

MINISTRY OF HEALTH OF UKRAINE
Kharkov National Medical University
Physiology department

Physiology

Frequently Asked Questions

Reasoning of tests tasks of license exam "Krok 1"
for individual work of English-medium students
of medical and dental faculties

Name _____

Faculty _____

Group _____ course _____

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Фізіологія. Найпоширеніші питання

**Пояснення до тренувальних тестів в форматі "Крок 1"
для самостійної підготовки студентів медичного
та стоматологічного факультетів
з англomовною формою навчання**

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GENERAL PHYSIOLOGY
HIGER INTEGRATIVE FUNCTIONS & SENSORY SYSTEMS

Physiology of excitable tissues

1. The penetration of the irritable cell membrane for potassium ions has been increased during an experiment. What changes of membrane electric status can occur?

- A. *Action potential.* C. *Depolarization.* E. *Local response.*
B. ***Hyperpolarization.*** D. *No changes.*

Reasoning: A negative overshoot called hyperpolarization occurs when potassium gates stay open longer than Na gates, so the amount of potassium that leaves the cell is greater than the amount of sodium that entered. Therefore, the membrane voltage drops to 1 or 2 mV more negative than the original RMP (when RMP becomes more negative, it means that RMP increased). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 458).

2. The action of electric current on the excitable cell caused depolarization of its membrane. Movement of what ions through the membrane caused depolarization?

- A. Na^+ . B. Ca^{2+} . C. K^+ . D. Cl^- . E. HCO^- .

Reasoning: When sodium ions arrive at the axon hillock, they depolarize the membrane at that point. This appears as a steadily rising local potential, this local potential must rise to a critical voltage called the **threshold** (This is the minimum needed to open voltage-regulated gates). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 458).

3. Ion channels have been blocked in the excitative cell. It doesn't change significantly the quiet potential, but the cell has lost its capacity to the generation of AP (action potential). What channels have been blocked?

- A. *Calcium.* B. *Chlorine.* C. ***Sodium.*** D. *Potassium.* E. *Sodium and potassium.*

Reasoning: Depolarization is caused by sodium ions influx. An **action potential** is produced by voltage-regulated ion gates in the plasma membrane. Action potentials occur only where there is a high enough density of voltage-regulated gates. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 458).

4. The penetration of the irritable cell membrane for potassium ions has been increased experimentally. What changes of membrane electric status can occur?

- A. *Depolarization.* C. *No changes.* E. ***Hyperpolarization.***
B. *Action potential.* D. *Local response.*

Reasoning: A negative overshoot called hyperpolarization occurs when potassium gates stay open longer than Na gates, so the amount of potassium that leaves the cell is greater than the amount of sodium that entered. Therefore, the membrane voltage drops to 1 or 2 mV more negative than the original RMP (when RMP becomes more negative, it means that RMP increased). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 458).

5. Due to activation of ion channels of external membrane of excitable cell its rest potential has significantly increased. What channels were activated?

- A. *Fast calcium channels.* C. *Slow calcium channels.* E. *Sodium channels.*
B. *Sodium and calcium channels.* D. ***Potassium channels.***

Reasoning: A negative overshoot called hyperpolarization occurs when potassium gates stay open longer than Na gates, so the amount of potassium that leaves the cell is greater than the amount of sodium that entered. Therefore, the membrane voltage drops to 1 or 2 mV more negative than the original RMP (when RMP becomes more negative, it means that RMP increased). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 458).

6. ATP synthesis is totally blocked in a cell. How will the value of membrane rest potential change?
- A. First it will increase and then decrease. D. It will be considerably increased.
 B. First it will decrease, then increase. E. It will be slightly increased.
 C. It will disappear.

Reasoning: The Na-K pump accounts for about 70 % of the energy (ATP) requirement of the nervous system. Every signal generated by a neuron slightly upsets the distribution of Na and K, so the pump must work continually to restore equilibrium to maintain the value of resting membrane potential. Sodium leaks into the cell and potassium leaks out, but the sodium-potassium (Na-K) pump continually compensates for this leakage. It pumps 3 Na out of the cell for every 2 K it brings in, consuming 1 ATP for each exchange cycle. By removing more cations from the cell than it brings in, it contributes about -3 mV to the resting membrane potential. The net effect of all this – K diffusion out of the cell, Na diffusion inward, and the Na-K pump is the resting membrane potential of – 70 (-90) mV. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 456).

7. Rest potential of a cell equals -80 mV. At what stage of action potential did the membrane potential equal +30 mV?

A. After depolarization. C. Reverse polarization. E. Depolarization.
 B. After hyperpolarization. D. –.

Reasoning: As the rising membrane potential passes 0 mV, Na gates are inactivated and begin closing. By the time all close and Na inflow ceases, the voltage peaks at approximately +35 (30) mV. The membrane is now positive on the inside and negative on the outside – its polarity is reversed compared to the RMP. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 458).

8. An isolated muscle fiber is under examination. It was established that the threshold of stimulation force became significantly lower. What is the cause of this phenomenon?

A. Inactivation of sodium channels of membrane.
 B. Activation of sodium channels of membrane.
 C. Inactivation of potassium channels of membrane.
 D. Activation of potassium channels of membrane.
 E. Block of energy production in the cell.

Reasoning: Threshold of stimulation force becoming lower if excitability of tissue is increased caused by activation of sodium channels of membrane and sodium influx. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 457).

9. Tissue is being stimulated by electric cathodic impulse with amplitude of 70 % of threshold. What changes of membrane potential will be observed?

A. Hyperpolarization. C. Partial depolarization. E. –.
 B. Action potential. D. No changes.

Reasoning: Local potentials are **graded**, meaning that they vary in magnitude (voltage) according to the strength of the stimulus. A more intense (threshold or suprathreshold) or prolonged stimulus opens more ion gates than a weaker stimulus (subthreshold). Thus, more Na enters the cell and the voltage changes more (forming an Action potential) than it does with a weaker stimulus (forming a local potential or partial depolarization) (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 457).

10. It is required to set an experiment on an isolated excitable cell and to achieve increase of membrane rest potential (hyperpolarization). What ion channels should be activated to achieve such a result?

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

Reasoning: A negative overshoot called hyperpolarization occurs when potassium gates stay open longer than Na gates, so the amount of potassium that leaves the cell is greater than the amount of sodium that entered. Therefore, the membrane voltage drops to 1 or 2 mV more

negative than the original RMP. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 458).

11. Microelectrode technique allowed registering a potential following "all-or-none" law and being able of undecremental spreading. Specify this potential:

- A. *Excitatory postsynaptic potential.*
- B. *Inhibitory postsynaptic potential.*
- C. *Rest potential.*
- D. *Receptor potential.*
- E. *Action potential.*

Reasoning: Action potentials follow an **all-or-none law**. If a stimulus depolarizes the neuron to threshold, the neuron fires at its maximum voltage (such as +35 mV); if threshold is not reached, the neuron does not fire at all. Above threshold, stronger stimuli do not produce stronger action potentials. Thus, action potentials are not graded (proportional to stimulus strength). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 457).

Comparison of local potential and action potential

Local Potential	Action Potential
Produced by ligand-regulated gates on the dendrites and soma	Produced by voltage-regulated gates on the trigger zone and axon
May be a positive (depolarizing) or negative (hyperpolarizing) voltage change	Always begins with depolarization
Graded; proportional to stimulus strength	All-or-none; either does not occur at all or exhibits same peak voltage regardless of stimulus strength
Reversible; returns to RMP if stimulation ceases before threshold is reached	Irreversible; goes to completion once it begins
Local; has effects for only a short distance from point of origin	Self-propagating; has effects a great distance from point of origin
Decremental; signal grows weaker with distance	Nondecremental; signal maintains same strength regardless of distance

12. In course of an experiment there has been an increase in the nerve conduction velocity. This may be caused by an increase in the concentration of the following ions that are present in the solution around the cell:

- A. *K⁺ and Na⁺.*
- B. *K⁺ and Cl⁻.*
- C. *Ca₂⁺ and Cl⁻.*
- D. *Na⁺.*
- E. *Ca₂⁺*

Reasoning: When an action potential occurs at the trigger zone, Na enters the axon and diffuses to adjacent regions just beneath the plasma membrane. The resulting depolarization excites voltage-regulated gates immediately distal to the action potential. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 460).

13. Microelectrode analysis of nerve fiber bioelectrical activity revealed, that its membrane potential equals 90 mV. Its initial rest potential was 85 mV. What process occurs in this case?

- A. *Repolarization.*
- B. *Depolarization.*
- C. *Overshoot.*
- D. *Supernormality.*
- E. *Hyperpolarization.*

Reasoning: A negative overshoot called hyperpolarization when potassium gates stay open longer than Na gates, so the amount of potassium that leaves the cell is greater than the amount of sodium that entered. Therefore, the membrane voltage drops to 1 or 2 mV more negative than the original RMP (when RMP becomes more negative, it means that RMP increased). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 458).

14. It was established that the conduction velocity in the nerve fibers was equal to 120 m/sec. Specify these fibers:

- A. *Preganglionic sympathetic.*
- B. *Preganglionic parasympathetic.*
- C. *Postganglionic sympathetic.*
- D. *Postganglionic parasympathetic.*
- E. *Motoneuron axons.*

Reasoning: In large myelinated fibers impulses travel as fast as 120 m/sec. Fast myelinated fibers are employed where speed is important, as in motor commands to the skeletal muscles. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 453).

15. Curariform substances introduced into a human body cause the relaxation of all skeletal muscles. What changes in the neuromuscular synapse cause this phenomenon?

- A. Impaired acetylcholine release.
- B. Impaired cholinesterase synthesis.
- C. Blockade of Ca^{2+} channels of the presynaptic membrane.
- D. Blockade of N-cholinergic receptors of the synaptic membrane.**
- E. Depolarization of the postsynaptic membrane.

Reasoning: Flaccid paralysis is a state in which the muscles are limp and cannot contract. It can cause respiratory arrest when it affects the thoracic muscles. Flaccid paralysis can be caused by poisons such as curare that compete with ACh for receptor sites but do not stimulate the muscle. It has been used to treat muscle spasms in some neurological disorders and to relax abdominal muscles for surgery, but other muscle relaxants have now replaced curare for most purposes. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 414–415).

16. A patient came to the hospital complaining about quick fatigability and apparent muscle weakness. Examination revealed an autoimmune disease that causes disorder of functional receptor condition in neuromuscular synapses. What transmitter will be blocked?

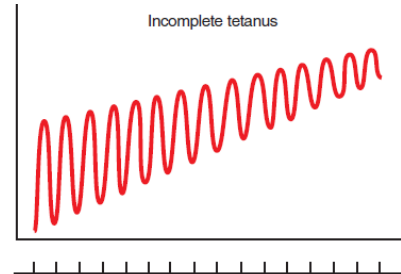
- A. Noradrenalin.
- B. Serotonin.
- C. Glycine.
- D. Dopamine.
- E. Acetylcholine.**

Reasoning: Many chemicals function as neurotransmitters, the one released at the neuromuscular junction is acetylcholine which is stored in spherical organelles called synaptic vesicles. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 414).

17. Isolated muscle of a frog is rhythmically irritated with electric impulses. Every next impulse is in a period of relaxation from the previous contraction. What contraction of the muscle appears?

- A. Tonic.
- B. Single.
- C. Continuous (smooth) tetanus.
- D. Asynchronous.
- E. Waved tetanus.**

Reasoning: At a higher stimulus frequency (20–40 stimuli/sec), each new stimulus arrives before the previous twitch is over (in period of relaxation). Each new twitch “rides piggyback” on the previous one and generates higher tension. This phenomenon goes by two names: temporal summation, because it results from two stimuli arriving close together, or wave summation, because it results from one wave of contraction added to another. Wave is added upon wave, so each twitch reaches a higher level of tension than the one before, and the muscle relaxes only partially between stimuli. This effect produces a state of sustained fluttering contraction called **incomplete tetanus**. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 425).



18. During the experiment on the influence chemical substances in the muscles the reaction of Ca^{2+} -pump is weakened. Which phenomenon will be observed?

- A. Activation of the sodium-potassium pump.
- B. Decreased AP.
- C. Prolonged duration of the AP
- D. Decreased velocity of the AP distribution.
- E. Prolonged relaxation.**

Reasoning: When work is done, a muscle fiber relaxes and returns to its resting length. Active transport pumps in the sarcoplasmic reticulum begin to pump Ca^{2+} from the cytosol back into the cisternae. Since active transport requires ATP, you can see that ATP is needed for muscle relaxation as well as for muscle contraction. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 422).

19. In course of an experiment a skeletal muscle is being stimulated by a series of electric impulses. What type of muscle contraction will arise, if every subsequent impulse comes in the period of shortening of the previous single muscle contraction?

A. *Asynchronous tetanus.*

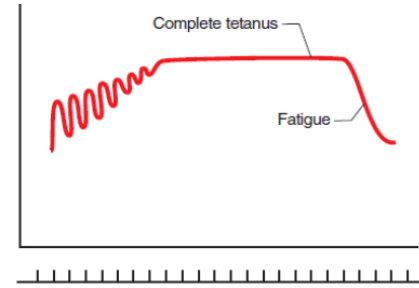
B. *Partial tetanus.*

C. ***Holotetanus (smooth).***

D. *A series of single contractions.*

E. *Muscle contracture.*

Reasoning: At a still higher frequency, such as 40 to 50 stimuli per second (when every next stimulus comes in period of contraction), the muscle has no time to relax at all between stimuli, and the twitches fuse into a smooth, prolonged contraction called **complete tetanus**. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 425).



20. Which muscle contraction will be observed in the upper extremity during holding (not moving) a load in a certain position?

A. *Isotonic.*

B. ***Isometric.***

C. *Auxotonic.*

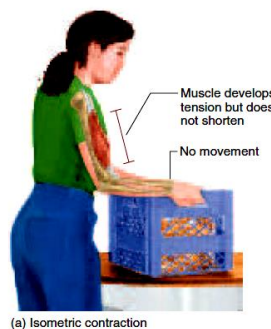
D. *Concentric.*

E. *Excentric.*

Reasoning:

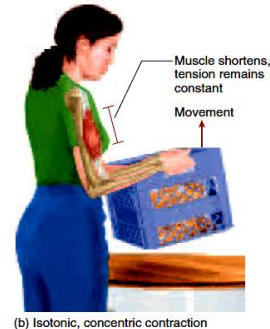
Isometric and Isotonic Contraction.

(a) Isometric contraction, in which a muscle develops tension but does not shorten. This occurs at the beginning of any muscle contraction but is prolonged in actions such as lifting heavy weights.

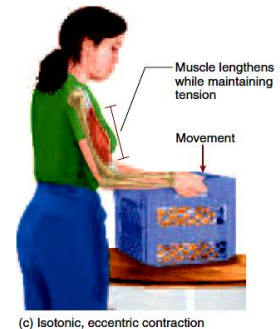


(a) Isometric contraction

(b) Isotonic concentric contraction, in which the muscle shortens while maintaining a constant degree of tension. In this phase, the muscle moves a load. (c) Isotonic eccentric contraction, in which the muscle maintains tension while it lengthens, allowing a muscle to relax without going suddenly limp. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 426).



(b) Isotonic, concentric contraction



(c) Isotonic, eccentric contraction

21. While exercising on a bicycle ergometer a sportsman was trying to choose such a load that would allow him to achieve the maximal performance of his muscles. What load intensity is required in this case?

A. *Minimal.*

C. *Maximal.*

E. *Continuous minimal.*

B. ***Middle.***

D. *Alternating minimal and maximal.*

Reasoning: The amount of tension generated by a muscle, and therefore the force of its contraction, depends on how stretched or contracted it was before it was stimulated, among other factors. This principle is called the length-tension relationship. If a fiber is overly contracted at rest, its thick filaments are rather close to the Z discs. The stimulated muscle may contract a little, but then the thick filaments butt up against the Z discs and can go no farther. The contraction is therefore a weak one. On the other hand, if a muscle fiber is too stretched before it is stimulated, there is relatively little overlap between its thick and thin filaments. When the muscle is stimulated, its myosin heads cannot “get a good grip” on the thin filaments, and again the contraction is weak. Between these extremes, there is an optimum resting length at which a muscle produces the greatest force when it contracts. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 422–423).

22. When measuring total muscle action potential it was subject to the power-law relationship. The reason for this is that individual muscle fibers differ in:

A. *Critical level of depolarization.*

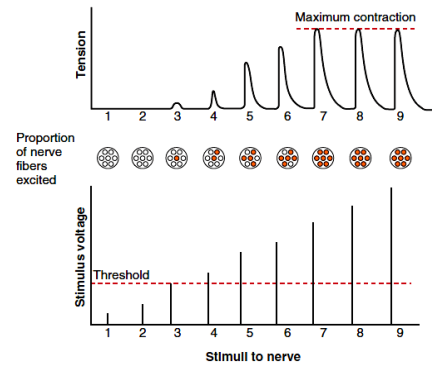
C. *Diameter.*

E. *Resting potential.*

B. ***Depolarization threshold.***

D. *Conduction velocity.*

Reasoning: The Relationship Between Stimulus Intensity (voltage) and Muscle Tension. Weak stimuli (1–2) fail to stimulate any nerve fibers and therefore produce no muscle contraction. When stimuli reach or exceed threshold (3–7), they excite more and more nerve fibers and motor units and produce stronger and stronger contractions. This is multiple motor unit summation (recruitment). Once all of the nerve fibers are stimulated (7–9), further increases in stimulus strength produce no further increase in muscle tension. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 424).

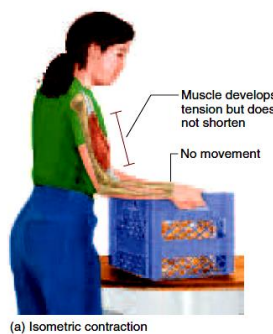


23. What kind of muscle contraction occurs in an upper limb during an attempt to lift a load beyond one's strength?

- A. *Isometric.* B. *Isotonic.* C. *Auxotonic.* D. *Phasic.* E. *Single.*

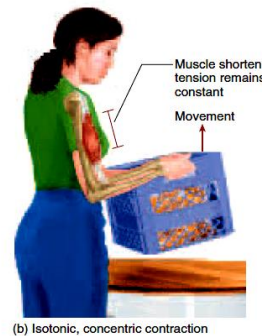
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Isometric and Isotonic Contraction.

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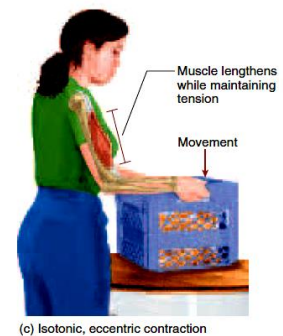


(a) Isometric contraction

(b) Isotonic concentric contraction, in which the muscle shortens while maintaining a constant degree of tension. In this phase, the muscle moves a load. (c) Isotonic eccentric contraction, in which the muscle maintains tension while it lengthens, allowing a muscle to relax without going suddenly limp. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 426).



(b) Isotonic, concentric contraction



(c) Isotonic, eccentric contraction

24. In the course of the experiment it is necessary to detect muscle excitation. For this purpose the following measurement should be made:

- A. *Electromyogram.* C. *Contraction duration.* E. *Ion concentration.*
B. *Mechanomyogram.* D. *Contraction strength.*

Reasoning: Electromyography EMG is an electrodiagnostic medicine technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG is performed using an instrument called an electromyography to produce a record called an electromyogram.

25. Increased stimulation rate of isolated heart of a rabbit leads to incomplete relaxation of the heart ventricles due to:

- A. *Inhibition of K-Na pump*
B. *Increased sodium content in cardiomyocytes*
C. *Increased content in cardiomyocytes*
D. *Increased potassium content in the interstitial tissue*
E. *Calcium accumulation in cardiomyocytes*

Reasoning: When work is done, a muscle fiber relaxes and returns to its resting length. Active transport pumps in the sarcoplasmic reticulum begin to pump Ca^{2+} from the cytosol back into the cisternae. Since active transport requires ATP, you can see that ATP is needed for muscle relaxation as well as for muscle contraction.

(Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 11 Muscular system, p. 422).

Physiology of central nervous system
Biological regulation. Reflex arc. Central synapses.
Mechanism of excitation and inhibition in CNS

1. Inhibition of alpha-motoneuron of the extensor muscles was noticed after stimulation of alpha-motoneuron of the flexor muscles during the experiment on the spinal column. What type of inhibition can this process cause?

- A. *Recurrent.* B. **Reciprocal.** C. *Presynaptic.* D. *Depolarizational.* E. *Lateral.*

Reasoning: Stretch reflexes and other muscle contractions often depend on reciprocal inhibition, a reflex phenomenon that prevents muscles from working against each other by inhibiting antagonists. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 506).

2. A sportsman was examined after an intensive physical activity. The examination revealed disorder of movement coordination but the force of muscle contractions remained the same. It can be explained by retarded speed of excitement conduction through:

- A. *Neuromuscular synapses.* C. **Central synapses.** E. *Afferent nerves.*
B. *Conduction tracts.* D. *Efferent nerves.*

Reasoning: Pool of neurotransmitter goes down during intensive physical activity and fatigue develops in central synapses which essential property is fatiguability. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 12. Nervous Tissue, p. 463).

3. After a long training session a sportsman has developed fatigue accompanied by abrupt performance decrement. What link of the reflex arch was the fatigue initiated in?

- A. *Muscles.* C. *Efferent conductor.* E. *Receptors.*
B. *Afferent conductor.* D. **Nerve centres.**

Reasoning: Fatiguability is essential property of nerve centers. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 12. Nervous Tissue, p. 465).

4. An experiment was aimed at testing flexor reflex in a spinal frog, which was initiated by simultaneous stimulation with isolated pre-threshold electrical impulses. The frequency of those impulses such, that the reflex occurred. What process in nerve centers can be observed during this experiment?

- A. *Presynaptic summation.* C. *Temporal summation.* E. **Spatial summation.**
B. *Postsynaptic summation.* D. *Threshold summation.*

Reasoning: Spatial summation occurs when EPSPs from several different synapses add up to threshold at the axon hillock. Any one synapse may admit only a moderate amount of Na⁺ into the cell, but several synapses acting together admit enough Na⁺ to reach a threshold. The presynaptic neurons cooperate to induce the postsynaptic neuron to fire. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 12. Nervous Tissue, p. 470).

Physiology of spinal cord

5. The ventral roots of 5 frontal segment of spinal cord were cut during experiment in the animal. What changes will take place in the innervation region?

- A. *Loss of temperature sensitivity.* D. **Loss of movements.**
B. *Loss of touch sensitivity.* E. *Hypersensitivity.*
C. *Loss of proprioceptive sensitivity.*

Reasoning: The ventral horns contain the large somas of the somatic motor neurons. Axons from these neurons exit by way of the ventral root of the spinal nerve and lead to the skeletal muscles. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 485).

6. When a patient with traumatic impairment of the brain was examined, it was discovered that he had stopped to distinguish displacement of an object on the skin. What part of the brain was damaged?

A. *Parietal zone of the cortex.*

D. ***Posterior central gyrus.***

B. *Frontal zone.*

E. *Occipital zone of the cortex.*

C. *Frontal central gyrus.*

Reasoning: The cortex of this gyrus is the primary somesthetic cortex (somatosensory area). Somesthetic fibers decussate on their way to the thalamus, so the right post- central gyrus receives signals from the left side of the body and the left gyrus receives signals from the right. (Saladin: *Anatomy & Physiology: The Unity of Form and Function (Third Edition)* / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 540).

7. During an experiment the dorsal roots of the spinal cord of an animal have been cut. What changes will be observed in the innervation zone?

A. *Sensitivity loss and loss of motor functions.*

D. *Decrease in muscle tone.*

B. *Loss of motor functions.*

E. *Increase in muscle tone.*

C. ***Sensitivity loss.***

Reasoning: The dorsal root carries sensory nerve fibers, which enter the dorsal horn of the cord and sometimes synapse with an interneuron there. (Saladin: *Anatomy & Physiology: The Unity of Form and Function (Third Edition)* / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 485).

8. An animal has an increased tonus of extensor muscles. This the result of intensified information transmission to the motoneurons of the spinal cord through the following descending pathways:

A. *Reticulospinal.*

C. *Lateral corticospinal.*

E. ***Vestibulospinal.***

B. *Rubrospinal.*

D. *Medial corticospinal.*

Reasoning: The vestibulospinal tract begins in a brainstem vestibular nucleus. The tract passes down the ventral column of the spinal cord and controls extensor muscles that maintain balance and posture. (Saladin: *Anatomy & Physiology: The Unity of Form and Function (Third Edition)* / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 489).

9. As a result of spinal-cord trauma a 33 y.o. man has a disturbed pain and temperature sensitivity that is caused by damage of the following tract:

A. *Medial spinocortical.*

C. *Posterior spinocerebellar.*

E. ***Spinothalamic.***

B. *Lateral spinocortical.*

D. *Anterior spinocerebellar.*

Reasoning: The spinothalamic tract passes up the anterior and lateral columns of the spinal cord. The spinothalamic tract carries signals for pain, temperature, pressure, tickle, itch, and light or crude touch. (Saladin: *Anatomy & Physiology: The Unity of Form and Function (Third Edition)* / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).

10. As a result of a trauma a patient has damaged anterior roots of spinal cord. What structures have been affected?

A. *Central processes of sensitive neurons of spinal ganglions.*

B. ***Axons of motoneurons and axons of neurons of lateral horns.***

C. *Axons of neurons of lateral horns.*

D. *Peripheral processes of sensitive spinal ganglions.*

E. *Dendrites of neurons of spinal ganglions.*

Reasoning: The ventral horns contain the large somas of the somatic motor neurons. Axons from these neurons exit by way of the ventral root of the spinal nerve and lead to the skeletal muscles. In the thoracic and lumbar regions, an additional lateral horn is visible on each side of the gray matter. It contains neurons of the sympathetic nervous system, which send their axons out of the cord by way of the ventral root along with the somatic efferent fibers. (Saladin: *Anatomy & Physiology: The Unity of Form and Function (Third Edition)* / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 485).

11. During an experiment the myotatic reflex has been studied in frogs. After extension in a skeletal muscle its reflectory contraction was absent. The reason for it might be a dysfunction of the following receptors:

- A. *Golgi tendon organs.* C. ***Muscle spindles.*** E. *Articular.*
B. *Tactile.* D. *Nociceptors.*

Reasoning: When a muscle is stretched, it “fights back”—it contracts, maintains increased tonus, and feels stiffer than an unstretched muscle. This response, called the stretch (myotatic) reflex, helps to maintain equilibrium and posture. Stretching of muscle stimulates their muscle spindles, which send afferent signals to nerve center (in spinal cord or brainstem) that leads to reflex contraction of stretched muscle. Thus, if stretching doesn’t lead to reflex contraction, it may be caused by dysfunction of muscle spindles. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 504).

12. A patient got an injury of spinal marrow in a road accident that caused loss of tactile sensation, posture sense, and vibration sense. What conduction tracts are damaged?

- A. *Anterior spinocerebellar tract.* D. *Tectospinal tract.*
B. *Rubrospinal tract.* E. ***Fascicle of Goll and cuneate fascicle.***
C. *Reticulospinal tract.*

Reasoning: The gracile fasciculus and cuneate fasciculus carry signals for vibration, visceral pain, deep and discriminative touch (touch whose location one can precisely identify), and especially proprioception from the lower limbs and lower trunk. (Proprioception is a nonvisual sense of the position and movements of the body.) (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).

13. As a result of a craniocerebral injury a patient has decreased skin sensitivity. What area of the cerebral cortex may be damaged?

- A. ***Posterior central gyrus.*** C. *Anterior central gyrus.* E. *Cingulate gyrus.*
B. *Frontal cortex.* D. *Occipital region.*

Reasoning: The cortex of this gyrus is the primary somesthetic cortex (somatosensory area) somesthetic fibers decussate on their way to the thalamus, so the right post- central gyrus receives signals from the left side of the body and the left gyrus receives signals from the right. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 540).

14. As a result of an injury of the anterior spinal cord root was broken. Specify the neurons and their processes that had been damaged:

- A. *Axons of sensory neurons.* C. ***Axons of motor neurons.*** E. *Dendrites of association*
B. *Dendrites of sensory neurons.* D. *Motor neuron dendrites.* *neurons.*

Reasoning: The ventral horns contain the large somas of the somatic motor neurons. Axons from these neurons exit by way of the ventral root of the spinal nerve and lead to the skeletal muscles. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 485).

15. During a brain surgery it was noticed that stimulation of certain zones of cerebral cortex caused tactile and thermal sensations in patient. Which zone was being stimulated?

- A. *Precentral gyrus.* C. *Superior lateral gyrus.* E. *Parahippocampal gyrus.*
B. ***Postcentral gyrus.*** D. *Cingulate gyrus.*

Reasoning: The gracile fasciculus and cuneate fasciculus carry signals for vibration, visceral pain, deep and discriminative touch (touch whose location one can precisely identify), and especially proprioception from the lower limbs and lower trunk. (Proprioception is a nonvisual sense of the position and movements of the body.). Postcentral gyrus is the final point of these pathways. The cortex of this gyrus is the primary somesthetic cortex (somatosensory area)

(Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).

16. A patient has damaged spinal cord white matter in the middle area of the posterior white columns, disrupted proprioceptive sensitivity of the lower limb joints and muscles. What fibers are affected?

A. *Tr. spinocerebellaris anterior.*

D. *Fasciculus gracilis.*

B. *Tr. spinothalamicus lateralis.*

E. *Tr. spinocerebellaris posterior.*

C. *Fasciculus cuneatus.*

Reasoning: The gracile fasciculus carries signals from the midthoracic and lower parts of the body. Below vertebra T6, it composes the entire dorsal column. At T6, it is joined by the cuneate fasciculus, discussed next. It consists of first-order nerve fibers that travel up the ipsilateral side of the spinal cord and terminate at the gracile nucleus in the medulla oblongata of the brainstem. These fibers carry signals for vibration, visceral pain, deep and discriminative touch (touch whose location one can precisely identify), and especially proprioception from the lower limbs and lower trunk. (Proprioception is a nonvisual sense of the position and movements of the body.).(Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).

17. After a traffic accident a 36-year-old patient has developed muscle paralysis of the extremities on the right, lost pain and thermal sensitivity on the left, and partially lost tactile sensitivity on both sides. What part of the brain is the most likely to be damaged?

A. *Right-hand side of the spinal cord.*

D. *Anterior horn of the spinal cord.*

B. *Motor cortex on the left.*

E. *Posterior horn of the spinal cord.*

C. *Left-hand side of the spinal cord.*

Reasoning: If the spinal cord is transected entirely, all sensations and motor functions distal to the segment of transection are blocked, but if the spinal cord is transected on only one side, the Brown-Séquard syndrome occurs. All motor functions are blocked on the side of the transection in all segments below the level of the transection. Yet only some of the modalities of sensation are lost on the transected side, and others are lost on the opposite side. The sensations of pain, heat, and cold—sensations served by the spinothalamic pathway—are lost on the opposite side of the body in all dermatomes two to six segments below the level of the transection. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit IX The Nervous System: A. General Principles and Sensory Physiology, p. 606).

18. During examination a neurologist taps the tendon under the patient's kneecap with a reflex hammer to evaluate reflex extension of the knee. This response is provoked by stimulation of the following receptors:

A. *Tactile receptors.*

C. *Golgi tendon organ.*

E. *Articular receptors.*

B. *Muscle spindles.*

D. *Nociceptors.*

Reasoning: A stretch reflex is mediated primarily by the brain and is not, therefore, strictly a spinal reflex, but a weak component of it is spinal and occurs even if the spinal cord is severed from the brain. The spinal component can be more pronounced if a muscle is stretched very suddenly. This occurs in a tendon reflex—the reflexive contraction of a muscle when its tendon is tapped, as in the familiar knee-jerk (patellar) reflex. Tapping the patellar ligament with a reflex hammer suddenly stretches the quadriceps femoris muscle of the thigh. This stimulates numerous muscle spindles in the quadriceps and sends an intense volley of signals to the spinal cord, mainly by way of primary afferent fibers. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 505).

19. An experiment was conducted to measure the threshold of tactile receptors stimulation with various stimuli. What stimulation will have the lowest threshold?

A. *Chemical stimulus.*

C. *Heat stimulus.*

E. *Cold stimulus.*

B. *Mechanical stimulus.*

D. *Photic stimulus.*

Reasoning: Tactile receptors are adapted to detection of various mechanical stimuli. Depending on type of receptor, they detect such modalities of stimuli as light touch, texture, deep pressure, stretch, tickle, and vibration. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. The Sense Organs, p. 588).

20. During a brain surgery stimulation of the cerebral cortex resulted in tactile and thermal sensations in the patient. What gyrus was stimulated?

- A. *Superior temporal gyrus.* C. *Cingulate convolution.* E. *Postcentral gyrus.*
B. *Precentral gyrus.* D. *Parahippocampal gyrus.*

Reasoning: The spinothalamic tract passes up the anterior and lateral columns of the spinal cord. The spinothalamic tract carries signals for pain, temperature, pressure, tickle, itch, and light or crude touch. Postcentral gyrus is the final point of these pathways. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).

Physiology of brainstem

21. As a result of damage to certain structures of brainstem an animal lost orientation reflexes. What structures were damaged?

- A. *Medial nuclei of reticular formation.* D. *Red nuclei.*
B. *Black substanc.* E. *Vestibular nuclei.*
C. *Quadritubercular bodies.*

Reasoning: Orientation reflexes are the reflex movements of the head, especially in response to visual and auditory stimuli. They are provided by tectospinal tract that begins in a midbrain region called the tectum and crosses to the contralateral side of the brainstem. The tectum consists of four nuclei, the corpora quadrigemina (also called quadrigeminal plate or quadritubercular bodies), which bulge from the midbrain roof. The two superior nuclei, called the superior (or anterior) colliculi, function in visual attention, visually tracking moving objects, and such reflexes as turning the eyes and head in response to a visual stimulus, for example to look at something that you catch sight of in your peripheral vision. The two inferior (or posterior) colliculi receive afferent signals from the inner ear and relay them to other parts of the brain, especially the thalamus. Among other functions, they mediate the reflexive turning of the head in response to a sound. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 528).

22. After destruction of CNS structures an animal lost orientative reflexes. What structure was destroyed?

- A. *Lateral vestibular nuclei.* C. *Medial reticular nuclei.* E. *Red nucleus.*
B. *Black substance.* D. *Quadrigeminal plate.*

Reasoning: Orientation reflexes are the reflex movements of the head, especially in response to visual and auditory stimuli. They are provided by tectospinal tract that begins in a midbrain region called the tectum and crosses to the contralateral side of the brainstem. The tectum consists of four nuclei, the corpora quadrigemina (also called quadrigeminal plate or quadritubercular bodies), which bulge from the midbrain roof. The two superior nuclei, called the superior (or anterior) colliculi, function in visual attention, visually tracking moving objects, and such reflexes as turning the eyes and head in response to a visual stimulus, for example to look at something that you catch sight of in your peripheral vision. The two inferior (or posterior) colliculi receive afferent signals from the inner ear and relay them to other parts of the brain, especially the thalamus. Among other functions, they mediate the reflexive turning of the head in response to a sound. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 528).

23. A patient with disturbed cerebral circulation has problems with deglutition. What part of brain was damaged?

- A. *Forebrain.* C. *Midbrain.* E. *Cervical part of spinal cord.*
B. *Interbrain.* D. *Brainstem.*

Reasoning: Nuclei of the medulla that is a part of brainstem are concerned with speech, coughing, sneezing, salivation, swallowing, gagging, vomiting, gastrointestinal secretion, sweating, and movements of the tongue and head. Many of the medulla's sensory and motor functions are mediated through the last four cranial nerves, which begin or end here: cranial nerves IX (glossopharyngeal), X (vagus), XI (accessory), and XII (hypoglossal). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 526).

24. As a result of destruction of certain brainstem structures an animal has lost its orientative reflexes in response to strong photic stimuli. What structures were destroyed?

- A. *Posterior tubercles of quadrigeminal plate.* D. *Vestibular nuclei.*
B. *Anterior tubercles of quadrigeminal plate.* E. *Black substance.*
C. *Red nuclei.*

Reasoning: Orientation reflexes are the reflex movements of the head, especially in response to visual and auditory stimuli. They are provided by tectospinal tract that begins in a midbrain region called the tectum and crosses to the contralateral side of the brainstem. The tectum consists of four nuclei, the corpora quadrigemina (also called quadrigeminal plate or quadritubercular bodies), which bulge from the midbrain roof. The two superior nuclei, called the superior (or anterior) colliculi, function in visual attention, visually tracking moving objects, and such reflexes as turning the eyes and head in response to a visual stimulus, for example to look at something that you catch sight of in your peripheral vision. The two inferior (or posterior) colliculi receive afferent signals from the inner ear and relay them to other parts of the brain, especially the thalamus. Among other functions, they mediate the reflexive turning of the head in response to a sound. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 528).

25. A laboratory experiment on dog was used to study central parts of auditory system. One of the mesencephalon structures was destroyed. The dog has lost its orientating response to auditory stimuli. What structures were destroyed?

- A. *Inferior colliculi of corpora quadrigemina.* D. *Vestibular nuclei.*
B. *Superior colliculi of corpora quadrigemina.* E. *Black substance.*
C. *Red nuclei.*

Reasoning: Orientation reflexes are the reflex movements of the head, especially in response to visual and auditory stimuli. They are provided by tectospinal tract that begins in a midbrain region called the tectum and crosses to the contralateral side of the brainstem. The tectum consists of four nuclei, the corpora quadrigemina (also called quadrigeminal plate or quadritubercular bodies), which bulge from the midbrain roof. The two superior nuclei, called the superior (or anterior) colliculi, function in visual attention, visually tracking moving objects, and such reflexes as turning the eyes and head in response to a visual stimulus, for example to look at something that you catch sight of in your peripheral vision. The two inferior (or posterior) colliculi receive afferent signals from the inner ear and relay them to other parts of the brain, especially the thalamus. Among other functions, they mediate the reflexive turning of the head in response to a sound. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 528).

26. In the experiment, an animal had its brainstem cut, which caused a rapid increase of extensor muscle tone (decerebrate rigidity). This condition arose because the muscles were no more under the control of the following brain structure:

- A. *Black substance.* B. *Red nucleus.* C. *Blue spot.* D. *Striatum.* E. *Gray tuber.*

Reasoning: When the brain stem of an animal is sectioned below the midlevel of the mesencephalon, but the pontine and medullary reticular systems as well as the vestibular system are left intact, the animal develops a condition called decerebrate rigidity. This rigidity does not

occur in all muscles of the body but does occur in the antigravity muscles—the muscles of the neck and trunk and the extensors of the legs. The cause of decerebrate rigidity is blockage of normally strong input to the medullary reticular nuclei from the cerebral cortex, the red nuclei, and the basal ganglia. Lacking this input, the medullary reticular inhibitor system becomes nonfunctional; full overactivity of the pontine excitatory system occurs, and rigidity develops (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XI The Nervous System: C. Motor and Integrative Neurophysiology, p. 692).

27. In course of an experiment a nerve is being stimulated by electric impulses. As a result of it sublingual and submaxillary glands discharge some dense viscous saliva. What nerve is being stimulated?

A. *N. glossopharyngeus.* B. *N. facialis.* C. *N. trigeminus.* D. *N. vagus.* E. *N. sympathicus.*

Reasoning: Salivary glands have dual innervation – sympathetic (by sympathetic nerves from Th2-6 segments of spinal cord through superior cervical ganglion) and parasympathetic (glossopharyngeal nerve (IX) innervates parotid gland and facial nerve (VII) innervates sublingual and submandibular glands). Thick mucous secretion of salivary glands is caused by their sympathetic stimulation (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 15. The Autonomic Nervous and Visceral Reflexes, p. 589).

28. A patient was diagnosed with paralysis of facial and masticatory muscles. The haematoma is inside the genu of internal capsule. What conduction tract is damaged?

A. *Tr. Cortico-spinalis.* C. *Tr. Cortico-fronto-pontinus.* E. *Tr. Cortico-temporo-parieto-occipitopontinus.*
B. *Tr. Cortico-thalamicus.* D. *Tr. Cortico-nuclearis.*

Reasoning: Corticobulbar (or corticonuclear) tract arises in the motor cortex and influence lower motoneurons in all brain stem nuclei that innervate skeletal muscles. This includes: • Muscles of mastication (CN V); • Muscles of facial expression (CN VII) - (partially bilateral); • Palate, pharynx, and larynx (CN X); • Tongue (CN XII); • Sternocleidomastoid and trapezius muscles (CN XI) (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 5 The Brain Stem, p. 396).

29. A patient caught a cold after which there appeared facial expression disorder. He cannot close his eyes, raise his eyebrows, bare his teeth. What nerve is damaged?

A. *Infraorbital.* B. *Trigeminus.* C. *Facial.* D. *Glossopharyngeal.* E. *Vagus.*

Reasoning: Functions of the facial nerve include major motor innervation of facial expression muscles; autonomic control of tear glands, nasal and palatine glands, submandibular and sublingual salivary glands; sense of taste from anterior 2/3 of tongue. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 552).

30. A 49-year old female patient has limitation of left limbs arbitrary movements. Muscular tonus of left hand and leg is overstrained and spasmodic, local tendon reflexes are strong, pathological reflexes are presented. What is the most likely development mechanism of hypertension and hyperreflexia?

A. *Motoneuron activation induced by stroke.*
B. *Activation of excitatory influence from the focus of stroke.*
C. *Inhibition of cerebral cortex motoneurons.*
D. *Reduction of descending inhibitory influence.*
E. *Activation of synaptic transmission.*

Reasoning: Upper motoneurons including the corticospinal tract have a net overall inhibitory effect on muscle stretch reflexes. As a result, upper motoneuron lesions combine paresis of skeletal muscles with muscle stretch or deep tendon reflexes that are hyperactive or hypertonic. The hypertonia may be seen as decorticate rigidity (i.e., postural flexion of the arm and extension of the leg) or decerebrate rigidity (i.e., postural extension of the arm and leg) depending on the location of the lesion. Lesions above the midbrain produce decorticate rigidity; lesions below the mid brain produce decerebrate rigidity. Upper motoneuron lesions result in atrophy of weakened muscles only as a result of disuse, because these muscles can still be contracted by stimulating muscle

stretch reflexes. In contrast to lower motoneuron lesions, lesions of upper motoneurons result in a spastic paresis that is ipsilateral or contra lateral and below the site of the lesion. Upper motoneuron lesions anywhere in the spinal cord will result in an ipsilateral spastic paresis below the level of the lesion. Upper motoneuron lesions between the cerebral cortex and the medulla above the decussation of the pyramids will result in a contra lateral spastic paresis below the level of the lesion. (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 5 The Brain Stem, p. 367).

31. The patient's pyramids of the medulla oblongata are damaged by tumor growth. As a result the conduction of nervous impulses will be impaired in the following pathway:

- A. *Tr. Corticonuclearis.* C. *Tr. Spinocerebellaris.* E. *Tr. Corticopontinus.*
 B. *Tr. Corticospinalis.* D. *Tr. Dentatorubralis.*

Reasoning: The corticospinal tracts carry motor signals from the cerebral cortex for precise, finely coordinated limb movements. The fibers of this system form ridges called pyramids on the ventral surface of the medulla oblongata, so these tracts were once called pyramidal tracts. Most corticospinal fibers decussate in the lower medulla and form the lateral corticospinal tract on the contralateral side of the spinal cord. A few fibers remain uncrossed and form the ventral corticospinal tract on the ipsilateral side. Fibers of the ventral tract decussate lower in the spinal cord, however, so even they control contralateral muscles. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 526).

32. Vestibular receptors of semicircular canals of an animal have been destroyed. What reflexes will disappear as a result?

- A. *Statokinetic reflex during movements with angular acceleration.* D. *Body-righting reflex.*
 B. *Statokinetic reflex during movements with linear acceleration.* E. *Primary orienting reflex.*
 C. *Head-righting reflex.*

Reasoning: The sense of equilibrium is divided into static equilibrium, the perception of the orientation of the head when the body is stationary, and dynamic equilibrium, the perception of motion or acceleration. Acceleration is divided into linear acceleration, a change in velocity in a straight line, as when riding in a car or elevator, and angular acceleration, a change in the rate of rotation. The saccule and utricle are responsible for static equilibrium and the sense of linear acceleration; the semicircular ducts detect only angular acceleration. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16, Sense Organs, p. 606).

33. A patient complains of an increased sensitivity of the posterior third of his tongue as well as of a gustatory disturbance in this region. What nerve is damaged?

- A. *Trigeminal.* B. *Facial.* C. *Glossopharyngeal.* D. *Accessory.* E. *Hypoglossal.*

Reasoning: Glossopharyngeal nerve innervates pharynx, middle and outer ear, posterior one-third of tongue (including taste buds), internal carotid arteries. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 553).

34. A patient consulted a doctor about loss of taste sensitivity on the tongue root. The doctor revealed that it is caused by nerve affection. Which nerve is it?

- A. *Trigeminal nerve.* C. *Glossopharyngeal.* E. *Superlaryngeal nerve.*
 B. *Facial nerve.* D. *Vagus nerve.*

Reasoning: Glossopharyngeal nerve innervates pharynx, middle and outer ear, posterior one-third of tongue (including taste buds), internal carotid arteries. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 553).

35. A patient consulted a doctor about a sensation of imbalance which appeared after a trauma. Which nerve is damaged?

- A. *Trigeminal nerve.* C. *Vagus nerve.* E. *Intermediate nerve.*
 B. *Facial nerve.* D. *Vestibulocochlear nerve.*

Reasoning: Function of vestibulocochlear nerve is providing of hearing and equilibrium. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 553).

36. As a result of a cold a patient has the abnormal pain and temperature sensitivity of the frontal 2/3 of his tongue. Which nerve must have been damaged?

A. *Trigeminus.* B. *Vagus.* C. *Glossopharyngeal.* D. *Sublingual.* E. *Accessory.*

Reasoning: Trigeminal nerve has three divisions. V1, Ophthalmic Division. Function: main sensory nerve of upper face (touch, **temperature, pain**); origin: superior region of face as illustrated, surface of eyeball, tear gland, superior nasal mucosa, frontal and ethmoid sinuses, effects of damage: loss of sensation; V2, Maxillary Division. Function: same sensations as V1 lower on face, origin: middle region of face as illustrated, nasal mucosa, maxillary sinus, palate, upper teeth and gums, effects of damage: loss of sensation; V3, Mandibular Division. Function: same sensations as V1–V2 lower on face; mastication. Sensory origin: Inferior region of face as illustrated, anterior two-thirds of tongue (but not taste buds), lower teeth and gums, floor of mouth, dura mater. Effects of damage: Loss of sensation; impaired chewing. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 551).

37. A 36-year-old patient had had a traumatic brain injury caused a swallowing impairment. Which part of brain was affected?

A. *Reticular formation.* C. *Diencephalon.* E. *Thalamus.*
B. *Medulla oblongata.* D. *Mesencephalon.*

Reasoning: Nuclei of the medulla that is a part of brainstem are concerned with speech, coughing, sneezing, salivation, swallowing, gagging, vomiting, gastrointestinal secretion, sweating, and movements of the tongue and head. Many of the medulla's sensory and motor functions are mediated through the last four cranial nerves, which begin or end here: cranial nerves IX (glossopharyngeal), X (vagus), XI (accessory), and XII (hypoglossal). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 526).

38. On examination a patient was found to have medial strabismus, the inward deviation of the eyeball and inability to abduct the eyeball outwards. What nerve is damaged?

A. *Oculomotor.* B. *Ocular.* C. *Trochlear.* D. *Abducent* E. *Visual.*

Reasoning: Abducent nerve innervates lateral rectus muscle of eye. Function of abducent nerve is providing eye movements to lateral side (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 552).

39. A 70-year-old patient is diagnosed with brainstem hemorrhage. Examination revealed increased tonus of flexor muscles accompanied by decreased tonus of extensor muscles. Such changes in muscle tonus can be explained by the irritation of the following brain structures:

A. *Reticular formation.* C. *Red nuclei.* E. *Black substance.*
B. *Vestibular nuclei.* D. *Quadrigeminal plate.*

Reasoning: Red nuclei through the rubrospinal pathways provide tonus of flexor muscles. If it increases, tonus of extensor muscles decreases. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 489).

40. In a cat with decerebrate rigidity the muscle tone is to be decreased. This can be achieved by:

A. *Stimulation of ampullar vestibular receptors.* D. *Stimulation of the vestibulocochlear nerve.*
B. *Stimulation of vestibular nuclei of Deiters.* E. *Destruction of vestibular nuclei of Deiters.*
C. *Stimulation of otolithic vestibular receptors.*

Reasoning: Rubrospinal and vestibulospinal pathways have reciprocal interconnections. Vestibular nuclei of Deiters through the vestibulospinal pathways provide tonus of extensor muscles. If it increases, tonus of flexor muscles decreases. (Saladin: Anatomy & Physiology:

The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 489).

41. Surface with an intact toad on it was inclined to the right. Tone of extensor muscles became reflectory higher due to the activation of the following receptors:

- A. Photoreceptors of retina.
- B. Vestibuloreceptors of semicircular ducts.
- C. Vestibuloreceptors of utricle and saccule.
- D. Proprioceptors.
- E. Mechanoreceptors of foot skin.

Reasoning: The sense of equilibrium is divided into static equilibrium, the perception of the orientation of the head when the body is stationary, and dynamic equilibrium, the perception of motion or acceleration. Acceleration is divided into linear acceleration, a change in velocity in a straight line, as when riding in a car or elevator, and angular acceleration, a change in the rate of rotation. The saccule and utricle are responsible for static equilibrium and the sense of linear acceleration; the semicircular ducts detect only angular acceleration. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16, Sense Organs, p. 606).

42. After a case of common cold the patient developed numbness of the right side of the face. Examination revealed disturbed pain and thermal sensitivity in the right half of the face. What nerve was damaged?

- A. Glossopharyngeal.
- B. Facial.
- C. Trigeminal.
- D. Hypoglossal.
- E. Vagus.

Reasoning: Trigeminal nerve has three divisions. V1, Ophthalmic Division. Function: main sensory nerve of upper face (touch, **temperature, pain**); origin: superior region of face as illustrated, surface of eyeball, tear gland, superior nasal mucosa, frontal and ethmoid sinuses, effects of damage: loss of sensation; V2, Maxillary Division. Function: same sensations as V1 lower on face, origin: middle region of face as illustrated, nasal mucosa, maxillary sinus, palate, upper teeth and gums, effects of damage: loss of sensation; V3, Mandibular Division. Function: same sensations as V1–V2 lower on face; mastication. Sensory origin: Inferior region of face as illustrated, anterior two-thirds of tongue (but not taste buds), lower teeth and gums, floor of mouth, dura mater. Effects of damage: Loss of sensation; impaired chewing. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 551).

43. An 84-year-old patient suffers from parkinsonism. One of the pathogenetic development elements of this disease is deficiency of a certain mediator in some of the brain structures. Name this mediator:

- A. Dopamine.
- B. Acetylcholine.
- C. Noradrenaline.
- D. Histamine.
- E. Adrenaline.

Reasoning: The substantia nigra, a dark gray to black nucleus pigmented with melanin and dopamine. This is a motor center that relays inhibitory signals to the thalamus and basal nuclei. Degeneration of the neurons in the substantia nigra leads to the muscle tremors of Parkinson disease. Parkinson30 disease (PD), also called paralysis agitans or parkinsonism, is a progressive loss of motor function beginning in a person’s 50s or 60s. It is due to degeneration of dopamine-releasing neurons in substantia nigra. Dopamine (DA) is an inhibitory neurotransmitter that normally prevents excessive activity in the basal nuclei. Degeneration of the dopamine-releasing neurons leads to an excessive ratio of ACh to DA, leading to hyperactivity of the basal nuclei. As a result, a person with PD suffers involuntary muscle contractions. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 475, 527).

Physiology of cerebellum, basal ganglia, cerebral cortex

44. Due to cranial trauma the patient developed the symptoms: intention tremor, dysmetria, adiadochokinesis, dysarthria. What structure of the brain is injured?

- A. Motor cortex.
- B. Pale sphere.
- C. Black substance.
- D. Cerebellu.
- E. Striatum.

Reasoning: The cerebellum smooths muscle contractions, maintains muscle tone and posture, coordinates the motions of different joints with each other (such as the shoulder and elbow joints in pitching a baseball), coordinates eye and body movements, and aids in learning motor skills. It

receives signals from the upper motor neurons about intended movements and gets feedback about the actual performance from proprioceptors in the muscles and joints, via the spinocerebellar tracts of the spinal cord. Main symptoms of lesions in the cerebellum are intention tremor, dysmetria (past pointing), dysdiadochokinesia (adiadochokinesia), scanning dysarthria, gaze dysfunction (nystagmus), hypotonia of muscles, difficulty maintaining posture, gait, or balance (an ataxic gait). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 543–544) (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 426).

45. A 50 year-old patient was injured on occipital region of the head. The closed skull's trauma was diagnosed. She 'as taken to the hospital. The medical examination on: deregulation of walking and balance, trembling of arms. What part of brain was injured?

- A. *The mind-brain.* C. *The medulla oblongata.* E. *The spinal cord.*
B. *The inter-brain.* D. ***The cerebellum.***

Reasoning: The cerebellum smooths muscle contractions, maintains muscle tone and posture, coordinates the motions of different joints with each other (such as the shoulder and elbow joints in pitching a baseball), coordinates eye and body movements, and aids in learning motor skills. It receives signals from the upper motor neurons about intended movements and gets feedback about the actual performance from proprioceptors in the muscles and joints, via the spinocerebellar tracts of the spinal cord. Main symptoms of lesions in the cerebellum are intention tremor, dysmetria (past pointing), dysdiadochokinesia (adiadochokinesia), scanning dysarthria, gaze dysfunction (nystagmus), hypotonia of muscles, difficulty maintaining posture, gait, or balance (an ataxic gait). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 543–544) (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 426).

46. A patient staggers and walks astraddle. He has hypomyotonia of arm and leg muscles, staccato speech. In what brain section is this affection localized?

- A. *Putamen.* B. *Caudate nucleus .* C. *Motor cortex.* D. *Red nucleus* E. ***Cerebellum.***

Reasoning: The cerebellum smooths muscle contractions, maintains muscle tone and posture, coordinates the motions of different joints with each other (such as the shoulder and elbow joints in pitching a baseball), coordinates eye and body movements, and aids in learning motor skills. It receives signals from the upper motor neurons about intended movements and gets feedback about the actual performance from proprioceptors in the muscles and joints, via the spinocerebellar tracts of the spinal cord. Main symptoms of lesions in the cerebellum are intention tremor, dysmetria (past pointing), dysdiadochokinesia (adiadochokinesia), scanning dysarthria, gaze dysfunction (nystagmus), hypotonia of muscles, difficulty maintaining posture, gait, or balance (an ataxic gait). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 543–544) (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 426).

47. Cerebral hemorrhage caused serious disturbance of taste sensibility. What brain structure is most likely to be damaged?

- A. *Hypothalamus.* C. ***Postcentral gyrus.*** E. *Substantia nigra.*
B. *Amygdaloid body.* D. *Hippocampus.*

Reasoning: All taste fibers synapse in the posterior brain stem in the nuclei of the tractus solitarius. These nuclei send second-order neurons to a small area of the ventral posterior medial nucleus of the thalamus, located slightly medial to the thalamic terminations of the facial regions of the dorsal column–medial lemniscal system. From the thalamus, third-order neurons are transmitted to the **lower tip of the postcentral gyrus** in the parietal cerebral cortex, where it curls deep into the sylvian fissure, and into the adjacent opercular insular area. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit X The Nervous System: B. The Special Senses, p. 666).

48. A patient after hypertension stroke does not have voluntary movements in his right arm and leg with the increased muscle tone in these extremities. What type of dysfunction of nervous system is it?

A. *Central paresis.*

C. ***Central paralysis.***

E. *Reflex paresis.*

B. *Peripheral paresis.*

D. *Peripheral paralysis.*

Reasoning: Paresis is the limitation of voluntary movements, while paralysis is total absence of voluntary movement. Peripheral paresis and paralysis result from lesion of lower motoneuron and are characterized by hypoactive muscle stretch reflexes and a reduction in muscle tone (hypotonicity) because lower motoneurons form the motor component of the reflex (thus, peripheral paralysis is flaccid paralysis). Central paresis and paralysis are the result of upper motoneuron lesions when muscle stretch or deep tendon reflexes are hyperactive or hypertonic. Thus, if there is total absence of voluntary movement with increased muscle tone it's central paralysis (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 5 The Brain Stem, p. 367).

49. A patient has a haemorrhage into the posterior central gyrus. What type of sensitivity on the opposite side will be disturbed?

A. *Visual.*

C. *Olfactory.*

E. ***Skin and proprioceptive.***

B. *Auditory.*

D. *Auditory and visual.*

Reasoning: The cortex of postcentral gyrus is the primary somesthetic cortex (somatosensory area). Skin and proprioceptive sensitivity (signals for pain, temperature, pressure, tickle, itch, and light or crude touch) is carried into the postcentral gyrus by spinothalamic tracts. Spinothalamic tracts decussate on their way to the thalamus (decussation is in same segment of spinal cord where they enter or few segments higher), so the right postcentral gyrus receives signals from the left side of the body and the left gyrus receives signals from the right. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487, 540).

50. A patient complains of rapid fatigability. Objectively: he staggers and overbalances in the upright position with closed eyes. Skeleton muscular tonus is decreased. What brain structure is most likely to be damaged?

A. *Precentral gyrus of cerebrum cortex.*

C. ***Cerebellum.***

E. *Hypothalamus.*

B. *Basal ganglions.*

D. *Thalamus.*

Reasoning: The cerebellum smooths muscle contractions, maintains muscle tone and posture, coordinates the motions of different joints with each other (such as the shoulder and elbow joints in pitching a baseball), coordinates eye and body movements, and aids in learning motor skills. It receives signals from the upper motor neurons about intended movements and gets feedback about the actual performance from proprioceptors in the muscles and joints, via the spinocerebellar tracts of the spinal cord. Main symptoms of lesions in the cerebellum are intention tremor, dysmetria (past pointing), dysdiadochokinesia (adiadochokinesia), scanning dysarthria, gaze dysfunction (nystagmus), hypotonia of muscles, difficulty maintaining posture, gait, or balance (an ataxic gait). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 543 –544) (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 426).

51. A patient got a trauma that caused dysfunction of motor centres regulating activity of head muscles. In what parts of cerebral cortex is the respective centre normally localized?

A. *Superior part of precentral gyrus.*

D. *Superior parietal lobule.*

B. ***Inferior part of precentral gyrus.***

E. *Angular gyrus.*

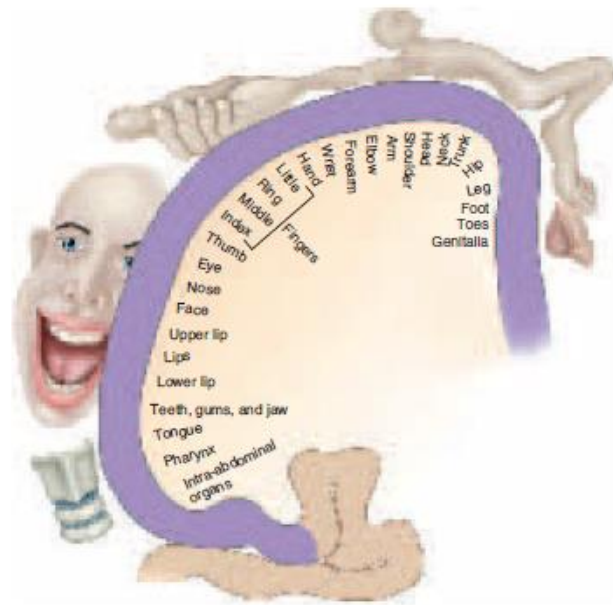
C. *Supramarginal gyrus.*

Reasoning: Somesthetic nerve signals travel up the spinal cord and brainstem to the thalamus, which routes them to the postcentral gyrus. The cortex of this gyrus is the primary somesthetic cortex (somatosensory area). Somesthetic fibers decussate on their way to the thalamus, so the right postcentral gyrus receives signals from the left side of the body and the left gyrus receives

signals from the right. Each gyrus is like an upside-down sensory map of the contralateral side of the body, traditionally diagrammed as a sensory homunculus. As the diagram shows, receptors in the lower limb project to the superior and medial parts of the gyrus and receptors in the face project to the inferior and lateral parts of the gyrus. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 540–541).

52. After a craniocerebral trauma a patient lost the ability to execute learned purposeful movements (apraxia). The injury is most likely localized in the following region of the cerebral cortex:
- A. *Gyrus parahippocampalis*. C. *Gyrus angularis*. E. *Gyrus paracentralis*.
 B. *Gyrus lingualis*. D. *Gyrus supramarginalis*.

Reasoning: The supramarginal gyrus is part of the somatosensory association cortex in posterior parietal association cortex, which interprets tactile sensory data and is involved in perception of space and limbs location. Lesions, usually in the dominant hemisphere which include areas of the posterior parietal association areas, often result in apraxia (also seen with lesions to the premotor cortex). Apraxia is a disruption of the patterning and execution of learned motor movements. This deficit seems to reflect a lack of understanding how to organize the performance of a pattern of movements (i.e., what should be done first, then next, etc.). The patient may be unable, for example, to draw a simple diagram (constructional apraxia) or describe how to get from his home to his work. Apraxia is probably a result of the loss of input to the premotor cortex (area 6), which is involved in the actual organization of motor movements into a goal-directed pattern. Lesions of angular gyrus in the dominant parietal lobe leads to alexia with agraphia (inability to read or write). (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 10 Cerebral Cortex, p. 465, 468).



53. A patient underwent an extraction of a part of a CNS structures by medical indications. As a result of the extraction the patient developed atony, astasia, intention tremor, ataxy and adiadochokinesis. Which part of CNS structure had been extracted?
- A. *Basal ganglions*. C. *Amygdaloid corpus*. E. *Limbic system*.
 B. *Cerebellum*. D. *Hippocamp*.

Reasoning: The cerebellum smooths muscle contractions, maintains muscle tone and posture, coordinates the motions of different joints with each other (such as the shoulder and elbow joints in pitching a baseball), coordinates eye and body movements, and aids in learning motor skills. It receives signals from the upper motor neurons about intended movements and gets feedback about the actual performance from proprioceptors in the muscles and joints, via the spinocerebellar tracts of the spinal cord. Main symptoms of lesions in the cerebellum are intention tremor, dysmetria (past pointing), dysdiadochokinesia (adiadochokinesia), scanning dysarthria, gaze dysfunction (nystagmus), hypotonia of muscles, difficulty maintaining posture, gait, or balance (an ataxic gait). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 543–544) (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 426).

54. A patient presents with the following motor activity disturbances: tremor, ataxia and asynergia movements, dysarthria. The disturbances are most likely to be localized in:
- A. *Cerebellum*. B. *Brainstem*. C. *Medulla oblongata*. D. *Basal ganglions*. E. *Limbic system*.

Reasoning: The cerebellum smooths muscle contractions, maintains muscle tone and posture, coordinates the motions of different joints with each other (such as the shoulder and elbow joints in pitching a baseball), coordinates eye and body movements, and aids in learning motor skills. It receives signals from the upper motor neurons about intended movements and gets feedback about the actual performance from proprioceptors in the muscles and joints, via the spinocerebellar tracts of the spinal cord. Main symptoms of lesions in the cerebellum are intention tremor, dysmetria (past pointing), dysdiadochokinesia (adiadochokinesia), scanning dysarthria, gaze dysfunction (nystagmus), hypotonia of muscles, difficulty maintaining posture, gait, or balance (an ataxic gait). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 543 –544) (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 426).

55. A male with a lesion of one of the CNS parts has asthenia, muscular dystonia, balance disorder. Which CNS part has been affected?

- A. *Vestibular nuclei.* C. *Red nuclei.* E. *Black substance.*
 B. *Reticular formation.* D. **Cerebellum.**

Reasoning: The cerebellum smooths muscle contractions, maintains muscle tone and posture, coordinates the motions of different joints with each other (such as the shoulder and elbow joints in pitching a baseball), coordinates eye and body movements, and aids in learning motor skills. It receives signals from the upper motor neurons about intended movements and gets feedback about the actual performance from proprioceptors in the muscles and joints, via the spinocerebellar tracts of the spinal cord. Main symptoms of lesions in the cerebellum are intention tremor, dysmetria (past pointing), dysdiadochokinesia (adiadochokinesia), scanning dysarthria, gaze dysfunction (nystagmus), hypotonia of muscles, difficulty maintaining posture, gait, or balance (an ataxic gait). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 543 –544) (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 426).

56. A patient complains that at the bare mention of the tragic events that once occurred in his life he experiences tachycardia, dyspnea and an abrupt rise in blood pressure. What structures of the CNS are responsible for these cardiorespiratory reactions in this patient?

- A. *Specific thalamic nuclei.* C. *Cerebellum.* E. *Quadrigemina of mesencephalon.*
 B. *Lateral hypothalamic nuclei.* D. **Cerebral cortex.**

Reasoning: If there is no direct stimulation of specific receptors, only emotions or memory are involved in appearance of a reflex (like fear during exam or remembering of tragic events), then that reflex is conditioned. Tachycardia and increase of BP are sympathetic responses. The department of brain responsible for conditioned reflexes establishment and execution is always cerebral cortex (C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learning and Memory, P. 5–261).

57. As a result of continuous chronic encephalopathy, a patient has developed spontaneous motions and a disorder of torso muscles tone. These are the symptoms of the disorder of the following conduction tracts:

- A. *Tractus spinothalamicus.* C. *Tractus corticonuclearis.* E. *Tractus corticospinalis.*
 B. *Tractus tectospinalis.* D. **Tractus rubrospinalis.**

Reasoning: Red nuclei through the rubrospinal pathways provide tonus of flexor muscles. If it increases, tonus of extensor muscles decreases. The rubrospinal tract facilitates motor neurons in the cervical and upper thoracic spinal cord supplying the flexor muscles of the upper extremities and torso. Thus, the disorder of those muscles tone is caused by rubrospinal tract disturbance. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 489)

58. During an animal experiment, surgical damage of certain brain structures has caused deep prolonged sleep. What structure is most likely to cause such condition, if damaged?

A. Cerebral cortex.

C. Basal ganglion.

E. Red nuclei.

B. Hippocampus.

D. Reticular formation.

Reasoning: The reticular formation has projections to the cerebral cortex and thalamus that allow it some control over what sensory signals reach the cerebrum and come to our conscious attention. It plays a central role in states of consciousness such as alertness and sleep. That role is played by ascending influences of reticular formation that create local depolarization of cortical neurons. Injury to the reticular formation can result in prolonged deep sleep and irreversible coma. General anesthetics work by blocking signal transmission through the reticular formation. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 529)

59. Parkinson's disease is caused by disruption of dopamine synthesis. What brain structure synthesizes this neurotransmitter?

A. Globus pallidus.

C. Red nucleus.

E. Substantia nigra.

B. Hypothalamus.

D. Corpora quadrigemina.

Reasoning: The substantia nigra, a dark gray to black nucleus pigmented with melanin and dopamine. This is a motor center that relays inhibitory signals to the thalamus and basal nuclei. Degeneration of the neurons in the substantia nigra leads to the muscle tremors of Parkinson disease. Parkinson disease (PD), also called paralysis agitans or parkinsonism, is a progressive loss of motor function beginning in a person's 50s or 60s. It is due to degeneration of dopamine-releasing neurons in substantia nigra. Dopamine (DA) is an inhibitory neurotransmitter that normally prevents excessive activity in the basal nuclei. Degeneration of the dopamine-releasing neurons leads to an excessive ratio of ACh to DA, leading to hyperactivity of the basal nuclei. As a result, a person with PD suffers involuntary muscle contractions. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 475, 527).

60. A patient with injury sustained to a part of the central nervous system demonstrates disrupted coordination and movement amplitude, muscle tremor during volitional movements, poor muscle tone. What part of the central nervous system was injured?

A. Cerebellum.

C. Olfactory bulb.

E. Prosencephalon.

B. Medulla oblongata.

D. Mesencephalon.

Reasoning: The cerebellum smooths muscle contractions, maintains muscle tone and posture, coordinates the motions of different joints with each other (such as the shoulder and elbow joints in pitching a baseball), coordinates eye and body movements, and aids in learning motor skills. It receives signals from the upper motor neurons about intended movements and gets feedback about the actual performance from proprioceptors in the muscles and joints, via the spinocerebellar tracts of the spinal cord. Main symptoms of lesions in the cerebellum are intention tremor, dysmetria (past pointing), dysdiadochokinesia (adiadochokinesia), scanning dysarthria, gaze dysfunction (nystagmus), hypotonia of muscles, difficulty maintaining posture, gait, or balance (an ataxic gait). (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 543–544) (Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 426).

61. A 64-year-old woman presents with disturbed fine motor functions of her fingers, marked muscle rigidity, and tremor. The neurologist diagnosed her with Parkinson's disease. What brain structures are damaged resulting in this disease?

A. Reticular formation.

B. Red nuclei.

C. Thalamus.

D. Cerebellum

E. Substantia nigra.

Reasoning: The substantia nigra, a dark gray to black nucleus pigmented with melanin and dopamine. This is a motor center that relays inhibitory signals to the thalamus and basal nuclei. Degeneration of the neurons in the substantia nigra leads to the muscle tremors of Parkinson disease. Parkinson disease (PD), also called paralysis agitans or parkinsonism, is a progressive loss of motor function beginning in a person's 50s or 60s. It is due to degeneration of dopamine-releasing neurons in substantia nigra. Dopamine (DA) is an inhibitory neurotransmitter that

normally prevents excessive activity in the basal nuclei. Degeneration of the dopamine-releasing neurons leads to an excessive ratio of ACh to DA, leading to hyperactivity of the basal nuclei. As a result, a person with PD suffers involuntary muscle contractions. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 475, 527).

62. A patient complaining of pain in the left shoulder-blade region has been diagnosed with myocardial infarction. What kind of pain does the patient have?

- A. *Epicritic.* B. **Radiating.** C. *Phantom.* D. *Visceral.* E. *Protophatic.*

Reasoning: Pain in the viscera is often mistakenly thought to come from the skin or other superficial sites—for example when the pain of a heart attack is felt “radiating” along the left shoulder and medial side of the arm. This phenomenon is called **referred pain or radiating pain**. It results from the convergence of neuronal pathways in the CNS (neospinothalamic pathway transmitting pain from skin and mucosa and paleo- and archispinothalamic tracts for visceral pain). In the case of cardiac pain, for example, spinal cord segments T1 to T5 receive input from the heart as well as the chest and arm. Pain fibers from the heart and skin in this region converge on the same spinal interneurons (neurons of wide input), then follow the same pathway from there to the thalamus and cerebral cortex. The brain cannot distinguish which source the arriving signals are coming from. It acts as if it assumes that signals arriving by this path are most likely coming from the skin, since skin has more pain receptors than the heart and suffers injury more often. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 590).

Autonomic regulation of visceral functions

63. Depression and emotional disturbances result from the lack of noradrenaline, serotonin and other biogenic amines in the brain. Their content in the synapses can be increased through administration of antidepressants that inhibit the following enzyme

- A *D- amino acid oxidase.* C. *Diamine oxidase.* E. **Monoamine oxydase.**
 B. *Phenylalanine 4-monoxygenase.* D. *L- amino acids oxidase.*

Reasoning: Monoamine oxidase (MAO) is an enzyme that provides breakdown of all monoamine neurotransmitters including noradrenalin, serotonin and dopamine. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 15. The Autonomic Nervous and Visceral Reflexes, p. 580).

64. During the sport competition a boxer received a strong blow to the abdomen, which caused a knockout due to a brief drop in blood pressure. What physiological mechanisms are the causes of this condition?

- A. **Stimulation of parasympathetic nerves.** D. *Stimulation of sympathetic nerves.*
 B. *Ischemia of the CNS.* E. *Alteration of transcapillary exchange.*
 C. *Abrupt change in the body fluid volume.*

Reasoning: Irritation of peritoneal receptors taking place after a blow on the abdomen is called **Golz’ reflex** (one of viscerovisceral autonomic reflexes); it is accompanied by typical parasympathetic effects – sharp reduction of heart rate, short-term respiratory arrest, reduction of blood pressure, muscular weakness, short-term sensory reduction in the visual, auditory, and other sensory systems (Physiology of biological regulation of organism’s functions: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva, R.V. Alekseenko. – Kharkiv: KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 96).

65. Monoamine oxidase inhibitors are widely used as psychopharmacological drugs. They change the level of nearly all neurotransmitters in synapses, with the following neurotransmitter being the exception:

- A. *Serotonin.* B. **Acetylcholine.** C. *Dopamine.* D. *Noradrenaline.* E. *Adrenaline.*

Reasoning: Monoamine oxidase (MAO) is an enzyme that provides breakdown of all monoamine neurotransmitters including noradrenalin, serotonin and dopamine. Acetylcholine is

broken down by another enzyme called acetylcholine esterase (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 15. The Autonomic Nervous and Visceral Reflexes, p. 574, 580).

66. After a patient had taken a blocking agent, his heart rate (HR) increased. Pressing on the eyeballs didn't result in the expected reflexory decrease in heart rate. What exactly was blocked by drug in the pacemaker cell?

- A. α 1-adrenergic receptors. C. M-cholinergic receptors. E. Ca^{2+} -L-type channels.
B. β -adrenergic receptors. D. Fast Na^+ channels.

Reasoning: Pressing on eyeballs usually causes a reduction of heart rate and respiratory rate; that unconditioned parasympathetic reflex is called oculocardiac or Dagnini-Ashner's reflex. Parasympathetic neurotransmitter of postganglionic parasympathetic fibers leading to heart (vagus nerve fibers) is acetylcholine (ACh), receptors in heart for ACh are M2-cholinergic receptors. (Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva, R.V. Alekseienko. – Kharkiv: KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 96) (Kaplan USMLE Step 1 Lecture Notes. Pharmacology, 2013. Section II Autonomic Pharmacology, Chapter 2 Cholinergic Pharmacology, p. 46).

67. A fixed-run taxi passenger has a sudden and expressed attack of tachycardia. A doctor travelling by the same taxi has managed to slow down his heart rate by pressing upon the eyeballs and thus causing the following reflex:

- A. Holtz's reflex. C. Bainbridge reflex. E. Frank-Starling mechanism.
B. Hering-Breuer reflex. D. Dagnini-Ashner reflex.

Reasoning: Pressing on eyeballs usually causes a reduction of heart rate and respiratory rate; that unconditioned parasympathetic reflex is called oculocardiac or Dagnini-Ashner's reflex (Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva, R.V. Alekseienko. – Kharkiv: KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 96)

68. A patient complains of pain in the heart area during acute attack of gastric ulcer. What vegetative reflex can cause this painful feeling?

- A. Visceromotor reflex. C. Viscerovisceral reflex. E. Dermatovisceral reflex.
B. Viscerodermal reflex. D. Motor-visceral reflex.

Reasoning: Viscerosvisceral reflex is the change in a functional state of some inner organ (receptors) is accompanied with a natural change in the functional state of some inner organ having common autonomic supply. Change in state of heart due to change of stomach state is an example of viscerovisceral reflex (Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva, R.V. Alekseienko. – Kharkiv: KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 96)

69. A patient has corestenoma. What is the reason of such condition?

- A. Increased tonus of sympathetic centres. D. Adrenaline action.
B. Increased activity of sympathoadrenal system. E. Noradrenaline action.
C. Increased tonus of parasympathetic centres.

Reasoning: Corestenoma is myosis (constriction of pupils). Myosis is an unconditioned parasympathetic reflex provided by parasympathetic stimulation of ciliary muscle of the eye by parasympathetic fibers of III cranial nerve (oculomotor), neurotransmitter – acetylcholine, receptors – M3-cholinergic receptors. (Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva, R.V. Alekseienko. – Kharkiv: KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 98, 100)

70. A man was intoxicated with mushrooms. They contain muscarine that stimulates muscarinic cholinoreceptors. What symptoms signalize intoxication with inedible mushrooms?

- A. *Bronchi dilatation.* C. *Rise of arterial pressure.* E. *Mydriatic pupils.*
B. *Increased heart rate.* D. *Myotic pupils.*

Reasoning: Myosis (pupil constriction) is an unconditioned parasympathetic reflex provided by parasympathetic stimulation of ciliary muscle of the eye by parasympathetic fibers of III cranial nerve (oculomotor), neurotransmitter – acetylcholine, receptors – M3-cholinergic receptors. Muscarin is agonist of M-cholinergic receptors (Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva, R.V. Alekseienko. – Kharkiv : KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 98, 100)

71. After a hemorrhage into the brainstem a patient has lost reflex of myosis as a reaction to increase of illumination. What structure was damaged?

- A. *Lateral reticular nuclei.* C. *Vegetative nuclei of oculomotor nerve.* E. *Black substance.*
B. *Medial reticular nuclei.* D. *Red nuclei.*

Reasoning: The eye is innervated by both parasympathetic and sympathetic nerve fibers. The parasympathetic preganglionic fibers arise in the Edinger-Westphal nucleus (the visceral nucleus portion of the third cranial nerve) and then pass in the third nerve to the ciliary ganglion, which lies immediately behind the eye. There, the preganglionic fibers synapse with postganglionic parasympathetic neurons, which in turn send fibers through ciliary nerves into the eyeball. These nerves excite (1) the ciliary muscle that controls focusing of the eye lens and (2) the sphincter of the iris that constricts the pupil. neurotransmitter – acetylcholine, receptors – M3-cholinergic receptors. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit X The Nervous System: B. Special Senses, p. 648).

72. A man presents with increased heart rate, mydriatic pupils, and dry mouth. This condition results from the activation of the following system of function regulation:

- A. *Hypothalamo-pituitary-adrenal.* C. *Parasympathetic.* E. *Vago-insular.*
B. *Sympathetic.* D. *Metasympathetic.*

Reasoning: Increased heart rate, mydriatic pupils, and dry mouth are effects of sympathetic system activation (Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva, R.V. Alekseienko. – Kharkiv: KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 101)

Humoral regulation

1. Some diseases reveal symptoms of aldosteronism with hypertension and edema due to sodium retention in the organism. What organ of the internal secretion is affected on aldosteronism?

A. *Hypophysis.* B. **Adrenal glands.** C. *Pancreas.* D. *Testicle.* E. *Ovaries.*

Reasoning: Aldosteronism is the disease caused by hypersecretion of aldosterone which increases sodium reabsorption and potassium excretion in kidneys. Aldosterone is the principal mineralocorticoid secreted by zona glomerulosa of adrenal cortex. Thus, the organs of internal secretion affected in case of aldosteronism are the adrenal glands (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 944)

2. A 19-year-old female suffers from tachycardia in rest condition, weight loss, excessive sweating, exophthalmos and irritability. What hormone would you expect to find elevated in her serum?

A. *ACTH.* B. *Mineralocorticoids.* C. **Thyroxin.** D. *Cortisol* E. *Insulin.*

Reasoning: The general effect of thyroid hormone is the generalized increase in functional activity throughout the body. A high state of excitability, intolerance to heat, increased sweating, mild to extreme weight loss (sometimes as much as 100 pounds), varying degrees of diarrhea, muscle weakness, nervousness or other psychic disorders, extreme fatigue but inability to sleep, tremor of the hands and exophthalmos are the typical symptoms of hyperthyroidism (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 940).

3. At head trauma in and around supraoptical and paraventricular nuclei of hypothalamus polyuria occurs. What results in development of the given phenomenon?

A. *ADH secretion increase.* D. *Sodium uretine peptide secretion decrease.*
B. **ADH secretion decrease.** E. *Aldosterone secretion increase.*
C. *Renin secretion increase.*

Reasoning: Supraoptic nuclei of hypothalamus are synthesizing primarily ADH, and paraventricular nuclei synthesize primarily oxytocin. Antidiuretic hormone (ADH) increases the reabsorption of water in collecting tubules and ducts of kidneys thus decreasing the diuresis (daily production of secondary urine). Due to deficiency or absence of ADH (for example, in case of trauma in and around supraoptical nuclei) polyuria (increased amount of secondary urine) occurs (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 928).

4. A man because of 1,5 litre blood loss has suddenly reduced diuresis. The increased secretion of what hormone caused such diuresis alteration?

A. *Natriuretic.* B. *Corticotropin.* C. *Parathormone.* D. **Vasopressin.** E. *Cortisol.*

Reasoning: Vasopressin (another name of ADH) causes the increased water reabsorption by kidneys and reduces diuresis and in large quantities has the potent effect of constricting the arterioles throughout the body and therefore increasing the arterial pressure. One of the stimuli for causing intense ADH secretion is decreased blood volume. This occurs especially strongly when the blood volume decreases 15 to 25 per cent or more (like in case of 1,5 l blood loss); the secretory rate then sometimes rises to as high as 50 times normal (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 929).

5. A 26-year old woman is complaining of thirst and dryness in her mouth. The examination has revealed glucosuria and blood glucose content of 6,5 mmol/l. What condition are these symptoms the most typical for?

A. *Diabetes insipidus.* C. *Steroid diabetes.* E. *Alimentary glucosuria.*
B. **Diabetes mellitus.** D. *Renal diabetes.*

Reasoning: In normal organism blood glucose content is 3,3 –5,5 mmol/l and glucose in urine is absent. Hyperglycemia (blood glucose level > 5,5 mmol/l) and glucosuria are the symptoms of inefficient uptake and utilization of glucose by most cells of the body, except those of the brain. The rapid uptake, storage, and use of glucose by almost all tissues of the body, but especially by the muscles, adipose tissue, and liver, is provided by insulin – hormone secreted by β -cells of

pancreas. Deficiency of insulin or decreased sensitivity of tissues to insulin leads to disease called diabetes mellitus (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 972).

6. A patient complaining of weight loss (10 kg during 2 months), palpitation and exophthalmos came to the endocrinologist. For the hyperfunction of what gland (glands) are these complaints the most typical?

A. *Pancreas.* B. *Ovaries.* C. *Adrenal glands.* D. *Parathyroid glands* E. *Thyroid.*

Reasoning: The general effect of thyroid hormone is the generalized increase in functional activity throughout the body. A high state of excitability, intolerance to heat, increased sweating, mild to extreme weight loss (sometimes as much as 100 pounds), varying degrees of diarrhea, muscle weakness, nervousness or other psychic disorders, extreme fatigue but inability to sleep, tremor of the hands and exophthalmos are the typical symptoms of hyperthyroidism (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 940).

7. Usage of oral contraceptives with sex hormones inhibits secretion of the hypophysiae hormones. Secretion of which of the indicated hormones is inhibited while using oral contraceptives with sex hormones?

A. *Thyrotropic.* B. *Somatotropic.* C. *Vasopressin.* D. *Oxytocin.* E. *Follicle-stimulating.*

Reasoning: Secretion of most hypophyseal hormones, including follicle-stimulating hormone (FSH), is controlled by negative feedback loop from target organ. FSH in ovaries stimulates the growth of follicles and secretion of estrogen by them. Increased level of estrogen inhibits the secretion of FSH by way of negative feedback loop. Oral contraceptives with sex hormones contain estrogen and progesterone thus increasing their level in blood and inhibiting the secretion of both FSH and LH of hypophysis (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 645).

8. A 2-year-old child experienced convulsions because of lowering calcium ions concentration in the blood plasma. Functions of what structure is decreased?

A. *Adrenal cortex.* B. *Pineal cortex.* C. ***Parathyroid glands.*** D. *Thymus.* E. *Hypophysis.*

Reasoning: When the concentration of calcium ions in blood falls below normal, the nervous system becomes progressively more excitable, because this causes increased neuronal membrane permeability to sodium ions, allowing easy initiation of action potentials. The peripheral nerve fibers become so excitable that they begin to discharge spontaneously, causing tetany or convulsions. Hypocalcemia usually occurs due to deficiency of parathyroid hormone that is produced by parathyroid glands and has the effect to increase calcium level in blood (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 979, 985).

9. Vegetative abnormalities in the sleep, heat regulation, all kinds of metabolism, diabetes insipidus are developing in the patient due to growth of the tumour in the III ventricle of brain. Irritation of the nucleus of what part of the brain can cause this symptom?

A. *Medulla.* C. *Mesencephalic tegmentum.* E. *Cerebral peduncles (crucis cerebri).*
B. *Pons cerebelli.* D. ***Hypothalamus.***

Reasoning: Listed vegetative abnormalities can be caused by irritation of hypothalamus that forms part of the walls and floor of the third ventricle of brain and includes nuclei concerned with a wide variety of visceral functions, such as hormone secretion, autonomic nervous system integration, thermoregulation, food and water intake, sleep and circadian rhythms regulation, formation of memory and emotional behavior (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14 The Brain and Cranial Nerves, p. 530-531).

10. The β cells of endocrine portion of pancreas are selectively damaged poisoning. How will it be reflected in plasma?

A. The content of globulins decreases.

D. The level of sugar decrease.

B. The content of albumins decreases.

E. The content of sugar increases.

C. The content of fibrinogen decrease.

Reasoning: β -cells of islets of Langerhans of pancreas secrete insulin – the hormone that cause the rapid uptake, storage, and use of glucose by almost all tissues of the body, but especially by the muscles, adipose tissue, and liver. Deficiency of insulin or decreased sensitivity of tissues to insulin leads to increase of the content of sugar in blood (diabetes mellitus) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 961, 963, 972).

11. Periodic renal colic attacks are observed in a woman with primer hyperparathyroidism. Ultrasonic examination revealed small stones in the kidneys. What is the most plausible reason of the stones' formation?

A. **Hypercalcemia.**

C. **Hyperuricemia.**

E. **Hypercholesterinemia.**

B. **Hyperphosphatemia.**

D. **Hyperkalemia.**

Reasoning: Hyperparathyroidism (hyperfunction of parathyroid glands) causes the hyperproduction of parathyroid hormone that increases calcium level and decreases phosphate level in blood. Excess calcium must be excreted by kidneys and can precipitate in them forming calcium phosphate or calcium oxalate stones that cause the periodic renal colic attacks (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 991).

12. Kidneys of a man under examination show increased resorption of calcium ions and decreased resorption of phosphate ions. What hormone causes this phenomenon?

A. **Hormonal form D_3 .**

C. **Parathormone.**

E. **Vasopressin.**

B. **Thyrocalcitonin.**

D. **Aldosterone.**

Reasoning: Parathormone (PTH) increases renal tubular reabsorption of calcium (in the late distal tubules, the collecting tubules, the early collecting ducts, and possibly the ascending loop of Henle) and at the same time diminishes proximal tubular reabsorption of phosphate ions (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 987).

13. Intake of oral contraceptives containing sex hormones inhibits secretion of the hypophysiae hormones. Secretion of which of the indicated hormones is inhibited while taking oral contraceptives with sex hormones?

A. **Somatotropic.** B. **Oxytocin.** C. **Vasopressin.** D. **Follicle-stimulating.** E. **Thyrotropic.**

Reasoning: Secretion of most hypophyseal hormones, including follicle-stimulating hormone (FSH), is controlled by negative feedback loop from target organ. FSH in ovaries stimulates the growth of follicles and secretion of estrogen by them. Increased level of estrogen inhibits the secretion of FSH by way of negative feedback loop. Oral contraceptives with sex hormones contain estrogen and progesterone thus increasing their level in blood and inhibiting the secretion of both FSH and LH of hypophysis (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 645).

14. A patient with diabetes mellitus experienced loss of consciousness and convulsions after injection of insulin, what is the result of biochemical blood analysis for concentration of the sugar?

A. **3,3 mmol/L.**

B. **8,0 mmol/L.**

C. **5,5 mmol/L.**

D. **1,5 mmol/L.**

E. **10,0 mmol/L.**

Reasoning: The normal blood glucose level is 3,3–5,5 mmol/l. Clonic seizures and loss of consciousness are likely to occur as the blood glucose level falls to 1,1–2,8 mmol/l (20 to 50 mg/100 ml). As the glucose level falls still lower, the seizures cease and only a state of coma remains. This syndrome is called insulin shock and can occur in patients with diabetes who administer too much insulin to themselves (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 976).

15. A person has reduced diuresis, hypernatremia, hypokalemia. Hypersecretion of what hormone can cause such changes?

- A. Parathormone. C. Adrenalin. E. Auricular sodiumuretic factor.
B. Aldosterone. D. Vasopressin.

Reasoning: Aldosterone is the hormone produced by adrenal cortex that cause increased renal tubule reabsorption of sodium and secretion of potassium. Simultaneously with sodium reabsorption in kidneys there is osmotic absorption of almost equivalent amounts of water that decrease the amount of urine. Hypersecretion of aldosterone will cause the reduced diuresis, hypernatremia and hypokalemia (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 948)

16. A teenager was irradiated with high radiation dose that resulted in serious damages of lymphoid system, lysis of many lymphocytes. Restoration of normal hemogram is possible due to the functioning of the following gland:

- A. Thyroid. B. Adrenal. C. Liver. D. Thymus. E. Pancreas.

Reasoning: Restoration of normal hemogram after the lysis of many lymphocytes can be achieved by functioning of thymus. Thymus produces thymopoietin and thymosins, hormones that regulate the development and later activation of T lymphocytes (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 647).

17. Inhabitants of territories with cold climate have high content of an adaptive thermoregulatory hormone. What hormone is meant?

- A. Insulin. B. Glucagon. C. Thyroxin. D. Cortisol. E. Somatotropin.

Reasoning: The primary effect of TH is to increase the body's metabolic rate. As a result, it raises oxygen consumption and has a calorigeniceffect — it increases heat production. TH secretion rises in cold weather and thus helps to compensate for increased heat loss. Inhabitants of territories with cold climate constantly have high content of thyroxin (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 647).

18. A concentrated solution of sodium chloride was intravenously injected to an animal. This caused decreased reabsorption of sodium ions in the renal tubules. It is the result of the following changes of hormonal secretion:

- A. Reduction of atrial natriuretic factor. B. Vasopressin increase. D. Aldosterone increase.
C. Aldosterone reduction. E. Vasopressin reduction.

Reasoning: The increased concentration of sodium ions in blood after injection of sodium chloride will cause the decreased secretion of aldosterone. Aldosterone is the hormone that increases sodium reabsorption and potassium secretion in kidneys. If sodium level in blood increases, the aldosterone secretion will decrease for homeostasis maintenance (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 950)

19. Parents of a 10 year old boy consulted a doctor about extension of hair-covering, growth of beard and moustache, low voice. Intensified secretion of which hormone must be assumed

- A. Of testosterone. B. Of somatotropin. C. Of progesterone. D. Of estrogen. E. Of cortisol.

Reasoning: Extension of hair-covering, growth of beard and moustache, low voice are the signs of masculine physique development. Development of the masculine physique, development of the male reproductive system in the fetus and adolescent, and the sex drive are stimulated by testosterone (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 652).

20. Atria of an experimental animal were superdistended by blood that resulted in decreased reabsorption of Na^+ and water in renal tubules. This can be explained by the influence of the following factor upon kidneys:

- A. Angiotensin. B. Aldosterone. C. Renin. D. Vasopressin. E. Natriuretic hormone.

Reasoning: Stretching of the heart wall stimulates muscle cells in the atria to secrete atrial natriuretic peptide (ANP). ANP decreases sodium reabsorption in renal tubules leading to decreased water reabsorption and increased urine output (Saladin: Anatomy & Physiology: The

Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 652).

21. A middle-aged man went to a foreign country because he had been offered a job there. However he had been unemployed for quite a long time. What endocrine glands were exhausted most of all in this man?

A. *Substernal gland.*

C. **Adrenal glands.**

E. *Seminal glands.*

B. *Thyroid gland.*

D. *Parathyroid glands.*

Reasoning: Either mental or physical stress can excite the sympathetic system that stimulates the adrenal medulla to release epinephrine and norepinephrine. Also almost any type of stress, whether physical or neurogenic, causes an immediate and marked increase in ACTH secretion by the anterior pituitary gland, followed within minutes by greatly increased adrenocortical secretion of glucocorticoids. As unemployment serves as a prolonged stressful situation, so adrenal glands will be under constant stimulation (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 952).

22. People adapted to high external temperatures have such peculiarity: profuse sweating isn't accompanied by loss of large volumes of sodium chloride. This is caused by the effect of the following hormone upon the perspiratory glands:

A. *Vasopressin.*

B. *Cortisol.*

C. *Thyroxin.*

D. **Aldosterone**

E. *Insulin.*

Reasoning: Aldosterone has almost the same effects on sweat glands and salivary glands as it has on the renal tubules. Both these glands form a primary secretion that contains large quantities of sodium chloride, but much of the sodium chloride, on passing through the excretory ducts, is reabsorbed, whereas potassium and bicarbonate ions are secreted. Aldosterone greatly increases the reabsorption of sodium chloride and the secretion of potassium by the ducts. The effect on the sweat glands is important to conserve body salt in hot environments, and the effect on the salivary glands is necessary to conserve salt when excessive quantities of saliva are lost (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 949).

23. A 35 year old man consulted a dentist about reduced density of dental tissue, high fragility of teeth during eating solid food. This patient suffers the most probably from the deficiency of the following mineral element:

A. *Potassium.*

B. *Iron.*

C. *Sodium.*

D. *Magnesium.*

E. **Calcium.**

Reasoning: The main body of the tooth is composed of dentin, which has a strong, bony structure. Dentin is made up principally of hydroxyapatite crystals (composed from calcium and phosphate) similar to those in bone but much more dense. These crystals are imbedded in a strong meshwork of collagen fibers. The calcium salts in dentin make it extremely resistant to compressional forces, and the collagen fibers make it tough and resistant to tensional forces that might result when the teeth are struck by solid objects. Therefore, the deficiency of calcium will lead to reduced density and fragility of teeth (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 992).

24. Examination of a patient revealed overgrowth of facial bones and soft tissues, tongue enlargement, wide interdental spaces in the enlarged dental arch. What changes of the hormonal secretion are the most likely?

A. *Hypersecretion of insulin.*

D. *Hyposecretion of thyroxin.*

B. **Hypersecretion of the somatotropic hormone.**

E. *Hyposecretion of insulin.*

C. *Hyposecretion of the somatotropic hormone.*

Reasoning: The hypersecretion of growth hormone (GH) in adults causes acromegaly—thickening of the bones and soft tissues with especially noticeable effects on the hands, feet, and face – like overgrowth of facial bones and soft tissues, tongue enlargement and wide interdental spaces in the enlarged dental arch (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 667).

25. A 32-year-old patient consulted a doctor about the absence of lactation after parturition. Such disorder might be explained by the deficit of the following hormone

A. Somatotropin.

C. Prolactin.

E. Glucagon.

B. Thyrocalcitonin.

D. Vasopressin.

Reasoning: Prolactin (PRL) is secreted by lactotropes (mammotropes) of anterior pituitary, which increase greatly in size and number during pregnancy. PRL level rises during pregnancy, but it has no effect until after a woman gives birth. Then, it stimulates the mammary glands to synthesize milk. Deficit of PRL can be the cause of lactation absence (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw-Hill Companies, 2003. Chapter 17 The Endocrine System, p. 642).

26. A patient has hypocalcemia. What hormone deficiency may be its cause?

A. Thyrocalcitonin. B. Corticotropin. C Corticoliberin. D. Parathormone. E Aldosterone.

Reasoning: Parathormone increases the blood calcium level by two effects – it increases calcium absorption from the bones and in the intestines and also decreases calcium excretion in kidneys. Hypofunction of the parathyroid glands and deficiency of parathormone cause hypocalcemia (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 985–987).

27. Humoral form of certain vitamin induces genome level synthesis of Ca-binding proteins and enterocytes thus regulating the intestinal absorption of Ca^{2+} ions required for dental tissue development. What vitamin is it?

A. K.

B. E.

C. B₁.

D. A.

E. D₃.

Reasoning: Vitamin D₃ (cholecalciferol) in his active form (1,25-dihydroxycholecalciferol) increases formation of Ca-binding proteins in the intestinal epithelial cells and causes the formation of (1) a calcium-stimulated ATPase in the brush border of the epithelial cells and (2) an alkaline phosphatase in the epithelial cells, therefore increasing calcium absorption in intestines (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 985–985).

28. A 36-year-old patient with diabetes mellitus had seizures with loss of consciousness after an insulin injection. What was the result of blood glucose test?

A. 10 mmol/l.

B. 8,0 mmol/l.

C. 5,5 mmol/l.

D. 3,3 mmol/l.

E. 2,5 mmol/l.

Reasoning: The normal blood glucose level is 3,3–5,5 mmol/l. Clonic seizures and loss of consciousness are likely to occur as the blood glucose level falls to 1,1–2,8 mmol/l (20 to 50 mg/100 ml). As the glucose level falls still lower, the seizures cease and only a state of coma remains. This syndrome is called insulin shock and can occur in patients with diabetes who administer too much insulin to themselves (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 976).

29. A 43-year-old female complains of weight loss, hyperhidrosis, low-grade fever, increased irritability. She has been found to have hyperfunction of sympathetic-adrenal system and the basal metabolism. These disorders can be caused by hypersecretion of the following hormone:

A. Corticotropin.

B. Somatotropin.

C. Aldosterone.

D. Insuline.

E. Thyroxine.

Reasoning: The complaints of that patient – weight loss, hyperhidrosis, low-grade fever, increased irritability – and the increase of basal metabolic rate are the symptoms of hypersecretion of thyroid hormones (hyperthyroidism) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 76 Thyroid metabolic hormones, p. 940).

30. A 49 year-old patient was found to have a disproportionate enlargement of hands, feet, nose, ears, superciliary arches and cheek bones. Blood test revealed hyperglycemia, impaired glucose tolerance. What is the most likely cause of this pathology development?

A. Vasopressin hyposecretion.

D. Glucocorticoids hypersecretion.

B. Insulin hyposecretion.

E. Posterior pituitary hormone hypersecretion.

C. Hypersecretion of growth hormone.

Reasoning: Disproportionate enlargement of hands, feet, nose, ears, superciliary arches and cheek bones are the symptoms of acromegaly – the disease caused by hypersecretion of growth hormone in adult person. Increased level of growth hormone can also cause hyperglycemia and impaired glucose tolerance (diabetogenic effects of growth hormone) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 923, 927).

31. A severe injury in 36-year-old patient resulted in significant blood loss which was accompanied by blood pressure drop. What hormones provide rapid recovery of blood pressure after blood loss?
A. *Oxytocin.* C. *Sex hormones.* E. ***Adrenaline, vasopressin.***

B. *Aldosterone.*

D. *Cortisol.*

Reasoning: Rapid recovery of blood pressure is provided mainly by 2 hormones – adrenaline and vasopressin (ADH). Stressful situation (severe injury) causes the activation of sympathetic nervous system and adrenal medulla which secretes adrenaline that causes vasoconstriction and increases cardiac output, thus elevating blood pressure. Blood loss is also the factor that stimulates the intense vasopressin secretion which in high concentration has a potent effect of constricting the arterioles throughout the body and therefore increasing the arterial pressure (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 60 Autonomic Nervous System and Adrenal Medulla, p. 755; Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 929).

32. A 12 year-old child is of short stature, has disproportionate body structure and mental retardation. These characteristics might be caused by the hyposecretion of the following hormone:
A. *Glucagon.* B. ***Thyroxine.*** C. *Somatotropin.* D. *Cortisol.* E. *Insulin.*

Reasoning: Short stature, disproportionate body structure and mental retardation are the symptoms of cretinism – the disease caused by hyposecretion of thyroid hormones during fetal life, infancy or childhood (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 76 Thyroid metabolic hormones, p. 942).

33. Following thyroid surgery, a 47-year-old female patient had fibrillary twitching of muscles in the arms, legs and face. These disorders can be treated by the introduction of the following hormone
A. *Thyroid-stimulating hormone.* C. *Thyroxine.* E. *Thyrotropin.*

B. *Triiodothyronine.*

D. ***Parathyroid hormone.***

Reasoning: Fibrillary twitching of muscles, tetany and convulsions are the symptoms of hypocalcemia. Hypocalcemia usually occurs due to deficiency of parathyroid hormone that is produced by parathyroid glands and has the effect to increase calcium level in blood. Introduction of parathyroid hormone will lead to disappearance of listed symptoms (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 979, 985).

34. A patient with signs of osteoporosis and urolithiasis has been admitted to the endocrinology department. Blood test revealed hypercalcemia and hypophosphatemia. These changes are associated with abnormal synthesis of the following hormone:

A. *Calcitonin.*

B. *Aldosterone.*

C. ***Parathyroid hormone.***

D. *Cortisol.*

E. *Calcitriol.*

Reasoning: Hypersecretion of parathyroid hormone causes extreme osteoclastic activity in the bones. This elevates the calcium ion concentration in blood while usually depressing the concentration of phosphate ions because of increased renal excretion of phosphate. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 987).

35. A 41-year-old male patient has a history of recurrent attacks of heartbeats (paroxysms), profuse sweating, headaches. Examination revealed hypertension, hyperglycemia, increased basal metabolic rate, and tachycardia. These clinical presentations are typical for the following adrenal pathology:

A. *Hyperfunction of the adrenal cortex.*

D. *Hypofunction of the medulla.*

B. *Primary aldosteronism.*

E. ***Hyperfunction of the medulla.***

C. *Hypofunction of the adrenal cortex.*

Reasoning: Recurrent attacks of heartbeats, profuse sweating, headaches, hypertension, hyperglycemia, increased basal metabolic rate and tachycardia are the symptoms of pheochromocytoma – a tumor of the adrenal medulla that secretes excessive amounts of epinephrine and norepinephrine (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 670).

36. A 19-year-old male was found to have an elevated level of potassium in the secondary urine. These changes might have been caused by the increase in the following hormone level:

A. Adrenaline. B. Aldosterone. C. Oxytocin. D. Glucagon E. Testosterone.

Reasoning: Aldosterone is the hormone produced by adrenal cortex that cause increased renal tubule reabsorption of sodium and secretion of potassium. Hypersecretion of aldosterone will cause increased amount of sodium in blood and elevated level of potassium in urine (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 948)

37. A 26-year-old woman at 40 weeks pregnant has been delivered to the maternity ward. Objectively: the uterine cervix is opened, but the contractions are absent. The doctor has administered her at hormonal drug to stimulate the labor. Name this drug:

A. Estrone. B. Hydrocortisone. C. Testosterone. D. Oxytocin. E. ACTH.

Reasoning: Oxytocin has two major roles - in childbirth, it stimulates smooth muscle of the uterus to contract, thus contributing to the labor contractions that expel the infant, and in lactating mothers, it stimulates muscle-like cells of the mammary glands to squeeze on the glandular acini and force milk to flow down the ducts to the nipple. So for labor stimulation administration of oxytocin is appropriate (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 644).

38. A 30-year-old female exhibits signs of virilism (growth of body hair, balding temples, menstrual disorders). This condition can be caused by the overproduction of the following hormone:

A. Oxytocin. B. Prolactin. C. Testosterone. D. Oestriol. E. Relaxin.

Reasoning: The signs of virilism (growth of body hair, balding temples, menstrual disorders etc.) in female are the symptoms of adrenogenital syndrome caused by an occasional adrenocortical tumor which secretes excessive quantities of androgens, mainly testosterone, that cause intense masculinizing effects throughout the female body (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 959).

39. As a result of a home injury, a patient suffered a significant blood loss, which led to a fall in blood pressure. Rapid blood pressure recovery after the blood loss is provided by the following hormones:

A. Aldosterone. C. Cortisol. E. Oxytocin.

B. Adrenaline, vasopressin. D. Sex hormones.

Reasoning: The rapid pressure recovery after significant blood loss is provided mainly by 2 hormones – adrenalin and vasopressin. Adrenaline is secreted by adrenal medulla activated in stressful situations and causes vasoconstriction and increases cardiac output, thus elevating blood pressure. Blood loss is also the factor that stimulates the intense vasopressin secretion which in high concentration has a potent effect of constricting the arterioles throughout the body and therefore increasing the arterial pressure (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 60 Autonomic Nervous System and Adrenal Medulla, p. 755; Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 929).

40. A 44 year old woman complains of general weakness, heart pain, significant increase of body weight. Objectively: moon face, hirsutism, AP is 165/100 mm Hg, height – 164 cm, weight – 103 kg; the fat is mostly accumulated on her neck, thoracic girdle, belly. What is the main pathogenetic mechanism of obesity?

A. Increased production of glucocorticoids. D. Reduced glucagon production.

B. Reduced production of thyroid hormones. E. Increased mineralocorticoid production.

C. Increased insulin production.

Reasoning: General weakness, heart pain, increased body weight with specific fat accumulation in thoracic and upper abdominal regions, hypertension, moon face, hirsutism are the signs of hypersecretion of glucocorticoids by adrenal cortex called the Cushing's syndrome (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 958).

41. A patient has a decreased vasopressin synthesis that causes polyuria and as a result of it evident organism dehydration. What is the mechanism of polyuria development?

- A. *Reduced tubular reabsorption of Na ions.* D. **Reduced tubular reabsorption of water.**
B. *Reduced tubular reabsorption of protein.* E. *Acceleration of glomerular filtration.*
C. *Reduced glucose reabsorption.*

Reasoning: Vasopressin (ADH) increases the reabsorption of water in collecting tubules and ducts of kidneys thus decreasing the diuresis (daily production of secondary urine). Deficiency or absence of vasopressin leads to polyuria and dehydration; that state is called diabetes insipidus (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 928).

42. A patient suffering from pheochromocytoma complains of thirst, dry mouth, hunger. Blood test for sugar revealed hyperglycemia. What type of hyperglycemia is it?

- A. *Hypocorticotoid.* B. **Adrenal.** C. *Alimentary.* D. *Somatotropic.* E. *Hypoinsulinemic.*

Reasoning: Pheochromocytoma is a tumor of the adrenal medulla that secretes excessive amounts of epinephrine and norepinephrine. So, in case of pheochromocytoma there is adrenal hyperglycemia (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 670).

43. Roentgenological examination of skull base bones revealed enlargement of sellar cavity, thinning of anterior clinoid processes, destruction of different parts of sella turcica. Such bone destruction might be caused by a tumour of the following endocrinous gland:

- A. *Epiphysis.* C. *Adrenal glands.* E. *Thyroid gland.*
B. *Thymus gland.* D. **Hypophysis.**

Reasoning: Sella turcica of the sphenoid bone is the localization of hypophysis, so bone destruction of sella turcica, enlargement of sellar cavity and thinning of anterior clinoid processes can be caused by a tumor of hypophysis (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 638).

44. A 46-year-old patient suffering from the diffuse toxic goiter underwent resection of the thyroid gland. After the surgery the patient presents with appetite loss, dyspepsia, increased neuromuscular excitement. The body weight remained unchanged. Body temperature is normal. Which of the following has caused such a condition in this patient?

- A. *Reduced production of thyroxin.* D. *Increased production of calcitonin.*
B. **Reduced production of parathormone.** E. *Increased production of thyroliberin.*
C. *Increased production of thyroxin.*

Reasoning: Appetite loss, dyspepsia, increased neuromuscular excitement are the symptoms of hypocalcemia caused by decreased level of parathormone. During thyroid operations the parathyroid glands are difficult to locate because they often look like just another lobule of the thyroid gland, so they are often removed causing deficiency of parathormone (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 987, 990).

45. Parodontitis is treated with calcium preparations and a hormone that stimulates tooth mineralization and inhibits tissue resorption. What hormone is it?

- A. **Calcitonin.** B. *Aldosterone.* C. *Parathormone.* D. *Adrenalin* E. *Thyroxine.*

Reasoning: Calcitonin inhibits tissue resorption of calcium by inhibiting the osteoclasts activity and stimulates deposition of calcium in the exchangeable bone and teeth calcium salts that leads to decrease of calcium level in blood (Medical physiology (eleventh edition) / Arthur C. Guyton,

John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 988–989).

46. A female patient presents with endocrine dysfunction of follicular cells of the ovarian follicles resulting from an inflammation. The synthesis of the following hormone will be inhibited:

A. *Estrogen*. B. *Progesterone*. C. *Lutropin*. D. *Follicle stimulating hormone*. E. *Follistatine*.

Reasoning: Endocrine dysfunction of the ovarian follicles after inflammation will lead to inhibition of hormone synthesis in the follicular cells themselves. During growth of follicles, the main secreted hormone is estrogen. So, dysfunction of ovarian follicles will lead to decreased synthesis of estrogen (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 81 Female Physiology Before Pregnancy and Female Hormones, p. 1015).

47. A patient complains of hydruria (7 liters per day) and polydipsia. Examination reveals no disorders of carbohydrate metabolism. These abnormalities might be caused by the dysfunction of the following endocrine gland:

A. *Adrenal cortex*. C. *Adenohypophysis*. E. *Islets of Langerhans (pancreatic islets)*.
B. *Adrenal medulla*. D. *Neurohypophysis*.

Reasoning: Hydruria and polydipsia in case of no disorders of carbohydrates metabolism are the symptoms of diabetes insipidus – the disease caused by deficiency of antidiuretic hormone secreted by neurohypophysis (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 666).

48. A child has abnormal formation of tooth enamel and dentin as a result of low concentration of calcium ions in blood. Such abnormalities might be caused by deficiency of the following hormone:

A. *Triiodothyronine*. C. *Parathormone*. E. *Somatotropic hormone*.
B. *Thyrocalcitonin*. D. *Thyroxin*.

Reasoning: Abnormal formation of tooth enamel and dentin as a result of low calcium concentration in blood might be caused by deficiency of parathormone that has the specific effect to increase blood calcium level and decrease phosphate level (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 985, 992).

49. Clinical examination of a female patient revealed reduction of basal metabolism by 40 %, gain in body mass, drop of body temperature, face puffiness, sexual dysfunctions, inertness and apathy, lowered intelligence. These symptoms are caused by dysfunction of the following endocrine gland:

A. *Hypophysis hyperfunction*. D. *Hypofunction of parathyroid glands*.
B. *Epiphysis hypofunction*. E. *Hypofunction of thyroid gland*.
C. *Hyperfunction of thyroid gland*.

Reasoning: Reduction of basal metabolism by 40%, gain in body mass, drop of body temperature, face puffiness, sexual dysfunctions, inertness and apathy and lowered intelligence are the symptoms of myxedema – the disease caused by extreme deficiency of thyroid hormones caused by hypofunction of thyroid gland (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 76 Thyroid metabolic hormones, p. 942).

50. Analysis of urine from a 24-year-old man revealed the following changes: daily diuresis – 10 l, relative density – 1,001, qualitative alterations are absent. A patient complains of excessive thirst, frequent urination. What is the most likely cause of this disease?

A. *Vasopressin hypersecretion*. D. *Relative insulin insufficiency*.
B. *Vasopressin hyposecretion*. E. *Aldosterone hypersecretion*.
C. *Glucocorticoid hypersecretion*.

Reasoning: Excessive thirst, frequent urination, increased diuresis with decreased relative density of urine (N = 1,010–1,025) and no qualitative alterations are the symptoms of diabetes insipidus that is caused by hyposecretion of vasopressin (ADH) (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 666).

51. A child presents with symptoms of psychic and physical retardation (cretinism). It is usually associated with the following hormone deficiency:

A. Somatotropic. B. Calcitonin. C. Insulin. D. Thyroxin. E. Testosterone.

Reasoning: Cretinism is caused by extreme deficiency of thyroxin during fetal life, infancy, or childhood and is characterized by failure of body growth and by mental retardation (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 76 Thyroid metabolic hormones, p. 942).

52. Indirect calorimetry allowed to establish that a 30-year-old male patient had a 30% decrease in basal metabolic rate. This might be caused by the reduced concentration of the following hormones in blood plasma:

A. Glucocorticoids. C. Thyrocalcitonin, parathormone. E. Triiodothyronine, tetraiodothyronine.
B. Catecholamines. D. Somatoliberin, somatostatin.

Reasoning: Thyroid hormones (triiodothyronine and tetraiodothyronine) increase metabolism in almost all cells of the body, therefore increasing the basal metabolic rate. 30-50% decrease of basal metabolic rate is caused by severe deficiency of thyroid hormones (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 76 Thyroid metabolic hormones, p. 936, 942).

53. A 20-year-old patient complains of morbid thirst and hyperdiuresis (up to 10 l daily). Glucose concentration in blood is normal but it is absent in urine. The patient has been diagnosed with diabetes insipidus. What hormonal drug is the most appropriate for management of this disorder?

A. Thyroxin. B. Oxytocin. C. Vasopressin. D. Cortisol. E. Insulin.

Reasoning: Diabetes insipidus is characterized by morbid thirst and hyperdiuresis with no alterations of glucose levels in blood and urine. The cause of this disease is the deficiency of vasopressin (antidiuretic hormone), so administration of vasopressin is the most appropriate treatment (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 17 The Endocrine System, p. 666).

54. A 5-month-old boy was hospitalized for tonic convulsions. He has a lifetime history of this disease. Examination revealed coarse hair, thinned and fragile nails, pale and dry skin. In blood: calcium – 1,5 millimole/l, phosphor – 1,9 millimole/l. These changes are associated with:

A. Hypothyroidism. C. Hypoparathyroidism. E. Hyperaldosteronism.
B. Hypoaldosteronism. D. Hyperparathyroidism.

Reasoning: Tonic convulsions, coarse hair, thinned fragile nails, pale and dry skin, hypocalcemia (N = 2,2–2,65 mmol/l) and hyperphosphatemia (N = 0,8–1,45 mmol/l) are the signs of parathyroid hormone deficiency – hypoparathyroidism (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 987, 990).

55. After a severe stress a patient was found to have eosinopenia. A decrease in the eosinophils number can be explained by the changed concentration of the following hormones:

A. Adrenaline. B. Glucocorticoids. C. Insulin. D. Mineralocorticoids. E. Vasopressin.

Reasoning: Glucocorticoids, especially cortisol, decrease the number of eosinophils and lymphocytes in the blood. Indeed, a finding of lymphocytopenia or eosinopenia is an important diagnostic criterion for overproduction of cortisol by the adrenal gland. Increased level of glucocorticoids is caused by activation of adrenal cortex during severe stress (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 958).

56. A 6-year-old child suffers from delayed growth, disrupted ossification processes, decalcification of the teeth. What can be the cause?

A. Decreased glucagon production. B. Hyperthyroidism. D. Vitamin C deficiency.
C. Insulin deficiency. E. Vitamin D deficiency.

Reasoning: Vitamin D increases calcium absorption in intestines, kidneys and bones and enhances the mineralization of teeth and bones. Therefore, the deficiency of vitamin D can lead to delayed growth, disrupted ossification process and decalcification of teeth (Medical

physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 985).

57. Prior to glucose utilization in cells it is transported inside cells from extracellular space through plasmatic membrane. This process is stimulated by the following hormone:

A. Aldosterone. B. Thyroxin. C. Adrenalin. **D. Insulin.** E. Glucagon.

Reasoning: Glucose transport inside the cells through plasmatic membranes, especially in muscle cells and adipose cells, is stimulated by insulin. Within seconds after insulin binds with its membrane receptors, the membranes of about 80 per cent of the body's cells markedly increase their uptake of glucose (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 963).

58. A 19-year old male was found to have an elevated level of potassium in the secondary urine. These changes might have been caused by the increase in the following hormone level:

A. Aldosterone. B. Oxytocin. C. Adrenalin. D. Glucagon. E. Testosterone.

Reasoning: Aldosterone is the hormone produced by adrenal cortex that causes increased renal tubule reabsorption of sodium and secretion of potassium. Hypersecretion of aldosterone will cause the reduced diuresis, hypernatremia and hypokalemia. Level of potassium in urine will be elevated because of increased potassium secretion. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 948)

59. A patient with signs of osteoporosis and urolithiasis has been admitted to the endocrinology department. Blood test revealed hypercalcemia and hypophosphatemia. These changes are associated with abnormal synthesis of the following hormone:

A. **Parathyroid hormone.** B. Calcitonin. C. Cortisol. D. Aldosterone. E. Calcitriol.

Reasoning: Parathormone (PTH) increases renal tubular reabsorption of calcium (in the late distal tubules, the collecting tubules, the early collecting ducts, and possibly the ascending loop of Henle) and at the same time diminishes proximal tubular reabsorption of phosphate ions. As a result, hypercalcemia and hypophosphatemia occur. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 987).

Sensory systems & higher nervous activity

1. A student is thoroughly summarizing a lecture. When his group mates begin talking the quality of the summarizing worsens greatly. What type of inhibition in the cerebral cortex is the cause of it?

- A. *Differential.* B. *Delayed.* C. ***External.*** D. *Dying.* E. *Protective.*

Reasoning: External inhibition occurs when current conditioned reflex is weakened or inhibited by a simultaneous excitatory process. A sudden noise or fear or any other emotion distracts the attention of the subject and inhibits conditioned reflex. Here, inhibition arises in the part of brain other than that where the conditioned reflex is initiated. As soon as the distraction is off, the conditioned reflex returns. Inhibition lasts as long as the distraction persists (C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learning and Memory, P. 5–261).

2. A 60-year-old patient was diagnosed with hypothalamic lateral nuclei stroke. What changes in patient's behavior may be expected?

- A. *Thirst.* C. *Unsatisfied hunger.* E. *Aggressive behavior.*
B. *Depression.* D. ***The rejection of food.***

Reasoning: The lateral hypothalamic area is associated with hunger. Damage to this area on both sides of the hypothalamus causes the rejection of food, sometimes causing lethal starvation (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 58 Behavioral and Motivational Mechanisms of the Brain—The Limbic System and the Hypothalamus, p. 734).

3. Middle part of cochlear of internal ear was destroyed in animal while experiment. It will cause abnormalities of the sound perception of the following frequencies:

- A. *High.* B. *Low.* C. ***Middle.*** D. *High and low.* E. *No abnormalities.*

Reasoning: According to the place principle of sound frequency determination, low-frequency sounds cause maximal activation of the basilar membrane near the apex of the cochlea, intermediate frequency sounds activate the membrane at intermediate distances and high-frequency sounds activate the basilar membrane near the base of the cochlea. Therefore, destruction of middle part of cochlea leads to abnormalities of middle frequencies perception (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 52 The Sense of Hearing, p. 656).

4. In the experiment on the animal the part of the cerebral cortex hemispheres was removed. It caused elimination of previously formed conditioned reflex to the light irritation. What part of the cortex was removed?

- A. *Precentral convolution.* C. *Temporal lobe.* E. *Limbic cortex.*
B. *Postcentral convolution.* D. ***Occipital cortex.***

Reasoning: Elimination of previously formed conditioned reflex is caused by removal of part of cerebral cortex in which the center of that reflex is located. Light is the adequate stimulus for visual sensory system and corresponding area of cerebral cortex for vision is the occipital cortex (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 51 The Eye: III. Central Neurophysiology of Vision, p. 642).

5. While shifting the gaze to the closely situated object the refracting power of eye's optical mediums will increase by 10 diopters. It results from changing of such eye structure:

- A. *Vitreous body.* C. *Cornea.* E. *Muscle that dilates pupil.*
B. *Liquid of the anterior chamber of eye.* D. ***Lens.***

Reasoning: Increase of refractive power of the eye that enables a person to focus on the closely situated object is called the accommodation reflex and by nature is a change in the curvature of the lens (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 618).

6. A patient has a hemorrhage into the posterior central gyrus. What type of sensitivity on the opposite side will be disturbed?

- A. *Visual.* C. *Auditory.* E. ***Skin and proprioceptive.***
B. *Auditory and visual.* D. *Olfactory.*

Reasoning: Posterior central gyrus is the primary somatosensory area concerned with perception and interpretation of somatosensory signals including skin and proprioceptive sensitivity (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 47 Somatic Sensations: I. General Organization, the Tactile and Position Senses, p. 589).

7. A man who went for a ride on a roundabout had amplification of heart rate, sweating and nausea. What receptors stimulation is it primarily connected with?

A. *Proprioceptors.* B. *Visual.* C. *Auditory.* D. *Tactors.* E. *Vestibular.*

Reasoning: Rotational acceleration is detected by vestibular receptors of the three semicircular ducts of inner ear. Signals from vestibular receptors by way of VIII cranial nerve reach vestibular nuclei of pons that are connected with hypothalamus, providing appearance of autonomic reactions in case of hyperexcitation of vestibular receptors (motion sickness, sea sickness, in case of prolonged rotations) (S.I. Fox, Human Physiology, © The McGraw–Hill Companies, 2016. Ch. 10 Sensory Physiology, p. 282).

8. A patient complains of dizziness and hearing loss. What nerve is damaged?

A. *Trochlear.* B. *Vagus.* C. *Vestibulocochlear.* D. *Sublingual.* E. *Trigeminus.*

Reasoning: Vestibulocochlear nerve (VIII pair of cranial nerves) provides transmission of signals for hearing and equilibrium. Damage of vestibulocochlear nerve can lead to nerve deafness, dizziness, nausea, loss of balance, and nystagmus (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 14. The Brain and Cranial Nerves, p. 553).

9. A man has normal sensitivity of his finger skin, however he doesn't sense his wedding ring around the finger. What process induced by wearing of the ring has caused this phenomenon?

A. *Impaired circulation.* D. *Abnormality of the epidermis structure.*

B. *Receptor adaptation.*

E. *Abnormality of the receptor structure.*

C. *Development of the fibrous tissue.*

Reasoning: As the man has normal overall sensitivity of his finger skin, then we can assume that the reason for him not feeling the wedding ring is sensory adaptation—if the stimulus is prolonged, firing frequency and conscious sensation decline. Constant wearing of the wedding ring acts as a prolonged stimulus causing adaptation of tactile receptors in that specific place (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 587).

10. According to audiometry data a patient has a disturbed perception of medium-frequency sounds. It might have been caused by a damage of:

A. *Cochlear nuclei.* C. *Spiral ganglion.* E. *Quadritubercular structure.*

B. *Lateral geniculate bodies.* D. *Middle part of helix.*

Reasoning: According to the place principle of sound frequency determination, low-frequency sounds cause maximal activation of the basilar membrane near the apex of the cochlea, intermediate frequency sounds activate the membrane at intermediate distances and high-frequency sounds activate the basilar membrane near the base of the cochlea. Therefore, disturbed perception of middle frequency sounds might have been caused by damage of middle part of helix (cochlea) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 52 The Sense of Hearing, p. 656).

11. Examination of a patient revealed a strong, balanced, inert type of higher nervous activity according to Pavlov. What temperament type does the patient have (according to Hippocrates classification)?

A. *Sanguine.* B. *Phlegmatic.* C. *Choleric.* D. *Melancholic.* E. *–.*

Reasoning: According to I.P. Pavlov, there are 4 types of HNA – sanguine, phlegmatic, melancholic and choleric. They are divided according to 3 main characteristics – strength of main processes (excitation and inhibition), balance between them and ability to switch from one to another. If HNA type is weak, it's melancholic, if it is strong and imbalanced – choleric. Strong, balanced and inert (slow switching) – phlegmatic. Strong, balanced and mobile (easy switching) – sanguine.

12. During an experiment the myotatic reflex has been studied in frogs. After extension in a skeletal muscle its reflexory contraction was absent. The reason for it might be a dysfunction of the following receptors:

A. Articular. B. Tactile. C. Golgi tendon organs. D. Muscle spindles. E. Nociceptors.

Reasoning: Extension (stretching) of muscle leads to excitation of the spindles that causes reflex contraction of the large skeletal muscle fibers of the stretched muscle and also of closely allied synergistic muscles. This reflex contraction is called the myotatic (stretch) reflex. Dysfunction of muscle spindles will lead to absence of muscle reflex contraction (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 54 Motor Functions of the Spinal Cord; the Cord Reflexes, p. 676).

13. Surface with an intact toad on it was inclined to the right. Tone of extensor muscles became reflexory higher due to the activation of the following receptors:

A. Mechanoreceptors of foot skin. D. Vestibuloreceptors of utricle and saccule.
B. Photoreceptors of retina. E. Vestibuloreceptors of semicircular ducts.
C. Proprioceptors.

Reasoning: Inclination of surface is movement with linear acceleration that is detected by vestibular receptors of the utricle and saccule (otolith receptors). (S.I. Fox, Human Physiology, © The McGraw–Hill Companies, 2016. Ch. 10 Sensory Physiology, p. 280).

14. In course of an experiment a toad's right labyrinth was destroyed. It will cause amyotonia of the following muscles:

A. Left flexors. B. Left extensors. C. Right extensors. D. Right flexors. E. Right and left extensors.

Reasoning: Signals from vestibular apparatus are transmitted by way of VIII cranial nerve to vestibular nuclei in medulla oblongata. The specific role of the vestibular nuclei is to selectively control the excitatory signals to the different antigravity muscles to maintain equilibrium by way of vestibulospinal tract in response to signals from the vestibular apparatus. There is no decussation in vestibulospinal tract, thus signals from right labyrinth go to right vestibular nuclei and from them to extensors of right half of the body (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 55 Cortical and Brain Stem Control of Motor Function p. 692).

15. In course of an experiment thalamocortical tracts of an animal were cut. What type of sensory perception remained intact?

A. Auditory. B. Exteroreceptive. C. Visual. D. Olfactory. E. Nociceptive.

Reasoning: The olfactory sensory system (its less old part) is the only system where sensory signals pass directly to the cortex without passing first through the thalamus (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 53 Chemical Senses, p. 669).

16. An experimentator wants a dog to develop conditioned salivary reflex. What conditioned stimulus will be appropriate to use?

A. Electric current. C. Zwieback. E. Very loud sound.
B. Moderately loud sound. D. Meat.

Reasoning: For development of conditioned reflex 2 stimuli should be present – conditioned stimulus (CS) and unconditioned one (US). CS has specific requirements – it should precede US, it should be weaker than US and its biological significance for the organism should be less than of US. Thus, electric current and too loud sound, both have too big significance, zwieback (type of snack) and meat are US for salivation, and only moderately loud sound fulfills all the requirements.

17. During a neuro-surgical operation the occipital areas of cerebral cortex are stimulated. What sensations will the patient have?

A. Tactile. B. Auditory. C. Olfactory. D. Gustatory. E. Visual.

Reasoning: Occipital cortex is visual area (V1 lies near calcarine fissure and V2, also called visual association areas, lie lateral, anterior, superior, and inferior to the primary visual cortex) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 51 The Eye, p. 642).

18. A patient has been prescribed the salt-free diet. What changes to the salt taste sensitivity threshold should be expected?

- A. *Decrease.* C. *Little change.* E. *Increase followed by a decrease.*
 B. *No changes.* D. *Increase.*

Reasoning: If a stimulus doesn't act on receptor for some time, receptor's sensitivity to it increases because threshold of receptor decreases.

19. A patient consulted a doctor about loss of taste at the root of tongue. The doctor established that this was due to nerve damage. What nerve was damaged?

- A. *Vagus.* B. *Facial.* C. *Superlaryngeal.* D. *Trigeminal.* E. *Glossopharyngeal.*

Reasoning: Taste impulses from the anterior two thirds of the tongue pass through the chorda tympani into the facial nerve, and finally into the tractus solitarius in the brain stem. Taste sensations from the back of the tongue and from other posterior regions of the mouth and throat are transmitted through the glossopharyngeal nerve also into the tractus solitarius (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 53 Chemical Senses, p. 666).

20. Before an exam a student complained of acute dental pain which grew less during the exam. What inhibition caused the pain abatement?

- A. *Protective.* B. *Delayed.* C. *External.* D. *Declining.* E. *Differentiating.*

Reasoning: External inhibition occurs when current conditioned reflex is weakened or inhibited by a simultaneous excitatory process. A sudden noise or fear (like during exam) or any other emotion distracts the attention of the subject and inhibits conditioned reflex. Here, inhibition arises in the part of brain other than that where the conditioned reflex is initiated. As soon as the distraction is off, the conditioned reflex returns. Inhibition lasts as long as the distraction persists (C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learning and Memory, p. 5–261).

21. A 60 year old patient has impaired perception of high-frequency sounds. These changes were caused by damage of the following auditory analyzer structures:

- A. *Main cochlea membrane near the helicotrema.* A. *Middle ear muscles.*
 B. *Main cochlea membrane near the oval window.* B. *Tympanic membrane.*
 C. *Eustachian tube.*

Reasoning: According to the place principle of sound frequency determination, low-frequency sounds cause maximal activation of the basilar membrane near the apex of the cochlea, intermediate frequency sounds activate the membrane at intermediate distances and high-frequency sounds activate the basilar membrane near the base of the cochlea. Therefore, impaired perception of high-frequency sounds is caused by abnormalities of cochlear membrane near oval window (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 52 The Sense of Hearing, p. 656).

22. A 75-year-old-female patient with complaints of visual impairment has been delivered to the ophthalmologic department. Objective examination revealed a brain tumor in area of the left optic tract. The patient has a visual field defect in the following area:

- A. *Left and right halves of the left eye retina.* D. *Left half of both eyes retina.*
 B. *Left and right halves of the right eye retina.* E. *Right half of both eyes retina.*
 C. *Left and right halves of both eyes retina.*

Reasoning: Fibers from retina form optic nerve that goes to optic chiasm where partial decussation (hemidecussation) occurs – only fibers from nasal halves of retina decussate to opposite side. Thus, left optic tract comprises fibers from left (temporal) half of left eye retina and left (nasal) half of right eye retina (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 626).

23. While examining the oral cavity a stomatologist revealed inflammation of papillae on the border of the median and posterior third of the back of tongue. What papillae are inflamed?

- A. *Papillae fungiformes.* C. *Papillae filiformes.* E. *Papillae conicae.*
 B. *Papillae foliatae.* D. *Papillae vallatae.*

Reasoning: Circumvallate (vallate) papillae form a V line on the border of the median and posterior third of the tongue (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 53 Chemical Senses, p. 665).

24. A male working as a blacksmith has been tested for auditory acuity. The tests revealed 50 % hearing loss in the low-frequency range and a near-normal auditory acuity in the high-frequency range. This condition has been caused by the damage to the following structures of the auditory system:

A. Median part of the Corti's organ.

D. Muscles of the middle ear.

B. Corti's organ – closer to the oval foramen.

E. Eardrum.

C. Corti's organ – closer to helicotrema.

Reasoning: According to the place principle of sound frequency determination, low-frequency sounds cause maximal activation of the basilar membrane near the apex of the cochlea, intermediate frequency sounds activate the membrane at intermediate distances and high-frequency sounds activate the basilar membrane near the base of the cochlea. Therefore, impaired perception of low-frequency sounds is caused by abnormalities of cochlear membrane with Corti's organ near helicotrema (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 52 The Sense of Hearing, p. 656).

25. After a craniocerebral injury a patient is unable to recognize objects by touch. What part of brain has been damaged?

A. Precentral gyrus.

C. Temporal lobe.

E. Cerebellum.

B. Postcentral gyrus.

D. Occipital lobe.

Reasoning: Posterior central gyrus is the primary somatosensory area concerned with perception and interpretation of somatosensory signals including skin (tactile, pain, temperature) and proprioceptive sensitivity (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 47 Somatic Sensations: I. General Organization, the Tactile and Position Senses, p. 589).

26. As a result of craniocerebral injury, a patient has decreased skin sensitivity. What area of cerebral cortex is likely to be damaged?

A. Cingulate gyrus.

C. Occipital region.

E. Frontal cortex.

B. Anterior central gyrus.

D. Posterior central gyrus.

Reasoning: Posterior central gyrus is the primary somatosensory area concerned with perception and interpretation of somatosensory signals including skin (tactile, pain, temperature) and proprioceptive sensitivity (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 47 Somatic Sensations: I. General Organization, the Tactile and Position Senses, p. 589).

27. The receptors under study provide transfer of information to the cortex without thalamic involvement. Specify these receptors:

A. Tactile.

B. Visual.

C. Auditory.

D. Gustatory

E. Olfactory.

Reasoning: The olfactory sensory system (its less old part) is the only system where sensory signals pass directly to the cortex without passing first through the thalamus (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 53 Chemical Senses, p. 669).

28. During the air and bone conduction tests it was revealed that the left ear the tones were louder by bone conduction. This might be associated with the disease of:

A. Left inner ear.

C. Right inner ear.

E. Right external ear.

B. Left middle ear.

D. Right middle ear.

Reasoning: Conduction test is performed with help of a tuning fork. Vibrating tuning fork is placed first near the forehead of the patient (air conduction), then on top of the head on the same distance from the patient's ears on top of thin skin in contact with the bone (bone conduction). The patient is asked to report in which ear the sound is heard louder in both parts of test. Normally, the volume of sound is the same in both options. If patient hears sounds better during contact with bone, it means that inner ear works normally and the problem lies in air conduction (middle or outer ear).

29. A sportsmen spontaneously held breath for 40 seconds, which resulted in an increase of heart rate and systemic arterial pressure. Changes of this indicators are due to activation of the following regulatory mechanisms:

- A. Conditioned sympathetic reflex.
- B. Conditioned parasympathetic reflex.
- C. Unconditioned sympathetic reflex.

- D. Unconditioned parasympathetic reflex.
- E. –.

Reasoning: If there is a direct stimulation of specific receptors (chemoreceptors of carotid and aortic bodies stimulated by accumulation of CO₂ and deficiency of O₂ in case of breath-holding), it's an unconditioned reflex. Increase of HR and BP are sympathetic responses.

30. In an experiment a dog had been conditioned to salivate at the sight of food and a flash of light. After conditioning the reflex, the light was then paired with the bell. The dog didn't start to salivate. What type of inhibition was observed?

- A. Differential.
- B. Protective.
- C. Extinctive.
- D. External
- E. Persistent.

Reasoning: External inhibition occurs when current conditioned reflex is weakened or inhibited by a simultaneous excitatory process. A sudden noise (like the bell) or fear or any other emotion distracts the attention of the subject and inhibits conditioned reflex. Here, inhibition arises in the part of brain other than that where the conditioned reflex is initiated. As soon as the distraction is off, the conditioned reflex returns. Inhibition lasts as long as the distraction persists (C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learning and Memory, p. 5–261).

31. Examination of a patient with an interbrain injury revealed the hearing impairment. What structures must be damaged?

- A. Lateral geniculate bodies of thalamus.
- B. Intralaminar nuclei of hypothalamus.
- C. Medial nuclei of hypothalamus.
- D. Medial geniculate bodies of thalamus.
- E. Frontal nuclei of hypothalamus.

Reasoning: Medial geniculate nuclei of thalamus are specific nuclei for auditory analyzer (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 657).

32. Before an exam a student complained of acute dental pain which grew less during the exam. What inhibition caused the pain abatement?

- A. Protective.
- B. External.
- C. Declining.
- D. Differentiating.
- E. Delayed.

Reasoning: External inhibition occurs when current conditioned reflex is weakened or inhibited by a simultaneous excitatory process. A sudden noise or fear (like during exam) or any other emotion distracts the attention of the subject and inhibits conditioned reflex. Here, inhibition arises in the part of brain other than that where the conditioned reflex is initiated. As soon as the distraction is off, the conditioned reflex returns. Inhibition lasts as long as the distraction persists (C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learning and Memory, p. 5–261).

33. A 68-year-old female patient with the history of glaucoma has increased intraocular pressure with normal secretion of aqueous humor by ciliary bodies. The inadequate outflow of fluid from the anterior chamber is associated with the damage to the following structure of the eyeball wall:

- A. Ciliary muscle.
- B. Ciliary body.
- C. Venous sinus.
- D. Choroid.
- E. Posterior corneal epithelium.

Reasoning: The aqueous humor is a serous fluid secreted by the ciliary body into the posterior chamber, a space between the iris and lens; then it flows through the pupil into the anterior chamber between the cornea and iris. From here, it is reabsorbed by a ring-like blood vessel called the scleral venous sinus (canal of Schlemm). Normally the rate of reabsorption balances the rate of secretion. If reabsorption is poor (blockage of venous sinus) or secretion is excessive, accumulation of aqueous humor leads to elevation of intraocular pressure – a state called glaucoma (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 613–614).

34. A patient with inflammation of tongue mucosa (glossitis) complains to taste sensitivity disorder in the two anterior third of his tongue. This is caused by the damage of the following nerve:

- A. Tympanic.
- B. Glossopharyngeal.
- C. Lesser petrosal.
- D. Lingual.
- E. Tympanic chord.

Reasoning: Tasteimpulses from the anterior two thirds of the tonguepass through thechorda tympani into the facial nerve, and finally intothe tractus solitarius in the brain stem (Medical

physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 53 Chemical Senses, p. 666).

35. A 42-year-old patient has an inflammation of the inner ear. After the examination, the doctor revealed the affection of the first neuron bodies of the auditory analyzer. Where are they localized?

- A. *G. geniculi*. B. *G. ciliare*. C. ***G. spirale***. D. *G. trigeminale*. E. *G. vestibulare*.

Reasoning: First-order neurons of auditory analyzer are located in the spiral ganglion of Corti, which lies in the modiolus (center) of the cochlea (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 52 The Sense of Hearing, p. 655).

36. A 46 year-old patient consulted an oculist about drooping of upper eye-field. On examination he was diagnosed with a brain tumor. The pathological process must have affected the nuclei of the following pair of cranial nerves:

- A. *IV*. B. *VII*. C. ***III***. D. *II*. E. *VI*.

Reasoning: Muscle that elevates upper eye-lid is innervated by oculomotor nerve (III) (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 612).

37. A 23 year-old patient consulted an oculist about vision impairment. Visual acuity was corrected by means of lenticular lenses. Specify a type of dysfunction of the visual analyzer in this patient:

- A. *Myopia*. B. ***Hyperopia***. C. *Astigmatism*. D. *Night-blindness*. E. *Daltonism*.

Reasoning: Lenticular lenses (convex) have high refractive power, thus are used for correction of hyperopia (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 619).

38. A patient under examination is in a stage of rapid eye movement sleep. This is confirmed by the following waves registered by EEG:

- A. *Alpha spindles*. B. *Alpha waves*. C. *Delta waves*. D. ***Beta waves***. E. *Theta waves*.

Reasoning: REM-sleep is also called paradoxical or desynchronized sleep because it is usually associated with active dreaming and active bodily muscle movements, the person is even more difficult to arouse by sensory stimuli than during deep slow-wave sleep, and yet in EEG beta-waves appear, that are usually seen when the person is awake and actively doing something (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 59 The States of Brain Activity, p. 743).

39. Examination of a patient with a brain cortex injury revealed that he had lost the tactile sensitivity. What part of the cerebral cortex is damaged?

- A. *Anterior central gyrus*. C. *Occipital lobe*. E. *Parietal lobe*.
B. ***Posterior central gyrus***. D. *Frontal lobe*.

Reasoning: Posterior central gyrus is the primary somatosensory area concerned with perception and interpretation of somatosensory signals including skin (tactile, pain, temperature) and proprioceptive sensitivity (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 47 Somatic Sensations: I. General Organization, the Tactile and Position Senses, p. 589).

40. A soldier with explosion-caused trauma was delivered to a hospital. Examination revealed his tympanic membrane to be intact. What defense reflex prevented the tympanic membrane from rupturing?

- A. *Contraction of m. auricularis anterior*. D. *Relaxation of m. auricularis anterior*.
B. ***Contraction of m. tensor tympani***. E. *Relaxation of m. tensor tympani*.
C. *Relaxation of m. stapedius*.

Reasoning: In response to a loud noise, the tensor tympani contracts and pulls the eardrum inward and tenses it, while the contraction of stapedius muscle reduces mobility of the stapes. Contraction of both tensor tympani and stapedius muscles provide tympanic (acoustic) reflex that muffles the transfer of vibrations from the eardrum to the oval window (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 602).

41. When taking exams students often have dry mouth. The mechanism that causes this state results from the following reflexes:

A. Unconditioned peripheral.

B. Unconditioned parasympathetic.

C. Unconditioned sympathetic.

D. Conditioned parasympathetic.

E. Conditioned sympathetic.

Reasoning: If there is no direct stimulation of specific receptors, only emotions or memory are involved in appearance of a reflex (like fear during exam), then that reflex is conditioned. Dry mouth is caused by decrease of saliva's volume because of activation of sympathetic system.

42. A laboratory experiment on a dog was used to study central part of auditory system. One of the mesencephalon structures was destroyed. The dog has lost the orientating response to auditory signals. What structure was destroyed?

A. Reticular formation nuclei.

B. Red nucleus.

C. Substantia nigra.

D. Superior colliculi of corpora quadrigemina.

E. Inferior colliculi of corpora quadrigemina.

Reasoning: Almost all auditory fibers relay in inferior colliculi of quadrigeminal plate in midbrain, from which they pass to medial geniculate bodies of thalamus (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 52 The Sense of Hearing, p. 657).

43. Workers of a conveyor workshop received recommendations for the effective organization of working time and higher working efficiency. What peculiarity of work in this workshop causes the greatest stress for the workers?

A. Increased intellectual component.

B. Increased responsibility.

C. Monotony of work.

D. State of «operating rest».

E. Social inefficiency of labor.

Reasoning: Work at conveyor is characterized by constantly repeated same actions without any possibility to shift the attention at any other kind of work, that monotony of work becomes the main stress factor.

44. A histological specimen of the eyeball shows a biconvex structure connected to the ciliary body by the fibers of the Zinn's zonule and covered with a transparent capsule. Name this structure:

A. Crystalline lens. B. Vitreous body. C. Ciliary body. D. Cornea. E. Sclera.

Reasoning: The lens is a transparent structure inserted in a capsule that is suspended behind the pupil by a ring of fibers of the Zinn's zonule called the suspensory ligament, which attaches it to the ciliary body (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 614).

45. Pupil dilation occurs when a person steps from a light room into a dark one. What reflex causes such a reaction?

A. Sympathetic unconditioned reflex.

B. Sympathetic conditioned reflex.

C. Metasympathetic reflex.

D. Parasympathetic unconditioned reflex.

E. Parasympathetic conditioned reflex.

Reasoning: Pupil dilation (mydriasis) is a sympathetic effect. Sympathetic innervation to the pupil originates, like all other sympathetic efferents, in the spinal cord (Th1-Th2). Preganglionic fibers lead from the thoracic cord to the superior cervical ganglion. From there, postganglionic fibers follow the carotid arteries into the head and lead ultimately to the pupillary dilator (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 616).

46. A patient demonstrates functional loss of nasal halves of the retinas. What area of visual pathways is affected?

A. Optic chiasm.

B. Left optic tract.

C. Right optic tract.

D. Left optic nerve.

E. Right optic nerve.

Reasoning: Fibers from retina form optic nerve that goes to optic chiasm where partial decussation (hemidecussation) occurs – only fibers from nasal halves of retina decussate to opposite side. Thus, damage of optic chiasm leads to loss of signals from nasal halves of retina (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16. Sense Organs, p. 626).

47. During experiment a dog has developed conditioned digestive reflex in response to a sound stimulus. This conditioned reflex will not be exhibited anymore after the extirpation of the following areas of the cerebral hemispheres:

A. Temporal lobe on both sides.

D. Temporal lobe on one side.

B. Occipital lobe on one side.

E. Occipital lobe on both sides.

C. Parietal lobe on both sides.

Reasoning: Signals from both ears are transmitted through the pathways of both sides of the brain to the auditory cortex of both hemispheres that lies principally on the supratemporal plane of the superior temporal gyrus (primary auditory cortex) and extends onto the lateral side of the temporal lobe, over much of the insular cortex, and even onto the lateral portion of the parietal operculum (secondary auditory cortex). Thus, to eliminate conditioned reflex in response to sound, both temporal lobes should be extirpated (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 52 The Sense of Hearing, p. 658).

48. A person with vitamin A deficiency develops twilight vision disturbance. Name the cells that fulfill this photoreceptors function.

A. Bipolar neurons.

C. Cone cells.

E. Horizontal cells of retina.

B. Rod cells.

D. Ganglionic nerve cells.

Reasoning: Twilight vision disturbance or night blindness occurs in any person with severe vitamin A deficiency. The simple reason for this is that without vitamin A, the amounts of retinal and rhodopsin (the photosensitive pigment that is present in rods) that can be formed are severely depressed. This condition is called night blindness because the amount of light available at night is too little to permit adequate vision in vitamin A-deficient persons (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 50 The Eye II, p. 629).

49. A student whose educational achievements throughout the semester were poor, feels emotionally tense during the final test. What is the primary cause that induced leading mechanism of emotional tension in this case?

A. Lack of energy.

D. Tight time and lack of energy.

B. Lack of energy and information.

E. Tight time.

C. Lack of information.

Reasoning: As the educational achievements of a student were bad during the semester, from 3 main factors of emotional stress (lack of energy, lack of information and lack of time) the deficiency of information will be the dominant cause of emotional tension.

Physical and chemical properties of blood

1. During total (with water) alimentary starvation the generalized edema has developed. Which of the pathogenic factors is dominant in this case?

- A. *Reduced osmotic pressure of blood plasma.*
- B. *Increased osmotic pressure of interstitial fluid.*
- C. ***Reduced oncotic pressure of blood plasma.***
- D. *Increased oncotic pressure of interstitial fluid.*
- E. *Reduced hydrostatic pressure of interstitial fluid.*

Reasoning: Several conditions can lead to hypoproteinemia, a deficiency of plasmaprotein: extremestarvation or dietary protein deficiency, liver diseases that interfere with protein synthesis, kidney diseases that result in protein loss through the urine, and severe burns that result in protein loss through the body surface. As the protein content of the blood plasma drops, so does its oncotic (colloid-osmotic) pressure. The bloodstream loses more fluid to the tissues than it reabsorbs by osmosis. Thus, the tissues become edematous and a pool of fluid may accumulate in the abdominal cavity—a condition called ascites (Saladin: *Anatomy & Physiology: The Unity of Form and Function (Third Edition)* / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 682).

2. The concentration of albumins in human blood sample is lower than normal. This leads to edema of tissues. What blood function is damaged?

- A. *Maintaining the -blood sedimentation system.*
- B. ***Maintaining the oncotic pressure of blood.***
- C. *Maintaining the body temperature.*
- D. *All answers are correct.*
- E. *Maintaining the pH level.*

Reasoning: Albumins are the smallest and most abundant plasmaproteins. Because of their major contributions to viscosity and osmolarity, pathological changes in albumin concentration strongly influence blood pressure, flow, and fluid balance. As the albumin content of the blood plasma drops, so does its oncotic (colloid-osmotic) pressure. The bloodstream loses more fluid to the tissues than it reabsorbs by osmosis. Thus, the tissues become edematous (Saladin: *Anatomy & Physiology: The Unity of Form and Function (Third Edition)* / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 694).

3. Osmotic pressure of a man's blood plasma is 350 mosmole/l (standard pressure is 300 mosmole/l). First of all it will result in high secretion of the following hormone:

- A. *Natriuretic.*
- B. *Aldosteron.*
- C. ***Vasopressin.***
- D. *Adrenocorticotropin.*
- E. *Cortisol.*

Reasoning: Antidiuretic hormone (ADH) increases the reabsorption of water in collecting tubules and ducts of kidneys thus decreasing the osmolarity of blood and decreasing the diuresis (daily production of secondary urine). When the osmolarity of the blood increases (like, for example, from 300 to 350 mOsm/L), it is detected by hypothalamic neurons called osmoreceptors. The osmoreceptors trigger ADH release, and ADH promotes water conservation. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 928).

4. After a surgery a 36-year-old woman was given an intravenous injection of concentrated albumin solution. This has induced intensified water movement in the following direction:

- A. *From the cells to the intercellular fluid.*
- B. *From the capillaries to the intercellular fluid.*
- C. ***From the intercellular fluid to the capillaries.***
- D. *From the intercellular fluid to the cells.*
- E. *No changes of water movement will be observed.*

Reasoning: Albumins are the smallest and most abundant plasmaproteins. Because of their major contributions to viscosity and osmolarity, changes in albumin concentration strongly influence blood pressure, flow, and fluid balance. As the albumin content of the blood plasma increases, so does its oncotic (colloid-osmotic) pressure that opposes filtration and increases reabsorption of fluid from tissues to capillaries (Saladin: *Anatomy & Physiology: The Unity of Form and Function (Third Edition)* / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 694).

5. As a result of long-term starvation the glomerular filtration of a man was accelerated by 20%. The most probable cause of filtration changes under such conditions is:

- A. *Increased permeability of renal filter.* D. *Growth of filtration coefficient.*
B. *Fall of oncotic pressure of blood plasma.* E. *Increase of renal plasma flow.*
C. *Rise of systemic arterial pressure.*

Reasoning: $GFR = K_f \times \text{Net filtration pressure}$. K_f is filtration coefficient, and the net filtration pressure represents the sum of the hydrostatic and colloid osmotic forces that either favor or oppose filtration across the glomerular capillaries. These forces include (1) hydrostatic pressure inside the glomerular capillaries (glomerular hydrostatic pressure, P_G), which promotes filtration; (2) the hydrostatic pressure in Bowman's capsule (P_B) outside the capillaries, which opposes filtration; (3) the colloid osmotic pressure of the glomerular capillary plasma proteins (p_G), which opposes filtration; and (4) the colloid osmotic pressure of the proteins in Bowman's capsule (p_B), which promotes filtration. Starvation leads to decrease of blood oncotic (colloid osmotic) pressure that usually opposes filtration, thus leading to increase of GFR (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 317).

6. Packed cell volume of a man was 40 % before the trauma. What packed cell volume will be observed 24 hours after blood loss of 750 ml?

- A. 55 % B. 50 % C. 45 % D. 40 % E. 30 %.

Reasoning: Packed cell volume (PCV) or hematocrit is the percentage of blood that is (normally, 42 to 52 % in men and 37–47 % in women). After rapid hemorrhage, the body replaces the fluid portion of the plasma in 1 to 3 days, but this leaves a low concentration of red blood cells, so PCV in 24 hours after the blood loss will be lower than initial (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 420, 426).

7. A patient is 44 years old. Laboratory examination of his blood revealed that content of proteins in plasma was 40 g/l. What influence will be exerted on the transcapillary water exchange?

- A. *Both filtration and reabsorption will be increase.*
B. *Both filtration and reabsorption will be decreased.*
C. *Filtration will be decreased, reabsorption – increased.*
D. *Filtration will be increased, reabsorption – decreased.*
E. *Exchange will stay unchanged.*

Reasoning: Normal value of total protein in blood is 65–85 g/L. As that patient has 40 g/L, hypoproteinemia is concluded. As the protein content of the blood plasma drops, so does its oncotic (colloid-osmotic) pressure that normally opposes filtration and increases reabsorption of fluid from tissues to capillaries. Thus, when oncotic pressure falls, the filtration increases and reabsorption decreases. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 682).

8. A patient who has been treated for viral hepatitis B developed symptoms of hepatic insufficiency. What changes indicating disorder in protein metabolism are likely to be observed in this case?

- A. *Absolute hyperfibrinogenemia.* D. *Absolute hyperalbuminemia.*
B. *Absolute hyperglobulinemia.* E. *Protein rate in blood will stay unchanged.*
C. *Absolute hypoalbuminemia.*

Reasoning: The liver produces as much as 4 g of plasma protein per hour, contributing all of the major proteins except γ -globulins. Albumins are the smallest and most abundant plasma proteins, constituting about 60 % from total protein of blood. Failure of liver to produce sufficient plasma proteins leads to decreased plasma colloid osmotic pressure and the generalized edema that goes with this condition. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 682).

9. To lose some weight a woman has been limiting the amount of products in her diet. 3 months later she developed edemas and her diuresis increased. What dietary component deficiency is the cause of this?

- A. *Proteins.* B. *Fats.* C. *Vitamins.* D. *Minerals.* E. *Carbohydrates.*

Reasoning: Dietary protein deficiency leads to hypoproteinemia. As the protein content of the blood plasmadrops, so does its oncotic (colloid-osmotic) pressure. The bloodstream loses more fluid to the tissues than it reabsorbs by osmosis. Thus, the tissues become edematous (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 682).

10. During acute hemorrhage the body loses not only fluid but also electrolytes. What substance solution can be used as a simple blood substitute?

A. *Albumin.*

C. *Sodium bromide.*

E. *Sodium chloride.*

B. *Calcium chloride.*

D. *Sodium nucleotide.*

Reasoning: The simplest blood substitute is isotonic 0.9% solution of sodium chloride (saline solution). Isotonic solutions are important in clinical medicine because they can be infused into the blood without the danger of upsetting osmotic equilibrium between the intracellular and extracellular fluids (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 298).

11. Examination of a man who had been working hard under higher temperature of the environment revealed abnormal quantity of blood plasma proteins. What phenomenon is the case?

A. *Absolute hyperproteinemia.*

C. *Relative hyperproteinemia.*

E. *Paraproteinemia.*

B. *Absolute hypoproteinemia.*

D. *Dysproteinemia.*

Reasoning: Hyperproteinemia – increase of the total contents of proteins in blood plasma. There are two types of hyperproteinemia – absolute and relative. Absolute hyperproteinemia – accumulation of the proteins in blood. It occurs in infection and inflammatory diseases (hyperproduction of immunoglobulins), rheumatic diseases (hyperproduction of C-reactive protein), some malignant tumors (myeloma) and others. Relative hyperproteinemia – the increase of the protein concentration but not the absolute amount of proteins. It occurs when organism loses water (diarrhea, vomiting, fever, intensive physical activity etc.). (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p.13).

12. Toxic affection of liver results in dysfunction of protein synthesis. It is usually accompanied by the following kind of dysproteinemia:

A. *Relative hypoproteinemia.*

C. *Absolute hypoproteinemia.*

E. *Paraproteinemia.*

B. *Relative hyperproteinemia.*

D. *Absolute hyperproteinemia.*

Reasoning: Hypoproteinemia – decrease of the total contents of proteins in blood plasma. Absolute hypoproteinemia occurs in old people as well as in pathological states accompanying with the oppressing of protein synthesis (liver diseases) and activation of decomposition of tissue proteins (starvation, hard infectious diseases, state after hard trauma and operations, cancer); also occurs in kidney diseases, when the increased excretion of proteins via the urine takes place. Relative hypoproteinemia (rare) is the decrease in protein concentration but not the absolute amount of protein due to blood dilution. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p.13).

13. Upon toxic damage of hepatic cells resulting in disruption of liver function the patient developed edemas. What changes of blood plasma are the main cause of edema development?

A. *Decrease of albumin content.*

D. *Increase of albumin content.*

B. *Increase of globulin content.*

E. *Decrease of globulin content.*

C. *Decrease of fibrinogen content.*

Reasoning: Albumins are the smallest and most abundant plasma proteins, constituting about 60 % from total protein of blood. Failure of liver to produce sufficient plasma proteins leads to decreased plasma colloid osmotic (oncotic) pressure and the generalized edema that goes with this condition. Edema develops as decrease of oncotic pressure leads to increase of filtration and decrease of reabsorption in capillaries (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 682).

Physiology of RBC

14. If strong oxidizers get into the bloodstream, a met-hemoglobin is formed. It is a compound, where iron (II) becomes iron (III). What has to be done to save the patient?

- A. He has to be given pure oxygen. D. Interchangeable hemotransfusion has to be done.
 B. Patient has to be exposed to the fresh air.
 C. Respiratory centers have to be stimulated. E. He has to be calmed down and put to bed.

Reasoning: A variety of nitrites or oxidant agents can convert the ferrous iron (Fe^{++}) in hemoglobin to the ferric form, Fe^{+++} , thus forming methemoglobin. Methemoglobin cannot bind O_2 and that compound is irreversible, so as treatment the transfusion should be done, giving the patient new RBC with normal hemoglobin able to bind oxygen (Uwe Ackerman – PDQ Physiology (Pretty Darned Quick Series): 1st (first) Edition, Chapter 3 Blood, p. 76).

15. A patient is diagnosed with chronic atrophic gastritis attended by deficiency of Castle's intrinsic factor. What type of anemia does the patient have?

- A. Iron refractory anemia. C. B_{12} -deficiency anemia. E. Hemolytic anemia.
 B. Iron-deficiency anemia. D. Protein-deficiency anemia.

Reasoning: Megaloblastic (pernicious) anemia can result from a deficiency of vitamin B_{12} , but this vitamin is so abundant in meat that a B_{12} deficiency is rare except in strict vegetarians. More often, it occurs when glands of the stomach fail to produce a substance called intrinsic factor that the small intestine needs to absorb vitamin B_{12} . This becomes more common in old age because of atrophy of the stomach. Pernicious anemia can also be hereditary. It is treatable with vitamin B_{12} injections; oral B_{12} would be useless because the digestive tract cannot absorb it without intrinsic factor (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 693).

16. A man lost consciousness in a car with running engine where he had been waiting for a friend for a long time. What hemoglobin compound can be found in the blood of the patient?

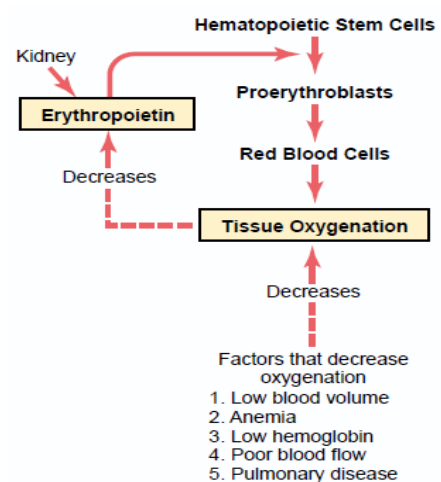
- A. Carbohemoglobin. C. Carboxyhemoglobin. E. Oxyhemoglobin.
 B. Methemoglobin. D. Deoxyhemoglobin.

Reasoning: Car fumes contain carbon monoxide. Hemoglobin has a much higher affinity for carbon monoxide (CO) than for O_2 . Consequently, CO displaces O_2 and thus reduces the oxygen-carrying capacity of erythrocytes. Carbon monoxide and Hb form carbon monoxyhemoglobin, also called carboxyhemoglobin. That compound is reversible, treatment is giving oxygen to a patient (Uwe Ackerman – PDQ Physiology (Pretty Darned Quick Series): 1st (first) Edition, Chapter 3 Blood, p. 76).

17. A man permanently lives high in the mountains. What changes of blood characteristics can be found in his organism?

- A. Decrease of hemoglobin content. D. Erythroblasts in blood.
 B. Decrease of reticulocytes number. E. Increase of erythrocytes number.
 C. Decrease of colour index of blood.

Reasoning: At very high altitudes, where the quantity of oxygen in the air is greatly decreased, insufficient oxygen is transported to the tissues, and red cell production is greatly increased. In this case, it is not the concentration of red blood cells in the blood that controls red cell production, but the amount of oxygen transported to the tissues in relation to tissue demand for oxygen. The principal stimulus for red blood cell production in low oxygen states is a circulating hormone called erythropoietin. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 422).



18. A 32-year-old patient was admitted to the hospital with gross blood loss due to auto accident trauma. Ps – 110 Bpm, RR – 22 pm, BP – 100/60 mm Hg. What changes in the blood will occur in an hour after the blood loss?

A. Erythropenia.

C. Hypovolemia.

E. Hypochromia of

B. Leukopenia.

D. Hypoproteinemia.

erythrocytes.

Reasoning: After hemorrhage, the body replaces the fluid portion of the plasma in 1 to 3 days, and the red blood cell concentration usually returns to normal within 3 to 6 weeks. 1 hour is not enough to restore even the fluid volume of blood, so hypovolemia will be seen (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 420, 426).

19. Examination of a pregnant woman revealed twice as much concentration of fibrinogen in blood plasma. What ESR can this woman have?

A. 0–5 mm/h.

B. 2–12 mm/h.

C. 5–10 mm/h.

D. 10–15 mm/h.

E. 40–50 mm/h.

Reasoning: ESR is erythrocyte sedimentation rate. Normal ESR for women is 2–15 mm/h, for men 1–10 mm/h. ESR increases in case of decrease of albumin content in blood, increase of globulins or fibrinogen content, advanced age, pregnancy, anemia, high cholesterol, kidney disease, thyroid disease, certain types of cancer, autoimmune diseases, inflammation. A low ESR test result may be due to hypofibrinogenemia, low plasma protein, leukocytosis, or a high white blood cell (WBC) count, sickle cell anemia. During pregnancy fibrinogen content of blood increases, so ESR also increases accordingly. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – P.11).

20. In a dysentery patient undergoing treatment in the contagious isolation ward, a significant increase in packed cell volume has been observed (60 %). What other value will be affected by this change?

A. Increasing blood viscosity.

D. Increasing volume of blood circulation.

B. Increasing erythrocyte sedimentation rate (ESR).

E. Thrombocytopenia.

C. Leukopenia.

Reasoning: Packed cell volume (PCV) or hematocrit is the percentage of blood that is cells (normally, 42 to 52 % in men and 37–47 % in women). Viscosity is the resistance of a fluid to flow due to cohesion between its particles. Viscosity depends primarily on RBC and protein content of blood. Thus, increased PCV leads to increase of blood viscosity (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 681).

21. A man weighs 80 kg, after long physical activity his circulating blood volume is reduced down to 5.4 l, hematocrit makes up 50 %, whole blood protein is 80 g/l. These blood characteristics are determined first of all by:

A. Increased number of erythrocytes.

D. Increased diuresis.

B. Increased protein concentration in plasma.

E. Water loss with sweat.

C. Increased circulating blood volume.

Reasoning: Normal value of RBC is $4,0–5,2 \times 10^{12}/l$ in men and $4,4–5,7 \times 10^{12}/l$ in women. Normal value of blood protein is 65–85 g/L. Decrease of circulating blood volume together with normal values of RBC content and total protein after physical activity can be explained by water loss during profuse sweating. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov: KhNMU, 2016 – p.21).

22. Examination of a 43 y.o. anephric patient revealed anemia symptoms. What is the cause of these symptoms?

A. Iron deficit.

C. Folic acid deficit.

E. Enhanced destruction

B. Vitamin B_{12} deficit.

D. Reduced synthesis of erythropoietins.

of erythrocytes.

Reasoning: The principal stimulus for red blood cell production is a circulating hormone called erythropoietin (EPO). In the normal person, about 90 per cent of all erythropoietin is formed in the kidneys; the remainder is formed mainly in the liver. Anephric person doesn't have a kidney, thus he will have anemia resulting from decreased EPO production (Medical physiology

(eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 422).

23. Examination of a patient, suffering from atrophic gastritis, revealed megaloblastic anemia. The anemia is likely to be caused by the deficiency of the following substance:

A. Iron. B. Vitamin B1. C. Vitamin B6. D. **Gastromucoproteid.** E. Erythropoietins.

Reasoning: Megaloblastic (pernicious) anemia can result from a deficiency of vitamin B₁₂, but this vitamin is so abundant in meat that a B₁₂ deficiency is rare except in strict vegetarians. More often, it occurs when glands of the stomach fail to produce a mucoprotein called intrinsic factor that the small intestine needs to absorb vitamin B₁₂. This becomes more common in old age because of atrophy of the stomach. Pernicious anemia can also be hereditary. It is treatable with vitamin B₁₂ injections; oral B₁₂ would be useless because the digestive tract cannot absorb it without intrinsic factor (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw-Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 693).

24. A 38-year-old woman was admitted to the admission-diagnostic department with uterine bleeding. What are the most likely changes of blood?

A. Leukopenia. C. Increase of haematocrite rate. E. Polycythemia.
B. Leucocytosis. D. **Reduction of haematocrite rate.**

Reasoning: After hemorrhage, the body replaces the fluid portion of the plasma in 1 to 3 days, and the red blood cell concentration usually returns to normal within 3 to 6 weeks. Packed cell volume (PCV) or hematocrit is the percentage of blood that is cells (normally, 42 to 52 % in men and 37–47 % in women). Thus, in a person with uterine bleeding hematocrit will be decreased (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 420, 426).

25. A blood drop has been put into a test tube with 0,3 % solution of NaCl. What will happen with erythrocytes?

A. Shrinkage. C. **Osmotic haemolysis.** E. Any changes will be observed.
B. Mechanical haemolysis. D. Biological haemolysis.

Reasoning: Isotonic solution of sodium chloride is 0,9 %. Solutions of sodium chloride with a concentration of less than 0.9 per cent are hypotonic and cause cells to swell. If a cell is placed into a hypotonic solution that has a lower concentration of impermeant solutes (less than 282 mOsm/L), water will diffuse into the cell, causing it to swell; water will continue to diffuse into the cell and the cell might burst. That process is called osmotic hemolysis (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 298).

26. A 42 y.o. patient complains of pain in the epigastral area, vomiting; vomit masses have the colour of "coffee-grounds", the patient has also melena. Anamnesis records gastric ulcer. Blood formula: erythrocytes – $2,8 \times 10^{12}/l$, leukocytes – $0038 \times 10^9/l$, Hb – 90 g/l. What complication is it?

A. Penetration. B. Perforation. C. Pyloric stenosis. D. **Haemorrhage.** E. Canceration.

Reasoning: Normal value of RBC is $4,0\text{--}5,2 \times 10^{12}/l$ in men and $4,4\text{--}5,7 \times 10^{12}/l$ in women, of WBC is $4\text{--}10 \times 10^9/l$, of hemoglobin 130–160 g/L for men and 120–140 g/L for women. Thus, that patient has anemia resulting from hemorrhage caused by gastric ulcer (Ciesla, Betty. Hematology in practice / Betty Ciesla. – Copyright © 2012 by F. A. Davis Company. 2nd ed. PART I • Basic Hematology Principles, p. 24).

27. It is known that people who permanently live in highland have an increased concentration of erythrocytes per each blood volume unit. Owing to this fact blood can optimally fulfil the following function:

A. Maintenance of acid-base balance. D. Amino acid transport.
B. Maintenance of ionic equilibrium. E. Haemostasis participation.
C. **Gas transport.**

Reasoning: At very high altitudes, where the quantity of oxygen in the air is greatly decreased, insufficient oxygen is transported to the tissues, and red cell production is greatly increased. In

this case, it is not the concentration of red blood cells in the blood that controls red cell production, but the amount of oxygen transported to the tissues in relation to tissue demand for oxygen. The principal stimulus for red blood cell production in low oxygen states is a circulating hormone called erythropoietin. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 422).

28. Long-term starvation cure of a patient resulted in diminished ratio of albumins and globulins in plasma. What of the following will be result of these changes?

- A. *Decrease of hematocrit.* C. *Decrease of ESR.* E. *Increase of ESR.*
 B. *Increase of hematocrit.* D. *Hypercoagulation.*

Reasoning: ESR is erythrocyte sedimentation rate. Normal ESR for women is 2–15 mm/h, for men 1–10 mm/h. ESR increases in case of decrease of albumin content in blood, increase of globulins or fibrinogen content, advanced age, pregnancy, anemia, high cholesterol, kidney disease, thyroid disease, certain types of cancer, autoimmune diseases, inflammation. A low ESR test result may be due to hypofibrinogenemia, low plasma protein, leukocytosis, or a high white blood cell (WBC) count, sickle cell anemia. Albumin-globulin ratio normally is 1,5–2,3, and decrease of that ratio shows that albumin content decreased. As albumins normally prevent sedimentation of RBC, decrease of their content causes increase of ESR (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p.11).

29. A 29-year-old patient was delivered to a hospital because of intoxication with carbon monoxide. Objectively: the patient presents with symptoms of severe hypoxia – evident dyspnea, cyanosis, tachycardia. What compound is produced as a result of intoxication with carbon monoxide?

- A. *Methemoglobin.* C. *Oxyhemoglobin.* E. *Sulfhemoglobin.*
 B. *Carbhemoglobin.* D. *Carboxyhemoglobin.*

Reasoning: Car fumes contain carbon monoxide. Hemoglobin has a much higher affinity for carbon monoxide (CO) than for O₂. Consequently, CO displaces O₂ and thus reduces the oxygen-carrying capacity of erythrocytes. Carbon monoxide and Hb form carbon monoxyhemoglobin, also called carboxyhemoglobin. That compound is reversible, treatment is giving oxygen to a patient (Uwe Ackerman – PDQ Physiology (Pretty Darned Quick Series): 1st (first) Edition, Chapter 3 Blood, p. 76).

Physiology of WBC

30. Blood sampling for bulk analysis is recommended to be performed on an empty stomach and in the morning. What changes in blood composition can occur if to perform blood sampling after food intake?

- A. *Reduced contents of erythrocytes.* D. *Increased plasma proteins.*
 B. *Increased contents of erythrocytes.* E. *Increased contents of leukocytes.*
 C. *Reduced contents of thrombocytes.*

Reasoning: Physiological leukocytosis is associated with natural functions and is caused by the redistribution of leucocytes between vessels of different organs and tissues. Leucocytes accumulated in the spleen, marrow and lungs are released from their depots and rapidly pass into the blood giving rise to leukocytosis. Digestive leukocytosis is one of types of physiological leukocytosis that normally occurs after meals (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p.28)

31. In allergic disease, a dramatic increase in basophilic leukocyte number in patient' blood is observed. This phenomenon is due to the following basophil function:

- A. *Phagocytosis of immune complexes.*
 B. *Phagocytosis of microorganisms and small particles.*
 C. *Participation in blood clotting.*
 D. *Participation of heparin and histamine in metabolism.*
 E. *Immunoglobulin synthesis.*

Reasoning: The mast cells and basophils play an exceedingly important role in some types of allergic reactions because the type of antibody that causes allergic reactions, the immunoglobulin E

(IgE) type has a special propensity to become attached to mast cells and basophils. Then, when the specific antigen for the specific IgE antibody subsequently reacts with the antibody, the resulting attachment of antigen to antibody causes the mast cell or basophil to rupture and release exceedingly large quantities of histamine, bradykinin, serotonin, heparin, slow-reacting substance of anaphylaxis, and a number of lysosomal enzymes. These cause local vascular and tissue reactions that cause many, if not most, of the allergic manifestations. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 436).

32. ESR of a patient with pneumonia is 48 mm/h. What caused such changes?

- A. Hypogammaglobulinemia. C. Hypergammaglobulinemia. E. Erythrocytosis.
 B. Hypoproteinemia. D. Hyperalbuminemia.

Reasoning: ESR is erythrocyte sedimentation rate. Normal ESR for women is 2–15 mm/h, for men 1–10 mm/h. ESR increases in case of decrease of albumin content in blood, increase of globulins or fibrinogen content, advanced age, pregnancy, anemia, high cholesterol, kidney disease, thyroid disease, certain types of cancer, autoimmune diseases, inflammation. A low ESR test result may be due to hypofibrinogenemia, low plasma protein, leukocytosis, or a high white blood cell (WBC) count, sickle cell anemia. During pregnancy fibrinogen content of blood increases, so ESR also increases accordingly.

33. A 3-year-old child had eaten some strawberries. Soon he developed a rash and itching. What was found in the child's leukogram?

- A. Neutrophilic leukocytosis. C. Lymphocytosis. E. Hypolymphemia.
 B. Monocytosis. D. Eosinophilia.

Reasoning: Eosinophils have a special propensity to collect in tissues in which allergic reactions occur, such as in the peribronchial tissues of the lungs in people with asthma and in the skin after allergic skin reactions. This is caused at least partly by the fact that many mast cells and basophils participate in allergic reactions. The mast cells and basophils release an eosinophil chemotactic factor that causes eosinophils to migrate toward the inflamed allergic tissue. The eosinophils are believed to detoxify some of the inflammation-inducing substances released by the mast cells and basophils and probably also to phagocytize and destroy allergen-antibody complexes, thus preventing excess spread of the local inflammatory process. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 436).

34. After an attack of bronchial asthma a patient had his peripheral blood tested. What changes can be expected?

- A. Thrombocytopenia. B. Leukopenia. C. Eosinophilia. D. Lymphocytosis. E. Erythrocytosis.

Reasoning: Eosinophils have a special propensity to collect in tissues in which allergic reactions occur, such as in the peribronchial tissues of the lungs in people with asthma and in the skin after allergic skin reactions. This is caused at least partly by the fact that many mast cells and basophils participate in allergic reactions. The mast cells and basophils release an eosinophil chemotactic factor that causes eosinophils to migrate toward the inflamed allergic tissue. The eosinophils are believed to detoxify some of the inflammation-inducing substances released by the mast cells and basophils and probably also to phagocytize and destroy allergen-antibody complexes, thus preventing excess spread of the local inflammatory process. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 436).

35. Blood count of an athlete is as follows: erythrocytes – $5,5 \times 10^{12}/l$, Hb – 180 g/l, leukocytes – $7 \times 10^9/l$, neutrophils – 64 %, basophils – 0,5 %, eosinophils – 0,5 %, monocytes – 8 %, lymphocytes – 27 %. First of all, such results indicate the stimulation of:

- A. Leukopoiesis. C. Granulocytopoiesis. E. Erythropoiesis.
 B. Lymphopoiesis. D. Immunogenesis.

Reasoning: Normal value of RBC is $4,0-5,2 \times 10^{12}/l$ in men and $4,4-5,7 \times 10^{12}/l$ in women, of WBC is $4-10 \times 10^9/l$, of hemoglobin 130–160 g/L for men and 120–140 g/L for women. The main stimulus for RBC production is erythropoietin that is released more in conditions of

hypoxia. One of reasons of hypoxia is an abrupt increase in the body's oxygen consumption. If a lethargic person suddenly takes up tennis or aerobics, for example, the muscles consume oxygen more rapidly and create a state of hypoxemia that stimulates erythropoiesis. Endurance-trained athletes commonly have RBC counts as high as $5,5-6,5 \times 10^{12}/l$ (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 685).

36. A patient with skin mycosis has disorder of cellular immunity. The most typical characteristic of it is reduction of the following index:

- A. *B-lymphocytes*. C. *Immunoglobulin G*. E. *Plasmocytes*.
 B. *T-lymphocytes*. D. *Immunoglobulin E*.

Reasoning: Two basic but closely allied types of acquired immunity occur in the body. In one of these the body develops circulating antibodies, which are globulin molecules in the blood plasma that are capable of attacking the invading agent. This type of immunity is called humoral immunity or B-cell immunity (because B lymphocytes produce the antibodies). The second type of acquired immunity is achieved through the formation of large numbers of activated T lymphocytes that are specifically crafted in the lymph nodes to destroy the foreign agent. This type of immunity is called cell-mediated immunity or T-cell immunity (because the activated lymphocytes are T lymphocytes) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 440).

37. Electrophoretic study of a blood serum sample, taken from the patient with pneumonia, revealed an increase in one of the protein fractions. Specify this fraction:

- A. *Albumins*. B. *α 1-globulins*. C. *α 2-globulins*. D. *β -globulins*. E. *γ -globulins*.

Reasoning: The γ -globulins, also called antibodies, come from plasma cells – connective tissue cells that are descended from white blood cells called B lymphocytes. They represent humoral link of immunity that is active in case of infections, like in case of pneumonia (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 18 The Circulatory system: Blood, p. 684).

38. The cellular composition of exudate largely depends on the etiological factor of inflammation. What leukocytes are the first to get into the focus of inflammation caused by pyogenic bacteria?

- A. *Monocytes*. C. *Myelocytes*. E. *Eosinophilic granulocytes*.
 B. *Basophils*. D. *Neutrophil granulocytes*.

Reasoning: It is mainly the neutrophils and tissue macrophages that attack and destroy invading bacteria, viruses, and other injurious agents. The neutrophils are mature cells that can attack and destroy bacteria even in the circulating blood. Neutrophils possess diapedesis, amoeboid movement and chemotaxis, thus they are able to move fast to origin of inflammation. When neutrophils and macrophages engulf large numbers of bacteria and necrotic tissue, essentially all the neutrophils and many, if not most, of the macrophages eventually die. After several days, a cavity is often excavated in the inflamed tissues that contains varying portions of necrotic tissue, dead neutrophils, dead macrophages, and tissue fluid. This mixture is commonly known as pus. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 431, 435).

39. After honey consumption a teenager had urticaria accompanied by leukocytosis. What type of leukocytosis is it in this case?

- A. *Lymphocytosis*. C. *Basophilic leukocytosis*. E. *Neutrophilic leukocytosis*.
 B. *Monocytosis*. D. *Eosinophilic leukocytosis*.

Reasoning: Eosinophils have a special propensity to collect in tissues in which allergic reactions occur, such as in the peribronchial tissues of the lungs in people with asthma and in the skin after allergic skin reactions. This is caused at least partly by the fact that many mast cells and basophils participate in allergic reactions. The mast cells and basophils release an eosinophil chemotactic factor that causes eosinophils to migrate toward the inflamed allergic tissue. The eosinophils are believed to detoxify some of the inflammation-inducing substances released by the mast cells and basophils and probably also to phagocytize and destroy allergen-antibody complexes, thus preventing

excess spread of the local inflammatory process. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 436).

40. Blood analysis of a patient showed signs of HIV infection (human immunodeficiency virus). Which cells does HIV-virus primarily affect?

- A. *Proliferating cells (stem hematopoietic cells).* C. ***Cells that contain receptor T4 (T-helpers).***
B. *Cells that contain receptor IgM (B-lymphocytes).* D. *Specialized nervous cells (neurons).*
E. *Mast cells.*

Reasoning: It is the helper T cells that are inactivated or destroyed by the human immunodeficiency virus (HIV), which leaves the body almost totally unprotected against infectious disease, therefore leading to the now well-known debilitating and lethal effects of AIDS. Some of the specific regulatory functions of T-helpers are the following: stimulation of growth and proliferation of cytotoxic T cells and suppressor T cells, stimulation of B-cell growth and differentiation to form plasma cells and antibodies, activation of the macrophage system, feedback stimulatory effect on the helper cells themselves. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 447).

41. Blood analysis of a 16-year-old girl suffering from the autoimmune inflammation of thyroid gland revealed multiple plasmatic cells. Such increase in plasmocyte number is caused by proliferation and differentiation of the following blood cells:

- A. *Tissue basophils.* C. *T-killers.* E. ***B-lymphocytes.***
B. *T-helpers.* D. *T-suppressors.*

Reasoning: Plasmocytes or plasma cells are formed from B-lymphocytes. Before exposure to a specific antigen, the clones of B lymphocytes remain dormant in the lymphoid tissue. On entry of a foreign antigen, macrophages in the lymphoid tissue phagocytize the antigen and then present it to adjacent B lymphocytes. In addition, the antigen is presented to T cells at the same time, and activated helper T cells are formed. These helper cells also contribute to extreme activation of the B lymphocytes. Those B lymphocytes specific for the antigen immediately enlarge and take on the appearance of lymphoblasts, some of which further differentiate to form plasmablasts – precursors of plasma cells. The plasmablasts then begin to divide giving in 4 days a total population of about 500 cells for each original plasmablast. The mature plasma cell then produces gamma globulin antibodies at an extremely rapid rate. In turn, the antibodies are secreted into the lymph and carried to the circulating blood. This process continues for several days or weeks until finally exhaustion and death of the plasma cells occur. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 443).

42. A 5 year old child is ill with measles. Blood analysis revealed increase of total number of leukocytes up to $13 \times 10^9/l$. Leukogram: basophils – 0, eosinophils – 1, myelocytes – 0, juvenile neutrophils – 0, band neutrophils – 2, segmented neutrophils – 41, lymphocytes – 28, monocytes – 28. Name this phenomenon:

- A. *Agranulocytosis.* C. *Eosinopenia.* E. *Neutropenia.*
B. *Lymphocytosis.* D. ***Monocytosis.***

Reasoning: Normal leukogram has following indexes: metamyelocytes = 0–1 %, stab (band) neutrophils = 1–6 %, segmented neutrophils = 47–72 %, basophils = 0–1 %, eosinophils = 0,5–5 %, lymphocytes = 18–37 %, monocytes = 3–11 %. Thus, that child has increased monocytes content called monocytosis, usually seen in case of viral infections and inflammation (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 29).

43. Differentiation of B-lymphocytes into plasma cells leads to synthesis of immunoglobulins that ensure specific immune response of the body. Differentiation of B-lymphocytes takes place in the following organ of immune system:

- A. *Liver.* B. *Tonsils.* C. *Thymus.* D. *Thyroid gland.* E. ***Red bone marrow.***

Reasoning: Fetal stem cells remain in the bone marrow to differentiate into B cells. They are also undergone to the selection and differentiation, much like as T cells. Self-tolerant B cells go on to produce surface receptors for antigens, divide, and produce immunocompetent B cell clones. These cells disperse throughout the body, colonizing the same organs as T cells. They are

abundant in the lymph nodes, spleen, bone marrow, and mucous membranes (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 33).

Coagulation

44. A clinic observes a 49 year old patient with significant prolongation of coagulation time, gastrointestinal hemorrhages, subcutaneous hematomas. These symptoms might be explained by the deficiency of the following vitamin:

- A. B1. B. B6. C. H. D. K. E. E.

Reasoning: Vitamin K is necessary for liver formation of five of the important clotting factors: prothrombin, Factor VII, Factor IX, Factor X, and protein C. In the absence of vitamin K, subsequent insufficiency of these coagulation factors in the blood can lead to serious bleeding tendencies. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 464).

45. A 3-year-old boy with pronounced hemorrhagic syndrome doesn't have antihemophilic globulin A (factor VIII) in the blood plasma. Hemostasis has been impaired at the following stage:

- A. Conversion of prothrombin to thrombin. D. External mechanism of prothrombinase activation.
B. Conversion of fibrinogen to fibrin. E. Internal mechanism of prothrombinase activation.
C. Blood clot retraction.

Reasoning: Factor VIII is the factor that is missing in a person who has hemophilia A, for which reason it is called antihemophilic factor A. Factors XII, XI, IX and VIII together with high molecular weight kininogen and prekallikrein participate in intrinsic mechanism of prothrombinase (prothrombin activator) generation (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 462–463).

46. A 16 years old boy after an illness has diminished function of protein synthesis in liver as a result of vitamin K deficiency. It will cause disturbance of:

- A. Anticoagulant generation. C. Erythrocyte sedimentation rate. E. Osmotic blood pressure.
B. Erythropoietin secretion. D. Blood coagulation.

Reasoning: Vitamin K is necessary for liver formation of five of the important clotting factors: prothrombin, Factor VII, Factor IX, Factor X, and protein C. In the absence of vitamin K, subsequent insufficiency of these coagulation factors in the blood can lead to serious bleeding tendencies. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 464).

47. Punctate hemorrhage was found out in the patient after application of a tourniquet. With disfunction of what blood cells is it connected?

- A. Neutrophiles. B. Eosinophiles. C. Monocytes. D. Lymphocytes E. Platelets.

Reasoning: Thrombocytopenia means the presence of very low numbers of platelets in the circulating blood. People with thrombocytopenia have a tendency to bleed, as do hemophiliacs, except that the bleeding is usually from many small venules or capillaries, rather than from larger vessels as in hemophilia. As a result, small punctate hemorrhages occur throughout all the body tissues. The skin of such a person displays many small, purplish blotches, giving the disease the name thrombocytopenic purpura. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 465).

48. A tooth extraction in a patient with chronic persistent hepatitis was complicated with prolonged hemorrhage. What is the reason for the haemorrhagic syndrome?

- A. Decrease in fibrin production. D. Increase in fibrinogen synthesis.
B. Decrease in thrombin production. E. Fibrinolysis intensification.
C. Increase in thromboplastin production.

Reasoning: With few exceptions, almost all the blood-clotting factors are formed by the liver. Therefore, diseases of the liver such as hepatitis, cirrhosis, and acute yellow atrophy can sometimes depress the clotting system so greatly that the patient develops a severe tendency to bleed. Prothrombin is formed continually by the liver, and it is continually being used

throughout the body for blood clotting. If the liver fails to produce prothrombin, in a day or so prothrombin concentration in the plasma falls too low to provide normal blood coagulation. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 460, 464).

49. A clinic observes a 49 year old patient with significant prolongation of coagulation time, gastrointestinal haemorrhages, subcutaneous hematomas. These symptoms might be explained by the deficiency of the following vitamin:

- A. B1. B. B6. C. H. D. K. E. E.

Reasoning: Vitamin K is necessary for liver formation of five of the important clotting factors: prothrombin, Factor VII, Factor IX, Factor X, and protein C. In the absence of vitamin K, subsequent insufficiency of these coagulation factors in the blood can lead to serious bleeding tendencies. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 464).

50. After implantation of a cardiac valve a young man constantly takes indirect anticoagulants. His state was complicated by hemorrhage. What substance content has decreased in blood?

- A. Heparin. B. Prothrombin. C. Haptoglobin. D. Creatin. E. Ceruloplasmin.

Reasoning: When an indirect anticoagulant, such as warfarin, is given to a patient, the plasma levels of prothrombin and Factors VII, IX, and X, all formed by the liver, begin to fall, indicating that warfarin has a potent depressant effect on liver formation of these compounds. Warfarin causes this effect by competing with vitamin K for reactive sites in the enzymatic processes for formation of prothrombin and the other three clotting factors, thereby blocking the action of vitamin K. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 466).

51. A patient is diagnosed with hereditary coagulopathy that characterized by factor VIII deficiency. Specify the phase of blood clotting during which coagulation will be disrupted in the given case:

- A. Fibrin formation. C. Thrombin formation. E. –.

- B. Thromboplastin formation. D. Clot retraction.

Reasoning: Factor VIII is the factor that is missing in a person who has hemophilia A, for which reason it is called antihemophilic factor A. Factors XII, XI, IX and VIII together with high molecular weight kininogen and prekallikrein participate in intrinsic mechanism of prothrombinase generation. Prothrombinase is also called prothrombin activator or thromboplastin (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 462–463).

52. After pancreatic surgery the patient developed hemorrhagic syndrome with disturbed 3rd stage of blood clotting. What will be the most likely mechanism of the hemostatic disorder?

- A. Decrease of prothrombin synthesis. D. Fibrin-stabilizing factor deficiency.

- B. Decrease of fibrinogen synthesis. E. Qualitative abnormalities of fibrinogenesis.

- C. Fibrinolysis activation.

Reasoning: Blood clotting have 3 stages – 1) vascular-platelet hemostasis (prephase of clotting); 2) coagulation hemostasis (consisting of prothrombinase generation, formation of thrombin, and formation of fibrin), and 3) clot retraction and fibrinolysis (after-phase of clotting). Due to large trauma of tissues during operations in abdominal cavity the coagulation cascade is activated and the widespread clotting triggers significant increase of fibrinolytic system activity that may lead to hemorrhages in postoperative period. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 457–466).

53. A 60-year-old man suffering from chronic hepatitis frequently observes nasal and gingival hemorrhages, spontaneous hemorrhagic rashes on the skin and mucosa. Such presentations result from:

- A Decreased synthesis of prothrombin and fibrinogen.

- B Increased blood content of aminotransferases.

- C Decreased synthesis of serum albumins.

- D Increased blood content of macroglobulins.

- E Decreased blood content of cholinesterase.

Reasoning: Prothrombin is formed continually by the liver, and it is continually being used throughout the body for blood clotting. If the liver fails to produce prothrombin, in a day or so

prothrombin concentration in the plasma falls too low to provide normal bloodcoagulation. Fibrinogen is formed inthe liver, and liver disease can decrease the concentrationof circulating fibrinogen, as it does the concentrationof prothrombin, pointed out above.(Medicalphysiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 460

54. A patient visited a dentist to extract a tooth. After the tooth had been extracted, bleeding from the tooth socket continued for 15 minutes. Anamnesis states that the patient suffers from active chronic hepatitis. What phenomenon can extend the time of hemorrhage?

- A. Decrease of fibrinogen content in blood.* *D. Increased activity of anticoagulation system.*
B. Thrombocytopenia. *E. Decrease of albumin content in blood.*
C. Hypocalcemia.

Reasoning: Fibrinogen is formed inthe liver, and liver disease can decrease the concentrationof circulating fibrinogen, as it does the concentrationof prothrombin. As only conversion of fibrinogen to fibrin leads to formation of the clot and is the target of coagulation, decrease of fibrinogen content causes insufficiency of clotting and leads to bleedings (Medicalphysiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 460)

55. A patient, who has been suffering for a long time from intestine disbacteriosis, has increased hemorrhaging caused by disruption of posttranslational modification of blood-coagulation factors II, VII, IX, and X in the liver. What vitamin deficiency is the cause of this condition?

- A. K.* *B. B12.* *C. B9.* *D. C.* *E. P.*

Reasoning: One of causes of depressed formation of clottingfactors by the liver is vitamin K deficiency.Vitamin Kis necessary for liver formation of five of the importantclotting factors: prothrombin, Factor VII, FactorIX, Factor X, and protein C. In the absence of vitaminK, subsequent insufficiency of these coagulationfactors in the blood can lead to serious bleeding tendencies.Vitamin K is continually synthesized in the intestinaltract by bacteria, so that vitamin K deficiency seldom occurs in the normal person as a result ofvitamin K absence from the diet (except in neonatesbefore they establish their intestinal bacterial flora).However, in case of disbacteriosis the microflora of intestine is disturbed and not able to produce vitamin K in adequate quantities leading to bleedings (Medicalphysiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 464).

56. A patient is diagnosed with hereditary coagulopathy that is characterized by factor VIII deficiency. Specify the phase of blood clotting during which coagulation will be disrupted in the given case:

- A. Thromboplastin formation.* *C. Fibrin formation.* *E. – .*
B. Thrombin formation. *D. Clot retraction.*

Reasoning: Factor VIII is the factor that is missing in a person who has hemophilia A, for which reason it is called antihemophilic factor A. Factors XII, XI, IX and VIII together with high molecular weight kininogen and prekallikrein participate in intrinsic mechanism of prothrombinase generation. Prothrombinase is also called prothrombin activator or thromboplastin (Medicalphysiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 462–463).

57. A patient visited a dentist to extract a tooth. After the tooth had been extracted, bleeding from tooth socket continued for 15 minutes. Anamnesis states that the patient suffers from active chronic hepatitis. What phenomenon can extend the time of hemorrhage?

- A. Decrease of albumin content in blood.* *D. Decrease of fibrinogen content in blood.*
B. Thrombocytopenia. *E. Hypocalcemia.*
C. Increased activity of anticoagulation system.

Reasoning: Fibrinogen is formed inthe liver, and liver disease can decrease the concentrationof circulating fibrinogen, as it does the concentrationof prothrombin. As only conversion of fibrinogen to fibrin leads to formation of the clot and is the target of coagulation, decrease of fibrinogen content causes insufficiency of clotting and leads to bleedings (Medicalphysiology

(eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 460)

58. A 3-year-old boy with pronounced hemorrhagic syndrome doesn't have antihemophilic globulin A (factor VIII) in the blood plasma. Hemostasis has been impaired at the following stage:

- A. *Internal mechanism of prothrombinase activation.*
- B. *External mechanism of prothrombinase activation.*
- C. *Conversion of prothrombin to thrombin.*
- D. *Conversion of fibrinogen to fibrin.*
- E. *Blood clot retraction.*

Reasoning: Factor VIII is the factor that is missing in a person who has hemophilia A, for which reason it is called antihemophilic factor A. Factors XII, XI, IX and VIII together with high molecular weight kininogen and prekallikrein participate in intrinsic mechanism of prothrombinase generation. Prothrombinase is also called prothrombin activator or thromboplastin (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 462–463).

59. A patient, who has been suffering for a long time from intestine disbacteriosis, has increased hemorrhaging caused by disruption of posttranslational modification of blood-coagulation factors II, VII, IX, and X in liver. What vitamin deficiency is the cause of this condition?

- A. P.
- B. C.
- C. K.
- D. B12
- E. B9.

Reasoning: One of causes of depressed formation of clotting factors by the liver is vitamin K deficiency. Vitamin K is necessary for liver formation of five of the important clotting factors: prothrombin, Factor VII, Factor IX, Factor X, and protein C. In the absence of vitamin K, subsequent insufficiency of these coagulation factors in the blood can lead to serious bleeding tendencies. Vitamin K is continually synthesized in the intestinal tract by bacteria, so that vitamin K deficiency seldom occurs in the normal person as a result of vitamin K absence from the diet (except in neonates before they establish their intestinal bacterial flora). However, in case of disbacteriosis the microflora of intestine is disturbed and not able to produce vitamin K in adequate quantities leading to bleedings (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 464).

60. A patient complains of frequent gingival haemorrhages he has been experiencing since his childhood. Blood test revealed a deficiency in blood-coagulation factor VIII. This means that the patient has an impairment of:

- A. *Thrombin generation.*
- B. *Fibrin generation.*
- C. *Prothrombinase generation.*
- D. *Thrombocyte adhesion.*
- E. *Thrombocyte aggregation.*

Reasoning: Factor VIII is the factor that is missing in a person who has hemophilia A, for which reason it is called antihemophilic factor A. Factors XII, XI, IX and VIII together with high molecular weight kininogen and prekallikrein participate in intrinsic mechanism of prothrombinase generation. Prothrombinase is also called prothrombin activator or thromboplastin (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 462–463).

61. A patient has petechial hemorrhages on the gums, hard and soft palate, buccal mucosa. This is caused by the dysfunction of the following blood corpuscles:

- A. *Eosinophils.*
- B. *Monocytes.*
- C. *Lymphocytes.*
- D. *Platelets.*
- E. *Erythrocytes.*

Reasoning: People with disorders of platelets or their decreased content (thrombocytopenia) have a tendency to bleed, as do hemophiliacs, except that the bleeding is usually from many small venules or capillaries, rather than from larger vessels as in hemophilia. As a result, small punctate hemorrhages occur throughout all the body tissues. The skin of such a person displays many small, purplish blotches, giving the disease the name thrombocytopenic purpura. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 465).

62. There is an inhibited coagulation in the patients with bile ducts obstruction, bleeding due to the low level of absorption of a vitamin. What vitamin is in deficiency?

A. Carotene. B. E. C. K. D. A. E. D.

Reasoning: One of causes of depressed formation of clotting factors by the liver is vitamin K deficiency. Vitamin K is necessary for liver formation of five of the important clotting factors: prothrombin, Factor VII, Factor IX, Factor X, and protein C. In the absence of vitamin K, subsequent insufficiency of these coagulation factors in the blood can lead to serious bleeding tendencies. Vitamin K is continually synthesized in the intestinal tract by bacteria, so that vitamin K deficiency seldom occurs in the normal person as a result of vitamin K absence from the diet (except in neonates before they establish their intestinal bacterial flora). However, in gastrointestinal disease, vitamin K deficiency often occurs as a result of poor absorption of fats from the gastrointestinal tract. The reason is that vitamin K is fat-soluble and ordinarily is absorbed into the blood along with the fats. One of the most prevalent causes of vitamin K deficiency is failure of the liver to secrete bile into the gastrointestinal tract (which occurs either as a result of obstruction of the bile ducts or as a result of liver disease). Lack of bile prevents adequate fat digestion and absorption and, therefore, depresses vitamin K absorption as well (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 464).

63. A clinic observes a 49 year old patient with significant prolongation of coagulation time, gastrointestinal hemorrhages, subcutaneous hematomas. These symptoms might be explained by the deficiency of the following vitamin:

A. B1. B. B6. C. H. D. K. E. E.

Reasoning: One of causes of depressed formation of clotting factors by the liver is vitamin K deficiency. Vitamin K is necessary for liver formation of five of the important clotting factors: prothrombin, Factor VII, Factor IX, Factor X, and protein C. In the absence of vitamin K, subsequent insufficiency of these coagulation factors in the blood can lead to serious bleeding tendencies (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 464).

64. A patient with tissue trauma was taken a blood sample for the determination of blood clotting parameters. Specify the right sequence of extrinsic pathway activation.

A. III–IV–Xa. B. IV–VIII: TF–Xa. C. IV–VIIa–Xa. D. III–VIII: TF–Xa. E. III–VIIa–Xa.

Reasoning: The extrinsic pathway for initiating the formation of prothrombin activator begins with a traumatized vascular wall or traumatized extravascular tissues that come in contact with the blood. Traumatized tissue releases a complex of several factors called tissue factor or tissue thromboplastin (Factor III). Factor III further complexes with blood coagulation Factor VII and, in the presence of calcium ions, acts enzymatically on Factor X to form activated Factor X (Xa). (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 461–462).

65. A 2-year-old child has got intestinal dysbacteriosis, which results in hemorrhagic syndrome. What is the most likely cause of hemorrhage of the child?

A. Activation of tissue thromboplastin. C. Vitamin K insufficiency. E. PP hypovitaminosis.
B. Fibrinogen deficiency. D. Hypocalcemia.

Reasoning: One of causes of depressed formation of clotting factors by the liver is vitamin K deficiency. Vitamin K is necessary for liver formation of five of the important clotting factors: prothrombin, Factor VII, Factor IX, Factor X, and protein C. In the absence of vitamin K, subsequent insufficiency of these coagulation factors in the blood can lead to serious bleeding tendencies. Vitamin K is continually synthesized in the intestinal tract by bacteria, so that vitamin K deficiency seldom occurs in the normal person as a result of vitamin K absence from the diet (except in neonates before they establish their intestinal bacterial flora). However, in case of dysbacteriosis the microflora of intestine is disturbed and not able to produce vitamin K in adequate quantities leading to bleedings (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 464).

66. A 29-year-old patient complains of frequent gingival hemorrhages. Blood test revealed the clotting factor II (prothrombin) deficiency. What phase of blood coagulation is impaired in this patient?

A. Clot retraction.

C. –.

E. Vascular-platelet haemostasis.

B. Fibrinolysis.

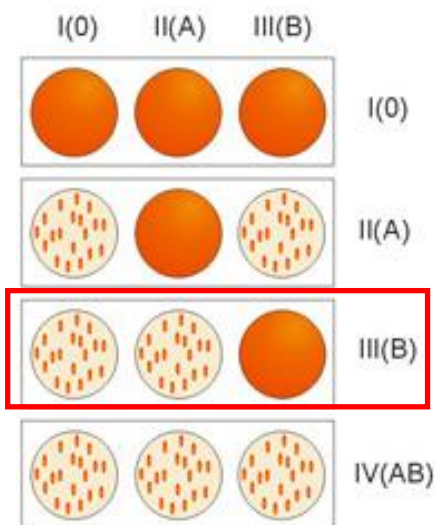
D. Thrombin generation.

Reasoning: Coagulation hemostasis consists of 3 stages – 1) prothrombinase generation, 2) formation of thrombin, and 3) formation of fibrin. The prothrombinactivator, in the presence of sufficient amounts of ionic Ca^{++} , causes conversion of prothrombin to thrombin. Thrombin then causes polymerization of fibrinogen molecules into fibrin fibers (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 459).

Blood types

67. It was established that agglutination of the recipient's blood erythrocytes had been caused by the standard sera from the I and II groups. Serum from the III group as well as anti-Rh serum hadn't provoke any agglutination. Which blood group and rhesus is allowed to be transfused this recipient?

A. $A\beta$ (II) Rh–. B. $B\alpha$ (III) Rh–. C. AB (IV), Rh–. D. $O\alpha\beta$ (I) Rh+. E. AB (IV), Rh+.



Reasoning: When standard sera are used for blood typing you have to represent exactly that serum of II group contents β agglutinins and reacts with RBCs of groups possessing B agglutinogens (III and IV). A serum of III group has α agglutinins and reacts with erythrocytes of groups which content A agglutinogens (II and IV). RBCs of I group possess no agglutinogens and never can agglutinate with any sera. In contrast erythrocytes of IV group with sera of all groups I, II and III. As no agglutination occurred with III group it means that examined blood doesn't have A antigen, only B, so this blood belongs to III type. As no agglutination occurred with anti-Rh serum it means that examined blood is rhesus negative. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 39).

68. Blood group of a 30 year old man was specified before an operation. His blood is Rh-positive. Reaction of erythrocyte agglutination was absent with standard sera of $O\alpha\beta$ (I), $A\beta$ (II), $B\alpha$ (III) groups. The blood under examination is of the following group:

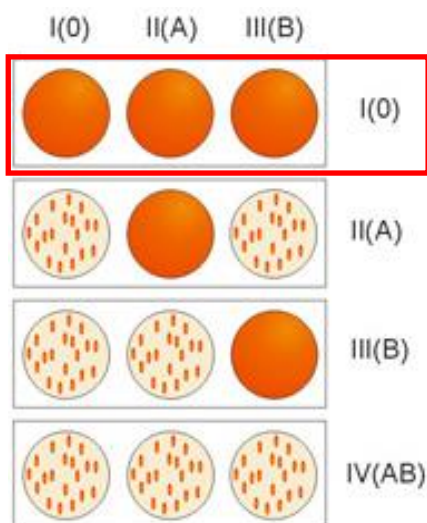
A. $O\alpha\beta$ (I).

B. $A\beta$ (II).

C. $B\alpha$ (III).

D. AB (IV).

E. –.



Reasoning: When standard sera are used for blood typing you have to represent exactly that serum of II group contents β agglutinins and reacts with RBCs of groups possessing B agglutinogens (III and IV). A serum of III group has α agglutinins and reacts with erythrocytes of groups which content A agglutinogens (II and IV). RBCs of I group possess no agglutinogens and never can agglutinate with any sera. In contrast erythrocytes of IV group with sera of all groups I, II and III. As no agglutination occurred with any of sera it means that examined blood doesn't have neither A antigen, nor B antigen, so this blood belongs to I type. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 39).

69. On blood grouping on the system ABO, standard serum of the I and II groups caused erythrocytes agglutination of the examined blood and serum group of the III didn't. What agglutinogens are in these erythrocytes?

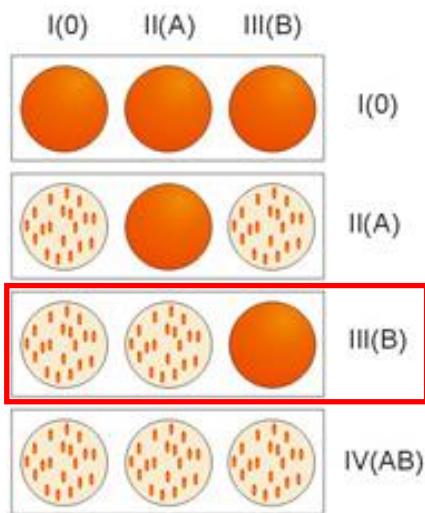
A. A and B.

B. A.

C. B.

D. D and C.

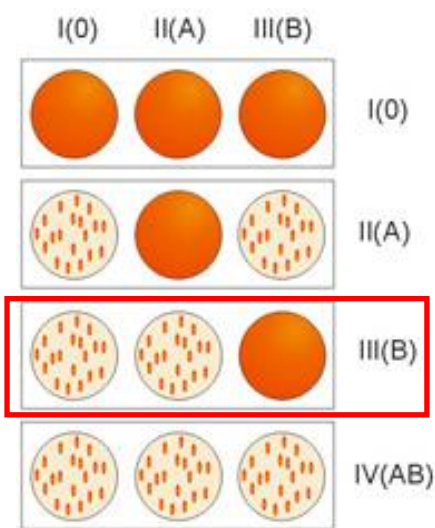
E. C.



Reasoning: When standard sera are used for blood typing you have to represent exactly that serum of II group contents β agglutinins and reacts with RBCs of groups possessing B agglutinogens (III and IV). A serum of III group has α agglutinins and reacts with erythrocytes of groups which content A agglutinogens (II and IV). RBCs of I group possess no agglutinogens and never can agglutinate with any sera. In contrast erythrocytes of IV group with sera of all groups I, II and III. As no agglutination occurred with III group it means that examined blood doesn't have A antigen, only B, so this blood belongs to III type. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov: KhNMU, 2016 – p. 39).

70. It was established that agglutination of the recipient's blood erythrocytes had been caused by the standard sera from the I and II groups. Serum from the III group as well as anti-Rh serum hadn't provoke any agglutination. Which blood group and rhesus is allowed to be transfused this recipient?

- A. $A\beta$ (II) Rh^- . B. $B\alpha$ (III) Rh^- . C. AB (IV), Rh^- . D. $O\alpha\beta$ (I) Rh^+ . E. AB (IV), Rh^+ .



Reasoning: When standard sera are used for blood typing you have to represent exactly that serum of II group contents β agglutinins and reacts with RBCs of groups possessing B agglutinogens (III and IV). A serum of III group has α agglutinins and reacts with erythrocytes of groups which content A agglutinogens (II and IV). RBCs of I group possess no agglutinogens and never can agglutinate with any sera. In contrast erythrocytes of IV group with sera of all groups I, II and III. As no agglutination occurred with III group it means that examined blood doesn't have A antigen, only B, so this blood belongs to III type. As no agglutination occurred with anti-Rh serum it means that examined blood is rhesus negative. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 39).

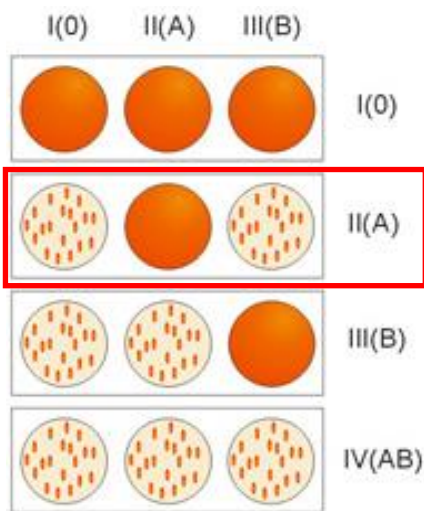
71. A woman with III (B), Rh^- blood group born a child with II (A) blood group. The child is diagnosed with hemolytic disease of newborn as a result of rhesus incompatibility. What blood group is the child's father likely to have?

- A. I (0), Rh^+ . B. II (A), Rh^+ . C. III (B), Rh^+ . D. I (0), Rh^- . E. II (A), Rh^- .

Reasoning: Hemolytic disease of newborns (HDN, erythroblastosis fetalis) is a disease of fetus and newborn child characterized by agglutination and phagocytosis of the fetus's red blood cells. In most instances of erythroblastosis fetalis, the mother is Rh^- and the father Rh^+ . The baby has inherited the Rh^+ antigen from the father, and the mother develops anti- Rh agglutinins from exposure to the fetus's Rh antigen. In turn, the mother's agglutinins diffuse through the placenta into the fetus and cause red blood cell agglutination. In ABO system, if mother has III (B), Rh^- blood group, then child got A antigen from his father. Thus, father's blood type is II (A), Rh^+ or IV (AB), Rh^+ . (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 451–454).

72. A pregnant woman had her blood group identified. Reaction of erythrocyte agglutination with standard serums of $O\alpha\beta$ (I), $B\alpha$ (III) groups didn't proceed with standard serum of $A\beta$ (II) group. The blood group under examination is:

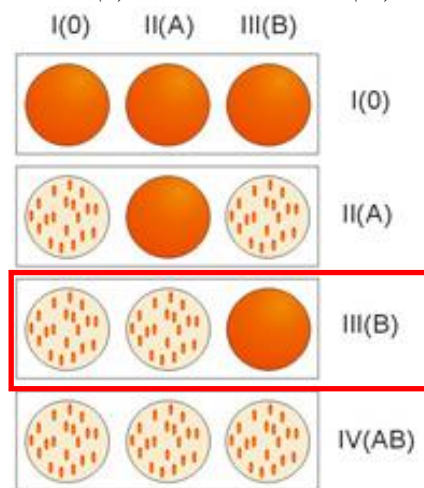
- A. $O\alpha\beta$ (I). B. $A\beta$ (II). C. $B\alpha$ (III). D. AB (IV). E. –.



Reasoning: When standard sera are used for blood typing you have to represent exactly that serum of II group contents β agglutinins and reacts with RBCs of groups possessing B agglutinogens (III and IV). A serum of III group has α agglutinins and reacts with erythrocytes of groups which content A agglutinogens (II and IV). RBCs of I group possess no agglutinogens and never can agglutinate with any sera. In contrast erythrocytes of IV group with sera of all groups I, II and III. As no agglutination occurred with II group it means that examined blood doesn't have B antigen, only A, so this blood belongs to II type. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov: KhNMU, 2016 – p. 39).

73. A pregnant woman underwent ABO blood typing. Red blood cells were agglutinated with standard sera of the I and II blood groups, and were not agglutinated with the III group serum. What is the patient's blood group?

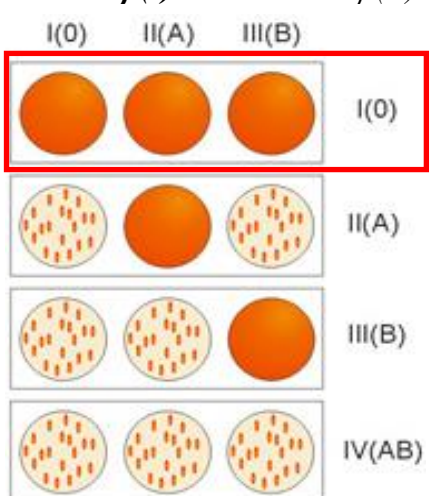
- A. $O(I)$. B. $A(II)$. C. $B(III)$. D. $AB(IV)$. E. –.



Reasoning: When standard sera are used for blood typing you have to represent exactly that serum of II group contents β agglutinins and reacts with RBCs of groups possessing B agglutinogens (III and IV). A serum of III group has α agglutinins and reacts with erythrocytes of groups which content A agglutinogens (II and IV). RBCs of I group possess no agglutinogens and never can agglutinate with any sera. In contrast erythrocytes of IV group with sera of all groups I, II and III. As no agglutination occurred with III group it means that examined blood doesn't have A antigen, only B, so this blood belongs to III type. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 39)

74. Blood group of a 30 year old man was specified before an operation. His blood is Rh-positive. Reaction of erythrocyte agglutination was absent with standard sera of $O\alpha\beta(I)$, $A\beta(II)$, $B\alpha(III)$ groups. The blood under examination is of the following group:

- A. $O\alpha\beta(I)$. B. $A\beta(II)$. C. $B\alpha(III)$. D. $AB(IV)$. E. –.



Reasoning: When standard sera are used for blood typing you have to represent exactly that serum of II group contents β agglutinins and reacts with RBCs of groups possessing B agglutinogens (III and IV). A serum of III group has α agglutinins and reacts with erythrocytes of groups which content A agglutinogens (II and IV). RBCs of I group possess no agglutinogens and never can agglutinate with any sera. In contrast erythrocytes of IV group with sera of all groups I, II and III. As no agglutination occurred with any of sera it means that examined blood doesn't have neither A antigen, nor B antigen, so this blood belongs to I type. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 39).

75. In hemotransfusions it is recommended to transfuse only phenotype-matched blood. According to the ABO system, blood group is determined by:

A. *Proteins of blood serum.*

B. *Protein determinants of erythrocyte membranes.*

C. *Protein-polysaccharide components of leukocytes.*

D. *Carbohydrate determinants of leukocyte membranes.*

E. ***Carbohydrate determinants of erythrocyte membranes.***

Reasoning: Two antigens – type A and type B – occur on the surfaces of the red blood cells in a large proportion of human beings. Antigens that are present on the surface of RBCs membrane are called agglutinogens; their name originates from of erythrocytes clumping (agglutination) in transfusion of mismatched blood. Because of the way these agglutinogens are inherited, people may have 1) neither of them on their cells, 2) they may have one – A type or B type, or 3) they may have both simultaneously. The antigens are glycoproteins and glycolipids – membrane proteins and phospholipids with short carbohydrate chains bond to them. Difference between A and B antigens is in terminal carbohydrates. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 37).

76. A woman with A (II), Rh-negative blood had a child with B (III), Rh-positive blood. The child was diagnosed with congenital anaemia of newborns. What is the most likely cause of its development?

A. *ABO-incompatibility.*

C. *Hereditary chromosomal*

D. *Intrauterine intoxication.*

B. ***Rhesus incompatibility.*** *pathology.*

E. *Intrauterine infection.*

Reasoning: Hemolytic disease of newborns (HDN, erythroblastosis fetalis) is a disease of fetus and newborn child characterized by agglutination and phagocytosis of the fetus's red blood cells. In most instances of erythroblastosis fetalis, the mother is Rh-negative and the father Rh positive. The baby has inherited the Rh-positive antigen from the father, and the mother develops anti-Rh agglutinins from exposure to the fetus's Rh antigen. In turn, the mother's agglutinins diffuse through the placenta into the fetus and cause red blood cell agglutination. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 451–454).

77. Determining a patient's blood group with monoclonal test-reagents revealed positive agglutination reaction to anti-A and anti-B reagents, and negative reaction to anti-D. What blood group does this patient have?

A. *I (O) Rh+.*

B. *II (A) Rh+.*

C. *III (B) Rh+.*

D. *IV (AB) Rh+.*

E. ***IV (AB) Rh-.***

Reasoning: A person's ABO blood type can be determined by placing one drop of blood in a pool of anti-A serum and another drop in a pool of anti-B serum. Blood type AB exhibits conspicuous agglutination in both antisera; type A or B agglutinates only in the corresponding antiserum; and type O does not agglutinate in either one. Anti-A reagent is actually the solution of α agglutinins, correspondently Anti-B is the solution of β ones. Blood cells become clumped if they possess the antigens for the antibodies (top row left, second row right, third row both) but otherwise remain uniformly mixed. Thus type A agglutinates only in anti-A; type B agglutinates only in anti-B; type AB agglutinates in both; and type O agglutinates in neither of them. If agglutination occurs with anti-D reagent, it means that person's blood has D antigen, thus the person is Rh positive; if no agglutination occurs with anti-D – person is Rh negative. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 39).

78. A pregnant woman underwent ABO blood typing. Red blood cells were agglutinated with standard sera of the I and II blood groups, and were not agglutinated with the III group serum. What is the patient's blood group?

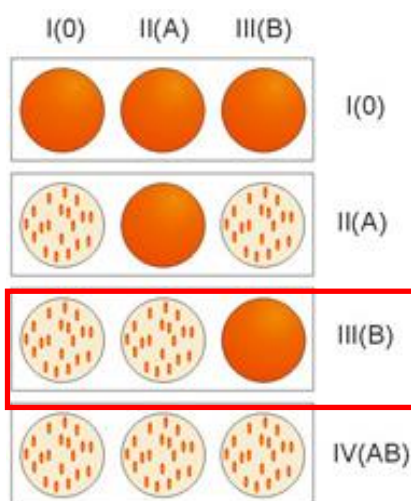
A. ***B(III).***

B. *O(I).*

C. *A(II).*

D. *AB(IV).*

E. *-.*



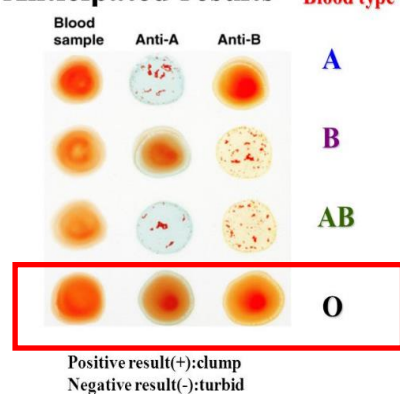
Reasoning: When standard sera are used for blood typing you have to represent exactly that serum of II group contents β agglutinins and reacts with RBCs of groups possessing B agglutinogens (III and IV). A serum of III group has α agglutinins and reacts with erythrocytes of groups which content A agglutinogens (II and IV). RBCs of I group possess no agglutinogens and never can agglutinate with any sera. In contrast erythrocytes of IV group with sera of all groups I, II and III. As no agglutination occurred with III group it means that examined blood doesn't have A antigen, only B, so this blood belongs to III type. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 39)

79. When defining blood group according to the ABO system, using salt solutions of monoclonal antibodies, agglutination didn't occur with any of the solutions. What blood group is it?

- A. 0 (I). B. A (II). C. B (III). D. AB (IV). E. –.

Reasoning: A person's ABO blood type can be determined by placing one drop of blood in a pool of anti-A serum and another drop in a pool of anti-B serum. Blood type AB exhibits conspicuous agglutination in both antisera; type A or B agglutinates only in the corresponding antiserum; and type O does not agglutinate in either one. Anti-A reagent is actually the solution of α agglutinins, correspondently Anti-B is the solution of β ones. Blood cells become clumped if they possess the antigens for the antibodies (top row left, second row right, third row both) but otherwise remain uniformly mixed. Thus type A agglutinates only in anti-A; type B agglutinates only in anti-B; type AB agglutinates in both; and type O agglutinates in neither of them. If agglutination occurs with anti-D reagent, it means that person's blood has D antigen, thus the person is Rh positive; is no agglutination occurs with anti-D – person is Rh negative. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 –

Anticipated results



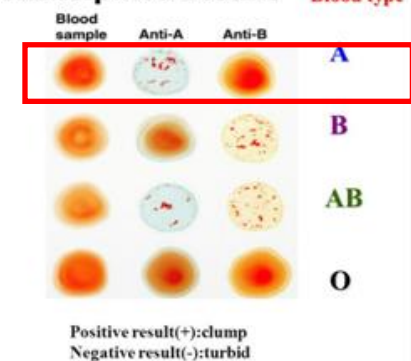
p. 39).

80. A woman with the III (B), Rh- blood group gave birth to a child with the II (A) blood group. The child is diagnosed with hemolytic disease of newborn caused by rhesus incompatibility. What blood group and Rh can the father have?

A. II (A), Rh+. B. I (0), Rh+. C. III (B), Rh+. D. I (0), Rh-. E. II (A), Rh-.

Reasoning: Hemolytic disease of newborns (HDN, erythroblastosis fetalis) is a disease of fetus and newborn child characterized by agglutination and phagocytosis of the fetus's red blood cells. In most instances of erythroblastosis fetalis, the mother is Rh negative and the father Rh positive. The baby has inherited the Rh-positive antigen from the father, and the mother develops anti-Rh agglutinins from exposure to the fetus's Rh antigen. In turn, the mother's agglutinins diffuse through the placenta into the fetus and cause red blood cell agglutination. In ABO system, if mother has III (B), Rh- blood group, then child got A antigen from his father. Thus, father's blood type is II (A), Rh+ or IV (AB), Rh+. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 451–454).

Anticipated results



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81. Determining a patient's blood group with monoclonal test-reagents revealed positive agglutination reaction to anti-A and anti-B reagents, and negative reaction to anti-D. What blood group does this patient have?

A. *IV (AB) Rh-*. B. *II (A) Rh+*. C. *III (B) Rh-*. D. *IV (AB) Rh+*. E. *I (O) Rh+*.

Reasoning: A person's ABO blood type can be determined by placing one drop of blood in a pool of anti-A serum and another drop in a pool of anti-B serum. Blood type AB exhibits conspicuous agglutination in both antisera; type A or B agglutinates only in the corresponding antiserum; and type O does not agglutinate in either one. Anti-A reagent is actually the solution of α agglutinins, correspondently Anti-B is the solution of β ones. Blood cells become clumped if they possess the antigens for the antibodies (top row left, second row right, third row both) but otherwise remain uniformly mixed. Thus type A agglutinates only in anti-A; type B agglutinates only in anti-B; type AB agglutinates in both; and type O agglutinates in neither of them. If agglutination occurs with anti-D reagent, it means that person's blood has D antigen, thus the person is Rh positive; if no agglutination occurs with anti-D – person is Rh negative (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina etc. – Kharkov : KhNMU, 2016 – p. 39).

82. A 25-year-old woman at her third pregnancy with impending miscarriage was brought to the hospital. What combination of Rh-factor of mother and the fetus can be the cause of this condition?

A. *Mother (-), fetus (+)*. C. *Mother (-), fetus (-)*. E. *-*.
B. *Mother (+), fetus (+)*. D. *Mother (+), fetus (-)*.

Reasoning: Hemolytic disease of newborns (HDN, erythroblastosis fetalis) is a disease of fetus and newborn child characterized by agglutination and phagocytosis of the fetus's red blood cells. In most instances of erythroblastosis fetalis, the mother is Rh negative and the father Rh positive. The baby has inherited the Rh-positive antigen from the father, and the mother develops anti-Rh agglutinins from exposure to the fetus's Rh antigen. In turn, the mother's agglutinins diffuse through the placenta into the fetus and cause red blood cell agglutination. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VI Blood Cells, Immunity, and Blood Clotting, p. 451–454).

Physiology of heart & circulation

1. Examination of a person revealed that minute volume of heart is 3 500 mL, systolic volume is 50 mL. What is the frequency of cardiac contraction?

- A. 90 bpm. B. 50 bpm. C. 80 bpm. D. 60 bpm. E. 70 bpm.

Reasoning: Cardiac output can be calculated using following formula: Cardiac output = stroke volume x heart rate, if CO and SV are known, so $HR = CO/SV$ (Stuart Ira Fox Human physiology, ninth edition, p. 426)

2. A person has steady HR not exceeding 40 bpm. What is the pacemaker of the heart rhythm in this person?

- A. *Atrioventricular node.* C. *Sinoatrial node.* E. *Branches of His' bundle.*
 B. *His' bundle.* D. *Purkinje' fibers.*

Reasoning: The A-V nodal fibers discharge at an intrinsic rhythmical rate of 40 to 60 times per minute. (Guyton and Hall, 11th edition, p. 120).

3. The electrocardiogram demonstrated that the duration of man's heart cycle is 1 sec. What is the heart rate per minute?

- A. 50. B. 60. C. 70. D. 80 E. 100.

Reasoning: At the average heart rate of 75 bpm, each cardiac cycle lasts 0,8 second, using following formula R-R interval (sec) = 60 second per minute / 75 bpm = 0,8 sec. If duration of R-R interval is known so $1 = 60 \text{ sec} / x$, $x = 60 / 1 = 60 \text{ bpm}$ (Stuart Ira Fox Human physiology, ninth edition, p. 397)

4. While preparing a patient to the operation the heart chambers' pressure was measured. In one of them the pressure changed during one heart cycle from 0 to 120 mm Hg. What chamber of heart was it?

- A. *Left atrium.* B. *Left ventricle.* C. *Right atrium.* D. *Right ventricle.* E. *—.*

Reasoning: The ejection of blood begins when ventricular pressure exceeds arterial pressure and forces the semilunar valves open. The pressure peaks at 120 mmHg in the left ventricle and 25 mmHg in the right. Blood spurts out of each ventricle rapidly at first (*rapid ejection*) and then flows out more slowly under less pressure (*reduced ejection*).

Pressure differential

Pressures in the Pulmonary Circulation		Pressures in the Systemic Circulation	
Right ventricle	25/0 mm Hg	Left ventricle	120/0 mm Hg
Pulmonary artery	25/8 mm Hg	Aorta	120/80 mm Hg
Mean pulm. art.	15 mm Hg	Mean art. blood p	93 mm Hg
Capillary	7–9 mm Hg	Capillary: skeletal renal glomerular	30 mm Hg 45–50 mm Hg
Pulmonary venous	5 mm Hg	Peripheral veins	15 mm Hg
Left atrium	5–10 mm Hg	Right atrium (central venous)	0 mm Hg
Pressure gradient	15–5 = 10 mm Hg	Pressure gradient	93–0 = 93 mm Hg

(Kaplan Medical. USMLE. Step 1. Lecture notes. Physiology. Section V. Peripheral circulation. p. 86)

5. An isolated cell of human heart automatically generates excitation impulses with frequency 60 times per minute. What structure does this cell belong to?

- A. *Ventricle.* C. *Atrioventricular node.* E. *Atrium.*
 B. *Sinoatrial node.* D. *His' bundle.*

Reasoning: Under normal conditions automaticity of all low-lying parts of the conductive system is suppressed by more frequent impulses arriving from the **sinoatrial node which is 60–80 per minute.**

(Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 75–76)

6. Examination of an isolated cardiomyocyte revealed that it didn't generate excitation impulses automatically. This cardiomyocyte was obtained from:

- A. *Sinoatrial node*. C. **Ventricles**. E. *His' bundle*.
 B. *Purkinje's fibers*. D. *Atrioventricular node*.

Reasoning: The specialized excitatory and conductive system of the heart that controls cardiac contractions includes: 1) *sinus node* (also called *sinoatrial* or *S–A node*), in which the normal rhythmical impulse is generated; 2) *internodal pathways* that conduct the impulse from the sinus node to the atrioventricular (A–V) node; 3) *A–V node*, in which the impulse from the atria is delayed before passing into the ventricles; 4) *A–V bundle of His*, which conducts the impulse from the atria into the ventricles; 5) *left and right branches of His bundle*, which conduct the cardiac impulse to all parts of the ventricles. The significance of the following structures is to generate impulses automatically and to conduct them along conduction system structures of the heart. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium)/ compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 76)

7. Vagus branches that innervate heart are being stimulated in course of an experiment. As a result of it the excitement conduction from atria to the ventricles was brought to a stop. It is caused by electrophysical changes in the following structures:

- A. *His' bundle*. B. *Atria*. C. **Atrioventricular node**. D. *Sinoatrial node*. E. *Ventricles*.

Reasoning: The *A–V node* and its *adjacent conductive fibers* that conduct and delay transmission of impulses into the ventricles. The *A–V node* is located in the posterior wall of the right atrium immediately behind the tricuspid valve. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov: KhNMU, 2016 – p. 76)

8. A cardiac electric stimulator was implanted to a 75 year old man with heart rate of 40 bpm. Thereafter the heart rate raised up to 70 bpm. The electric stimulator has undertaken the function of the following heart part:

- A. *His' bundle branches*. C. *His' bundle fibers*. E. *Atrioventricular node*.
 B. ***Sinoatrial node***. D. *Purkinje's fibers*.

Reasoning: Under normal conditions automaticity of all low-lying parts of the conductive system is suppressed by more frequent impulses arriving from the **sinuatrial node which is 60–80 per minute**. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 75–76)

9. In a healthy adult speed of the excitement conduction through the atrioventricular node is 0,02–0,05 m/sec. Atrioventricular delay enables:

- A. *Simultaneity of both atria contractions*. D. *Sufficient force of ventricular contractions*.
 B. *Simultaneity of both ventricles contractions*. E. ***Sequence of atrial and ventricular contractions***.
 C. *Sufficient force of atrial contractions*.

Reasoning: Cardiac impulse does not travel from the atria into the ventricles too rapidly; this delay allows time for the atria to empty their blood into the ventricles before ventricular contraction begins. It is primarily the *A–V node* and its *adjacent conductive fibers* that delay this transmission into the ventricles. Then there is a delay of another 0.09 second in the *A–V node* itself before the impulse enters the *penetrating portion of the A–V bundle*, where it passes into the ventricles. A final delay of another 0.04 second occurs mainly in this penetrating *A–V bundle*, which is composed of multiple small fascicles passing through the fibrous tissue separating the atria from the ventricles. Thus, the total delay in the *A–V nodal and A–V bundle system* is about 0.13 second. This, in addition to the initial conduction delay of 0.03 second from the sinus node to the *A–V node*, makes a total delay of 0.16 second before the excitatory signal finally reaches the contracting muscle of the ventricles. (Guyton and Hall, 11th edition, p. 118–119).

10. During phonocardiogram registration it was ascertained that the duration of the first heart sound twice exceeds the norm. It is most likely that patient has the following organ affected:

- A. *Cardiomyocytes of heart atriums.* **D. Atrioventricular valves.**
B. *Cardiomyocytes of ventricles.* E. *Semilunar valves.*
C. *Cardiomyocytes of atriums.*

Reasoning: When the ventricles contract, one first hears a sound caused by closure of the A-V valves. The vibration is low in pitch and relatively long-lasting and is known as the *first heart sound*. When the aortic and pulmonary valves close at the end of systole, one hears a rapid snap because these valves close rapidly, and the surroundings vibrate for a short period. This sound is called the *second heart sound*. (Guyton and Hall, 11th edition, p. 110).

11. An isolated cell of human heart automatically generates excitement impulses with frequency of 60 times per minute. This cell was taken from the following heart structure:

- A. *Atrium.* B. *Ventricle.* C. ***Sinoatrial node.*** D. *Atrioventricular node.* E. *His' bundle.*

Reasoning: Under normal conditions automaticity of all low-lying parts of the conductive system is suppressed by more frequent impulses arriving from the **sinuatrial node which is 60–80 per minute**. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 75–76)

12. During ventricular systole, the cardiac muscle does not respond to additional stimulation because it is in the phase of:

- A. *Hyperexcitability.* **C. Absolute refractoriness.** E. *There is no correct answer.*
B. *Subnormal excitability.* D. *Relational refractoriness.*

Reasoning: Cardiac muscle is refractory to restimulation during the action potential. Therefore, the refractory period of the heart is the interval of time, during which a normal cardiac impulse cannot re-excite an already excited area of cardiac muscle. The normal refractory period of the ventricle is 0.25 to 0.30 second, which is about the duration of the prolonged plateau action potential. There is an additional *relative refractory period* of about 0.05 second during which the muscle is more difficult than normal to excite but nevertheless can be excited by a very strong excitatory signal. The refractory period of atrial muscle is much shorter than that for the ventricles (about 0.15 second for the atria compared with 0.25 to 0.30 second for the ventricles). (Guyton and Hall, 11th edition, p. 105–106).

13. During examination the doctor performs auscultation to assess the functioning of the patient's mitral valve. Where can the sound of this valve be auscultated?

- A. *At the edge of the sternum in the 2nd intercostal space on the right.*
B. *At the edge of the sternum over the 5th costal cartilage on the right.*
C. At the apex of the heart.
D. *At the edge of the sternum in the 2nd intercostal space on the left.*
E. *At the edge of the sternum over the 5th costal cartilage on the left.*

Reasoning: When the ventricles contract, one first hears a sound caused by closure of the A–V valves. The vibration is low in pitch and relatively long-lasting and is known as the *first heart sound*. The mitral area is over the apex of the left ventricle, which is the portion of the heart nearest the surface of the chest. (Guyton and Hall, 11th edition, Chapter 23, p. 271).

14. Auscultation reveals that in the patient's II intercostal space along the parasternal line on the right the II heart sound is better heard than the I heart sound. What valve produces this sound when closing?

- A. *Bicuspid valve.* C. *Tricuspid valve.* E. *Semilunar pulmonary valve.*
B. *Bicuspid and tricuspid valves.* **D. Semilunar aortic valve.**

Reasoning: The aortic area is upward along the aorta in II intercostal space along the parasternal line on the right (Guyton and Hall, 11th edition, Chapter 23, p. 270–271).

15. Electrocardiogram of a man showed absence of P-wave in all leads. What part of the conducting system is blocked?

- A. *Common branch of the bundle of His.* **D. Branches of the bundle of His.**
B. *Atrioventricular node.* E. *Purkinje's fibers.*
C. Sinu-atrial node.

Reasoning: The P wave is caused by electrical potentials generated by SA node and then the atria depolarize before atrial contraction begins. (Stuart Ira Fox Human physiology, ninth edition, p. 405, Guyton and Hall, 11th edition, p. 123)

16. ECG study showed that the T-waves were positive in the standard extremity leads, their amplitude and duration were normal. The right conclusion would be that the following process runs normally in the heart ventricles:

- A. *Depolarization.* **B. Repolarization.** C. *Excitement.* D. *Contraction.* E. *Relaxation.*

Reasoning: The T wave is generated by ventricular repolarization immediately before diastole. The ventricles take longer to repolarize than to depolarize; the T wave is therefore smaller and more spread out than the QRS complex, and it has a rounder peak. Even in cases where the T wave is taller than the QRS complex, it can be recognized by its relatively rounded peak. (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 730)

17. Processes of repolarization are disturbed in ventricular myocardium in examined person. It will cause amplitude abnormalities of configuration and duration of the wave:

- A. *P.* B. *Q.* C. *R.* D. *S* E. *T.*

Reasoning: The T wave is generated by ventricular repolarization immediately before diastole. The ventricles take longer to repolarize than to depolarize; the T wave is therefore smaller and more spread out than the QRS complex, and it has a rounder peak. Even in cases where the T wave is taller than the QRS complex, it can be recognized by its relatively rounded peak. (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 730)

18. A patient has delayed conduction of excitement through the atrioventricular node. What changes of ECG will be observed?

- A. *Prolongation of Q-S interval.* D. **Prolongation of P-Q interval.**
B. *Negative T wave.* E. *Prolongation of Q-T interval.*
C. *S-T-segment displacement.*

Reasoning: In ECG PR interval shows atrial depolarization and conduction through AV node (Ganong's Review of medical physiology, 23 edition, Chapter 30, Table 30–2)

19. ECG of a patient shows prolongation of T-wave. This is caused by deceleration in ventricles of:

- A. *Depolarization and repolarization.* C. **Repolarization.** E. *Relaxation.*
B. *Depolarization.* D. *Contraction.*

Reasoning: The T wave is generated by ventricular repolarization immediately before diastole. The ventricles take longer to repolarize than to depolarize; the T wave is therefore smaller and more spread out than the QRS complex, and it has a rounder peak. Even in cases where the T wave is taller than the QRS complex, it can be recognized by its relatively rounded peak. (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 730)

20. ECG of a patient with hyperfunction of thyroid gland showed heart hurry. It is indicated by depression of the following ECG element:

- A. *QRS complex.* **B. R–R interval.** C. *P–Q interval.* D. *P–Q segment.* E. *P–T interval.*



Reasoning: There are several methods for determining heart rate. Count the number of small boxes for a typical R-R interval. Divide this number into 1500 to determine heart rate. In the image, the number of small boxes for the R–R interval is 21.5. The heart rate is 1500/21.5, which is 69.8. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 159)

21. ECG of a patient showed that RR interval equaled 1,5 s, heart rate equaled 40 bpm. What is the cardiac pacemaker?

- A. *Sinus node.* C. *His' bundle.* E. *Right branch of His' bundle.*
B. **Atrioventricular node.** D. *Left branch of His' bundle.*

Reasoning: The A–V nodal fibers discharge at an intrinsic rhythmical rate of 40 to 60 times per minute. (Guyton and Hall, 11th edition, p. 120).

22. A 50 y.o. man abruptly felt palpitation, heart ache, strong weakness, rise of arterial pressure. His pulse is irregular and deficient. ECG shows no P wave and different R–R intervals. What cardiac rate abnormality is it?

- A. *Respiratory arrhythmia.* C. *Paroxysmal tachycardia.* E. *Sinus extrasystole.*
B. *Ciliary arrhythmia.* D. *Atrioventricular heart block.*

Reasoning: ciliary arrhythmia (Greek arrhythmia lack of a rhythm; synonym: *atrial fibrillation, fibrillation of auricles, arrhythmia perpetua, pulsus perpetuus irregularis, delirium cordis, fibrillatio et tachysystolia atriorum*) Atrial fibrillation: Characteristics • Rhythms: Irregularly irregular • Rates: Atrial—usually greater than 400 beats/minute; ventricular – varies from 100 to 150 beats/minute but can be lower • P waves: Absent, • R–R intervals: Wide variation (ECG interpretation made incredibly easy! – 5th ed. Lippincott Williams & Wilkins, p. 106).

23. A 15-year-old teenager complains of lack of air, general weakness, palpitation. Heart rate is 130 bpm., BP is 100/60 mm Hg. ECG: QRS complex has normal shape and duration. The number of P waves and ventricular complexes is equal, T waves merges with P wave. What type of cardiac arrhythmia is observed in the teenager?

- A. *Paroxysmal atrial tachycardia.* C. *Sinus extrasystole.* E. *Sinus tachycardia.*
B. *Atrial thrill.* D. *Atrial fibrillation.*

Reasoning: Sinus tachycardia Characteristics • Rhythms: Regular • Rates: Both equal, generally 100 to 160 beats/minute • PR interval: Normal • QRS complex: Normal • T wave: Normal • QT interval: Shortened (ECG interpretation made incredibly easy! – 5th ed. Lippincott Williams & Wilkins, p. 82)

24. The patient's ECG shows that in the second lead from the extremities the P waves are positive. Their amplitude is 0.1 mV (norm is 0.05–0.25 mV), duration – 0.1 sec (norm is 0.07–0.10 sec). It can be concluded that the following process occurs normally in the cardiac atria:

- A. *Activation.* B. *Relaxation.* C. *Depolarization.* D. *Repolarization.* E. *Contraction.*

Reasoning: P wave is the first deflection and is normally a positive (upward) waveform. It indicates atrial depolarization. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 158)

25. A 67-year-old man was delivered to the cardiology unit with complaints of periodical pain in the heart, dyspnea after even insignificant physical exertion, cyanosis, and edemas. ECG revealed additional contractions of the heart ventricles. Name this type of rhythm disturbance:

- A. *Tachycardia.* B. *Flutter.* C. *Fibrillation.* D. *Extrasystole.* E. *Bradycardia.*

Reasoning: A premature ventricular contraction (PVC) — also known as a premature ventricular complex, ventricular premature contraction (VPC), ventricular premature beat (VPB), or ventricular extrasystole (VES) Premature ventricular contraction Characteristics • Rhythms: Irregular during PVC; underlying rhythm may be regular • Rates: Patterned after underlying rhythm • P wave: Absent • PR interval: Unmeasurable • QRS complex: Wide and bizarre • T wave: Opposite direction from QRS complex • QT interval: Unmeasurable • Other: Possible compensatory pause (ECG interpretation made incredibly easy! – 5th ed. Lippincott Williams & Wilkins, p. 82)

26. ECG of a 46-year-old patient shows an increase the QRS duration. It might be caused by:

- A. **Increased ventricular activation time.** D. *Conduction disturbances in the AV node.*
B. *Increased atrial and ventricular excitability.* E. *Increased atrial excitability.*
C. *Increased atrial activation time.*

Reasoning: The QRS complex follows the P wave and represents depolarization of the ventricles. Immediately after the ventricles depolarize, as represented by the QRS complex, they contract. That contraction ejects blood from the ventricles and pumps it through the arteries, creating a pulse. (ECG interpretation made incredibly easy! — 5th ed. Lippincott Williams & Wilkins, p. 45)

27. A patient has a first-degree atrioventricular block accompanied by the prolongation of P-Q interval up to 0,25 s. Under such conditions the following myocardial function will be disturbed:

- A. *Excitability.* B. **Conduction.** C. *Automatism.* D. *Contractibility.* E. —.

Reasoning: The PR interval tracks the atrial impulse from the atria through the AV node, bundle

of His, and right and left bundle branches. When evaluating a PR interval, look especially at its duration. Changes in the PR interval indicate an altered impulse formation or a conduction delay, as seen in AV block. A normal PR interval has the following characteristics (amplitude, configuration, and deflection aren't measured): • location — from the beginning of the P wave to the beginning of the QRS complex • duration – 0.12 to 0.20 second (ECG interpretation made incredibly easy! – 5-th ed. Lippincott Williams & Wilkins, p. 45)

28. ECG of a patient shows that T-waves in the second standard extremity lead are positive, their amplitude and duration are normal. It would be true that the following process is taking its normal course in the cardiac ventricles:

A. *Excitement.* B. *Contraction.* C. *Depolarization.* D. *Relaxation.* E. ***Repolarization.***

Reasoning: The T wave is generated by ventricular repolarization immediately before diastole. The ventricles take longer to repolarize than to depolarize; the T wave is therefore smaller and more spread out than the QRS complex, and it has a rounder peak. Even in cases where the T wave is taller than the QRS complex, it can be recognized by its relatively rounded peak. (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 730)

29. A patient complains of palpitation after stress. The pulse is 104 bpm, P–Q=0,12 seconds, there are no changes of QRS complex. What type of arrhythmia does the patient have?

A. *Ciliary arrhythmia.* C. ***Sinus tachycardia.*** E. *Extrasystole.*
B. *Sinus bradycardia.* D. *Sinus arrhythmia.*

Reasoning: Sinus tachycardia Characteristics • Rhythms: Regular • Rates: Both equal, generally 100 to 160 beats/minute • PR interval: Normal • QRS complex: Normal • T wave: Normal • QT interval: Shortened (ECG interpretation made incredibly easy! – 5th ed. Lippincott Williams & Wilkins, p. 82).

30. ECG of a patient displays an abnormally long R wave (up to 0,18 s). This is caused by a decrease in the conduction velocity of the following heart structures:

A. *Right ventricle.* C. *Atrio-ventricular node.* E. ***Ventricles.***
B. *Left ventricle.* D. *Atria.*

Reasoning: The **QRS complex** consists of a small downward deflection (Q), a tall sharp peak (R), and a final downward deflection (S). It marks the firing of the AV node and the onset of ventricular depolarization. Its complex shape is due to the different sizes of the two ventricles and the different times required for them to depolarize. (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 730).

31. A 67-year-old man was delivered to a cardiology department with complaints of periodical pains in his heart, dyspnea caused by even slight exertion, cyanosis and edemas. ECG shows additional excitations of heart ventricles. Name this type of rhythm disturbance:

A. *Fibrillation.* C. *Tachycardia.* E. ***Extrasystole.***
B. *Bradycardia.* D. *Flutter.*

Reasoning: A premature ventricular contraction (PVC) – also known as a premature ventricular complex, ventricular premature contraction (VPC), ventricular premature beat (VPB), or ventricular extrasystole (VES) Premature ventricular contraction Characteristics • Rhythms: Irregular during PVC; underlying rhythm may be regular • Rates: Patterned after underlying rhythm • P wave: Absent • PR interval: Unmeasurable • QRS complex: Wide and bizarre • T wave: Opposite direction from QRS complex • QT interval: Unmeasurable • Other: Possible compensatory pause (ECG interpretation made incredibly easy! — 5th ed. Lippincott Williams & Wilkins, p. 82)

32. A 56 year old patient suffering from cardiac insufficiency has edema of feet and shins, edematous skin is pale and cold. What is the leading mechanism of edema pathogenesis?

A. *Drop of oncotic pressure in capillaries.* D. *Disorder of lymph outflow.*
B. ***Rise of hydrostatic pressure in venules.*** E. *Positive water balance.*
C. *Increase of capillary permeability.*

Reasoning: Increased capillary filtration results from increases in capillary BP or permeability. Poor venous return, for example, causes pressure to back up into the capillaries. Congestive heart failure and incompetent heart valves can impede venous return from the lungs

and cause pulmonary edema. Systemic edema is a common problem when a person is confined to a bed or wheelchair, with insufficient muscular activity to promote venous return. (Stuart Ira Fox Human physiology, ninth edition, p. 763)

33. Blood minute volume of a 30 year old woman at rest is 5 l/m. What blood volume is pumped through the pulmonary vessels per minute?

- A. 3,75 l. B. 1,5 l. C. 2,5 l. D. 2,0 l. E. 5 l.

Reasoning: Both ventricles eject the same amount of blood even though pressure in the right ventricle is only about one fifth the pressure in the left. Blood pressure in the pulmonary trunk is relatively low, so the right ventricle does not need to generate very much pressure to overcome it. It is essential that both ventricles have the same output. If the right ventricle pumped more blood into the lungs than the left side of the heart could handle on return, blood would accumulate in the lungs and cause pulmonary hypertension and edema (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 736)

34. A patient is 44 years old. Laboratory examination of his blood revealed that content of proteins in plasma was 40 g/l. What influence will be exerted on the trans-capillary water exchange?

- A. Exchange will stay unchanged.
B. Filtration will be decreased, reabsorption- increased.
C. Filtration will be increased, reabsorption-decreased.
D. Both filtration and reabsorption will be increased.
E. Both filtration and reabsorption will be decreased.

Reasoning: Normal amount of plasma proteins 65–85 g/l. The pressure created by the concentration of colloidal proteins in the blood is called the blood colloidal osmotic pressure (BCOP) that normally equals 25–30 mm Hg. Reduction of plasma proteins content leads to reduction of oncotic pressure of blood and resulting in intensification of water filtration. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 121)

35. A patient under test was subjected to a moderate physical stress. His minute blood volume amounted 10 l/min. What blood volume was pumped through his lung vessels every minute?

- A. 4 l/min. B. 5 l/min. C. 6 l/min. D. 7 l/min. E. 10 l/min.

Reasoning: Both ventricles eject the same amount of blood even though pressure in the right ventricle is only about one fifth the pressure in the left. Blood pressure in the pulmonary trunk is relatively low, so the right ventricle does not need to generate very much pressure to overcome it. It is essential that both ventricles have the same output. If the right ventricle pumped more blood into the lungs than the left side of the heart could handle on return, blood would accumulate in the lungs and cause pulmonary hypertension and edema (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 736)

36. In elderly person the change in heart force and vessels physical properties were detected; they can be clearly observed on graphic recording of carotid pulse waves. What method was applied?

- A. Rheography. C. Phlebography. E. Myography.
B. Plethysmography. D. Sphygmography.

Reasoning: The method of graph recording of arterial pulse is called sphygmography (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 101)

37. An experiment was conducted to study major indicators of hemodynamics. What hemodynamics indicator would be the same for both systemic and pulmonary circulation?

- A. Diastolic blood pressure. C. Linear blood flow velocity. E. Vascular resistance.
B. Volumetric blood flow rate. D. Mean arterial pressure.

Reasoning: Both ventricles eject the same amount of blood even though pressure in the right ventricle is only about one fifth the pressure in the left. Blood pressure in the pulmonary trunk is relatively low, so the right ventricle does not need to generate very much pressure to overcome it. It

is essential that both ventricles have the same output. If the right ventricle pumped more blood into the lungs than the left side of the heart could handle on return, blood would accumulate in the lungs and cause pulmonary hypertension and edema (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 736)

38. The calcium canals of cardiomyocytes have been blocked on an isolated rabbit's heart. What changes in the heart's activity can happen as a result?

- A. *Decreased heart beat rate.*
- B. *Heart stops in systole.*
- C. *Decreased force of the contraction.*
- D. ***Decreased rate and force heart beat.***
- E. *Heart stops in diastole.*

Reasoning: In cardiac muscle, the action potential is caused by opening of two types of channels: (1) the same fast sodium channels as those in skeletal muscle and (2) another entirely different population of slow calcium channels, which are also called calcium-sodium channels. Deficiency of calcium ions causes cardiac flaccidity, similar to the effect of high potassium. (Guyton and Hall, 11th edition, p. 105, 114)

39. After the trauma, the patient's right n. vagus was damaged. Which violation of the cardiac activity is possible in this case?

- A. *Violation of the automatism of an atrio-ventricular node.*
- B. ***Violation of the automatism of a Kiss-Fleck node.***
- C. *Block of a conductivity in the atrio-ventricular node.*
- D. *Violation of conductivity in the right auricle.*
- E. *Arrhythmia.*

Reasoning: Right n. vagus controls mainly right atrium and SA node. Left n. vagus control AV node, His bundle and all contractile myocardium. So irritation of right nerve causes bradycardia. Effects of left nerve lead to decrease of contractility and conductivity. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 121).

40. The heart rate and the systemic arterial blood pressure of a man have increased due to voluntary respiratory delay for 40 c. Realization of what regulation mechanism caused these changes?

- A. *–*
- B. *Conditioned parasympathetic reflexes.*
- C. *Conditioned sympathetic reflexes.*
- D. *Unconditioned parasympathetic reflexes.*
- E. ***Unconditioned sympathetic reflex.***

Reasoning: A **chemoreflex** is an autonomic response to changes in blood chemistry, especially its pH and concentrations of O₂ and CO₂. It is initiated by chemoreceptors within small organs called **aortic bodies** and **carotid bodies**, located in the aortic arch, subclavian arteries, and external carotid arteries. The primary role of chemoreflexes is to adjust respiration to changes in blood chemistry, but they have a secondary role in stimulating vasomotion. Hypoxemia (O₂ deficiency), hypercapnia (CO₂ excess), and acidosis (low blood pH) stimulate the chemoreceptors and act through the vasomotor center to cause widespread vasoconstriction. This increases overall BP, thus increasing perfusion of the lungs and the rate of gas exchange. Chemoreceptors also stimulate one's breathing, so increased ventilation of the lungs matches their increased perfusion. (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 759)

41. Accelerated frequency of the heart rate and increased blood pressure were marked in the sportsman on the start before the competitions. Influence of what parts of the CNS can explain these changes?

- A. *Medulla.*
- B. *Mesencephalon.*
- C. *Diencephalon.*
- D. *Hypothalamus.*
- E. ***Cortex of the large hemispheres.***

Reasoning: Central nervous system mechanisms function to initiate, coordinate, and anticipate autonomic responses. They also provide set points and adapt them to circumstances when that is warranted by Hierarchy of Central Autonomic Control **Limbic cortex and amygdala** – these very high centers function both as a brake on automatic responses that may accompany emotional states, such as fear, rage, embarrassment, or sexual desire, and as direct activators of the system. The latter is seen prominently in two circumstances: (1) in the responses of blood pressure, sweat glands, or genitalia to dreams and fantasies and (2) in the volitional control of

resting autonomic functions during states of deep meditation. In this state, metabolic rate, heart rate, arterial blood pressure, and distribution of blood flow can all be modified by application of conscious mental effort. Autonomic responses that are coordinated at this high CNS level are physically and emotionally complete whole-body responses in that they include the subjective feelings of fear, joy, pleasure, and pain. (Ackermann PDQ Physiology, p. 102–103)

42. Arterial hypertension is caused by the stenosis of the renal arteries in the patient. Activation of what system is the main link in the pathogenesis of this form of hypertension?

- A. *Sympathoadrenal.* C. *Parasympathetic.* E. *Kallikrein-kinin.*
B. **Renin-angiotensin.** D. *Hypothalamic-pituitary.*

Reasoning: The renin-angiotensin-aldosterone mechanism has a major effect upon the cardiovascular system. Renin is an enzyme, although because of its importance in the renin-angiotensin-aldosterone pathway, some sources identify it as a hormone. Specialized cells in the kidneys found in the juxtaglomerular apparatus respond to decreased blood flow by secreting renin into the blood. Renin converts the plasma protein angiotensinogen, which is produced by the liver, into its active form – angiotensin I. Angiotensin I circulates in the blood and is then converted into angiotensin II in the lungs. This reaction is catalyzed by the enzyme angiotensin-converting enzyme (ACE). Angiotensin II is powerful vasoconstrictor substance. As little as *one millionth* of a gram can increase the arterial pressure of a human being 50 mm Hg or more. The effect of angiotensin II is to constrict powerfully the small arterioles. The real importance of angiotensin II is that it normally acts on many of the arterioles of the body at the same time to increase the *total peripheral resistance*, thereby increasing the arterial pressure. (Guyton and Hall, 11th edition, p. 201–202).

43. On experiment on the dog the peripheral part of nervus vagus of the neck was irritated. What changes of the heart function would be observed?

- A. *Increased contraction force and rate.* D. *Increased atrioventricular conduction.*
B. *Increased myocardial excitability.* E. **Decreased contraction rate.**
C. *Increased contraction force.*

Reasoning: Vagus nerve releases Ach and through cholinergic M₂ Gi – protein- coupled receptors causing negative effects to the heart: decreased chronotropy, inotropy, dromotropy and bathmotropy (Guyton and Hall, 11th edition, p. 112–113).

44. While emotional excitement the heart rate in a 30-year-old person run up to 112 Bpm. What part of the conducting system of the heart caused it?

- A. *Purkinje's fibers.* C. *His bundle.* E. *Intraventricular node.*
B. **Synoatrial node.** D. *His bundle branches.*

Reasoning: Tachycardia is a persistent, resting adult heart rate above 100 bpm. It can be caused by emotional and physical stress, anxiety, drugs, heart disease, or fever. Heart rate also rises to compensate to some extent for a drop in stroke volume. Thus, the heart races when the body has lost a significant quantity of blood or when there is damage to the myocardium. (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 738)

45. A peripheral segment of vagus nerve on a dog's neck was being stimulated in course of an experiment. The following changes of cardiac activity could be mean while observed:

- A. *Heart rate and heart force amplification.* D. *Heart hurry.*
B. *Enhancement of atrioventricular conduction.* E. *Increased excitability of myocardium.*
C. **Heart rate fall.**

Reasoning: Vagus nerve releases Ach and through cholinergic M₂ Gi – protein- coupled receptors causing negative effects to the heart: decreased chronotropy, inotropy, dromotropy and bathmotropy. (Guyton and Hall, 11th edition, p. 112–113).

46. A patient who suffers from severe disorder of water-salt metabolism experienced cardiac arrest in diastole. What is the most probable mechanism of cardiac arrest in diastole?

- A. *Hypernatremia.* C. *Hypokaliemia.* E. **Hyperkaliemia.**
B. *Hyponatremia.* D. *Organism dehydration.*

Reasoning: In hyperkalemia the membrane potential becomes less negative, therefore in first phase of hyperkalemia it is easier to induce stimuli. The excitability is increased, arrhythmias can occur, patients have paresthesias. In severe hyperkalemia is the membrane potential even less negative, sodium channels stay inactive and second phase of hyperkalemia comes with muscle weakness, paralysis, bradycardia and QRS widening on ECG. In case of extreme hyperkalemia the whole process can end with ventricular fibrillation or the heart stops in diastole (asystole). (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 739, 924)

47. Short-term physical activity resulted in reflex amplification of heart rate and raise of systemic arterial pressure. What receptors activation was the main cause of pressor reflex realization?

A. *Vascular chemoreceptors.*

D. *Hypothalamus thermoreceptors.*

B. *Vascular volume receptors.*

E. *Vascular baroreceptors.*

C. ***Proprioceptors of active muscles.***

Reasoning: Physical loading results in activation of sympathetic division of cardiovascular center caused by stimulation of proprioceptors of active muscles. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 129).

48. A 63 y.o. man with collapse symptoms was delivered to the emergency hospital. A doctor chose noradrenaline in order to prevent hypotension. What is the action mechanism of this medication?

A. *Activation of dopamine receptors.*

D. ***Activation of α 1-adrenoreceptors.***

B. *Block of M -cholinoreceptors.*

E. *Activation of β -adrenoreceptors.*

C. *Activation of serotonin receptors.*

Reasoning: Circulating Norepinephrine Causes:

- Increased heart rate (although only transiently) and increased inotropy (β_1 -adrenoceptor mediated) are the direct effects norepinephrine on the heart.

- Vasoconstriction occurs in most systemic arteries and veins thus increasing blood pressure (postjunctional α_1 adrenoceptors). (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 129)

49. An aged man had raise of arterial pressure under a stress. It was caused by activation of:

A. *Functions of thyroid gland.*

C. *Functions of adrenal cortex.*

E. *Parasympathetic*

B. ***Sympathoadrenal system.***

D. *Hypophysis function.*

nucleus of vagus.

Reasoning: The catecholamines epinephrine and norepinephrine are released by the adrenal medulla, and enhance and extend the body's sympathetic or «fight-or-flight» response. They increase heart rate and force of contraction, while temporarily constricting blood vessels of organs not essential for flight-or-fight responses and redirecting blood flow to the liver, muscles, and heart. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 142)

50. An animal with aortic valve insufficiency got hypertrophy of its left heart ventricle. Some of its parts have local contractures. What substance accumulated in the myocardiocytes caused these contractures?

A. *Lactic acid.*

B. *Potassium.*

C. *Carbon dioxide.*

D. *Sodium.*

E. ***Calcium.***

Reasoning: An excess of calcium ions causes effects almost exactly opposite to those of potassium ions, causing the heart to go toward spastic contraction. This is caused by a direct effect of calcium ions to initiate the cardiac contractile process.

51. Systemic arterial pressure of an adult dropped from 120/70 to 90/50 mm Hg that led to reflexory vasoconstriction. The vasoconstriction will be maximal in the following organ:

A. *Heart.*

B. *Kidneys.*

C. *Adrenals.*

D. *Brain.*

E. ***Bowels.***

Reasoning: The cardiovascular system responds to hypotension and hypovolemic shock by increasing the heart rate, increasing myocardial contractility and constricting peripheral blood vessels as result of the direct stimulation via the sympathetic system on heart and vessels by the cardiac and vasomotor centers in the reticular activating substance of lower pons and medulla oblongata. The sympathetic system releases catecholamines (noradrenaline and adrenaline) that

will cause different effect on vessels of different organs according to type of adrenergic receptors that are predominant in those vessels. Brain is the most protected organ as there is the absence of direct sensitivity in the brain vessels to vasoconstricting catecholamines (predominance of α_2 - and β_2 -receptors instead of α_1 as in systemic circulation arterioles); heart also has high protection due to abundant β_2 -receptors in coronary vessels. Thus, during the blood is shifted, literally squeezed, by the mechanism of vasoconstriction from skin and soft tissues first and from visceral organs to follow (gut, liver and lungs with kidney dysfunction) toward heart and brain. Vessels of skin and intestine have almost no β_2 -receptors, only α_1 , making them the first victims of the sympathetic vasoconstriction during hemorrhage, aiming to divert by squeeze the blood toward more important organs and safeguard prioritized functions. Thus, maximal vasoconstriction will be seen in skin, mucosa and gut (bowels), and minimal – in brain and heart. (Bonanno FG. Physiopathology of shock. Journal of Emergencies, Trauma and Shock. 2011;4(2):222–232. doi:10.4103/0974-2700.82210.).

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3132363/>

52. The minute blood volume in a patient with transplanted heart has increased as a result of physical activity. What regulative mechanism is responsible for these changes?

- | | |
|---|---|
| <i>A. Sympathetic unconditioned reflexes.</i> | <i>D. Sympathetic conditioned reflexes.</i> |
| <i>B. Parasympathetic conditioned reflexes.</i> | <i>E. Catecholamines.</i> |
| <i>C. Parasympathetic unconditioned reflexes.</i> | |

Reasoning: Cardiac allografts are denervated such that the sympathetic nervous system is disconnected from the heart, and thus heart activity is not regulated by neural mechanisms but only by hormonal and in case of physical activity by catecholamines. (Physiology. Pre-test. Self-Assessment and Review. 14th Edition. p. 173)

53. In response to a change in body position from horizontal to vertical blood circulation system develops reflectory pressor reaction. Which of the following is its compulsory component?

- | | |
|--|--|
| <i>A. Decrease in the circulating blood volume.</i> | <i>D. Increase in the heart rate.</i> |
| <i>B. Systemic constriction of the venous vessels.</i> | <i>E. Weakening of the pumping ability of heart.</i> |
| <i>C. Systemic dilatation of the arterial resistive vessels.</i> | |

Reasoning: The transition from horizontal to vertical position (*orthostasis*) leads to changes in hydrostatic pressure in the vascular system. The action of gravity makes it difficult to return blood to the heart from the veins to even healthy individuals with paralyzed leg muscles, additional delay of 300 to 800 ml of blood. As a result, venous return and thus cardiac stroke volume are reduced. Consequently, falls impulses from mechanoreceptors of the aorta, carotid sinus, pulmonary artery trunk, leading to an increase in heart rate not more than 20 beats/min. In case of failure of compensatory responses to orthostatic stress developing orthostatic circulatory disorders, dangerous for the brain may develop. Subjectively, it is shown as a dizziness, «darkening» in the eyes, maybe even loss of consciousness. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 130)

54. Introduction of a big dose of histamine to an experimental animal caused abrupt drop of arterial pressure as a result of:

- | | | |
|-----------------------------------|---|---|
| <i>A. Increase of heart rate.</i> | <i>C. Decrease of heart rate and force.</i> | <i>E. Constriction of resistance vessels.</i> |
| <i>B. Decrease of heart rate.</i> | <i>D. Dilatation of resistance vessels.</i> | |

Reasoning: Histamine via H_2 receptors produces relaxation of vascular smooth muscle that is independent of the endothelium. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 142)

55. Vagus branches that innervate heart are being stimulated during an experiment. This caused reduction of heart rate due to the intensification of the following process (through the cell membrane of cardiac pacemaker):

- | | | |
|--|--------------------------------|------------------------------|
| <i>A. Calcium and potassium ion yield.</i> | <i>C. Potassium ion yield.</i> | <i>E. Calcium ion yield.</i> |
| <i>B. Potassium ion entry.</i> | <i>D. Calcium ion entry.</i> | |

Reasoning: Acetylcholine (ACh) released from the vagus nerve binds to the muscarinic (M_2) receptor, leading to the activation, and dissociation of inhibitory G protein heterotrimers. The resulting $\beta\gamma$ -dimer directly activates the G protein coupled inward rectifying potassium (GIRK) channel. Once the ion channel is activated, K^+ ions flow out of the cell and cause it to hyperpolarize. In its hyperpolarized state, the neuron cannot fire action potentials as quickly, which slows the heartbeat slowing pacemaker depolarization, and sinus rate. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016. – P. 122)/

56. A patient with kidney disease has high blood pressure, especially the diastolic one. Hypersecretion of what biologically active substance causes blood pressure rise?

A. Adrenaline. B. Noradrenaline. C. Vasopressin. D. Catecholamines. E. Renin.

Reasoning: The renin-angiotensin-aldosterone mechanism has a major effect upon the cardiovascular system. Renin is an enzyme, although because of its importance in the renin-angiotensin-aldosterone pathway, some sources identify it as a hormone. Specialized cells in the kidneys found in the juxtaglomerular apparatus respond to decreased blood flow by secreting renin into the blood. Renin converts the plasma protein angiotensinogen, which is produced by the liver, into its active form – angiotensin I. Angiotensin I circulates in the blood and is then converted into angiotensin II in the lungs. This reaction is catalyzed by the enzyme angiotensin-converting enzyme (ACE). Angiotensin II is powerful vasoconstrictor substance. As little as *one millionth* of a gram can increase the arterial pressure of a human being 50 mm Hg or more. The effect of angiotensin II is to constrict powerfully the small arterioles. The real importance of angiotensin II is that it normally acts on many of the arterioles of the body at the same time to increase the *total peripheral resistance*, thereby increasing the arterial pressure. (Guyton and Hall, 11th edition, p. 201–202).

57. A month after surgical constriction of rabbit's renal artery the considerable increase of systematic arterial pressure was observed. What of the following regulation mechanisms caused the animal's pressure change?

A. Adrenaline. B. Vasopressin. C. Angiotensin-II. D. Noradrenaline E. Serotonin.

Reasoning: Angiotensin II is powerful vasoconstrictor substance. As little as *one millionth* of a gram can increase the arterial pressure of a human being 50 mm Hg or more. The effect of angiotensin II is to constrict powerfully the small arterioles. The real importance of angiotensin II is that it normally acts on many of the arterioles of the body at the same time to increase the *total peripheral resistance*, thereby increasing the arterial pressure. (Guyton and Hall, 11th edition, p. 201–202).

58. While a 24 year old woman was waiting for tooth extraction, tonus of sympathetic part of autonomic nervous system rose. What reaction will the patient display?

A. Miotic pupils. B. Bronchus constriction. C. Increased frequency of heartbeat. D. Hyperperistalsis. E. Hypersecretion of digestive juices.

Reasoning: Effects of sympathetic supply to the heart:

Adrenalin and noradrenalin stimulate heart activity and cause positive regulatory effects:

- a) Positive inotropic effect - increasing strength of heart contractions;
- b) **Positive chrono-tropic effect – increasing heartbeat rate;**
- c) Positive dromo-tropic effect – increasing heart conductivity;
- d) Positive bathmo-tropic effect – increasing excitability of heart muscle.

Norepinephrine increases permeability of cardiac fiber membrane to Na^+ and Ca^{2+} . (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 739, 924)

59. In course of an experiment the peripheral segment of vagus nerve of an animal was stimulated. The following changes of heart activity were observed:

- A. Increase of frequency and force of heartbeat.
- B. Increased excitability of myocardium.
- C. Increased conduction of excitement through myocardium.
- D. Increased force of heartbeat.
- E. **Reduced heart rate.**

Reasoning: Acetylcholine (ACh) released from the vagus nerve binds to the muscarinic (M_2) receptor, leading to the activation, and dissociation of inhibitory G protein heterotrimers. The resulting $\beta\gamma$ -dimer directly activates the G protein coupled inward rectifying potassium (GIRK) channel. Once the ion channel is activated, K^+ ions flow out of the cell and cause it to hyperpolarize. In its hyperpolarized state, the neuron cannot fire action potentials as quickly, which slows the heartbeat slowing pacemaker depolarization, and sinus rate. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 122).

60. A patient was stung by a bee. Examination revealed that his left hand was hot, pink, edematous, there was a big red blister on the site of sting. What is the leading mechanism of edema development?

- A. Injury of vessels caused by the sting. D. Increased vessel permeability.
 B. Drop of oncotic pressure in tissue. E. Reduced vessel filling.
 C. Drop of osmotic pressure in tissue.

Reasoning: Basophils are real «actories» for production of BAS. Their large granules contain heparin, **histamine**, serotonin, kallikrein, bradykinin and others. Most of these substances are important factors in regulation of **capillaries permeability** and microcirculation in the inflammatory focus. The basophils and mast cells play an exceedingly important role in some types of **allergic reactions** (reactions of hypersensitivity of immediate type). The immunoglobulin E (IgE) type has a special propensity to become attached to mast cells and basophils. Then, during the successive reactions with the specific IgE, the resulting attachment of antigen to antibody causes the mast cell or basophil to rupture and release exceedingly large quantities of histamine, bradykinin, serotonin, heparin, slow-reacting substance of anaphylaxis, and a number of lysosomal enzymes. These cause local vascular and tissue reactions that cause many, if not most, of the allergic manifestations. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 39)

61. A 49 year old woman spent a lot of time standing. As a result of it she got leg edema. What is the most likely cause of the edema?

- A. Decrease in hydrostatic pressure of blood in veins.
 B. Decrease in hydrostatic pressure of blood in arteries.
 C. Increase in hydrostatic pressure of blood in veins.
 D. Increase in oncotic pressure of blood plasma.
 E. Increase in systemic arterial pressure.

Reasoning: Increased capillary filtration results from increases in capillary BP or permeability. Poor venous return, for example, causes pressure to back up into the capillaries. Congestive heart failure and incompetent heart valves can impede venous return from the lungs and cause pulmonary edema. Systemic edema is a common problem when a person is confined to a bed or wheelchair, with insufficient muscular activity to promote venous return. (Stuart Ira Fox Human physiology, ninth edition, p. 763)

62. Atria of an experimental animal were superdistended by blood that resulted in decreased reabsorption of Na^+ and water in renal tubules. This can be explained by the influence of the following factor upon kidneys:

- A. Vasopressin. B. Angiotensin. C. Renin. D. Natriuretic hormone. E. Aldosterone.

Reasoning: Rise in arterial pressure or increased venous return for any other reason leads to increased urine production (increased water and sodium excretion) due to the following mechanism: \uparrow VR \rightarrow stretch receptors of left atrium, aortic arc and carotid sinus are stimulated \rightarrow activate sensory fibers of vagus nerve to the HPT and inhibit ADH secretion and stimulate release of ANP from atria leading to increased excretion of sodium and water. (Stuart Ira Fox Human physiology, ninth edition, p. 436)

63. During fighting a man had a cardiac arrest as a result of a hard blow to the upper region of anterior abdominal wall. Which of the described mechanisms might have provoked the cardiac arrest?

- A. *Parasympathetic conditioned reflexes.* D. *Sympathetic unconditioned reflexes.*
 B. **Parasympathetic unconditioned reflexes.** E. *Peripheric reflexes.*
 C. *Sympathetic conditioned reflexes.*

Reasoning: Pain from the trigger zones (sensitive areas) e.g. larynx, **epigastrium**, pericardium and testis produces severe decrease in HR and even cardiac arrest. These areas are richly supplied by parasympathetic fibers. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 121)

64. A 35-year-old man developed acute heart failure while running for a long time. What changes in ionic composition can be observed in the cardiac muscle?

- A. *Reduction of Na⁺ and Ca²⁺ ions in the myocardium cells.*
 B. *Reduction of Na⁺ and Ca²⁺ ions in the extracellular space.*
 C. **Accumulation of Na⁺ and Ca²⁺ ions in the myocardium cells.**
 D. *Reduction of K⁺ and Mg²⁺ ions in the extracellular space.*
 E. *Accumulation of K⁺ and Mg²⁺ ions in the myocardium cells.*

Reasoning: An excess of calcium ions causes effects almost exactly opposite to those of potassium ions, causing the heart to go toward spastic contraction. This is caused by a direct effect of calcium ions to initiate the cardiac contractile process.

65. A patient with a pathology of the cardiovascular system developed edema of the lower extremities. What is the mechanism of cardiac edema development?

- A. *Increased hydrostatic pressure at the arterial end of the capillary.*
 B. **Increased hydrostatic pressure at the venous end of the capillary.**
 C. *Increased oncotic pressure.*
 D. *Reduced osmotic pressure.*
 E. *Lymph efflux disorder.*

Reasoning: Increased capillary filtration results from increases in capillary BP or permeability. Poor venous return, for example, causes pressure to back up into the capillaries. Congestive heart failure and incompetent heart valves can impede venous return from the lungs and cause pulmonary edema. Systemic edema is a common problem when a person is confined to a bed or wheelchair, with insufficient muscular activity to promote venous return. (Stuart Ira Fox Human physiology, ninth edition, p. 763)

66. An animal experiment is aimed at studying of cardiac cycle. All the heart valves are closed. What phase of cardiac cycle is characterized by this status?

- A. *Protodiastolic period.* C. **Isometric contraction.** E. *Reduced filling.*
 B. *Asynchronous contraction.* D. *Rapid filling.*

Reasoning: The atria repolarize, relax, and remain in diastole for the rest of the cardiac cycle. The ventricles depolarize, generate the QRS complex, and begin to contract. Pressure in the ventricles rises sharply and reverses the pressure gradient between atria and ventricles. The AV valves close as ventricular blood surges back against the cusps. Heart sound S1 occurs at the beginning of this phase and is produced mainly by the left ventricle; the right ventricle is thought to make little contribution. Causes of the sound are thought to include the tensing of ventricular tissues, acceleration of the ventricular wall, turbulence in the blood as it surges against the closed AV valves, and impact of the heart against the chest wall. This phase is called *isovolumetric* because even though the ventricles contract, they do not eject blood yet, and there is no change in their volume. This is because pressures in the aorta (80 mmHg) and pulmonary trunk (10 mmHg) are still greater than the pressures in the respective ventricles and thus oppose the opening of the semilunar valves. **The myocytes exert force, but with all four valves closed, the blood cannot go anywhere.** (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 735–736).

67. Experimental stimulation of the sympathetic nerve branches that innervate the heart caused the increase in force of heart contraction because the membrane of typical cardiomyocytes permitted an increase in:

- A. *Potassium ion entry.* C. *Calcium ion exit.* E. *Calcium and potassium ions exit.*
 B. *Potassium ion exit.* D. **Calcium ion entry.**

Reasoning: Stimulation of the sympathetic nerves releases the hormone *norepinephrine* at the sympathetic nerve endings. The sequence of the developing events is as follows: stimulation of myocardial β -receptors by catecholamines activates the intracellular enzyme adenylate cyclase which accelerates the reaction of 3,3-cyclic adenosine monophosphate formation (cAMP). cAMP activates phosphorylase that causes the breakdown of intramuscular glycogen and production of glucose (energy source for the contracting myocardium). In addition, phosphorylase is required for activation of Ca^{2+} ions that realize excitation-contraction coupling in the myocardium to increase a positive inotropic catecholamine action. Besides, catecholamines increase cell membrane permeability to Ca^{2+} ions facilitating their increased passage from the intercellular spaces into the cell, on the one hand, and mobilization of Ca^{2+} ions from the intracellular depot, on the other.

Effects of sympathetic supply to the heart:

Adrenalin and noradrenalin stimulate heart activity and cause positive regulatory effects:

- a) Positive inotropic effect – increasing strength of heart contractions;
- b) Positive chrono-tropic effect – increasing heartbeat rate;
- c) Positive dromo-tropic effect – increasing heart conductivity;
- d) Positive bathmo-tropic effect – increasing excitability of heart muscle.

Norepinephrine increases permeability of cardiac fiber membrane to Na^+ and Ca^{2+} . (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 739, 924)

68. A 16-year-old female patient has fainted after quickly changing her body position from horizontal to vertical one. Which process from the ones listed below has caused the loss of consciousness in the first place?

- A. *Increasing venous return.*
- B. *Decreasing venous return.*
- C. *Increasing arterial pressure.*
- D. *Increasing central venous pressure.*
- E. *Decreasing oncotic pressure of blood plasma.*

Reasoning: The transition from horizontal to vertical position (*orthostasis*) leads to changes in hydrostatic pressure in the vascular system. The action of gravity makes it difficult to return blood to the heart from the veins to even healthy individuals with paralyzed leg muscles, additional delay of 300 to 800 ml of blood. As a result, venous return and thus cardiac stroke volume are reduced. Consequently, falls impulses from mechanoreceptors of the aorta, carotid sinus, pulmonary artery trunk, leading to an increase in heart rate not more than 20 beats/min. In case of failure of compensatory responses to orthostatic stress developing orthostatic circulatory disorders, dangerous for the brain may develop. Subjectively, it is shown as a dizziness, «darkening» in the eyes, maybe even loss of consciousness. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov: KhNMU, 2016 – p. 130).

69. Dentists commonly practice local anaesthetization by applying Novocain solution with 0,1 % adrenalin solution. The added adrenalin induces:

- A. *Arterial pressure drop.*
- B. *Arterial pressure rise.*
- C. ***Local vasoconstriction.***
- D. *Local vasodilatation.*
- E. *Decrease in vascular resistance.*

Reasoning: Circulating Norepinephrine Causes:

- Increased heart rate (although only transiently) and increased inotropy (β_1 -adrenoceptor mediated) are the direct effects norepinephrine on the heart.
- Vasoconstriction occurs in most systemic arteries and veins (postjunctional α_1 adrenoceptors). (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 129)

70. As a result of a rapid change from horizontal to vertical body position a 16-year-old girl lost consciousness. What is the reason for it?

- A. *Heart rate decrease.*
- B. *Arterial pressure rise.*
- C. ***Decreased venous return.***
- D. *Increased venous return.*
- E. *–.*

Reasoning: The transition from horizontal to vertical position (*orthostasis*) leads to changes in hydrostatic pressure in the vascular system. The action of gravity makes it difficult to return

venous blood to the heart from the veins to even healthy individuals with paralyzed leg muscles, additional delay of 300 to 800 ml of blood. As a result, venous return and thus cardiac stroke volume are reduced. Consequently, falls impulses from mechanoreceptors of the aorta, carotid sinus, pulmonary artery trunk, leading to an increase in heart rate not more than 20 beats/min. In case of failure of compensatory responses to orthostatic stress developing orthostatic circulatory disorders, dangerous for the brain may develop. Subjectively, it is shown as a dizziness, «darkening» in the eyes, maybe even loss of consciousness. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 130).

71. In course of an experiment researchers stimulate a branch of a sympathetic nerve that innervates heart. What changes in cardiac activity should be registered?

- | | |
|------------------------------------|--|
| <i>A. Decrease in heart force.</i> | <i>D. Increase in arterial pressure.</i> |
| <i>B. Increase in heart rate.</i> | <i>E. Increase in heart rate and heart force.</i> |
| <i>C. Increase in heart force.</i> | |

Reasoning: Stimulation of the sympathetic nerves releases the hormone *norepinephrine* at the sympathetic nerve endings. The sequence of the developing events is as follows: stimulation of myocardial β -receptors by catecholamines activates the intracellular enzyme adenylate cyclase which accelerates the reaction of 3,3-cyclic adenosine monophosphate formation (cAMP). cAMP activates phosphorylase that causes the breakdown of intramuscular glycogen and production of glucose (energy source for the contracting myocardium). In addition, phosphorylase is required for activation of Ca^{2+} ions that realize excitation-contraction coupling in the myocardium to increase a positive inotropic catecholamine action. Besides, catecholamines increase cell membrane permeability to Ca^{2+} ions facilitating their increased passage from the intercellular spaces into the cell, on the one hand, and mobilization of Ca^{2+} ions from the intracellular depot, on the other.

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Norepinephrine increases permeability of cardiac fiber membrane to Na^+ and Ca^{2+} . (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 739, 924)

72. A student who unexpectedly met his girlfriend developed an increase in systemic arterial pressure. This pressure change was caused by the intensified realization of the following reflexes:

- | | |
|---|--|
| <i>A. Unconditional parasympathetic.</i> | <i>D. Conditional parasympathetic.</i> |
| <i>B. Unconditional sympathetic.</i> | <i>E. Conditional sympathetic and parasympathetic.</i> |
| <i>C. Conditional sympathetic.</i> | |

Reasoning: Central nervous system mechanisms function to initiate, coordinate, and anticipate autonomic responses. They also provide set points and adapt them to circumstances when that is warranted by Hierarchy of Central Autonomic Control **Limbic cortex and amygdala** – these very high centers function both as a brake on automatic responses that may accompany emotional states, such as fear, rage, embarrassment, or sexual desire, and as direct activators of the system. The latter is seen prominently in two circumstances: (1) in the responses of blood pressure, sweat glands, or genitalia to dreams and fantasies and (2) in the volitional control of resting autonomic functions during states of deep meditation. In this state, metabolic rate, heart rate, arterial blood pressure, and distribution of blood flow can all be modified by application of conscious mental effort. Autonomic responses that are coordinated at this high CNS level are physically and emotionally complete whole-body responses in that they include the subjective feelings of fear, joy, pleasure, and pain. (Ackermann PDQ Physiology, p. 102–103)

73. In the solution being used for perfusing the isolated heart of rat, the K^+ concentration has been increased to 8 mmol/l. What changes in the heart are to be expected?

A. There will be no changes. C. Heart rate increase. E. Heart force increase.

B. Diastolic arrest. D. Systolic arrest.

Reasoning: In hyperkalemia the membrane potential becomes less negative, therefore in first phase of hyperkalemia it is easier to induce stimuli. The excitability is increased, arrhythmias can occur, patients have paresthesias. In severe hyperkalemia is the membrane potential even less negative, sodium channels stay inactive and second phase of hyperkalemia comes with muscle weakness, paralysis, bradycardia and QRS widening on ECG. In case of extreme hyperkalemia the whole process can end with ventricular fibrillation or the heart stops in diastole (asystole). (Saladin K.S. Anatomy and physiology 3rd edition, 2003, p. 739, 924)

74. A patient with hypertensive crisis has increased content of angiotensin II in blood. Angiotensin pressor effect is based on:

A. Activation of kinin-kallikrein system. D. Activation of biogenic amine synthesis.

B. Prostaglandin hypersecretion. E. Vasopressin production stimulation.

C. Contraction of arteriole muscles.

Reasoning: Angiotensin II is powerful vasoconstrictor substance. As little as *one millionth* of a gram can increase the arterial pressure of a human being 50 mm Hg or more. The effect of angiotensin II is to constrict powerfully the small arterioles. The real importance of angiotensin II is that it normally acts on many of the arterioles of the body at the same time to increase the *total peripheral resistance*, thereby increasing the arterial pressure. (Guyton and Hall, 11th edition, p. 201–202).

75. A patient with constant headaches, pain in the occipital region, tinnitus, dizziness has been admitted to the cardiology department. Objectively: AP – 180/110mm Hg, heart rate – 95/min. Radiographically, there is a stenosis of one of the renal arteries. Hypertensive condition in this patient has been caused by the activation of the following system:

A. Renin-angiotensin. B. Hemostatic. C. Sympathoadrenal. D. Kinin. E. Immune.

Reasoning: Angiotensin II is powerful vasoconstrictor substance. As little as *one millionth* of a gram can increase the arterial pressure of a human being 50 mm Hg or more. The effect of angiotensin II is to constrict powerfully the small arterioles. The real importance of angiotensin II is that it normally acts on many of the arterioles of the body at the same time to increase the *total peripheral resistance*, thereby increasing the arterial pressure. (Guyton and Hall, 11th edition, p. 201–202).

76. Patient's systolic blood pressure is 90 mm Hg, diastolic – 70 mm Hg. Such blood pressure is caused by decrease of the following factor:

A. Pumping ability of the left heart. D. Total peripheral resistance.

B. Pumping ability of the right heart. E. Vascular tone.

C. Aortic compliance.

Reasoning: The systolic pressure is the higher value (typically around 120 mm Hg) and reflects the arterial pressure resulting from the ejection of blood during ventricular contraction, or systole (left ventricle). The diastolic pressure is the lower value (usually about 80 mm Hg) and represents the arterial pressure of blood during ventricular relaxation, or diastole (left ventricle). (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 99).

77. Due to blood loss the circulating blood volume of the patient decreased. How will it affect the blood pressure in this patient?

A. Systolic pressure will decrease while diastolic will increase.

B. Only systolic pressure will decrease.

C. Diastolic pressure will decrease while systolic will increase.

D. Systolic and diastolic pressure will decrease.

E. Only diastolic pressure will decrease.

Reasoning: Both systolic and diastolic pressures depend on blood volume. Low blood volume, called *hypovolemia*, may be caused by bleeding, dehydration, vomiting, severe burns, or some medications used to treat hypertension. It is important to recognize that other regulatory mechanisms in the body are so effective at maintaining blood pressure that an individual may be asymptomatic until 10–20 percent of the blood volume has been lost. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – P. 104).

78. Vascular endothelium is characterized by high metabolic activity and synthesizes vasoactive substances. Among these substances there is a potent vasodilator synthesized from L-arginine. Name this vasodilator.

A. *Bradykinin.* B. *Histamine.* C. ***Nitrogen oxide.*** D. *Adrenaline* E. *Acetylcholine.*

Reasoning: NO is synthesized from arginine in a reaction catalyzed by nitric oxide synthase (NO synthase, NOS). The NO that is formed in the endothelium diffuses to smooth muscle cells, where it activates soluble guanylyl cyclase, producing cyclic 3,5-guanosine monophosphate, which in turn mediates the relaxation of vascular smooth muscle. NO is inactivated by hemoglobin. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov: KhNMU, 2016 – p. 133).

79. A test animal receives electrical impulses that irritate the sympathetic nerve that innervates blood vessels of the skin. What reaction will it cause in the blood vessels?

A. ***Arterial and venous constriction.*** D. *No reaction.*
B. *Arterial and venous dilation.* E. *Arterial dilation.*
C. *Venous dilation.*

Reasoning: Sympathetic noradrenergic fibers end on blood vessels in all parts of the body to mediate vasoconstriction. When the sympathetic nerves are cut (sympathectomy), the blood vessels dilate. In most tissues, vasodilation is produced by decreasing the rate of tonic discharge in the vasoconstrictor nerves, although in skeletal muscles it can also be produced by activating the sympathetic cholinergic vasodilator system. Vasoconstriction and a decrease in the stores of blood in the venous reservoirs usually accompany increases in arteriolar constriction, although changes in the capacitance vessels do not always parallel changes in the resistance vessels. In the presence of an increase in sympathetic nerve activity to the heart and vasculature, there is usually an associated decrease in the activity of vagal fibers to the heart. Conversely, a decrease in sympathetic activity causes vasodilation, a fall in blood pressure, and an increase in the storage of blood in the venous reservoirs. There is usually a concomitant decrease in heart rate, but this is mostly due to stimulation of the vagal innervation of the heart. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov: KhNMU, 2016 – p. 133).

80. During the prestart period an athlete develops increased frequency and force of cardiac contraction. These changes are caused by intensification of the following reflex responses:

A. *Sympathetic unconditioned.* D. *Parasympathetic unconditioned.*
B. *Parasympathetic conditioned.* E. ***Sympathetic conditioned.***
C. *Peripheral.*

Reasoning: Central nervous system mechanisms function to initiate, coordinate, and anticipate autonomic responses. They also provide set points and adapt them to circumstances when that is warranted by Hierarchy of Central Autonomic Control. **Limbic cortex and amygdala** – these very high centers function both as a brake on automatic responses that may accompany emotional states, such as fear, rage, embarrassment, or sexual desire, and as direct activators of the system. The latter is seen prominently in two circumstances: (1) in the responses of blood pressure, sweat glands, or genitalia to dreams and fantasies and (2) in the volitional control of resting autonomic functions during states of deep meditation. In this state, metabolic rate, heart rate, arterial blood pressure, and distribution of blood flow can all be modified by application of conscious mental effort. Autonomic responses that are coordinated at this high CNS level are physically and emotionally complete whole-body responses in that they include the subjective feelings of fear, joy, pleasure, and pain. (Ackermann PDQ Physiology, p. 102–103)

81. After a traffic accident a man presents with severe blood loss, consciousness disturbance, low blood pressure, as well as compensatory activation of the renin-angiotensin system, which results in:

A. ***Hyperproduction of aldosterone.*** D. *Intensification of heart contractions.*
B. *Increased blood coagulation.* E. *Hyperproduction of vasopressin.*
C. *Intensification of erythropoiesis.*

Reasoning: The renin-angiotensin-aldosterone mechanism has a major effect upon the cardiovascular system. Renin is an enzyme, although because of its importance in the renin-angiotensin-aldosterone pathway. Specialized cells in the kidneys found in the juxtaglomerular apparatus respond to decreased blood flow by secreting renin into the blood. Renin converts the plasma protein angiotensinogen, which is produced by the liver, into its active form – angiotensin I. Angiotensin I circulates in the blood and is then converted into angiotensin II in the lungs. This reaction is catalyzed by the enzyme angiotensin-converting enzyme (ACE). Angiotensin II is a powerful vasoconstrictor, greatly increasing blood pressure. It also stimulates the release of aldosterone, a hormone produced by the adrenal cortex. Aldosterone increases the reabsorption of sodium into the blood by the kidneys. Since water follows sodium, this increases the reabsorption of water. This in turn increases blood volume, raising blood pressure. Angiotensin II also stimulates the thirst center in the hypothalamus, so an individual will likely consume more fluids, again increasing blood volume and pressure. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov: KhNMU, 2016 – p. 143).

82. In the course of experiment the vagus nerve of the test animal was severed, which resulted in the animal developing constant tachycardia. What effect of parasympathetic nervous system on cardiac performance is demonstrated by this experiment?

A. Stimulation.

C. Mixed effect.

E. Stimulus summation.

B. Inhibition.

D. Paradoxical response.

Reasoning: *Vagus tone:* During rest vagus nerve continuously discharges and sends inhibitory impulses to the heart to suppress the high rhythm of S–A node (from 110–120 beat / min to 70 beat/min), this is called **vagus tone**.

Mechanism of vagus tone: at the rest state the tone of parasympathetic nervous system little bit higher than sympathetic; this is the cause of maintenance of HR and ABP at the optimal range.

Receptors: baroreceptors (or pressure receptors) are localized in carotid sinus and aortic arch.

Afferents: through sinus nerve which is a branch of glossopharyngeal nerve (IX) and aortic nerve which is a branch of vagus nerve (X).

Centre: Cardiac Inhibitory Center.

Efferent: vagus nerve which reduces the high rhythm of SA node.

Proof: Cutting of both vagi in animal result in rise of HR (from 70 to 120 bpm). Stimulation of the cut end of vagus leads to reduction of HR.

Vagus tone is higher: In man more than women, in athletes more than in nonathletic, and in adult more than children.

Physiological significance of vagus tone: Vagus tone reduces HR from 120 to 70 beat/min. This reduction in HR is a reserve to be used at times of need as in muscular exercise.

(Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov: KhNMU, 2016 – p. 123).

83. It is necessary to decrease pumping ability of the patient's heart. What membrane cytoceptors must be blocked to achieve this effect?

A. β -adrenergic receptors.

D. α -adrenergic receptors.

B. Nicotinic acetylcholine receptors.

E. α - and β -adrenergic receptors.

C. Muscarinic acetylcholine receptors.

Reasoning: Stimulation of the sympathetic nerves releases the hormone *norepinephrine* at the sympathetic nerve endings stimulating myocardial β -adrenergic receptors resulting in positive regulatory effects:

a) Positive inotropic effect – increasing strength of heart contractions;

b) Positive chrono-tropic effect – increasing heartbeat rate;

c) Positive dromo-tropic effect – increasing heart conductivity;

d) Positive bathmo-tropic effect – increasing excitability of heart muscle.

Thus blockage of β 1-adrenergic receptors will result in reduction of the pumping ability of the patient's heart. (Physiology of visceral systems: manual for second-year students of medical faculty (English-medium) / compilers: D.I. Marakushin, L.V. Chernobay, I.S. Karmazina, I.N. Isaeva etc. – Kharkov : KhNMU, 2016 – p. 124–125).

Physiology of respiration system

1. Spasm of smooth muscle of bronchi developed in the patient. Usage of activators of what membrane cytoceptors is physiologically valid to decrease attack?

- A. α - and β -adrenoreceptors. C. β -adrenoreceptors. E. N-cholinoreceptors.
B. α -adrenoreceptors. D. M-cholinoreceptors.

Explanation: Spasm of smooth muscle of bronchi is a parasympathetic effect caused by activation of M_3 cholinergic receptors. Thus, it can be relieved by inhibition of M_3 -cholinergic receptors or by activation of β_2 – adrenoreceptors (Kaplan Medical USMLE Step 1 Pharmacology Lecture Notes, p. 57).

2. Lung of premature infant is presented on electronic photomicrography of biopsy material. Collapse of the alveolar wall caused by the deficiency of surfactant was revealed. Disfunction of what cells of the alveolar wall caused it?

- A. Alveocytes type I. C. Secretory cells. E. Alveolocytes type II.
B. Alveolar macrophagcs. D. Fibroblasts.

Explanation: Surfactant is a detergent-like lipoprotein that forms a thin film on the insides of the alveoli and bronchiole that decreases surface tension and prevents collapse of alveoli. Surfactant is produced by alveolocytes type II (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 849, 855).

3. Child asked you to puff up the balloon as much as possible for a one exhalation. What air volume will you use?

- A. **Vital volume of the lungs.** D. *Inspiration volume.*
B. *Total volume of the lungs.* E. *Functional residual volume.*
C. *Backup volume of the inspiration.*

Explanation: Vital volume (vital capacity) of lungs is the amount of air that can be exhaled with maximum effort after maximum inspiration (tidal volume TV + inspiratory reserve volume IRV + + expiratory reserve volume ERV) (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 856).

4. The alveolar ventilation of the patient is 5 L/min, the breath frequency is 10 per/min, and the tidal volume is 700 ml. What is the patient's dead space ventilation?

- A. 0,7 L/min. B. 4,3 L/min. C. –. D. 2,0 L/min. E. 1,0L/min.

Explanation: Alveolar ventilation can be calculated by following equation: $V_A = RR \times (V_T - V_D)$, where V_A – alveolar ventilation, RR – respiratory rate, V_T – tidal volume, V_D – dead space volume. Dead space ventilation is the volume of air that passes through dead space per minute ($V_D \times RR$). Therefore:

$$V_A = RR \times (V_T - V_D)$$

$$V_A = RR \times V_T - RR * V_D$$

$RR \times V_D$ (dead space ventilation) = $RR \times V_T - V_A = 10 \times 700 - 5000 = 2000 \text{ ml/min} = 2,0 \text{ l/min}$ (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit VII Respiration, p. 477–478).

5. A patient after pathological process has a thickened alveolar membrane. The direct consequence of the process will be the reduction of:

- A. **Diffuse lung capacity.** D. *Alveolar lung ventilation.*
B. *Reserve expiratory capacity.* E. *Oxygen capacity of blood.*
C. *Minute respiratory capacity.*

Explanation: Main function of alveolar (respiratory) membrane is to provide adequate diffusion of oxygen from the alveolus into the red blood cell and diffusion of carbon dioxide in the opposite direction. Rate of diffusion of gases through alveolar membrane is inversely proportional to the thickness of the membrane, and any factor that increases the thickness to more than two to three times normal can interfere significantly with normal respiratory exchange of gases (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit VII Respiration, p. 497–498).

6. Intrapleural pressure is being measured in a person. In what phase does a person hold his breath if the pressure is -25 cm of water?

- A. *Forced expiration.* C. *–.* E. *Quiet expiration.*
B. *Quiet inspiration.* D. *Forced inspiration.*

Explanation: Intrapleural pressure changes in different phases of respiratory cycle: quiet inspiration = -6 mm Hg ($-7,5$ mm of H_2O), quiet expiration = -3 mm Hg (-5 mm of water), forced inspiration = -20 mm Hg (-25 mm of water) and forced expiration = $0 - +3$ mm Hg.

7. Part of alveoles of a preterm infant didn't spread because of enhanced elastic recoil of lungs. How can this recoil be reduced?

- A. *By fluid suction from the respiratory tracts.* D. *By artificial pulmonary ventilation.*
B. *By glyose introduction.* E. *By pure oxygene inhalation.*
C. *By surfactant introduction.*

Explanation: Surfactant is a detergent-like lipoprotein that forms a thin film on the insides of the alveoli and bronchiole that decreases surface tension and prevents collapse of alveoli. Surfactant is produced by alveolocytes type II. Deficiency of surfactant in newborns causes respiratory distress syndrome that is treated by surfactant introduction (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 849, 855).

8. A man took a quiet expiration. Name an air volume that is meanwhile contained in his lungs:

- A. *Expiratory reserve volume.* D. *Vital lung capacity.*
B. *Functional residual capacity.* E. *Respiratory volume.*
C. *Residual volume.*

Explanation: After a quiet expiration in lungs the functional residual capacity is left – amount of air remaining in the lungs after a normal tidal expiration (residual volume RV +expiratory reserve volume ERV) (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 856).

9. A group of mountain climbers went through the blood analysis at the height of 3000 m. It revealed decrease of HCO_3^- to 15 micromole/l (standard is 22–26 μ mole/l). What is the mechanism of HCO_3^- decrease?

- A. *Intensification of acidogenesis.* D. *Decrease of bicarbonate reabsorption in kidneys.*
B. *Hypoventilation.* E. *Decrease of ammoniogenesis.*
C. *Hyperventilation.*

Explanation: At high altitudes, the partial pressures of all atmospheric gases including O_2 are lower. The O_2 gradient from air to blood is proportionately less, and less O_2 diffuses into the blood. This causes increase of respiratory rate and depth (hyperventilation) and leads to increased elimination of CO_2 , that is shown in decrease of HCO_3^- in blood (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 861).

10. A man's intrapleural pressure is being measured. In what phase did the man hold his breath, if his pressure is $-7,5$ mm Hg?

- A. *Forced expiration.* C. *–.* E. *Forced inspiration.*
B. *Quiet inspiration.* D. *Quiet expiration.*

Explanation: Intrapleural pressure changes in different phases of respiratory cycle: quiet inspiration = -6 mm Hg ($-7,5$ mm of H_2O), quiet expiration = -3 mm Hg (-5 mm of water), forced inspiration = -20 mm Hg (-25 mm of water) and forced expiration = $0 - +3$ mm Hg.

11. Vagi of an experimental animal were cut on both sides. What respiration changes will be observed?

- A. *It will become shallow and frequent.* D. *It will become deep and infrequent.*
B. *It will become shallow and infrequent.* E. *It will become deep and frequent.*
C. *No changes will be observed.*

Explanation: Stretch receptors of the walls of the bronchi and bronchioles transmit signals through the vagi into the dorsal respiratory group of neurons when the lungs become

overstretched. These signals «switch off» the inspiratory center and thus stop further inspiration. Thus, if nn. vagi are cut, respiration will become deeper and also less frequent (to maintain adequate O₂ and CO₂ concentrations) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 516).

12. A 35 year old man got an injury that caused complete disruption of spinal cord at the level of the first cervical segment. What respiration changes will be observed?

- A. *No changes will be observed.*
- B. *It will become infrequent and deep.*
- C. *Thoracic respiration will be maintained, diaphragmal respiration will disappear.*
- D. ***It will come to a standstill.***
- E. *Diaphragmal respiration will be maintained, thoracic respiration will disappear.*

Explanation: Spinal cord innervates respiratory muscles: C3–C5 = diaphragm, Th2–Th6 – external intercostal muscles, Th1–Th6 – internal intercostal muscles. Complete disruption of spinal cord at C1 leads to absence of innervation of all respiratory muscles, thus respiration will stop.

13. A patient has a transverse disruption of spinal cord below the IV thoracic segment. What changes of respiration will it cause?

- A. *Respiration will stop.*
- B. *Respiration will become less frequent.*
- C. *Respiration will become deeper.*
- D. *Respiration will become more frequent.*
- E. ***Respiration will stay unchanged.***

Explanation: Spinal cord innervates respiratory muscles: C3–C5 = diaphragm, Th2–Th6 – external intercostal muscles, Th1–Th6 – internal intercostal muscles. Complete disruption of spinal cord below Th4 saves the innervation of inspiratory muscles, thus respiration will not change significantly.

14. Lung ventilation in a person is increased as a result of physical activity. Which of the following indices of the external respiration is much higher than in a state of rest?

- A. *Inspiratory reserve volume.*
- B. *Expiratory reserve volume.*
- C. *Total lung capacity.*
- D. ***Respiratory volume.***
- E. *Vital capacity of lungs.*

Explanation: During physical exercises sympathetic nervous system causes dilation of bronchi, therefore, respiratory volume (tidal volume) that a person inhales and exhales increases.

15. If a man has an attack of bronchospasm it is necessary to reduce the effect of vagus on smooth muscles of bronchi. What membrane cytoceptors should be blocked for this purpose?

- A. *N-cholinoreceptors.*
- B. ***M-cholinoreceptors.***
- C. *α-adrenoreceptors.*
- D. *β-adrenoreceptors.*
- E. *α- and β-adrenoreceptors.*

Explanation: Spasm of smooth muscle of bronchi is a parasympathetic effect caused by activation of M₃ cholinergic receptors. Thus, it can be relieved by blockage of M₃-cholinergic receptors or by activation of β₂ – adrenoreceptors (Kaplan Medical USMLE Step 1 Pharmacology Lecture Notes, p. 57).

16. A doctor asked a patient to breathe out fully after taking a normal breath. What muscles contract during such exhalation?

- A. ***Abdominal muscles.***
- B. *Trapezius muscles.*
- C. *Pectoral muscles.*
- D. *External intercostal muscles.*
- E. *Diaphragm.*

Explanation: Respiratory muscles include: for quiet inspiration = external intercostal and diaphragm; for forced inspiration = external intercostal, diaphragm, pectoral, scalene, sternocleidomastoid; quiet expiration is passive – doesn't require any muscles; for forced expiration = internal intercostal and abdominal. For breathing out fully it's necessary to contract abdominal muscles.

17. Voluntary breath-holding caused increase of respiration depth and frequency. The main factor stimulating these changes of external respiration is:

- A. *Decreased concentration of H⁺ in blood.*
- B. *Decreased tension of O₂ in blood.*
- C. *Decreased tension of CO₂ in blood.*
- D. ***Increased tension of CO₂ in blood.***
- E. *Increased tension of O₂ in blood.*

Explanation: CO² is the main stimulator of respiration because it stimulates both central chemoreceptors (in medulla) and peripheral chemoreceptors (in aortic and carotid body) leading to increase of respiration rate and depth. The same effect is seen when H⁺ ions increase. O₂ concentration stimulates only peripheral chemoreceptors, thus its effect on respiration is less (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 517–518).

18. Lungs of a preterm infant have areas of atelectasis (pulmonary collapse). The main cause is:

- A. *Underdeveloped inspiration muscles.* D. *Increased viscous resistance.*
 B. *Diminished force of surface tension of lungs.* E. *Surfactant excess.*
 C. **Surfactant deficiency.**

Explanation: Surfactant is a detergent-like lipoprotein that forms a thin film on the insides of the alveoli and bronchiole that decreases surface tension and prevents collapse of alveoli. Surfactant is produced by alveolocytes type II. Deficiency of surfactant in newborns causes respiratory distress syndrome that is treated by surfactant introduction (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 849, 855).

19. A young woman who entered a production department where it strongly smelt of paints and varnishes had a bronchospasm. This reflex was caused by irritation of the following receptors:

- A. *Juxtaglomerular.* C. **Irritant.** E. *Central chemoreceptors.*
 B. *Peripheral chemoreceptors.* D. *Pleura receptors.*

Explanation: The epithelium of the trachea, bronchi, and bronchioles is supplied with sensory nerve endings called pulmonary irritant receptors that are stimulated by many incidents (dust, strong smell, etc.). Their irritation causes coughing and sneezing, and may also cause bronchial constriction in such diseases as asthma and emphysema (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 517–521).

20. A man has trauma of greater pectoral muscle. What index' decrease will it cause?

- A. *Functional residual lung capacity.* D. **Inspiratory reserve volume.**
 B. *Residual volume.* E. *Respiratory volume.*
 C. *Expiratory reserve volume.*

Explanation: Respiratory muscles include: for quiet inspiration = external intercostal and diaphragm; for forced inspiration = external intercostal, diaphragm, pectoral, scalene, sternocleidomastoid; quiet expiration is passive – doesn't require any muscles; for forced expiration = internal intercostal and abdominal. Trauma of pectoral muscle will decrease forced inspiration (inspiratory reserve volume).

21. A patient has a transverse laceration of spinal cord below the VI thoracal segment. How will it change the character of breathing?

- A. *It will stop.* C. *It will become more deep.* E. **It won't change essentially.**
 B. *It will become more rare.* D. *It will become more frequent.*

Explanation: Spinal cord innervates respiratory muscles: C3–C5 = diaphragm, Th2–Th6 – external intercostal muscles, Th1–Th6 – internal intercostal muscles. Complete disruption of spinal cord below Th6 saves the innervation of inspiratory muscles, thus respiration will not change significantly.

22. A man has been holding his breath for 60 seconds. After that the respiratory minute volume has increased up to 12 L. What blood change is the main reason for the increase of respiratory minute volume?

- A. *Increase of pH.* C. **Increase of pCO₂.** E. *Increase of pO₂.*
 B. *Decrease of pO₂.* D. *Decrease of pCO₂.*

Explanation: After breath holding there are decrease of O₂ and increase of CO₂ and H⁺ in blood. CO₂ is the main stimulator of respiration because it stimulates both central chemoreceptors (in medulla) and peripheral chemoreceptors (in aortic and carotid body) leading to increase of respiration rate and depth. The same effect is seen when H⁺ ions increase. O₂ concentration stimulates only peripheral chemoreceptors, thus its effect on respiration is less (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 517–518).

23. A patient has a traumatic injury of sternocleidomastoid muscle. This has resulted in decrease in the following value:

- A. *Residual volume.* C. ***Inspiratory reserve volume.*** E. *Respiratory volume.*
B. *Expiratory reserve volume.* D. *Functional residual lung capacity.*

Explanation: Respiratory muscles include: for quiet inspiration = external intercostal and diaphragm; for forced inspiration = external intercostal, diaphragm, pectoral, scalene, sternocleidomastoid; quiet expiration is passive – doesn't require any muscles; for forced expiration = internal intercostal and abdominal. Trauma of sternocleidomastoid muscle will decrease forced inspiration (inspiratory reserve volume).

24. When studying the signs of pulmonary ventilation, reduction of forced expiratory volume has been detected. What is the likely cause of this phenomenon?

- A. *Increase of functional residual lung capacity.* D. *Increase of inspiratory reserve volume.*
B. *Increase of pulmonary residual volume.* E. ***Obstructive pulmonary disease.***
C. *Increase of respiratory volume.*

Explanation: Obstructive disorders narrow the airways and interfere with airflow; thus, expiration either requires more effort or is less complete than normal. Airflow is measured by having the subject exhale as rapidly as possible into a spirometer and measuring forced expiratory volume. Therefore, decrease of forced expiratory volume is a sign of obstructive disease of lungs (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 856).

25. A female patient, having visited the factory premises with lots of dust in the air for the first time, has got cough and burning pain in the throat. What respiratory receptors, when irritated, cause this kind of reaction?

- A. *Thermoreceptors.* C. ***Irritant receptors.*** E. *Proprioceptors of*
B. *Juxtacapillary (J) receptors.* D. *Stretch receptors of lungs.* *respiratory muscles.*

Explanation: The epithelium of the trachea, bronchi, and bronchioles is supplied with sensory nerve endings called pulmonary irritant receptors that are stimulated by many incidents (dust, strong smell, etc.). Their irritation causes coughing and sneezing, and may also cause bronchial constriction in such diseases as asthma and emphysema (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 517–521).

26. During auscultation a 26-year-old patient was asked to breathe deep. After 10 breaths the patient lost consciousness, which is associated with the development of the following condition:

- A. *Carbon dioxide acidosis.* C. *Polycythemia.* E. *Erythropenia.*
B. ***Respiratory alkalosis.*** D. *Reduced oxygen capacity of blood.*

Explanation: Increase of respiratory rate and depth (hyperventilation) leads to increased elimination of CO₂ that leads to decrease of H⁺ in blood and causes respiratory alkalosis (H⁺ binds with HCO₃⁻ to form carbonic acid that dissociates into CO₂ and H₂O). Alkalosis and hypocapnia cause constriction of vessels in brain leading to loss of consciousness (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 517–518).

27. The air in a room has increased concentration of carbonic acid. What respiratory changes (depth and rate) will be observed in a person after entering this room?

- A. *Decrease in depth.* C. *Increase in rate.* E. ***Increase in depth and rate.***
B. *Decrease in rate.* D. *Increase in depth.*

Explanation: Carbonic acid dissociates into CO₂ that is the main stimulator of respiration because it stimulates both central chemoreceptors (in medulla) and peripheral chemoreceptors (in aortic and carotid body) leading to increase of respiration rate and depth. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 517–518).

28. A man who has been staying in a stuffy room for a long time lost consciousness. He regained consciousness after inhalation of ammonia spirit vapour. This substance's effect is connected with direct influence upon the following structures:

- A. *Respiratory centre.* C. **Receptors of upper airways.** E. *Capacitive vessels.*
 B. *Vasculomotor centre.* D. *Resistive vessels.*

Explanation: Ammonia spirit is a reflex respiratory stimulant that acts by causing peripheral irritation of the sensory receptors of upper airways, esophageal mucosa, and fundus of the stomach.

29. A man is in the state of rest. He has been forcing himself to breathe deeply and frequently for 3–4 minutes. What effect will it have upon acid-base balance of the organism?

- A. *Metabolic alkalosis.* D. **Respiratory alkalosis.**
 B. *Metabolic acidosis.* E. *There will be no change in acid-base balance.*
 C. *Respiratory acidosis.*

Explanation: Increase of respiratory rate and depth (hyperventilation) leads to increased elimination of CO₂ that leads to decrease of H⁺ in blood and causes respiratory alkalosis (H⁺ binds with HCO₃⁻ to form carbonic acid that dissociates into CO₂ and H₂O). Alkalosis and hypocapnia cause constriction of vessels in brain leading to loss of consciousness (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 517–518).

30. There is a strict time limit for people to stay at a height of 8000 m above sea level without oxygen cylinders. Specify the life-limiting factor in this case:

- A. *Humidity rate.* C. *Earth gravity.* E. **Partial pressure of oxygen in air.**
 B. *Temperature.* D. *Rate of ultraviolet radiation.*

Explanation: At high altitudes, the partial pressures of all atmospheric gases including O₂ are lower. The O₂ gradient from air to blood is proportionately less, and less O₂ diffuses into the blood. At height of 8000 m above the sea level partial pressure of O₂ is so low that staying without oxygen cylinders will lead to hypoxia (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 861).

31. A group of students who were climbing up a mountain presented with euphoria, tachypnea, tachycardia. Specify the immediate reason for hypocapnia accompanying mountain sickness:

- A. *Erythrocytosis.* D. **Increase in respiration rate and depth.**
 B. *Anaemia.* E. *Decrease in respiration depth.*
 C. *Increase in heart rate.*

Explanation: At high altitudes, the partial pressures of all atmospheric gases including O₂ are lower. The O₂ gradient from air to blood is proportionately less, and less O₂ diffuses into the blood. This causes increase of respiratory rate and depth (hyperventilation) and tachycardia, and leads to increased elimination of CO₂ (hypocapnia) (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 861).

32. An unconscious young man with signs of morphine poisoning entered admission office. His respiration is shallow and infrequent which is caused by inhibition of respiratory centre. What type of respiratory failure is it?

- A. *Ventilative obstructive.* C. **Ventilative dysregulatory.** E. *Diffusive.*
 B. *Ventilative restrictive.* D. *Perfusive.*

Explanation: Morphine inhibits respiratory center (inhibition of regulative apparatus) without influencing state of airways (obstructive failure), vessels (perfusion failure) lungs or alveolar membrane (restrictive and diffusive failure).

33. When water affects mucous membrane of the inferior nasal meatuses, this causes “diver reflex” that provokes:

- A. *Bronchospasm.* C. *Reflectory hyperpnea.* E. *Cough.*
 B. *Reflectory dyspnea.* D. **Reflectory apnea.**

Explanation: Diver reflex (apnoe reflex) is apnea caused by closure of larynx by epiglottis to prevent passage of water into the airways when the water triggers receptors of lower nasal meatus.

34. To assess the effectiveness of breathing in patients, the indicator of functional residual capacity is used. It includes the following volumes:

A. *Inspiratory reserve volume, tidal volume, residual volume.*

B. *Inspiratory reserve volume and tidal volume.*

C. *Inspiratory reserve volume and residual volume.*

D. *Expiratory reserve volume and tidal volume.*

E. ***Expiratory reserve volume and residual volume.***

Explanation: Functional residual capacity is the amount of air remaining in the lungs after a normal tidal expiration (residual volume RV +expiratory reserve volume ERV) (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 856).

35. Analysis of the experimental spirogram of a 55-year-old person revealed a decrease in tidal volume and respiratory amplitude compared to the situation of ten years ago. The change in these indicators is caused by:

A. *Physical build of a person.*

B. *Height of a person.*

C. *Body mass of a person.*

D. ***Decreased force of respiratory muscle contraction.***

E. *Gas composition of the air.*

Explanation: Tidal volume is the amount of air inhaled or exhaled in one respiratory cycle during quiet respiration. Inhalation is an active process that uses inspiratory muscles (diaphragm and external intercostal), which can weaken with age.

36. A patient has a trauma of sternocleidomastoid muscle. This caused a decrease in value of the following indicator of external respiration:

A. *Residual volume.*

B. ***Inspiratory reserve volume.***

C. *Expiratory reserve volume.*

D. *Respiratory capacity.*

E. *Functional residual lung capacity.*

Explanation: Respiratory muscles include: for quiet inspiration = external intercostal and diaphragm; for forced inspiration = external intercostal, diaphragm, pectoral, scalene, sternocleidomastoid; quiet expiration is passive – doesn't require any muscles; for forced expiration = internal intercostal and abdominal. Trauma of sternocleidomastoid muscle will decrease forced inspiration (inspiratory reserve volume).

37. Electrical activity of neurons is being measured. They fire prior to and at the beginning of inhalation. Where are these neurons situated?

A. *Diencephalon.*

B. *Mesencephalon.*

C. ***Medulla oblongata.***

D. *Spinal cord.*

E. *Cerebral cortex.*

Explanation: Neurons that fire right before and in the beginning of inspiration belong to dorsal respiratory group of the medulla oblongata (inspiratory center) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 514).

38. Work in a mine is known to cause inhalation of large amount of coal dust. Inhaled coal dust can be detected in the following pulmonary cells:

A. *Pericapillary cells.*

B. *Secretory endothelial cells.*

C. *Capillary endothelial cells.*

D. ***Alveolar macrophages.***

E. *Respiratory epithelial cells.*

Explanation: Alveolar macrophages (dust cells) wander the lumens of the alveoli and the connective tissue between them. They are the last line of defense against inhaled matter. Many particles smaller than 2 μm (like the coal dust particles) make their way into the alveoli, where they are phagocytized by the alveolar macrophages (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 849).

39. Alveolar space of acinus was invaded by bacteria that interacted with the surfactant. This led to the activation of the cells that are localized in the alveolar walls and on the surface. Name these cells:

A. *Alveolocytes type II.*

B. ***Alveolar macrophages.***

C. *Endothelial cells.*

D. *Clara cells.*

E. *Alveolocytes type I.*

Explanation: Alveolar macrophages (dust cells) wander the lumens of the alveoli and the connective tissue between them. They are the last line of defense against inhaled matter. In lungs that are infected or bleeding, the macrophages also phagocytize bacteria and loose blood cells (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 849).

40. A patient demonstrates sharp decrease of pulmonary surfactant activity. This condition can result in:

- A. *Alveolar tendency to recede.*
- B. *Decreased airways resistance.*
- C. *Decreased work of expiratory muscles.*
- D. *Increased pulmonary ventilation.*
- E. *Hyperoxemia.*

Explanation: Surfactant is a detergent-like lipoprotein that forms a thin film on the insides of the alveoli and bronchiole that decreases surface tension and prevents collapse of alveoli. Surfactant is produced by alveolocytes type II. Deficiency of surfactant increases alveolar tendency to recede and leads to their collapse (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 849, 855).

41. During recording of a spirogram a patient calmly exhaled. How do we call the volume of air remaining in the lungs?

- A. *Functional residual capacity.*
- B. *Pulmonary residual volume.*
- C. *Expiratory reserve volume.*
- D. *Tidal volume.*
- E. *Vital capacity of lungs.*

Explanation: After a quiet expiration in lungs the functional residual capacity is left – amount of air remaining in the lungs after a normal tidal expiration (residual volume RV + expiratory reserve volume ERV) (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 856).

42. During training session in the laboratory the students were performing spirometry on themselves. What indicator CANNOT be measured with this method?

- A. *Functional residual capacity.*
- B. *Respiratory rate.*
- C. *Maximal breathing capacity.*
- D. *Vital capacity.*
- E. *Respiratory minute volume.*

Explanation: The spirometer cannot be used in a direct way to measure the functional residual capacity, because the air in the residual volume of the lungs cannot be expired into the spirometer, and this volume constitutes about one half of the functional residual capacity. To measure functional residual capacity, the spirometer must be used in an indirect manner, usually by means of a helium dilution method (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit VII Respiration, p. 476).

43. Patient who has been suffering from bronchial asthma for a long time, developed acute respiratory failure. What is the main mechanism of pathology development in this case?

- A. *Obstructive disorders of pulmonary ventilation.*
- B. *Pulmonary blood supply disturbance.*
- C. *Pulmonary enzyme system disturbance.*
- D. *Decrease elasticity of the pulmonary tissue.*
- E. *Restrictive disorders.*

Explanation: Obstructive disorders narrow the airways and interfere with airflow; thus, expiration either requires more effort or is less complete than normal. In bronchial asthma, there is a potent bronchoconstriction (narrowing of airways), thus, acute respiratory failure in that case is caused by obstructive disorder (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 22 The Respiratory System, p. 856).

Physiology of digestion system

1. When the pH level of the stomach lumen decreases to less than 3, the antrum of the stomach releases peptide that acts in paracrine fashion to inhibit gastrin release. This peptide is:

- A. *Somatostatin.* C. ***GIF.*** E. *Acetylcholine.*
B. *Gastrin-releasing peptide.* D. *Vasoactive intestinal peptide.*

Explanation: Presence of acids leads to release of gastrin-inhibiting factor/peptide (GIF/GIP) by K-cells of stomach and duodenum that inhibits gastric HCl secretion and gastric motility and stimulates intestinal secretion (Uwe Ackerman – PDQ Physiology (Pretty Darned Quick Series): 1st (first) Edition, Chapter 8. Gastrointestinal System, p. 306).

2. The patient with hypersecretion of gastric juice was recommended to exclude concentrated bouillon and vegetable decoctions from the diet because of their stimulation of gastric secretion. What is dominating mechanism of stimulation of secretion in this case?

- A. *Irritation of mechanoreceptors of the stomach.*
B. *Stimulation of excretion of secretin in the duodenum.*
C. *Irritation of taste receptors.*
D. ***Stimulation of gastrin production by G-cells.***
E. *Irritation of mechanoreceptors of the oral cavity.*

Explanation: Gastrin is itself a hormone secreted by gastrin cells, also called G cells. These cells are located in the pyloric glands in the distal end of the stomach. Gastrin secretion is stimulated by mainly by presence of peptides (plus Ca^{++}), also by high concentration of catecholamines and by bombesin (GRP). The vigorous mixing of the gastric juices transports the gastrin rapidly to the ECL cells in the body of the stomach, causing release of histamine directly into the deep oxyntic glands. The histamine then acts quickly to stimulate gastric hydrochloric acid secretion. As concentrated bouillons and decoctions contain a lot of peptides, they are potent stimulators of gastric secretion. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 797–798).

3. A 60-year-old patient was diagnosed with hypothalamic lateral nuclei stroke. What changes in patient's behavior may be expected?

- A. *Unsatisfied hunger.* C. *Aggressive behavior.* E. *Depression.*
B. ***The rejection of food.*** D. *Thirst.*

Explanation: Lateral nuclei of the hypothalamus is feeding center or center of hunger; when it is destroyed in animals, they exhibit drastic loss of appetite and total rejection of food and starve to death if not force-fed. The ventromedial nuclei of hypothalamus are a center of saturation; damage here causes hyperphagia (overeating) and extreme obesity (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 26 Nutrition and Metabolism, p. 986–987).

4. The patient in consequence of postulcerative cicatricial changes had the constriction of pyloric part of the stomach (pyloric stenosis). Which functional manifestations hamper during digestion in the stomach?

- A. *Carbohydrate hydrolysis.* C. *Fat hydrolysis.* E. *Secretion of gastric juice.*
B. *Albuminolysis.* D. ***Evacuation of contents.***

Explanation: The distal opening of the stomach is the pylorus. Here the thickness of the circular wall muscle becomes 50 to 100% greater than in the earlier portions of the stomach antrum, and it remains slightly tonically contracted almost all the time. Therefore, the pyloric circular muscle is called the pyloric sphincter. Constriction of pyloric sphincter normally prevents passage of food particles until they have become mixed in the chyme to almost fluid consistency. In case of pyloric stenosis the passage of food (evacuation) from stomach is constantly impaired (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 785).

5. Experimental method «fictitious feeding» proves the realization of control mechanisms for gastric secretion which are named as:

- A. *Gastric phase.* C. ***Complex-reflex phase.*** E. *Humoral phase.*
B. *Intestinal phase.* D. *Neurohumoral phase.*

Explanation: The cephalic (complex-reflex) phase of gastric secretion occurs even before food enters the stomach, especially while it is being eaten. It results from the sight, smell, thought, or taste of food. Method of «fictitious feeding» means that lower part of esophagus of the animal by special surgery is brought out, thus the food doesn't reach the stomach. However, the stomach secretion still increases in that case, proving the role of cephalic phase in stimulation of gastric secretion (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 798).

6. As a result of a trauma the patient had the damaged lateral nuclei of hypothalamus. Which from the listed conditions of the organism causes such damage?

A. *Bulimia.* B. *Aphagia.* C. *Hyperphagia.* D. *Anorexia.* E. *Areflexia.*

Explanation: Lateral nuclei of the hypothalamus is feeding center or center of hunger; when it is destroyed in animals, they exhibit aphagia and total rejection of food and starve to death if not force-fed. The ventromedial nuclei of hypothalamus is a satiety center; damage here causes hyperphagia (overeating) and extreme obesity (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 26 Nutrition and Metabolism, p. 986–987).

7. The digestion system is a part of general system of discharge in an organism. Which from the listed functions does digestion system fulfill?

A. *Motor.* B. *Secretory.* C. *Excretory.* D. *Protective.* E. *Incretory.*

Explanation: Discharge (excretion) is carried out by respiratory, integumentary (skin and mucous membranes), digestive and urinary systems. The digestive system not only eliminates food residue (which is not a process of excretion) but also actively excretes water, salts, carbon dioxide, lipids, bile pigments, cholesterol, and other metabolic wastes. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 23 Urinary system, p. 881).

8. A college entrant constantly experiences "dry mouth" before entrance examination. Which regulation mechanism from the named below basically causes this condition?

A. *Humoral.* C. *Conditioned-reflex.* E. *Local-reflex.*
B. *Unconditioned-reflex.* D. *Paracrine.*

Explanation: Central nervous system mechanisms function to initiate, coordinate, and anticipate autonomic responses. They also provide set points and adapt them to circumstances when that is warranted by Hierarchy of Central Autonomic Control **Limbic cortex and amygdala** – these very high centers function both as a brake on automatic responses that may accompany emotional states, such as fear, rage, embarrassment, or sexual desire, and as direct activators of the system. The latter is seen prominently in two circumstances: (1) in the responses of blood pressure, sweat glands, or genitalia to dreams and fantasies and (2) in the volitional control of resting autonomic functions during states of deep meditation. Activation of sympathetic nervous system under the influence of higher nervous centers causes sympathetic responses, including change of salivation (small volume of viscous saliva) that causes sensation of dry mouth (Ackermann PDQ Physiology, p. 102–103).

9. During the examination of the group of people enzymatic activity of saliva was defined. Which enzyme activity from the named below was examined?

A. *Pepsin.* B. *Amylases.* C. *Gastricsin.* D. *Lactases.* E. *Trypsin.*

Explanation: Saliva contains 2 enzymes -salivary α -amylase (ptyalin), an enzyme that begins starch digestion in the mouth; and lingual lipase, an enzyme that is activated by stomach acid and digests fat after the food is swallowed. Thus, enzymatic activity of saliva in the mouth means only activity of α -amylase (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 946).

10. The person distinguishes four gustatory qualities: sweet, sour, bitter and salt. Which from the listed gustatory substances is the sensitivity expressed in greater degree to?

A. *Bitter.* B. *Salt.* C. *Sour.* D. *Sweet.* E. *Mixed.*

Explanation: The threshold for the bitter taste is the lowest of all—that is, we can taste lower concentrations of alkaloids than of acids, salts, and sugars. That can be related to the fact that most toxins and poisons have bitter taste (protective function of such high sensitivity - bitter compounds tend to trigger rejection responses such as gagging to protect against the ingestion of toxins). The senses of sweet and salty are the least sensitive. (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 16 Sense Organs, p. 594).

11. The patient after the gastric resection had derangements of digestion processes. Which regulation mechanism change from the named below results in derangements development in this case?

- A. *Complex-reflex.* C. *Neurohumoral.* E. *Nervous.*
B. *Humoral.* D. *Unconditioned-reflex.*

Explanation: Stomach plays an important role in both nervous (vagovagal and enterogastric reflexes) and humoral (secretion of histamine and gastrin) regulation of digestion (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 957).

12. During the examination of acid-forming stomach function the patient in fasting condition had the following parameters: total acidity is 120 mmole/l, pH – 0.9. What from the named below corresponds to estimation of acid-forming function to the greatest degree?

- A. *Normal secretion.* C. *Hyposecretion.* E. *Achylia.*
B. *Submaximal secretion.* D. *Hypersecretion.*

Explanation: In fasting conditions pH of gastric juice is 1,5–2,5 and total acidity 40–60 mmole/l. If pH is below 1,5 and total acidity is higher than 60 mmole/l, it indicates hyperacidic state (hypersecretion) of stomach.

13. At artificial feeding of infants the cow milk is used which is necessarily diluted. Which from the listed features of infants' gastric digestion is the reason of diluted milk use?

- A. *Low acidity.* C. *Low activity of pepsin.* E. *Low acid discharge.*
B. *High activity of lipase.* D. *Small stomach volume.*

Explanation: Optimal pH for pepsin is 1,8–3,5, and in infants pH of gastric juice is 2,0–5,0, thus activity of pepsin is lower. Above a pH of about 5 it has almost no proteolytic activity and becomes completely inactivated in a short time. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 797).

14. In clinic the research of gastric maximal secretion is carried out using gastrointestinal hormones as the secretion stimulators. What from the listed is the most appropriate to use for this purpose?

- A. *Gastricsin.* B. *Secretin.* C. *Motilin.* D. *Cholecystokinin* E. *Pentagastrin.*

Explanation: Pentagastrin is an artificial polypeptide that has similar structure as gastrin, thus it causes release of histamine directly into the deep oxyntic glands. The histamine then acts quickly to stimulate gastric hydrochloric acid secretion. As concentrated bouillons and decoctions contain a lot of peptides, they are potent stimulators of gastric secretion. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 797–798).

15. Exocrinous activity of pancreas is in formation and discharge into duodenum of the juice containing zymogens. What from the listed causes zymogens' activation of pancreas juice?

- A. *Hydrochloric acid.* B. *Histamine.* C. *Chemotrypsin.* D. *Enterokinase* E. *Trypsin.*

Explanation: When first synthesized in the pancreatic cells, the proteolytic digestive enzymes are in the inactive forms of trypsinogen, chymotrypsinogen, and procarboxypolypeptidase, which are all inactive enzymatically. They become activated only after they are secreted into the intestinal tract. Trypsinogen is activated by an enzyme called enterokinase, which is secreted by the intestinal mucosa when chyme comes in contact with the mucosa. Other proteolytic enzymes are activated by trypsin (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 800).

16. The patient has entered in gastroenterological department with the complaint for diarrhea which appears after rich and fatty food intake. What from the named can be the most probable reason of such condition development?

- A. *Low activity of phospholipase.* C. *High activity of lipase.* E. *Biliation decrease.*
B. *Low activity of trypsin.* D. *Cholepoiesis increase.*

Explanation: Bile acids in the bile do two things: (1) they help to emulsify the large fat particles of the food into many minute particles, the surface of which can then be attacked by lipase enzymes secreted in pancreatic juice, and (2) they aid in absorption of the digested fat end products through the intestinal mucosal membrane. Deficiency of bile causes disturbances of fats digestion and absorption leading to diarrhea (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 802).

17. Often gastroesophagal reflux (regurgitation of food from a stomach into esophagus) is the gastrointestinal tract motor disorders. What from the named forwards the development of such condition to the greatest degree?

- A. *Pyloric sphincter tonus decrease.* D. *Inferior esophageal sphincter tonus decrease.*
B. *Pyloric sphincter tonus increase.* E. *Cardia tonus increase.*
C. *Inferior esophageal sphincter tonus increase.*

Explanation: Gastroesophageal reflux, the backflow of stomach contents into the esophagus, is normally prevented partly by the tonus of lower (inferior) esophageal sphincter. If tonus of that sphincter decreases, reflux occurs (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 948).

18. The patient has the low acidity of gastric juice. What from the listed functions changes in the greater degree at the lack of the given component?

- A. *Activation of lipolysis.* C. *Activation of proteolysis.* E. *Motility depression.*
B. *Activation of glycolysis.* D. *Activation of glycogenolysis.*

Explanation: Acidity of gastric juice depends on concentration of HCl in it. HCl in stomach activates proteolytic enzyme pepsin (that is first secreted in inactive form of pepsinogen). Thus, if acidity decreases, activation of proteolysis will be disturbed. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 797).

19. For clinical research of the patient's saliva it is necessary to define its digesting ability. What substrate is it necessary to use during this research?

- A. *Albumin.* B. *Globulin.* C. *Fibrinogen.* D. *Glucose.* E. *Amylum.*

Explanation: Saliva contains 2 enzymes -salivary α -amylase (ptyalin), an enzyme that begins starch digestion in the mouth; and lingual lipase, an enzyme that is activated by stomach acid and digests fat after the food is swallowed. Thus, for research of saliva's digestive ability starch (amylum) is used (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 946).

20. A patient with brain bloodstream disorder has got difficulties with swallowing; he can choke over while eating liquid food. What part of the brain is damaged?

- A. *Medulla.* C. *Cerebellum.* E. *Cervical part of the spinal medulla.*
B. *Thalamencephalon.* D. *Midbrain.*

Explanation: The areas that control swallowing are collectively called the deglutition or swallowing center and are located in the medulla and lower pons (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 783).

21. An experimental dog by means of stomach tube was given 150 ml of meat broth. The concentration of which of the below mentioned substances will be increased in animal's blood?

- A. *Neurotensin.* C. *Somatostatin.* E. *Insulin.*
B. *Vasoactive intestinal polypeptide.* D. *Gastrin.*

Explanation: Broth, bouillons and decoctions contain a lot of peptides that are the main stimulator of gastrin secretion (by G-cells of stomach) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 797–798).

22. Because of present gallstone in the common bile duct, a patient has no bile excretion into duodenum. What disorder can it cause?

- A. *Carbohydrates digestion.* C. ***Lipids digestion.*** E. *Proteins absorption.*
B. *Proteins digestion.* D. *Carbohydrates absorption.*

Explanation: Bile acids in the bile do two things: (1) they help to emulsify the large fat particles of the food into many minute particles, the surface of which can then be attacked by lipase enzymes secreted in pancreatic juice, and (2) they aid in absorption of the digested fat end products through the intestinal mucosal membrane. Deficiency of bile causes disturbances of fats digestion and absorption leading to diarrhea (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 802).

23. Secretion of which gastrointestinal hormones is primarily decreased in patient with removed duodenum?

- A. *Histamine.* C. *Gastrin and histamine.* E. *Neurotensin.*
B. *Gastrin.* D. ***Cholecystinin and secretin.***

Explanation: Epithelium of duodenum and jejunum contains I-cells that produce CCK (cholecystinin) and S-cells that produce secretin, so removal of duodenum will decrease secretion of those 2 hormones (Uwe Ackerman – PDQ Physiology (Pretty Darned Quick Series): 1st (first) Edition, Chapter 8. Gastrointestinal System, p. 306).

24. A 57-year-old patient was admitted to the gastroenterological department with suspicion on Zollinger-Ellison syndrome because of rapid increase of gastrin level in the blood serum. What disorder of the secretory function of the stomach is the most likely?

- A. *Hypoacid hypersecretion.* C. ***Hyperacid hypersecretion.*** E. *Achylia.*
B. *Hyperacid hyposecretion.* D. *Hypoacid hyposecretion.*

Explanation: Gastrin is the main stimulator of gastric secretion that acts on ECL cells in the body of the stomach, causing release of histamine that stimulates gastric hydrochloric acid secretion. Increase of gastrin level will cause hypersecretion of hydrochloric acid (hyperacidic hypersecretion) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 797–798).

25. A 30-year-old woman was diagnosed with insufficiency of exocrine function of pancreas. Hydrolysis of what nutrients will be disturbed?

- A. *Proteins.* C. *Proteins, carbohydrates.* E. ***Proteins, fats, carbohydrates.***
B. *Fats, carbohydrates.* D. *Proteins, fats.*

Explanation: Pancreatic secretion contains multiple enzymes for digesting all of the three major types of food: proteins (trypsin, chymotrypsin, and carboxypolypeptidase), carbohydrates (pancreatic amylase), and fats (pancreatic lipase, cholesterol esterase and phospholipase). It also contains large quantities of bicarbonate ions, which play an important role in neutralizing the acidity of the chyme emptied from the stomach into the duodenum (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 799).

26. A 2-year-old child has got intestinal dysbacteriosis, which resulted in hemorrhagic syndrome. What is the most likely cause of hemorrhage of the child?

- A. *Fibrinogen deficiency.* C. *PP hypovitaminosis.* E. *Activation of tissue thromboplastin.*
B. *Hypocalcemia.* D. ***Vitamin K deficiency.***

Explanation: Vitamin K is necessary for the formation by the liver of prothrombin, Factor VII (proconvertin), Factor IX, and Factor X, all of which are important in blood coagulation. Therefore, when vitamin K deficiency occurs, blood clotting is retarded. Vitamin K is fat-soluble, thus it's absorbed only in presence of bile, and also is synthesized by bacteria in the colon. Deficiency of bile in intestine (obstruction of bile ducts) and dysbacteriosis of intestine both lead to deficiency of vitamin K causing hemorrhages (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 878).

27. Examination of a 35 year old patient revealed high acidity of gastric juice. What receptors should be blocked in order to reduce it?

- A. α 1-adrenoreceptors. C. β 1-adrenoreceptors. E. **Histamine.**
 B. β 2-adrenoreceptors. D. α 2-adrenoreceptors.

Explanation: The rate of formation and secretion of hydrochloric acid by the parietal cells is directly related to the amount of histamine secreted by the ECL cells. Thus, blockage of histamine receptors will decrease HCl secretion and correct acidity of gastric juice (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 797).

28. After consumption of rich food a patient has nausea and heartburn, steatorrhea. This condition might be caused by:

- A. *Increased lipase secretion.* D. *Disturbed phospholipase synthesis.*
 B. **Bile acid deficiency.** E. *Disturbed trypsin synthesis.*
 C. *Amylase deficiency.*

Explanation: Bile acids in the bile do two things: (1) they help to emulsify the large fat particles of the food into many minute particles, the surface of which can then be attacked by lipase enzymes secreted in pancreatic juice, and (2) they aid in absorption of the digested fat end products through the intestinal mucosal membrane. Deficiency of bile causes disturbances of fats digestion and absorption leading to diarrhea with steatorrhea (undigested fats appearing in feces) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 802).

29. A patient ill with chronic gastritis went for endogastric pH-metry that allowed to reveal decreased acidity of gastric juice. It is indicative of diminished function of the following cells:

- A. **Parietal exocrinocytes.** C. *Endocrinocytes.* E. *Chief exocrinocytes.*
 B. *Accessory cells.* D. *Cervical cells.*

Explanation: The only cells that secrete hydrochloric acid are parietal cells located deep in the oxyntic glands of the main body of stomach (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 802).

30. Surgical removal of a part of stomach resulted in disturbed absorption of vitamin B12, it is excreted with feces. The patient was diagnosed with anemia. What factor is necessary for absorption of this vitamin?

- A. *Gastrin.* C. *Hydrochloric acid.* E. *Pepsin.*
 B. *Folic acid.* D. **Gastromucoprotein.**

Explanation: The substance called intrinsic factor (Castle's factor, gastromucoprotein), essential for absorption of vitamin B12 in the ileum, is secreted by the parietal cells of stomach along with the secretion of hydrochloric acid. When the acid-producing parietal cells of the stomach are destroyed, which frequently occurs in chronic gastritis, the person develops not only achlorhydria (lack of stomach acid secretion) but often also pernicious anemia because of failure of maturation of the red blood cells in the absence of vitamin B12 stimulation of the bone marrow (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 797).

31. A patient underwent an operation on account of gall bladder excision that resulted in obstruction of Ca²⁺ absorption through the bowels wall. What vitamin will stimulate this process?

- A. C. B. B₁₂. C. D₃. D. K. E. PP.

Explanation: Vitamin D increases calcium absorption from the gastrointestinal tract and helps to control calcium deposition in the bone. The mechanism by which vitamin D increases calcium absorption is mainly to promote active transport of calcium through the epithelium of the ileum. In particular, it increases the formation of a calcium-binding protein in the intestinal epithelial cells that aids in calcium absorption (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 878).

32. A patient has a disturbed absorption of fat hydrolysates. It might have been caused by a deficit in the small intestine cavity:

- A. *Of bile pigments.* C. **Of bile acids.** E. *Of liposoluble vitamins.*
 B. *Of lipolytic enzymes.* D. *Of sodium ions.*

Explanation: Bile acids in the bile do two things: (1) they help to emulsify the large fat particles of the food into many minute particles, the surface of which can then be attacked by lipase enzymes secreted in pancreatic juice, and (2) they aid in absorption of the digested fat end products through the intestinal mucosal membrane. Deficiency of bile causes disturbances of fats digestion and absorption leading to diarrhea with steatorrhea (undigested fats appearing in feces) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 802).

33. A 60-year-old patient presents with weakened peristaltic activity of the bowels. Which of the following foodstuffs would stimulate peristalsis most of all?

A. Meat. B. White bread. C. **Brown bread.** D. Lard. E. Tea.

Explanation: Food that contains a lot of fiber greatly stimulates motility of intestine by bulking up the stool and retaining water. Fiber-rich products include vegetables, fruits, beans, and whole grains. Brown bread is made with significant amounts of whole grain flour, usually wheat, thus it's a potent stimulator of peristalsis.

34. A patient consumed a lot of rich in proteins food that caused increase of rate of proteolytic enzymes of pancreatic juice. It is also accompanied by increase of rate of the following enzyme:

A. Trypsin. B. Pepsin. C. **Enterokinase.** D. Gastriczin. E. Renin.

Explanation: When first synthesized in the pancreatic cells, the proteolytic digestive enzymes are in the inactive forms of trypsinogen, chymotrypsinogen, and procarboxypolypeptidase, which are all inactive enzymatically. They become activated only after they are secreted into the intestinal tract. Trypsinogen is activated by an enzyme called enterokinase, which is secreted by the intestinal mucosa when chyme comes in contact with the mucosa. Other proteolytic enzymes are activated by trypsin. Enterokinase itself is regulated dramatically in duodenum by pancreatic secretions (the more is pancreatic secretion, the more is activity of enterokinase) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 800).

35. In course of an experiment chorda tympani of an animal was being stimulated by electric current, as a result the parotid duct excreted:

A. A lot of viscous saliva. C. A small quantity of fluid saliva. E. Saliva wasn't excreted.
B. A lot of fluid saliva. D. A small quantity of viscous saliva.

Explanation: Parasympathetic nervous system through VII and IX cranial nerves stimulates the salivary glands to produce a lot of fluid, thin saliva rich in enzymes (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 947).

36. In course of an experiment a nerve is being stimulated by electric impulses. As a result of it sublingual and submaxillary glands discharge some dense viscous saliva. What nerve is being stimulated?

A. *N. glossopharyngeus.* B. *N. facialis.* C. *N. trigeminus.* D. *N. vagus.* E. ***N. sympathicus.***

Explanation: A little amount of dense, viscous, thick saliva with a lot of mucus is caused by sympathetic stimulation (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 947).

37. Alterations in protein digestion in the small intestine are induced by the impairment of trypsin and chymotrypsin activity. What enzyme deficiency may be the cause of this impairment?

A. Lipase. B. Maltase. C. Pepsin. D. Amylase. E. **Enterokinase.**

Explanation: When first synthesized in the pancreatic cells, the proteolytic digestive enzymes are in the inactive forms of trypsinogen, chymotrypsinogen, and procarboxypolypeptidase, which are all inactive enzymatically. They become activated only after they are secreted into the intestinal tract. Trypsinogen is activated by an enzyme called enterokinase, which is secreted by the intestinal mucosa when chyme comes in contact with the mucosa. Other proteolytic enzymes are activated by trypsin. Thus, low activity of proteolytic enzymes can be caused by deficiency of enterokinase (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 800).

38. A 36-year-old male patient has malabsorption of sodium ions from the intestinal lumen into blood. At the same time, absorption of the following substances remains unchanged:

- A. *Proteins.* B. *Fats.* C. *Chlorides.* D. *Carbohydrates* E. *Water.*

Explanation: Absorption of proteins and carbohydrates in intestine occurs by way of Na⁺-co-transport. Absorption of water goes along the osmotic gradient created by Na⁺ concentration, and Cl⁻ is absorbed by diffusion down the electrical gradient created by movement of Na⁺ ions. Only fats diffuse immediately out of the micelles and into the interior of the epithelial cells, which is possible because the lipids are also soluble in the epithelial cell membrane. Therefore, only fats absorption will not change because it doesn't depend on Na⁺ absorption (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 817).

39. A patient consulted a doctor about difficult chewing. On the examination he was found to have the atrophy of the right temporal muscle and masticatory muscles. Upon opening the mouth, the patient's jaw deviates to the left. What nerve is affected?

- A. *Maxillary.* C. *Facial.* E. *Motor portion of the mandibular nerve.*
B. *Inferior alveolar.* D. *Mandibulohyoid.*

Explanation: Most of the muscles of chewing (including right temporal and masticatory) are innervated by the motor branch of the fifth cranial nerve, and the chewing process is controlled by nuclei in the brain stem (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 781).

40. Stimulation of peripheral segment of Chorda tympani in an experimental animal resulted in the discharge of the following secretion from the parotid salivary fistula:

- A. *A lot of viscose saliva.* C. *A small amount of viscose saliva.* E. *There is no saliva.*
B. *A lot of liquid saliva.* D. *A small amount of liquid saliva.*

Explanation: Parasympathetic nervous system through VII and IX cranial nerves stimulates the salivary glands to produce a lot of fluid, thin saliva rich in enzymes (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw-Hill Companies, 2003. Chapter 25 The Digestive System, p. 947).

41. An animal has been given a weak solution a hydrochloric acid introduced into the duodenum through a tube. Which hormone concentration will increase in the animal?

- A. *Neurotensin.* C. *Cholecystokinin (pancreozym).* E. *Gastrin.*
B. *Glucagon.* D. *Secretin.*

Explanation: Acidic chyme stimulates S-cells of the duodenum to secrete secretin that stimulates the hepatic bile ducts and pancreatic ducts to secrete bicarbonates, so the bile and pancreatic juice both help to neutralize stomach acid in the duodenum (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw-Hill Companies, 2003. Chapter 25 The Digestive System, p. 964).

42. A 48-year-old female patient with history of cholelithiasis has recurring steatorrhea. What vitamin deficiency may develop as a complication of the current disease?

- A. *PP.* B. *K.* C. *B₆.* D. *B₁₂.* E. *C.*

Explanation: Vitamin K is necessary for the formation by the liver of prothrombin, Factor VII (proconvertin), Factor IX, and Factor X, all of which are important in blood coagulation. Therefore, when vitamin K deficiency occurs, blood clotting is retarded. Vitamin K is fat-soluble, thus it's absorbed only in presence of bile, and also is synthesized by bacteria in the colon. Deficiency of bile in intestine (obstruction of bile ducts) and dysbacteriosis of intestine both lead to deficiency of vitamin K causing hemorrhages (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 878).

43. A patient has a critical impairment of protein, fat and hydrocarbon digestion. Most likely it has been caused by low secretion of the following digestive juice:

- A. *Gastric juice.* B. *Intestinal juice.* C. *Pancreatic juice.* D. *Saliva* E. *Bile.*

Explanation: Pancreatic secretion contains multiple enzymes for digesting all of the three major types of food: proteins (trypsin, chymotrypsin, and carboxypolypeptidase), carbohydrates (pancreatic amylase), and fats (pancreatic lipase, cholesterol esterase and phospholipase). It also contains large quantities of bicarbonate ions, which play an important role in neutralizing the acidity of the chyme emptied from the stomach into the duodenum (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 799).

44. A 30-year-old woman has subnormal concentration of enzymes in the pancreatic juice. This might be caused by the hyposecretion of the following gastrointestinal hormone:

- A. *Somatostatin*. C. *Cholecystokinin-pancreozymin*. E. *Vaso-intestinal peptide*.
B. *Secretin*. D. *Gastro-inhibiting peptide*.

Explanation: I-cells of duodenum secrete CCK that triggers three responses: (1) contraction of the gallbladder, which forces bile into the bile duct; (2) secretion of pancreatic enzymes; and (3) relaxation of the hepatopancreatic sphincter, which allows bile and pancreatic juice to be released into the duodenum. Thus, subnormal concentration of enzymes is caused by deficiency of CCK (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 963).

45. Examination of a patient revealed that dental hypoplasia was caused by hypovitaminosis of vitamins A and D. These vitamins were administered perorally but they didn't have any medicinal effect. What is the probable cause of disturbed vitamin assimilation?

- A. *Achylia*. C. ***Bile acid deficiency***. E. *Hyperchlorhydria*.
B. *Achlorhydria*. D. *Hypochlorhydria*.

Explanation: Vitamins A, D, E and K are fat-soluble, thus they are absorbed only in presence of bile. Deficiency of bile in intestine (obstruction of bile ducts) will lead to deficiency of fat-soluble vitamins due to their malabsorption (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 878).

46. During an acute experiment some of diluted solution of hydrochloric acid was injected into the duodenal cavity of an experimental animal. This will result in hypersecretion of the following hormone:

- A. *Histamine*. B. *Gastrin*. C. *Motilin*. D. *Neurotensin*. E. ***Secretin***.

Explanation: Presence of acid in duodenal lumen stimulates S-cells of the duodenum to secrete secretin that stimulates the hepatic bile ducts and pancreatic ducts to secrete bicarbonates, so the bile and pancreatic juice both help to neutralize stomach acid in the duodenum (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 964).

47. In order to administer general health improving therapy a parodontist intends to study factors of nonspecific resistance of saliva and mucous secretion. Which of the following factors of nonspecific resistance should be studied in the first line?

- A. *Secretory IgA*. B. *Properdin*. C. *Interferon*. D. *Complement* E. ***Lysozyme***.

Explanation: Saliva contains several factors that destroy bacteria. One of these is thiocyanate ions and another is several proteolytic enzymes—most important, lysozyme—that (a) attack the bacteria, (b) aid the thiocyanate ions in entering the bacteria where these ions in turn become bactericidal, and (c) digest food particles, thus helping further to remove the bacterial metabolic support (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal Physiology, p. 794).

48. Roentgenologically confirmed obstruction of common bile duct resulted in preventing bile from inflowing to the duodenum. What process is likely to be disturbed?

- A. *Protein absorption*. D. *Hydrochloric acid secretion in stomach*.
B. *Carbohydrate hydrolysis*. E. *Salivation inhibition*.

C. ***Fat emulgation***.

Explanation: Bile acids in the bile do two things: (1) they help to emulsify the large fat particles of the food into many minute particles, the surface of which can then be attacked by lipase enzymes secreted in pancreatic juice, and (2) they aid in absorption of the digested fat end

products through the intestinal mucosal membrane. Deficiency of bile causes disturbances of fats digestion and absorption leading to diarrhea with steatorrhea (undigested fats appearing in feces) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 802).

49. After examining the patient the doctor recommended him to eliminate rich meat and vegetable broth, spices, smoked products from the diet, since the patient was found to have:

- A. *Reduced secretion of hydrochloric acid by the stomach glands.*
- B. *Increased secretion of hydrochloric acid by the stomach glands.***
- C. *Reduced motility of the gastrointestinal tract.*
- D. *Reduced salivation.*
- E. *Biliary dyskinesia.*

Explanation: Broth, bouillons and decoctions contain a lot of peptides that are the main stimulator of gastrin secretion (by G-cells of stomach). Gastrin acts on the ECL cells in the body of the stomach, causing release of histamine that stimulates gastric hydrochloric acid secretion (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 797–798).

50. A patient complains of frequent diarrheas, especially after consumption of rich food, weight loss. Laboratory examination revealed steatorrhea; his feces were hypocholic. What might have caused such condition?

- A. *Unbalanced diet.*
- B. *Lack of pancreatic lipase.*
- C. *Lack of pancreatic phospholipase.*
- D. *Obturation of biliary tracts.***
- E. *Inflammation of mucous membrane of small intestine.*

Explanation: Bile acids in the bile do two things: (1) they help to emulsify the large fat particles of the food into many minute particles, the surface of which can then be attacked by lipase enzymes secreted in pancreatic juice, and (2) they aid in absorption of the digested fat end products through the intestinal mucosal membrane. Deficiency of bile causes disturbances of fats digestion and absorption leading to diarrhea with steatorrhea (undigested fats appearing in feces) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 802).

51. A newborn child suffers from milk curdling in stomach, this means that soluble milk proteins (caseins) transform to insoluble proteins (paracaseins) by means of calcium ions and a certain enzyme. What enzyme takes part in this process?

- A. *Lipase.*
- B. *Gastrin.*
- C. *Secretin.*
- D. *Renin.***
- E. *Pepsin.*

Explanation: In infants, the chief cells of gastric glands besides pepsin also secrete gastric lipase and chymosin (rennin). Gastric lipase digests some of the butterfat of milk, and chymosin curdles milk by coagulating its proteins (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 954).

52. A 30-year-old male patient with acute pancreatitis has been found to have a disorder of cavitory protein digestion. The reason for such condition can be the hyposynthesis and hyposecretion of the following enzyme:

- A. *Pepsin.*
- B. *Dipeptidase.*
- C. *Trypsin.***
- D. *Lipase.*
- E. *Amylase.*

Explanation: When first synthesized in the pancreatic cells, the proteolytic digestive enzymes are in the inactive forms of trypsinogen, chymotrypsinogen, and procarboxypolypeptidase, which are all inactive enzymatically. They become activated only after they are secreted into the intestinal tract. Trypsinogen is activated by an enzyme called enterokinase, which is secreted by the intestinal mucosa when chyme comes in contact with the mucosa. Other proteolytic enzymes are activated by trypsin (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 800).

53. A 60 year old patient was found to have a dysfunction of main digestive enzyme of saliva. This causes the disturbance of primary hydrolysis of:

- A. *Cellulose.*
- B. *Carbohydrates.***
- C. *Fats.*
- D. *Proteins*
- E. *Lactose.*

Explanation: Saliva contains 2 enzymes -salivary α -amylase (ptyalin), an enzyme that begins starch digestion in the mouth; and lingual lipase, an enzyme that is activated by stomach acid and digests fat after the food is swallowed. Thus, enzymatic activity of saliva in the mouth means only activity of α -amylase that starts digestion of carbohydrates (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 946).

54. A newborn develops dyspepsia after the milk feeding. When the milk is substituted by the glucose solution the dyspepsia symptoms disappear. The newborn has the subnormal activity of the following enzyme:

A. *Maltase.* B. *Isomaltase.* C. *Lactase.* D. *Invertase* E. *Amylase.*

Explanation: A child shows signs of dyspepsia only after milk intake, i.e. he has intolerance of lactose (disaccharide of milk) caused by deficiency of enzyme for it called lactase. If people with lactose intolerance consume milk, lactose passes undigested into the large intestine, increases the osmolarity of the intestinal contents, and causes colonic water retention and diarrhea. In addition, lactose fermentation by intestinal bacteria produces gas, resulting in painful cramps and flatulence (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 970).

55. A patient has normally coloured stool including a large amount of free fatty acids. The reason for this is a disturbance of the following process:

A. *Biliary excretion.* C. *Choleresis.* E. *Lipase secretion.*
B. *Fat hydrolysis.* D. *Fat absorption.*

Explanation: Digestion of lipids includes 3 main steps: 1) emulsification of fats by bile with formation of smaller emulsification droplets by certain components of the bile—lecithin (a phospholipid) and bile acids (steroids); 2) digestion of lipids by pancreatic lipase, as a result two free fatty acids (FFAs) and a monoglyceride are formed from each triglyceride; 3) bile acids coat these and other lipids and form micelles, droplets about 5 nm in diameter containing bile acids, FFAs, monoglycerides, cholesterol, and fat-soluble vitamins; micelles pass amid the microvilli of the brush border and release their lipids, which diffuse freely through the plasma membranes (which are themselves mostly lipid) into the absorptive cells of small intestine. Therefore, if a patient has a lot of free fatty acids in feces, it means that digestion of lipids occurred, however, absorption didn't (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 25 The Digestive System, p. 972).

56. A 35-year-old man with peptic ulcer disease has undergone antrectomy. After the surgery secretion of the following gastrointestinal hormone will be disrupted the most:

A. *Histamine.* B. *Gastrin.* C. *Neurotensin.* D. *Cholecystokinin* E. *Secretin.*

Explanation: The pyloric glands are located in the antral portion of the stomach, the distal 20 per cent of the stomach. The pyloric glands secrete mainly mucus for protection of the pyloric mucosa from the stomach acid and the hormone gastrin. Thus, antrectomy (resection of antral portion of stomach) will lead to decrease of gastrin secretion (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 795).

57. A patient is diagnosed with atrophic gastritis attended by deficiency of Castle's intrinsic factor. What type of anemia does the patient have?

A. *B₁₂-deficiency anemia.* C. *Iron-deficiency anemia.* E. *Hemolytic anemia.*
B. *Iron refractory anemia.* D. *Protein-deficiency anemia.*

Explanation: The substance called intrinsic factor (Castle's factor, gastromucoprotein), essential for absorption of vitamin B₁₂ in the ileum, is secreted by the parietal cells of stomach along with the secretion of hydrochloric acid. When the acid-producing parietal cells of the stomach are destroyed, which frequently occurs in chronic gastritis, the person develops not only achlorhydria (lack of stomach acid secretion) but often also pernicious anemia because of failure of maturation of the red blood cells in the absence of vitamin B₁₂ stimulation of the bone marrow (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XII Gastrointestinal physiology, p. 797).

58. Due to the blockage of the common bile duct (which was radiographically confirmed), the biliary flow to the duodenum was stopped. We should expect the impairment of:

- A. *Fat emulsification.* C. *Carbohydrate hydrolysis.* E. *Salivation inhibition.*
B. *Protein absorption.* D. *Secretion of hydrochloric acid.*

Explanation: Bile acids in the bile do two things: (1) they help to emulsify the large fat particles of the food into many minute particles, the surface of which can then be attacked by lipase enzymes secreted in pancreatic juice, and (2) they aid in absorption of the digested fat end products through the intestinal mucosal membrane. Deficiency of bile causes disturbances of fats digestion and absorption leading to diarrhea (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal physiology, p. 802).

59. Protective function of saliva is based on several mechanisms, including the presence of enzyme that has bactericidal action and causes lysis of complex capsular polysaccharides of staphylococci and streptococci. Name this enzyme.

- A. *Alpha-amylase.* C. *oligo-1,6-glucosidase.* E. *Beta-glucuronidase.*
B. *Lysozyme.* D. *Collagenase.*

Explanation: Saliva contains several factors that destroy bacteria. One of these is thiocyanate ions and another is several proteolytic enzymes—most important, lysozyme—that (a) attack the bacteria, (b) aid the thiocyanate ions in entering the bacteria where these ions in turn become bactericidal, and (c) digest food particles, thus helping further to remove the bacterial metabolic support (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XII Gastrointestinal Physiology, p. 794).

Physiology of energy exchange and thermoregulation

1. The population of the countries with hot climate and low humidity of air don't have hyperthermia. What from the listed factors of thermal acclimatization is the leading one?

- A. *Convection.* C. *Pulmonary ventilation.* E. *Behavioral adaptation.*
B. *Heat conduction.* D. *Evaporation.*

Explanation: If the temperature of environment is higher than body temperature and the humidity of air is below 100 %, the main way of heat loss is evaporation of sweat (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 892).

2. The patient's body weight increase in relation to normative one is corrected with protein diet. What from the listed processes will cause mass normalization in these conditions?

- A. *Carbohydrate depots emaciation.* D. *Fat depot emaciation.*
B. *Power inputs increase.* E. *Maximal oxygen consumption.*
C. *Glycolysis depression.*

Explanation: After a meal is ingested, the metabolic rate increases as a result of the different chemical reactions associated with digestion, absorption, and storage of food in the body. This is called the thermogenic effect of food. After a meal that contains a large quantity of carbohydrates or fats, the metabolic rate usually increases about 4 per cent. However, after a high-protein meal, the metabolic rate usually begins rising within an hour, reaching a maximum of about 30 per cent above normal, and this lasts for 3 to 12 hours. This effect of protein on the metabolic rate is called the specific dynamic action of protein (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 887).

3. After intensive muscular work respiratory coefficient exceeds 1.0. What from the named factors causes increase of this parameter?

- A. *Oxygen debt.* B. *Hyperventilation.* C. *Lactic acid accumulation.* D. *Hypoxia.* E. *Hypoxemia.*

Explanation: In case of O₂ deficiency (like during intensive exercises) for formation of ATP glucose breaks down to pyruvic acid, the major portion of which is converted into lactic acid. Lactic acid diffuses readily out of the cells into the extracellular fluids and to blood, as a result pH of blood decreases leading to increased activity of buffer systems of blood, especially bicarbonate buffer system. Side product of bicarbonate buffering of acids is CO₂. Thus, during strenuous exercise, the volume of CO₂ production rises as a result of hyperventilation and the increased buffering of blood lactic acid derived from skeletal muscles (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 837, 867, 883, 1058).

4. At definition of the basal metabolism of two patients of one age and with identical body weight the increase of this parameter is fixed at the patient who is higher. What from the listed factors is the principal cause of the detected difference?

- A. *Cellular metabolism.* C. *The body surface area.* E. *Oxygenation of blood.*
B. *Activity of hormonal link.* D. *Maximal oxygen consumption.*

Explanation: Minimum level of energy required to exist (to perform all the chemical reactions of the body in resting state) is called the basal metabolic rate (BMR). Skeletal muscle, even under resting conditions, accounts for 20 to 30 per cent of the BMR. For this reason, BMR is usually corrected for differences in body size by expressing it as Calories per hour per square meter of body surface area, calculated from height and weight. Thus, in a taller person BMR will be higher because of bigger body surface area (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 886).

5. In a sauna at low humidity the temperature of air achieves 100°C. Which from the specified thermoregulation mechanisms protects the person from overheating?

- A. *Pulmonary ventilation.* C. *Heat conduction.* E. *Evaporation of sweat.*
B. *Thermal radiation.* D. *Convection.*

Explanation: If the temperature of environment is higher than body temperature and the humidity of air is below 100 %, the main way of heat loss is evaporation of sweat (Medical

physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 892).

6. Which from the given parameters reflects energy metabolism intensity?
- A. *Quantity of consumed oxygen.*
 - B. **Quantity of emitted heat.**
 - C. *Quantity of the discharged water.*
 - D. *Composition of the food taken.*
 - E. *Quantity of discharged CO₂.*

Explanation: Not all the energy in foods is transferred to ATP; instead, a large portion of this energy becomes heat. On average, 35 per cent of the energy in foods becomes heat during ATP formation. Then, still more energy becomes heat as it is transferred from ATP to the functional systems of the cells, so that even under optimal conditions, no more than 27 per cent of all the energy from food is finally used by the functional systems. Even when 27 per cent of the energy reaches the functional systems of the cells, most of this eventually becomes heat. Therefore, the whole-body metabolic rate can be determined by simply measuring the total quantity of heat liberated from the body in a given time (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 885).

7. Why are carbohydrates the first to be oxidized in the organism during physical exercise?
- A. *Carbohydrates during oxidation in the organism give the greatest respiratory coefficient.*
 - B. **For oxidation of 1 gram of carbohydrates the least quantity of O₂ is used.**
 - C. *Carbohydrates have the least size of thermal equivalent.*
 - D. *Carbohydrates have the greatest thermal value.*
 - E. *For oxidation of 1 gram of carbohydrates the greatest quantity of O₂ is used.*

Explanation: For oxidation of 1 molecule of glucose only 6 molecules of O₂ are used (C₆H₁₂O₆ + 6 O₂ → 6 CO₂ + 6 H₂O) and 38 ATP are formed (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 26 Nutrition and Metabolism, p. 1002).

8. What from the given complexes of normative conditions is used for definition of the basal metabolism?
- A. *Fasting, during sleep, sitting position, ambient temperature: + 20 °C.*
 - B. *Fasting, wakefulness, lying position, ambient temperature: +10 °C.*
 - C. **Fasting, wakefulness, lying position, ambient temperature: +18 – +20 °C.**
 - D. *In 12 hours after a meal, sitting, wakefulness condition, ambient temperature: +20 °C.*
 - E. *In 1 hour after a meal, sitting, wakefulness condition, at temperature of physiological comfort.*

Explanation: The usual method for determining BMR is to measure the rate of oxygen utilization over a given period of time under the following conditions: 1. The person must not have eaten food for at least 12 hours. 2. The BMR is determined after a night of restful sleep. 3. No strenuous activity is performed for at least 1 hour before the test. 4. All psychic and physical factors that cause excitement must be eliminated. 5. The temperature of the air must be comfortable and between +18° and +20 °C. 6. No physical activity is permitted during the test (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 886).

9. What from the specified processes provides isothermia?
- A. *Processes of chemical thermoregulation.*
 - B. *Processes of physical thermoregulation.*
 - C. *Level of oxidizing processes in the organism.*
 - D. *Activity of exothermal reactions in the organism.*
 - E. **Optimum ratio of heat production and thermolysis.**

Explanation: The body temperature is controlled by balancing heat production against heat loss (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 889).

10. What from the listed thermoregulation processes are activated in conditions of ambient temperature drop?
- A. *Physical thermoregulation.*
 - B. *Pulmonary ventilation and sweat secretion.*
 - C. *Increase of muscle performance.*
 - D. **Chemical thermoregulation.**
 - E. *Heat conduction increase.*

Explanation: When the body is too cold, the temperature control system institutes increase in thermogenesis (heat production). Heat production by the metabolic systems is increased by promoting shivering, sympathetic excitation of heat production, and thyroxine secretion. An increase in either sympathetic stimulation or circulating norepinephrine and epinephrine in the blood can cause an immediate increase in the rate of cellular metabolism. This effect is called chemical thermogenesis. It results at least partially from the ability of norepinephrine and epinephrine to uncouple oxidative phosphorylation, which means that excess foodstuffs are oxidized and thereby release energy in the form of heat but do not cause adenosine triphosphate to be formed (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 895-896).

11. A young man increased his energy inputs from 500 to 2000 kJ per hour. What from the suggested can cause it?

- A. *Physical activity.* C. *Food taking.* E. *Mental activity.*
B. *Rising of external temperature.* D. *Change of sleeping for waking.*

Explanation: Such dramatic increase of energy inputs (300% more than initial) can be seen only in case of physical exercise. Rise of environmental temperature decreases metabolic rate (MR), food intake can increase MR not more than on 30%, during sleep MR is lower and awakening just returns it to normal value, and mental activity comprises about 20% (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 887).

12. Buffer capacity of blood was decreased in the worker due to exhausting muscular work. Entry of what acid substance to the blood can this state be explained?

- A. *Pyruvate.* B. *Lactate.* C. *3-phosphoglycerate.* D. *1,3-bisphosphoglycerate.* E. *α -ketoglutarate.*

Explanation: In case of O₂ deficiency (like during intensive exercises) for formation of ATP glucose breaks down to pyruvic acid, the major portion of which is converted into lactic acid. Lactic acid diffuses readily out of the cells into the extracellular fluids and to blood, as a result pH of blood decreases (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 837, 867, 883, 1058).

13. Respiratory coefficient was studied in the patient who strictly kept certain diet for 10 days. It was determined that it is 1. What diet does the patient follow?

- A. *With domination of carbohydrates.* D. *With domination of fat and carbohydrates.*
B. *Mixed.* E. *With domination of proteins and carbohydrates.*
C. *With domination of proteins and fat.*

Explanation: «Respiratory quotient» is the ratio of CO₂ production to O₂ utilization and can be used to estimate fat and carbohydrate utilization. When carbohydrates are metabolized with oxygen, exactly one carbon dioxide molecule is formed for each molecule of oxygen consumed. This ratio of carbon dioxide output to oxygen usage is called the respiratory quotient, so the respiratory quotient for carbohydrates is 1.0 ($C_6H_{12}O_6 + 6 O_2 \rightarrow 6 CO_2 + 6 H_2O$) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 867).

14. What heat transfer mechanism is the most effective while the man being at 80 % moisture and the temperature +35 °C?

- A. *Evaporation.* B. *–.* C. *Radiation.* D. *Heat conduction* E. *Convection.*

Explanation: If the temperature of environment is higher than body temperature and the humidity of air is below 100 %, the main way of heat loss is evaporation of sweat (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 892).

15. The energy inputs of a healthy man have been measured. In what position was the patient if his energy inputs were less than the main exchange?

- A. *Nervous exertion.* B. *Easy work.* C. *Sleep.* D. *Rest* E. *Calmness.*

Explanation: The metabolic rate decreases 10 to 15 per cent below normal during sleep. This fall is due to two principal factors: (1) decreased tone of the skeletal musculature during sleep and (2) decreased activity of the central nervous system (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 887).

16. A lightly dressed man is standing in a room, air temperature is +14 °C, windows and doors are closed. In what way does he emit heat the most actively?

A. *Perspiration.* B. *Heat conduction.* C. **Heat radiation.** D. *Convection.* E. *Evaporation.*

Explanation: If the temperature of environment is lower than body temperature and the clothes are light or person is nude, the main way of heat loss is radiation of heat (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 891).

17. A human body cools in water much faster than in the air. What way of heat emission in water is much more efficient?

A. *Convection.* B. *Heat radiation.* C. **Heat conduction.** D. *Sweat evaporation* E. –.

Explanation: The rate of heat loss to water is usually many times greater than the rate of heat loss to air because heat conductivity in water is very great in comparison with that in air (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 891).

18. An infant has apparent diarrhea resulting from improper feeding. One of the main diarrhea effects is plentiful excretion of sodium bicarbonate. What form of acid-base balance disorder is the case?

A. *Metabolic alkalosis.*

D. *Respiratory acidosis.*

B. *Respiratory alkalosis.*

E. **Metabolic acidosis.**

C. *No disorders of acid-base balance will be observed.*

Explanation: Acidosis occurs when the ratio of HCO₃⁻ to CO₂ in the extracellular fluid decreases, thereby decreasing pH. If this ratio decreases because of a fall in HCO₃⁻, the acidosis is referred to as metabolic acidosis. If the pH falls because of an increase in PCO₂, the acidosis is referred to as respiratory acidosis. In that child there is excessive excretion of sodium bicarbonate, thus it's metabolic acidosis (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V Body Fluids and Kidneys, p. 396).

19. Workers of a hothouse farm work under conditions of unfavorable microclimate: air temperature is +37 °C relative humidity is 90 %, air speed is 0,2 m/s. The way of heat emission under these conditions will be:

A. *Radiation.* B. *Convection.* C. *Heat conduction.* D. *All the ways* E. **Evaporation.**

Explanation: If the temperature of environment is higher than body temperature and the humidity of air is below 100 %, the main way of heat loss is evaporation of sweat (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 892).

20. The temperature of the ambient environment is +38°C and relative air humidity is 50%. What ways of heat emission provide maintaining a constant temperature of the human body?

A. **Evaporation.** B. *Radiation.* C. *Heat conduction.* D. *Convection.* E. *Convection and conduction.*

Explanation: If the temperature of environment is higher than body temperature and the humidity of air is below 100 %, the main way of heat loss is evaporation of sweat (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 892).

21. A man is being measured power inputs on an empty stomach, in the lying position, under conditions of physical and psychic rest at a comfortable temperature. Power inputs will reach the maximum at:

A. **5–6 p.m.**

B. *7–8 a.m.*

C. *10–12 a.m.*

A. D. *2–3 p.m.*

E. *3–4 a.m.*

Explanation: Minimal power inputs in human are seen in the early morning (4–5 a.m.), and maximal power inputs in the early evening (4–6 p.m.). Such changes are related to circadian rhythms and to rotation of Earth around its axis.

22. A man's energy consumption is measured on an empty stomach, in lying position, under conditions of physical and psychic rest, at comfortable temperature. At what time will the energy consumption be the lowest?

A. **At 3–4 o'clock a.m..**

C. *At 10–12 o'clock a.m..*

E. *At 5–6 o'clock p.m..*

B. *At 7–8 o'clock a.m..*

D. *At 2–4 o'clock p.m..*

Explanation: Minimal power inputs in human are seen in the early morning (3–5 a.m.), and maximal power inputs in the early evening (4–6 p.m.). Such changes are related to circadian rhythms and to rotation of Earth around its axis.

23. A man left a conditioned premise and went outside. The outside temperature was +40 °C, the air moisture 60 %. What way of heat emission will be mostly involved in this case?

A. *Sweat evaporation.* B. *Convection.* C. *Radiation.* D. *Conduction.* E. –.

Explanation: If the temperature of environment is higher than body temperature and the humidity of air is below 100 %, the main way of heat loss is evaporation of sweat (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 892).

24. In a hot weather, the microclimate in hot rooms is often normalized by fans. At the same time heat radiation from the human body increases through:

A. *Convection.* B. *Heat conduction.* C. *Conduction.* D. *Radiation* E. *Evaporation.*

Explanation: When the body is exposed to wind (including that made by fans), the layer of air immediately adjacent to the skin is replaced by new air much more rapidly than normally, and heat loss by convection increases accordingly. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 892).

25. In a young man during exercise, the minute oxygen uptake and carbon dioxide emission equaled to 1000 ml. what substrates are oxidized in the cells of the body?

A. *Proteins.* C. *Fats.* E. *Carbohydrates and fats.*

B. *Carbohydrates.* D. *Carbohydrates and proteins.*

Explanation: «Respiratory quotient» is the ratio of CO₂ production to O₂ utilization and can be used to estimate fat and carbohydrate utilization. Respiratory quotient for carbohydrates is 1.0 (C₆H₁₂O₆ + 6 O₂ → 6 CO₂ + 6 H₂O), for fats RQ=0,7 and for proteins=0,8. In that case, 1000 ml CO₂ / 1000 ml O₂ = 1,0, thus the body is using carbohydrates (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 867).

26. The processes of heat transfer in a naked person at room temperature have been studied. It was revealed that under these conditions the greatest amount of heat is transferred by:

A. *Heat radiation.* B. *Heat conduction.* C. –. D. *Convection.* E. *Evaporation.*

Explanation: If the temperature of environment is lower than body temperature and the clothes are light or person is nude, the main way of heat loss is radiation of heat (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 891).

27. Which way of heat emission by the bodies of greenhouse workers is the most effective at the temperature of 36°C degrees and relative humidity of 70%?

A. *Liquid evaporation.* B. *Thermal conduction.* C. *Heat radiation.* D. *Convection.* E. –.

Explanation: If the temperature of environment is higher than body temperature and the humidity of air is below 100 %, the main way of heat loss is evaporation of sweat (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 892).

28. Power inputs of a man were measured. In what state was this man if his power inputs were lower than basal metabolism?

A. *Relaxation.* B. *Simple work.* C. *Rest.* D. *Sleep.* E. *Nervous tension.*

Explanation: The metabolic rate decreases 10 to 15 per cent below normal during sleep. This fall is due to two principal factors: (1) decreased tone of the skeletal musculature during sleep and (2) decreased activity of the central nervous system (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 887).

29. Thermometry revealed that the temperature of the exposed skin is by 1–1,5 °C lower than the temperature of the adjacent areas covered with clothing from natural fabrics. The reason for this is that the clothes reduce the heat loss through:

A. *Convection.* B. *Radiation.* C. *Conduction.* D. *Evaporation.* E. –.

Explanation: The clothes prevent contact of new portions of cold air with skin, thus decreasing emission of heat by convection (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 891).

30. At the end of the working day a worker of a hot work shop has been delivered to a hospital. The patient complains of a headache, dizziness, nausea, general weakness. Objectively: the patient is conscious, his skin is hyperemic, dry, hot to the touch. Heart rate is of 130/min. Respiration is rapid, superficial. What disorder of thermoregulation is most likely to have occurred in this patient?

- A. Increased heat transfer and reduced heat production.
- B. Increased heat transfer and heat production.
- C. Increased heat production with no changes to the heat transfer.
- D. Reduced heat transfer.**
- E. Reduced heat production with no changes to the heat transfer.

Explanation: Listed symptoms belong to condition named heat stroke that develops when the body temperature rises above normal. The most often reason of heat stroke is reduced heat release in case of high temperature of environment. As in that case the person has physical activity (workshop) and the temperature of environment is high, the heat production in him is increased while heat release decreases due to high environmental temperature, and reduce of heat release causes development of heat stroke (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 899).

31. It was determined that basal metabolic rate of a patient under study increased due value by 8 %. This means that the intensity of energetic metabolism processes in this patient is:

- A. Normal.
- B. Moderately increased.
- C. Moderately inhibited.
- D. Essentially inhibited.
- E. Essentially increased.

Explanation: Changes of BMR in range $\pm 10\%$ are considered as normal.

32. A month after a serious operation a 38-year-old patient has recovered and has now positive nitrogen balance. Urine of this patient may be found to have low concentration of the following nitrogen-containing substance:

- A. Lactate.
- B. 17-ketosteroids.
- C. Urea.
- D. Stercobilinogen
- E. Galactose.

Explanation: Nitrogenbalance is a state in which the rate of nitrogen ingestion equals the rate of excretion (chiefly as nitrogenous wastes). Positive nitrogen balance occurs when ingestion of proteins exceeds their excretion. The average protein contains about 16 per cent nitrogen. During metabolism of the protein, about 90 per cent of this nitrogen is excreted in the urine in the form of urea, uric acid, creatinine, and other less important nitrogen products. This, in case of positive nitrogen balance the concentration of urea as a breakdown product will decrease (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 866).

33. When measuring power input of a person by the method of indirect calorimetry the following result was obtained: oxygen consumption is 1000 ml and carbon dioxide production is 800 ml per minute. The person under examination has the following respiratory coefficient:

- A. 1,25.
- B. 1,0.
- C. 0,9.
- D. 0,84.
- E. 0,8.

Explanation: «Respiratory quotient» is the ratio of CO₂ production to O₂ utilization and can be used to estimate fat and carbohydrate utilization. In that case, 800 ml CO₂ / 1000 ml O₂ = 0,8 (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit XIII Metabolism and Temperature Regulation, p. 867).

34. For people adapted to high external temperature profuse sweating is not accompanied by loss of large volume of sodium chloride. This is caused by the effect the following hormone has on the perspiratory glands:

- A. Cortisol.
- B. Vasopressin.
- C. Aldosterone.
- D. Thyroxin.
- E. Natriuretic.

Explanation: Aldosterone has almost the same effects on sweat glands and salivary glands as it has on the renal tubules. Both these glands form a primary secretion that contains large quantities of sodium chloride, but much of the sodium chloride, on passing through the excretory ducts, is reabsorbed, whereas potassium and bicarbonate ions are secreted. Aldosterone greatly increases the reabsorption of sodium chloride and the secretion of potassium by the ducts. The effect on the sweat glands is important to conserve body salt in hot environments, and the effect on the salivary glands is necessary to conserve salt when excessive quantities of saliva are lost (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 949).

Physiology of excretion system

1. Person felt thirsty after staying in heat for a long time. Signals of what receptors caused it first of all?

A. *Baroreceptors of aortic arch.*

D. *Sodium receptors of hypothalamus.*

B. **Osmoreceptors of hypothalamus.**

E. *Glucoreceptors of hypothalamus.*

C. *Osmoreceptors of the liver.*

Explanation: Heat causes loss of water from the organism through sweating, and leads to increase of blood osmolarity. That causes the special nerve cells called osmoreceptor cells, located in the anterior hypothalamus near the supraoptic nuclei, to shrink and to fire impulses (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 358).

2. Shock and signs of acute renal failure (ARF) developed in the patient due to severe injury. What is the leading cause of development of ARF in the case?

A. *Decreased oncotic blood pressure.*

D. *Increased pressure in the renal arteries.*

B. **Decreased arterial pressure.**

E. *Urine excretion violation.*

C. *Increased pressure in the nephron capsule.*

Explanation: Acute renal failure (ARF) can be caused by 3 reasons: 1) decreased blood supply to the kidneys (prerenal ARF) – a consequence of heart failure with reduced cardiac output and low blood pressure or conditions associated with diminished blood volume and low blood pressure, such as severe hemorrhage; 2) Intrarenal ARF resulting from abnormalities within the kidney itself, including those that affect the blood vessels, glomeruli, or tubules; and 3) Postrenal ARF, resulting from obstruction of the urinary collecting system anywhere from the calyces to the outflow from the bladder (most common causes are kidney stones, caused by precipitation of calcium, urate, or cysteine). As a result of severe injury, the blood pressure decreases leading to ARF development (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 405).

3. During some diseases the patient experiences glucosuria. What is the possible reason of this phenomenon?

A. *Mechanisms of secondary active transport are broken.*

B. **The level of glucose in blood is higher than 10 millimole/l.**

C. *The permeability of the renal filter increases.*

D. *ADH Level in blood increases.*

E. *Aldosterone secretion decreases.*

Explanation: In normal conditions, all filtered glucose is reabsorbed from primary urine. Renal threshold for glucose when its total reabsorption occurs is 10 mmol/L (or about 200 mg/dL). Glucose in urine appears if its concentration exceeds the renal threshold (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 331).

4. For definition of effective renal plasma flow the substance is used which is freely filtrated, does not reabsorb and is completely secreted. What substance clearance is calculated for ERP definition?

A. *Insulin.*

B. *Inulin.*

C. **PAG.**

D. *Urea.*

E. *Creatinine.*

Explanation: PAH (para-aminohippuric acid) is the only substance that is almost completely cleared from plasma (about 90%) because it's excreted by tubular secretion as well as glomerular filtration. Therefore, the clearance of PAH can be used as an approximation of renal plasma flow (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 345).

5. The patient with diabetes had chronic renal failure, with the development of uremia, glomerular filtration rate decreased up to 8 ml/min. What was the reason of the GFR drop?

A. **Nephron number decrease through the development of nephrosclerosis.**

C. *Osmotic blood pressure increase.*

D. *Systemic arterial pressure decrease.*

B. *Afferent arteriole spasm.*

E. *Ureteral obstruction with stone.*

Explanation: Chronic renal failure results from progressive and irreversible loss of large numbers of functioning nephrons. Serious clinical symptoms often do not occur until the number of functional nephrons falls to at least 70 to 75 per cent below normal. Decrease of number of functioning nephrons decreases GFR (N GFR is about 125 ml/min constituting about 20 % of renal plasma flow) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 406, 316).

6. During the person's ageing gradual retrogression of the metabolic processes supplying energy in tissues is observed. What stage of uropoiesis will suffer in this case first of all?

A. Concentration. B. Filtration. C. Secretion. D. Reabsorption E. Synthesis.

Explanation: Tubular reabsorption includes passive and active mechanisms, and active mechanisms require adequate energy supply. Thus, decreased energy supply will lead to disorders of reabsorption first of all (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 328).

7. During laboratory examination of the patient sugar in urine is detected. Glucose concentration in blood plasma is within the limits of physiological norm. What processes derangements are observed in this case?

A. Glomerular filtration. C. Tubular secretion. E. Aldosterone secretions.

B. Tubular reabsorption. D. Insulin secretions.

Explanation: In normal conditions, all filtered glucose is reabsorbed from primary urine. Renal threshold for glucose when its total reabsorption occurs is 10 mmol/L (or about 200 mg/dL). Glucose in urine appears if its concentration exceeds the renal threshold. If glucose concentration in blood is normal, it means that the mechanisms of its reabsorption in nephrons are disturbed (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 331).

8. At acute cardiovascular collapse the urine formation stops, anuria occurs. What from the listed results in anuria development?

A. Oncotic blood pressure decrease. D. Derangements of the renal filter work.

B. Water reabsorption increase in tubules. E. ABP drop and GFR decrease.

C. Hydrostatic pressure of primary urine increase.

Explanation: Acute renal failure (ARF) can be caused decreased blood supply to the kidneys (prerenal ARF) – a consequence of heart failure with reduced cardiac output and low blood pressure or conditions associated with diminished blood volume and low blood pressure, such as severe hemorrhage. As a result of blood pressure drop, the GFR decreases leading to ARF development (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 405).

9. At head trauma in and around supraoptical and paraventricular nuclei of hypothalamus polyuria occurs. What results in development of the given phenomenon?

A. ADH secretion decrease. D. Sodium uretine peptide secretion decrease.

B. ADH secretion increase. E. Aldosterone secretion increase.

C. Renin secretion increase.

Explanation: Supraoptic nuclei of hypothalamus are synthesizing primarily ADH, and paraventricular nuclei synthesize primarily oxytocin. Antidiuretic hormone (ADH) increases the reabsorption of water in collecting tubules and ducts of kidneys thus decreasing the diuresis (daily production of secondary urine). Due to deficiency or absence of ADH (for example, in case of trauma in and around supraoptical nuclei) polyuria (increased amount of secondary urine) occurs (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 928).

10. At the decrease of systemic ABP the decrease of diuresis is observed. What mechanism derangements result in development of the given phenomenon?

A. Urine concentration in receiving tubules. D. Glomerular filtration.

B. Tubular reabsorption. E. Urine flow from urinary bladder.

C. Tubular secretion.

Explanation: As a result of blood pressure drop, the glomerular filtration rate (GFR) decreases leading to ARF development. That occurs due to decrease of hydrostatic pressure inside the glomerular capillaries (glomerular hydrostatic pressure), which promotes filtration (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 405, 317).

11. Glomerular filtration rate (GFR) increased by 20 % due to prolonged starvation of the person. The most evident cause of filtration changes under these conditions is:

A. Increase of filtration coefficient.

B. Increase of penetration of the renal filter.

C. Increase of systemic blood pressure.

D. Decrease of oncotic pressure of blood plasma.

E. Increase of renal plasma stream.

Explanation: $GFR = K_f \times \text{Net filtration pressure}$. K_f is filtration coefficient, and the net filtration pressure represents the sum of the hydrostatic and colloid osmotic forces that either favor or oppose filtration across the glomerular capillaries. These forces include (1) hydrostatic pressure inside the glomerular capillaries (glomerular hydrostatic pressure, PG), which promotes filtration; (2) the hydrostatic pressure in Bowman's capsule (PB) outside the capillaries, which opposes filtration; (3) the colloid osmotic pressure of the glomerular capillary plasma proteins (pG), which opposes filtration; and (4) the colloid osmotic pressure of the proteins in Bowman's capsule (pB), which promotes filtration. Starvation leads to decrease of blood oncotic (colloid osmotic) pressure that usually opposes filtration, thus leading to increase of GFR (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 317).

12. The low specific gravity of the secondary urine (1002) was found out in the sick person. What is the most distant part of nephron where concentration of secondary urine takes place?

A. In the nephron's glomerulus.

B. In ascending part of loop of Henle.

C. In distal tubule of nephron.

D. In proximal tubule of nephron.

E. In the collecting duct.

Explanation: The final urine output of water and solutes is determined by reabsorption and secretion in collecting ducts. The permeability of the medullary collecting duct to water is controlled by the level of ADH. With high levels of ADH, water is avidly reabsorbed into the medullary interstitium, thereby reducing the urine volume and concentrating most of the solutes in the urine (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 338).

13. A 16 year-old patient got numerous traumas in automobile accident. Now the patient is having a shock. AP – 80/60 mm Hg, daily urine volume 60–80 ml. What pathogenic mechanism leads to kidneys function violation?

A. Increased vasopressin blood concentration.

B. Decreased hydrostatic pressure in glomerular capillaries.

C. Trauma of the urinary bladder.

D. Increased osmotic pressure in glomerular capillaries.

E. Increased pressure in Bowman's capsule.

Explanation: As a result of blood pressure drop, the glomerular filtration rate (GFR) decreases leading to ARF development. That occurs due to decrease of hydrostatic pressure inside the glomerular capillaries (glomerular hydrostatic pressure), which promotes filtration (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 405, 317).

14. A 58-year-old patient with acute cardiac insufficiency has decreased volume of daily urine - oliguria. What is the mechanism of this phenomenon?

A. Decreased number of functioning glomerules.

B. Drop of oncotic blood pressure.

C. Rise of hydrostatic blood pressure in capillaries.

D. Reduced permeability of renal filter.

E. Decreased glomerular filtration.

Explanation: As a result of acute cardiac insufficiency, the renal blood flow and the glomerular filtration rate (GFR) decrease leading to ARF development. That occurs due to decrease of

hydrostatic pressure inside the glomerular capillaries (glomerular hydrostatic pressure), which normally promotes filtration (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 405, 317).

15. Examination of a patient revealed hyperkalemia and hyponatremia. Low secretion of which hormone may cause such changes?

A. *Natriuretic.* B. *Parathormone.* C. *Cortisol.* **D. *Aldosteron.*** E. *Vasopressin.*

Explanation: Aldosterone is the hormone produced by adrenal cortex that causes increased renal tubule reabsorption of sodium and secretion of potassium. Simultaneously with sodium reabsorption in kidneys there is osmotic absorption of almost equivalent amounts of water that decrease the amount of urine. Hyposecretion of aldosterone will cause the reduced diuresis, hypernatremia and hypokalemia (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 77 Adrenocortical hormones, p. 948)

16. A driver who got a trauma in a road accident and is shocked has reduction of daily urinary output down to 300 ml. What is the main pathogenetic factor of such diuresis change?

A. *Decreased number of functioning glomerules.* **D. *Drop of arterial pressure.***
B. *Increased vascular permeability.* E. *Drop of oncotic blood pressure.*
C. *Secondary hyperaldosteronism.*

Explanation: Shock is a state of abrupt drop of blood pressure that leads to decrease of the renal blood flow and the glomerular filtration rate (GFR) (acute renal failure development). That occurs due to decrease of hydrostatic pressure inside the glomerular capillaries (glomerular hydrostatic pressure), which normally promotes filtration. Daily urinary output normally is about 1,5–2 L, in case of ARF decreases drastically (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 405, 317).

17. A patient has a decreased vasopressin synthesis that causes polyuria and as a result of it evident organism dehydration. What is the mechanism of polyuria development?

A. *Reduced tubular reabsorption of protein.* **D. *Reduced tubular reabsorption of water.***
B. *Reduced tubular reabsorption of Na ions.* E. *Acceleration of glomerular filtration.*
C. *Reduced glucose reabsorption.*

Explanation: Vasopressin (antidiuretic hormone, ADH) increases the reabsorption of water in collecting tubules and ducts of kidneys thus decreasing the diuresis (daily production of secondary urine). Due to deficiency or absence of vasopressin tubular reabsorption of water decreases and polyuria (increased amount of secondary urine) occurs (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 928).

18. A patient with diminished excretory function of kidneys has bad breath. What substance which is excessively excreted by salivary glands is the main cause of this occurrence?

A. *Alpha-amylase.* B. *Lysozyme.* C. *Phosphatase.* **D. *Urea*** E. *Mucin.*

Explanation: In case of renal failure high concentration of the nonprotein nitrogens — especially urea, creatinine, and uric acid—resulting from failure of the body to excrete the metabolic end products of proteins appears. This total condition is called uremia because of the high concentration of urea in the body fluids. Due to high concentration of urea in blood it starts to filter in saliva leading to bad breath (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 411).

19. Glucose concentration in a patient's blood is 15 mmole/l (reabsorption threshold is 10 mmole/l). What effect can be expected?

A. *Diuresis reduction.* **D. *Reduced aldosterone secretion.***
B. *Reduced glucose reabsorption.* **E. *Glucosuria.***
C. *Reduced vasopressin secretion.*

Explanation: In normal conditions, all filtered glucose is reabsorbed from primary urine. Renal threshold for glucose when its total reabsorption occurs is 10 mmol/L (or about 200 mg/dL). Glucose in urine appears if its concentration exceeds the renal threshold, and that condition is called glucosuria (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 331).

20. A 48 year old male patient was admitted to the hospital with acute attack of chronic glomerulonephritis. Examination revealed chronic renal failure. What is the cause of hyperazotemia by chronic renal failure?

- A. **Reduction of glomerular filtration.** D. *Disorder of protein metabolism.*
B. *Reduction of tubular reabsorption.* E. *Disorder of water-electrolytic metabolism.*
C. *Reduction of tubular excretion.*

Explanation: Chronic renal failure results from progressive and irreversible loss of large numbers of functioning nephrons. Serious clinical symptoms often do not occur until the number of functional nephrons falls to at least 70 to 75 per cent below normal. Decrease of number of functioning nephrons decreases glomerular filtration rate (N GFR is about 125 ml/min constituting about 20% of renal plasma flow) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 406, 316).

21. A 23-year-old patient with diabetes mellitus has hyperglycemia at the rate 19 mmol/l which is clinically manifested by glycosuria, polyuria, polydipsia. Which is the listed below mechanisms is responsible for the development of glycosuria?

- A. *Polydipsia.* D. *Non-enzymatic glycosylation of proteins.*
B. *Tissue dehydration.* E. **Exceedence of glucose renal threshold.**
C. *Polyuria.*

Explanation: In normal conditions, all filtered glucose is reabsorbed from primary urine. Renal threshold for glucose when its total reabsorption occurs is 10 mmol/L (or about 200 mg/dL). Glucose in urine appears if its concentration exceeds the renal threshold, and that condition is called glucosuria (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 331).

22. In 52-year-old patient with chronic glomerulonephritis, the glomerular filtration rate (GFR) was reduced by 20 % compared to normal. What causes the decrease in GFR in patient with chronic renal failure?

- A. *Obstruction of urinary tract.* D. **Reduced number of active nephrons.**
B. *Renal artery thrombosis.* E. *Tubulopathy.*
C. *Renal ischemia.*

Explanation: Chronic diseases of kidneys can lead to chronic renal failure results from progressive and irreversible loss of large numbers of functioning nephrons. Serious clinical symptoms often do not occur until the number of functional nephrons falls to at least 70 to 75 per cent below normal. Decrease of number of functioning nephrons decreases glomerular filtration rate (N GFR is about 125 ml/min constituting about 20 % of renal plasma flow) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 406, 316).

23. Arterial pH is 7,4; primary urine – 7,4; final urine – 5,8. Decrease in the pH of final urine is the result of the secretion of the following ions in the nephron tubules:

- A. *Hydrogen carbonate ions.* C. **Hydrogen ions.** E. *Urea.*
B. *Creatinine.* D. *Potassium ions.*

Explanation: pH depends on concentration of hydrogen ions. Secretion of hydrogen ions in nephron occurs in proximal tubule by the secondary active secretion of and by late distal tubule and the cortical collecting tubule (intercalated cells) by an active hydrogen-ATPase mechanism (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 337).

24. A 29-year-old patient with pyelonephritis has been found to have hyposthenuria combined with polyuria. According to this data, what process is most likely to be disrupted?

- A. *Glomerular filtration.* C. *–.* E. **Tubular reabsorption.**
B. *Tubular excretion.* D. *Tubular secretion.*

Explanation: Polyuria (increased volume of urine) and hyposthenuria (low specific gravity of urine; N = 1,010–1,025) are the signs of diluted urine, i.e. urine with great volume of water. Water loss with urine depends on reabsorption of water in different parts of nephron. Thus,

polyuria and hyposthenuria are caused by impairment of tubular reabsorption as a result of pyelonephritis. Pyelonephritis begins in the renal medulla and therefore usually affects the function of the medulla more than it affects the cortex, at least in the initial stages. Because one of the primary functions of the medulla is to provide the countercurrent mechanism for concentrating urine, patients with pyelonephritis frequently have markedly impaired ability to concentrate the urine (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 332, 409).

25. Examination of a patient revealed glycosuria and hyperglycemia. He complains of dry mouth, itchy skin, frequent urination, thirst. He has been diagnosed with diabetes mellitus. What is the cause of polyuria in this patient?

A. Increased filtration pressure.

D. Decreased plasma oncotic pressure.

B. Increased plasma oncotic pressure.

E. Decreased cardiac output.

C. Increased urine osmotic pressure.

Explanation: The polyuria results from a high concentration of glucose in the renal tubule. Presence of glucose in urine increases the osmotic pressure of urine and opposes the osmotic reabsorption of water, so more water is passed in the urine (osmotic diuresis) and a person may become severely dehydrated. In diabetes mellitus the high glucose concentration in the tubule is a result of hyperglycemia (Saladin: Anatomy & Physiology: The Unity of Form and Function (Third Edition) / Saladin K.S. – © The McGraw–Hill Companies, 2003. Chapter 23 The Urinary System, p. 902).

26. Urine analysis has shown high levels of protein and erythrocytes in urine. This can be caused by the following:

A. Hydrostatic blood pressure in glomerular capillaries. D. Oncotic pressure of blood plasma.

B. Renal filter permeability.

E. Effective filter pressure.

C. Hydrostatic pressure of primary urine.

Explanation: Renal filter has 3 major layers: (1) the endothelium of the capillary, (2) a basement membrane, and (3) a layer of epithelial cells (podocytes) surrounding the outer surface of the capillary basement membrane. Together, these layers make up the filtration barrier, which, despite the three layers, filters several hundred times as much water and solutes as the usual capillary membrane. Even with this high rate of filtration, the glomerular capillary membrane normally prevents filtration of plasma proteins, moreover of RBC. In case of increased permeability of filter due to inflammation etc. both protein and red blood cells to leak from the blood of the glomerular capillaries into the glomerular filtrate (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 316, 406).

27. A patient has insufficient blood supply to the kidneys, which has caused the development of pressor effect due to the constriction of arterial resistance vessels. This is the result of the vessels being greatly affected by the following substance:

A. Renin. B. Angiotensinogen. C. Angiotensin II. D. Catecholamines E. Norepinephrine.

Explanation: Decreased blood supply to kidneys causes secretion of renin and the activation of RAAS. Renin converts angiotensinogen into angiotensin I, which is further transformed into angiotensin II by ACE. Angiotensin II is a potent vasoconstrictor that preferentially constricts in kidneys efferent arterioles, raises glomerular hydrostatic pressure while reducing renal blood flow (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 322).

28. Diabetic nephropathy with uremia has developed in patient with pancreatic diabetes. The velocity of glomerular filtration is 9 ml/min. What mechanism of a decrease in glomerular filtration velocity and chronic renal failure development is most likely in the case of this patient?

A. Reduction of active nephron mass.

D. Obstruction of nephron tubules with hyaline casts.

B. Tissue acidosis.

C. Decrease in systemic arterial pressure.

E. Arteriolar spasm.

Explanation: Chronic diseases of kidneys can lead to chronic renal failure results from progressive and irreversible loss of large numbers of active functioning nephrons. Serious clinical symptoms often do not occur until the number of functional nephrons falls to at least 70 to 75 per cent below normal. Decrease of number of functioning nephrons decreases glomerular filtration rate (N GFR is about 125 ml/min constituting about 20% of renal plasma flow) (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 406, 316).

29. A patient with massive burns developed acute renal insufficiency characterized by a significant and rapid deceleration of glomerular filtration. What is the mechanism of its development?

- A. *Reduction of functioning nephron number.* D. **Reduction of renal blood flow.**
B. *Damage of glomerular filter.* E. *Renal artery embolism.*
C. *Rise of pressure of tubular fluid.*

Explanation: Acute renal failure (ARF) can be caused by 3 reasons: 1) decreased blood supply to the kidneys (prerenal ARF) – a consequence of heart failure with reduced cardiac output and low blood pressure or conditions associated with diminished blood volume and low blood pressure, such as severe hemorrhage; 2) Intrarenal ARF resulting from abnormalities within the kidney itself, including those that affect the blood vessels, glomeruli, or tubules; and 3) Postrenal ARF, resulting from obstruction of the urinary collecting system anywhere from the calyces to the outflow from the bladder (most common causes are kidney stones, caused by precipitation of calcium, urate, or cysteine). As a result of severe injury, the blood pressure decreases leading to ARF development (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 405).

30. A child has an acute renal failure. What biochemical factor found in saliva can confirm this diagnosis?

- A. *Increase in glucose concentration.* D. *Increase in concentration of higher fatty acids.*
B. *Decrease in glucose concentration.* E. *Decrease in nucleic acid concentration* .
C. **Increase in urea concentration.**

Explanation: In case of renal failure high concentration of the nonprotein nitrogens— especially urea, creatinine, and uric acid—resulting from failure of the body to excrete the metabolic end products of proteins appears. This total condition is called uremia because of the high concentration of urea in the body fluids. Due to high concentration of urea in blood it starts to filter in saliva leading to bad breath (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 411).

31. Histologic specimen of the kidney demonstrates cells closely adjoined to the renal corpuscle in the distal convoluted tubule. Their basement membrane is extremely thin and has no folds. These cells sense the changes in sodium content of urine and influence renin secretion occurring in juxtaglomerular cells. Name these cells:

- A. **Macula densa cells.** C. *Mesangial cells.* E. *Juxtaglomerular cells.*
B. *Glomerular capillary endothelial cells.* D. *Podocytes.*

Explanation: Changes in sodium chloride concentration are sensed by cells of macula densa - a patch of slender, closely spaced epithelial cells at the start of the distal convoluted tubule, directly across from the juxtaglomerular cells. In case of decrease in sodium chloride concentration signals from the macula densa (1) decrease resistance to blood flow in the afferent arterioles, which raises glomerular hydrostatic pressure and helps return GFR toward normal, and (2) increase renin release from the juxtaglomerular cells of the afferent and efferent arterioles. Renin released from these cells then functions as an enzyme to increase the formation of angiotensin I, which is converted to angiotensin II. Finally, the angiotensin II constricts the efferent arterioles, thereby increasing glomerular hydrostatic pressure and returning GFR toward normal (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit V The Body Fluids and Kidneys, p. 324).

32. A patient with a history of chronic glomerulonephritis presents with azotemia, oliguria, hypo- and isosthenuria, proteinuria. What is the leading factor in the pathogenesis of these symptoms development under chronic renal failure?

A. Mass decrease of active nephrons.

B. Intensification of glomerular filtration.

C. Tubular hyposecretion.

D. Disturbed permeability of glomerular membranes.

E. Intensification of sodium reabsorption.

Explanation: Chronic diseases of kidneys can lead to chronic renal failure results from progressive and irreversible loss of large numbers of active functioning nephrons. Serious clinical symptoms often do not occur until the number of functional nephrons falls to at least 70 to 75 per cent below normal. Decrease of number of functioning nephrons decreases glomerular filtration rate (N GFR is about 125 ml/min constituting about 20 % of renal plasma flow), leads to appearing of proteins in urine, disturbs the concentrating ability of kidneys (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 406, 316).

33. Due to the use of poor-quality measles vaccine for preventive vaccination, a 1-year-old child developed an autoimmune renal injury. The urine was found to contain macromolecular proteins. What process of urine formation was disturbed?

A. Filtration.

C. Secretion.

E. Secretion and filtration.

B. Reabsorption.

D. Reabsorption and secretion.

Explanation: In normal conditions the proteins are not filtered into urine due to renal filter that has 3 major layers: (1) the endothelium of the capillary, (2) a basement membrane, and (3) a layer of epithelial cells (podocytes) surrounding the outer surface of the capillary basement membrane. In case of increased permeability of filter due to inflammation etc. both protein and red blood cells start to leak from the blood of the glomerular capillaries into the glomerular filtrate (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 316, 406).

34. According to the results of glucose tolerance test, the patient has no disorder of carbohydrate tolerance. Despite that, glucose is detected in the patients's urine (5 mmol/l). The patient has been diagnosed with renal diabetes. What renal changes cause glucosuria in this case?

A. Decreased activity of glucose reabsorption enzymes.

D. Increased glucose secretion.

B. Increased activity of glucose reabsorption enzymes.

E. Increased glucose filtration.

C. Exceeded glucose reabsorption threshold.

Explanation: If person has glucosuria despite normal blood glucose concentration, it means that the transport mechanism for tubular reabsorption of glucose is greatly limited or absent. Glucose is cotransported with Na⁺ by carriers called sodium-glucose transport proteins (SGLTs). It is then removed from the basolateral surface of the cell by facilitated diffusion. Normally all glucose in the tubular fluid is reabsorbed and there is none in the urine (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 413).

35. A man presents with glomerular filtration rate of 180 ml/min, while norm is 125 ml/min. The likely cause of it is the decreased:

A. Effective filtration pressure.

D. Renal blood flow.

B. Plasma oncotic pressure.

E. Permeability of renal filter.

C. Hydrostatic blood pressure in the glomerular capillaries.

Explanation: $GFR = K_f \times \text{Net filtration pressure}$. K_f is filtration coefficient, and the net filtration pressure represents the sum of the hydrostatic and colloid osmotic forces that either favor or oppose filtration across the glomerular capillaries. These forces include (1) hydrostatic pressure inside the glomerular capillaries (glomerular hydrostatic pressure, P_G), which promotes filtration; (2) the hydrostatic pressure in Bowman's capsule (P_B) outside the capillaries, which opposes filtration; (3) the colloid osmotic pressure of the glomerular capillary plasma proteins (p_G), which opposes filtration; and (4) the colloid osmotic pressure of the proteins in Bowman's capsule (p_B), which promotes filtration. Decrease of effective filtration pressure, hydrostatic pressure of capsule, and permeability of renal filter will decrease GFR. (Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elsevier, 2006. Unit V The Body Fluids and Kidneys, p. 317).

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