NORMAL PHYSIOLOGY

Practicum manual for specialty “Stomatology”

In 2 parts

Part 1

Minsk BSMU 2016

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ
КАФЕДРА НОРМАЛЬНОЙ ФИЗИОЛОГИИ

НОРМАЛЬНАЯ ФИЗИОЛОГИЯ

NORMAL PHYSIOLOGY

Практикум для специальности «Стоматология»

В 2-х частях

Часть 1

Минск БГМУ 2016

УДК 612 (811.111)-054.6 (076.5) (075.8)
ББК 28.707 (81.2 Англ-923)
Н62

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А в т о р ы: ст. преп. Белорусского государственного медицинского университета О. С. Никитина (1–17 занятия); д-р мед. наук, проф. Смоленского государственного медицинского университета А. В. Евсеев (14–16 занятия); канд. мед. наук, доц. Смоленского государственного медицинского университета Л. П. Нарезкина (14–16 занятия); д-р мед. наук, проф. Белорусского государственного медицинского университета В. А. Переверзев (1–17 занятия)

Р е ц е н з е н т ы: канд. мед. наук, доц. В. Э. Бутвиловский; д-р мед. наук, проф. А. Д. Таганович

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Представлены вопросы к практическим занятиям и к итоговым семинарам по всем разделам курса нормальной физиологии; описания лабораторных работ и протоколы их выполнения; необходимая дополнительная информация по темам занятий.

Предназначен для студентов 1–2-го курсов медицинского факультета иностранных учащихся, обучающихся на английском языке по специальности «Стоматология».

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Никитина Ольга Сергеевна
Евсеев Андрей Викторович
Нарезкина Лариса Петровна
Переверзев Владимир Алексеевич

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На английском языке

В 2-х частях

Часть 1

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Переверзев Владимир Алексеевич
доктор медицинских наук, профессор
Белорусский государственный медицинский университет
Заведующий кафедрой нормальной физиологии

Никитина Ольга Сергеевна
старший преподаватель
Белорусский государственный медицинский университет

Евсеев Андрей Викторович
доктор медицинских наук, профессор
Смоленский государственный медицинский университет

Нарезкина Лариса Петровна
кандидат медицинских наук, доцент
Смоленский государственный медицинский университет

Navigation: our site — bsmu.by → student;

	Theme classes	Class pass	Theme lectures (short)	Lecture pass
1.	Opening session. Physiology as a scientific basis of medicine. The value of Normal physiology for dentists		1. Excitable tissues	
2.	The concept of chemical and electrical signaling. Receptors, their types. Excitable tissues and their general properties. Bioelectrogenesis. Electroodontodiagnostics		2. Skeletal muscles	
3.	Conduction of excitation along the nerve fibers and synapses. Physiological basis of conductive anesthesia in dental practice		3. Central nervous system	
4.	Physiology of skeletal muscles		4. The autonomic nervous system	
5.	Physiology of muscle maxillofacial region. Physiology of smooth muscles. Notion of the myoepithelial and glandular cells		5. The endocrine system	
6.	Physiology of nervous system. Processes of excitation and inhibition in CNS. Reflexes. General principles of CNS coordination activity		6. Blood cells. Hemopoesis.	
7.	**Colloquium "Excitable tissues"**		7. Blood groups. Hemostasis.	
8.	The nervous regulation of somatic functions		8. Physiology of heart.	
9.	The nervous regulation of autonomic functions		ATTENTION: 2nd semester. Lectures — 16 h (lecture 8), practical class — 54 hours (18 lessons), colloquim — 3 (7, 13 and 17)	
10.	Humoral regulation of functions. Physiology of the endocrine system. Lesson № 1			
11.	Humoral regulation of functions. Physiology of the endocrine system. Lesson № 2			
12.	Regulation of calcium and phosphorus in the body of the bone tissue and teeth			
13.	**Colloquium "Mechanisms of functions regulation"**			
14.	Body fluids (blood, lymph, liquor, saliva, etc.)			

15.	Blood cells. Erythrocyte sedimentation rate. The total clinical blood analysis. Hemopoesis		Pass/Fail Test: – without skipping lectures and practical classes, – lectures, – filled practical manual.
16.	Blood groups. Blood preparations. Blood substituting solutions. Hemostasis		
17.	**Colloquium "Body fluids"**		
18.	Pass/Fail Test		

Lesson 1. OPENING SESSION. PHYSIOLOGY AS A SCIENTIFIC BASIS OF MEDICINE. THE VALUE OF NORMAL PHYSIOLOGY FOR DENTISTS

DATE OF CLASSES

«____» _____ 201___

day month year

Main questions:	Navigation:
1. Physiology as a scientific basis of medicine. Application of knowledge on normal physiology for dentists. 2. Stages of Physiology evaluation (short story). The contribution of native scientists in the development of physiology. 3. The concept of physiological research methods. Safety rules when performing physiological studies. 4. The cell as a structural and functional basis of a living organism, its main features and functions. 5. Modern concept about the structure and function of membranes. Transport of substances through the cell membrane. 6. The concept of ion channels in cell membranes: sodium, potassium, calcium, chloride and water.	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. P. 1–17, 27–35. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005. P. 43–59.

Work 1.1. Physiology as a scientific basis of medicine. Application of knowledge on normal physiology for dentists.

Work 1.2. Stages of Physiology evaluation (short story). The contribution of native scientists in the development of physiology.

The Nobel Prize in Physiology or Medicine 1904
Ivan Pavlov

Official date of the physiology originating is _____ year.

William Harvey (1578–1657) _____

Stage 1 _____

Stage 2 _____

I. P. Pavlov (1849–1936) _____

Stage 3 _____

Work 1.3. Safety rules when performing physiological studies.

The training program at the Department of Normal Physiology provides students perform practical work, practical skills of working with some electrical appliances, computers, research equipment, glassware, chemical reagents and biological fluids.

In addition, students may be allowed to do research in the laboratories of the department during school hours.

General requirements.

1. Students are to enter the training room should wear a medical gown.

2. To assign the duty student.

On duty:

– Monitoring procedures, compliance with the rules and compliance with the requirements of safety at work in the classroom;

– Getting the key for the school laboratory and some training materials needed to perform practical work in

	the laboratory room **№ 131**; – Check the state of the school laboratory — turn off the water and electricity; – At the end of the lesson, the duty shall deliver the training box in room **№ 131.**
Safety rules when working with electrical equipment. When working with electrical equipment and appliances may be cases of electric shock or fire. The reason for this can serve as: – Work with defective electrical equipment (circuit breakers, outlets); – Lack of grounding electrical equipment; – Improper use of electrical appliances; – Touch hands or metal objects with live elements. In case of malfunction or electrical appliance, the student must inform the teacher or the laboratory assistant. When working with electrical equipment and appliances are strictly prohibited: – Check for voltage by fingers and touch live parts; – Work on an ungrounded electrical equipment and devices, unless permitted by the instruction to the device; – Use faulty electrical equipment and wiring; – Leave without supervision electrical circuit energized.	**General rules of first aid.** First aid to victims should be provided immediately and correctly. Life depends on it and the effects of trauma, burns and poisoning. With its specific rules providing you will meet on the clinical departments. If somebody received serious injuries or burns by the electric shock, it is necessary to call the ambulance. It should be remembered that, helping people under the influence of the current, we cannot touch it with your bare hands. First of all, you need to turn off the unit (device), which concerns the victim. If it is impossible disable the entire system must be separated from live parts of the victim, using sticks, boards and other dry items that are not electrically conductive, or cut the wires with an ax handle dry. In all cases, you must call the duty laboratory assistant, who is in the room **№ 131**, or lecturer.

Actions in case of fire.	**Instructions for protocol registration:**
In the event of ignition you should immediately turn off the power, call for help the duty laboratory assistant, who is in the room **№ 131**, or lecturer and begin to extinguish the fire. Then use a fire extinguisher. To extinguish, you can also use the existing fire hoses: unwind sleeve, open the tap.	After reading the rules and instructions of the safety sign your name in the record, as well as in the "Journal of checklists coaching students (students) safety" in the class number 104. **PROTOCOL** With safety regulations have read and instructed _____ _____ _____ Date Signature Student's name completely and legibly

Work 1.4. Study of the teaching methods in the computer class (№ 104)	
A. **Working in computer library**	Monitor – Кафедра нормальной физиологии – For English Students – Lesson 1. Use materials of Lesson 1 to fill a table work 1.1 and work 1.2
B**. Computer testing**	Monitor – "Тестирование". Next steps are on figures:

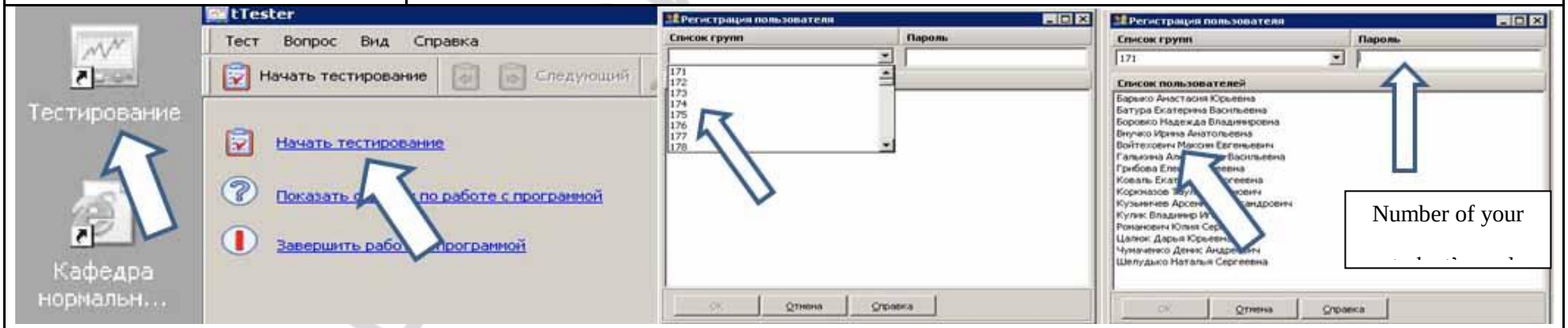
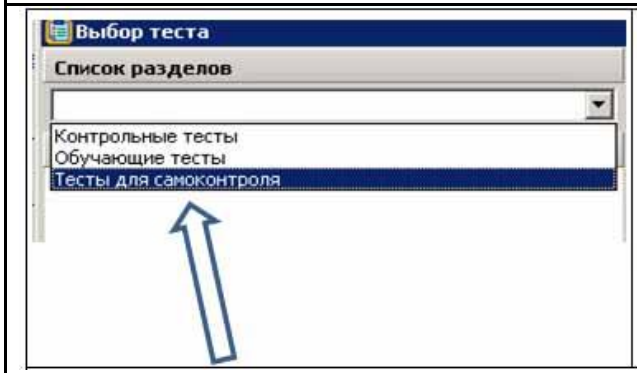
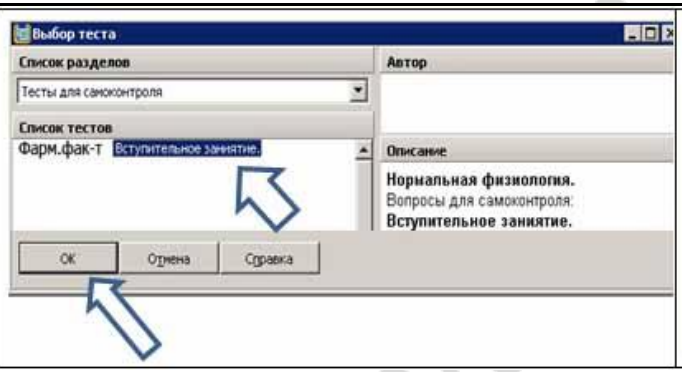


Fig. 1.1 Fig. 1.2 Fig. 1.3 Fig. 1.4





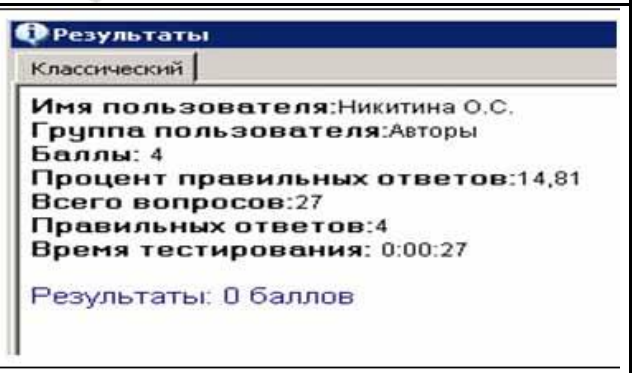


Fig. 1.5 Fig. 1.6. Select the number of the current classes Fig. 1.7

PROTOCOL

The testing result is:

_____ %, mark is _____

Work 1.5. The effect of catecholamine's on the heart rate changes.	Use program link "Physiol 2". Next steps are on figures:

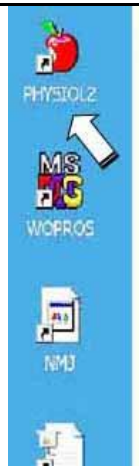


Fig. 1.1

Fig. 1.2

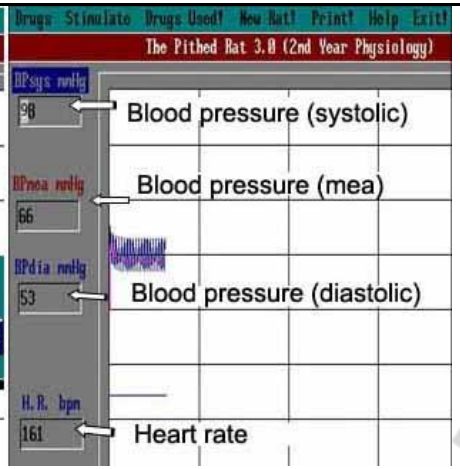


Fig. 1.3

PROTOCOL

New rat			HR, bpm
Rat 1	baseline		
	Injected Adrenaline	5 mg/kg	
New rat			
Rat 2	baseline		
	Injected Propanalol	100 mg/kg	
	Injected Adrenaline	5 mg/kg	

Conclusion:

Fig. 1.4

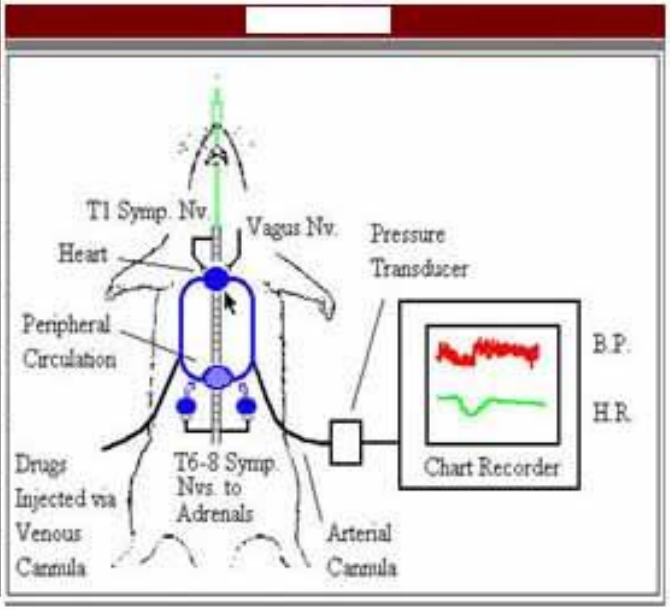


Fig. 1.5

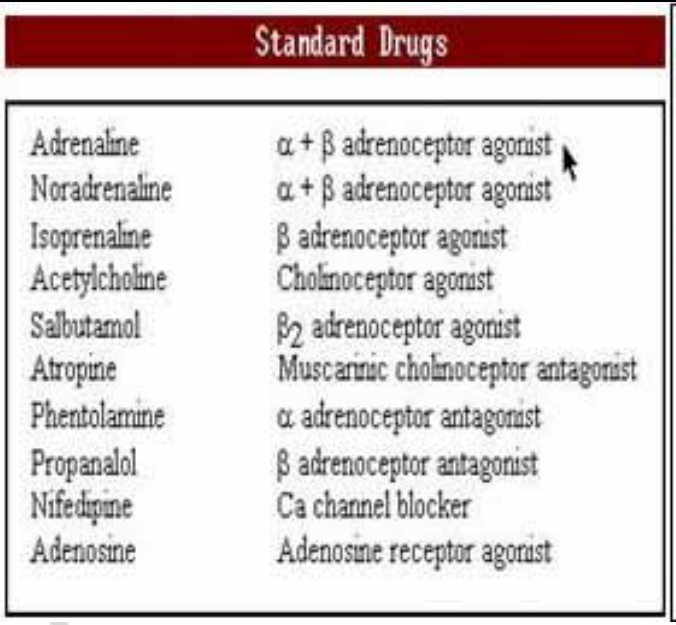


Fig. 1.6

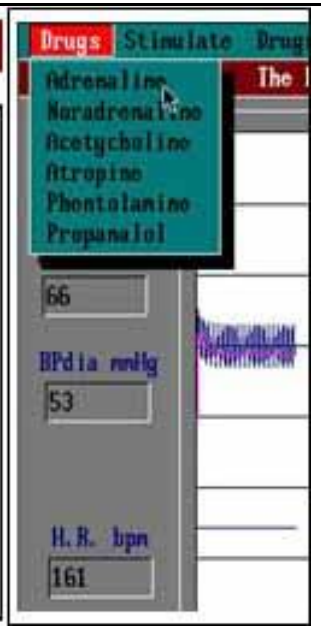
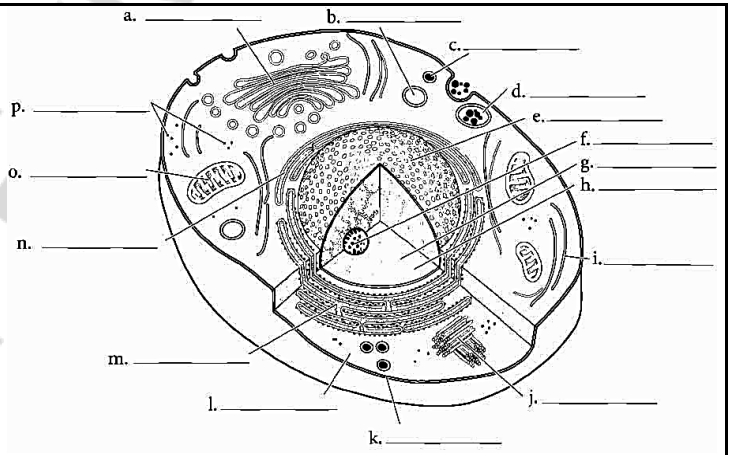


Fig. 1.7

Work 1.6. The cell as a structural and functional basis of a living organism, its main features and functions.

Overview of cell and cell membrane. Cells consist of an enclosing **plasma membrane**, an inner **cytoplasm** with numerous **organelles,** and other cellular structures. The fluid portion of the cell is called the **cytosol.** Color the cytosol in last after you color the rest of the cellular structures. One of the major structures in the cell is the **nucleus.** It is the genetic center of the cell and consists of fluid **karyoplasm, chromatin** (containing **DNA**), and the **nucleolus**. Color these features and label them on the illustration. **The cytoskeleton** consists of microtubules, intermediate filaments and microfilaments. It is involved in maintaining cell shape, fixing organelles, and directing some cellular activity. Label the organelles of the cell and use a different color for each one. The **mitochondria** are the energy-producing structures of the cell while the **Golgi apparatus** assembles complex biomolecules and transports them out of the cell.	Fill up the gaps:
Proteins are made in the cell by ribosomes. If the ribosomes are found by themselves in the cytoplasm, they are called **free ribosomes**. If they are attached to the **rough endoplasmic reticulum,** they are called	

bound ribosomes. The **smooth endoplasmic reticulum** manufactures lipids and helps in breaking down toxic materials in the cell. Other structures in the cell are **vesicles** (sacs that hold liquids). **Phagocytic vesicles** ingest material into the cell. **Lysosomes** contain digestive enzymes while **peroxisomes** degrade hydrogen peroxide in the cell. After you label and color the organelles make sure to go back and shade in the cytosol. **Centrioles** are microtubules grouped together and arc involved in cell division.



The stucture of the eucariotic cell

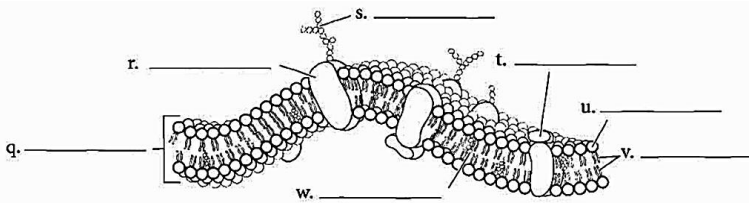
Work 1.7. Modern concept about the structure and function of membranes. Transport of substances through the cell membrane.

A cell membrane is a lipid bilayer composed mainly of phospholipid. Dynamic properties are due to the protein component, which includes pumps, channels, receptors, and carriers. Simple diffusion and facilitated transport are both passive processes (not energy-dependent) driven by concentration gradients.

The rate of protein-mediated transport will increase with increased substrate delivery until the carriers are saturated. The maximum rate (carrier saturation) is called TM and this rate is directly proportional to the number of functioning carriers present in the system. Secondary active transport is driven by the sodium gradient across the cell membrane, which is maintained by the Na/K-ATPase pump.

Endocytosis and exocytosis represent active uptake and extrusion of macromolecules via vesicular transport.

Fill up the gaps:



The structure of the cytoplasmic membrane

The **plasma membrane** is composed of a **phospholipid bilayer.** Color the **phosphate molecules** on the outside and inside of the membrane one color and the **lipid layer** another color. **Cholesterol molecules** occur in the membrane and, depending on their concentration, can make the membrane stiff or more fluid.

Proteins that are found on the outside of the membrane are called **peripheral proteins** while proteins that pass through the membrane are called **integral proteins.** Frequently these make up gates or channels that allow material to pass through the membrane. Attached to proteins on the cell membrane are **carbohydrate chains.** These provide cellular identity. Label and color the cell membrane structures.

Answer Key: a. Golgi apparatus, b. Lysosome, c. Peroxisome, d. Phagocytic vesicle, e. Nucleus, f. Nucleolus, g. Chromatin, h. Karyoplasm, i. Cytoskeleton, j. Centrioles, k. Plasma membrane, I. Cytoplasm, m. Rough endoplasmic reticulum, n. Smooth endoplasmic reticulum, o. Mitochondrion, p. Free ribosomes, q. Phospholipid bilayer, r. Integral protein, s. Carbohydrate chain, t. Peripheral protein, u. Phosphate molecule, v. Lipid layer, w. Cholesterol molecule.

Work 1.8. The concept of ion channels in cell membranes: sodium, potassium, calcium, chloride and water

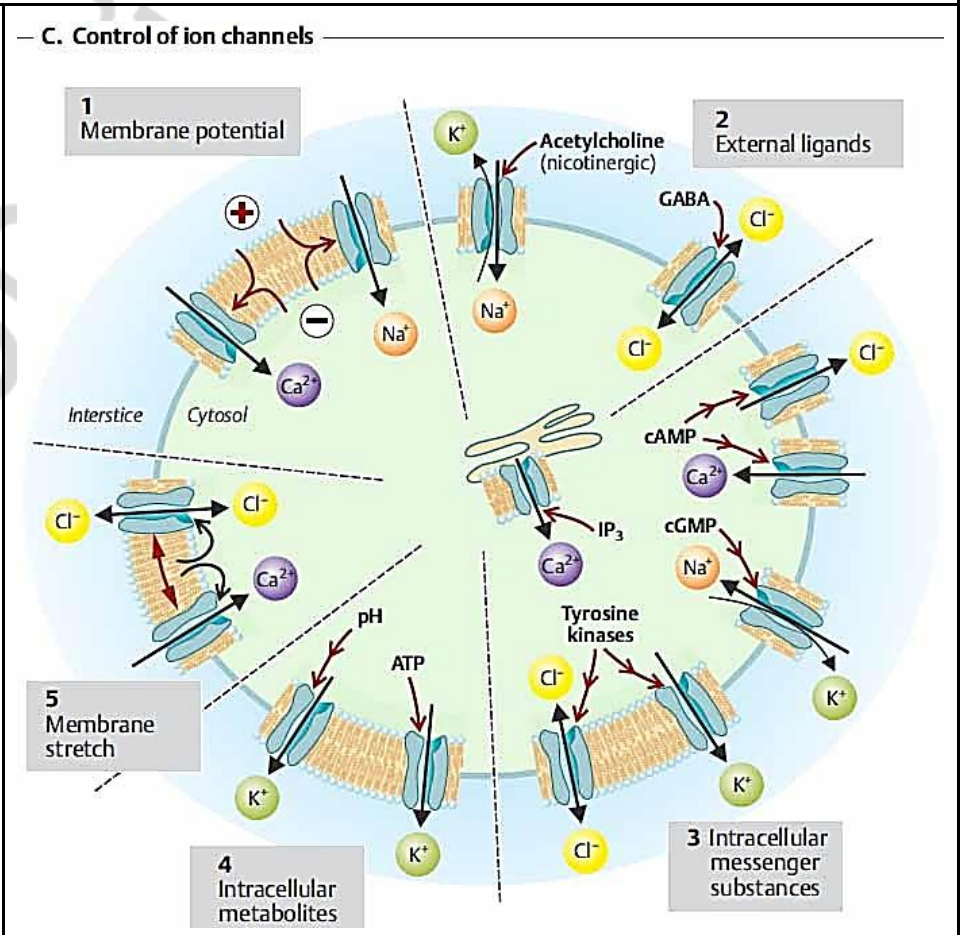
Control of ion channels. Channel open-probability is controlled by five main factors:

- Membrane potential (1), especially in Na+, Ca^{2+} and K^+ channels in nerve and muscle fibers.
- External ligands that bind with the channel (2). This includes **acetylcholine** on the postsynaptic membrane of nicotinic synapses (cation channels), glutamate (cation channels), and glycine or GABA (Cl^- channels).
- Intracellular messenger substances (3) such as:

– cAMP (e. g., in Ca^{2+} channels in myocardial cells and Cl^- channels in epithelial cells);
– cGMP (plays a role in muscarinergic effects of acetylcholine and in excitation of the retinal rods);
– IP3 (e. g. opening of Ca^{2+} channels of intracellular Ca^{2+} stores);
– G-proteins (e. g. Ca^{2+} channels of the cell membrane);
– Tyrosine kinases (e. g. Cl^- and K^+ channels during apoptosis);
– Ca^{2+} (affects, for instance, K^+ channels and degree of activation of rapid Na^+ channels;

- Intracellular metabolites (4) such as ATP (e. g., in K^+ channels in the heart and B cells in pancreatic islets) or H^+ ions (e. g., in K^+ channels in renal epithelial cells);
- Membrane stretch (5), the direct or indirect effects of which play a role in Ca^{2+} channels of smooth muscle fibers and generally in normal K^+ and Cl^- channels in swelling cells.

Buzzword	Full name	Function
GABA		
cAMP		
cGMP		



IP3			
ATP			
Ach			

THE LABORATORY WORKS ARE PASSED WITH MARK

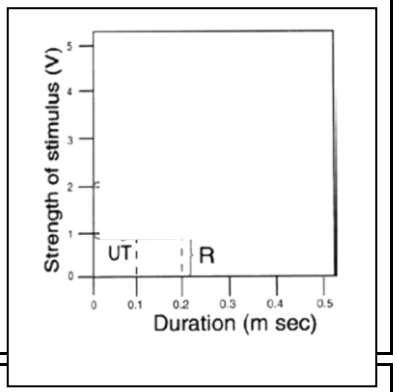
SECTION "EXCITABLE TISSUES"

Lesson 2. THE CONCEPT OF CHEMICAL AND ELECTRICAL SIGNALING. RECEPTORS, THEIR TYPES. EXCITABLE TISSUES AND THEIR GENERAL PROPERTIES. BIOELECTROGENESIS. ELECTROODONTODIAGNOSTICS

DATE OF CLASSES
«____» _____ 201___
day month year

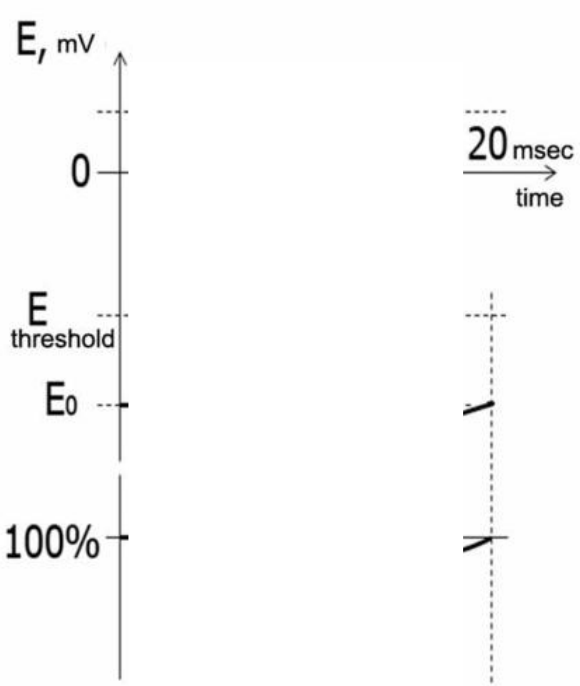
Main questions:	Navigation:
1. The concept of chemical and electrical signaling, responses of cells to signals of environmental. 2. The concept of information. The signals and their types. The concept of cellular receptors and its functions. The receptor mechanisms of signals perception. 3. General properties of excitable tissues. Excitation and forms of its manifestation. Indicators (parameters) excitability. Electrodontometry, its use in dentistry. 4. Biopotentials, their types. Membrane resting potential, its origin. The concept of galvanism. 5. The action potential. Changes excitability in the excitation process. 6. The laws of the response of excitable tissues to the action of irritants. Chronometry, its use to study the excitability of muscles and nerves. 7. Sensory receptors: definition, classification, role, basic properties. Receptor and generator potentials. The concept of principles of information coding in sensory receptors.	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. P. 49–61. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005. P. 60–70. 6. Severina T. G. Physiology of blood. P. 13–20

Electrodontometry, its use in dentistry.	Chronometry, its use to study the excitability of muscles and nerves. Draw, label and explain: – Rheobase — is – Utilization time — is – Chronaxie — is
The concept of galvanism.	



Work 2.1. Buzzwords	
Irritability —	Refractory —
Excitability —	Chronaxie —
Excitation —	Law “all or nothing” —
Resting potential —	Irritation force law —
Local potential —	Law force-time (strength-duration curve) —
Action potential —	Lability —
Polarization —	Adaptation —
Depolarization —	Accommodation —
Repolarization —	Receptor —
Hyperpolarization —	Receptor potential —

	Excitable tissues —
The ratio of permeability of ions RP ($P_{K^+} : P_{Na^+} : P_{Cl^-}$) —	The ratio of permeability of ions AP ($P_{K^+} : P_{Na^+} : P_{Cl^-}$) —
Membrane resting potential, its origin.	Biopotentials, their types.

Work 2.2. The action potential	**Work 2.3. Changes excitability in the excitation process**
	 0 – RP 1 – depolarization 2 – overshoot 3 – repolarization 4 – after depolarization 5 – fast repolarization 6 – hyperpolarization 7 – 100% excitability 8 – supernormal period 9 – absolute refractory period 10 – absolute refractory

Work 2.4. The laws of the response of excitable tissues to the action of irritants	

Work 2.5. The influence of ions Na^+ and K^+ on the membrane resting potential and the action potential "NMJ" (neuromuscular junction)

1. The work is done in the computer laboratory (class 104). The student loads the program NMJ (on the desktop, locate the same label). The program NMJ virtual simulates the operation of an isolated nerve-muscle preparation, placed in physiological solution (fig. 2.1) when the stimulation.

2. Click in the top row (line):
1) Ions → potassium (K+) → 5 mm, sodium (Na+) → 120 mm;
2) Stimulated → Nerve;
3) Clipboard → Copy to clipboard (fig. 2.2–2.4).

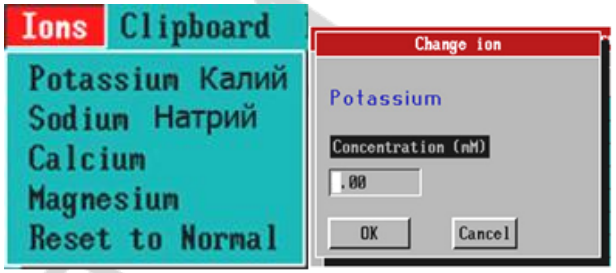


Fig. 2.2 Fig. 2.3

3. You will get the picture, two graphs, as in fig. 2.5, which shows the value of RP (resting potential) (arrow 1) in terms of the optimal content of ions, K^+ (potassium) and Na^+ (sodium) in physiological solution (arrow 2) (fig. 2.5) and graphs AP for electrical stimulation of muscles with a single electric current amplitude of 2 mA during 1 ms (fig. 2.4).

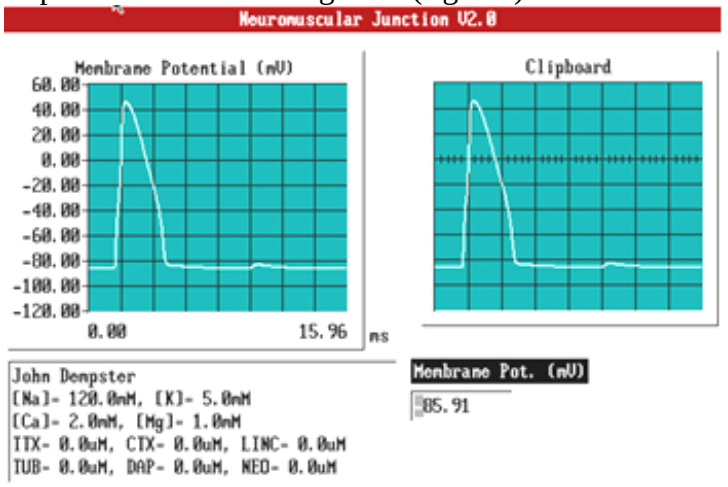


Fig. 2.5

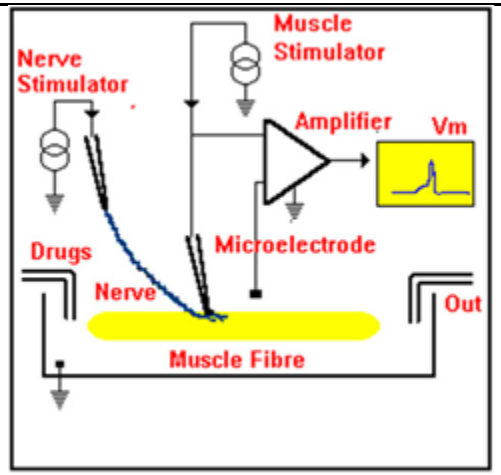


Fig. 2.1

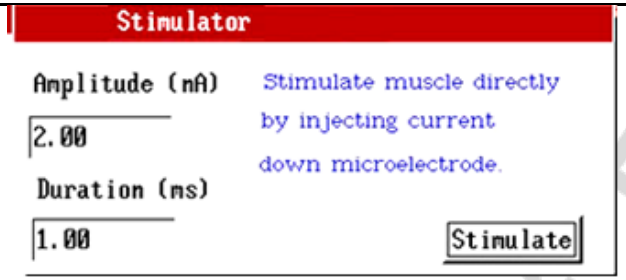


Fig. 2.4

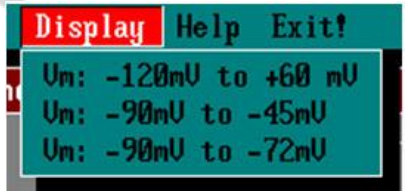


Fig. 2.6

4. Next, the program allows you to simulate changes in the concentration of electrolytes potassium and sodium in solution using commands "Ions" (fig. 2.2.) and "Concentration" (fig. 2.3) and record the values of RP and AP (fig. 2.6) for electrical stimulation of muscles with a single electric current amplitude of 2 mA during 1 ms – "stimulated – nerve".

Work 2.5. (sequential)

Directions for recording the Protocol:

1. Simulate changing membrane potentials (RP and AP) for electrical stimulation of muscles in the optimal content of ions K^+ and Na^+ at increase and decrease of their concentration (according to instructions in the table 2.1) in the surrounding muscle solution.

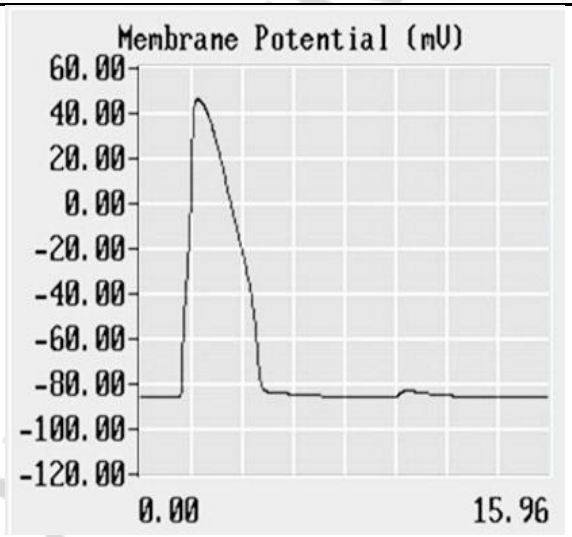
2. Record the results values of RP and AP in the table 2.1.

3. Figure 2.7 colored pencils paint the obtained

PROTOCOL

Table 2.1

The content of ions			The magnitude of the potentials	
potassium	sodium		resting	action
5 mM	120 mM	Copy to clipboard	–85,9 mV	+45 mV
8 mM	120 mM	Copy to clipboard		
2 mM	120 mM	Copy to clipboard		
Clipboard clear				
5 mM	160 mM	Copy to clipboard		
5 mM	100 mM	Copy to clipboard		

graphics of RP and AP in terms of changes in the concentrations of potassium and sodium ions. 4. Explain the effect of the concentration of the ions K^+ and Na^+ on the value of RP and AP.	 Fig. 2.7 Conclusion: the content of potassium ions in the extracellular fluid determines magnitude of the *resting/action* potential, while the content of sodium ions determines magnitude of the *resting/action* potential.

Work 2.6. Receptors and their types.

Cell receptors — is		Sensory receptors — is	
Classification of cell (molecular) receptors.	Ligands (example)	Classification of sensory receptors.	The main categories of information signals
Membrane receptors: 1._____ 2._____ 3._____ Intracellular receptors:	_____ _____ _____		The chemical nature: _____ _____ The physical nature: _____ _____

<table>
<tr><td colspan="2">1. _____
2. _____</td><td>_____
_____</td><td colspan="2"></td><td>_____
Physico-chemical nature:
Signals, indicating complex events:</td></tr>
<tr><td colspan="3">Schematic structure of membrane receptors</td><td colspan="3">Schematic structure of sensory neurons</td></tr>
<tr><td>7-TMSRs</td><td>1-TMSRs</td><td>LGICs</td><td colspan="2">Pseudo unipolar (somatic, autonomic sensory) neuron</td><td>Bipolar (neurons of smell and vision) neuron</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
</table>

THE LABORATORY WORKS ARE PASSED WITH MARK:

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Teacher's signature

Lesson 3. NERVE FIBERS. SYNAPSES. PHYSIOLOGICAL BASIS OF CONDUCTIVE ANESTHESIA IN DENTAL PRACTICE

DATE OF CLASSES
«_____» _____ 201___
day month year

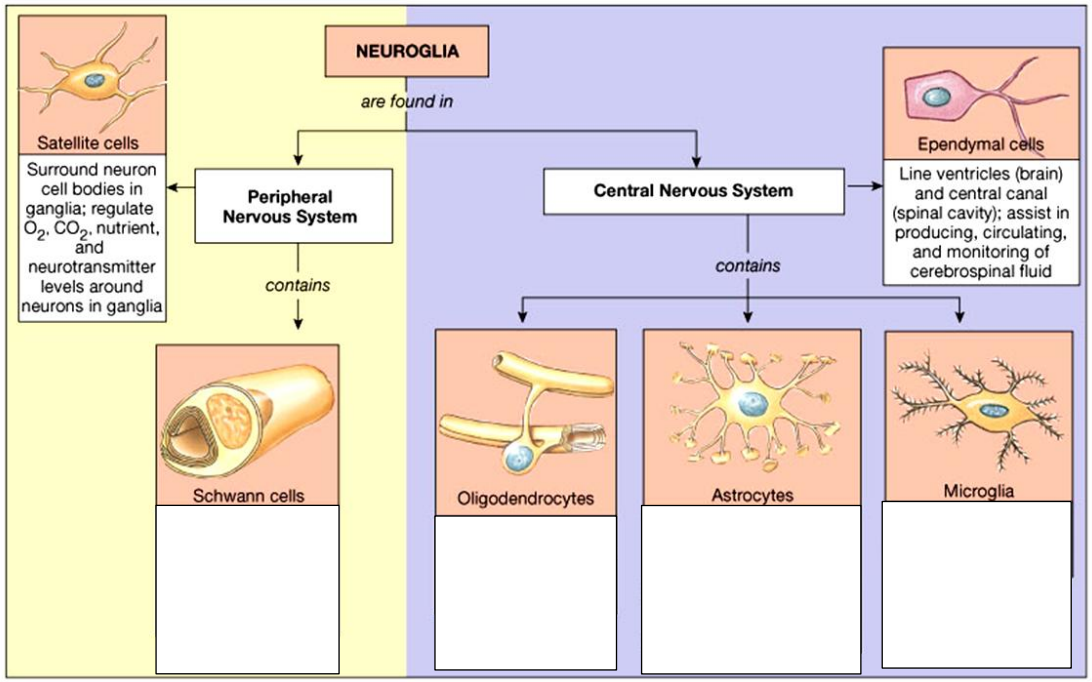
Main questions:	Navigation:
1. Nerve fibers: structure, types, and functions. 2. Mechanisms and laws of impulse conduction by myelinated and unmyelinated nerve fibers. 3. Physiological basis of conductive anesthesia in dental practice. 4. Transport substance of nerve fibers: types, functions. 5. Synapses: structure, classification, functions. 6. Modern concepts of transfer excitation mechanisms in synapses. Excitation neurotransmitters. EPSP. 7. Inhibitory synapses, its neurotransmitters. Ion mechanisms of inhibitory synapse functioning, IPSP. 8. The possibility of directed pharmacological effects on synaptic transmission.	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.

Buzzwords

Nerve fibers — is	Types of nerve fibers: 1. _____, 2. _____
Continuous conduction —	Saltatory conduction —
Cells in Nervous Tissue: _____ and _____	

Work 3.1. Nerve fibers: structure, types, and functions.

Draw a neuron, departments of neuron, its function:	Draw continuous conduction	Draw saltatory conduction



Work 3.2. Neuroglia

Using the lecture examples scheme sign.

The name of the cells and their main functions.

Two types in the PNS

Schwann cells

satellite cells

Work 3.3. Laws of impulse conduction by myelinated and unmyelinated nerve fibers

1.

2.

3.

Work 3.4

Classification of nerve fibers and sensitivity to anesthesia

Fiber type	Mielinization	Diameter (μm)	Conduction rate (m/s)	Sensitivity to anesthesia	Function according to fiber type
A_α	+	12–22	70–120	+	Skeletal muscle efferent, afferents in muscle spindles (Ib) and tendon organs (Ib)
A_β	+	8–12	40–70	++	Mechanoafferents of skin (II)
A_γ	+	4–8	15–40	++	Muscle spindle efferents
A_δ	+	1–4	5–15	++++	Skin afferents (temperature and “fast” pain) (III)
B	+ –	1–3	3–18	++++	Sympathetic preganglionic, visceral afferents
C	–	0,5–1,5	0,5–2	++++	Skin afferents (“slow” pain), sympathetic postganglionic afferents (IV)

Work 3.5. Transport substance of nerve fibers: types, functions

Label: a — anterograde transport is mediated by kinesin, b — retrograde transport is mediated by dynein, c — synaptic cleft, d — neurotransmitter, e — receptor

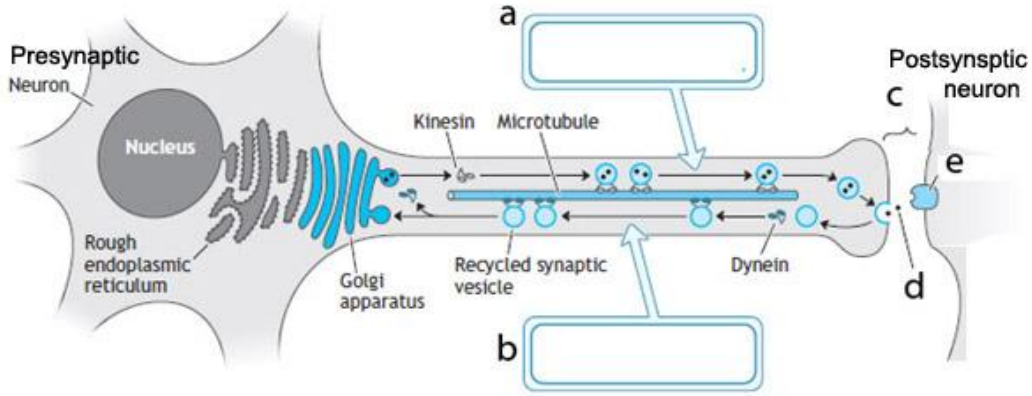


Fig. 3.1. Transport substance of nerve fibers

Work 3.6. Synapses: structure, classification, functions

Excitatory synapse, EPSP	Inhibitory synapse, IPSP
EPSP —	IPSP —
neurotransmitter —	neurotransmitter —
mv — 5, 90, 120	5, 90, 120
Depo/repolarisation	Depo/repolarisation

EPSP and IPSP

Characteristics of Postsynaptic Potentials

All postsynaptic potentials have certain characteristics in common Importantly, the local potential is a graded potential; that is, its amplitude is proportional to the size of the stimulus. Measurement of a local potential uses the resting potential as its baseline. If the membrane's resting potential is depolarized from –80 to –70 mV during the local potential, the local potential has an amplitude of 10 mV. This potential change is one of decreasing negativity (or of depolarization = excitatory postsynaptic potential EPSP), but it could also be one of increasing negativity (or of hyperpolarization = inhibitory postsynaptic potential IPSP).

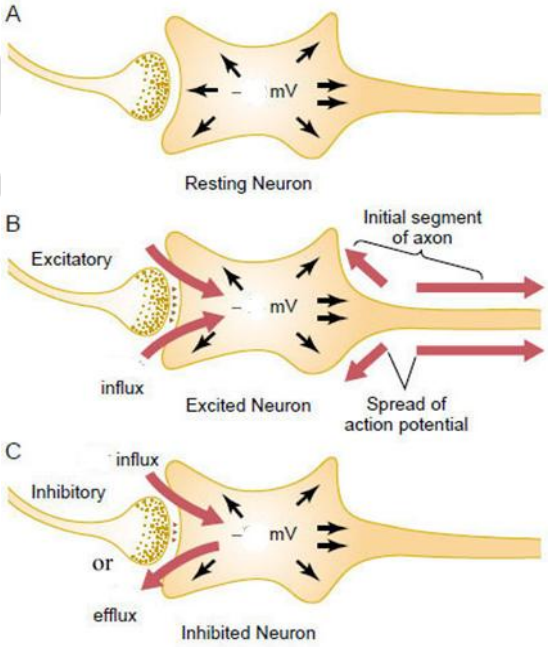


Fig. 3.2

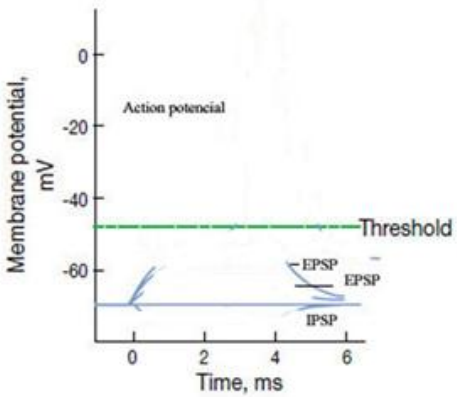


Fig. 3.3

Work 3.7. Modern concepts of transfer excitation mechanisms in synapses. Excitation neurotransmitters. EPSP	Work 3.8. Inhibitory synapses, its neurotransmitters. Ion mechanisms of inhibitory synapse functioning, IPSP

Work 3.9. Diagram of structure of neuro-effector junction (on smooth myocytes, glandular cells, myoepithelial cells)

Label

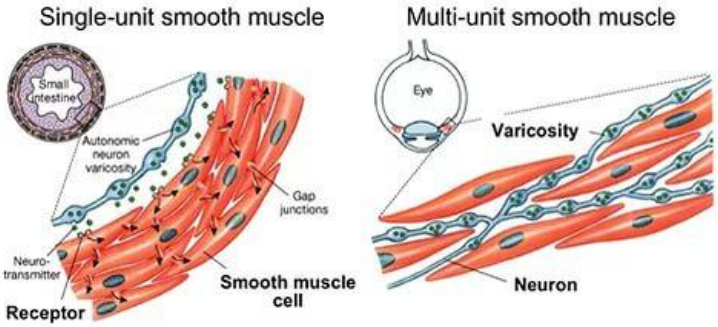


Fig. 3.4. Diagram of structure of neuro-effector junction

surrounding the conductive nerve trunks (conduction anesthesia) or its peripheral ending (infiltration anesthesia).

Local anesthetics (procaine, lidocaine) reversibly block impulse conduction along the axon membrane and other excitable membranes that use sodium channels as the main generator of action potentials.

The mechanism of action of local anesthetics are associated with their effects on receptors located near a intracellular inactive gates (h-gate) of the sodium channel, resulting in marked time and the block voltage-gated sodium channels.

Thus, local anesthetics interfere penetration of sodium ions through the membrane and its depolarization. As a result of blocked: emergence (generation) of action potentials in nerve (pain) terminals at infiltration and/or surface anesthesia, as well as conduction of excitation (action potentials) along nerve fibers with conduction anesthesia. Recovery of sodium channel from blockade by local anesthetic is 10–1000 times slower than from normal physiological inactivation of channels. Conductor (regional) anesthesia is achieved towards the introduction of anesthetic to the conductive nerve trunks or tangles. In this off pain sensitivity entire anatomical region that is far from place injection of anesthetic solution.

Local anesthetics can block transmission of signal on any nerve fibers, but the sensitivity of latter to anesthetic effects depends on its myelination, size, frequency of impulses on them, the provisions of fibers in the bundle.

Work 3.10. Physiological bases of conduction anesthesia

Anesthesia (anesthesia) in modern dentistry is a set of procedures aimed at the reduction or complete relief of pain during the treatment.

There are two kinds of anesthesia — local and general.

Local anesthesia involves the injection and application anesthesia, physical and physicochemical methods.

Two kinds of injection anesthesia — conduction and infiltration, which is carried out by introducing local anesthetics into the tissue

First, the signal transmission is blocked by the fibers B and C, then Aδ fibers. Thus, the pain disappears first, then other types of sensitivity are suppressed, and the motor functions and more.

Myelinated fibers are blocked before unmyelinated the same diameter. For termination of myelinated fibers on need to blockade extended to three successive node of Ranvier. The effect is more pronounced in the anesthesia of active axons, which have greater access to local anesthetics. Aδ and C fibers have a small diameter and are involved in the transmission of pain impulses high. So they blocked earlier and lower concentrations of local anesthetics than Aα fibers. Anatomical features of the location of the nerve fibers in the bundle (or a large nerve trunk) can change a rule differentiated nerve blocks. Thus, a major nerve trunks motor fibers are often located on the outer surface of the first contact and therefore with local anesthetics, and therefore the motor blockade may occur earlier than sensitive.

Lesson 4. PHYSIOLOGY OF SKELETAL MUSCLES

Teacher's signature

DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions: 1. Physiological properties of skeletal muscles and their functions. 2. Types of muscle fibers. Motor units and their features in different muscles. 3. Neuromuscular synapse: mechanisms of signal transmission. 4. Structural and functional characteristics of muscle fiber. 5. Mechanism of contraction and relaxation of a single muscle fiber and whole muscle. 6. A single contraction and its phase. Types and contraction regimen of skeletal muscle. Tetanic contraction and it types. 7. Force and work of muscle. Fatigue, physiological properties. 8. Dynamometry of a hand and back muscles.	Navigation: 1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.
Buzzword	
There are three types of muscle tissue: 1 _____, 2 _____, 3 _____	Sarcomere —
Muscle tissues share four basic properties:	Tetanic —

Skeletal muscles perform the following functions: 1 _____, 2 _____, 3 _____ 4 _____, 5 _____	Fatigue —
Motor units — is	

Practical works

Work 4.1. Types of muscle fibers

Complete the table using lecture and computer class.

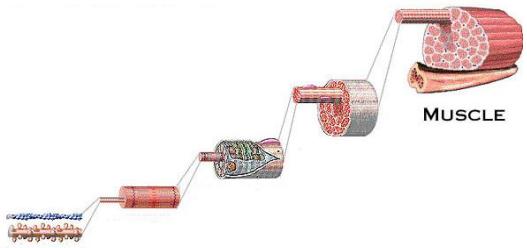
Type			
Description			
myoglobin			
mitochondria			
Fatigues			
color			
Diameter			

Work 4.2. Motor units

Using lecture draw motor units.

Work 4.3. Organizational levels of Skeletal Muscle

Using lecture label.



Work 4.4. Neuromuscular synapse:

mechanisms of signal transmission

Draw a sarcomere; mark the mechanisms of signal transmission.

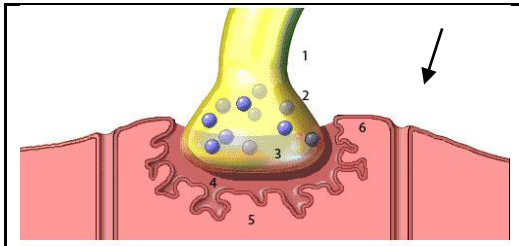
1. AP
2. _____
3. _____
4. _____

Work 4.5. Structural and functional characteristics of muscle fiber

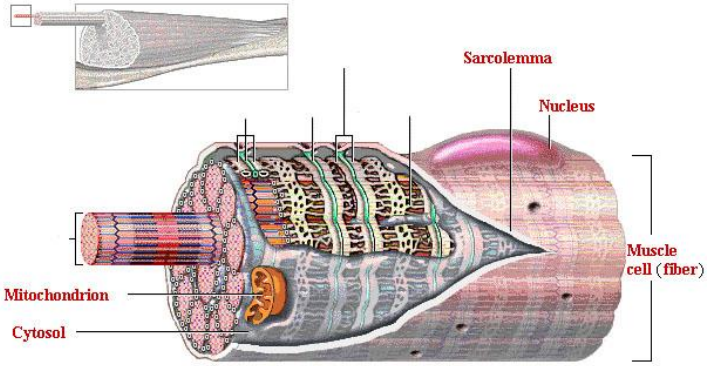
Using a lecture or program Interactive Physiology sign scheme.

Write the function of the following structures:

Structure	Function
Myofibril	

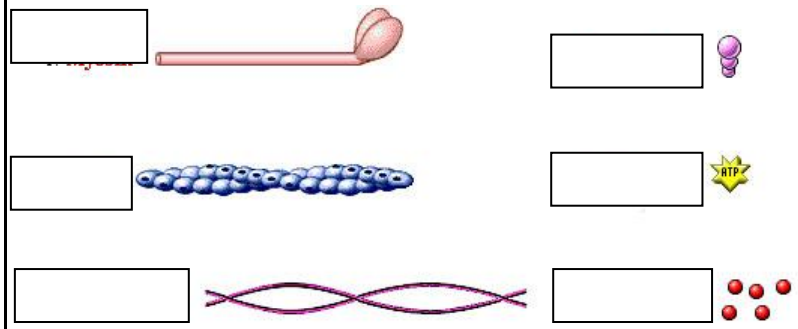


Draw Sarcomere



Work 4.6. Molecular participants

Sign the names of:

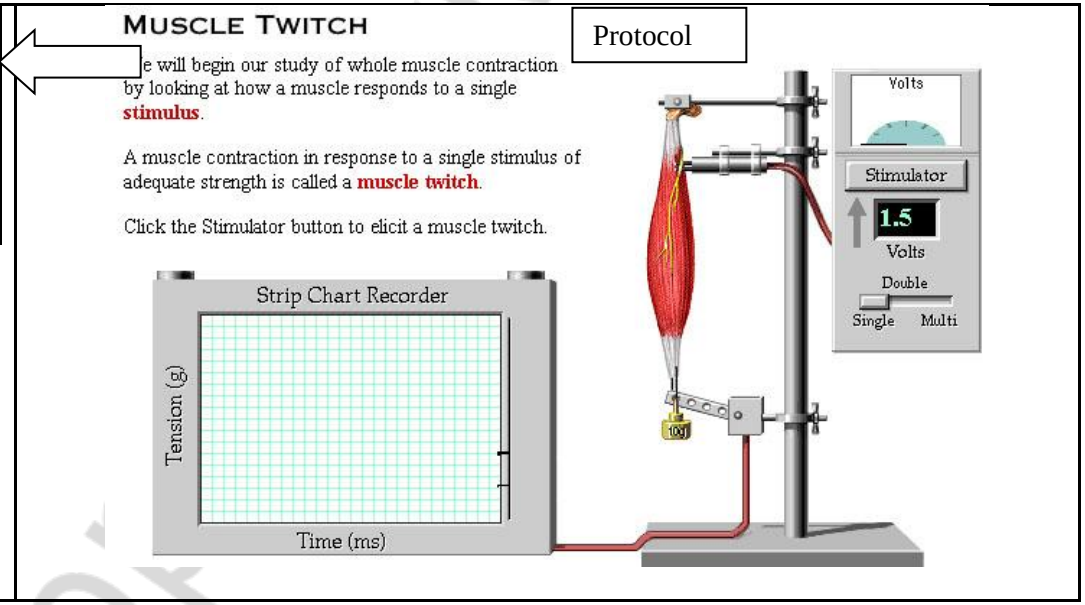


Phase	Explanation

Work 4.7. Mechanism of contraction and relaxation of whole muscle

Open IP – muscular – contraction of whole muscle – read and go p. 4 (muscle twitch) – draw a graph contraction of muscle fiber and mark contraction phase.

1	
2	
3	



Works 4.8. Electromyography (EMG)

Electromyography (EMG) — a method of recording the electrical activity (bio currents) of skeletal muscle.

Abduction of muscle biopotentials by means of surface (cutaneous, overhead) or needle (injected) electrodes.

Advantage total EMG — noninvasive studies and, as a rule, no electro stimulation of muscles and nerves. This method allows you to explore the nature of bio currents muscle at rest and during voluntary contraction, which provided it wide application in physiological and clinical practice.

EMG is a result of the interference of the set of action potentials occurring asynchronously in different motor units.

Accomplishment. The subject is standing record bipolar electrodes on the skin of the biceps of his right hand. Common electrode applied to the skin shoulder not far from the point of registration EMG. Pre skin in the areas of electrodes defatted with alcohol and lubricated paste electrodes, and then recorded and analyzed EMG in different functional states:

a) the rest: arms hanging freely down, the muscles are relaxed;
b) bending arm at the elbow from the position "a";
c) extension of the hand from the "b";

Directions for recording the Protocol:

At present, the quantitative analysis of EMG is performed using special devices that measure the frequency of oscillation, to conduct spectral analysis and value of the total and the average amplitude of impulses. One of common methods of analysis bio currents of muscles is their integration, sum of all amplitudes per unit time. Division of total amplitude by number of impulses calculated their average amplitude. This index is proportional to quantity of muscle force.

At rest, the registered low-amplitude EMG (5–10 mV) associated with the redistribution of muscle tone while maintaining posture. With a weak construction and tension of muscle observe increase of electrical activity, which reaches a maximum at voluntary force (amplitude bio currents can increase up to 3000 mV at a frequency up to 100 Hz).

Materials and equipment: surface silver electrodes (6 pcs.), Conductive paste, 70 % solution of ethanol, cotton-Mar-left swabs, rubber clamps (2 pcs.), A set of loads from 0.5 to 3 kg, Bioamplifier (UBP4-03), recorder (N388), oscillographic indicator (MI-789) and the analyzer myographic (AMG-01).

1. Draw the EMG under different conditions.

PROTOCOL

1. Figures in EMG conditions:

EMG drawing of the biceps under various conditions	rest	Arm bending	Arm extension	fixation

2. Conclusion: The electrical activity of the biceps in the experimental conditions (when bent arm at the elbow, and especially with the additional muscle tension to hold the load) with respect to a standstill much _____ (increases or decreases), evidenced by _____ (increase or decrease) amplitude and frequency of the waves EMG.

Work 4.9. Dynamometry manual and back muscle

Dynamometry is a method of measuring the force of muscle contraction.

Force of muscle — a measure of contractility of the muscles and physical development of the human body. It is estimated the weight of weighting that is able to keep the muscle at maximum excitation, without changing its length. The force of muscle contraction depends on its physiological cross-section, of the original length, speed contraction, and other factors. The force of muscle contraction is measured by dynamometers and is expressed in absolute units (kg or N, and kg/cm^2

Accomplishment. The strength of the hands is determined using a hand dynamometer. Dynamometer hold in a hand parallel to the floor (fig. 4.4).

cross-sectional muscle (ranging from 2 to 10 kg/cm^2)) or in relative units (relative to body weight, expressed in %). Dynamometry (especially manual) is widely used in medicine and physiology of labor and sports activities.

Materials and equipment: hand dynamometer, back dynamometer, medicine scale (fig. 4.1, 4.2, 4.3).

Fig. 4.1. Hand dynamometer (location laboratory room № 131)

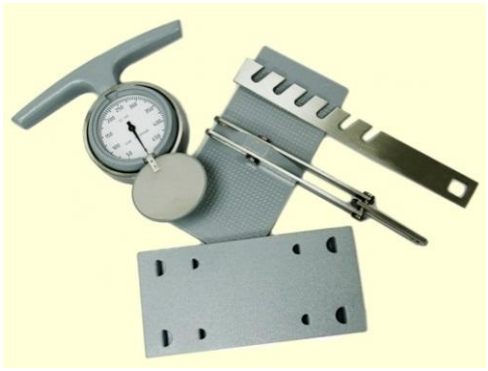


Fig. 4.2. Back dynamometer (location laboratory room № 131)

Fig. 4.3. Medical scale (location laboratory room № 135)

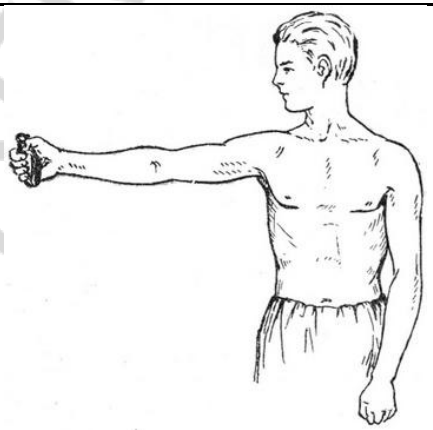


Fig. 4.4

Doing single-stage maximum compression. The measurement was performed three times with each hand. Of three measurements (for each hand) choose the greatest.

Measure body mass (without shoes) on medical scale and minus from it 1 kg (weight of clothes).

Then calculate the hand strength index (HSI) for right and left hands by the formula:

HIS = muscle strength in kg : body mass in kg × 100 %

HIS_____ = _____ : _____ × 100 %

	Satisfactory HSI for men is 55 units, for women — 50 units.

Assessment of relative strength of muscles of hands (HIS) is shown in table 4.1. The strength of hand muscles of the students during last ten years has decrease. In this connection, in table 4.1 standards are hand strength, taking into account the trend of its change in students BSMU (boys and girls) in recent years.

Fig. 4.5

Strength muscles extensor back is determined using a back dynamometer measured three times and choose the highest value of the index.

Then calculate the back strength index (BSI) by the formula:

Table 4.1

Hand strength index of humans

Sex	Level of hand strength index (%)				
	low	below the average	average	above the average	high
Male	less 41	41–50	51–60	61–70	more 70
Female	less 21	21–25	26–30	31–40	more 40

Directions for recording the Protocol:

1. Put down the obtained data into the Protocol

2. Calculate HIS, BIS.

3. Evaluate muscle strength of the tested person and indicate what it depends on.

PROTOCOL

BIS = muscle strength in kg : body mass in kg Satisfactory of back index strength for men — 2, for woman — 1.5.	1. Body mass _____ (kg), sex ____ (м. or f.), muscle strength of the left hand: ____ (kg), muscle strength of the right hand: ____ (kg), strength of back extensors: ____ (kg). 2. Left hand strength index: _____ (%), right hand strength index: ____ (%), back strength index: _____ 3. Conclusion: Level of right hand strength index _____, level of left hand strength index _____ (low, below the average, average, above the average, high). Back index strength _____ (satisfactory, unsatisfactory).

THE LABORATORY WORKS ARE PASSED WITH MARK

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Teacher's signature

Lesson 5. PHYSIOLOGY OF MUSCLE MAXILLOFACIAL REGION. PHYSIOLOGY OF SMOOTH MUSCLES. NOTION THE MYOEPITHELIAL AND GLANDULAR CELLS

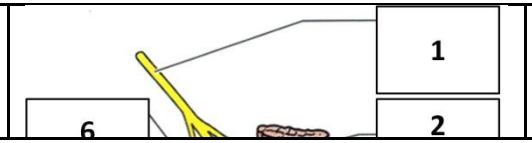
DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions:	Navigation:
1. The concept of components of masticatory system and their functional interaction. Movement of mandible. Physiological occlusion. 2. The muscles of maxillofacial area and their functions. Functionality individual masticatory muscles. 3. Work and force of masticatory muscles. Regulation of contraction of chewing muscles. 4. Periodontal, its stamina to pressure developed chewing muscles. 5. Physiological properties and characteristics of smooth muscle. Smooth muscle tone. 6. Transmission of information from nerve fibers to smooth muscle. Neuroeffector connections of smooth muscle. 7. The concept of myoepithelial cells (salivary and other exocrine glands) and its functions. 8. Glandular epithelium, glands: functions, properties, especially bioelectrogenesis.	6. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 7. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 8. Lecture. 9. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 10. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.

Buzzwords

Masticatory system —		**Work 5.1. Muscles of Mastication**

Physiological occlusion —	Fig. 5.1	Muscle / Function
Centric occlusion —		
Centric relation —		
Intercuspal position (2–4 mm) —		
Electromyography —		
Chewing muscles —		

Work 5.2. Electromyography of masticatory muscles This way the bipolar registration total electrical activity of masticatory muscles using surface plate electrodes. At a chewing food mandible towards the upper commits the movement on six areas due to the complex structure of the temporomandibular joint and the location of the masticatory muscles. Chewing musculature, especially proper chewing and medial pterygoid muscles, refers to power muscles. On Weber these muscles with a cross-section of 1 cm^2 can develop strength in 10 kg, i.e. more than gastrocnemius (5.9 kg/cm^2). Innervation of the masticatory	Meashurens. Person seat in an armchair, degrease the skin in places overlay electrodes. On chewing and digastric muscles face attach on two electrodes, preliminary having greased their toothpaste, common electrode fix on earlobe using clips, and then record the electrical activity of muscles at different functional states of oral cavity organs:

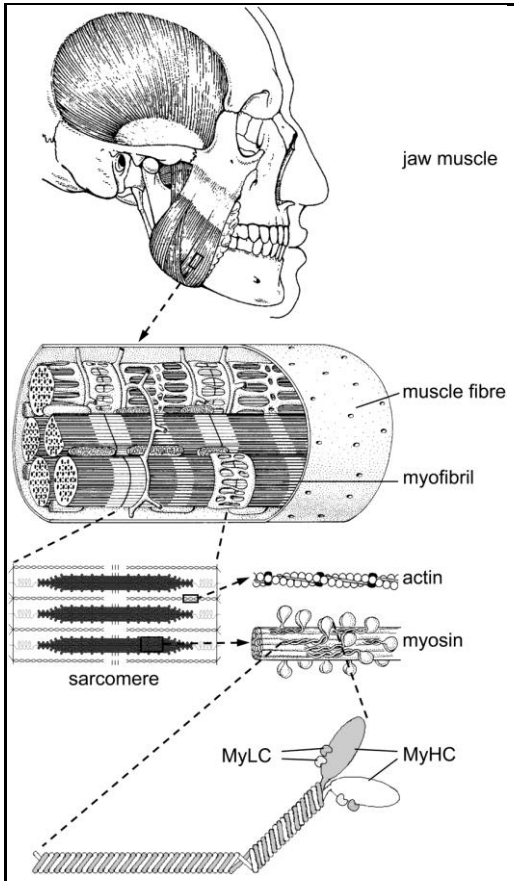


Fig. 5.2

compression teeth.

muscles is performed by the mandibular branch of the trigeminal nerve. Development of pathological processes in the mandible leads to disruption of digestion in oral cavity. Pain reflex reduces airway and electrical activity of the masticatory muscles.

Currently, the quantitative analysis of EMG is performed using special instruments that can measure the frequency of oscillations, conduct secondary analysis and evaluation of the spectral amplitude of the pulses. One of the common methods of analysis of EMG is its integration (definition of the average value of amplitude per unit time, i.e. division of total amplitude for the number of measurements per second, for example). This rate is proportional to the largest developed muscular effort. Alone recorded the electrical activity of the muscles of the low amplitude, which reaches a peak when a random

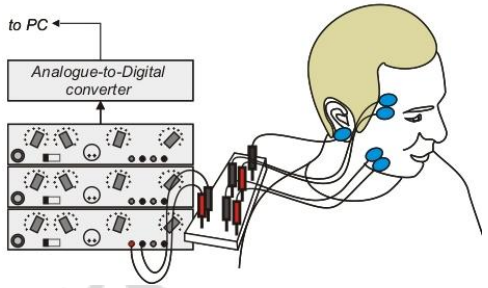


Fig. 5.3

a) rest: the facial muscles are relaxed, open teeth, lower jaw slightly lowered;

b) open mouth wide open jaws;

c) closed mouth: jaws tightly compressed;

d) standard chewing gum;

e) maximum compression jaws through standard chewing gum.

PROTOCOL

1. Draw EMG in different conditions. 2. Determine the frequency of low density and summary in the masseter muscle. 3. In the output to see the results of the study the electrical activity of masticatory muscles in different conditions.

1. EMG quoted in pictures:

Record EMG from muscles	**rest**	**open mouth**	**closed mouth**	**chewing**
masseter				
digastric				

3. Conclusion. Alone the electrical activity of masseter and digastric muscle _____. Open mouth increased electrical activity in _____ muscle. Closed mouth increased electrical activity in _____ muscle. When chewing _____ frequency and amplitude in the investigated muscles.

Work 5.3. Study of mandibular movements. Gothic arch

MANDIBULAR MOVEMENTS

In lateral movements, the condyle appears to rotate with a slight lateral shift in the direction of the movement. This movement is called the **Bennett movement** and may have both immediate and progressive components. By the use of recording equipment such as a pantograph or kinesiograph, it is possible to record mandibular movements in relation to a particular plane of reference (e.g., sagittal, horizontal, or frontal planes). If a point (the incisive point) located between the incisal edges of the two mandibular central incisors is tracked during maximal lateral, protrusive, retrusive, and wide opening movements, such movements are seen to take place within a border or envelope of movements. Functional and parafunctional movements occur within these borders. However, most functional movements such as those associated with mastication occur chiefly around centric. Border movements in the horizontal plane are shown in fig. 5.1.

Figure 5.1. Right mandibular movement with schematic representation of movement at the incisal point in the horizontal plane *(CR, LL, P, RL)* and at the condyle *(W, C, B, P)* made by a pantograph. Teeth are not in occlusion. *CR*, Centric relation; *LL*, left lateral; *P*, protrusive; *RL*, right lateral; *CO*, centric occlusion; *IEC*, incisal edge contact. On the right side, the condyle moves from *C* (centric) to right working *(W)*. On the balancing side, the left condyle moves from *C* along line *B* and makes an angle *BG*, called the *Bennett angle*. *C* to *P*, Straight protrusive movement.

The maximum opening movement is 50 to 60 mm, depending on the age and size of the individual. An arbitrary lower limit for normal of 40 mm may be in error, inasmuch as some individuals may have no difficulty incising a large apple and have no history of TMJ muscle dysfunction. The maximum lateral movement in the absence of TMJ muscle dysfunction, including pain, is about 10 to 12 mm. The maximum protrusive movement is approximately 8 to 11 mm, again depending on the size of the subject and skull morphology.

Materials and equipment: millimeter ruler.

The progress of the work. Open your mouth as widely as possible. Measure the distance between the upper and lower blades with precision of up to 1 mm. Normal — 40–50 mm. Inserted between the cutters 3 middle finger broken hands. Normal at maximum lowering of the mandible primary divisions of 3 medium-sized fingers should go between the upper and lower jaws cutters. Describe your lower jaw “Gothic arc” first without contact, and then in contact with the teeth of the upper jaw. During normal chewing function lower jaw system evenly (right to left or left to right) describes the “Gothic arc” within the scope of its movements without contact and in contact with the teeth of the upper jaw.

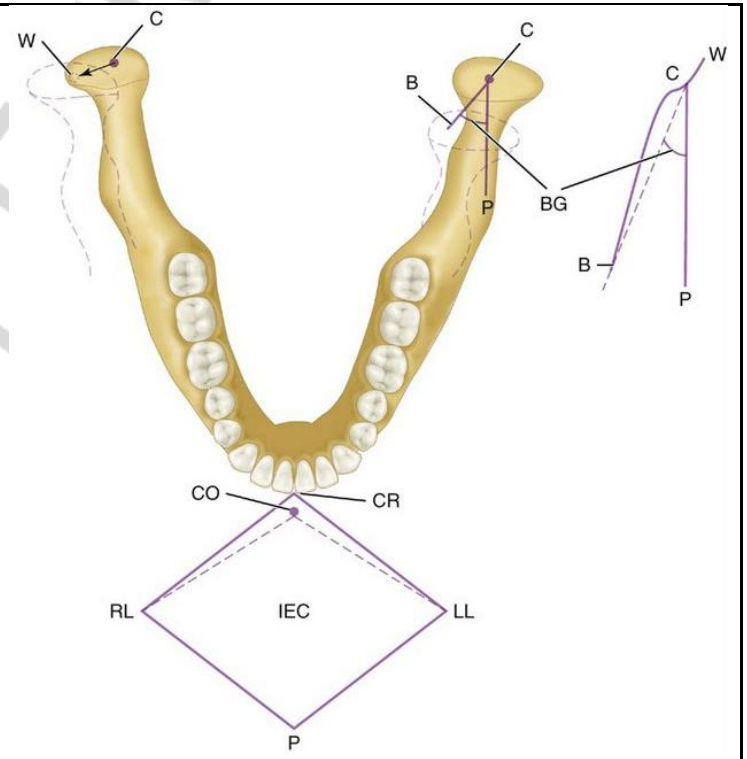


Fig. 5.4

Protocol: 1. Specify the distance between the upper and lower jaws cutters at the maximum opening of the mouth. 2. Visually evaluate when moving the mandible “Gothic arc” is described fully or aborted. 3. Make a conclusion on the extent of the movement of the lower jaw.	**PROTOCOL** 1. The distance between the upper and lower jaws cutters at the maximum opening mouth amounted to _____ mm. 2. When moving the mandible “Gothic arc” _____ described (or aborted). 3. Conclusion. The amounts of mandibular movements have tested _____ (full or limited).

Work 5.4. Occlusion (dentistry)

Occlusion, in a dental context, means simply the contact between teeth. More technically, it is the relationship between the maxillary (upper) and mandibular (lower) teeth when they approach each other, as occurs during chewing or at rest.

Malocclusion is the misalignment of teeth and jaws, or more simply, a “bad bite”. Malocclusion can cause number of health and dental problems. **Static occlusion** refers to contact between teeth when the jaw is closed and stationary, while **dynamic occlusion** refers to occlusal contacts made when the jaw is moving, as with chewing. **Centric occlusion** is the occlusion of opposing teeth when the mandible is in centric relation. Centric occlusion is the first tooth contact and may or may not coincide with maximum intercuspation. It is also referred to as a person's habitual bite, bite of convenience, or intercuspation position (ICP). *Centric relation*, not to be confused with *centric occlusion*, is a relationship between the upper and lower jaw.

MANDIBULAR POSITIONS

Basic jaw positions are usually described as **centric occlusion, intercuspal position, centric relation**, retruded contact position, and rest position of the mandible. *Centric occlusion* or *intercuspal position* is defined as maximum intercuspation of the teeth. Centric relation is a position of the mandible (or path of opening and closing without translation of the condyles) in which the condyles are in their uppermost position in the mandibular fossae and related anteriorly to the distal slope of the articular eminence. Because the mandible appears to rotate around a transverse axis through the condyle in centric relation

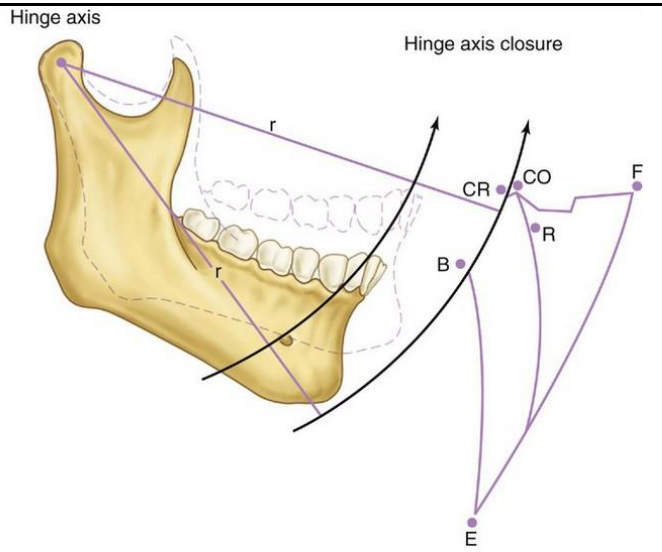


Fig. 5.5

Materials and supplies: pencil (or handle), ruler, caliper.

Mark two points on the skin, one at the tip of the nose, the other on the chin. Sit upright, with a wink of her lips and fully relax your facial muscles. With full relaxation of the facial and

movement, guidance of the jaw by the clinician in opening and closing movements that do not have translation is referred to as **hinge axis movement**. In this position, the condyles are considered to be in the terminal hinge position. Under physiological conditions of the masticatory system, centric relation is used to transfer the position of the mandible (in relation to the maxilla) to an articulator. Figure 5.5 schematic representation of mandibular movement envelope in the sagittal plane. *CR*, Centric relation; *CO*, centric occlusion; *F*, maximum protrusion; *R*, rest position; *E*, maximum opening; *B* to *CR*, opening and closing on hinge axis with no change in radius *(r)*. In the natural dentition, centric occlusion is, in the majority of people, anterior to centric relation contact on the average by approximately 1 mm. Centric occlusion (or **acquired** or **habitual centric** as it is sometimes called) is a tooth-determined position, whereas centric relation is a jaw-to-jaw relation determined by the condyles in the fossae. Closure into occlusion occurs usually anterior to centric relation; however, a coincidence of centric relation contact and the intercuspal position is evident in about 10 % of the population. Rest position is a postural position of the mandible determined largely by neuromuscular activity and to a lesser degree by the viscoelastic properties of the muscles. Thus, because tonicity of muscles may be influenced by the central nervous system as a result of factors such as emotional stress and by local peripheral factors such as a sore tooth, the rest position of the mandible is not consistent. The **interocclusal space** with the mandible in rest position and head in upright position is about 1 to 3 mm at the incisors but has considerable normal variance even up to 8 to 10 mm without evidence of dysfunction.	masticatory muscles of the lower jaw position of **rest position**. Slide gauge measure the distance between the marked points. It is the **centric relation**. Then clench your teeth. Measure the distance between the same points on the skin. It is the **centric occlusion**. The difference between the **rest position** and a **centric occlusion** is **interocclusal space**. 1. Specify values for the **rest position** and **centric occlusion**. 2. Calculate **interocclusal space**. 3. Make a conclusion about **interocclusal space**. **PROTOCOL** 1. **centric relation** _____ мм; **centric occlusion** _____ мм. 2. **intercuspal position** _____ мм. 3. Conclusion. Value of **intercuspal position** _____ _____ (normal, increased, reduced).

Work 5.5. Smooth muscles. Contraction of Smooth Muscle	**Work 5.6. Types of Smooth Muscle**

Mechanism and Characteristics of Contraction:

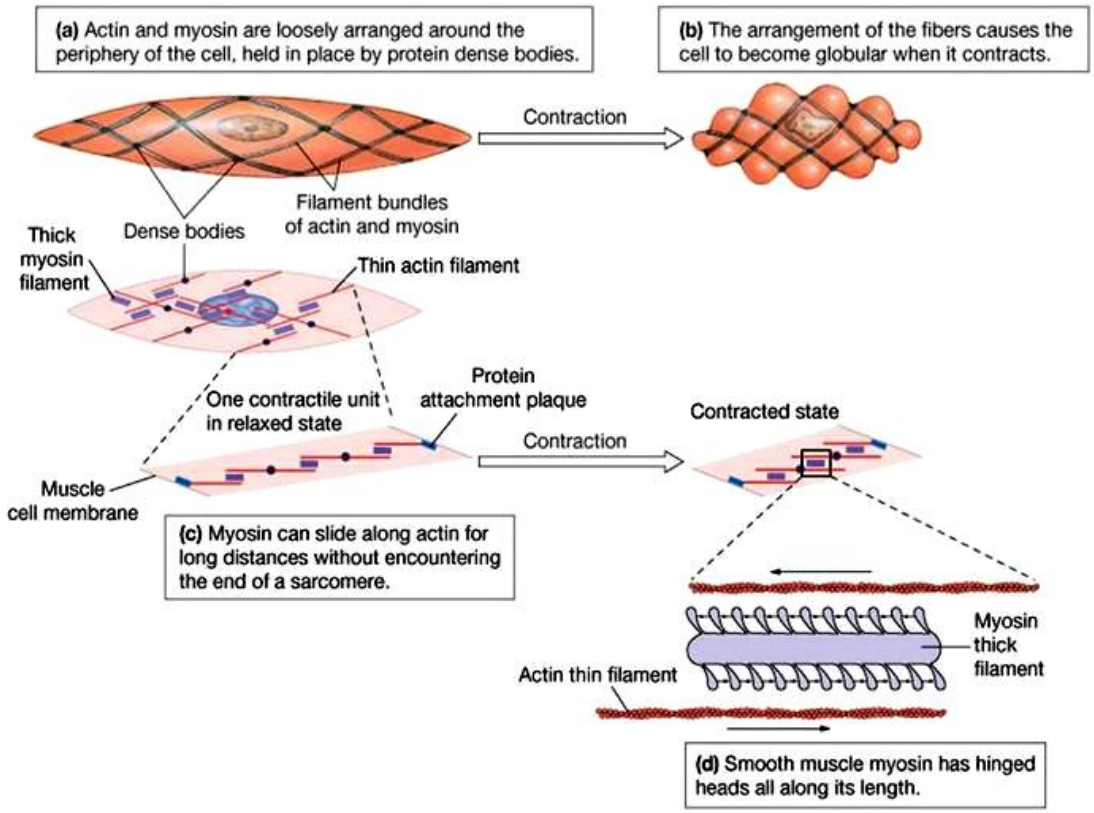


Fig. 5.6

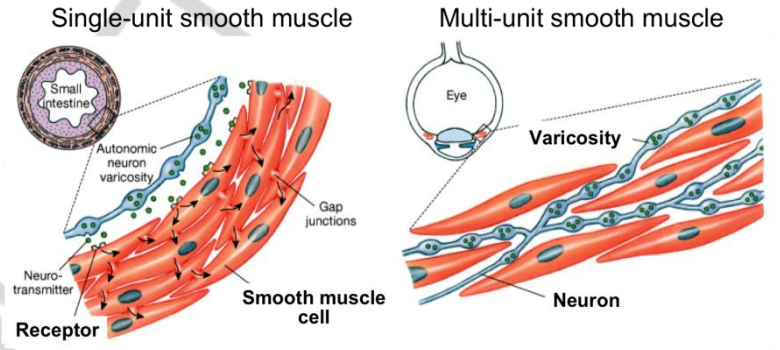


Fig. 5.7

1. _____

2. _____

Work 5.5. Regulation of Contraction

1. _____

2. _____

THE LABORATORY WORKS ARE PASSED WITH MARK

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Teacher's signature

Lesson 6. PHYSIOLOGY OF NERVOUS SYSTEM. PROCESSES OF EXCITATION AND INHIBITION IN CNS. REFLEXES. GENERAL PRINCIPLES OF CNS COORDINATION ACTIVITY

DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions:	Navigation:
1. Nervous system and it role in providing vital activity of the whole organism. Concept of research methods of central nervous system. 2. Neuron: classification, structure, functions, properties, interaction with glial cells. The role of	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) –

glia. Liquor: composition, properties and functions. 3. Excitatory and inhibitory neurotransmitters, receptor mechanisms of their action. 4. The nerve centers: the concept of physiological functions, properties. 5. Reflex principle of functioning of the nervous system. Types of reflexes. The structure of the reflex arc (somatic reflex). Feedback and its value. 6. The basic principles of propagation of excitation in the central nervous system. Excitatory synapses and their mediator mechanisms EPSP. 7. Inhibition of the nervous system, its type (primary and secondary) and role. Concept of the mechanisms of central inhibition. 8. The basic principles of coordination of the CNS: reciprocal inhibition, total final path, dominant, afferentation feedback.	Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.

Buzzwords	Inhibition —
Liquor —	The nerve center — is
Liquor composition —	Feedback — is
Liquor properties —	Reflex —
Liquor functions —	Nerve nuclei —
Work 6.1. Neuron: classification 1 2	Draw

3	

Work 6.2. Excitatory and inhibitory neurotransmitters, receptor mechanisms of their action

Fill in the table:

Excitatory neurotransmitters	Enzyme — NT	Receptor	Mechanisms of its action

Inhibitory neurotransmitters	Enzyme — NT	Receptor	Mechanisms of their action

Work 6.3. Reflex principle of functioning of the nervous system. The structure of reflex arc (somatic, autonomic reflexes)

Draw diagrams of monosynapticc and polysynaptic somatic reflexes.

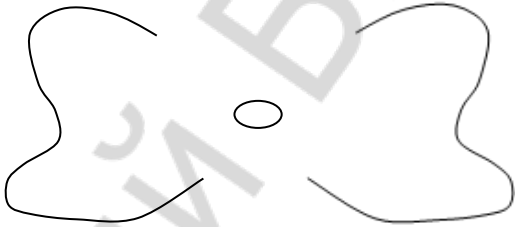
Specify five diagrams links the reflex arc figures and sign numbers in table 6.1

link	The full name, synonym,
1	
2	
3	
4	
5	

Table 6.2

PROTOCOL

Monosynaptic somatic reflex



Polysynaptic somatic reflex

Reflex arch links of a monosynaptic somatic reflex:	Reflex arch links of a polysynaptic somatic reflex:
1. Receptor link is presented by the following receptors of skeletal muscles: 1.1 _____	1. Receptor link is presented by the following receptors of: 1.1 _____; 1.2 _____
2. Afferent link is presented by _____, which are located in _____	2. Afferent link is presented by_____, which are located in _____
3. Inserted link.	3. Inserted link.
4. Efferent link is presented by ___ or ___motor neurons, which are located in _____	4. Efferent link is presented by ___ or ___motor neurons, which are located in _____
5. Working organs. They are _____ and _____ muscular fibers of skeletal muscles.	5. Working organs. They are _____ and _____ muscular fibers of skeletal muscles.
6. Signal transmission rate (of action potential [AP]) is from ____ m/sec to ____ m/sec in efferent fibers, as they have ____ sheath and are referred to the type _____	6. Signal transmission rate (of action potential [AP]) is from ____ m/sec to ____ m/sec in efferent fibers, as they have ____ sheath and are referred to the type _____
7. Neurotransmitter in neuromuscular synapse is _____, that acts upon _____ type of	7. Neurotransmitter in neuromuscular synapse is _____, that acts upon _____ type of

		_____ receptors.	_____ receptors.

Fill in table 6.2.

Work 6.4. Studying of a knee (tendon) reflex

Tendon reflexes participate in regulation of muscle tone and support of the body posture.	The knee-jerk reflex. This is an example of a monosynaptic stretch reflex.

In clinical practice tendon reflexes are studied to determine the functional state of different parts of the reflex arch and for the topic diagnosis of some CNS diseases.

Materials and equipment. A percussion hammer.

Accomplishment. A knee jerk reflex.

The examined person should sit down on the chair and put one his leg on the other. Hit the tendon of a quadriceps muscle of the hip below the patella with the percussion hammer. Observe the extension movement of the leg in the knee joint. Compare the reflex reaction on both extremities.

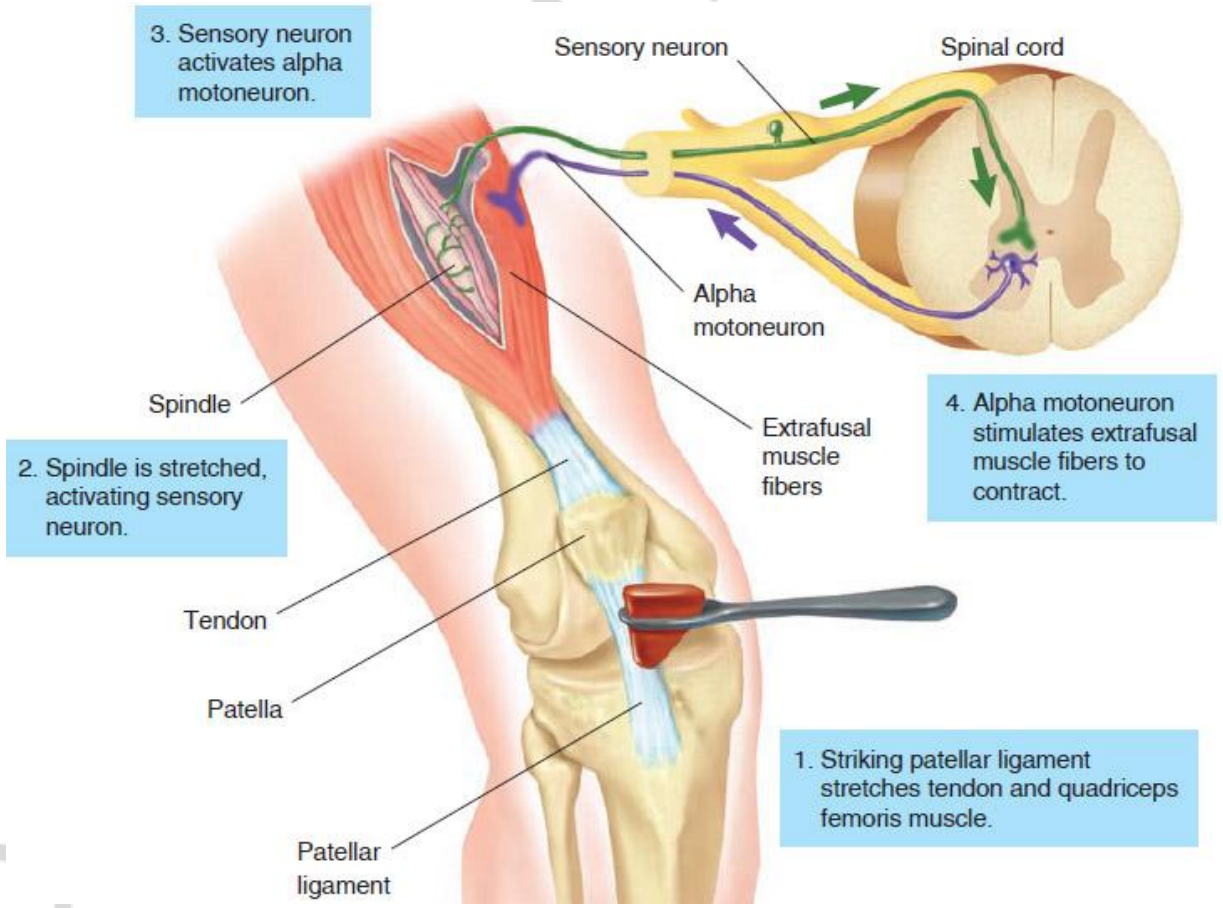
Directions for recording the Protocol:

1. Evaluate the expression degree of the reflexes, their symmetry.

2. Make a conclusion about the state of reflex reaction.

1. Knee and ankle reflex _____ (are marked, absent) on _____ (one or both extremities).

2. Conclusion: the reflex reaction is _____ _____ (in norm, asymmetric, absent)



Work 6.5. The study of reciprocal inhibition of motor reactions by electromyography

Electromyography is a recording method of total bioelectric activity of the muscle. Electromyogram (EMG) reflects the tone state of the muscle at rest and its functional activity during contraction.

An electromyogram is made, when a person is awake and at rest, it having the character of continuous frequent oscillations with a very low amplitude (from 5 to 10 mcV). When the contraction and tension are weak, an increase of electric activity is observed reaching its maximum in voluntary contraction (oscillation amplitude may reach 1000-2000 mcV, oscillation frequency – 100 Hz). Electromyographic studies are used in clinical practice, physiology of labor and sport.

Materials and equipment: superficial (cutaneous) electrodes, an electromyograph or an electroencephalograph for EMG recording; a set of weighs from 0.5 to 2 kg.

Directions for recording the Protocol:

1. The result of the experiment: compare the character of EMG under various conditions (amplitude and frequency of impulses) visually. Draw an EMG recorded during the experiment.

2. Make a conclusion about the state of the motor center activity that innervates the shoulder biceps under the

Accomplishment. Electrodes (bipolar) are applied to the arm skin of the examined person in the region of biceps and they are attached to the electromyograph.

The EMG is recorded under various conditions: a) at rest; b) the arm is bent at the elbow; c) the arm is extended; d) the biceps are at tension produced by increasing the load.

In the last case the examined person is standing with his hands down free. Then the examined person bends his elbow so that the forearm is in a horizontal position. Put weighs on the palm of the examined increasing their weight, e.g. 0.5, 1 and 2 kg and asking the examined to keep the forearm horizontally.

PROTOCOL

1. EMG drawing of the biceps under various conditions

EMG recording from the muscle	Rest	Arm bending	Arm extension	Under tension (holding the load)
biceps				
triceps				

experiment.

Accomplishment. Electrodes (bipolar) are applied to the skin arm of the examined in the region of biceps and triceps, they being attached to the electromyograph.

EMG is recorded under various conditions: a) at rest; b) the arm is bent at the elbow; c) the arm is extended; d) at synergic tension of the arm biceps and triceps.

Directions for recording the Protocol:

1. Draw EMG recorded under various conditions.

2. Make a conclusion about the activity state of the motor centers innervating the biceps and triceps of the shoulder under the experiment.

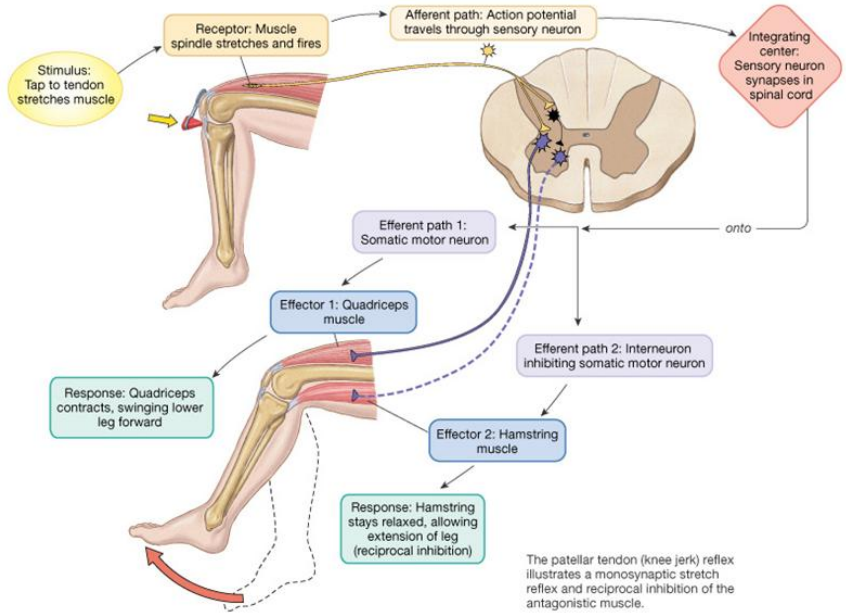
2. Conclusion: electric activity of the shoulder biceps and that of nerve centers innervating it, under experiment (while bending the arm at the elbow and particularly in additional tension of the muscle for holding the weighs) versus the state of rest is considerably

_____

(increased or reduced), it being testified by

_____

(increase or decrease of amplitude and frequency of EMG waves).



Work 6.6. The basic principles of coordination of the CNS

Enter the basic principles of coordination	Explain
1.	
2.	
3.	
4.	

Inhibition of the nervous system, its type (primary and secondary).

Fill in the table: using a lecture or computer class

Work 6.7. Concept of the mechanisms of central inhibition (using lecture or computer class)

Enter a name of the mechanisms of central inhibition	Draw a diagram and explain the
1.	
2.	

THE LABORATORY WORKS ARE PASSED WITH MARK

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Teacher's signature

Lesson 7. COLLOQUIUM "EXCITABLE TISSUES"

Main questions:	Navigation:
1. Physiology as a scientific basis of medicine. The value of Normal Physiology to the dentist. 2. General properties of excitable tissues. Excitation and forms of its manifestation. Indicators (parameters) excitability. Electroodontometry, its use in dentistry. 3. Modern concept of the structure and functions of membranes. Transport of substances across the cell membrane. 4. The concept of cellular receptors and its functions. 5. Biopotentials, their types. Membrane resting potential, its origin. The concept of galvanism. 6. Modern concept of the mechanisms and the developmental phases of the action potential. Changes in excitability in the excitation process. 7. The laws of the response of excitable tissues to the action of irritants. Chronaximetry, its use to study the excitability of the muscles and nerves. 8. Neuron: structure, function, properties, interaction with glial cells. The role of glial cell. 9. Sensory receptors: definition, classification, role, basic properties. Receptor and generator potentials. The concept of principles of information coding in sensory receptors. 10. Nerve fibers: structure, classification, function. The mechanism and laws of the conduction of excitation along the nerve fiber. Physiological basis of conductive anesthesia in dental practice. 11. Synapse: structure, classification, general properties, physiological role. Current views on the mechanisms of excitation transfer in the synapses. 12. Physiological properties of skeletal muscles and their functions. 13. Types of muscle fibers. Motor units and their features in different muscles. 14. Neuromuscular synapse: mechanisms of signal transmission. 15. Structural and functional characteristics of muscle fiber.	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of

16. Mechanism of contraction and relaxation of a single muscle fiber and whole muscle. 17. A single contraction and its phase. Types and contraction regimen of skeletal muscle. Tetanic contraction and it types. 18. Force and work of muscle. Fatigue, physiological properties. 19. Dynamometry of a hand and back muscles. 20. The concept of components of masticatory system and their functional interaction. Movement of mandible. Physiological occlusion. 21. Physiological properties and characteristics of smooth muscle. Smooth muscle tone. 22. Transmission of information from nerve fibers to smooth muscle. Neuro effector connections of smooth muscle. 23. Central nervous system (CNS) and its role vital activity of the entire organism and its relationship with the environment. Nerve centers: the physiological concept, functions, properties. 24. Reflex principle of the nervous system functioning. Types of reflexes. The structure of the reflex arch (somatic, autonomic reflexes). Feedback and its importance. 25. Basic principles of propagation of excitation in central nervous system. Excitatory synapses and neurotransmitter mechanisms, EPP (excitatory postsynaptic potential). 26. Inhibition in the nervous system, its types (primary and secondary) and role. Current views on the mechanisms of central inhibition. 27. The main principles of coordination in CNS: principle of reciprocal inhibition, the final common pathway principle (C. Sherrington), dominance principle (A. A. Uhtomsky), principle of feedback afferentation (P. K. Anokhin). Excitatory and inhibitory neurotransmitters, its receptor mechanisms.	Medical Physiology, 12th ed. WB Saunders, 2005. **Computer test "Lesson 07" or in writing** Тестирование → Контрольные тесты → Lesson 07

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SECTION “MECHANISMS OF FUNCTIONS REGULATION”

Lesson 8. NERVOUS REGULATION OF SOMATIC FUNCTIONS

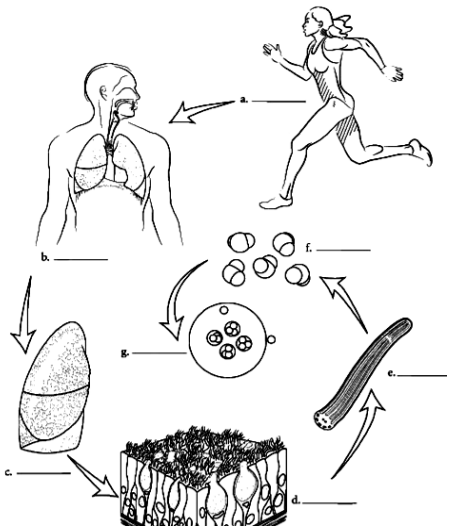
DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions:	Navigation:
1. The concept of physiological function and its regulation. Levels of regulation. The types of regulation. 2. Nervous and humoral mechanisms of regulation of functions, their comparative characteristics. 3. The structure and function of the spinal cord. Spinal reflexes. 4. The concept of the spinal level regulation of muscle tone. The consequences of spinal cord injury. 5. Functions of the medulla oblongata, pons and midbrain. Vital centers of the brain stem and their functions. Reticular formation, function. 6. The functions of the cerebellum. The consequences of damage to the cerebellum. 7. Diencephalon. The functions of the thalamus and hypothalamus. 8. The modern concept of localization of function in the cerebral cortex of the brain. Functional asymmetry of the cortex. 9. Pore brain structures. The concept of the basal ganglia, limbic system and their functions.	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.

Work 8.1. Levels of regulation	Buzzwords	



function	reflex
regulation	muscle tone
Levels of regulation	
The types of regulation	

Answer Key: a. Organism (human), b. Organ system (respiratory system) c. Organ (lung), d. Tissue (epithelium), e. Organelle (cilia), f. Molecule, g. Atom, h. cells

Work 8.2. Mechanisms of regulation

Mechanisms of regulation of functions

– metabolites – electrolytes – neurohormones	– reflexes somatic – reflexes autonomic	– automaticity – contraction after stretching

Answer Key: humoral, nerve-, myogenic.

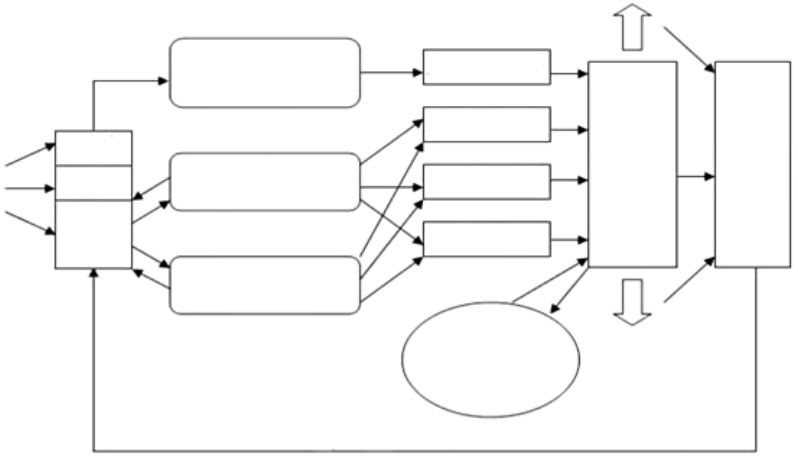
Work 8.3. Mechanisms of regulation of functions, their comparative characteristics

Fill in the table

Indicator	Neural mechanism	Humoral mechanism

Work 8.4. The general scheme of the functional system of regulation of functions "on a deviation". Complete scheme

Regulation accuracy		
Methods of communication		
Speed regulation		
Duration of the regulation		



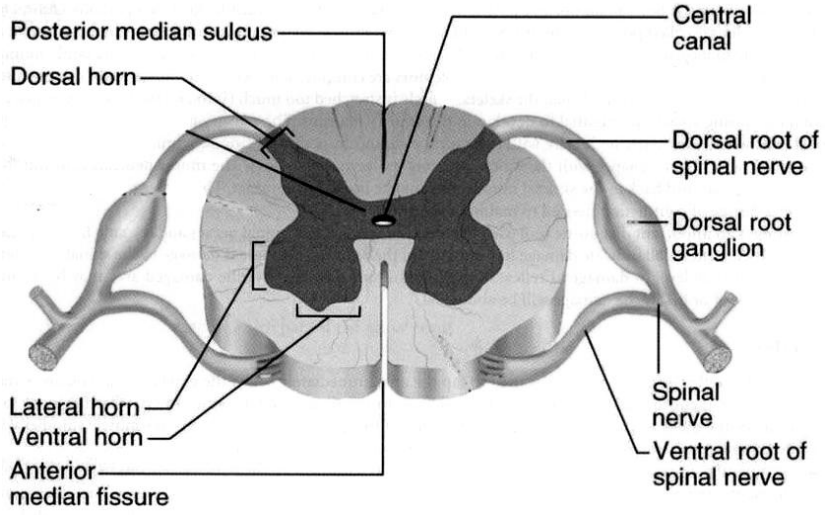
Work 8.5. The structure and function of the spinal cord. Spinal reflexes

The spinal cord is the simplest part of the central nervous system (CNS).

A. The spinal cord extends from the foramen magnum approximately to the level of the body of the L2 vertebra in adults.

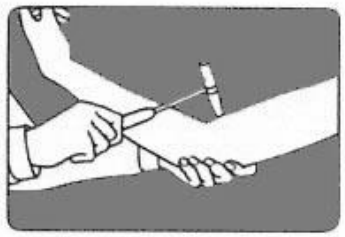
B. The spinal cord contains an inner core of gray matter that is completely surrounded by white matter (fig. 8.1).

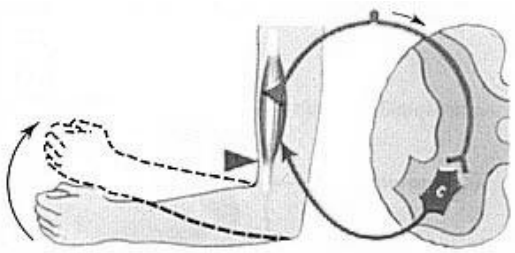
1. The gray matter is divided into a dorsal horn and a ventral horn, which are separated by an intermediate zone; the gray matter of the spinal cord has a "butterfly" shape in transverse sections.

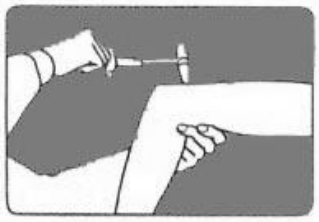


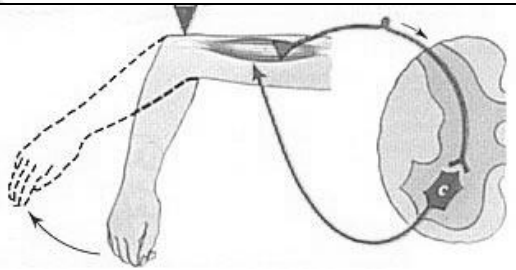
Work 8.6. Understanding the Stretch Reflex (or Myotatic Reflex)

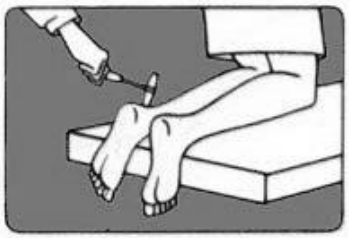
Write the name of reflex and segment circuit in the spinal cord:

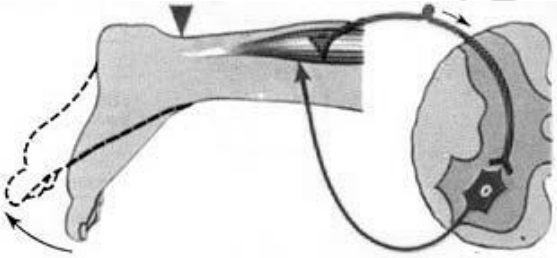


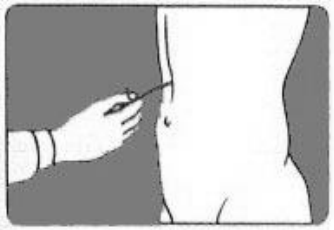


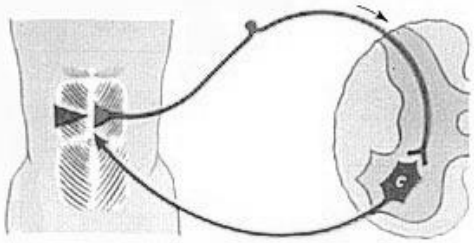






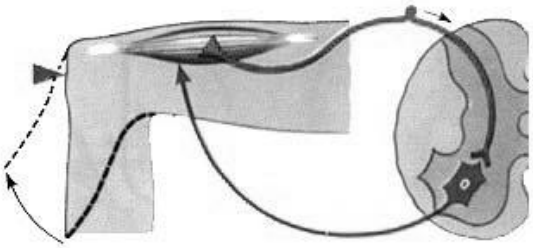






1. Reflexes _____
(are marked, absent, asymmetric)

2. Conclusion: the state of reflex reactions is _____



(in norm, impaired)

Work 8.7. Study of cerebellum control of motor activity

Efferent signals from the cerebellum regulate neuronal activity of vestibular (Deiters') and red nuclei, the thalamus nuclei, and through them the activity of peripheral (α- and γ-motor neurons of the spinal cord and nuclei of cranial nerves) and central (cortical) motor neurons. Through these pathways efferent signals from the cerebellum regulate contractions muscle strength ensuring the ability for prolonged tonic muscle contraction, relate the volume of a voluntary movement with the distance to the aim of this movement, quickly pass from flexing to extending and vice versa. The cerebellum provides the synergy of contractions in complex movements. In functional impairment of

Materials and equipment: a glass, a book.

Accomplishment. The examined performs actions and exercises indicated in table 12.

Table 12

Cerebellum control of skeletal muscles motor activity

Type of experiment	Technique
Romberg's pose	The examined should stand with feet close and hands

the human cerebellum the impairment of motor functions is noted that is manifested by: decrease of muscle contraction force (asthenia; the ability loss of prolonged muscle contraction that makes standing, sitting difficult (astasia); involuntary change of muscular tone (dystony); finger trembling at rest (tremor); movement impairment revealed as excessive or insufficient movement (dysmetry); coordination impairment (ataxy) that is manifested in "drunk" (swaying) gait and etc.; impairment of organization of speech motor actions (dysartria); swinging rhythmic twitching of eye-balls (nystagmus); impairment of interchanging opposite movements (adiodochokinesis), etc.

Directions for recording the protocol:

1. Point out, if the examined succeeded correctly (without faults) to perform the offered tests.

2. Make a conclusion about the quality of the cerebellum control of motor activity.

1. The tests for ataxia in the examined were _____ (+ or –), as in Romberg's pose he _____ (kept or didn't) balance, his gait was _____ (normal or impaired); tests for dysmetry and tremor were _____ (+ or –); dysarthry _____ (was or wasn't) revealed.

2. Conclusion. The cerebellum control of motor activity in the examined was _____ (in norm or impaired)

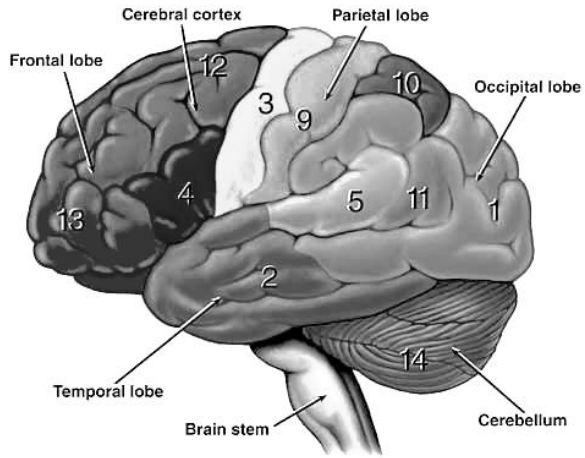
(coordination assessment of movements or abasia test	stretched forward, at first with open and then with closed eyes. In norm the person keeps the balance in Romberg's pose (i.e. the abasia test is negative)
Gait (assessment of movements coordination or ataxia test)	Encourage the examined to walk about the room forward and backward with open and closed eyes. In norm the gate of a healthy person is usual, without swaying to the sides and broad placing his feet (i.e. the ataxia test is negative)
Dysmetria test	The examined should take from the table and put back some object (a book, a glass). In norm the person puts the subject to the same place with an error ±2 cm (i.e. the dysmetry test is negative)
Speech (dysarthria test)	The examined should repeat some difficult for pronunciation words (earthquake, aircraft building, administrating etc.). Note, if there is delay, spreading or pushlike speech
Finger-nose test (for dysmetry and tremor)	The examined should point with his index finger (at first of the left and then of the right hand) to the tip of his nose with open and closed eyes. In norm the person touches his nose tip (with accuracy of ±1 cm) without tremor of fingers (i.e. the test for dysmetry and tremor is negative). When the cerebellum is impaired he misses the nose tip and his fingers tremble while reaching the nose

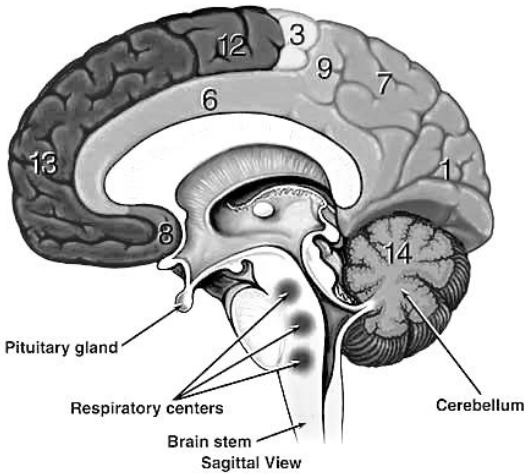
Functional Areas of the Cerebral Cortex

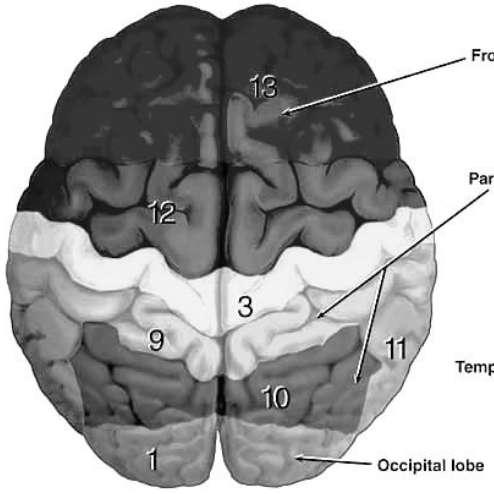
1. **Visual Area:**
   Sight
   Image recognition
   Image perception
2. **Association Area**
   Short-term memory
   Equilibrium
   Emotion
3. **Motor Function Area**
   Initiation of voluntary muscles
4. **Broca's Area**
   Muscles of speech
5. **Auditory Area**
   Hearing
6. **Emotional Area**
   Pain
   Hunger
   "Fight or flight" response
7. **Sensory Association Area**
8. **Olfactory Area**
   Smelling
9. **Sensory Area**
   Sensation from muscles and skin
10. **Somatosensory Association Area**
    Evaluation of weight, texture, temperature, etc. for object recognition
11. **Wernicke's Area**
    Written and spoken language comprehension
12. **Motor Function Area**
    Eye movement and orientation
13. **Higher Mental Functions**
    Concentration
    Planning
    Judgment
    Emotional expression
    Creativity
    Inhibition

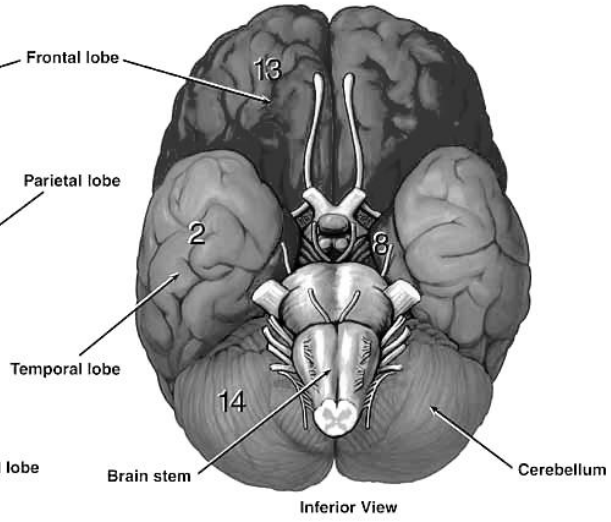
Functional Areas of the Cerebellum

14. **Motor Functions**
    Coordination of movement
    Balance and equilibrium
    Posture









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Lesson 9. NERVOUS REGULATION OF AUTONOMIC FUNCTIONS (PHYSIOLOGY AUTONOMIC NERVOUS SYSTEM)

DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions: 1. The role and functions of the autonomous (vegetative) nervous system (ANS). 2. Comparative characteristics of somatic and autonomic nervous system (sensory receptors, afferent, efferent, and intercalary divisions, effector organs). 3. Differences neuroeffector compounds of smooth muscle and neuromuscular synapses of skeletal muscle. 4. Comparative characteristics of the structure and neurochemical mechanisms of the sympathetic and parasympathetic divisions of the ANS, as well as their influence on the effector organs. 5. The concept of metasympathetic department ANS. 6. Objective and subjective indicators of the functional state of the various divisions of the ANS. 7. The concept of the principles of correction of autonomic functions (for example, salivation) by affecting the neurotransmitter-receptor mechanisms.	Navigation: 1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.
Sensory receptors —	
Afferent —	
Efferent —	

Effector organs —	
ANS —	

Work 9.1. Description of spinal reflexes of the sympathetic and somatic nervous system	
PROTOCOL **Somatic reflex diagram**	**Autonomous (sympathetic) reflex diagram**
Reflex arch links of a somatic reflex:	**Reflex arch links of a vegetative (sympathetic) reflex:**
1. Receptor link is presented by the following receptors of skeletal muscles: 1.1 _____; 1.2 _____	1. Receptor link is presented mainly by _____ receptors.
2. Afferent link is presented by_____, which are located in _____	2. Afferent link is presented by _____, which are located in_____
3. Inserted link.	3. Inserted link.
4. Efferent link is presented by _____ or _____ motor neurons, which are located in _____	4. Efferent link is presented by 2 neurons, which are located in _____ _____ and in _____ accordingly.
5. Working organs. They are _____ and _____ muscular fibers of skeletal muscles.	5. Working organs. They are _____ muscular cells; cardiomyocytes; gland cells, myoepitheliocytes.

6. Signal transmission rate (of action potential [AP]) is from ____ m/sec to ____ m/sec in efferent fibers, as they have _____ sheath and are referred to the type _____	6. Signal transmission rate (AP) is from _____ m/sec to _____ v/sec in efferent postganglionic fibers, as they do not have _____ sheath and are referred to the type _____
7. Neurotransmitter in neuromuscular synapse is _____, that acts upon _____ type of _____ receptors.	7. Main neurotransmitter in neuroeffector connection is_____, that acts upon _____ and _____ types of _____ receptors.

Work 9.2. Clinostatic reflex	**Work 9.3. Orthostatic reflex**
Reflex study allows determining the functional state of parasympathetic and sympathetic centers regulating the heart function. When a man passes from standing to lying position, the heart beat rate decreases that is normally manifested by pulse retardation by 4–6 beats/min. Pulse retardation over 6 beats/min evidences the tone increase of the parasympathetic department of ANS that regulates the heart functioning. The absence of reaction or its paradox character — pulse acceleration — evidences tone dominance of the sympathetic department of ANS that regulates heart functioning. **Materials and equipment**: a couch, a stop-watch. **Accomplishment**. At first the pulse of the examined is counted, when he is standing. Then, in 10–25 seconds after the examined lay down, the pulse is counted again. **Directions for recording the Protocol**: 1. Put down the pulse rate in standing position and then in lying position, count the pulse difference. 2. Make a conclusion of the tone of the sympathetic and parasympathetic departments of ANS regulating the heart functioning of the examined. **PROTOCOL** Pulse rate in standing is _____ beats/min. Pulse rate in lying _____ beats/min. Pulse difference [PR lying - PR standing] _____ beats/min. Conclusion:	Reflex study allows determining the functional state of sympathetic and parasympathetic centers regulating the heart functioning. When a man passes from lying to standing position, the heart beat rate increases normally by 6–24 beats /min. Pulse acceleration over 24 beats/min evidences the tone dominance of the sympathetic department of ANS, under 6 beats/min — that of the parasympathetic department of ANS. **Materials and equipment**: a coach, a stop-watch. **Accomplishment**. The pulse of the examined is counted when he is lying (the man is lying quietly for 4–6 min before the count starts). Then he is asked to stand up and his pulse is counted in 15–25 sec again. **Directions for recording the Protocol**: 1. Put down the pulse rate (PR) in lying and standing position, calculate the pulse difference. 2. Make a conclusion of the tone of the sympathetic and parasympathetic departments of ANS regulating the heart functioning in the examined. **PROTOCOL** Pulse rate lying _____ beats/min. Pulse rate standing_____ beats/min. PR difference [PR standing – PR lying] _____ beats/min. Conclusion:

Work 9.4. Hering's respiratory-cardiac reflex	
Reflex study allows determining the functional state (tone) of the parasympathetic center regulating the heart functioning. When respiration is held on after a deep inhalation, the tone of nuclei n. vagi and heart beat	**Directions for recording the Protocol**: 1. Put down the pulse rate (PR) before the breath is held on and when breath is held on during inhalation. Calculate the pulse difference.

rate decreases normally by 4–6 beats/min. Pulse retardation by 8–10 beats/min and over evidences the tone increase of the ANS parasympathetic department , under 4 beats/min — tone decrease.

Materials and equipment: a stop-watch.

Accomplishment. The pulse is counted when the examined is sitting, then he is asked to make a deep inhalation and hold on the breath and the pulse is counted again.

2. Make a conclusion about the tone of the ANS parasympathetic department regulating the heart function in the examined.

PROTOCOL

Pulse rate before breath holding (BH) _____ beats/min.

Pulse rate (PR) during BH on inhalation _____ beats/min.

Pulse difference (PR on inhalation - PR before BH) _____ beats/min.

Conclusion:

Work 9.5. Assessment of neuro-mediator mechanisms of the effect of sympathetic and parasympathetic departments of ANS on the heart functioning (demonstrative computer work)

Accomplishment. The program "**Physiol** 2" is used; it allows performing various experiments on rats.

Directions for recording the Protocol:

1. Fill in the table. Abbreviations: HR — Heart Rate, BP_{syst} — Systolic Blood Pressure, BP_{diast} — Diastolic Blood Pressure, BP_{mean} — Mean Hemodynamic Blood Pressure.
2. Than choose Help → Preparation.
3. Help → Drugs
4. Drugs — injected or stimulation
5. New Rat
6. Make a conclusion about the character of the effect of the ANS sympathetic and parasympathetic departments on the force and heart beat rate as well as about neurotransmitter mechanisms realizing these effects.

PROTOCOL

Effects of the heart		HR	BP_{sys}	BP_{diast}	BP_{mean}
1	New Rat — Initial data (baseline)	161	98	53	66
2	Stimulation Symp. Nerves to heart T_1	210	130	95	106
3	New Rat + Injection of noradrenaline, 5 μg/kg	212	130	95	133
4	New Rat + Phentolamine(α-adrenoblocker), 100 mg/kg	161	98	53	66
5	New Rat + Phentolamine (α-adrenoblocker), 100 mg/kg + Stimulation Symp. Nerves to heart T_1	210	114	98	106
6	New Rat + Propranolol (β-adrenoblocker), 100 mg/kg	161	98	53	66
7	New Rat + Propranolol (β-adrenoblocker), 100 mg/kg + Stimulation Symp. Nerves to heart T_1	170	99	65	75
8	New Rat + Stimulation Vagus Nerve to heart	112	42	30	40
9	New Rat + injection of acetylcholine, 5 μg/kg	115	31	19	28
10	New Rat + Atropine (M-cholineblocker), 10.0 mg/kg	161	98	53	66
11	New Rat + Atropine (M-cholineblocker), 10.0 mg/kg + StimulationVagus Nerve to heart	161	98	53	66

Conclusion: _____

	_____

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Lesson 10. HUMORAL REGULATION OF FUNCTIONS.

PHYSIOLOGY OF THE ENDOCRINE SYSTEM. PART № 1

DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions:	Navigation:
1. The concept of the endocrine system. Endocrine role in the regulation of physiological functions.	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students.
2. The concept of an autocrine, paracrine, endocrine and neuroendocrine. Hormones, their chemical and functional classification, mechanisms of action. Second messengers.	2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson.
3. Methods of assessment of the endocrine system in humans.	3. Lecture.
4. The pituitary gland, its connection with the hypothalamus. Pituitary and hypothalamus, their role in the regulation of endocrine and not endocrine organs.	4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB

5. The concept of endocrine function of the pineal gland (melatonin). 6. Gonads. Male and female sex hormones and their physiological role.	Saunders, 2005.
Endocrine system —	Second messengers —
Autocrine —	Pituitary gland —
Paracrine —	
Endocrine —	
Neuroendocrine —	
Hormon —	
Hormones, their chemical classification	Hormones, their functional classification

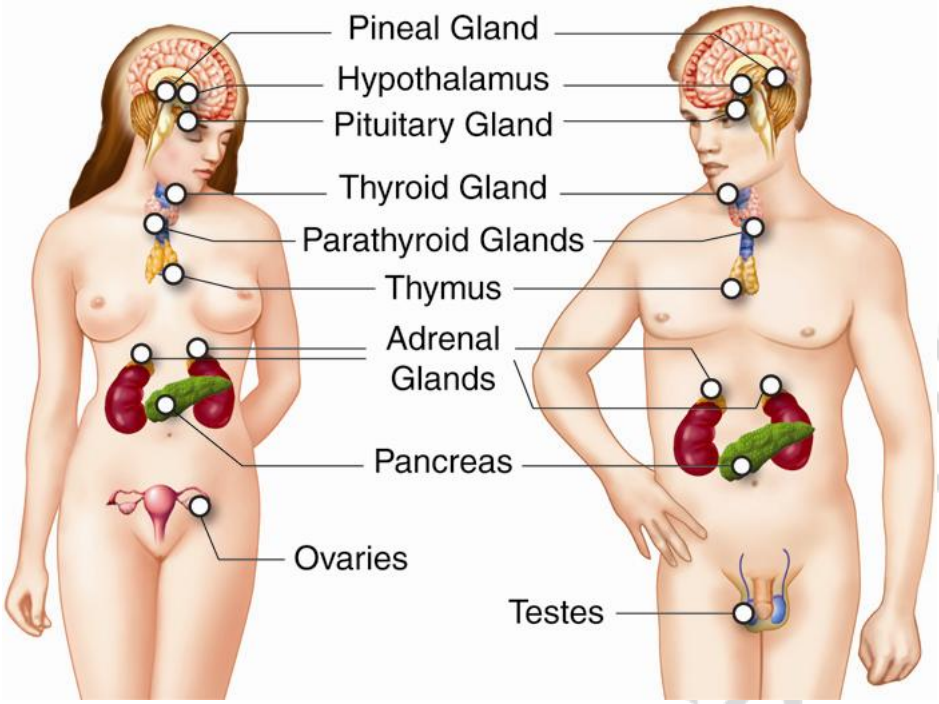
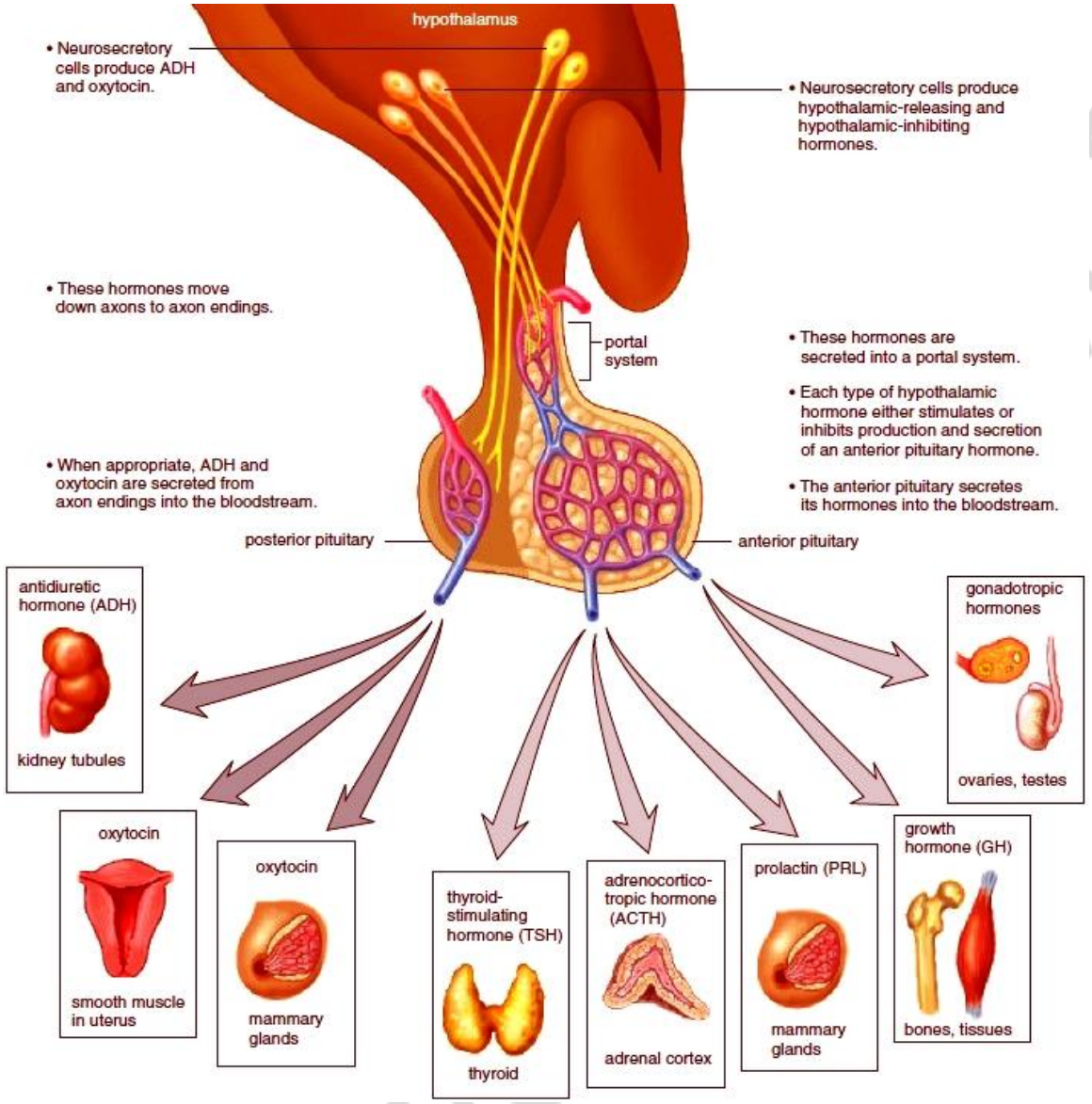


Fig. 10.1

Work 10.1

Write these glands that produce hormones and their main functions

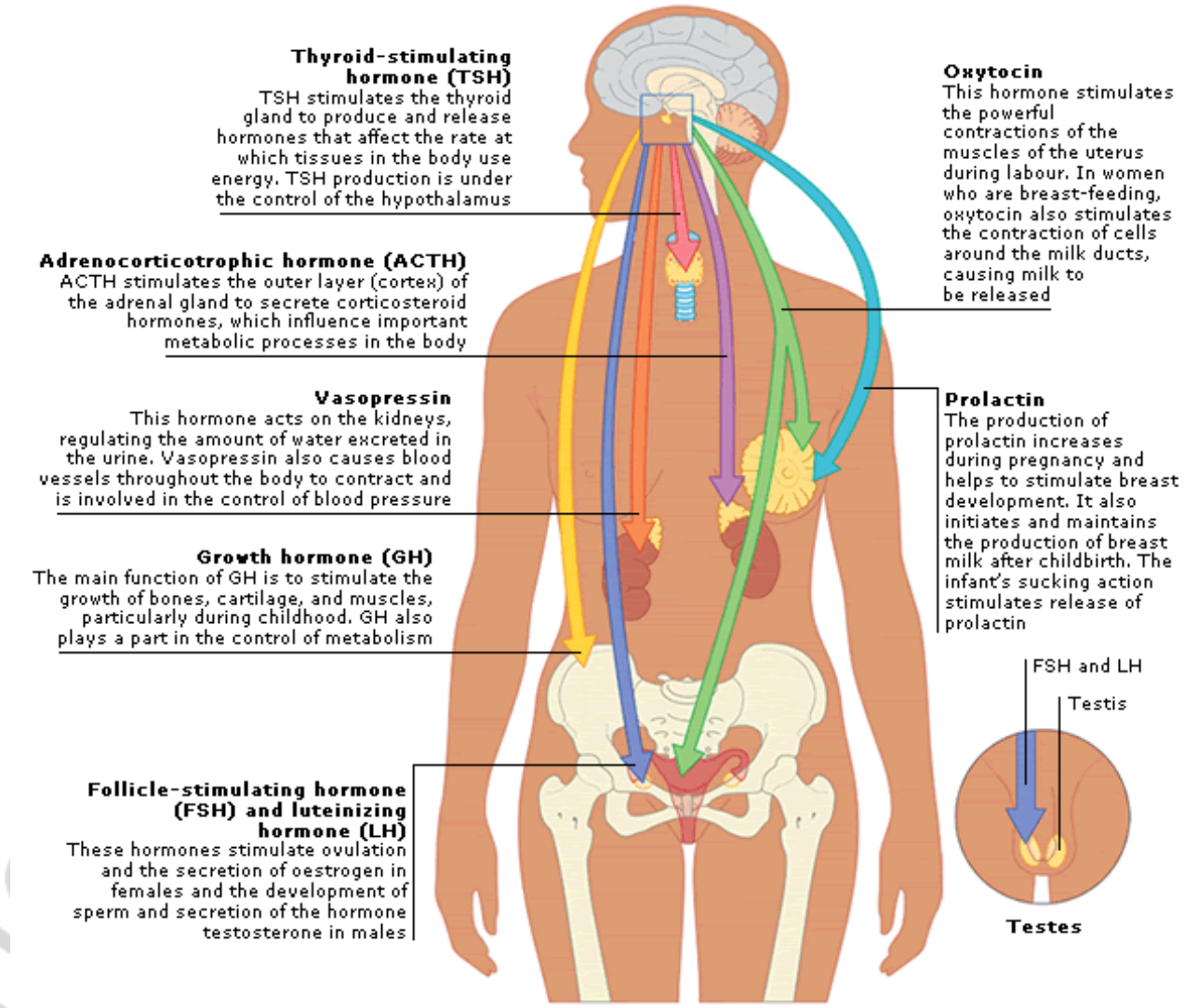
Gland	Hormone	Mean function



Fill up the table:

Hormone	Function	Hyper	Hypo

Gonads. Male and female sex hormones and their physiological role.	Additional information


Thyroid-stimulating hormone (TSH)
TSH stimulates the thyroid gland to produce and release hormones that affect the rate at which tissues in the body use energy. TSH production is under the control of the hypothalamus
Adrenocorticotrophic hormone (ACTH)
ACTH stimulates the outer layer (cortex) of the adrenal gland to secrete corticosteroid hormones, which influence important metabolic processes in the body
Vasopressin
This hormone acts on the kidneys, regulating the amount of water excreted in the urine. Vasopressin also causes blood vessels throughout the body to contract and is involved in the control of blood pressure
Growth hormone (GH)
The main function of GH is to stimulate the growth of bones, cartilage, and muscles, particularly during childhood. GH also plays a part in the control of metabolism
Follicle-stimulating hormone (FSH) and luteinizing hormone (LH)
These hormones stimulate ovulation and the secretion of oestrogen in females and the development of sperm and secretion of the hormone testosterone in males
Oxytocin
This hormone stimulates the powerful contractions of the muscles of the uterus during labour. In women who are breast-feeding, oxytocin also stimulates the contraction of cells around the milk ducts, causing milk to be released
Prolactin
The production of prolactin increases during pregnancy and helps to stimulate breast development. It also initiates and maintains the production of breast milk after childbirth. The infant's sucking action stimulates release of prolactin
FSH and LH
Testis
Testes

Work 10.2. Human height evaluation

Human height is one of basic development characteristics. Linear height is an irregular process. Maximum growth rate is noted in newborns and infants and then it considerably decreases. Some increase of growth rate is noted in girls from 9 to 14 years and in boys from 11 to 16 years, then it decreases again. By 16 years in girls and by 18 years in boys the body growth is practically completed and in norm it does not exceed 1 cm/year. Complete ossification occurs by 20–23 years in a female organism and by 21–25 years in a male organism. The height of an adult of 130–200 cm in males and 120–190 cm in females is considered normal. Men smaller than 130 cm and women smaller than 120 cm are dwarfs. People-giants are women higher than 190 cm and men higher than 200 cm. Height is an integral factor of the effect of genetic, hormonal, tissue and external factors on the bony and other tissues of the organism. The height genetic program is realized through the humoral endocrine system including all known hormones (thyroid, insulin, calcium-regulating, adrenal, sex), but the most important is hypothalamic and hypophyseal growth regulation, the central link of which is somatotropin. Sopmatotropin (GH — somatotropic hormone or GH — growth hormone) is a basic hormone stimulating linear growth. GH stimulates growth of bones in length, growth and differentiation of internal organs, development of muscular tissue. A basic effect of GH at a bony tissue level is its stimulation of cartilage growth, protein synthesis and cellular mitosis induction. GH effects are mediated by insulin-like growth factors (IFR-I, IFR-II) or comedian's that are synthesized under the influence of this hormone mainly in the liver and kidneys. The linear human growth is completed, when growth zones have become closed under the effect of sex hormones. The most simple and accessible method of studying the somatotropic function is anthropometrics, i.e. the human height is evaluated versus its predicted height calculated on the basis of an average height of his parents. To determine the final height range the following formula is used:

Predicted final height of a male = (father's height + mother's height + 13 cm) : 2

Predicted final height of a female= (father's height + mother's height – 13 cm) : 2

The measured height of an adult must coincide with a predicted height or deviate from a calculated value no more than 2 standard deviations (SD), i.e. ± 10 cm from a calculated height value. Deviations of the measured height exceeding 2 SD from a calculated height value evidences a pathologically low or high human height. In this case it is necessary to perform detailed studies of the hypophysis somatotropic function to clear up the cause of growth impairment, as well as to study the state of other glands (first of all sex and thyroid glands).

Materials and equipment: a height meter.

PROTOCOL

1. Height of the examined is _____ cm. Sex of the examined _____.

2. Parents' height of the examined: mother's _____ cm; father's _____ cm.

Calculation of predicted height of the examined (PHE)

PHE = (father's height + mother's height ± 13 cm) : 2 = _____ cm.

3. **Conclusion**. Height of the examined is _____ (in norm, pathologically high, pathologically low).

4. Excess of growth hormone in childhood or adolescence or insufficiencies of sex hormones may result in pathologically _____ height. Insufficiency of growth hormone in childhood and adolescence or excess of sex hormones may result in pathologically _____ _____ height.

To perform the work one should know the heights of the parents. **Accomplishment.** Height measurement is performed in standing position with the height meter. The examined should stand without shoes (in thin socks) in the right position: arms down; heels together; heels, buttocks and scapulae are pressed to the board of the height meter. The head is in position of "Frankfurt's plane", i.e. the lower edge of the eye and the external hearing passage should lie on one horizontal line. Measurements are performed on exhalation. The plank of the height meter is lowered to the level of the head of the examined. Measurements are performed with precision of 0.5 cm.	

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Lesson 11. HUMORAL REGULATION OF FUNCTIONS. PHYSIOLOGY OF THE ENDOCRINE SYSTEM. PART № 2

DATE OF CLASSES

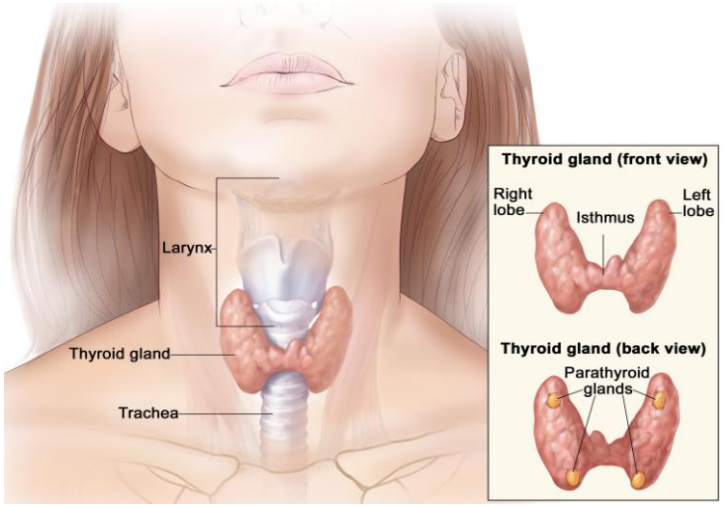
«_____» _____ 201___

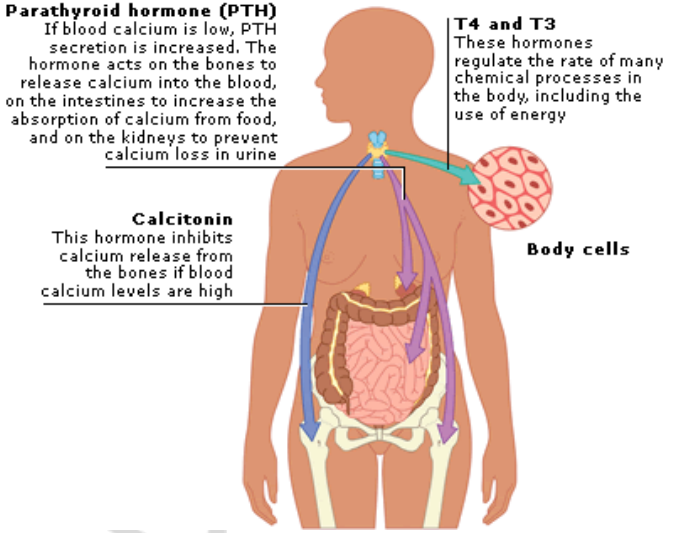
day month year

Key questions include: 1. The endocrine function of the thyroid and parathyroid glands. 2. Physiology of the adrenal glands. The role of hormones the cortex and medulla of the adrenal glands in the regulation of body functions. 3. The concept of stress, its mechanisms and methods of prevention. 4. The endocrine function of the pancreas and its role of hormones in the regulation of carbohydrate, fat and protein metabolism. 5. The concept of the endocrine function of the heart (atriopeptid), kidney	Navigation: 1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill

(calcitriol, erythropoietin). Salivary gland (parotin). The liver (somatomedin C, thrombopoetin, 1 (OH)-VitD3). 6. The concept of physiological approaches to the use of hormones to correct body functions.	Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.
Stress	Somatomedin C
T3	Thrombopoetin
T4	1 (OH)-VitD3
Calcitonin	
Calcitriol	
Atriopeptid	
Erythropoietin	
D3	
Parotin	

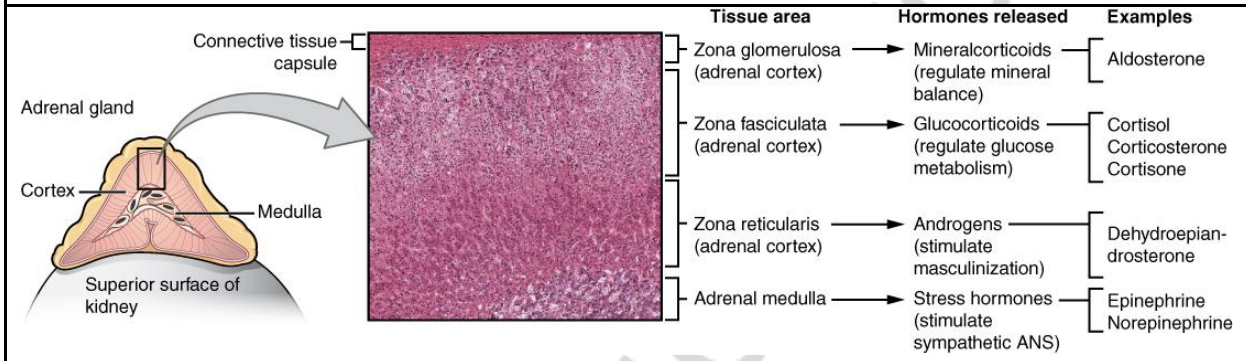
Work 11.1. The endocrine function of the thyroid and parathyroid glands

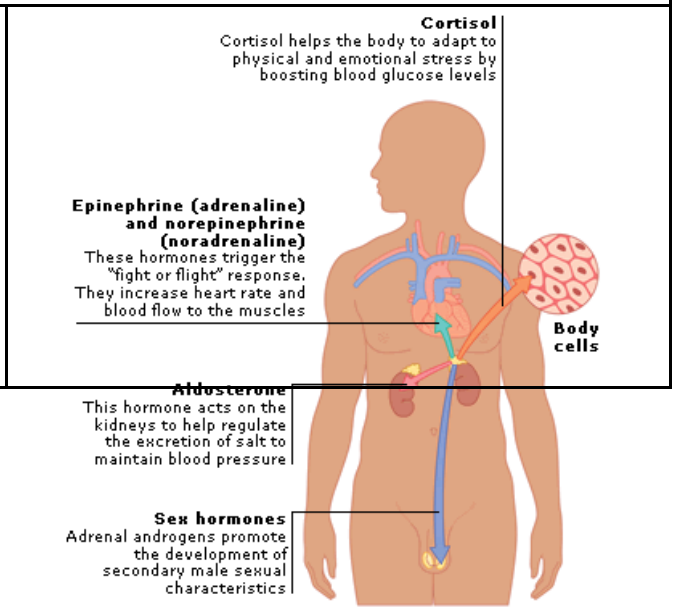




hyper
hypo

Work 11.2. Physiology of the adrenal glands

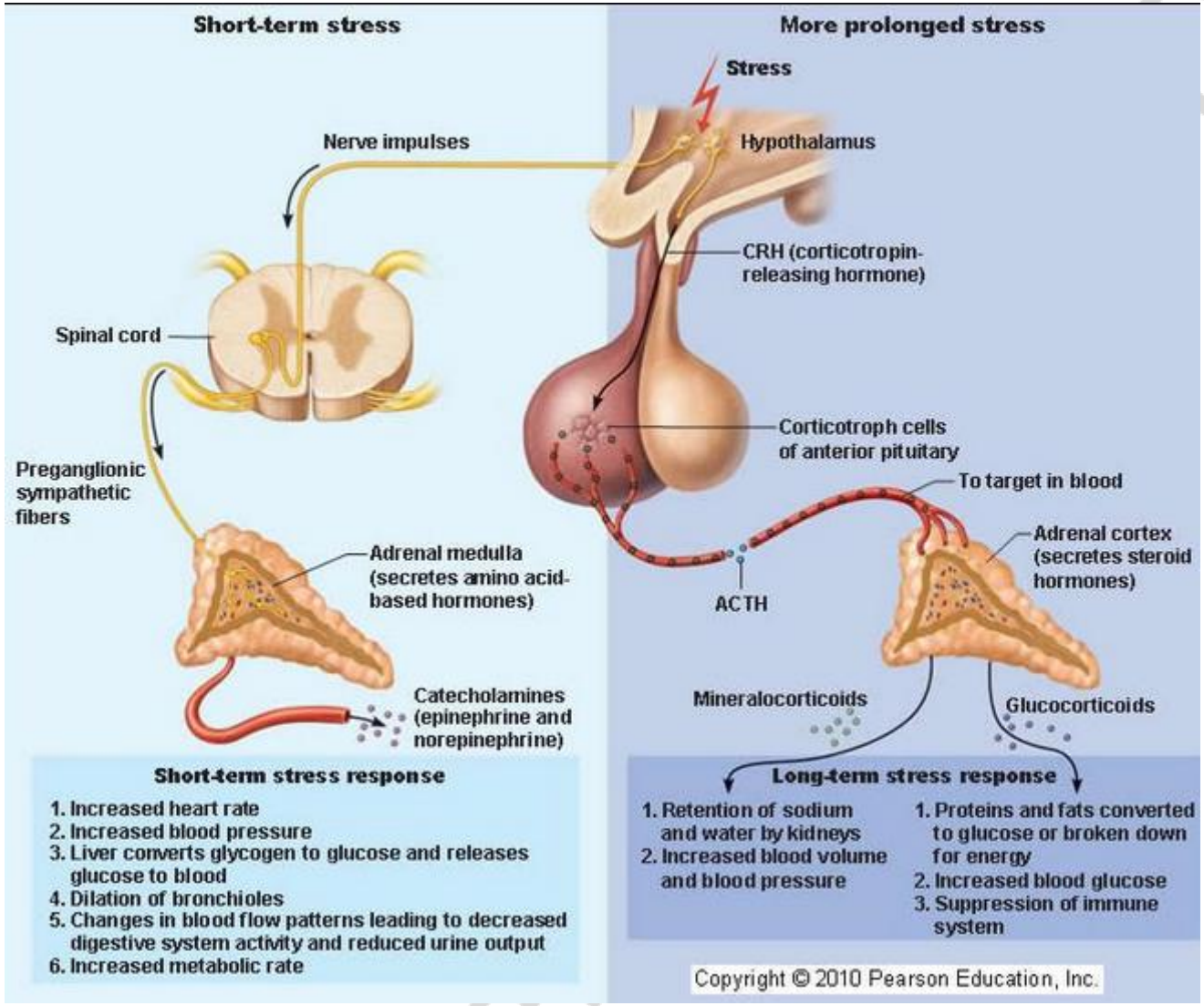




Fill in the table

Hormone	Function	Hypo	Hyper

Work 11.3. The concept of stress



Describe the mechanism of development of stress

Work 11.4. Analysis of the effect of catecholamines as hormones (adrenal medullar substance) and as neuro-mediators (ANS sympathetic department) on cardio-vascular system factors (demonstrative computer work)

Accomplishment. The program "Physiol 2" is used, it allows performing virtual experiments on rats.

PROTOCOL

Effect on the heart	HR	BP_{syst}	BP_{diast}	BP_{mean}
Initial factors				
Stimulation Symp. Nerves to heart T_1				
Stimulation Symp. Nerves to adrenals$T_{6–8}$				
Phentolamine (α-adrenoblocker), 100 mg/kg + **stimulation** Symp. Nerves to heart T_1				

Directions for recording the Protocol:

1. Fill in the table. Abbreviations: HR – Heart Rate, BPsyst – Systolic Blood Pressure, BPdiast – Diastolic Blood Pressure, BPmean – Mean Hemodynamic Blood Pressure.

2. Make a conclusion, what is the difference between the action of catecholamines as mediators of sympathetic nerves and as hormones of the adrenal medullar substance. Indicate, by what types of adrenoreceptors
the effect of noradrenalin and adrenalin on
the cardio-vascular system is predominantly realized.

Propranolol (β-adrenoblocker), 100 mg/kg + **stimulation** Symp. Nerves to heart T_1				
Propranolol (β-adrenoblocker), 100 mg/kg + **stimulation** Symp. Nerves to adrenals T_{6-8}				
Injection noradrenaline, 5μg/kg				
Injection adrenaline, 5μg/kg				

Conclusion: _____
_____
_____

THE LABORATORY WORKS ARE PASSED WITH MARK

_____
Teacher's signature

Lesson 12. REGULATION OF CALCIUM AND PHOSPHORUS IN THE BODY, OF THE BONE TISSUE AND TEETH

DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions:	Navigation:
1. Role of calcium and phosphate in the body, their connections and maintenance of bone and teeth. 2. Bone: functions, features of the structure and composition, age-related changes. 3. The dental hard tissues: types, functions. Enamel: structure, properties, functions, features "power". 4. The dental formula children and permanent teeth. 5. The balance of calcium and phosphate in the body and in the bone: age-specific features, mechanisms of regulation. The daily requirement for calcium, phosphate and fluoride. 6. The concept of homeostasis. Mechanisms to maintain a constant internal environment of the body (for example, the regulation of calcium levels in the blood calcitonin, calcitriol and PTH). 7. Factors of maintaining bone health and teeth.	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.

Work 12.1. Evaluation of a dental formula. Definition of occlusion

Materials and equipment: dental mirror (preferably an individual (personal) each student), a glass of potassium permanganate or hloraminom. The progress of the work. Ask the examinee to maximally open mouth and inspect the presence and location of teeth with (or without) a dental mirror. Then ask the examinee to maximally close the jaw and oskalit' teeth. Consider the nature of the ratio of teeth position anteriors (overlap incisors, as well as the ratio of the first antagonistično located premolars) and

PROTOCOL

1. Dental formula of deciduous teeth the upper jaw right _____ _____ the upper jaw left lower jaw right _____ _____ lower jaw left.

Dental formula for permanent teeth the upper jaw right _____ _____ the upper jaw left lower jaw right _____ _____ lower jaw left.

would appreciate the option of bite from the examinee. Specify the Protocol: 1. Write a normal clinical dental formula proposed by who, for milk and permanent teeth healthy child and adult. 2. Write the dental formula of a subject and would appreciate his “tooth” age (passport). 3. Evaluate option permanent occlusion at the subject.	2. Dental formula for permanent teeth examinee (age _____ years as per passport). Specify only the existing teeth. Draw attention to the availability of the third molars. The upper jaw right _____ the upper jaw left lower jaw right _____ lower jaw left «Dental» the age of a subject meets/does not meet (strike out what does not apply) passport.

THE LABORATORY WORKS ARE PASSED WITH MARK

_____

Teacher’s signature

Lesson 13. COLLOQUIUM "MECHANISMS OF FUNCTIONS REGULATION"

Main questions:	Navigation:
1. Comparative characteristics of somatic and autonomic nervous system (sensory receptors, afferent, association and efferent divisions, effector organs). Differences neuroeffector connections of smooth muscle from the neuromuscular synapses of skeletal muscles. 2. Comparative characteristics of the structure and neurochemical mechanisms of functioning of the sympathetic and parasympathetic divisions of the ANS, as well as their impact on effector organs. The concept of principles correction of vegetative functions (for example, salivation), through the impact on transmitter-receptor mechanisms. 3. The concept of physiological function and it regulation. Levels of regulation. Types of regulation. Nervous and humoral mechanisms of functions regulation, their comparative characteristics. 4. The concept of homeostasis. Mechanisms to maintain the constancy of the internal environment of the body (for example, regulation of calcium levels in the blood calcitonin, calcitriol and parathyroid hormone). 5. The concept of the endocrine system. The pituitary gland, its connections with the hypothalamus. Hormones of the pituitary and hypothalamus, their role in endocrine and non-endocrine organs regulation. 6. Endocrine function of the thyroid and parathyroid glands. 7. Physiology of the adrenal glands. Hormones of the adrenal cortex and adrenal medulla, its role in the regulation of body functions. 8. Endocrine function of the pancreas and role it of hormones in the regulation of carbohydrate, fat and protein metabolism. 9. The sex glands. Male and female sex hormones and their physiological role. 10. The concept of endocrine function of the pineal (epiphysis) gland (melatonin), heart (natriuretic hormone), kidney (calcitriol, erythropoietin, and other), salivary glands (parotid and others), liver (somatomedin, thrombopoetin, vitamin D3 or cholecalciferol). 11. Physiological properties of skeletal muscles and their functions. Force and work of muscles for example of the masticatory muscles. Gnatodinamometry. Dynamometry of hands and back muscles. 12. Motor units and their characteristics in different muscles. Types of muscle fibers. 13. Single contraction and its phases. Types and modes of contraction. Summation of contractions (tetanus), its types. 14. The mechanism of contraction and relaxation of single muscle fibers and muscle (the theory of sliding filaments). 15. The functionality of individual masticatory muscles. Movement of the lower jaw (mandibula). Physiological occlusion (bite, neutrocclusion). 16. Physiological properties and characteristics of smooth muscle compared to skeletal. Smooth muscle tone. The concept of myoepithelial cells.	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005. COMPUTER TEST "LESSON 13" OR IN WRITING Тестирование – Контрольные тесты – Lesson 13.

THE COLLOQUIUM ARE PASSED WITH MARK

Teacher's signature

SECTION “BODY FLUIDS”

Lesson 14. BODY FLUIDS (BLOOD, LYMPH, CEREBROSPINAL FLUID, SALIVA)

DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions:	Navigation:
1. Role of water in the body, its content, the distribution, balance. Body fluids, their types. 2. The concept of the blood system. The composition, number, properties and functions of blood. Basic physiological constant of blood. 3. Acid-base status of the blood and the mechanisms of its regulation. 4. The composition, amount, and properties of blood plasma. Hemolysis and its types. 5. Blood plasma proteins, and their characteristic value. 6. The electrolyte composition of blood plasma. The osmotic pressure of the blood and its regulation (ADH, RAAS). 7. Lymph, its composition, physicochemical properties and functions. 9. Cerebrospinal fluid (CSF), its quantity, composition and function. 10. The oral fluid: oral (“mixed saliva”), gingival, saliva salivary glands. The acid-base status of the oral cavity	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.

Body fluids	pH of blood

blood system	Basic physiological constant of blood.
Hemolysis	Oral (“mixed saliva”)
Blood plasma	Gingival
Osmotic pressure	
ADH	
RAAS	
Lymph	
CSF	
Oral fluid	

Practical works

Work 14.1. Methods of taking capillary blood (demonstration). Measures to prevent infection

Total clinical blood test is one of the most common laboratory examinations. Capillary blood is often used for this purpose.

Working with blood one should remember that blood can be virulent (HIV, hepatitis, etc.) and doctors and laboratory assistants performing serological and clinical tests are at risk of getting infected. That is why while making blood tests one should follow orders of the Health Ministry of the Republic of Belarus № 66 of 2.04.1993 and № 351 of 16.12.1998 on prophylaxis of viral hepatitis and AIDS in medical workers engaged in taking and analyzing blood.

While performing laboratory tests of the blood and other biological fluids one should use individual protective means: a medical gown and rubber gloves, spectacles, a mask (or a shield).

When biological material has got on mucous membranes of:

– the oral cavity: rinse the mouth with 70 % alcohol;

– the nasal cavity: drop in 30 % solution of **albucid** from a tube-dropper;

– eyes: wash with water (with clean hands), drop in 30 % solution of albucid from a tube-dropper. In case 30 % solution of **albucid** is absent one can use 0.05 % solution of potassium permanganate for rinsing mucous membranes of the nose and eyes.

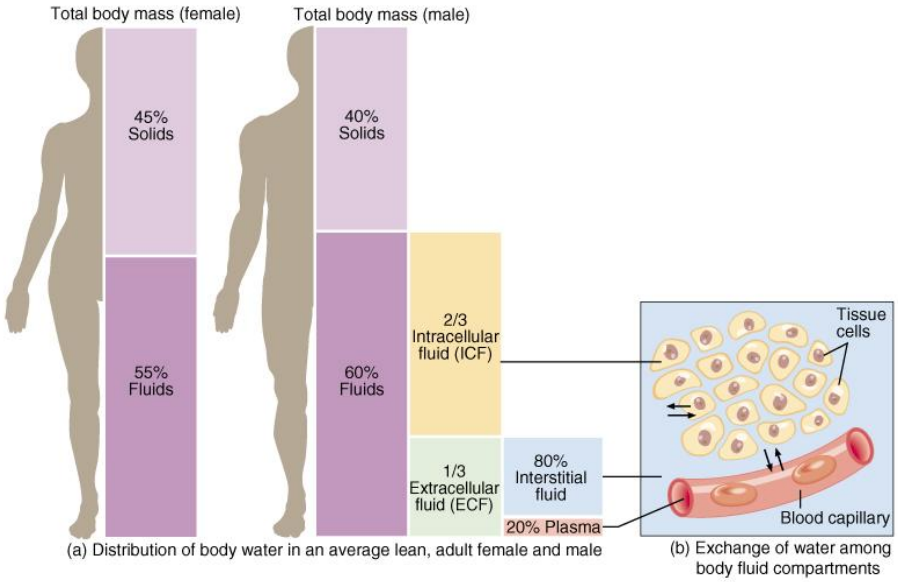
When biomaterial gets on the gown or clothes, this site should be immediately treated with one of disinfectors.

Materials and equipment: scarificators in sterilizers, cotton wool, alcohol, iodine, rubber gloves, masks, 3 % solution of chloramines.

Accomplishment. Taking capillary blood from the patient should be done as follows:

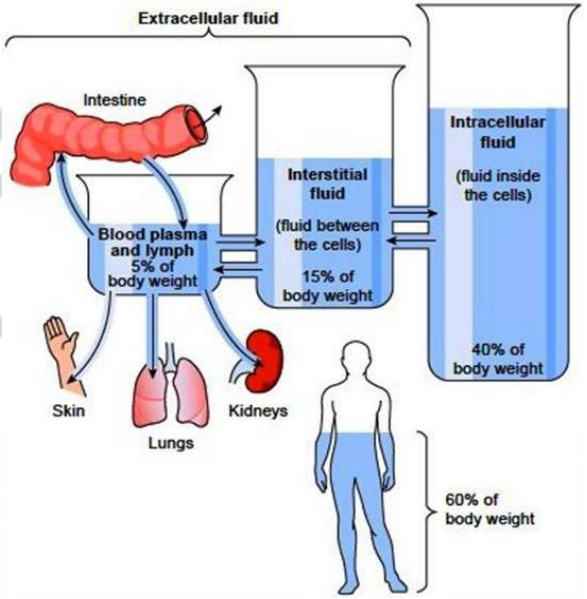
Any injury of the skin, mucous membranes, getting blood or other biological fluid of the patient there should be qualified as a possible contact with the material containing HIV or other infected agent. If the contact with blood or other biological fluid was associated with integument lesions (puncture, cut) the victim should: – quickly take off the gloves with the working surface inside; – squeeze out some blood from the wound immediately; – rinse the injured site with one of disinfectors (70 % alcohol, 5 % iodine in cuts, 3 % peroxide solution in punctures, etc.); – wash the hands with soap under running water and then rinse with alcohol; – apply a plaster onto the wound. In case of contamination with blood or other biological fluid without cutaneous lesions: – rinse the skin with alcohol or other disinfectors if it is absent; – wash the contaminated site with water and soap and rinse it with alcohol again.	1. The patient should sit opposite the doctor, the patient's hand (better non-working) should be on the table. 2. Taking blood is done from the 4th finger, as its synovial sheath is isolated preventing the spread of an inflammatory process to the wrist in case of infecting the site of puncture. 3. The finger skin is disinfected with alcohol. 4. The **scarificator** is taken from the sterilizer by the middle with pincers, then with the hand by the end opposite to a puncturing one. The **scarificator** point should be kept upward to prevent a water drop getting to a cutting edge. 5. A skin puncture is done in the central point of the finger-cushion, the **scarificator** being thrust to a full depth of a cutting surface. 6. The first blood drop is wiped away with dry cotton wool (to remove tissue fluid), the finger is carefully wiped out (the skin should be dry). 7. The next blood drop should have a convex meniscus and not spread about the finger, this drop and the next ones are taken for analysis. 8. Having taken the blood the puncture site is treated with alcohol or iodine. Answer to the questions: Why isn't the first blood drop recommended to be used for analysis: _____ _____ Why is the blood usually taken from the 4^{th} finger of a non-working hand? _____ _____ With safety provisions while performing practical works with blood and other biological fluids as well as with tissues has been acquainted and instructed _____ (signature)

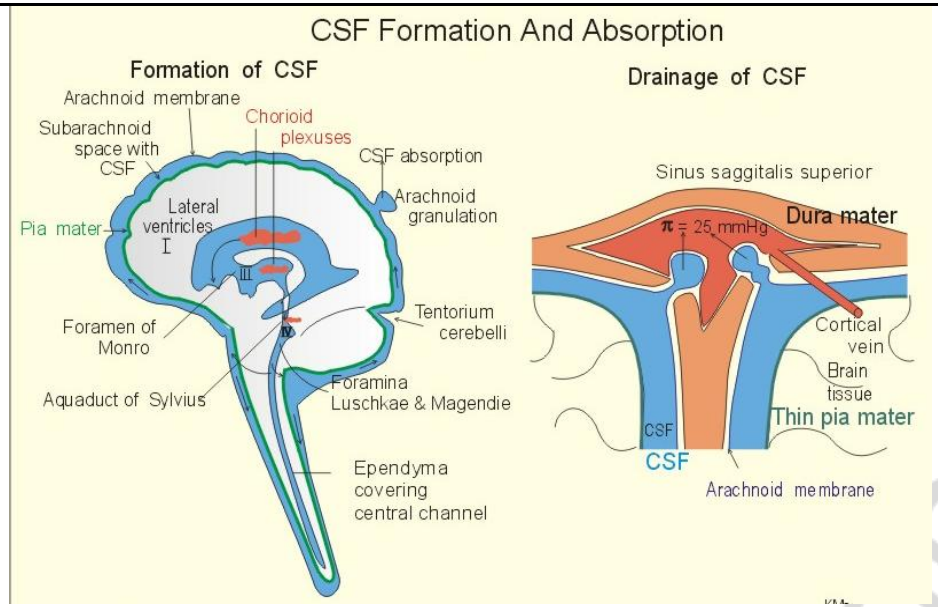
Body fluids	



(a) Distribution of body water in an average lean, adult female and male

(b) Exchange of water among body fluid compartments

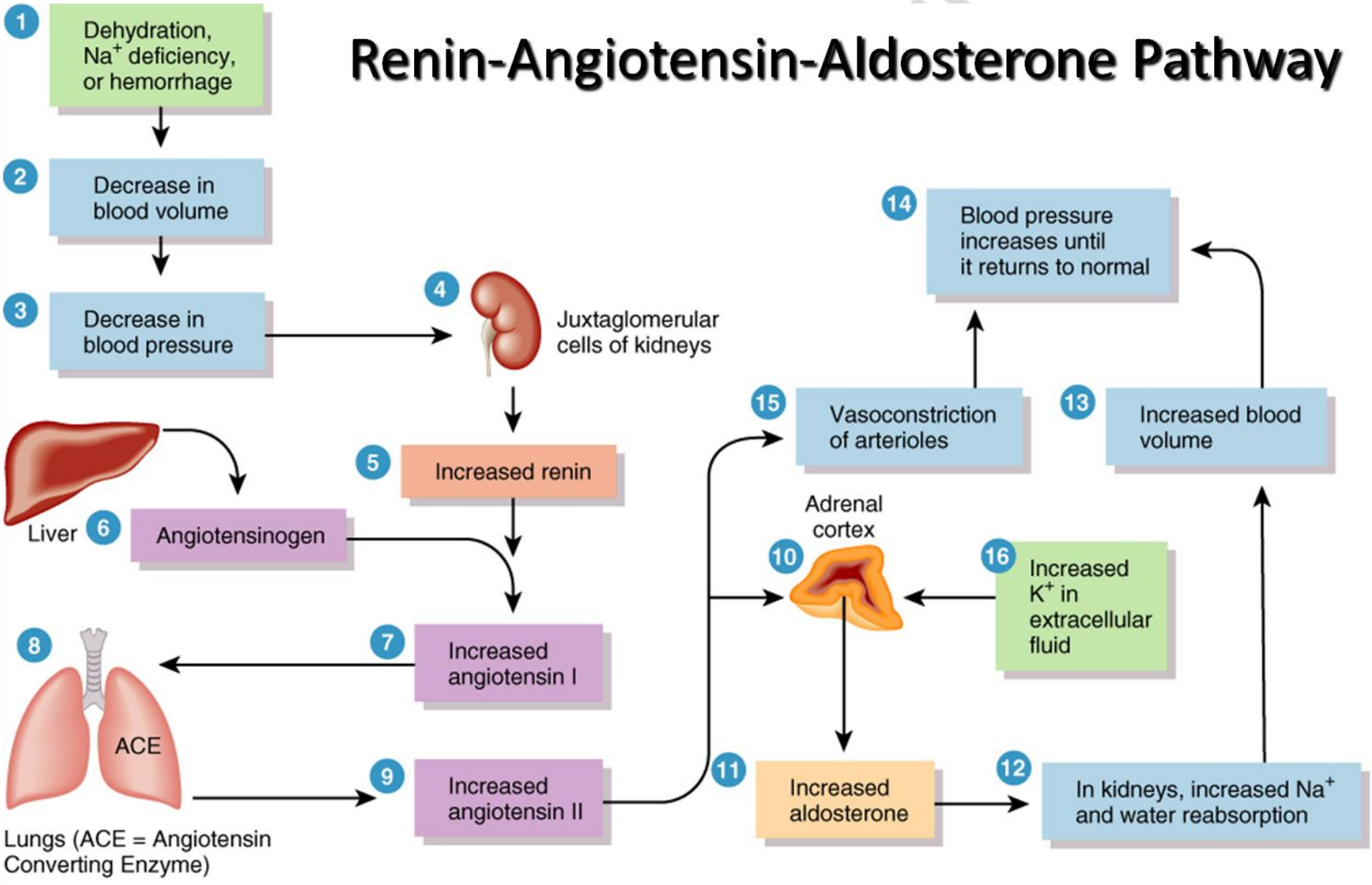




Daily Intake and Output of Water (ml/day)

	Intake	**Output**
Total		

Renin-Angiotensin-Aldosterone Pathway



Lesson 15. BLOOD CELLS. THE ERYTHROCYTE SEDIMENTATION RATE. THE TOTAL CLINICAL BLOOD ANALYSIS. HEMOPOESIS

DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions:	Navigation:
1. Erythrocytes: features of the structure, quantity, functions. Types of hemoglobin and its compounds, their physiological significance. 2. The erythrocyte sedimentation rate (ESR): definition, factors affecting it. Diagnostic value of ESR. 3. Leukocytes, their types, quantity, functions. Leukogram, age peculiarities. Leukocytosis and leukopenia. 4. The concept of levels and mechanisms of nonspecific and specific protection (resistance) of the body. 5. Platelets: structure, quantity, functions. 6. General clinical analysis of blood and physiological evaluation of its results. 7. Hemopoiesis. Nervous and humoral mechanisms of regulation of hemopoiesis. The role of vitamins (B12, B9 and others) and trace elements (Fe^{2+} and others).	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.
Buzzwords	Scheme Hemopoiesis. Draw scheme hemopoiesis using lecture
BLOOD CELLS —	
HEMOPOESIS —	
Hemoglobin	

Types of hemoglobin	
ESR	
Leukocytes	
Leukogram	
Leukocytosis	
Leukopenia	
Platelets	

Work 15.1. Evaluation of a color index

To evaluate an absolute content of hemoglobin in every erythrocyte the MCN (Mean Corpuscular Hemoglobin) index approximately equal to 30 pg (25.4–34.6) is used. Its value is obtained by division of the hemoglobin content in 1 liter by red blood cells count in 1 liter.

The color index (CI) is a relative value of hemoglobin content in red blood cells. CI is calculated by division of the hemoglobin content in g/l (Hb) by the number of the first three digits of red blood cells count in 1 liter of blood with multiplication of the received value by 3. The calculation can be presented by the following formula. For example, the blood hemoglobin content is 152 g/l, the erythrocyte count is 4.56 × 1012/l; then CI is equal to 3 × 152 : 456 = 1.00.

CI of a healthy person is 0.8–1.05 (normochromia). In decreased hemoglobin content in red blood cells CI is less than 0.8 (hypochromia that usually occurs in iron deficiency in the organism), in increased — over 1.05 (hyperchromia which is noted in insufficiency of vitamin B12 and/or folic acid in the organism).

Directions for recording the Protocol:

Under physiological conditions an increased ESR is noted during pregnancy, in eating dry food and fasting, after vaccination (due to an increase of globulins and fibrinogens in plasma). Delayed ESR can be noted in blood thickening due to enhanced perspiration (for example, in high external temperature) or enhanced formation and content of erythrocytes in blood (for example, in Alpine residents and mountaineers).

Many diseases are accompanied by ESR changes. Thus, an increased ESR is noted in the majority of infectious, inflammatory and autoimmune diseases (due to hyper-globulinemia and/or hyperfibrinogenemia), kidney diseases with nephrotic syndrome (due to a loss of albumins with urine and development of hypoalbuminemia), malignant tumors and hemoblastoses (due to an increased content of large-molecular proteins in the blood and/or depression of erythropoesis and development of anemia), endocrine diseases (thyrotoxicosis and diabetes mellitus) and anemia of different genesis. A decreased ESR, up to a complete stop of sedimentation, occurs in erythrocytosis.

Materials and equipment: Panchenkov's device, a watch glass, scarificators in sterilizers, rubber gloves, masks, cotton wool, alcohol, iodine, 3 % solution of chloramine, 5 % solution of sodium citrate.

Calculate CI of the tested blood using the data of works 3.3 and 3.4.

Evaluate the obtained result (normo-, hypo- or hyperchromia).

PROTOCOL

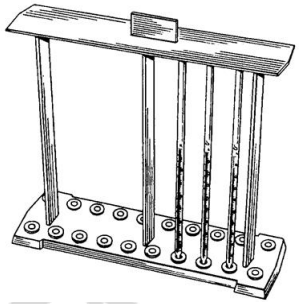
1. Hemoglobin content in tested blood is equal to _____ g/l.
   Red blood cells count in tested blood is equal to _____ × 10^{12}/l.

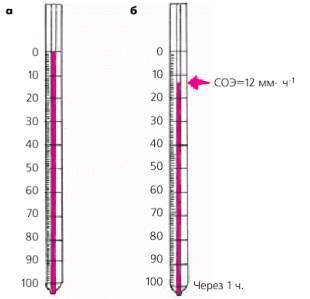
CI = 3 × (_____ : _____) = _____

2. Conclusion: _____ (normo-, hypo- or hyperchromia)

Work 15.2. ESR evaluation by Panchenkov's method (demonstration)

Unless the blood is not coagulated, red blood cells sediment to the test-tube bottom as their specific weight (1.096 g/ml) is higher than that of plasma (1.027 g/ml). Normal values of ESR in healthy people are: in men 1–10 mm/h; in women 2–15 mm/h. The most important factors affecting ESR are the proportion of various kinds of blood plasma proteins as well as red blood cells content. An increase of large plasma proteins, globulins and fibrinogen, and/or decrease of albumins in plasma as well as decrease of red blood cells is associated with an increase of ESR. An increase of red blood cells in the blood as well as an increase of albumin and bile pigments results in a decrease of ESR. A higher value of the ESR norm in women is associated with a less red blood cells content.





Accomplishment. Panchenkov's device is used to evaluate ESR. A pipette (capillary) of the device is washed with 5 % solution of sodium citrate. The taken blood is carefully stirred with sodium citrate on the watch glass. The mixture is drawn into the pipette to mark 0. The pipette is placed into the stand for 1 hour in a strictly vertical position. The result is assessed by a decrease of a red column of red blood cells in the capillary from point 0 (in millimeters).

While evaluating ESR this should be followed strictly: the proportion of sodium citrate and blood 1:4; verticality of the pipette in the stand; the temperature in the room — 18–22 °C (in lower temperature ESR decreases and in higher — increases).

PROTOCOL

1. ESR of tested blood = _____ mm/h.
2. ESR normal values: in men _____ mm/h; in women _____ mm/h;
3. While evaluating ESR the blood is mixed with 5% solution of Na citrate with the aim _____
4. Conclusion: ESR is _____ (in norm, increased or decreased)

Work 15.3. Physiological assessment of the total blood test

Total clinical blood test is one of the most common laboratory examinations. It includes evaluation of the following indices:

1) hemoglobin content (g/l);

2) red blood cells count per 1 liter of blood;

3) calculation of color index;

PROTOCOL

Factor	Norm	Main function
1. Red Blood Cells (RBC)	(3,9–5,1) × 10^{12}/l, men (3,7–4,9) × 10^{12}/l, women	
2. Hemoglobin (Hb)	130–170 g/l, men 120–150 g/l, women	
3.Color index	0,8–1,05	
4. ESR	1–10 mm/h, men 2–15 mm/h, women	

4) white blood cells count per 1 liter of blood;

5) leukocyte formula;

6) erythrocyte sedimentation rate (ESR).

Additional examinations include: evaluation of platelets in 1 liter of blood, count of reticulocyte percentage and some other indices. Modern hematologic analyzers allow additional evaluation of: the hematocrit, mean volumes of red blood cells, white blood cells and platelets; mean hemoglobin content in red blood cell, etc.

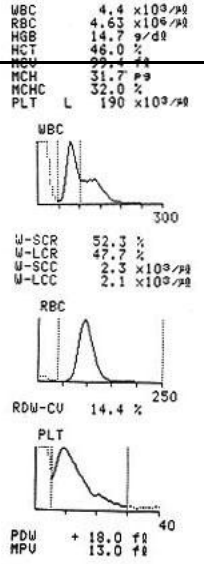
Using total blood test indices the doctor may assess the respiratory function of the blood (by the hemoglobin content, red blood cells count); erythropoesis intensity (by the reticulocyte count); suggest the presence of infectious, inflammatory and autoimmune processes in the organism (by the white blood cells count, shift of the leukocyte formula to the left and ESR changes) etc.

Directions for recording the Protocol:

Fill in the table of the total blood test indices.

5. White Blood Cells (WBC)	(4–9) × 10^9/l	
6.Leukocyte formula	Per 100 cells (100 %)	
6.1. Basophils	0–1 %	
6.2. Eosinophils	1–5 %	
6.3. Neutrophils: myelocytes young rod nuclear segmented	 0 % 0–1 % 1–5 % 46–68 %	
6.4. Monocytes	2–9 %	
6.5. Lymphocytes	18–40 %	

Abbreviations used for hematologic factors



1. WBC (white blood cells) — total leukocyte count; 2. RBC (red blood cells) — erythrocyte count; 3. HGB (hemoglobin) hemoglobin content; 4. HCT (hematocrit) — hematocrit factor; 5. MCV (mean corpuscular volume) — mean red blood cells volume; 6. MCH (mean corpuscular hemoglobin) — mean hemoglobin content in an red blood cell; 7. MCHC (mean corpuscular hemoglobin concentration) — hemoglobin content in 100 ml of red blood cells (hemoglobin concentration in one red blood cell); 8. PLT (platelets) — thrombocyte count; 9. W-SCR — percentage of small leukocytes, i.e. lymphocytes; 10. W-LCR — percentage of large leukocytes, i.e. total percentage of neutrophils + monocytes + basophils + eosinophils; 11. W-SCC — or LYMPH - absolute small leukocyte count, i.e. lymphocytes; 12. W-LCC — or MO + GR — absolute count of large cells, i.e. total count of neutrophils + monocytes + basophils + eosinophils; 13. RDW (red cell distribution width) — distribution width of red blood cells by the volume; 14. PDW (platelet distribution width) — distribution width of platelets by the volume; 15. MPV (mean platelet volume) — mean thrombocyte volume.	

Lesson 16. BLOOD GROUPS. BLOOD PREPARATIONS. BLOOD SUBSTITUTING SOLUTIONS. HEMOSTASIS

DATE OF CLASSES

«_____» _____ 201___

day month year

Main questions:	Navigation:
1. Blood groups (systems: ABO, Rh +, HLA). Determination of blood group ABO and Rh^+. 2. The concept of blood preparations and blood substitutes. Principles of blood preparations transfusion. 3. The concept of hemostatic system and its links. 5. Primary and secondary hemostasis and basic methods of evaluation. Prolonged bleeding after tooth extraction. 6. The concept of assessment methods of primary and secondary hemostasis. Determining the duration of bleeding by Duke. 7. Anticoagulants, inhibitors of blood coagulation. 8. Fibrinolysis, its mechanisms.	1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005.

Buzzwords	Anticoagulants —
Hemostasis —	Fibrinolysis —

Primary hemostasis —	Secondary hemostasis —
Standard serum —	Agglutinins —
Agglutination —	Petechiae —
Monoclonal antibodies —	Coagulation —
Agglutinogens —	Anticoagulants —

Work 16.1. Blood typing in the O-A-B system using standard serums (demonstration)

The O-A-B system blood group is determined by the presence of agglutinogens in red blood cells which is revealed by the hemagglutination reaction using standard serums. The interaction between red blood cells antigens of the tested blood and corresponding antibodies (agglutinins) of the standard serum underlies the bases of such reaction. As antibodies contained in standard serums are known, red blood cells antigens of the tested blood and consequently the blood group in the O-A-B system are determined by the presence or absence of agglutination.

***Materials and equipment*: standard serums of 0αβ(I), Aβ(II), Bα(III) and AB0(IV) groups of two**

Standard serums of 0αβ(I), Aβ(II), Bα(III) and AB0(IV) groups of two various series

various series; pipettes for them; special plate; glass sticks; isotonic (0.9 %) solution of NaCl; scarificators in sterilizers; cotton wool; alcohol; iodine; rubber gloves; masks; 3 % chloramine solution.

Accomplishment. Blood typing should be done in the room with sufficient illumination and at the temperature of **15–25 °C**.

Determination is done on special plate. 0.1 ml (1 large drop) of every standard serum of two series is applied to appropriate depressions of the plate.

The blood for the test is taken from the finger in compliance with all necessary rules. The first blood drop is taken off with a gauze ball. Then the blood is added with glass sticks **(5–10-fold less than the serum)** to every drop of the serum and carefully stirred. The obtained mixture is mixed again by rocking the plate.

Special plate

Scarificators

Four different combinations of the reaction are possible:

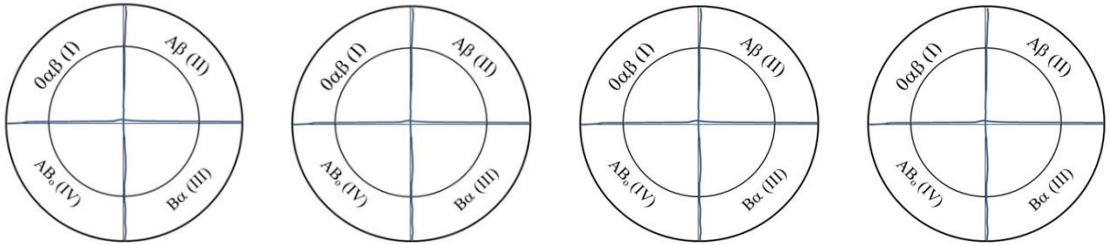
Agglutinins of standard serums of all 3 groups did not cause agglutination, and all drops stayed regularly stained in red. In this case the blood belonged to group 0αβ(I) (type O).

Agglutinins of standard serums of groups 0αβ (I) and Bα (III) caused a positive reaction of agglutination, and serums of group Aβ (II) — a negative one. The tested blood belongs to group Aβ (II) (type A).

Agglutinins of standard serums of groups 0αβ (I) и Aβ (II) caused a positive reaction of agglutination, while serums of group Bα (III) — a negative one. The tested blood belongs to group Bα (III) (type B).

Agglutinins of standard serums of all three groups caused a positive reaction of agglutination. The tested blood belongs to

Draw scheme for each experiment: **(5–10-fold less than the serum, 15–25 °C)**



0αβ(I) /type O/	Aβ (II) (type A)	Bα (III) (type B)	ABo(IV) (type AB)

ABo(IV) group (type AB).				

Work 16.2. Blood typing in the O-A-B system using standard serums (demonstration) (2)

In this case, before giving such a conclusion, to exclude non-specific agglutination, it is necessary to do an additional control test with the standard serum of AB0(IV) group by the same technique. The absence of agglutination in this test allows to consider the former reactions specific and refer the tested blood to AB0(IV) group. The presence of agglutination with the serum of AB0(IV) group reveals non-specific agglutination. In this case the test should be repeated with washed red blood cells.

Revealing other combinations of agglutination reactions testifies to improper blood typing.

Errors while determining blood groups are possible in situations, when agglutination is not revealed or a false agglutination occurs.

The absence of agglutination may be due to the following causes: 1) retardation of this reaction at high temperature of the environment >25 °C (blood typing should be done only at the room temperature of 15–25 °C); 2) addition of an excess of tested blood to standard serums resulting in a decrease of agglutinin titer in their content (remember that a drop of the applied blood should be 5–10 times less than that of the serum); 3) weak activity of the standard serum or low agglutinin ability of red blood cells.

Revealing false agglutination in its real absence may be due to drying of a serum drop and formation of red blood cells "monetary columns" (nummiform red cells aggregarion) or appearance of cold agglutination at the temperature less than 15 °C. The addition of a drop of isotonic NaCl solution to the tested mixture of serum and blood and performing the test at the temperature higher than 15 °C allow to avoid the mentioned errors.

The reaction is observed during 5 minutes. Usually the agglutination reaction starts during the first 10-30 seconds, however agglutination may be late, e.g. with red blood cells of A2β(II) group. As agglutination occurs, but not earlier than in 3 minutes, per 1 drop of NaCl isotonic solution are added into those drops, where agglutination has already occurred, and observation is continued followed by rocking the plate for 5 minutes, and only then the final result is assessed.

The reaction in every drop may be either positive or negative. In a positive reaction there appear small red granules (agglutinates) seen with naked eye in the mixture; they consist of glued red blood cells. Step-by-step they cluster and form larger granules or flakes of irregular shape. Meanwhile the serum becomes completely or partially decolorized. In case of a negative reaction the content of drops stays regularly stained in red, and agglutinates are not revealed there. The results of the reaction in both serum series should be identical.

N o t e. In case of a doubtful or unclear result during the first determination of blood group a repeated test of the blood group of the same blood with standard serums of other series should be done. If the results remain still unclear, the blood group should be determined by a cross-method using standard serums and standard red blood cells or monoclonal antibodies (see the supplement).

Directions for recording the Protocol:

Fill in tables 16.1 and 16.2.

Indicate in table 16.2, when agglutination occurs (+) and when doesn't (–).

Table 16.1

Blood groups	Serum agglutinins	Red blood cells agglutinogens
0αβ (I)		
Aβ (II)		
Bα (III)		
AB_0 (IV)		

Table 16.2

Blood groups	Standard serums			
	0αβ (I)	Aβ (II)	Bα (III)	AB (IV)
0αβ (I)				
Aβ (II)				
Bα (III)				
AB_0 (IV)				

Work 16.3. Evaluation and physiological assessment of primary hemostasis indices

The term **hemostasis** means a complex of reactions to stop bleeding in vascular injuries and maintenance of blood liquid state in vessels.

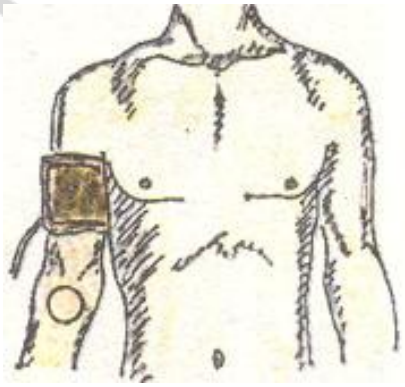
Since bleeding and thrombus formation in vessels of various sizes have different courses, there are two basic mechanisms of hemostasis:

microcirculatory, vascular-thrombocyte or primary mechanism of hemostasis. It starts reactions of hemostasis in capillaries, venous and arterial vessels **up to 200 μm in diameter**. This process involves platelets and endothelium of vessels. Almost 80 % of bleedings and 95 % of thrombus formations are associated with the impairment of this mechanism.

Macrocirculatory, hemocoagulatory or secondary mechanism starts as a rule on the basis of the primary one and follows it. It is accomplished by the blood coagulation system. Due to the secondary hemostasis a red thrombus is formed, it consists mainly of fibrin and blood cells. It provides a final stop to bleeding from injured macro vessels (**over 200 μm in diameter**).

A. Bandage test (evaluation of a vascular component of the primary hemostasis)

The method is based on the fact that dosed mechanic action (pressure) on skin capillaries of a healthy person does not cause any substantial changes. When the normal state of a capillary wall is impaired, increased vascular fragility occurs and after mechanic action at the site of the pressure multiple petechiae or hemorrhage appear manifesting the impairment of a vascular component of hemostasis.



Materials and equipment: a tonometer, a stop-watch, a circle of dense card-board 2.5 cm in diameter, a pen or a pencil.

Accomplishment. The test is done on the forearm. A circle 2.5 cm in diameter is outlined 1.5–2.0 cm from the ulnar pit. To do a test one should check if there are any hemorrhages in this circle (and their number if there are any). The blood pressure cuff is applied and the pressure of 80 mm Hg is created. The pressure is sustained at this level for 5 minutes pumping the air if necessary. The arm of the examined person should be relaxed and lie freely.

All **petechiae** that appeared in the outlined circle are counted in 10–15 minutes (taking into consideration those present before). In healthy persons petechiae are not

Primary (vascular-thrombocyte, microcirculatory) hemostasis means fast (within several minutes) formation of platelet clots at the site of vessel injury what is very important for stopping bleeding from small vessels with low blood pressure.

The components of the primary hemostasis are vascular wall, platelets and their coagulation factors.

The primary hemostasis stages are:

1) spasm of vessels;

2) platelets adhesion (involving Willebrand's factor), their activation and secretion of platelets granules (involving thromboxane A2 through a phospholipase mechanism), as well as platelets aggregation (at first it is reversible and then irreversible due to the action of thrombin and fibrin traces) with the formation of a platelets plug;

3) retraction (constriction and consolidation) of the platelets plug.

The most important screening indices characterizing the primary hemostasis are: **bandage test, platelets count, bleeding time by Aivy or Duke.**

formed or their number does not exceed 10 in the circle and their sizes are not more than 1 mm in diameter (negative bandage test). An increase of the petechiae number over 10 and petechiae sizes over 1 mm in diameter or the presence of a hemorrhage (positive bandage test) evidence the following: wall defects of micro vessels due to endocrine changes (menstrual period); infectious-toxic effect (sepsis etc.); insufficiency of vitamin C; the impairment of Willebrand's factor formation, etc.; the presence of thrombocytopenia or thrombocytopathia etc.

PROTOCOL

1. Petechiae number in the circle before the test _____ (no, 1, 2, 3…)
   Petechiae number in the circle in 10–15 minutes after the test ____ (no, 1, 2, 3,…).
   If petechiae are present, indicate their diameter _____ (below 1mm or over 1mm).
2. Conclusion: bandage test _____

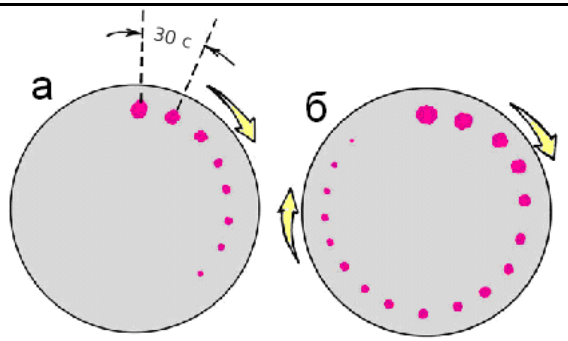
(negative= without petechiae or positive = with petechiae)

B. Time of bleeding by Duke.

The time of bleeding evaluated by Duke's method gives a general idea, if the primary hemostasis function is normal (and first of all it allows evaluating the function of platelets, their ability for adhesion or aggregation). An increase of bleeding time evidences the impairment of the primary hemostasis due to thrombocytopenias, thrombocytopathias, vascular wall injuries or

Materials and methods: a stop-watch, sterile filter paper, scarificators in sterilizers, cotton wool, alcohol, iodine, rubber gloves, masks, 3 % solution of chloramine.

Accomplishment. Puncture the 4th finger-cushion to the depth of 3 mm. If this is done properly, the blood is discharged spontaneously without pressure. Having made a puncture, switch on the stop-watch. Touch the first appearing blood drop with a strip of sterile filter paper that absorbs the blood. Then take off further blood drops

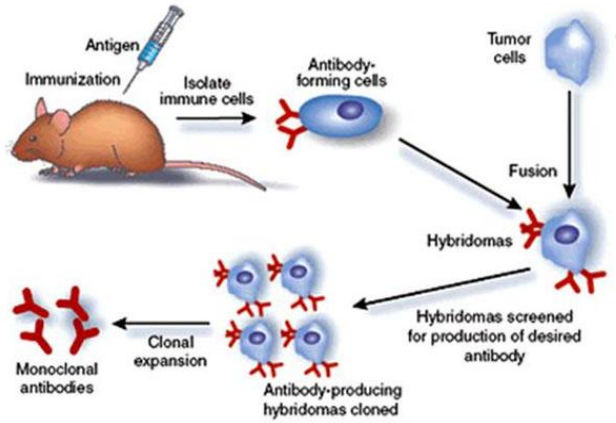
a combination of these factors. Reducing the bleeding time evidences only an enhanced spastic ability of peripheral vessels.	with sterile filter paper every 30 sec. Avoid touching the skin with filter paper, as it stimulates premature stop of bleeding. Continue till blood traces are absent on the filter paper. In norm the bleeding time by Duke is 2–4 min.
	**PROTOCOL** 1. Bleeding time is _____ min _____ sec. 2. Conclusion: Bleeding time _____ (norm, increased, reduced)

Work 16.4. Fibrinolysis, its mechanisms. Draw cheme

MONOCLONAL SERUMS: APPLICATION OF MONOCLONAL ANTIBODIES IN BLOOD TYPING

At present O-A-B-typing reagents produced from the human or animal serum with antibodies to red blood cells agglutinogens are still often used. These antibodies are the result of a polyclonal immune response, i.e. they come from various clones of antibody-forming cells and are the mix of immunoglobulins of various classes. To get such serums a great amount of donor blood is needed. Besides, the titer of natural antibodies in the human blood is usually low, that is why produced serums have low activity and one has to use serums obtained from specially immunized people.

Antibody-producing technology based on the fusion of a malignant myeloma cell and an antibody-forming lymphocyte of mice, becomes more and more widespread. As a result of fusion a hybrid cell (hybridoma) is formed inheriting basic properties of its parents: immortality and the ability to constant growth — from a tumor cell, and the ability to produce antibodies — from a B-lymphocyte.



Antibodies secreted by cells-descendants of such hybrids are monoclonal, i.e. they come from one

The benefits of monoclonal reagents are their high activity, standardization, reliability of revealing appropriate antigens, absence of false-positive reactions that is due, first of all, to the absence of antibodies of other specificity. Monoclonal reagents are not products of human cells that it excludes the possibility of transmitting viruses of hepatitis and AIDS.

Two types of monoclonal reagents are necessary for blood typing — anti-A and anti-B that are produced by two different hybridomas and contain correspondingly α- and β-agglutinins.

Blood typing in the O-A-B system using monoclonal serums

Blood group

Reaction of tested red blood cells with monoclonal reagents

	anti-A (α)	anti-B (β)
0 (I)	–	–

Per one large drop of anti-A and anti-B reagents is applied on a special plate or a porcelain dish under corresponding signs

cellular clone, belong to one class of immunoglobulins, are aimed at one antigen, are standard and able to grow both in culture and in the mouse's organism as an ascite tumor producing antibodies in high concentrations, up to some tens of grams per liter. To obtain O-A-B-typing monoclonal reagents it is enough to make a wash-out of tissue culture or take some ascite fluid and dilute these fluids as the titer of antibodies in them is very large (often for dilution 0.3 M solution of NaCl is used). At present O-A-B monoclonal reagents are commercially produced in England, Germany, Canada and Russia.	"anti-A" and "anti-B". Next to reagent drops small drops of the tested blood are applied (proportion 10:1). The reagent is carefully mixed with the blood with glass sticks. Observation of the course of the reaction is done by rocking the plate for 1–2.5 minutes. Agglutination with monoclonal reagents usually occurs within the first 3–5 sec. But the observation should be continued for 2.5 min due to a possibility of late agglutination with red blood cells containing weak types of antigens A and B.

THE LABORATORY WORKS ARE PASSED WITH MARK

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Lesson 17. COLLOQUIUM “BODY FLUIDS”

Main questions: 1. The concept of the blood system. The composition, quantity, properties, functions of blood. Basic physiological constants of blood. Acid-base status of the blood and the mechanisms of its regulation. Acid-base status the oral cavity. 2. The role of water in the body, its content, distribution, balance. Electrolyte composition of blood plasma. Osmotic blood pressure and its regulation (ADH, RAAS, and others). 3. Blood plasma proteins, their characteristics and value. ESR (erythrocyte sedimentation rate): definition, factors affecting it. 4. Erythrocytes: features of the structure, quantity, functions. Types of hemoglobin and its compounds, their physiological value. 5. Leukocytes, their types, quantity, functions. WBC, percentage of leucocytes types (leucocyte formula), age peculiarities. Leukocytosis and leukopenia. 6. Platelets: structure, quantity, functions. The concept of the hemostasis system. Primary and secondary hemostasis and the basic methods of their assessment. The duration of bleeding after tooth extraction. 7. Blood group system ABO, Rh, HLA. Determination of blood groups in ABO system. Principles of transfusion of blood substituting solutions. Risk factors when working with blood: for medical staff, patients, donors. 8. Nervous and humoral mechanisms of regulation of hemopoiesis. The role of vitamins (B12, B9 and others) and trace elements (Fe^{2+} and others).	Navigation: 1. www.bsmu.by – Студенту (at the right bottom) – For English Groups – Normal Physiology – For Dentistry Students. 2. www.bsmu.by – Студенту (at the right bottom) – Дистанционное обучение (http://etest.bsmu.by/) – Стоматология – Normal Physiology – Lesson. 3. Lecture. 4. Ganong W. F. Review of Medical Physiology. 23th ed. McGraw-Hill Companies, Inc., 2010. 5. Guyton A. C., Hall J. E. Textbook of Medical Physiology, 12th ed. WB Saunders, 2005. COMPUTER TEST “LESSON 17” OR IN WRITING Тестирование – Контрольные тесты – Lesson 17

THE COLLOQUIUM ARE PASSED WITH MARK

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Teacher’s signature

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