the external respiration apparatus and system of blood circulation. So, the duration of voluntary maximal breath-holding can be used as functional test.

In healthy people maximal breath-holding time after quiet inspiration is 50–60 sec, after quiet expiration it is less than 30–40 sec. These indications change at forced ventilation.

Purpose of work: to measure time of breath-holding and factors influencing the time of breath-holding.

Necessary material: stop-watch. Object of research — a person.

Course of work

Measure the maximal breath-holding time at inspiration (Stange's test) and expiration (Genche's test) while breathing quietly. The individual should breathe quietly for 3–4 minutes, then, after usual expiration breathe in or breathe out deeply and hold up breathing as long as possible. Using stop-watch, measure time from the moment of breath-holding till the moment it re-starts. In both cases to measure the time of maximal breath-holding, use the data of 3 attempts and take simple average.

To measure time of the maximal breath-holding for inspiration and expiration during voluntary forced breathing (after artificial hyperventilation of lung). For this purpose the individual should breath with the maximal depth (not frequency) for 1–2 minutes and then hold up breath at the maximal inspiration or expiration. Each time to measure the size of the maximal breath-holding taking the simple average of 3 attempts.

Write down the obtained results into the table. 5.4.

Table 5.4 — Results of functional test with breath-holding

Maximal breath holding time, s	After a calm breathing	After artificial hyperventilation of lungs
After deep inspiration (Stange's test)		
After deep expiration(Genche's test)		

Analyze the data obtained using the following:

Stange's test (after *deep inspiration*):

< 39 sec — unsatisfactory;

40–49 sec — satisfactory;

> 50 sec — good.

Genche's test (after *deep expiration*):

< 34 sec — unsatisfactory;

35–39 sec — satisfactory;

> 40 sec — good.

Write down the received data in the protocol.

In conclusion compare size of the maximal breath-holding at expiration and inspiration. Also, compare size of the maximal breath-holding at inspiration, after quiet and after forced breathing. Explain the reason for observed differences.

Lab. work 5.5. Evaluation of physical endurance in a person with calculation of cardiorespiratory index

Parameters of the systems of blood circulation and respiration are widely used when testing physical endurance and training level of a person. For example, cardiorespiratory Samko's index (CRSI) is used which unites seven parameters and can be easily performed in a lab.

Purpose of work: using cardiorespiratory index, evaluate the level of physical endurance of the individual.

Necessary material: sphygmomanometer, phonendoscope, alcohol, cotton wool, spirometer, stop-watch. Object of research — a person.

Course of work

Take the arterial pressure in the individual (systolic and diastolic). Then measure maximal pressure of expiration. To do this, the individual should take rubber tube of sphygmomanometer into his mouth make a maximal breathe out. With spirometer measure vital capacity of lung, and with stop-watch count heart rate for 10 sec and time of the maximal breath-holding. Calculate CRSI with formula:

$$CRIS = \frac{VCL + MPE + MBH + A}{SP + DP + HR},$$

where: VCL — vital capacity of lung (the volume in milliliters divided by 100);

MPE — maximal pressure of expiration, mm Hg;

MBH — maximal breath-holding after quiet inspiration, sec.;

A — age, amount of complete years;

SP — systolic pressure, in mm Hg;

DP — diastolic pressure, mm Hg;

HR — heart rate for 1 minute.

It is possible to identify the three values of the CRIS at physical activity: adynamic, dynamic and restorative.

Adynamic phase corresponds to 10-minute rest, dynamic phase — to dosed exercise stress, size about 20 kilojoule (30 squats), and recovery phase is determined by time necessary returning of CRSI to initial level.

In well-trained athletes size of CRSI in adynamic phase is 1.000 and higher, in unexercised but practically healthy people — from 0.800 to 0.900, in patients with various cardiovascular and respiratory abnormality size of CRSI is within 0,300–0,400.

Measuring of CRSI made during dynamic phase have shown that in well trained athletes the decrease of size of CRSI up to 5 % of the initial size is observed. In unexercised but practically healthy people the decrease of CRSI is 15–30 %, and in patients with various cardiovascular and respiratory abnormality — 35–65 %.

In recovery phase in unexercised but practically healthy people, recovery of the initial parameters takes 1–3 minutes, in patients with cardiovascular and respiratory abnormality — 10 and more minutes.

Calculate sizes of CRSI in the individual in adynamic, dynamic and recovery phases, draw conclusion on the level of physical endurance. Write down the obtained results into the table. 5.5.

Table 5.5 — Results of cardiorespiratory index measurement

Parameters	Value		
	Adynamic phase	Dynamic phase	Recovery phase
SP (Systolic pressure), mm Hg.			
DP (Diastolic pressure), mm Hg;			
MPE (Maximal pressure of expiration), mm Hg			
VCL vital capacity of lung, L (VCL/100)			
HR (Heart rate for 1 minute)			
MBH (Maximal breath-holding after quiet inspiration), s			
A (Age, years)			
CRIS			

Lab. 5.6. Measurement of peak expiratory flow rate

Peakflowmetry is applied in practice for measurement of respiratory ways patency.

Purpose of work: to learn the technique of measurement of peak expiratory flow rate at the examined person.

Necessary material: peak flow meter, cotton wool, 3 % solution of hydrogen peroxide with addition of 0,5 % washing solution or 5 % solution of chloroamine. Object of research — a person.

Course of work

Lower the cursor of peak flow meter down (establish 0 on a scale). Disinfect a mouthpiece and attach it to peak flow meter. Then the examinee has to get up, make a deep inspiration through the mouth, tightly clasp a mouthpiece by lips

and exhale air quickly and strongly. Find the number opposite to which the cursor stopped. Repeat the experiment several times and find the average value. It is necessary to hold peak flow meter by one hand and not to put fingers on a scale.

In conclusion note peak expiratory flow rate determined in the examinee and compare to normal parameters of peak expiratory flow rate in adults (figure 5.4).

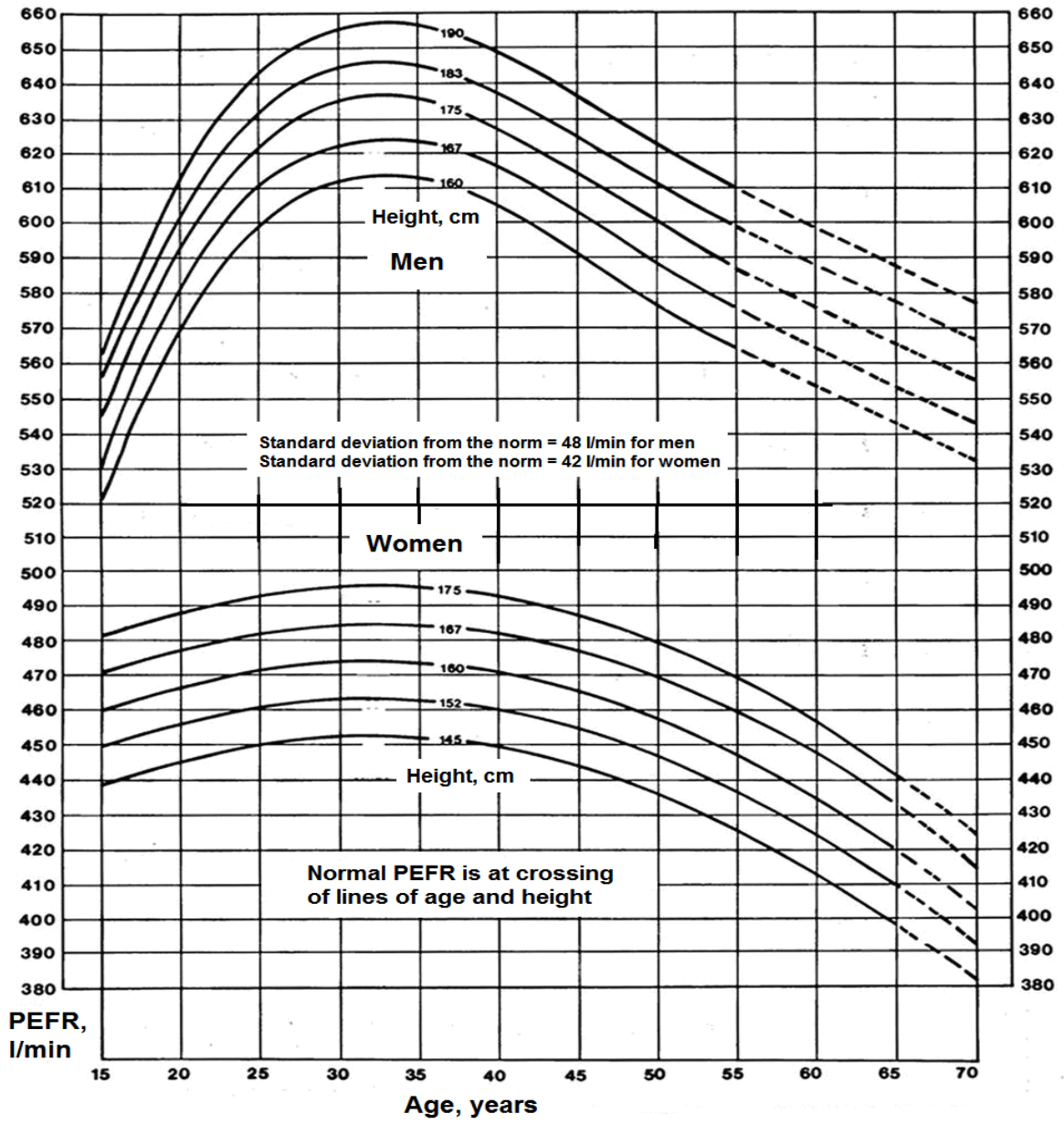


Figure 5.4 — Parameters of peak expiratory flow rate (PEFR) in adults

Virtual experiments on the topic "Physiology of respiration"

1. The mechanism of respiration; pulmonary volumes and capacities; the role of the diameters of the airways.
2. Influence of pressure in a pleural cavity on ventilation of lungs.
3. The influence of surfactant on pulmonary ventilation.

THE BASIC CONSTANTS OF RESPIRATORY SYSTEM

Parameter	Values
Respiration rate: in adults	12–18 / minute
in neonatal	40–55 / minute
in baby	30–40 / minute
General respiratory surface of lungs	50–90 m^2
Excursion of thorax: (m)	7–10 cm
(f)	5–8 cm
Negative pressure in pleural cavity: at inspiration	6–8 cm H_2O, or 4–5 mm Hg
at expiration	3–5 cm H_2O, or 2–3 mm Hg
Interrelation of duration inspiration-expiration	1:1.2
Thickness of lungs membrane	0,4–1,5 micrometer
Tidal (respiratory) volume	0,3–0,9 l
Inspiratory reserve volume	1,5–2,0 l
Expiratory reserve volume	1,0–1,5 l
Vital capacity of lungs	3,5–5,0 l
Residual volume	1,0–1,5 l
Functional residual capacity	2,5 l
Inspiratory capacity	2,0 l
Dead space	140–170 ml
Coefficient of lung ventilation	1/7
Respiratory minute volume : at rest	up to 7 l
at physical activity	Up to 120 l/minute
Alveolar ventilation	4,2–5,6 l/minute
Maximal voluntary ventilation	120–170 l/minute
pO_2 in alveolar air	100 mm Hg
pCO_2 in alveolar air	40 mm Hg
pO_2 in arterial blood	96 mm Hg
pCO_2 in arterial blood	39 mm Hg
pO_2 in venous blood	40 mm Hg
pCO_2 in venous blood	46 mm Hg
Forced expiratory volume (VEF)	3 l
Oxygen-binding ability of Hb	1,34 ml/g
Oxygen capacity of blood	19 percent by volume
Ventilation-perfusion coefficient	0,8–0,9
Consumption of oxygen: at rest	350 ml/min
at physical activity	under 5000 ml
Coefficient of O_2 utilization: at rest	40%
at physical activity	under 50–60%
Critical limit of hypoxia (pO_2)	30–35 mm Hg in alveolar air

6. PHYSIOLOGY OF HEART

Lab. work 6.1. Electrocardiography

Electrocardiography — the method of registration of electrical phenomena which arise in the heart during the cardiac cycle. The electric potential generated by the cardiac muscle may be register from the body surface. Electrocardiogram (ECG) usually has three upward-directed positive waves P, R, T, and two downward-directed negative waves Q, S. It has five intervals:

P-Q, QRS, S-T, Q-T, R-R. P wave — atrial complex of ECG; it is the algebraic sum of the potentials arising in the right and left atriums at their excitation. QRST — ventricular potentials, they reflect processes of the excitation of ventricles (figure 6.1, table 6.1). State of heart is judged upon the voltage of waves (it is measured from the isoline to top) and duration of intervals.

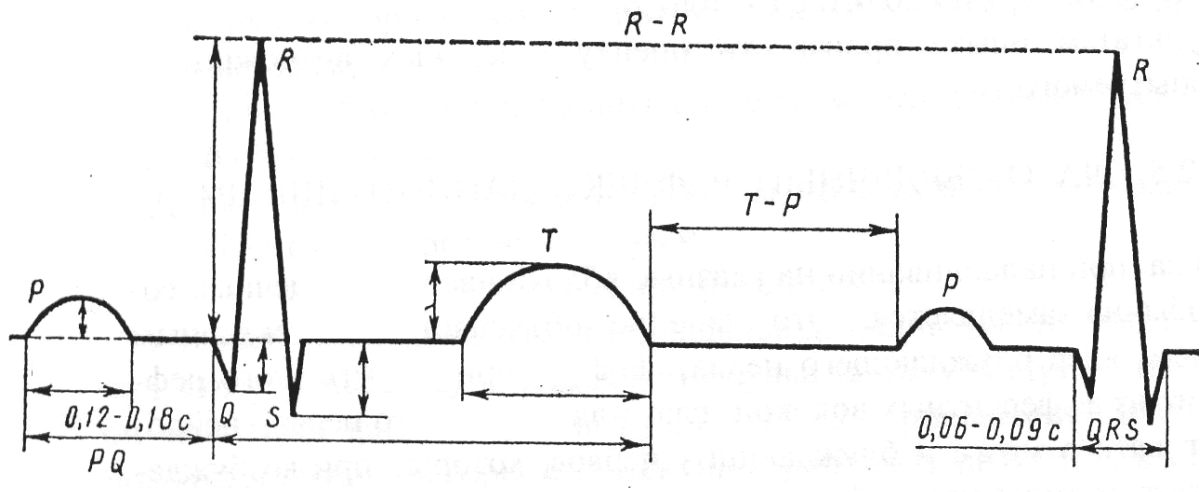


Figure 6.1 — Scheme of electrocardiogram (explained in the text)

Table 6.1 — Amplitude and duration of the waves in the II standard lead

Waves of ECG	Amplitude of waves, mV	Duration of waves, s
P	0,05–2,5	0,1
Q	0–0,3	0-0,03
R	1–2	0,03-0,09
S	0–0,6	0-0,03
T	0,2–0,5	0,12-0,16

At electrocardiography the method of bipolar and unipolar leads is used. Perform electrocardiography, three standard bipolar leads are applied with which potential difference between extremities is recorded:

I — right hand — left hand; II — right hand — left leg; III — left hand — left leg. (figure 6.2).

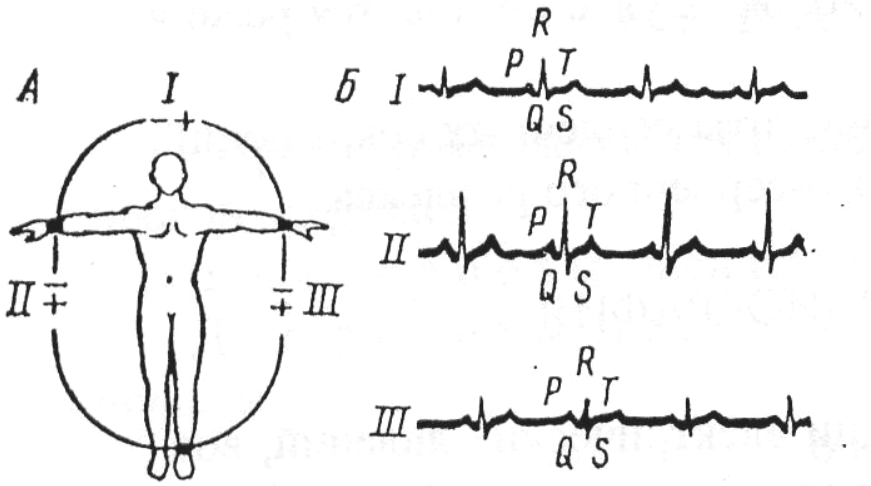


Figure 6.2 — Scheme of electrocardiography leads and curves features received.
A — standard leads, B — recording of ECG in 3 standard leads

Purpose of work: to learn technique, to record and interpret the ECG.

Necessary material: electrocardiograph, electrodes, electrode paste or 1,0 % solution of NaCl, gauze or filter paper, glue, alcohol-ether. Object of research — a person.

Course of work

A. Application of electrodes. The patient lays on a couch. Treat electrodes and spots of body where electrodes will be applied with alcohol. Oil electrodes with the current-conducting pasta or moisten filter paper with 1,0 % solution of NaCl. Apply electrodes according to the scheme: red — right hand, yellow — the left hand, green — left leg, black — indifferent, applied on the right leg.

B. Record ECG with all standard leads and attach it into the copy-book.

1. Note waves and intervals as appropriate.

2. Determine HR and heart rhythm — by the duration of R-R intervals. Compare with the norm.

3. Measure voltage of P, Q, R, S, T waves.

4. Measure duration of waves and intervals (considering 1 mm = 0,04 sec, proceeding from the speed of tape — 25 mm/sec).

Write down the obtained date into the table 6.2.

Table 6.2 — Results of ECG

Amplitude of waves, mV		Duration of waves and intervals, sec	
Values	Norm	Values	Norm
P =	P =	P =	P =
Q =	Q =	T =	T =
R =	R =	$PQ_{interval}$ =	$PQ_{interval}$ =
S =	S =	$RR_{interval}$ =	$RR_{interval}$ =
T =	T =	$QRST_{interval}$ =	$QRST_{interval}$ =

Calculate the heart rate per minute by the formula:

$$HR = \frac{60}{R - R(\text{sec}\,onds)}$$

On the basis of ECG analysis characterize in conclusion the functional state of heart of the person.

Lab. work 6.2. Calculation of cardiac cycle duration in person by pulse

The duration of cardiac cycle depends on the heart rate. Also, arrhythmia of cardiac activity connected with phases of respiration (respiratory arrhythmia) which can be caused by fractional calculation of pulse (every 5 sec) with subsequent calculation of duration of cardiac cycle for every 5 sec of the calculation.

Purpose of work to learn technique and to calculate the duration of cardiac cycle by pulse.

Necessary material stop-watch. Object of research — a person.

Course of work

Reveal the pulsing of the radial artery and count heart rate (HR) for 5 sec some times within 3 minutes. Divide 5 by each HR value to calculate duration of one cardiac cycle. Calculate average duration of cardiac cycle in every 5 sec of the analysis.

Then count HR within 1 minutes. Divide 60 by HR value and determine the average duration of cycle.

Write down the obtained date into the table 6.3.

Table 6.3 — Duration of cardiac cycle

Parameters	HR Values				
	1	2	3	Average value	HR per 1 min
HR per 1 minute (n_1)					
Average HR duration per 1 min ($60/n_1$)					
HR in 5 seconds (n_2)					HR per min ($n_2 \times 12$)
HR average duration for every 5 seconds counting ($5/n_2$)					

Note if there is a difference in duration of cardiac cycle at different methods of analysis. In conclusion specify an advantage and disadvantage of both methods.

Lab. work 6.3. Auscultation of cardiac tones

Cardiac tones (heart sounds) relate to external parameters of work of heart. When auscultating heart with stethoscope, two tones of different height and du-

ration are heard. There are the first (systolic) and the second (diastolic) tones. Systolic tone is dull, long and low, diastolic — short, high and clear. Systolic tone is caused by the contraction of ventricles, simultaneous closure of atrioventricular valves, strain of muscles of ventricles, papillary muscles and vibration of tendinous strands. The second tone depends exclusively on closure of semilunar valves of aorta and pulmonary artery. Both tones are auscultated on the surface of thorax in heart region, but best of all — at projections of heart valves.

To auscultate the tones, place stethoscope on the thorax in places where sounds of separate valves are conducted, then each tone is heard more clearly than another one. The place of mitral valve projection lays below the attachment of the third left costal cartilage to the thorax, it is best auscultated on the left in the fifth intercostal space, 1,0–1,5 cm towards inside from mammary line. The place of projection of the tricuspid valve is on medium line of the thorax, lower than place of the fourth costal cartilages are attached to the thorax; its tone is best auscultated in the region of the lower third of the thorax on the right. The semilunar valve of the pulmonary artery is projected in the second intercostal space but only on the right from the breast bone (figure 6.3).

Purpose of work: to learn technique of auscultation and differentiate cardiac tones.

Necessary material phonendoscope. Object of research — a person.

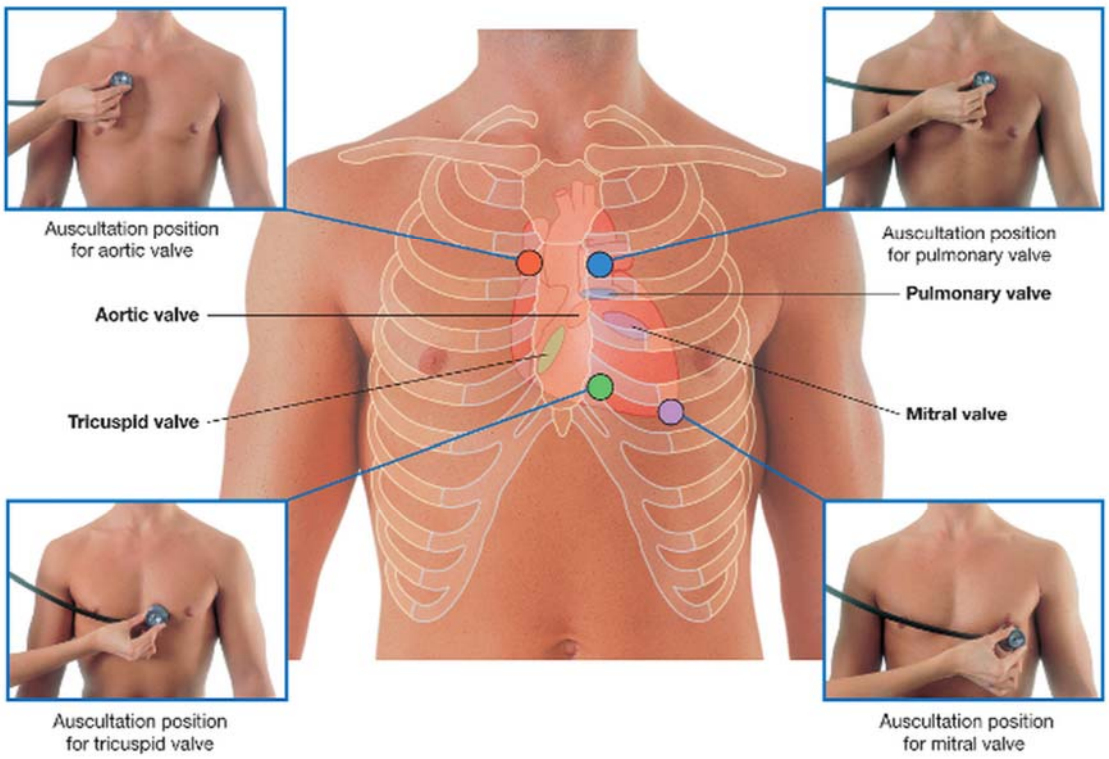


Figure 6.3 — Areas of the thoracic surface where the sounds of the heart can be best detected

Course of work

Systolic tone is best heard in the fifth intercostal space, one finger left from the nipple. Semilunar valves are projected on the right at the level of the second intercostal space at breast bone — the second sound is heard here. Hold phonendoscope without touching its membrane with finger to prevent side murmurs.

Determine two separate tones and characterize them.

Lab. work 6.4. Calculation of stroke volume and cardiac output

With each contraction, heart outputs into arteries a certain amount of blood which is called stroke (systolic) volume. The amount of blood output by the ventricle within a minute is called cardiac output (minute volume of blood). To calculate stroke volume and cardiac output of the examined person, one should know his diastolic (DP), pulse pressure (PP), heart rate and age. Starr formula is commonly applied to calculate stroke volume and cardiac output:

$$SV = 101 + 0,5 \times PP - 0,6 \times DP - 0,6 \times A,$$

where*:* SV — stroke volume (ml);

PP — pulse pressure;

DP — diastolic pressure;

A — age of the examinee (years).

Purpose of work: to calculate stroke volume and cardiac output.

Necessary material: tonometer, phonendoscope, stop-watch. Object of research — a person.

Course of work

Measure arterial pressure (systolic, diastolic, pulse) and heart rate in a person for one minute at rest. Then the person does exercises — 15–20 squats. After the exercises, count pulse for the first 10 seconds and multiply by 6 (HR per minute). Measure systolic, diastolic and pulse pressure.

Calculate size of stroke volume by Starr formula.

Calculate cardiac output (Q) at rest and after physical exercise by the formula:

$$Q\ (ml/min) = SV \times HR$$

Write down the obtained results in the table 6.4.

Table 6.4 — **S**troke volume and cardiac output at rest and after physical exercise

Parameters	Values	
	Before exercise	After exercise
SP (systolic pressure) mm Hg		
DP (diastolic pressure) mm Hg		
PP (pulse pressure) mm Hg		
Heart rate per minute		
SV (calculated by formula)		
Q (calculated by formula)		
Age of the examinee (years)		

In conclusion compare the obtained size of SV and Q with the norm, note changes SV and Q after exercises.

Lab. work 6.5. Evaluation of reserve resources of heart (Roufier's test)

Test is used to evaluate the working capacity of heart at exertion.

Purpose of work: to evaluate reserve resources of heart.

Necessary material: stop-watch. Object of research — a person.

Course of work

Count pulse of a person for 15 sec at rest (P1), then let him do 30 squats for 1 minutes and count pulse for the first and last 15 sec (P_2, P_3) during the first minute after exercises. Calculate cardiac activity (PCA) with the formula:

$$PCA = \frac{4 \times (P1 + P2 + P3) - 200}{10}$$

Result of test:

At PCA from 0,1 up to 5 — excellent.

At PCA from 5,1 up to 10 — good.

At PCA from 10,1 up to 15 — satisfactory.

At PCA from 15,1 up to 20 — bad.

Write down the obtained results in the table 6.5.

Table 6.5 — Results of Roufier's test

Heart rate at rest (pulse for 15 seconds)	Heart rate after exercise (pulse is calculated during first minute)		PCA
P_1 (for 15 sec)	P_2 (for the first 15 sec)	P_3 (for the last 15 sec)	

Evaluate reserve resources of heart of the person upon these results.

Lab. work 6.6. Danini-Achner's ocular-cardiac reflex

Heart rate (HR) frequency of a person is usually slowed down when pressing his eyeball. This phenomenon is explained by reflex excitation of the vagus nerve nuclei. The reflex path of this reflex consists of afferent fibers of third cranial nerve, neurons of medulla and vagus nerves which when excited inhibit heart work (figure 6.4).

Purpose of work: to evaluate change of cardiac activity influenced by vagus nerve.

Necessary material: stop-watch. Object of research — a person.

Measure HR of the person. Press his closed eyes for 10–20 sec (so that not to cause unpleasant sensations or pains) with your thumbs. Simultaneously, count his pulse rate. Then count pulse rate again 20 sec having stopped pressure.

Usually, HR decreases in 10 contraction per minute when eyeballs are pressed.

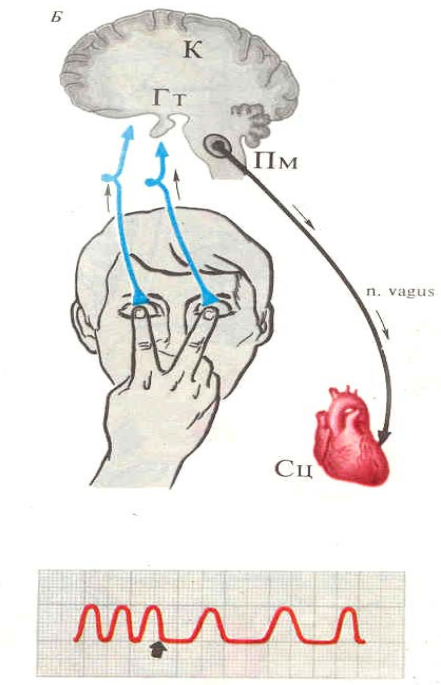


Figure 6.4 — Danini-Achner's ocular-cardiac reflex

Course of work

Write down the obtained results into the table 6.6

Table 6.6 — Resuts of Danini-Achner's ocular-cardiac reflex

Parameters (counted within 10 s)	HR per min
Heart rate at rest	
Heart rate during pressure on the eyes	
Heart rate after pressure on the eyes	

In conclusion characterize change of HR, list parts of reflex path of the oculocardiac reflex.

Lab. work 6.7. Respiratory-cardiac reflex of Hering

This reflex allows to evaluate the tone of vagus nerve center. At breath-holding after a deep inspiration the frequency of heart contractions decreases due to increasing of a tone of vagus nerve nuclei. This is normally shown by decreasing of heart rate on 4-6 beats per 1 minute. Decreasing of heart rate on 8-10 beats per 1 minute and more indicates the increase of a tone of parasympathetic department of VNS, decreasing of heart rate less than four beats per 1 minute – indicates the decrease of a tone of parasympathetic department of VNS.

Purpose of work: to evaluate the change of heart activity at change of a tone of the respiratory center.

Necessary material: stop-watch. Object of research — a person.

Course of work

The examinee is in a sitting position. Count pulse of the examinee, and then ask him to make a deep breath and to hold the breath. At this time count pulse once again.

Write down the results:

Heart rate before breath-holding _____ per 1 minute.
Heart rate during breath-holding at inspiration _____ per 1 minute.
Difference of heart rate before breath-holding and during breath-holding at inspiration _____ per 1 minute.

In the conclusion characterize the tone of parasympathetic department of VNS (n.vagus) (tone is normal, decreased or increased).

Virtual experiments on the topic "Physiology of heart"

1. The effect of electrical stimuli on cardiac activity.
2. The effect of several drugs and some chemical mediators of the cardiac activity.
3. The effect of vagus excitation on cardiac activity.
4. The Stannius ligatures.

7. PHYSIOLOGY OF VASCULAR SYSTEM

Lab. work 7.1. Research of arterial pulse properties by palpation

Arterial pulse is easily palpated on the arteries located superficially, in practice — more often on the radial one.

Purpose of work: to learn the technique and evaluate properties of pulse by means of palpation.

Necessary material stop-watch. Object of research — a person.

Course of work

Grab the wrist of the surveyed person with your right hand in region of radiocarpal articulation so that your thumb were on the outside of the forearm, and anothers — on the inside. Having determined the radial artery, press it slightly with three fingers till pulse appear. Assess pulse by the following parameters:

1. HEART RATE: low, high, normal. Count pulse within 1 minute (or within 10 seconds and multiply it by 6). In children at rest pulse is more rapid. In newborns on the average pulse is 140 beats per minute, influenced only by sympathetic nerve. In sportsmen pulse at rest is slower due to predominant influence of vagus nerve and increase of stroke volume of blood.

2. RHYTHM: rhythmic, arrhythmic. It is determined by the duration of the interval between the pulse beats or R-R interval on the ECG. Respiration (respiratory arrhythmia) influences the rhythm. At inspiration the pulse raises, at expiration it slows down.

3. FILLING (height): good, satisfactory, weak, thready pulse. Filling depends on stroke volume and volume velocity of blood-flow in diastole, elasticity of walls of vessels. It is determined by the height the arterial wall rises, and palpated volume of the artery under the fingers during systole.

4. PULSE VELOCITY: normal, rapid, slow pulse. It is determined by the velocity of ascending and descending of the arterial wall. Rapid pulse can reflect insufficiency of the aortic valve. The increased amount of blood is pumped out, part of blood returns into ventricle. Slow pulse can be observed aortic stenosis when blood comes slower to the aorta.

5. PULSE TENSION (strain): moderate, firm, mild pulse. It is determined by pressing of an artery till the pulse disappears under the fingers located next to the pressed spot.

Put the results of checkup into the table 6.7.

Table 6.7 — Results of research of arterial pulse properties

Properties of the pulse	Norm	Deviations	Result
Heart rate:	normal (60–80)	slow, rapid	
Rhythm:	rhythmic	arrhythmic	
Filling (height)	good	satisfactory, weak, thready pulse	
Strain	moderate	firm, mild pulse	
Rate	normal	rapid, slow pulse	

Lab. work 7.2. Measuring of arterial pressure in person

Arterial pressure changes depending on the phases of the cardiac cycle. In systole period it is increased (systolic, or maximal), in diastole period it is decreased (diastolic, or minimal). The difference between the value of systolic and diastolic pressure is called pulse pressure. There are different of methods of taking arterial pressure: auscultation (N.S. Korotkov's method), palpation (Riva-Roche's method) and with various devices.

A. Palpation method of Riva-Roche's

Purpose of work: to learn the technique of measurement of arterial pressure by *Riva-Roche's* method.

Necessary material tonometer. Object of research — a person.

Course of work

The method allows to measure only the maximal (systolic) pressure. Place the cuff on the arm above the elbow, hand of the examined is on table in comfortable position. Pressure is created in the cuff till pulsing in the radial artery is not palpated. Decreasing pressure in the cuff, note indications of the manometer at moment when pulse appears. These indications correspond to maximal (systolic) pressure in radial artery.

B.N S. Korotkov's auscultation method

Purpose of work: to learn technique of measurement of arterial pressure by N.S. Korotkov's and to determine its value in the individual.

Necessary material: tonometer, phonendoscope. Object of research — a person.

Course of work

With this method it is possible to measure both systolic and diastolic pressure. An individual is sitting on a chair, his relaxed hand on the table. Put the cuff onto the naked arm so that it were overlapped tightly but do not squeeze tissues. The lower edge of the cuff should be placed 1,5 cm higher of the elbow. In the antecubital fossa determine the pulsating brachial artery and place the head of the phonendoscope above it (figure 7.1).

Pumping in the cuff, create a pressure in it exceeding the expected systolic in 20–25 mm Hg. Letting the air out, hear the tones in the phonendoscope (Korotkov's tones) in the brachial artery. The moment tones appear corresponds to systolic pressure. Continue reducing the pressure in the cuff and hear the increasing tones which then weaken and disappear. The moment they disappear corresponds to diastolic pressure.

Write down the obtained results in the table 6.8.

Table 6.8 — Parameters of arterial pressure

Name of an examined person	Systolic pressure	Diastolic pressure	Pulse pressure
1.			
2.			
3.			

Make a comparative analysis of the results of taking the arterial pressure by the described methods and compare them with norms.

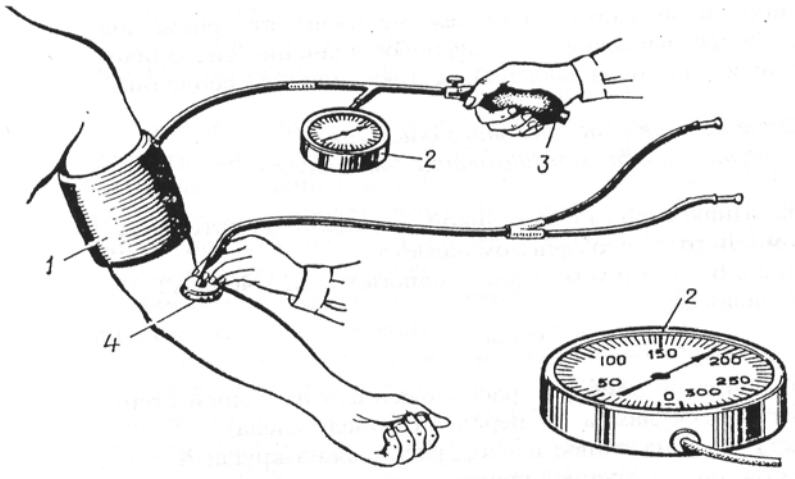


Figure 7.1 — Taking arterial pressure in the person by Korotkov's auscultation method:
1 — rubber cuff, 2 — tonometer, 3 — bulb, 4 — phonendoscope

Lab. work 7.3. Orthostatic test

The test allows to characterize the functional appropriateness of the reflex mechanisms of hemodynamics regulation and evaluation of excitability of sympathetic innervation centers.

Purpose of work: to learn technique taking orthostatic test and to evaluate the type of hemodynamic reactions to change of body posture of an individual.

Necessary material: tonometer, phonendoscope, stop-watch. Object of research — a person.

Course of work

The individual lays relaxed on his back in thermoneutral environment for 6 minutes. Measure his arterial pressure 3 times and calculate heart rate (HR), take average values of these parameters. After the individual has stood up, calculate immediately his HR during the 1st, 3rd and the 5th minutes, arterial pressure — during the 3rd and the 5th minutes.

Put the data into the table.

To evaluate the results of the orthostatic test, changes of diastolic pressure (DP) should be considered.

a) *Hemodynamic reaction is normal* if the first minute after the individual has stood up his diastolic pressure is decreased in no more than 5 mm Hg, systolic pressure (SP) changes within 5 %, HR increases on the average in 20 %.

b) *Hyperdynamic type of reaction* — diastolic pressure increases in more than 5 mm hg, systolic decreases even bigger value, pulse pressure decreases significantly, HR increases more than in 20 % (reaction is caused by the substantial increase of the tonus of sympathetic nervous system).

c*) Hypodynamic type of reaction* — both systolic and diastolic pressure decrease, pulse pressure decreases, HR practically does not change (due to the decreased tonus of sympathetic nervous system).

Write down the obtained results in the table 6.9.

Table 6.9 — Orthostatic test results.

Time	Heat rate	% deviation	SP mm Hg	% deviation	DP mm Hg	% deviation
lying position (average)						
vertical position						
1st min						
3d min						
5th min						

By results of research evaluate the type of hemodynamic reactions of the individual to the orthostatic test.

Lab. work 7.4. Functional test for reactivity of cardiovascular system

Synchronic registration of separate parameters of the cardiovascular system activity at change of the body posture and under the influence of the dosed exertion allows to estimate its reactivity that has the certain diagnostic value.

Purpose of work: with the help of functional test, evaluate the reactivity of the cardiovascular system to the changes of body posture and exercises.

Necessary material: phonendoscope, sphygmomanometer, couch, stop-watch. Object of research — a person.

Course of work

At least 4 persons participate in the test. Prepare the table. The individual sits on a couch. One of assistants measures his arterial pressure, another fills up the table, the third counts the pulse rate and puts it into the table too. The arterial pressure is taken simultaneously with the measuring of HR. Measurement is carried out for some times till 2 identical (close) values of the arterial pressure and pulse are not received.

Then the individual stands up and is measured pressure for several times successively with saying outloud the found parameters of the monometer. Simultaneously, each 15 sec data of pulse rates are said. Measuring proceeds till parameters do not return to the initial values.

Similar observation is made after exercises (20 squats).

Write down the received data into table 6.10.

Table 6.10 — Results of functional test for reactivity of cardiovascular system

Parameters	Rest	Stand up			After the work is completed in		
		1 min	2 min	3 min	1 min	2 min	3 min
HR							
SP							
DP							

In the adult healthy person hemodynamic parameters (pulse rate, arterial pressure) normalize within 3 minutes after the exercise is done.

Estimate the reactivity of cardiovascular system of the individual.

Lab. work 7.5. Influence of exercises on cardiovascular system

Functionalities of the cardiovascular system of a person can be evaluated with the help of special dosed loads. One of such functional tests is S.P. Letunova's test. It consist of three consecutive exercises — 20 squats within 30 seconds, in 3 minutes — running with the maximal speed for 15 seconds, and in 4 minutes — 3 minutes running on one place with the rate of 180 steps per minute. Test allows to characterize completely the state of cardiovascular system since the high-speed load (15-seconds run) and the load for exercise tolerance (3-minutes run) assert different demands to the organism. Reaction of the organism to the load is evaluated by the changes of the pulse rate and values of arterial pressure.

Purpose of work: to learn technique of S.P. Letunov’s test and investigate functional state of cardiovascular system in the individual.

Necessary material: tonometer, phonendoscope, stop-watch, metronome. Object of research — a person.

Course of work

In state of rest the individual sitting on a chair is counted HR and measured the arterial pressure. Then the individual should make 20 deep squats for 30 sec with his hands stretched forward. Do not remove the cuff of the tonometer. Once the exercise is done, the individual sits on the chair and is measured pulse and the arterial pressure every minute for 5 minutes. Run test is performed in similar way.

The dynamics of change of arterial pressure and pulse reveals the physical training of the individual. With good functional state of cardiovascular system after load HR increases in 50–70 % from the initial level and systolic pressure in 20–40 mm Hg. Recovery of initial parameters comes to the end in 1–3 minutes.

Received data to be put into the table 6.11.

Table 6.11 — Results of S. P. Letunov's test

Parameters	At rest	Period of rehabilitation														
		After 20 squats					After 15-second of running					After 3-minute of running				
		Minutes					Minutes					Minutes				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Heart rate																
Systolic pressure																
Diastolic pressure																
Pulse pressure																

To draw a conclusion on functional state of cardiovascular system at the individual.

Virtual experiments on the topic "Physiology of vascular system"

1. The influence of pressure and viscosity of a fluid and the radius and length of the vessel on the flow of a fluid through this vessel.
2. The influence of the cardiac output, peripheral resistance and the vascular elasticity on arterial pressure.
3. Influence of adrenaline, acetylcholine, atropine and adrenaline on the basis of atropine on arterial pressure
4. Measurement of arterial pressure by Korotkov method.

THE BASIC CONSTANTS OF CARDIOVASCULAR SYSTEM

Parameter	Values
Heart rate:	
at adults	60–80 in minutes
at newborn	135–140 in minutes
Stroke (systolic) volume of blood	65–70 ml
Cardiac output (minute volume of blood):	

Parameter	Values
at rest	4,5–5 l
At exercise stress up	to 30 l
Duration of cardiac cycle	0.75–1,0 sec
Arterial pressure:	
Max (systolic)	110–139 mm Hg
Min (diastolic)	60–89 mm Hg
At newborn:	
Max	50–60 mm Hg
Min	34–40 mm Hg
Pressure in capillaries	30–10 mm Hg
Average rate of blood flow:	
large arteries of	0,5 m/s
Veins of average calibre	60–140 mm / sec
Veins cava	200 mm / sec
The capillary	0,5–1,0 mm / sec
Time complete circulation of bloods	20–23 sec
Coronary circulation	200–250 ml / minutes
At an exercise stress	up to 3–4 l/minutes

8. PHYSIOLOGY OF DIGESTION AND ABSORPTION

Lab. work 8.1. Examination of gastric juices acidity

The pH parameter reflects the activity of hydrogen ions, the value of the latter influences the hydrolytic action of pepsin.

Purpose of work: to learn the technique of potentiometric titration of gastric juice and measurement the concentration of H^+ in it.

Necessary material: ionomer, electrodes for pH instrumention, electromagnetic blender with a magnet, beaker, micropipet, distilled water with pH 7,0, automatic pipettes on 1,0 ml, measuring beaker, 0,1, normality solution of NaOH, filter paper, gastric juice.

Course of work

For make titration of the gastric juice, they use a device which consists of pH-meter, the electromagnetic blender, ionselective electrode with a reference electrode.

Bring distilled water to pH 7.0 with the alkali solution and pour 20 ml of water into the glass. Put the magnet into the glass and place it on the blender. Switch the blender on and put the electrodes into the glass carefully. In this case

the arrow of the pH-meter shows pH 7,0 on the scale. Adding 2–3 ml of acidic gastric juice into the glass makes the arrow deviate towards lower pH values. The degree of arrow deviation depends on gastric juice acidity.

Collect 0,1 normal solution of NaOH into the micropipet. Carefully put it into the glass till its tip contacts the contents of the glass. Watch the indication of the pH-meter. Slowly add alkali from the micropipet into the titrate solution. In the result of neutralization of the hydrochloric acid of the gastric juice with the alkali solution arrow of the device moves towards higher pH. Once the arrow has reached pH 7,0, stop the addition of the alkali and mark the amount of the alkali needed for titration of the gastric juice in the glass.

Example of calculation. Assume that for titration 1 ml of gastric juice it was taken 0,5 ml of 0,1 n solution of NaOH. Then, for titration of 1000 ml of juice it is necessary 500 ml of the alkali solution. Hence, concentration of H^+ in the gastric juice is:

$$\frac{5000 \times 0{,}1}{1000} = 0{,}05 mole/l = 50 mmole/l$$

Make titration of test of the gastric juice, write down the results into the report.

Lab. work 8.2. Digestion of starch with enzymes of the person's saliva

Chemical treatment of food begins in the oral cavity with the participation of enzymes of saliva: alpha-amylases, dextrinases and maltases. Alpha-amylase splits up starch and glycogen to dextrins. Under the action of dextrinase dextrins split up to maltose. Maltose under the influence of maltase is hydrolyzed to glucose. Optimal conditions for the action of amylolytic enzymes of saliva is the alkalescent medium and temperature 37–38 °C.

Purpose of work: examine conditions of action of enzymes of saliva on starch.

Necessary material: thermostat, spirit-lamp, matches, support with tubes, pipettes, saliva of the person, solutions: 1 % of cooked starch, 1 % of uncooked starch, Lugol's iodine solutions, Pheling's solutions, 0,5 % of HCI), litmus paper, ice, tube carrier, thermometers. Object of research — a person.

Course of work

To make the test, it is necessary about 10 ml of saliva. Saliva is collected by splitting out into the tube through the funnel. Put 1 ml of saliva to each of the 5 numbered tubes. In the 1st tube add 3 ml of 1 % solution of the cooked starch. Saliva in the 2nd tube is boiled on the spirit-lamp and, after cooling, add 3 ml of cooked starch (mind safety rules). In the 3rd tube add 0,5 % of HCI solution till litmus paper stains, and after that 3 ml of 1 % solution of cooked starch.

Table 8.1 — Results of starch digestion by saliva

№ of tubes	Contents of tubes	Color of contents tubes after addition		Test results
		Lugol's iodine solution	Feling's solution	
1.	1 ml of saliva + 3 ml of cooked starch			
2.	1 ml of boiled saliva + 3 ml of cooked starch			
3.	1 ml of saliva + 0,5% solution of HCl + 3 ml of cooked starch			
4.	1 ml of saliva + 3 ml of uncooked starch			
5.	1 ml of saliva + 3 ml of cooked starch + cold			

In the 4th add 3 ml of 1 %. solution of uncooked starch. In the 5th tube, once it's cold, add 3 ml of cooked starch solution. Place tubes 1, 2, 3, 4 for 30 minutes into the bain-marine or thermostat (37–38°C), tube 5 is put into the pot with snow.

In a while, divide the contents of tubes into two equal parts. Check the first group of tubes for starch, the second one — for sugars. For this, add 2–3 drops of Lugol's iodine solution into each of the first group tubes. Intensive staining of the content into in dark blue color testifies presence of starch. Add 5–6 drops of Feling's solution to the contents of the second group tubes. This solution is prepared by students beforehand. For this, mix Rochelle salt and $CuSO_4$, 10–15 drops each.

Contents of tubes is heated on the spirit-lamp till boiling. At splitting of starch to glucose the contents of tubes are stained into orange-red color.

Write down the results in the table 8.1. Note in what tubes starch has split up to sugars (in full or partially), in what it has remained unchanged. Conclude upon how various factors influence enzymatic properties of saliva.

Lab. work 8.3. Digestion of protein by gastric juice. Role of hydrochloric acid

Gastric juice has some forms of proteoclastic enzymes characterized by various spectrum of pH of their optimal effect that determines high proteoclastic activity in stomach in wide diapason of pH.

Purpose of work: investigate conditions of action of enzymes of gastric juice and role of HCl in this process.

Necessary material: gastric juice, 0,5 % solution of HCl, 10 % solution of sodium of hydrate natrium, 0,1 % solution of cuprous sulphate, baking soda, tubes, support, thermostat, spirit-lamp, tube carrier.

Course of work

Number 4 tubes. Add 2 ml of gastric juice to each 3 tubes, to the 4th–2 ml of HCl. Add baking soda into the 2nd tube till complete neutralization of HCl (stop of bubbling). Boil slowly gastric juice in the 3rd tube (inactivate enzymes).

Put small piece of egg-white into all 4 tubes. Place tubes into thermostat at 38 °C for 15 minutes. Cool them afterwards. Make biuret reaction (add 4 drops of solution of sodium hydroxide and 2 drops of solution of cuprous sulphate into each tube).

Write down the results of the test into the table 8.2.

Table 8.2 — Results of protein digestion by gastric juice

№ of tubes	Components of tube	Absence or presence of peptones
1.	2 ml gastric juices + egg-white.	
2.	2 ml of gastric juice + baking soda + egg-white	
3.	2 ml of gastric juice. Boil thoroughly + egg-white	
4.	2 ml HCI + egg-white	

In tubes with unsplit protein the contents stains blue-violet, with hydrolysates of protein peptones — pinky-violet.

In conclusion note optimal conditions of proteopepsis by gastric juice and role of HCI in the given process.

Lab. work 8.4. Influence of bile on fats

Bile has an ability to emulsify fats which come in gastrointestinal tract with food. It promotes an increase of interaction of substrate (fat) with the enzyme (lipase) resulting in acceleration of hydrolysis.

Purpose of work: to study emulsifying action of the bile on fats.

Necessary material: fresh bile, vegetable oil, water, pipettes, slide, glass rod, magnification glass or microscope.

Course of work

Place drop of bile on the clean slide and drop of water next to it. To each drop add small amount of vegetable oil. Carefully mix with glass rod. Examine the contents of drops immediately and in 10–15 minutes with the magnifier or microscope.

Describe the obtained distribution of fats, explain different results for drops of bile and water.

Virtual experiments on the topic "Physiology of digestion"

1. Substrate specificity of amylase of saliva.
2. Influence of pH on the effect of pepsin.
3. The role of bile in the activity of lipase of pancreas.

THE BASIC CONSTANTS OF THE DIGESTIVE SYSTEM

Parameter	Values
Saliva: amount of excreted saliva daily	1,5 l/day
pH	5,8–7,8
Gastric juice: daily volume	2,0–2,5 l
pH	1,5–1,8; (0,3–0,5 % HCI)

Parameter	Values
Intestinal juice: pH of juice of duodenal glands	7,0–8,0
pH of juice of small intestines	5,05–7,07
Pancreas juice: daily volume	1,5–2,0 l
pH	7,8–8,4
Bile	
Hepatic bile: water	97 %
solid residual	3 %
pH	7,5–8,0
cystic bile: water	87–90 %
solid residual	10–13 %
pH	7,8–8,4
daily volume	500–1500 ml

9. METABOLISM AND ENERGIES

Lab. work 9.1. Calculation of basal metabolism by the tables of Harrison-Benedict

The power consumption at muscular and psychological rest, at an empty stomach and at 18 °C (zone of temperature comfort) is called basal metabolism. It reflects minimal level of power consumption for maintenance of vital activity of all systems of an organism. The value of basal metabolism depends on age, sex, body mass and height. Special tables help to determine the average level of human basal metabolism.

Purpose of work: to calculate basal metabolism by the tables and to determine its value in a person.

Necessary material: auxanometer, scales, tables for calculation of basal metabolism. Object of research — a person.

Course of work

Place the person onto scales to measure his weight. Measure their height with auxanometer. To calculate basal metabolism, use tables of Harrison-Benedict which consider sex of the examinee since the level of basal metabolism in men on the average is 10 % higher than in women.

For example, an examined is a 27 years old man, 160 cm height, 74 kg weight.

The table has two parts, A and B. In table A find body mass of the examinee and figure 1084 standing next on the right. In table B across find age (27 years), and, along, height (160 cm). On the cross of height/age columns there is figure 618. By summarizing both determined figures, obtain 1084+618=1702 kcal. Using recalculation quotient, express result in kilojoule (1702×4,19 = 7125,93 kJ).

Table A
The table for calculation of basal metabolism in men
(1 kcal = 4,19 kilojoule)

Body weight, kg	kcal	Body weight, kg	kcal	Body weight, kg	kcal	Body weight, kg	kcal
1	2	3	4	5	6	7	8
44	672	64	947	84	1222	104	1497
45	685	65	960	85	1235	105	1510
46	699	66	974	86	1249	106	1524
48	727	68	1002	88	1277	108	1552
49	740	69	1015	89	1290	109	1565
50	754	70	1029	90	1304	110	1579
51	768	71	1043	91	1318	111	1593
52	782	72	1057	92	1332	112	1607
53	795	73	1070	93	1345	113	1620
54	809	74	1084	94	1359	114	1634
55	823	75	1098	95	1373	115	1648
56	837	76	1112	96	1387	116	1662
57	850	77	1125	97	1046	117	1675
58	864	78	1139	98	1414	118	1689
59	878	79	1153	99	1428	119	1703
60	892	80	1167	100	1442	120	1717
61	905	81	1180	101	1455	121	1730
62	919	82	1194	102	1469	122	1744
63	933	83	1208	103	1483	123	1758

Table B
Men (age)

Height, cm	17	19	21	23	25	27	29	31	33	35	37	39	41
140	553	528	–	–	–	–	–	–	–	–	–	–	–
144	593	568	–	–	–	–	–	–	–	–	–	–	–
148	663	608	–	–	–	–	–	–	–	–	–	–	–
152	673	648	619	605	592	578	565	551	538	524	511	497	484
156	713	678	669	625	612	598	585	571	558	554	531	517	504
160	743	708	659	645	631	618	605	591	578	564	551	537	524
164	773	738	679	665	652	638	625	611	598	584	571	557	544
168	803	768	699	685	672	658	645	631	618	604	591	577	564
172	823	788	719	705	692	678	665	651	638	624	611	597	584
176	843	808	729	725	718	698	685	671	658	644	631	617	604

Height, cm	17	19	21	23	25	27	29	31	33	35	37	39	41
180	863	828	759	745	732	718	705	691	678	664	651	637	624
184	883	848	779	765	752	738	725	711	698	684	671	657	644
188	903	868	799	785	772	758	745	731	718	704	691	677	664
192	923	888	819	805	792	778	765	751	731	724	711	697	684
196	–	908	839	825	812	898	785	771	758	744	731	717	704
200	–	–	859	845	832	818	805	791	778	764	751	737	724

Table A
The table for calculation of basal metabolism in women
(1 kcal = 4,19 kilojoule)

Body weight, kg	kcal	Body weight, kg	kcal	Body weight, kg	kcal	Body weight, kg	kcal
44	1076	64	1267	84	1458	104	1650
45	1085	65	1277	85	1468	105	1659
46	1095	66	1286	86	1478	106	1669
47	1105	67	1296	87	1487	107	1678
48	1114	68	1305	88	1497	108	1688
49	1124	69	1315	89	1506	109	1698
50	1133	70	1325	90	1516	110	1707
51	1143	71	1334	91	1525	111	1717
52	1152	72	1344	92	1535	112	1726
53	1162	73	1353	93	1544	113	1736
54	1172	74	1363	94	1554	114	1745
55	1181	75	1372	95	1564	115	1755
56	1191	76	1382	96	1573	116	1764
57	1200	77	1391	97	1583	117	1774
58	1210	78	1401	98	1592	118	1784
59	1219	79	1411	99	1602	119	1793
60	1229	80	1420	100	1611	120	1803
61	1238	81	1430	101	1621	121	1812
62	1148	82	1439	102	1631	122	1822
63	1258	83	1449	103	1640	123	1831

Table B Women (age)

Height, cm	17	19	21	23	25	27	29	31	33	35	37	39	41
132	123	114	–	–	–	–	–	–	–	–	–	–	–
136	139	130	–	–	–	–	–	–	–	–	–	–	–
140	155	146	–	–	–	–	–	–	–	–	–	–	–
144	172	162	–	–	–	–	–	–	–	–	–	–	–
148	187	178	–	–	–	–	–	–	–	–	–	–	–
152	201	192	183	174	164	155	146	136	127	117	108	99	89

Height, cm	17	19	21	23	25	27	29	31	33	35	37	39	41
156	215	206	190	181	172	162	153	144	134	125	116	106	97
160	229	220	198	188	179	170	160	151	142	132	123	114	104
164	243	234	205	196	186	177	168	158	149	140	130	121	112
168	255	246	213	203	194	184	175	166	156	147	138	128	119
172	267	258	220	211	201	192	183	173	164	154	145	136	126
176	279	270	227	218	209	199	190	181	171	162	153	146	134
180	291	282	235	225	216	207	197	188	179	169	160	151	141
184	303	294	242	233	223	214	204	195	186	177	167	158	149
188	313	304	250	240	231	221	215	203	193	184	175	165	156
192	322	314	257	248	238	239	220	210	201	191	182	173	164

The due basic metabolism can also be ccounted by formulas (for persons from the ages of 18 to 40 years):

for men: DBM = 1,0 ×BM × 24;

for women: DBM = 0,9 × BM × 24.

where BM — body mass

In conclusion note the value of «due» basal metabolism of the examinee.

Lab. work 9.2. Calculation of the deviation of size of the basic metabolism by Read's formula and the nomogram

Based on the interrelation between heart rate, arterial pressure and heat formation in an organism it is possible to estimate the percent of deviation of values of basal metabolism from the «standard». It is estimated with the Read's formula.

Purpose of work: to estimate deviation of basal metabolism value from the standard and to calculate this parameter in the examined person.

Necessary material: sphygmomanometer, phonendoscope, stop-watch. Object of research — a person.

Course of work

Test pulse rate, arterial pressure (by Korotkov's method) at least 3 times with intervals of 1–2 minutes following, if possible, conditions necessary for calculation of basal metabolism (12 hours after eating, laying relaxed, at temperature of 18 °C).

The deviation percent (DP) from the norm is calculated with Read's formula:

$$DP = 0{,}75 \times (HR + PP \times 0{,}74) - 72,$$

where: DP — deviation percent of the basal metabolism from the norm;

HR — heart rate;

PP — pulse pressure (difference of systolic and diastolic pressure in mm Hg).

Calculate using simple average of 3 measuring of heart rate and arterial pressure.

Estimation of deviation value of basal metabolism is simplified at the use of specific nomogram (figure 9.1). Figures at the cross of the line drawn through the parameters of pulse rate and pulse pressure with the middle line show the deviation percent of basal metabolism from the norm.

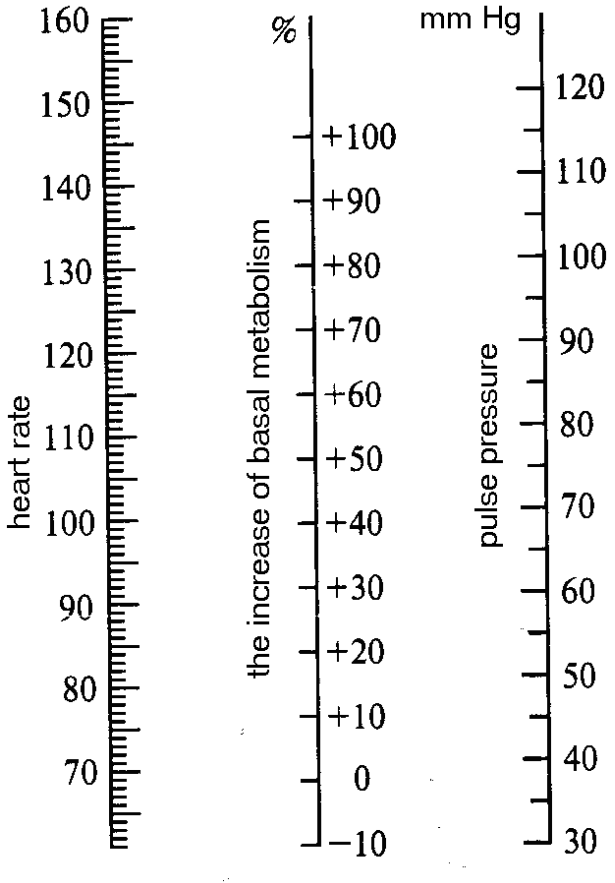


Figure 9.1 — Nomogram for Read's formula

The allowable variation of basal metabolism deviation from the standard makes 10 %.

In conclusion note the deviation value of basal metabolism from the norm.

Lab. work 9.3. Making the daily diet

Making the daily diet (food balancing) is necessary to bring into accord the quantity of the energy received with food with energy needs of an organism. For this purpose it is necessary to calculate amount of received nutrients and their energy value. The last one is evaluated by thermal coefficients of nutrients. We calculate the energy value of food products by multiplication of thermal coefficients to the content of carbohydrates, fats and proteins in them. Data on structure of some main food products and their energy value are provided in special tables.

Purpose of work: to learn the technique of making a diet.

Necessary material: tables.

Course of work

At making a diet it is necessary to remember that the amount daily food has to cover completely the energy needs of an organism by the caloric content taking into account comprehensibility of food. Making a due diet should take into account the principles of the balanced diet.

At making diets consider the following parameters:

The ratio between proteins, fats, carbohydrates is accepted:

1:1,1:4,1 — for men and women occupied with brainwork;

1:1,3:5 — at hard physical work.

We divide daily need for energy and necessary amount of nutrients (proteins — 100 g, fats — 70–80 g, carbohydrates — 500 g per day) into three parts corresponding to a breakfast, a dinner and a super. Using the tables, we make the daily diet according to the scheme given below.

Thus we consider that the breakfast has to make 30 % of daily energy value of a diet, a dinner — 50 %, a supper — 20 %. The amount of proteins and the general caloric content of a daily diet can be exceeded in comparison with calculations, but no more than for 10 %.

Represent the results of work in the form of table 9.1.

In the conclusion note the general energy value of the daily diet in kcal and compare it with the daily energy needs of an organism.

Table 9.1 — The daily diet of the student

Name of a product	Portion, g	Content of nutrients, g			Energy value of the portion, kcal
		proteins	fats	carbohydrates	
Breakfast					
Total:					
Dinner					
Total:					
Supper					
Total:					
Total per day:					

Lab. work 9.4. Ratio of individual body weight from the due

The body weight (BW) reflects the development of bone and muscular tissues, hypodermic fatty layer, internal organs and serves as one of objective indicators of correct nutrition. In men and women respectively weight of a skeleton makes 18 and 16 %, muscles — 42 and 32 % (in athletes to 50 %) and fatty layer — 12 and 18 % from BW. Level of genetically inherited basal metabolism, constitution type, functional activity of endocrine glands, physical activity, sex, age, height and some other factors influence on BW. It is necessary to know, in what degree individual actual BW corresponds to due body weight (DBW) taking into account sex, age and height.

Purpose of work: to evaluate the compliance of the actual body weight with the due.

Necessary material: scales, height meter. Object of research — a person.

Course of work

1) Measure the actual body weight (BW).

2) Calculate the due body weight (DBW) depending on sex and height of a person with the formula:

for men: DBW = 48 + (Height(cm) – 152) ×1,1, kg/cm;
for women: DBW = 48 + (Height(cm) – 152) ×0,9, kg/cm.

At asthenic type of constitution DBW can be reduced on 10 %, at hypersthenic — it can be increased on 10 %.

Both increased and decreased body weight can be dangerous for health.

Increase of BW of the person in comparison with DBW:

— for 15–29 % testifies reflects obesity of the I degree;
— for 30–49 % — obesity of the II degree;
— for 50–100 % —obesity of the III degree;
— more, than for 100 % — obesity of the IV degree.

Decreased BW of the person in comparison with DBW:

— for 10–20 % can reflect low degree of protein-calorie deficiency of a diet;
— for 21–30 % — moderate degree of protein-calorie deficiency of a diet;
— for 31–40 % — severe degree of protein-calorie deficiency of a diet;
— more than for 40 % reflects cachexia.

3) Calculate the body mass index (BMI) with the formula:

BMI = Body weight (kg) / (Height(m))^2

According to received BMI it is possible to evaluate the risk of development of some diseases.

BMI	**Hypotrophy (decreased body weight)**	**Normal body weight**	**Obesity (increased body weight)**
	< 18,5	**18,5–25,0**	**> 25,0**
The risk of diseases	Anemia, decrease of immunity and increase of infectious diseases frequency, osteoporosis; cachexia	Minimal	Obesity, diabetes mellitus, atherosclerosis; arterial hypertension, etc.

BMI	Hypotrophy (decreased body weight)	Normal body weight	Obesity (increased body weight)
	< 18,5	18,5–25,0	> 25,0
The general recommendations	Change a diet and physical activity so that the energy intake with food became more than energy expenditure	Keep an existing diet and activities	Change a diet and physical activity so that the energy intake with food became less than energy expenditure

Write down the obtained results in the table 9.2.

Table 9.2 — Results of body weight measurement

Parameter	Value
The actual body weight (kg)	
The due body weight (DBW, kg)	
Difference of actual BW from DBW (in %)	
Body mass index (BMI)	

In the conclusion note the actual body weight, the due body weight, body mass index and evaluate the compliance of the actual body weight with the due.

Lab. work 9.5. Calculation of working metabolism at the dosed physical activity

Purpose of work: to calculate energy consumption of an organism at rest and during the work.

Necessary material: stop watch, calculator. Object of research — a person.

Course of work

1 Count the respiration rate in quietly sitting examinee and calculate energy consumption at rest.

2. Tell the examinee to make the dosed physical activity (20 sit-ups at fast speed). Calculate energy consumption after physical activity.

For calculation of energy consumption of an organism use the formula:

$$M = 0{,}198 \times (RR - 3{,}06),$$

where M — energy consumption (kcal/min.);
RR — respiration rate (cycle/min).

In the conclusion note the energy consumption of an organism at rest and after physical activity.

Lab. work 9.6. Taking the human body temperature

Physiological mechanisms of thermoregulation constantly maintain the human body temperature at a definite level. Change of body temperature is an important parameter of health state of the person.

Body temperature is measured with a medical mercury thermometer or an electrothermometer at axilla, oral cavity or rectally. With this, it is necessary to hold the exposure time of the thermometer in the measuring point.

Purpose of work: to evaluate the minimal measuring time of temperature at axilla.

Necessary material: the mercury medical thermometer, antiseptic solution, stop-watch. Object of research — a person.

Course of work

Shake the thermometer and place it at the axilla for 1 minute. In a minute, note its indications, shake again and place at the axilla.

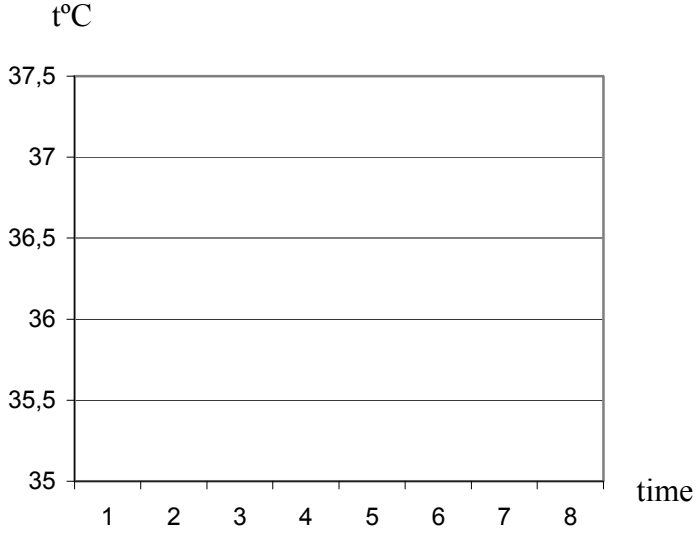


Figure 9.2 — Dependence of thermometer indications on its exposure time

Measure the temperature in similar way within 2, 3, 4, 5 minutes, etc., till the indication of the thermometer remain constant.

Using results of the test make a diagram (figure 9.2) of indications of the thermometer depending on time of measuring.

In conclusion note the shortest time of keeping the thermometer in the axilla for measuring of the body temperature.

THE BASIC CONSTANTS METABOLISM AND ENERGY

Parameter	Values
Biological value of proteins:	
animal origin	70–95 %
vegetable origin	60–65 %
Daily need:	
Proteins	70–80 g (of them 30 % are animals)
Fats	70–80g (of them 75–80 % are animals)
Carbohydrates	400–450 g
Water content in an organism	

Parameter	Values
Men	61 %
Women	51 %; (compare 53,5 %)
Neonatal	75 %
Formation of water in an organism at oxidation:	
100 g of carbohydrates	55 ml
100 g of proteins	41 ml
100 fats	107 ml
Daily balance of water	near 2,5 l
Food value:1 g of fats	9,3 kcal (39,0 kilojoule)
1 g of carbohydrates	4,1 kcal (17,1 kilojoule)
1 g of proteins	4,1 kcal (17,1 kilojoule)
Respiratory coefficient at oxidation in an organism	
Carbohydrates	1
Fats	0,7
Proteins	0,8
The basic metabolism:	
Men	7117 kilojoule (1700 kcal) a day
Women	6410 kilojoule (1530 kcal) a day
temperature	
axilla	36,5–36,9 ºC
in oral cavity	36,4–37,2 ºC
rectum	36,8–37,6 ºC
daily temperature fluctuation	0,5–0,7 ºC
Max	at 4–6 p.m.
Min	at 3–4 a.m.
hyperthermia	body temperature > 37 ºC
hypothermia	body temperature < 35 ºC

10. EXCRETION

Lab. work 10.1. Detection of protein in urine

Purpose of work: to study the technique of protein detection in urine.

Necessary material: 20 % solution of salicyl-sulphonic acid, protein-containing urine, and normal urine. Object of research — a person.

Course of work

To 1 ml of urine in the tube add 3 drops of 20 % salicyl-sulphonic acid (green). With the presence of protein in the urine, white sediment or mud is formed the amount of which depends on the concentration of protein in urine.

By results of work identify the urine samples with contain protein.

Lab. work 10.2. Detection of sugar in urine

Principle of method. As the result of interaction of sugars in the urine with Heines' reagent, valence of copper changes. This ensures decolourization of the medium.

Purpose of work: to learn the technique of sugar detection in urine.

Necessary material: Heines' reagent, tubes, pipettes, bain-marie, sugar-containing urine and normal urine. Object of research — a person.

Course of work

Into a tube add 2 ml of Heines' reagent and 4 drops of urine. Keep the content for 5 minutes in the boiling bain-marie. If there is sugar in the urine, the content will stain pink. Significant concentration of sugar results in formation of red crystals.

Intensity of pink color depends on the concentration of sugar in urine. At absence of sugar in urine the reagent remains its dark blue color.

By results of work identify the urine samples which contain sugar.

Lab. work 10.3. Combined express-diagnostic test for evaluation of certain physico-chemical properties of urine

Final result of kidney activity is the urine which represents complex biological fluid. It contains more than 150 chemicals of organic and inorganic substances. Reaction of urine (pH) is determined by concentration of free hydrogen ions in it. In physiological conditions pH fluctuations depend both on feeding and many other factors. Sugar (glucose) in the urine of the healthy person is absent, except for cases of slight glucosuria at the excessive carbohydrates intake with food. Ketone bodies appear in the urine at the number of diseases (diabetes, diseases of liver, etc.). At pathology urine can have blood as undestroyed erythrocytes (hematuria) or dissolved bloody pigment (hemoglobinuria). The hemoglobinuria is met rarely, for example, at transfusion of incompatible blood. Hematuria appears at affection of kidney or urinary ducts. There is minimal amount of protein in the urine of the healthy person.

The combined express-test allows to measure values of the most important physico-chemical properties of the urine.

Purpose of work: to study the procedure of express-diagnostic test of physico-chemical properties of urine sample.

Necessary material: test-strips, scale for comparison of parameters with norm, support with tubes, filter paper, forceps, stop watch. Object of research — a person.

Course of work

Add 10 ml of the examined urine into the tube. Put test-strip into tube for a few seconds. Then take the test-strip with forceps and put it onto the filter paper, dry out. Compare the results with the scale on the pack.

Write down the obtained results into the table.

glu-cose	biliru-bin	ketone bodies	density	erythro-cytes	pH	protein	urobilin	nitrite	leuco-cytes

In conclusion write down if the results of the urinalysis correspond to physico-chemical parameters in norm.

Virtual experiments on the topic "Excretion"

1. Demonstration of the effects of hydrostatic pressure, osmotic pressure and diameter of the glomerular afferent and efferent arterioles on urine formation.

2. Influence of aldosterone and antidiuretic hormone on the urine formation;

3. Influence of glucose on urine formation.

THE BASIC CONSTANTS OF EXCRETORY SYSTEM

Parameter	Values
Efficient filtration pressure	20 mm Hg
General filtration surface of glomuluses	1.5–2 m^2
Renal blood flow	of 1200 ml/minutes
Renal plasma flow	650 ml/minutes
Amount of initial urine a day	150–170 l
Amount of final urine a day	1,5 l
Relative density	1,012
Color	from amber-yellow to stramineous
Transparence	transparent
pH	5,0–7,0

11. PHYSIOLOGY OF SENSORY SYSTEMS

Lab. work 11.1. Detection of the black spot on the retina of the eye (Mariott's experience)

The place where optic nerve inters into the retina is free from photosensitive receptors, that is why this field of the retina is light-insensitive and is called a black spot. The gap in visual field ensured by the black spot is usually not noticed as it is compensated by the activity of adjacent fields of retina. Black spot is detected with Mariott's test.

Purpose of work: to be convinced in presence of the black spot.

Necessary material: Mariott's picture (on the black background of paper two white images are drawn — a circle and a cross). Object of research — a person.

Course of work

The person closes the left eye to fix the right one on the cross located on the left side of the picture (figure 11.1). By moving the picture at the distance from 10 to 25 cm they find such position at which white circle on the right side of the picture becomes invisible as result of matching of the picture with the black spot, i.e. the field of the retina conforming to the place where optic nerve comes into it and there is no photoreceptors. In the same way the picture is looked at by the left eye with closed right eye (first, the picture should be positioned so that the cross was on the right and the circle on the left).

Figure 11.1 — Mariott's drawing

Lab. work 11.2. Measurement of the visual field (perimeter)

The visual field is a space seen by the eye at fixation in one point. It depends on the functional state of the retina, anatomical features of the face (depth of eye location, form of eyeball, superciliary arch, nose), and also on the color of subjects. The visual field for black-and-white subjects (achromatic) is larger than for color ones (chromatic) that is caused by unequal location of rods and conuses in the center and on periphery of the retina. Chromatic visual field depends also on the kind of color (for green it is the smallest, for the yellow it is the largest). Borders of achromatic visual field are: external — 90°, upward and internal — 60°; downward — 65°.

Measurement of visual field has an important diagnostic value in detection of the retina affection.

Purpose of work: to learn the perimeter technique and detect visual field of the person.

Necessary material: perimeter, white and color circles with clamps, forms of normal visual field, color pencils. Object of research — a person.

Course of work

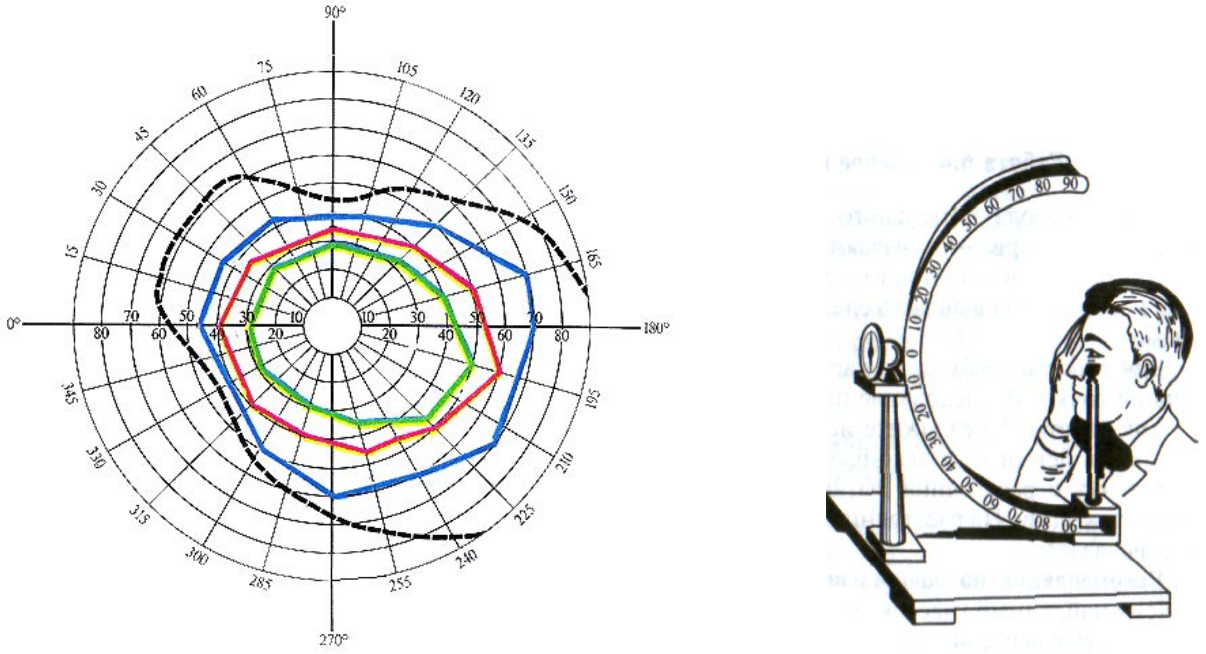
To measure a visual field, Forster's perimeter (figure 11.2) is used. It represents mobile semicircle strengthened in support with graduation in angle degrees, with a white point in the middle. On the second support the chin of the person is placed.

The person is sitting with his back to the light. Measurement of visual field is made separately for each eye. At horizontally positioned semicircle of the perimeter the person closes one eye with his hand, the second eye fixes white point in the middle of the perimeter arch. The experimenter slowly moves white circle on the internal surface of the arch from periphery to the center.

The person signals when the identification circle becomes seen immobile by the eye. On the scale they measure the angle and note it in a standard form (see the examples in the figure 11.2).

The same is done with another eye, the angle is noted in the form.

The data obtained reflect external and internal borders of the visual field. Then arch of the perimeter is fixed vertically and test is repeated again. First, identification circle is moved from the top to the center (for measurement of the superior border of visual field), and then from the bottom to the center (for measurement of the inferior border of visual field).



a **b**

Figure 11.2 — (a) achromatic and chromatic vision fields measured by perimeter technique;
(b) measurement of vision fields with the Forster's perimeter

Results of are noted (figure 11.3) in the standard form. The line drawn through all marked points in the standard form reflect the visual field. Each measurement is made twice.

Visual field is measured for each eye in turns.

The more meridians of the visual field are detected, the better accuracy of the measuring is.

To learn the measuring technique, on the practical classes it is enough to measure two meridians (horizontal and vertical), thus detecting visual fields for each eye in outward, inward, upward and downward directions.

Having measured visual field for white identification circle, the same method is used to measure its borders for the red, green, dark blue and yellow colors.

Standard forms (figure 11.3) are filled in with visual fields data for both eyes and all colors.

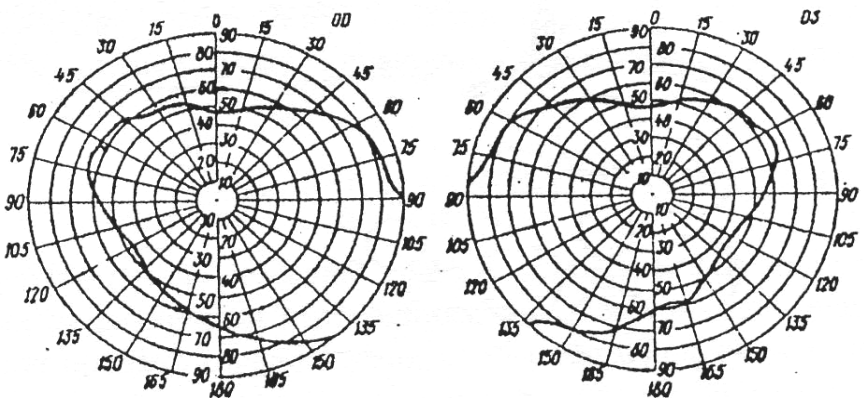


Figure 11.3 — Examples of a standard form for measurement of visual fields of the left (OS) and the right (OD) eye. The form has normal visual fields for a white object

In conclusions compare the size of the visual field for all colors. Pay attention to the dependence of visual field on the anatomical features of face of the person.

Lab. work 11.3. Contrast phenomenon in the visual analyzer

The contrast phenomenon is revealed in increased natural difference between the two simultaneous or consecutive sensations (simultaneous and after-contrasts). As an example of simultaneous contrast is a grey area which seems more dark on a light background, more light on the black background. Simultaneous contrast is typical both for achromatic and chromatic vision. For example, grey color on a red background seems a bit greenish, on a dark blue background it acquires yellow tint. Successive contrasts arise from formation of visual negative images. For example, if to look intently at a colored subject for 15–20 sec and then to transfer the look onto white surface there arises an image of the same shape but of other color. The basis of this phenomenon are physiological mechanisms connected by inductive relations between the focuses of excitation and adjacent fields in sensory region of the visual analyzer.

Purpose of work: to detect visual contrasts depending on situation.

Necessary material: paper strips of grey color, black and white paper, special pictures (figure 11.4). Object of research — a person.

Course of work

1. Examine the tint of the white circle or paper strip on a black and grey background.

2. Examine the size of the black paper circle on a white background and white circle of the same size on the black background.

3. To examine the color intensity of the grey paper strip on the white and black backgrounds.

Different optical illusions are revealed:

a) In overestimate of vertical lines in comparison with the horizontal (figure 11.4, A — the height of the cylinder seems bigger than its width though they are equal).

b) In influence of angles on the perception of direction of their sides (figure 11.4, B — upper parallel lines seem divergent, and inferior — convergent).

c) At assessment of the dimension by the contour (figure 11.4, C — the circle between large circles seems smaller than the same circle between small circles).

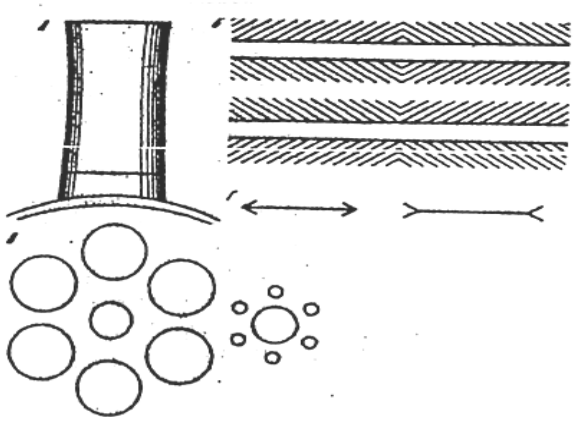


Figure 11.4 — Examples of visual illusions

d) At perception of parts of figure in relation to the figure on the whole (figure 11.4, D — of the two equal segments the one with outward-directed arrows seems longer than that with inward-directed arrows.

Lab. work 11.4. Eye accommodation

Adaptation of the eye to clear vision of objects located at various distances is called accommodation. For clear vision of subject it is necessary that its image was clearly focused on the retina. Contraction of unstriped muscular cells of a ciliary body decreases the traction force of ciliary zonule that increases the convexity of lens due to its elasticity. When looking at distant objects, vice versa, the ciliary body is relaxed and lens flatten.

Purpose of work: to observe the impossibility of simultaneous clear vision of distant and close objects.

Necessary material: 15×20 cm frame with gauze stretched firmly on it, typed text. Object of research — a person.

Course of work

Through the gauze stretched on the frame the person looks at the text located behind the gauze at a distance of 50 cm from eyes. At fixed look on letters threads of gauze are blurred; if to fix the look at threads of gauze, letters become blurred.thus, it is impossible to see clearly objects situated at different distance.

Write the results of the observation and to give explanation to morphophysiologic mechanisms of accommodation and role of optical system of eye in this process.

Lab. work 11.5. Measurement of visual acuity

Acuity of vision is characterized by the smallest visual angle at which the eye can see two separate points. Normal visual acuity is an ability of the eye to

distinguish between the details of surrounding situation seen at the visual angle of 1 minute. The visual angle of 1 minute is traditionally accepted in practice as a norm of acuity of vision. Macula lutea is a typical maximal acuity of vision.

Measurement of visual acuity is made with special tables in which parallel lines of letters or open-ended rings located in decreasing order downwards. Each line is marked with distance in meters from which a person should distinguish letters of the line.

Purpose of work: to learn the technique and measure acuity of vision in person.

Necessary material: special tables for measurement of visual acuity, pointer, the screen for eye closing. Object the research — a person.

Course of work

Mount the table for definition of visual acuity on a well illuminated wall. The person sits on a chair 5 meters from the table. Closing one eye with the screen, he says names of letters or marks on the table starting from the top and proceeding downwards. Determine the final lines where letters were said correctly. This line is used to establish the acuity of vision.

Repeat this procedure for another eye.

Visual acuity is calculated by the formula (Snellen's relationship):

$$V = \frac{d}{D}$$

where: V — visual acuity;

d — is the distance of the examined person from the table (m);

D — is the distance from which the normal eye clearly sees the signs of a particular line.

In conclusions note acuity of vision of both eyes and compare with the norm.

Lab. work 11.6. Evaluation of color vision

Human eye can perceive all variety of colors which can be divided into two groups: achromatic (colorless) and chromatic (having color background). According to three-components theory, color perception is provided by three types of cones with various color sensitivity. One of them is sensitive to red color, others — to green, and the third — to blue. Some people have a decreased ability of both to distinguish between color tints, and in the form of partial or complete color-blindness. There are 3 kinds of partial color-blindness: protanopia (red color blindness), deuteranpia (red and green but with especially lowered ability of green color perception) and tritanopia (dark blue and violet colors). Complete color-blindness is a rare phenomenon.

Research of color vision is extremely significant for evaluation of professional suitability of people whose work is connected with color perception (for example, drivers).

Purpose of work: to learn the procedure of color vision detection.

Necessary material: E.B. Rabkin's polychromatic tables, screen for eye closing. Object of research — a person.

Course of work

A person stands with his back to light 1 m from polychromatic tables mounted at his eyes level. He is shown one by one the tables with digits and various figures of certain color. The background on these images are points and circles of other color.

For evaluation of color sensitivity the person is shown tables 1–10. Thresholds of color sensitivity is evaluated with tables 11–15. To evaluate the contrast sensitivity, tables 16–20 are used. Time of examining of an image should make about 5 sec. The test is performed for each eye separately. The person should name a figure or a digit shown on each table. Trichromates distinguish images well. Errors occur at abnormality of color vision.

In conclusions describe results of color vision test.

Lab. work 11.7. Examination of air and bone conduction of sound

Sound irritation is accepted by receptor formations of the internal ear at passing of fluctuations both through the external acoustic duct (air transfer) and through bones of skull and labyrinth (bone transfer). Effectiveness of air transfer is much more higher than bone transfer.

Purpose of work: to learn the technique, to reveal the presence of air and bone conduction of sound.

Necessary material: tuning fork, hammer, cotton wool. Object of research — a person.

Course of work

A sounding tuning fork is applied with its base to the medium line of the head. Due to the presence of bone conduction the person hears sound of equal force with both ears. Close external acoustic duct of one ear with the cotton wool tampon and repeat the test. The sound will be more intensive at the tamponed ear since the tamponade reduces loss of sound energy through the external acoustic duct.

Apply the sounding tuning fork to the mastoid. The man will hear gradually weakening sound. Once the sound has disappeared, the tuning fork is applied to the ear and the sound is heard again since air conduction effectiveness is better than that of bone.

Write down the results of investigation and make conclusion.

Lab. work 11.8. Examination of tactile sensitivity. Esthesiometry

Receptors of tactile sensitivity cover all surface of human skin and some mucous membranes. They are distributed irregularly: most of them are on the fingertips, on the tip of a tongue, nose; the smallest number is on forearm, crus, back. For examination of the tactile sensitivity the method of the esthesiometry is used allowing to measure threshold of spatial sensitivity, i.e. minimal distance between two points of skin at which irritation of two touches is distinguished.

Purpose of work: to learn the esthesiometry method and to measure spatial sensitivity threshold in the person. Object of research — a person.

Necessary material: esthesiometer (Weber's compasses; figure 11.5), millimetric ruler.

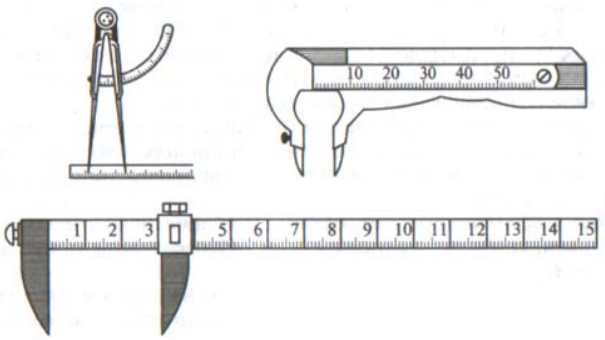


Figure 11.5 — Esthesiometer (Weber's compasses)

Course of work

The person comfortably seats in a chair with closed eyes. The assistant touches different parts of the person's skin with Weber's compasses whose legs are maximally thrown together. Touch the skin with both legs in one time with equal force. The person should answer how much points of touch he is feeling. Gradually moving legs aside, continue to touch the given area until the two touches are distinguished. Mark the minimal distance between the two points, which the person distinguishes as two touches.

This will be the threshold of spatial sensitivity.

Threshold evaluation can be started with the maximal distance by gradually reducing the distance between the legs of the sensimeter.

Data to be written down into the table 11.1.

Table 11.1 — Results of esthesiometry

Field of skin	Threshold of spatial sensitivity
Finger	
Palms	
Forearm	
Upper arm	
Back	
Neck	
Nose	
Forehead	

In conclusions compare thresholds of spatial tactile sensitivity of the investigated fields of skin and explain reasons of the revealed differences.

Lab. work 11.9. Binaural hearing evaluation

The person identifies position of sound source in the space with the help binaural hearing. If the medium line of the head and source of sound are located not in one line, one ear accepts sound wave a bit earlier and with bigger in comparison with another ear.

Purpose of work: to learn the method and to evaluate the presence of binaural hearing.

Necessary material: tuning fork, phonendoscope with tubes of different length, cotton wool, alcohol. Object of research — a person.

Course of work

The person sits in a chair with his back to the assistant. The person inserts ends of rubber tubes of the phonendoscope into the ears. Strike a metal plate before the membrane of phonendoscope or place the tuning fork before the membrane. The person should determine from what side he can heard sound. After that one of the tubes is replaced with longer one and the test is repeated. This time the person should identify from what side the sound comes earlier.

In conclusion specify why the source of sound seems to be displaced to the shorter way.

Lab. work 11.10. Examination of proprioception at the person

The musculoskeletal apparatus is an executive system of the organism and its receptors — proprioreceptors — play especial role among other sensitive formations.

Proprioreceptors are the mechanoreceptors sending to CNS the information on position, deformation and shifts of various parts of body. Their functioning ensures coordination of all mobile organs and tissues of the person at rest and at any motor acts. Once proprioreceptors are not working, the organism loses ability to keep natural postures, to move and react appropriately to external influences.

The person, owing to proprioreception, feels position of his parts of body. Proprioreception disorder can be compensated by other sensory systems, especially by eyes. That is why tests performed with closed eyes allow to find out disorders of proprioreception.

Purpose of work: to learn the method and to evaluate the level proprioreceptive sensitivity.

Necessary material: dynamometer. Object of research — a person.

Course of work

Examination of the proprioreceptive sensitivity level is carry out with closed eyes:

1. Romberg's test — the person stands upright, heels together, then he is asked to raise one leg.

In norm, the person becomes to rock slightly, at proprioreception disorder rocking is more strong and the person can even fall.

2. To the person is asked to stretch his right hand aside, and then quickly to touch his tip of the nose, then to repeat this with another hand.

Fix the position of his hand and fingers, then tell him to reproduce this position in other hand.

At disorder of proprioreception the person can fail to repeat this.

3. The person is asked to compress a dynamometer first with open eyes, then with closed eyes, applying equal force.

In conclusions explain the observed phenomena.

Lab. work 11.11. Tests of the vertical and horizontal writing («writing» tests)

Disorders of vestibular system in a person are usually accompanied by dizziness, spontaneous nystagmus of eyeballs, nystagmus of a head, and change of extremities muscular tone. Also usually the evaluation of vertical and horizontal parameters of surrounding space is impaired, first of all as a result of pattern change in proprioceptive impulsation which forms one of channels of the reverse afferentation in system of functional providing a normal pose and a locomotion of the person.

Purpose of work: to evaluate the functional state of vestibular system by the tests of the vertical and horizontal writing.

Necessary material: a pen, sheet of paper 10×15 cm, protractor. Object of research — a person.

Course of work

Tell the examinee sitting at a table and holding the pen to write vertical and horizontal rows of any number (15–25 times). At the beginning tests are carried out with opened, then with closed eyes. Evaluate the results by measuring the angle of deviation of the numbers' row from horizontal or vertical lines. Significant are deviations more than 10 by the vertical line and more than 5 by the horizontal line (figure 11.6).

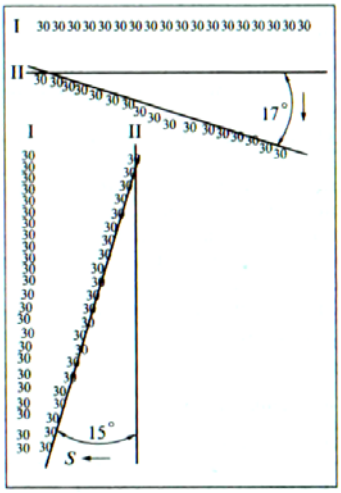


Figure 11.6 — Tests of the vertical and horizontal writing in a person with vestibular systemdisorders: *I —with opened eyes; II —with closed eyes*

In the conclusion note the presence or absence of vestibular dysfunction symptoms. Compare the results of measurements received in different examinees.

THE BASIC CONSTANTS OF SENSORY SYSTEMS

Parameter	Values
Frequency of sound fluctuations heard by the person	16–20000 Hz
The maximum level of loudness	1–14 Bel
Depth of tympanic membrane	0,1 mm
Frequency range of the maximal sensitivity of hearing in person	1000–4000 Hz
Discrimination of locating of source of sound	1 angle degree
Closest point of clear vision	10 cm
Radius of pupil at day vision on the average	2,4 mm
In the darkness extends to	7,5 mm
at bright light decreases t	1,8 mm
acuity visual	1,0 and higher

12. HIGHER NERVOUS ACTIVITY

The higher department of the central nervous system of the person is organized by the cortex of cerebrum (CC) and adjacent subcortical formations providing the individual adaptation of an organism to the environment changes.

Physiological basis of the higher nervous activity (HNA) are the conditioned reflexes formed on the basis of unconditional ones with obligatory participation of CC. Development of conditioned reflexes is e ensured by simultaneous action of conditioned and unconditioned irritants. Here, the action of the first one should precede and be powerful enough to cause the focus of excitation in the responding region of CC. If the produced conditioned reflex to not supported by the unconditioned one, its manifestation will gradually fade.

Opposite to animals, a person (for whom the development of the second signaling system is typical) learning to speak has strong links between the fields of CC accepting signals from various subjects, and the speech centers accepting verbal notes of subjects.

A conditioned reflex to the sound of bell arises at hearing the word «bell». Moreover, the conditioned reflex arises also if a person is shown the written word «bell». It proves the interrelation between the first and the second signaling systems.

Lab. work 12.1. Development and suppression of conditioned pupillary reflex to the bell in person

Pupillary reflex is reflex change of pupil's size depending on light amount. Physiological function of the pupillary reflex is a regulation of the amount of

light getting into an eye.

Purpose of work: to learn the technique of the development and suppression of the conditioned reflex in person.

Necessary material: bell, desk lamp, screen for closing the eye. Object of research — a person.

Course of work

To perform the test, choose a person with expressed pupillary response to light. The experimenter and the person are sitting face-to-face. With good daylight the person can sit facing the window. He closes one eye with his palm (constantly during the experiment), the second eye is closed with the screen for several seconds. Once the eye is opened, the pupillary reflex is observed (pupil contracts at once as the eye opens). Turn on the bell and make sure it does not influence the pupillary reflex, then proceed to develop the conditioned reflex. For this purpose, first turn on the bell, then close the eye with the screen, i.e. two irritants work at one time: closing of the eye — unconditioned irritant producing dilation of the pupil, and the second irritant — the bell (conditioned irritant). Here, the conditioned irritant (bell) should surpass a little the unconditioned one.

Repeat the combined action of the two irritants 7–10 times with the intervals of 40–50 seconds. Then, without closing the eye with the screen, switch on the bell and watch dilation of the pupil, i.e. the appearance of the conditioned reflex where the bell is the conditioned irritant.

To fix the developed conditioned reflex repeat the test several more times. Then, instead of the bell, pronounce loudly the word «bell», eye opened, and watch the dilation of the pupil, i.e. the presence of the conditioned reflex.

Now fade the developed conditioned pupillary reflex: switch on the bell for several times without closing the eye.

Write down the results, explain the mechanism of the conditioned reflex development induced by the bell and the word «bell».

Lab. work 12.2. Measurement of short-term acoustical memory volume

The short-term memory of the person is characterized by a certain volume which is determined, for example, by the number of simple symbols (digits or letters), remembered correctly upon the first presentation. The assessment can be made by the information perceived by acoustical or visual analyzers. In adult people the normal volume of the short-term memory upon the first presentation is 3–7 symbols bearing no information.

Purpose of work: to measure the volume of the short-term acoustical memory.

Necessary material alphabetic and digital tables. Object of research — a person.

Course of work

To the person reads lines of numbers from table A. After reading the top lines of digits with equal intervals (2–3 seconds) the person is to repeat them. If he repeats them in correct order, he reads the next line which has one digit more in a line making 5–6 seconds pause after each digit. The volume of the short-term memory is equal to the number of digits in the longest line which has been repeated correctly.

In case the line has been repeated incorrectly, the person reads similar number of digits from another table (table B).

Table A	Table B	Table C	Table D
318	931	QWE	POI
6294	2865	URTY	OIPL
47983	74528	TYUIO	UYTRF
537416	816452	UIOPLK	QWERTY
9261483	9753861	ASDCXZV	ASRTGFE
17259463	32491576	GFEASJUI	MNBHYTEB
597183624	893652475	TYUIOLKJH	QAUTKFPFR
2673594813	6182496342	HGFDSAQWER	OIRNMDUEMS

If mistakes are made again, the test is completed and the volume of the short-term memory is equal to the number of symbols from the previous line.

Testing of the short-term memory volume with alphabet letters is performed in similar way (table C and D).

In conclusion assess the volume of short-term acoustical memory of the person.

Lab. work 12.3. Investigation of period of simple sensomotor reactions

Simple and complex responses of the person to various irritants arise not at once but in a certain latent period. Presence of the latent period is caused by the consecutive transition of the information through the various departments of analyzers, reflex arches and in many cases depends on the time of signal processing in the central nervous system. Normally, latent period of simple response to light in adults is 180–200 milliseconds, that to the sound — 150–180 milliseconds. More complex responses are characterized by the increase of the latent period of a reflex.

Purpose of work: to measure the time of simple sensomotor reactions to light and sound irritants, to investigate the time of responses in conditions of the abstract attention.

Necessary material: multipurpose diagnostic device. Object of research — a person.

Course of work

To investigate simple sensomotor reactions, the person should sit in a chair in relaxed state. The person holds the control unit with a lamp and the control

knob. The person is provided with 20 automatic consecutive flashes with irregular intervals between them. The person should press the button instantly each time the lamp flashes. The device automatically processes the intervals between flashing of the lamp and pressing the button. After the button has been pressed the last time, the devise will display the average response time in milliseconds. Then the latent period of response to sound is estimated.

After that, responses to light and sound in conditions of the abstract attention are estimated. The person is asked questions (maths problems), along with it he has to respond to light irritant.

Write down the obtained results into the table 12.1.

Table 12.1 — Results of measurement of simple sensomotor reaction time

Reaction	Time of a simple reaction	Normal time of reaction	Reaction time at abstract attention
1. To the light		180–200 ms	
2. To the sound		150–180 ms	

Compare the obtained periods of the simple reaction at rest and at abstract attention.

Lab. work 12.4. Evaluation of the type of human working capacity («owl–lark» test)

The type of the human working capacity (morning, evening, arrhythmic) is substantially determined by his constitutional features.

Purpose of work: to evaluate the type of human working capacity with the «owl — lark» test.

Necessary material: questionnaires.

Course of work

Answer the following questions:

Question	Answer	Code
1. It is hard for you to get up early in the morning?	Yes, almost always Sometimes Seldom Extremely seldom	3 2 1 0
2. If you had an opportunity to choose, what time would you go to bed in the evening?	After 1 o'clock at night Before 1 o'clock Before 23 o'clock Before 22 o'clock	3 2 1 0
3. What breakfast do prefer to have during the first hour after having got up?	Full course Less full Boiled egg Cup of tea or coffee	0 1 2 3

Question	Answer	Code
4. If to recollect your last quarrels at work or at home, when did they mainly occur?	First half of a day Second half of a day	0 1
5. What can you refuse easily?	Morning tea, coffee Evening tea	2 0
6. Take the watch and note the time time. Simultaneously, without looking at the watch, try to measure 1 minute as precise as you can, then look up at the watch again. How precisely can you measure the time within one minute?	Less than a minute More than a minute	0 2
7. How easily can you change your meal habits during holidays, travel?	Very easily Easily Difficult Remains unchanged	0 1 2 3
8. If you have an important job to do in the morning, how earlier do you to bed?	More than two hours One-two hours Less than an hour As usual	3 2 1 0

Calculation of results. Summarize using codes and evaluate the type of working capacity:

0–7 points — morning type («lark»);

8–13 points — arrhythmic type («pigeon»);

14–20 points — evening type («owl»).

In conclusion note the type of working capacity of the person.

Lab. work 12.5. Evaluation of dominating type of memory

Memory is a very complex process including perception, fixation, storing and reproduction of information. There is a genetic memory, immunological (linked with the genetic) memory and neurological memory which is divided into short-term and long-term memory.

Different people may have different memory — acoustical, visual, motor or combined.

Purpose of work: evaluation of dominating type of memory.

Necessary material: separate cards with four lines of words (10 words in each line). The number of cards should correspond to the number of people. Object of research — a person.

Course of work

1. The experimenter reads out loud the first line of words with the 5 seconds intervals. After 10 seconds rest people write down the remembered words. Then they have a pause for 5 min.

2. The experimenter distributes cards, text faces down. Upon the command students turn the cards over and read the text for 1 mines, then turn the cards

over again and in 10 seconds write down the remembered words. Then they have a pause for 5 min.

3. The experimenter reads out loud the words of the 3rd line, students repeat them in whisper and «write down» them in imagination. After 10 sec an interval write down the remembered words. Then they have a pause for 5 min.

4. The students are distributed cards with the words of the 4th line and read them, then the experimenter reads them aloud.

Students repeat them in whisper and «write down» them in imagination. In 10 seconds they write remembered words down in writing-books.

The data of the experiment are written down into the table 12.2.

Table 12.2 — Results of evaluation of dominating type of memory

Type of memory	No. of words in a line (a)	No. of words kept in memory (b)	Coefficient of memory
Acoustical			
Visual			
Motor-acoustical			
Combined			

Make a conclusion on the dominating type of memory.

Lab. work 12.6. Detection of the higher nervous activity features of a person depending on prevalence of I or II signal system

Several types of communications between neurons participate in the behavioral act of a person: unconditioned reflexes, temporary connections of the first and second signal systems. The behavior of the person is the result of the activity of both signal systems, subcortical and stem structures of a brain.

The second signal system prevails over first and to a certain extent suppresses it. At the same time the first signal system in a certain degree determine the activity of the second one.

Purpose of work: to learn the technique and to assess features of higher nervous activity (HNA) in the examinee.

Necessary material: stop watch, writing-materials. Object of research — a person.

Course of work

The experimenter without hurrying says aloud the word. The examinee has to answer quickly with the first word which arises at him on association with the word of the experimenter. The secretary notes on a stop watch time from each said word to the answer of the examinee and writes down the answer and its latent period in the protocol. Determine the features of HNA by results of the test:

1. Duration of the latent period less than 3 seconds reflects good mobility of nervous processes.

2. Gradual prolongation of the latent periods by the end of the test reflects fast fatigability of neurons, i.e. to weakness of nervous processes.

3. Repetition of identical answers is a sign of inertness of nervous processes.

4. Prevalence of concrete or abstract concepts in answers allows to make a conclusion about the features of the highest nervous activity — prevalence of an art or intellectual component.

Represent the results of work in the form of table 12.3.

Table 12.3 — The features of the highest nervous activity

Variant 1			Variant 2		
Word	Answer	Latent period	Word	Answer	Latent period
Fire			Air		
Portrait			Grass		
School			Book		
Tree			Earth		
Dresse			Wind		
Water			Brush		
Hospital			House		
Spider			Laughter		
Telephone			Trolleybus		
Snow			Ladder a		
Smile			Ice cream		
Song			Pumpkin		
Car			Rainbow		
Bread			Violin		
Flower			Cat т		
Ring o			Sand		
River			Window		
Sweets			Mother		
Dog			Sun		
Chess			Children		

In the conclusion note the mobility and force of nervous processes and the prevalence of an art or cogitative component in the examinee.

Lab. work 12.7. Determination of HNA types by parameters of force, balance and mobility of nervous processes

The type of nervous system is a set of properties of nervous processes which are determined by hereditary features and acquired during individual life.

Force of nervous processes is the ability of cerebrum cortex cells to keep proper responses to strong and super strong stimuli.

Balance is the identical reactivity of nervous system in response to exciting and inhibiting influences.

Mobility is the speed of transition of excitement process to inhibition and vice versa.

Types of higher nervous activity and temperament (by the classification of I. P. Pavlov — Hippocras):

1. Strong — unbalanced — mobile (choleric person).
2. Strong — balanced — mobile (sanguine person).
3. Strong — balanced — inert (phlegmatic person).
4. Weak — unbalanced —inert (melancholic person).

I.P. Pavlov has correlated each of these types to the corresponding temperament according to Hippocras. Between the main types of nervous system there are transitional (intermediate) types. The main properties of nervous processes are inherited (genotype). Phenotype is the complex of HNA features which is formed as a result of combination of congenital features and conditions of upbringing. Pavlov connected the concept "genotype" with the concept «temperament», and «phenotype» — with the concept «character».

Purpose of work: to determine the HNA type by parameters of force, balance and mobility of nervous processes.

Necessary material: questionnaires.

Course of work

Give the answers expressed in points, using a scale of points (table 12.4).

For each feature of nervous processes find the algebraic sum (Σ) of the given points, taking into account the mathematical sign.

Table 12.4 — Expression of the parameters of nervous system properties

Expression of the parameters of nervous system properties	Points
Positive answer :	
а) high degree	+3
б) medium degree	+2
в) small degree	+1
Uncertain answer:	0
Negative answer:	
а) small degree	-1
б) medium degree	-2
в) high degree	-3

Evaluation of the force of nervous processes

№	**Question**	Points
1.	At the end of each class I don't feel fatigue; I can study well at the beginning of the class and at the end of the class	
2.	At the end of the academic year I study with the same activity and efficiency, as in the beginning	
3.	I keep high working capacity up to the end during examinations	
4.	I quickly restore forces after the exam session and any work	
5.	In danger situations I act boldly and can easily suppress excessive nervousness, uncertainty and fear	

№	Question	Points
6.	I am inclined to risk and "sharp" feelings, even during examinations and in other "dangerous" situations	
7.	At meetings and in the group of people I safely express the opinion and criticize shortcomings of friends	
8.	I seek to participate in public work	
9.	Unsuccessful attempts of the task solution, examinations, etc. will mobilize me for achievement of a goal	
10.	In case of an unsuccessful answer at examinations, or incompletes I persistently prepare for a repeating an examination	
11.	Criticism from parents, teachers, friends (reprimand, punishment, unsatisfactory assessment, joke) has positive impact on my state and behavior	
12.	I am indifferent to mocking and jokes	
13.	I easily concentrate and keep attention during mental work at hindrances (walking, talk)	
14.	After troubles I calm down easily and focus on work	
	The sum of points	Σ_1

Evaluation of the balance of nervous processes

№	Question	Points
1.	I perform the hard and uninteresting work quietly and methodically	
2.	I keep calm before examinations and performances	
3.	Before the examinations, moving and travels, I don't worry much and my behavior is usual	
4.	I sleep well before serious tests (examinations, competitions, etc.)	
5.	I am easily self-controlled, I calm down quickly	
6.	In the concerning situations (a dispute, a quarrel) I am self-controlled and calm	
7.	I am annoyed and irritated about everything	
8.	I show restraint and self-control at unexpected unpleasant or joyful news	
9.	I easily keep unexpected news a secret	
10.	I always finish the begun work	
11.	I carefully prepare for the solution of difficult questions and assignments	
12.	My mood is generally calm and steady	
13.	The activity in studying and physical work is stable, without periodic recessions and rises.	
14.	I have a smooth and uniform speech and restrained clam movements	
	The sum of points	Σ_2

Evaluation of the mobility of nervous processes

№	Question	Points
1.	I seek to begin and finish quickly all educational and public assignments instructions	
2.	I hurry therefore I make many mistakes	
3.	I start performance of tasks at once, not always well considering them	

№	Question	Points
4.	I easily change habits and skills and also I easily acquire them	
5.	I get used to new people and to new living conditions quickly	
6.	I like to be with people and I make friends easily	
7.	I am quickly involved in new work	
8.	I pass from one work to another easily	
9.	I like when tasks often change	
10.	I fall asleep and get up easily and quickly	
11.	I easily switch from experience of failures and troubles to activity	
12.	My feelings are brightly shown in emotions, mimic and vegetative reactions (I redden, turn pale, sweat, shiver, feel dryness in a mouth, etc.)	
13.	My mood changes often and about everything	
14.	I have fast speech and movements	
	The sum of points	Σ_3

Evaluation of the received results:

1. Having received numerical results of nervous processes features (Σ_1, Σ_2, Σ_3), mark the points of their values on the corresponding scales of the circular nomogram of temperament determination (figure 12.1). Construct a triangle on the three marked points on the nomogram. Find the center of received triangle (the T point, is determined by crossing of medians of a triangle).

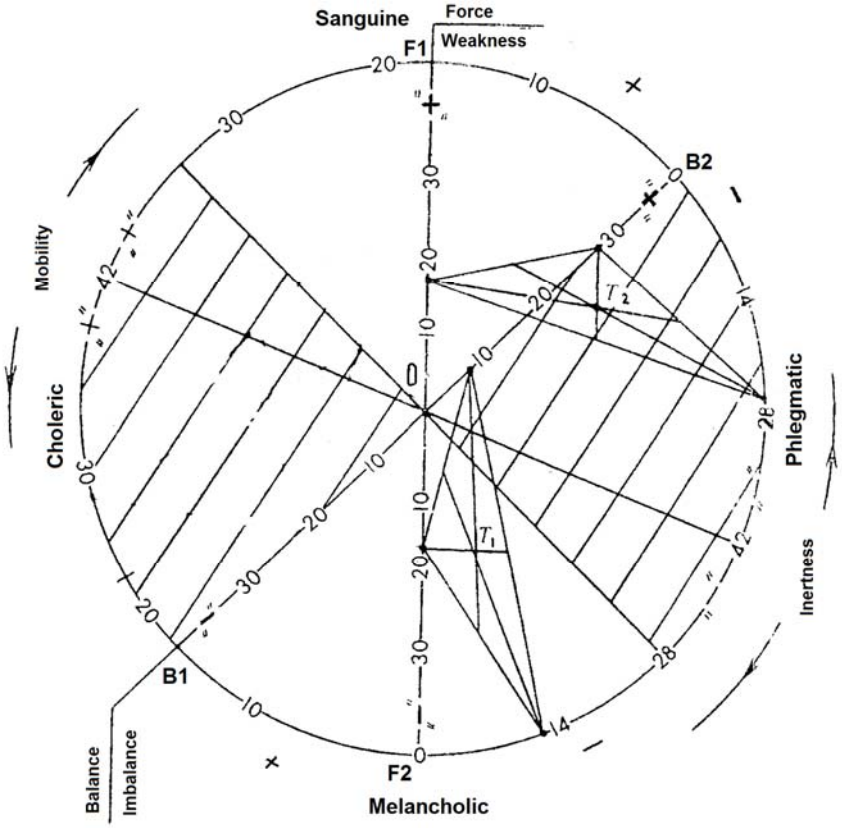


Figure 12.1 — Circular nomogram of temperament determination

Force of nervous processes is marked on the vertical diameter of a circle: OF1 — the positive force, OF2 — the negative force (weakness).

Balance: OB2 — positive, OB1 — negative.

The mobility is marked depending on the sign of force. At the positive value of force — the reference point is B2. From this point the positive value of mobility is marked counterclockwise. The negative value is marked clockwise.

At the negative value of force — the reference point is F2. From this point the negative value of mobility (inertness) is marked counterclockwise. The positive value is marked clockwise.

By localization of T point in the corresponding sector of the circular nomogram it is possible to determine the temperament of an examined person.

The advantage of the offered temperament assessment is the determination of not only «pure» temperaments, but also all possible mixed types of temperament.

In the conclusion determine the type of HNA and give its characteristics.

Lab. work 12.8. Assessment of attention parameters

Attention is one of the main psychological processes influencing on success of educational and professional activity.

The main characteristics of attention:

— *stability* — ability of maintaining attention at the same high level during the long period of time;

— *distribution* — ability which allows to keep a number of diverse events in the sphere of attention at the same time;

— *switching* — property which is characterized by the speed of switching of attention from one object or an event to others*;*

— *the volume of attention* is quantity of objects or events which can be in the sphere of attention at the same time.

At the research of attention parameters by the offered method the ability of the examinee to concentration and stability of attention can be evaluated.

The research is performed by means of special tables — forms with row of randomly arranged Landolt's rings, letters, figures. As the main methodical material for assessment of stability, distribution and switching of attention the alphabetic version tables is chosen.

Purpose of work: to estimate attention parameters.

Necessary material: a stop watch, standard tables with row of letters randomized without intervals, a pencil.

Course of work

Standard tables for assessment of attention contain 1600 signs. Time of work is 5 min.

On a signal the examinee starts to look attentively through each row of the table from left to right. He has to find and cross out the letter with which this row begins. Work is carried out with the maximum speed and accuracy. Every

minute at the command "line" the examinee draws the vertical line on that place on the table where he is found by this command. Work stops at the command "stop".

The instruction for writing the protocol.

1. Count the quantity of the letters (N) seen in every minute, and in 5 minutes in general.

2. Count the quantity of errors (missed letters or incorrect crossed out letters) (n), made in the course of work in every minute, and in 5 minutes in general.

3. Calculate attention parameters in every minute of work and in 5 minutes in general.

The volume of attention is estimated by the number of the letters checked in 5 min. (normally 850 and more letters).

Concentration of attention is estimated by quantity of the mistakes made in 5 min. (normally 5 and less).

The efficiency and stability of attention is calculated by formula:

$$S = (0{,}5N - 2{,}8n) \div t;$$

where S — an indicator of efficiency and stability of attention in unit of time;

N — the number of the checked letters in unit of time;

n — quantity of the mistakes made in unit of time;

t — operating time (in sec.).

Assessment of results:

S — higher than 1,25 = 10 points — efficiency and stability of attention is very high;

S — 0–1,25 = 8–9 points — efficiency and stability of attention is high;

S — 0,5–1,0 = 4–7 points — efficiency and stability of attention is average;

S — 0,2–0,5 = 2–3 points — efficiency and stability of attention is low;

S — 0,0–0,2 = 0–1 point — efficiency and stability of attention is very low.

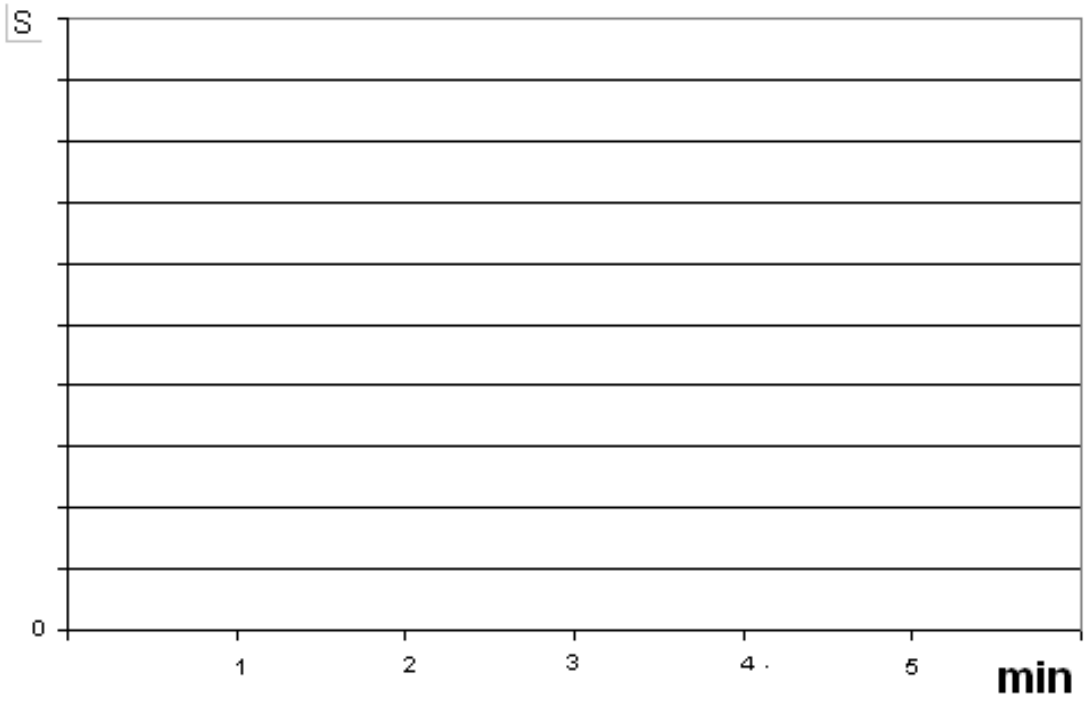
By all received «S» parameters the diagram is made by which it is possible to evaluate the dynamics of efficiency and stability of attention (figure 12.2.). Write down the obtained results in the table 12.5.

Table 12.5 — Assessment of results

Protocol
1 min — N =_____; n=_____; S =_____;
2 min — N =_____; n=_____; S =_____;
3 min — N =_____; n=_____; S =_____;
4 min — N =_____; n=_____; S =_____;
5 min — N =_____; n=_____; S =_____;
for 5 minutes — N =_____; n=_____; S =_____;

Attention volume _____ signs in 5 min. (850 and more letters are normal).

Concentration of attention _____ mistakes in 5 min. (5 and less is normal).



The figure 12.2 — Dynamics of efficiency and stability of attention

Table 12.5 — Standard table for measurement of attention parameters

SHAVSHEVWHNWSHNVHVKMNAWSEMVHENAWSNPUKSOV
VENHWVSNAVVSAVSAEKMAHVKEORUMLPNAVYVAMPRW
NHSROVNVOTKNLMCAMOLTVNLMWSMGUBVVNSMLOTLB
HAKWTONVMMBLCSHNGHAWHKMWNGSBCHFWSBLMOGNH
AHVSTMONEUBSTGAHDSNATNVLSMNGAHVVLGMVEMNM
SORNVULONSMSLNHCSSWOLKOMGWSMVLHTSWMNEPSM
UHRAOPNWSMWOTUHDNGVZYSGVWMTSNUHLOGNTSWMU
WKNGAEPVORSMWTUHYZBSWNUHTYDLANTSWMHVUMOL
BVAPMWSROKNEOLETFOEUBVOAZMBNAOPMYEHDTSAM
SWTNYDAOREGSMWTANTHEOALSMAYZCHTSNMKEAVEH
VAPUEKACMSWTVDLMTWNFECBGGKPBYEHYSANSMVAT
EKNMSWTVDYBSEGOVCBYEHYTGMWOUEAVSBYYHTTMA
MNGAELWBYMPVEHFLUEASMOLVGOWBCSMKENGOVMAE
HVAMSWRNKEGOMLEYBSMWHVANEGLHUYMSOLETETMG
NGMWTGOLHWNAPMTWNGOLESVAWNRHVALEYMWNERPM
APRVMWSNKMGOAMWVTHWNVEAPROLAWSENVHAEVMMA
BVMWENKLOVMABHMKENGWTMABLOMNGEOELAVTMMBM
UWMEVARPOTWMTWGOHYBTWSMULOANEGWAUFVASMWA
TNGORAMWSPARVEMTSASNKTOVMNGARMWSTEHVMWMT
VAPNSWMOLHEVTOENGAMWSVDLARPNMGMWTSYBVAHE
LNHCSSWOLKODLMTWNBTWSMULPROWSMEALOVBWTYM
OREGSMWTAMKMAHVKEORUMFECBGGKORMGSMMWWRSA
UKENAPMSWRVSOROAPMUEKNGTSOEVKENVUAEPWSFM
BYEHYSMVPAEVKBLVRANGEWMTBDYAPORAOSUOVLFE
MTONAPSMWVPRAOEHSKNEVASMWFAVKENSWAREOTWV
KHAPRSMWTOVPNAKMGODLATSWVPAMKEGNHLOYVAPK
SMMMWVPAEANKGAROAWPTSMSVPAENUGKNRWMWMEAT
WTOSMSVAEAUKGNVDLAOPEBTSWMPVAMBLCSMWVAEH
HVAPRSMWTSFSVHAPKENUWTSOLEVATWSREVSLAOEM
ENGARPSMWVAPROWTWSMPVAEUHEDVAPRSSMWAPKNV
GOVRPASKNSWTVOGAESDARSMWVAKMNTGSWTLVOARO
ABSRPVAMKENGMTWBLVESWVAENVLOARSAMWAHUFAP
VOLSMWAPNSUHEVTSWAPAMNEVRLECSAVKAWSMRAEV
ROVNVSTLMTWROTWMRSNEHVAPSRTWMKMPVGKNEPRA
BVAEKUMWTFEEAPRSWMHBVALOKENGMWBELAYVSMWE
AUKSNMWSMAVORWTBEVORAMNKGLOMWSTTYHELAORS
KNAEVPSMWMRLEYBSMWKSVPOLEHUNVEKPRVSMWTOR
WMAKENVAEOLMTWSPEANVSGFHVPARULOSWMTROAHE
HKENWSMPVAMCSWTVARPOLHGNKEEFYVUKESWMAPHA
TORVMSWPEUKNVGLOEHFTUEMSWTMOARPNEKHNKSAG

LITERATURE

1. *Gartner, L. P.* Textbook of histology / L. P. Gartner. — 4th ed. — Philadelphia: Elsevier, 2017. — XIII, 656 p.

2. Guyton and Hall physiology review / T. H. Adair [andoth.]; ed. by J. E. Hall. — 3rd ed. — Philadelphia: Elsevier, 2016. — X, 256 p.

3. *Hall, J. E.* Guyton and Hall Textbook of medical physiology / John E. Hall, Arthur C. Guyton. — India: Elsevier, 2016. — XIX, 1145 p.

4. Medical physiology / ed. by W. F. Boron, E. L. Boulpaep. — 3rd ed. — Philadelphia: Elsevier, 2017. — XII, 1297 p.

5. *Meisenberg, G.* Principles of medical biochemistry / G. Meisenberg, W. H. Simmons. — 4 th ed. — Philadelphia: Elsevier, 2017. — XIX, 617 p.

6. Sobotta. Atlas of human anatomy: V. 2. Internal organs / ed. by F. Paulsen, J. Waschke. — 15th ed. — München: Elsevier. Urban & Fischer, 2011. — 259 p.

7. Weir & Abrahams' imaging atlas of human anatomy / ed.: J. D. Spratt [and oth.]; consultant eds.: J. Weir, P. H. Abrahams. — 5th ed. — Barcelona: Elsevier, 2017. — XVI, 263 p.

8. *Кубарко, А. И.* Нормальная физиология: учебник: в 2 ч. / А. И. Кубарко, А. А. Семенович, В. А. Переверзев; под ред. А. И. Кубарко. — Минск: Выш. шк., 2013.

9. *Медведева, Г. А.* Физиология пищеварения: учеб.-метод. пособие / Г. А. Медведева. — Гомель: ГомГМУ, 2017. — 48 с.

10. *Мельник, С. Н.* Физиология жидких сред организма человека: учеб.-метод. пособие / С. Н. Мельник, Ю. И. Брель. — Гомель: ГомГМУ, 2014. — 85 с.

11. Тестовые задания по нормальной физиологии: учеб.-метод. пособие / Н. И. Штаненко [и др.]. — 2-е изд., перераб. и доп. — Гомель: ГомГМУ, 2017. — 300 с.

12. Физиология кровообращения: учеб.-метод. пособие / С. Н. Мельник [и др.]. — Гомель: ГомГМУ, 2017. — 86 с.

13. Физиология: учебник для студ. учреждений высш. образования / под ред. В. М. Смирнова, В. А. Правдивцева, Д.С. Свешникова. — 5-е изд., испр. и доп. — М.: Медицинское информационное агентство, 2017. — 511 с.

CONTENTS

Учебное издание

Мельник Виктор Александрович,
Брель Юлия Игоревна,
Мельник Светлана Николаевна и др.

РУКОВОДСТВО
К ПРАКТИЧЕСКИМ ЗАНЯТИЯМ
ПО НОРМАЛЬНОЙ ФИЗИОЛОГИИ
(на английском языке)

Учебно-методическое пособие
для студентов 2 курса
факультета по подготовке специалистов для зарубежных стран,
обучающихся на английском языке,
учреждений высшего медицинского образования

Редактор ***Т. М. Кожемякина***
Компьютерная верстка ***Ж. И. Цырыкова***

Подписано в печать 18.09.2018.
Формат 60×84$^{1}/_{16}$. Бумага офсетная 80 г/м^{2}. Гарнитура «Таймс».
Усл. печ. л. 6,28. Уч.-изд. л. 6,86. Тираж 200 экз. Заказ № 414.

Издатель и полиграфическое исполнение:
учреждение образования «Гомельский государственный медицинский университет».
Свидетельство о государственной регистрации издателя,
изготовителя, распространителя печатных изданий № 1/46 от 03.10.2013.
Ул. Ланге, 5, 246000, Гомель.