**MINISTRY OF HEALTH OF UKRAINE**
**KharkovNationalMedicalUniversity**
**Physiology department**

# STUDY GUIDE

## Part I

### GENERAL PHYSIOLOGY
### HIGER INTEGRATIVE FUNCTIONS & SENSORY SYSTEMS

Name_____

Faculty_____

Group _____ course _____

2020

**MINISTRY OF HEALTH OF UKRAINE**
**Kharkov National Medical University**
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# STUDY GUIDE

**Part I**

**GENERAL PHYSIOLOGY**
**HIGER INTEGRATIVE FUNCTIONS & SENSORY SYSTEMS**

***Training tests of license exam "Krok 1"***
***with answers and explanations***
***for individual work of English-speaking students***
***for medical and dental faculties***

**Частина І. «Загальна фізіологія.**
**Вищі інтегративні функції та сенсорні системи»**

**Тренувальні тести в форматі «Крок 1»**
**для самостійної підготовки студентів**
**з англомовною формою навчання**
**з відповідями та поясненнями**
**(для медичних та стоматологічного факультетів).**

Затверджено
Вченою радою ХНМУ.
Протокол № 12 від 17.12.2020.

**Kharkiv**
**KNMU**
**2020**

Study guide. Part I “General Physiology. High Integrative Functions& Sensory Systems”: Training tests of license exam "Krok 1" with answers and explanations for individual work of English-speaking students (for medical and dental faculties) / compil. D. I. Marakushin, L. V. Chernobay, I. S. Karmazina et al. – Kharkov : KhNMU, 2020.– 100 p.

Compilers D. I. Marakushin
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Тренувальні тести в форматі "Крок 1" для самостійної підготовки студентів з англомовною формою навчання з відповідями та поясненнями (для медичних та стоматологічного факультетів). Частина І. "Загальна фізіологія. Вищі інтегративні функції та сенсорні системи" / упоряд. Д. І. Маракушин, Л. В. Чернобай, І. С. Кармазіна та ін. – Харків : ХНМУ, 2020. – 100 с.

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**Dear Students!**

This Study Guide was created to help you to get ready for License exam "Krok 1", but it's not the only reason. In your future life as a doctor every day you will face different clinical situations and you will have to make a decision what to do. Each task in this manual is a little clinical situation which you have to solve and get the proper answer about diagnosis, research methods, and appropriate treatment, etc. So, in fact, it is the first step to achieve your dream to become a doctor. Physiology is a base of all medical sciences that's why whichever medical career you may choose you'll use your physiology knowledge anyway. Our subject may be difficult but we hope for you it will become interesting and one of your favorites and this Study Guide will help you to make a firm step towards your dream!

Good luck! Let's start to work!

**The strategy and algorithm of task solution**

1. **Read the task carefully and while reading chose the key words, which are the most relevant for the solution!**
2. **Think about the mechanism and try to represent it schematically.**
3. **Chose one correct option.**
4. **Compare your answer with the correct one and read explanation attentively.**
5. **If you need to revise more information or work out the mechanism, follow the reference given in the explanation.**

For example:

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.*

**1. Read the task carefully!**

**2. Chose key words!** They are **PENETRATION, POTASSIUM, INCREASED**

**3.** Positive after-potential (hyperpolarization, after-hyperpolarization) linked with changes (increased) in permeability of cell membrane for potassium ions.

**4. So, chose correct option which is B. Hyperpolarization.**

## PHYSIOLOGY OF EXCITABLE TISSUES

### *Questions*

### Membrane Potentials. Rest Membrane Potential. Action Potential

**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.*

**Notes:**_____

**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.* $HCO^-$.

**Notes:**_____

**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.*

**Notes:**_____

**4**. 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. Natrium channels.*
*B. Sodium and calcium channels.* *D. Potassium channels.*

**Notes:**_____

**5**. 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.*

**Notes:**_____

**6**. 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 hyperpolarizatio.* *D. –.*

**Notes:**_____

**7**. 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.*

**Notes:**_____

**8**. 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.*

**Notes:**_____

**9**. In the dental practice, the vitality of tooth tissues is estimated by electric pulp test. What parameter is assessed?

*A. Chronaxie.* *C. Accommodation.* *E. Threshold stimulus intensity.*
*B. Productive time.* *D. Lability.*

**Notes:**_____

**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.*

***Notes:***_____

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

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

**Notes:**_____

**12**. It is required to evaluate the level of tissue excitability. For this purpose one should determine:

*A. Resting potential.* *C. Action potential amplitude.* *E. Depolarization threshold.*
*B. Critical level of depolarization.* *D. Action potential duration.*

**Notes:**_____

**13**. 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. $Ca^{2+}$ and Cl−.* *D. Na+.* *E. $Ca^{2+}$.*

**Notes:**_____

**14**. In the experiment, the permeability of excitable cell membrane for potassium ions has been increased. What changes can be expected in the membrane state?

*A. There will be no changes.* *C. Hyperpolarization.* *E. Local response.*
*B. Depolarization.* *D. Action potential.*

**Notes:**_____

**15**. 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*

**Notes:**_____

**16.** *KCl* concentration in a solution that surrounds an isolated cell was increased. How will resting membrane potential (RMP) and cell excitability change in this case?

*A. RMP increases, excitability decreases.*
*B. RMP and excitability remain unchanged.*
*C. RMP increases, excitability increases.*
*D. RMP decreases, excitability increases.*
*E. RMP decreases, excitability remains unchanged.*

**Notes:**_____

## Mechanism of excitation conduction in nerve fiber and neuromuscular synapse

**17**. 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.*

**Notes:**_____

**18**. 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 Ca2+ channels of the presynaptic membrane.*
*D. Blockade of N-cholinergic receptors of the synaptic membrane.*
*E. Depolarization of the postsynaptic membrane.*

**Notes:**_____

**19**. 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. Glyeine.* *D. Dopamine.* *E. Acetylcholine.*

**Notes:**_____

## Mechanism of muscle contraction and relaxation

**20**. After prolonged exercising people usually experience intense muscle pain. What is its most likely cause?

*A. Increased concentration of ADP in muscles.*
*B. Increased muscle excitability.*
*C. Intensified disintegration of muscle proteins.*
*D. Accumulation of lactic acid in muscles.*
*E. Accumulation of creatinine in muscles.*

**Notes:**_____

**21**. 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.* *C. Continuous (smooth) tetanus.* *E. Waved tetanus.*
*B. Single.* *D. Asynchronous.*

**Notes:**_____

**22**. 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.* *D. Decreased velocity of the AP distribution.*
*B. Decreased AP.* *E. Prolonged relaxation.*
*C. Prolonged duration of the AP.*

**Notes:**_____

**23**. 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.* *C. Holotetanus (smooth).* *E. Muscle contracture.*
*B. Partial tetanus.* *D. A series of single contractions.*

**Notes:**_____

**24**. 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.*

**Notes:**_____

**25**. 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.*

**Notes:**_____

**26**. 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.*

**Notes:**_____

**27**. 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.*

**Notes:**_____

**28**. 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.*

**Notes:**_____

**29**. 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 cardiomyocyes.*

**Notes:**_____

**30.** I.M. Sechenov has proven that a tired limb restores its working capacity faster if during its period of rest another limb woks. It becomes a basis for the concept of:

*A. Pessimum.* *B. Optimum.* *C. Fatigue.* *D. Active rest.* *E. Parabiosis.*

**Notes:**_____

**31.** People, who for a long time remained in hypodynamic state, develop intense pain in muscles after a physical exertion. What is the most likely cause of this pain?

*A. Accumulation of lactic acid in muscles.* *D. Decreased content of lipids in muscles.*
*B. Intensive breakdown of muscle proteins.* *E. Accumulation of creatinine in muscles.*
*C. Increased content of ADP in muscles.*

**Notes:**_____

**PHYSIOLOGY OF EXCITABLE TISSUES**

***Answers***

**Membrane Potentials. Rest Membrane Potential. Action Potential**

**1. Correct answer is B.** *(Saladin, Chapter 12:Nervous Tissue, p. 458; Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, p. 133–135).*

A negative overshoot called **hyperpolarization** occurs when potassium voltage-gated channels stay open longer than sodium gates, so the amount of potassium that leaves the cell is greater than the amount of sodium that entered *(fig. 1)*. 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).

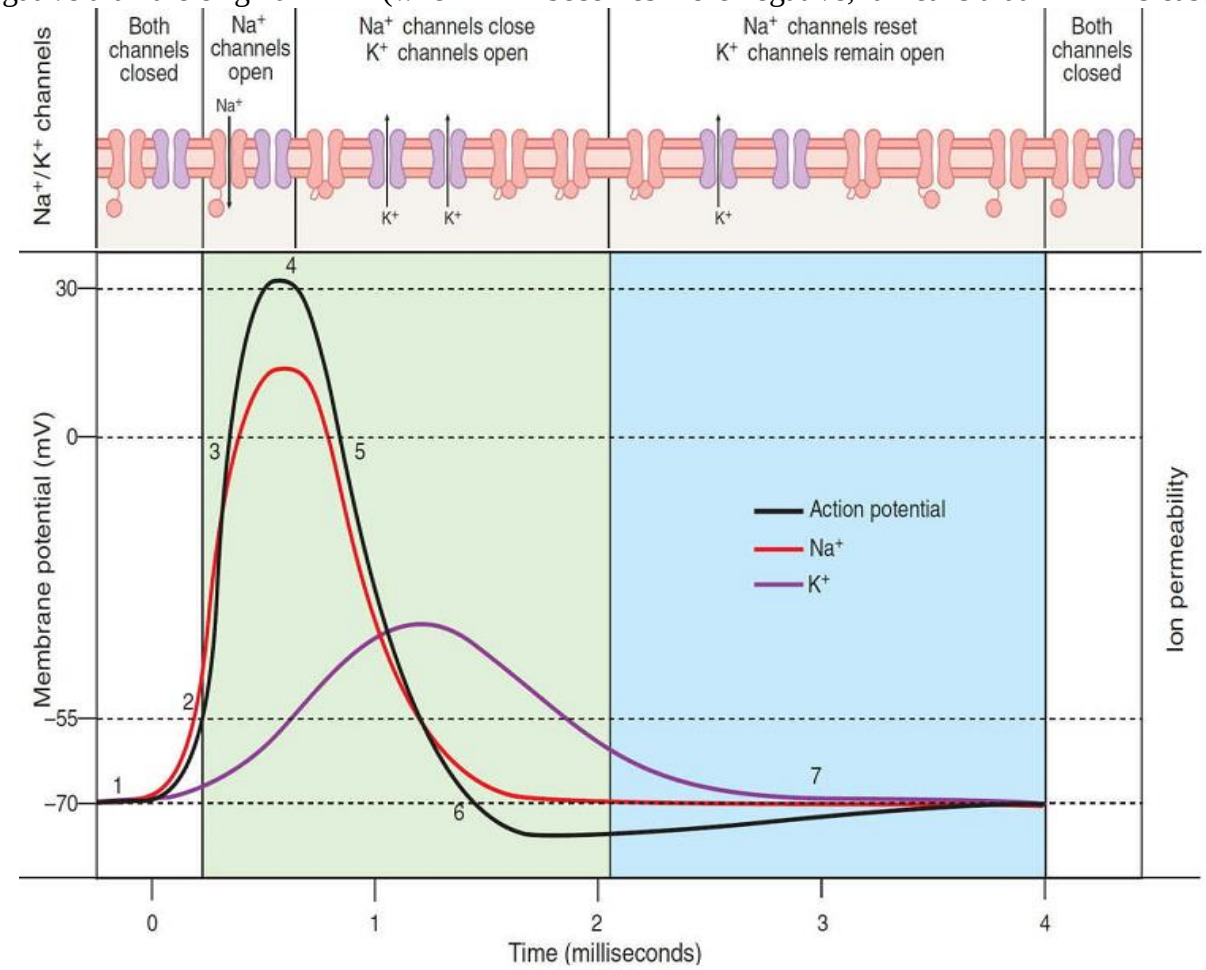



**Figure 1. Changes in membrane potential and relative membrane permeability to Na+ and K+ during an action potential:**

*1*, 7 – rest membrane potential, 2 – threshold potential, 3 – rapid depolarization, 4 – overshoot (reversed polarization), 5- repolarization, 6 – hyperpolarization. Pay attention on the state of voltage-gated $Na^+$ and $K^+$ channel during excitation!

**2. Correct answer is A.** *(Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, pp. 20–22, 136).*

Concentration of $Na^+$ ionsin the extracellular fluid is 135–145 mmol/L and in the cytosol is about 15 mmol/L. A depolarizing stimulus such as electric current causes opening of voltage-gated sodium channels and **inward movement of $Na^+$** resulting in reduction of cell membrane potential, i.e. *depolarization*.

**3. Correct answer is C.** *(Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, pp. 20–22, 136).*

In this case "quiet potential" means "rest membrane potential" (RMP). As assumed, in the most of excitable cells RMP results from leaking of potassium ions from the cell, and the upstroke of an action potential depends on the influx of sodium into the cell (options A, B and E are irrelevant). As

the cell RMP *didn't change significantly*, potassium channels were not blocked. Thus, the *inability of the cell to generate AP* is the evidence of **sodiumvoltage-gated channels blocking** in the course of the mentioned experiment.

**4. Correct answer is D.** *(Saladin,Chapter 12:Nervous Tissue, p. 458; Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, p. 133–135).*

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 (*fig. 1*). 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). Thus, **activation of potassium channels** results in *increase of the cell membrane potential* (option D). In contrast, activation of any other mentioned channels causes inward movement of positively charged ions leading to depolarization, i.e. reduction of the cell membrane voltage (options A, B, C, and E are irrelevant).

**5. Correct answer is C.** *(Saladin, Chapter 12:Nervous Tissue, p. 456).*

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. Thus, blocking of ATP synthesis leads to insufficiency of $Na^+$-$K^+$ pump resulting in eventual equalization of $Na^+$ and $K^+$ concentrations across the plasma membrane and **disappearance of RMP.**

**6. Correct answer is C.** *(Saladin, 2003. Chapter 12:Nervous Tissue, p. 458).*

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 mV. The membrane is now positive on the inside and negative on the outside – its polarity is **reversed** compared to the RMP (*fig. 2*).

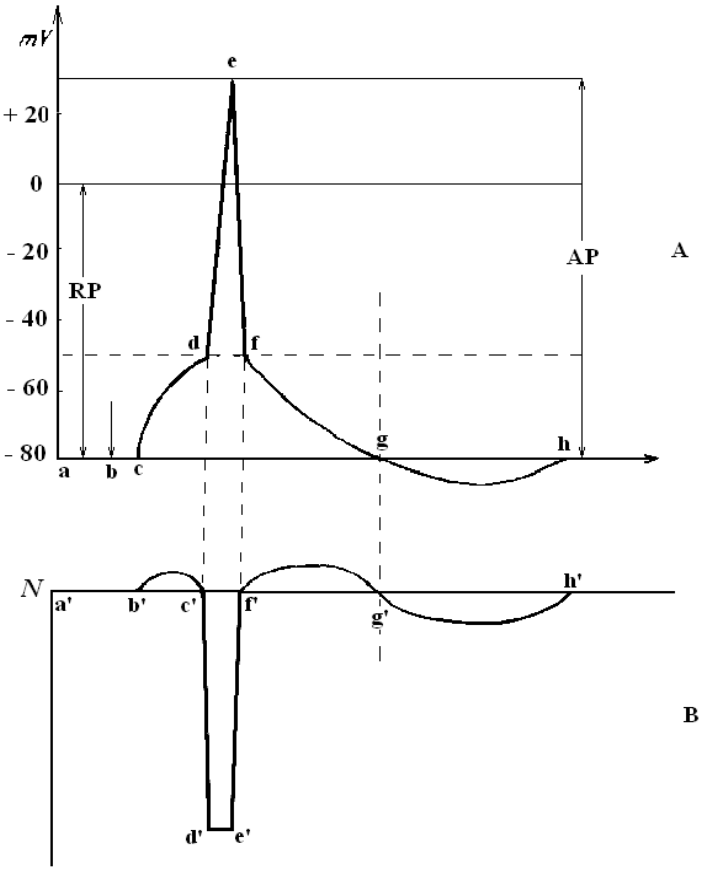



**Figure 2. Graphic presentation of cell excitation and excitability (pay attention on correspondence of theirphases!):**

*A – Phases of an Action Potential*

**(ab –** rest condition (static polarization), rest membrane potential;
**bh –** excitation (action potential);
**bc –** latent period;
**ce –** depolarization (**cd –** slow; **de -** rapid);
**d –** critical level of depolarization, threshold;
**eg –** repolarization
(**ef –** rapid; **fg –** slow, negative after-potential);
**gh –** hyperpolarization, positive after-potential).

*B – Dynamics of cell excitability during excitation*

(**a'b' –** normal excitability;
**b'c'; f'g' –** supernormal excitability;
**c'd'; e'f' –** relative refractory period;
**d'e'** – absolute refractory period;
**g'h' –** supernormal excitability

**7. Correct answer is B.** *(Saladin,Chapter 12:Nervous Tissue, p. 457).*
Threshold of stimulation is the minimum strength of stimulus which must be applied in order to cause an excitable cell to generate AP. *Threshold of stimulation force becomes lower* if excitability of a tissue is supranormal (higher than normal) (*fig. 2*). Cells possess supranormal excitability when the membrane is partially depolarized. In most of excitable cells (with a few exceptions) depolarization usually results from the**activation of sodium channels of membrane** and sodium influx.
**8. Correct answer is C.** *(Saladin,Chapter 12:Nervous Tissue, p. 457; Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, p. 137).*
Local potentials are **graded,** meaning that they vary in magnitude (voltage) according to the strength of the stimulus (*fig. 3*). 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). In the case, as the cell was stimulated by the subthreshold stimulus (threshold stimulus is 100 per cent, therefore *70 per cent is subthreshold* one), this cell can generate the **partial depolarization** only, but not action potential which requires threshold or suprathreshold stimulus (option B is irrelevant).

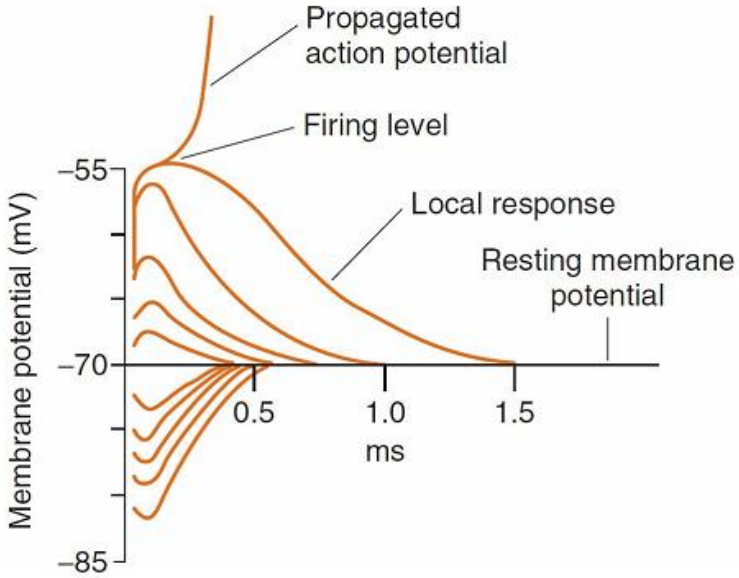



**Figure 3. Graded potentials:** the magnitude of a Local Response depends on strength of stimulus

**9. Correct answer is E. (***Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, p.137)*
An electrical current can be applied to the tooth in order to generate anaction potentialin the nerve fibres within pulp, eliciting a neurological response. In the course of the electric pulp test (EPT), a conducting medium (e.g. toothpaste) is applied on a dried tooth, and then the probe tip of an electric pulp tester is placed on the surface of the tooth closest to the pulp horn(s). The patient is directed to hold the end of the conducting probe when a 'tingling' sensationis felt. If tooth pulp is traumatized, inflamed, etc., **theintensity of electric stimulus** in order to reach the **threshold** of nerve fiber excitation and following sensation can vary. Answers A, B, and D are irrelevant, as chronaxia, productive time and lability cannot be measured with the help of EPT. Accommodation is the reduction of cell excitability due to the inactivation of sodium voltage-gated channels under the prolonged stimulation by subthreshold stimuli (irrelevant D).
**10. Correct answer is B.** *(Saladin, Chapter 12Nervous Tissue, p. 458).*
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). Thus, **activation of potassium channels** results in *hyper polarization (increase membrane potential) (fig. 1).*

**11. Correct answer is E.** *(USMLE Step 1 Lecture Notes, Kaplan, 2018. –Physiology. Part II: Excitable tissues. Chapter 2: The Neuron Action Potential and Synaptic Transmission, p. 27; Saladin, Chapter 11: Muscular system, p. 457).*

**Action potentials** follow an *all-or-none law*, which states that threshold and suprathreshold stimuli cause the same response of an excitable cell which is the Action Potential (AP), and subthreshold stimuli are unable to cause AP but do cause the Local Potential (local depolarization)**.** If a stimulus depolarizes the neuron to threshold, the neuron fires at its maximum voltage (it varies from 0 to +60 mV, tending to reach $Na^+$ equilibrium potential); if threshold is not reached, the neuron does not fire at all. Above threshold, stronger stimuli do not produce stronger action potentials. Thus, having been generated, then AP spreads all along the membrane of an excitable cell in *undecremental manner*, i.e. with the same amplitude regardless the distance (*see table 1*).

**Table 1**

**Comparison of Local Potential and Action Potential Properties**

| *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. Correct answer is E. (***Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, p.137; Human physiology volume I / G.I. Kositsky.- Medicine, 1990).*

There are four following criteria *of tissue excitability*: 1) **threshold of depolarization, *mV*** (stimulus intensity) – minimal strength of stimulus which is enough to cause action potential (at the curve strength-duration it is determined as ***rheobase)***; 2) **productive time, *msec*** – minimal time necessary to cause AP if the current with the strength equals 1 rheobase is applied*;* 3) **chronaxia, *msec*** – minimal time necessary to cause AP if the current with the strength of double rheobase is applied (*fig. 4*); and 4) **lability, *imp/sec*** – frequency of impulses generation under the successive stimulation; lability is inversely proportional to the duration of the absolutely refractive period. Other answers (A, B, C and D) are irrelevant, because neither characterizes tissue excitability.

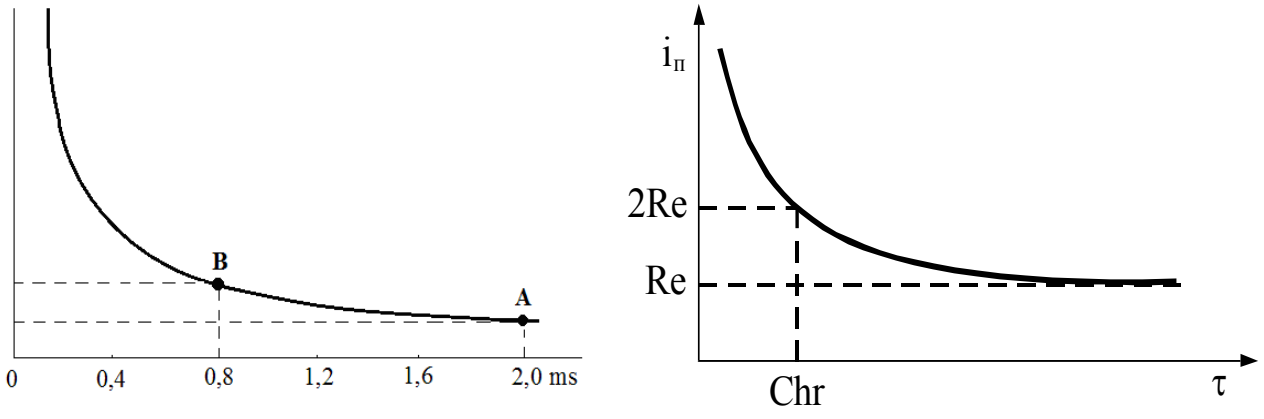



**Figure 4. The curve "strength-duration"**: vertical axis – strength; horizontal axis – time of irritant action; point **A** – threshold force (rheobase) and threshold (useful) time; point **B** – double rheobase and chronaxie

**13. Correct answer is D.** *(Linda. S. Costanzo, Chapter 1: Cellular Physiology,Action Potentials, Propagation of Action Potentials, p. 24; Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, p.138.); Saladin, Chapter 12Nerve Tissue, p. 458).*
The speed at which action potentials are conducted along a nerve or muscle fiber is the *conduction velocity*. This property is of great physiologic importance because it determines the speed at which information can be transmitted in the nervous system. 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-gated Na channels immediately distal to the action potential (*fig. 5*). Therefore, if in the course of an experiment **the concentration of $Na^+$ ions increases** in the extracellular fluid, the concentration gradient for this ion rises resulting in intensified sodium diffusion into the cell which can cause the *increase of the nerve conduction velocity.*

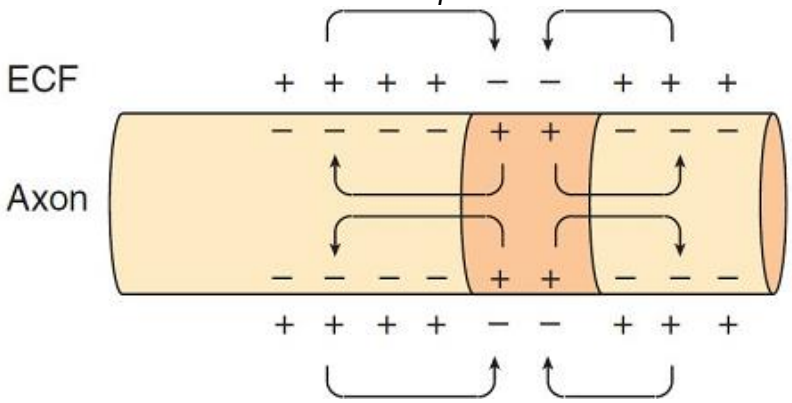



**Figure 5. Mechanism of excitation conduction in nerve fiber (unmyelinated).**
Positive charged Na ions from the membrane ahead of and behind the action potential flow into the area of negativity represented by the action potential

**14. Correct answer is C.** *(USMLE Step 1 Lecture Notes, Kaplan, 2018. – Physiology. Part II: Excitable tissues. Chapter 1: Ionic Equilibrium and Resting Membrane Potential, p. 22)*
The RMP depends entirely on the cell membrane permeability for potassium ions due to the fact that an excitable tissue has a considerable number of leak channels for $K^+$, but not for $Cl^-$, $Na^+$, or $Ca^{2+}$. Thus, *increase in membrane permeability for potassium ions* (high conductance) results in outflow of more positively charged $K^+$ ions down their concentration gradient. It increases the cell membrane polarization, i.e. causes **hyperpolarization**.
Therefore, altering the conductance (*g*) for $K^+$ has the following effects*(fig. 6)*:***1) Increasing g*** causes $K^+$ to leave the cell, resulting in hyperpolarization of the cell (increasing *g* for an ion causes the membrane potential *Em* to move toward the equilibrium potential for that ion. Thus, the cell will move from -70 mV toward -95 mV); ***2) Decreasing g*** depolarizes the cell (cell moves away from $K^+$ equilibrium). This applies to $K^+$ because of its high resting *g*.

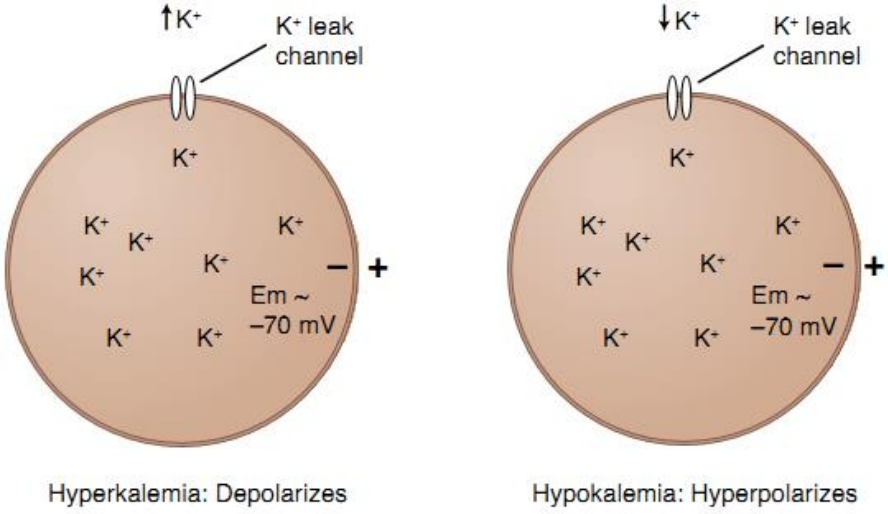



**Figure 6. Effect of changes in Extracellular K+ on Resting Membrane Potential**

**15. Correct answer is E. (***Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, p.132; Saladin, Chapter 11 Nerve tissue, p. 458).*
As the value of the *cell membrane voltage changed from –85 mV to –90 mV*, membrane becames more polarized. This phenomenon is known as **hyperpolarization**. Answers B and C are irrelevant because both Repolarization and Overshot occur with the reduction of cell membrane voltage. The term "Repolarization" means recovery of the initial membrane potential (irrelevant A), and the term "Supernormality" describes rather cell excitability than its excitation (irrelevant D).
**16. Correct answer is D. (***Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, p.136; USMLE Step 1 Lecture Notes, Kaplan, 2018. – Physiology. Part II: Excitable tissues. Chapter 1: Ionic Equilibrium and Resting Membrane Potential, p. 23.)*
Since the resting membrane potential is close to theequilibrium potential for $K^+$, changes in the external concentration of this ion can have majoreffects on the resting membrane potential. If the extracellular level of $K^+$ is increased(hyperkalemia), the resting potential moves closer to the threshold for eliciting an actionpotential, thus the neuron **RMP decreases** and the cell becomes **more excitable**. If the extracellular level of $K^+$ isdecreased (hypokalemia), the membrane potential is reduced and the neuron ishyperpolarized.

**Mechanism of excitation conduction in nerve fiber and neuromuscular synapse**

**17. Correct answer is E.** *(Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 4Excitable Tissue: Nerve, p.140; Saladin, Chapter 12 Nervous tissue, p. 453).*
Mammalian nerve fibers are divided into three major groups (A, B, and C); the A group isfurther subdivided into α, β, γ, and δ fibers (*Table 2*). In general, the greater the diameter of a nerve fiber, the greater is its speed ofconduction. The large axons are concerned primarily with proprioceptive sensation, somaticmotor function, conscious touch, and pressure, while the smaller axons subserve pain and temperature sensations and autonomic function. 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.

**Table 2**

**Types of mammalian nerve fibers**

| Type | Diameter, μm | Conduction velocity, m/sec | Duration AP peak, msec | Function |
|---|---|---|---|---|
| $A_\alpha$ | 12–22 | 70–120 | 0,4–0,5 | 1. Motor fibers of skeletal muscles<br>2. Afferent fibers from muscular receptors |
| $A_\beta$ | 8–12 | 40–70 | 0,4–0,6 | Afferent fibers from tactile receptors |
| $A_\gamma$ | 4-8 | 15–40 | 0,5–0,7 | 1. Afferent fibers from tactile and pressure receptors;<br>2. Efferent fibers to muscle spindles |
| $A_\delta$ | 1–4 | 5–15 | 0,6–1,0 | Afferent fibers from certain receptors of heat, pressure and pain |
| B | 1–3,5 | 3–18 | 1–2 | Preganglionic autonomic fibers |
| C | 0,5–2,0 | 0,5–3 | 2,0 | 1. Postganglionic autonomic fibers,<br>2. Afferent fibers from certain receptors of heat, pressure and pain |

**18. Correct answer is D.** *(Saladin, Chapter 11 Muscular system, p. 414-415).*Flaccid paralysisis 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.

**Table 3**

**Chemicals affecting the synaptic transmission**

| *Drug* | *Origin* | *Effects* |
|---|---|---|
| ***Botulinum toxin*** | ***Produced by Clostridiumbotulinum (bacteria)*** | ***Inhibits release of ACh*** |
| ***Curare*** | ***Resin from a South American tree*** | ***Prevents interaction of Ach with its nicotinic receptor protein*** |
| ***α-Bungarotoxin*** | ***Venom of Bungarus snake*** | ***Competes with the Ach for its receptor proteins*** |
| ***Tetrodotoxin*** | ***Pufferfish*** | ***Blocks voltage-gated Na+ channels*** |
| ***Nerve gas*** | ***Artificial*** | ***Inhibits acetylcholinesterase in postsynaptic membrane*** |
| ***Neostigmine*** | ***Nigerian bean*** | ***Inhibits acetylcholinesterase in postsynaptic membrane*** |
| ***Strychnine*** | ***Seeds of Asian tree*** | ***Prevents IPSPs in spinal cord that inhibit contraction of antagonistic muscles*** |

**19. Correct answer is E.** *(Saladin, Chapter 11 Muscular system, p. 414).* Many chemicals function as neurotransmitters; the only *neurotransmitter* released at the *neuromuscular junction* is **acetylcholine** which is stored in spherical organelles called synaptic vesicles.

**Mechanism of muscle contraction and relaxation**

**20. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. Unit XV. Sports Physiology, p. 1056; Unit IX. The Nervous System: A. General Principles and Sensory Physiology. Chapter 48: Somatic Sensations: II. Pain, Headache, and Thermal Sensation, p. 599)*

In muscles, there are three metabolic systems determinethe limits of physical activity: 1) the phosphocreatine-creatine system, 2) the glycogenlactic acid system, and 3) the aerobic system (*fig. 7*).

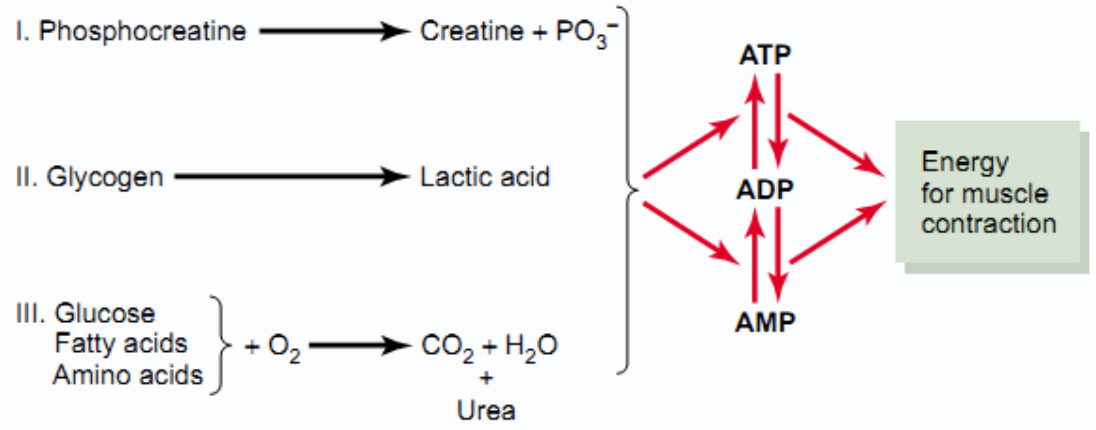



**Figure 7. Metabolic systems that supply energy for muscle contraction**

Under optimal conditions, the *glycogen-lactic acid system* is extremely important in moderate exercises (intermediate races as the 100-to 400-meter runs, tennis, soccer, etc.) and contributes approximately 1.3 to 1.6 minutes of maximalmuscle activity in addition to the 8 to 10 seconds provided by the phosphocreatine-creatine system. This system utilizes glycogen stored in muscles in two stages: 1) glycolysis – anaerobic process during which each glucose molecule is split into twopyruvic acid molecules, and energy is released to form 4 ATP molecules for each original glucose molecule; 2) Krebs cycle – ordinarily, the pyruvicacid then enters the mitochondria of the muscle cellsand reacts with oxygen to form still many moreATP molecules. However, when there is

insufficientoxygen for this second stage (the oxidative stage) ofglucose metabolism to occur, most of the pyruvic acid then is converted into lactic acid, which diffuses out ofthe muscle cells into the interstitial fluid and blood. Therefore, much of the muscle glycogen is transformedto lactic acid which accumulates in muscles. Then, hydrogen ions originating from **lactic acid** (along with other chemicals such as bradykinin, serotonin, histamine, potassiumions, etc.) *enhance the sensitivity of pain receptors and cause pain sensation*.

**21. Correct answer is E.** *(Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 5Excitable Tissue: Muscle, p.163; Saladin, Chapter 11 Muscular system, p. 425).*

The electrical response of a muscle fiber to repeated stimulation is like that of nerve. Thefiber is electrically refractory only during the rising phase and part of the falling phase of thespike potential. At this time, the contraction initiated by the first stimulus is just beginning.However, because the contractile mechanism does not have a refractory period, repeatedstimulation before relaxation has occurred produces additional activation of the contractileelements and a response that is added to the contraction already present. This phenomenon isknown as **summation of contractions,**because it results from onewave of contraction added to another. The tension developed during summation isconsiderably greater than that during the single muscle twitch. With rapidly repeatedstimulation, activation of the contractile mechanism occurs repeatedly before any relaxationhas occurred, and the individual responses fuse into one continuous contraction. Such aresponse is called **tetanus**. At a stimulus frequency (20–40 stimuli/sec), each new stimulus arrives before theprevious twitch is over (*in period of relaxation*). This effect produces a state of sustained-fluttering contraction called **incomplete tetanus** *(fig. 8).*

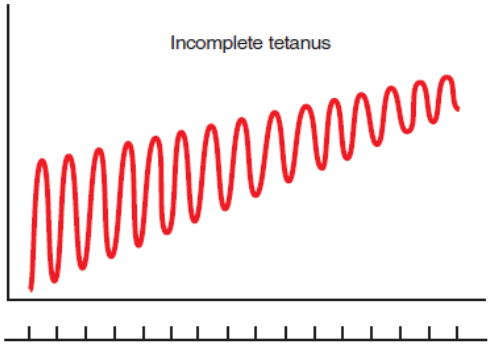
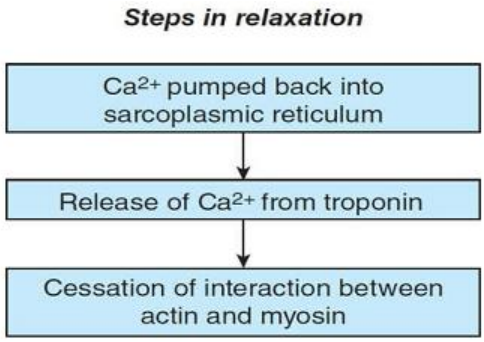



**Figure 8. Incomplete tetanus**

**22. Correct answer is E.** *(Kim E. Barret, Section I Cellular and Molecular basis for Medical Physiology, Chapter 5 Excitable Tissue: Muscle, p. 161–162; Saladin, Chapter 11 Muscular system, p. 422).*

When work is done, a muscle fiber relaxes and returns to its resting length. $Ca^{2+}$ concentration is reduced in the muscle cell by the sarcoplasmic or endoplasmic reticulum $Ca^{2+}$ ATPase (SERCA). The SERCA pump uses energy from ATP hydrolysis to remove $Ca^{2+}$ from the cytosol back into the terminal cisterns where it is stored until released by the next action potential. Once the $Ca^{2+}$ concentration outside the sarcoplasmic reticulum has been lowered sufficiently, chemical interaction between myosin and actin ceases and the muscle relaxes. Note that ATP provides the energy for both contraction (at the myosin head) and relaxation (via SERCA).




Thus, if *$Ca^{2+}$-pump is weakened*, more time is required for reduction of sarcoplasmic $Ca^{2+}$, and **prolonged relaxation** takes place.

**23. Correct answer is C.** *(Saladin, Chapter 11 Muscular system, p. 425).* 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** *(fig. 9).*

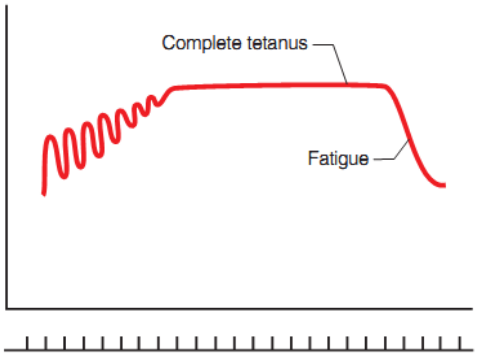



**Figure 9. Complete tetanus**

**24. Correct answer is B.** *(Saladin, Chapter 11 Muscular system, p. 426).* When the *upper extremity is holding (not moving) a load in a certain position*, its length remains the same. This type of muscular contraction is called **isometric** (literally, the same length) (*fig. 10*).

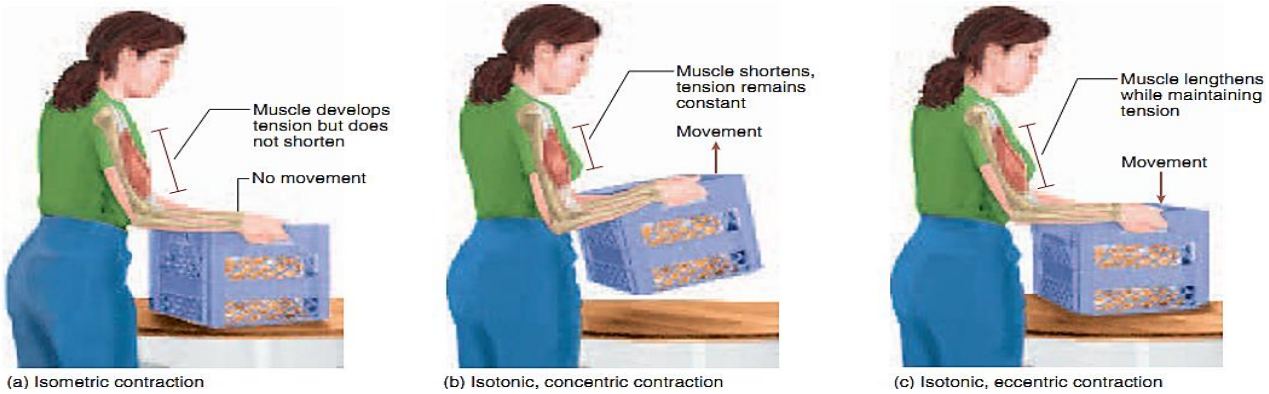



**Figure 10. Types of muscular contraction:** (*a*) Isometric contraction, in which a muscle develops tension but does not shorten. This occurs at the beginning of any muscle contraction but is prolonged in actions such as lifting heavy weights. (*b*) Isotonic concentric contraction, in which the muscle 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.

**25. Correct answer is B.** *(Saladin, Chapter 11 Muscular system, p. 422–423).*
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.
**26. Correct answer is B.** *(Saladin, Chapter 11 Muscular system, p. 424).*
Although skeletal muscle fibers resemble one another in a general way, skeletal muscle is aheterogeneous tissue made up of fibers that vary in **excitability (threshold is one of the criteria of cell excitability)**, myosin ATPase activity, contractilespeed, and other properties.As long as the voltage of an artificial stimulus delivereddirectly to a muscle is at threshold or higher, a muscle givesa single muscle contraction (twitch). If the nerve innervating a muscle is stimulated, higher voltages produce stronger muscle contractionsbecause they excite more nerve fibers and therefore moremotor units. The more motor units that contract, the morestrongly the muscle as a whole contracts (*fig. 11*). Eachsingle motor neuron and the muscle fibers it innervates constitute a motor unit.

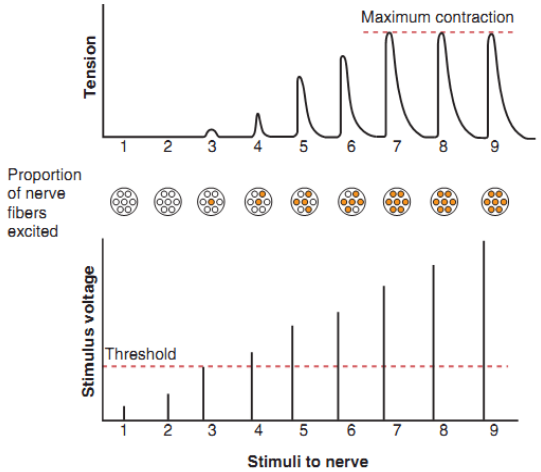



**Figure 11. The Relationship Between Stimulus Intensity(voltage) and Muscle Tension.** Weak stimuli (*1–2*) fail to stimulate any nerve fibers and therefore produce no muscle contraction. When stimuli reach or exceed threshold (*3–7*), they excite more and more nerve fibers and motor units and produce 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

**27. Correct answer is A.** *(Saladin, Chapter 11 Muscular system, p. 426).*
When one makes the attempt to lift a load beyond their strength, muscle cannot shorten down, and its length remains the same. This type of muscular contraction is called isometric (literally, the same length) (*fig. 9*).

**28. Correct answer is A.** *(Ackerman – Physiology / Basic Sciences: p.60).*
**Electromyography** EMG is an electrodiagnostic medicine technique for evaluating and recording the electrical activity produced by skeletal muscles (including excitability). EMG is performed using an instrument called an electromyography to produce a record called an electromyogram.
**29. Correct answer is E.** *(Saladin, Chapter 19 The Circulatory System: The heart, p. 734).* Relaxation of heart chambers (diastole) is extremely important period for recovery processes in cardiomyocyte cells: 1) resynthesis of ATP, 2) pumping $Ca^{2+}$ back into the sarcoplasmic reticulum (SPR) and to the ECF, and 3) restoration of $Na^{+}$ and $K^{+}$ ionic gradients by activating $Na^{+}$,$K^{+}$-pump. As time of diastole reduces *(incomplete relaxation*), $Ca^{+}$-pump has no enough time for pumping it to SPR leading to **accumulation of calcium** in the sarcoplasm.
**30. Correct answer is D.** ***(****Human physiology volume I / G.I. Kositsky. – Medicine, 1990).*
I. M. Sechenov was the first who proved experimentally (1903) that restoration of *capacity for work in tired muscles* of human upper extremity occurred faster if other extremity is performing a work during resting period. Moreover, other motor activities, for instance, working of low limb muscles, can significantly reduce the recovery period of working capacity of tired limb. This experimental data gave rise to Sechenov's concept of "**active rest"**. The probable mechanism of the phenomenon of active rest is the development of fatigue in nerve centers rather than in muscles or nerve fibers themselves.
**31. Correct answer is A.** *(Arthur C. Guyton, John E. Hall. Unit XV. Sports Physiology, p. 1056).*
Physical exertion requires energy supply for muscles contraction and may result in **accumulation of lactic acid** due to the anaerobic oxidation of glycogen (*see explanation to Task 20*). In people, who for a long time remained in hypodynamic state, respiratory system is unable to provide sufficient amount of oxygen for aerobic stage of glycogen oxidation.

## NEUROPHYSIOLOGY

### *Questions*

### 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.* *C. Presynaptic.* *E. Lateral.*
*B. Reciprocal.* *D. Depolarizational.*

**Notes:**_____

**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.*

**Notes:**_____

**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.*

**Notes:**_____

**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 summatio.* *D. Threshold summation.*

**Notes:**_____

### 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.*

**Notes:**_____

**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.* *C. Frontal central gurus.* *E. Occipital zone of the cortex.*
*B. Frontal zone.* *D. Posterior central gurus.*

**Notes:**_____

**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.*

**Notes:**_____

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

*A. Reticulospinal.* *C. . Lateral corticospinal* *E. Vestibulospinal.*
*B. Rubrospinal.* *D. Medial corticospinal.*

**Notes:**_____

**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.*

**Notes:**_____

**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.*

***Notes:***_____

**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.* *B. Tactile.* *C. Muscle spindles.* *D. Nociceptors.* *E. Articular.*

**Notes:**_____

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

**Notes:**_____

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

**Notes:**_____

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

**Notes:**_____

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

**Notes:**_____

**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.*
*B. Tr. spinothalamicus lateralis.*
*C. Fasciculus cuneatus.*
*D. Fasciculus gracilis.*
*E. Tr. spinocerebellaris posterior.*

**Notes:**_____

**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.*
*B. Motor cortex on the left.*
*C. Left-hand side of the spinal cord.*
*D. Anterior horn of the spinal cord.*
*E. Posterior horn of the spinal cord.*

**Notes:**_____

**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.*
*B. Muscle spindles.*
*C. Golgi tendon organ.*
*D. Nociceptors.*
*E. Articular receptors.*

**Notes:**_____

**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.*
*B. Mechanical stimulus.*
*C. Heat stimulus.*
*D. Photic stimulus.*
*E. Cold stimulus.*

**Notes:**_____

**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.*
*B. Precentral gyrus.*
*C. Cingulate convolution.*
*D. Parahippocampal gyrus.*
*E. Postcentral gyrus.*

**Notes:**_____

**21.** After a trauma thepatienthas developed right-side paralysesand disturbed pain sensitivity. On the left side no paralyses are observed, but pain and thermal sensitivity is disturbed. What is the cause of this condition?

*A. Cerebellar injury.*
*B. Unilateral right-side spinal cord injury.*
*C. Motor cortex injury.*
*D. Brainstem injury.*
*E. Midbrain injury.*

**Notes:**_____

## Physiology of brainstem

**22**. 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 substance.* *E. Vestibular nuclei.*
*C. Quadritubercular bodies.*

**Notes:**

**23**. 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.*

**Notes:**

**24**. 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.*

**Notes:**

**25**. 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.*

**Notes:**

**26**. 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.*

**Notes:**

**27**. In the experiment, an animal had its brain stem 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.*

**Notes:**

**28**. 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.* *C. N. trigeminus.* *E. N. sympathicus.*
*B. N. facialis.* *D. N. vagus.*

**Notes:**_____

**29**. 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.* *D. Tr. Cortico-nuclearis.*
*B. Tr. Cortico-thalamicus.* *E. Tr.Cortico-temporo-parieto-occipitopontinu.*
*C. Tr. Cortico-fronto-pontinus.*

**Notes:**_____

**30**. 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.*

**Notes:**_____

**31**. 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.*

**Notes:**_____

**32**. 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.*

**Notes:**_____

**33**. 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.*

**Notes:**_____

**34**. 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. Glossopharyngea.* *D. Accessory.* *E. Hypoglossal.*

**Notes:**

**35**. A patient complains about pain in his upper jaw and toothache. Objectively: the patient feels pain when pressed in the region of the supraorbital foramen. What nerve is affected?

*A. The first branch of trigeminus.* *C. The third branch of trigeminu.* *E. Facial nerve.*
*B. The second branch of trigeminu.* *D. Trochlear nerve.*

**Notes:**

**36**. 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.*

**Notes:**

**37**. 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.*

**Notes:**

**38**. 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.*

**Notes:**

**39**. 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 oblongat.* *D. Mesencephalon.*

**Notes:**

**40**. 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.*

**Notes:**_____

**41**. 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.*

**Notes:**_____

**42**. 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.*

**Notes:**_____

**43**. 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.* *D. Proprioreceptors.*
*B. Vestibuloreceptors of semicircular ducts.* *E. Mechanoreceptors of foot skin.*
*C. Vestibuloreceptors of utricle and saccule.*

**Notes:**_____

**44**. 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.*

**Notes:**_____

**45**. 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. Noradrenalin. D. Histamine. E. Adrenaline.*

**Notes:**_____

**Physiology of cerebellum, basal ganglia and cerebral cortex**

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

*A. Motor cortex.* *B. Pale sphere.* *C. Black substance.* *D. Cerebellum.* *E. Striatum.*

**Notes:**_____

**47**. 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.*

**Notes:**_____

**48**. 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.* *C. Motor cortex.* *E. Cerebellum.*
*B. Caudate nucleus.* *D. Red nucleus.*

**Notes:**_____

**49**. 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.*

**Notes:**_____

**50**. 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.*

**Notes:**_____

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

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

**Notes:**_____

**52**. 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.*

**Notes:**_____

**53**. 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.*

**Notes:**_____

**54**. 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.*

**Notes:**_____

**55**. 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.*

**Notes:**_____

**56**. 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.*

**Notes:**_____

**57**. 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.* *B. Reticular formation.* *C. Red nuclei.* *D. Cerebellum.* *E. Black substance.*

**Notes:**_____

**58**. 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.*
*B. Lateral hypothalamic nuclei.*
*C. Cerebellum.*
*D. Cerebral cortex.*
*E. Quadrigemina of mesencephalon.*

**Notes:**

**59**. 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. Tractuc spinothalamicus.*
*B. Tractus tectospinalis.*
*C. Tractus corticonuclearis.*
*D. Tractus rubrospinalis.*
*E. Tractus corticospinalis.*

**Notes:**

**60**. 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. B. Hippocampus. C. Basal ganglion. D. Reticular formation. E. Red nuclei.*

**Notes:**

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

*A. Globus pallidus.*
*B. Hypothalamus.*
*C. Red nucleus.*
*D. Corpora quadrigemina.*
*E. Substantia nigra.*

**Notes:**

**62**. 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. B. Medulla oblongata. C. Oliencephalon. D. Mesencephalon. E. Prosencephalon.*

**Notes:**

**63**. 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.*

**Notes:**

**64**. A 64-year-old man presents with tremor in his legs and arms. He says he has had the tremor for "many years", but it has worsened in the last years. The tremor is more prominent at rest and nearly disappears on movement. His daughter mentioned that his movements have become slower. The patient is afebrile and vital signs are within normal limits. On physical examination, the patient is hunched over and his face is expressionless throughout examination. There is a "pill-rolling" resting tremor that is accentuated when the patient is asked to clench the contralateral hand and alleviated by finger-nose testing. When asked to walk across the room, the patient has difficulty taking the first step, has a stooped posture and takes short rapid shuffling steps. A doctor initiates pharmacotherapy and the drug of first line, levodopa, is prescribed. Which of the following is the most likely mechanism of action of this drug?

*A. Cholinesterase inhibition.* *D. Activation of M2-colinergic receptors.*
*B. Stimulation of dopamine production.* *E. Activation of M2-colinergic receptors.*
*C. –.*

**Notes:**_____

## Autonomic regulation of visceral functions

**66**. 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-monooxygenase.* *D. L-amino acids oxidase.*

**Notes:**_____

**67**. 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.*

**Notes:**_____

**68**. 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.*

**Notes:**_____

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

*A. б1-adrenergic receptors.* *C. M-cholinergic receptors.* *E. Ca2+-L-type channels.*
*B. в-adrenergic receptors.* *D. Fast Na+ channels.*

**Notes:**

**70**. 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-Aschner reflex.*

**Notes:**

**71**. 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.*

**Notes:**

**72**. 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.*

**Notes:**

**73**. 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.*

**Notes:**

**74**. 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.* *D. Red nuclei.*
*B. Medial reticular nuclei.* *E. Black substance.*

**Notes:**

**75**. 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.*

**Notes:**

**Neurophysiology**

***Answers***

**Biological regulation. Reflex arc. Central synapses**

**Mechanism of excitation and inhibition in CNS**

**1. Correct answer is B.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 506).*
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.

**2. Correct answer is C.** *(Saladin, Chapter 12. Nervous Tissue, p. 463).*
Pool of neurotransmitter goes down during intensive physical activity and fatigue develops in central synapses which essential property is fatiguability.

**3. Correct answer is D.** *(Saladin, Chapter 12. Nervous Tissue, p. 465).*
Fatigability is essential property of nerve centers.

**4. Correct answer is E.** *(Saladin, Chapter 12. Nervous Tissue, p. 470).*
**Spatial summation** occurs when EPSPs from several different synapses add up to threshold at the axon hillock (*fig. 12b*). 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.

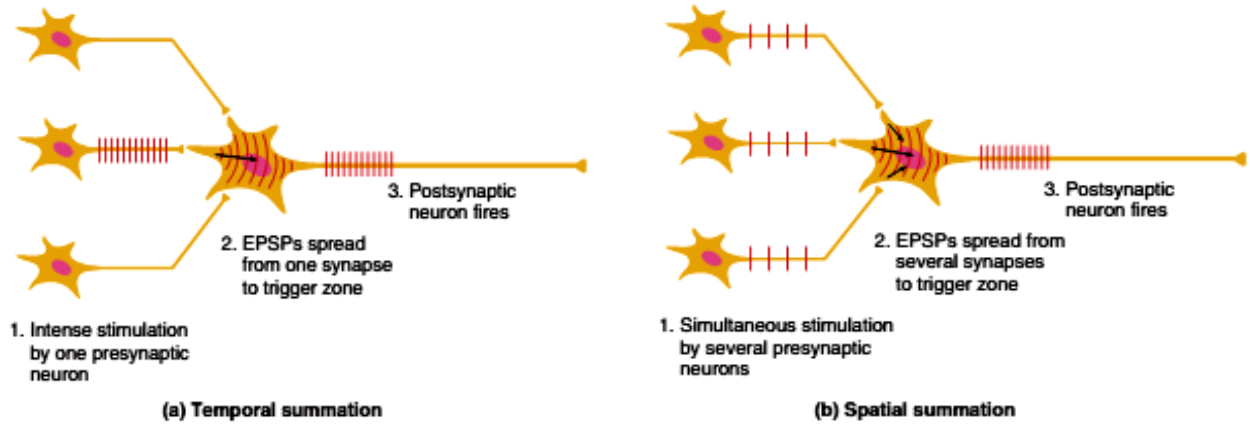



**Figure 12. Types of EPSR Summation**

**Physiology of spinal cord**

**5. Correct answer is D.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 485; USMLE Step 1 Lecture Notes, Kaplan, 2018. – Anatomy. Part III: Neuroscience. Chapter 4: Spinal Cord, p. 267).*
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 to control their contraction and relaxation, i.e. **movements**.

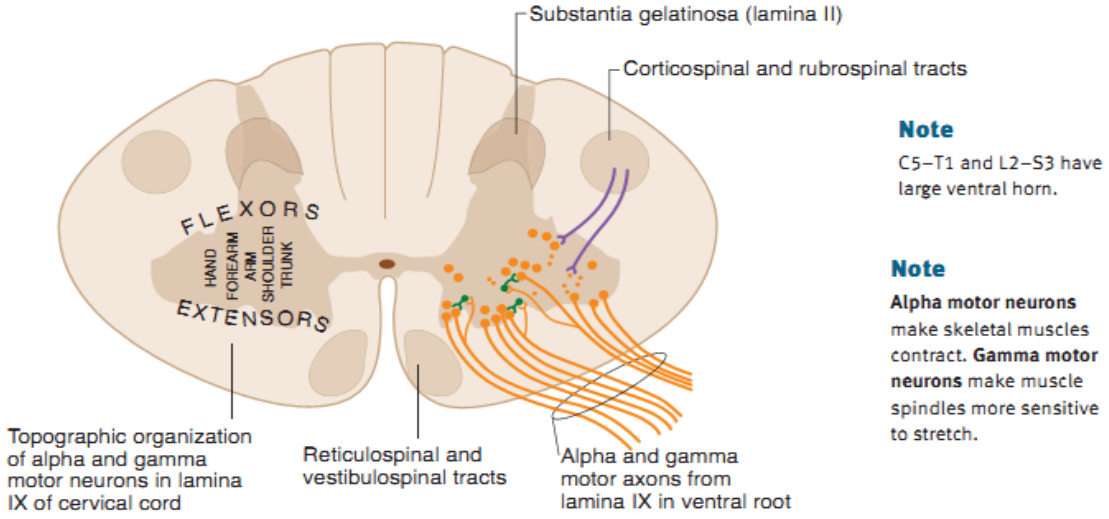



**Figure 13.** Topographic organization of spinal cord ventral horns and ventral roots

**6. Correct answer is D.** *(USMLE Step 1 Lecture Notes, Kaplan, 2018. – Anatomy. Part III: Neuroscience. Chapter 4: Spinal Cord, p. 361; Kim E. Barret, Section III Central & Peripheral Neurophysiology, Chapter 8Somatosensory Neurotransmission: Touch, Pain, & Temperature, p. 237–240).* The cortex of **posterior central gyrus** is the *primary somesthetic cortex (somatosensory area) (fig. 14).* 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 (*fig. 15*).

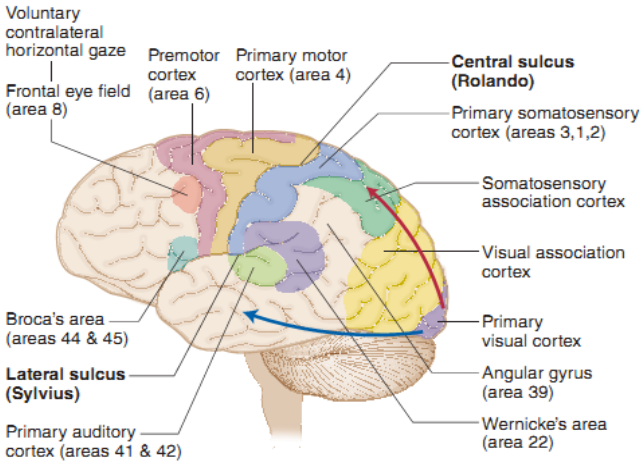



**Figure 14.** Functional areas of cortex hemispheres

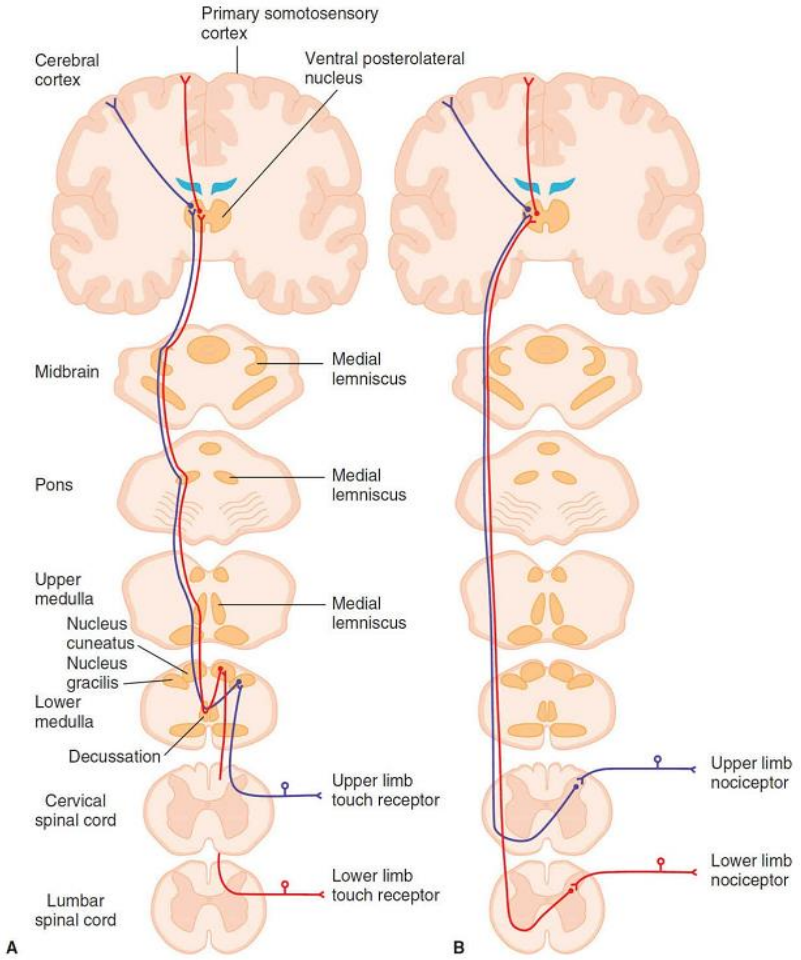



**Figure15. Ascending tracts carrying sensory information from peripheral receptors to the cerebral cortex:** A) *Dorsal column pathway* mediates touch, vibratory sense, and proprioception.Sensory fibers ascend ipsilaterally via the spinal dorsal columns to medullary gracilis and cuneatenuclei; from there the fibers cross the midline and ascend in the medial lemniscus to the contralateralthalamic ventral posterior lateral (VPL) and then to the primary somatosensory cortex; B) *Ventrolateral spinothalamic tract* mediates pain and temperature. These sensory fibers terminate in the dorsal hornand projections from there cross the midline and ascend in the ventrolateral quadrant of the spinal cordto the VPL and then to the primary somatosensory cortex.

**7. Correct answer is C.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 485).* The dorsal root carries *sensory nerve fibers*, which enter the dorsal horn of the cord and sometimes synapse with an interneuron there (*fig. 16*). Then, the dorsal horn is dominated by neurons that respond to sensory stimulation. All incoming sensory fibers in spinal nerves enter the dorsolateral part of the cord adjacent to the dorsal horn in a dorsal root. Neurons in the dorsal horn project to higher levels of the CNS to carry sensations to the brain stem, cerebral cortex, or cerebellum. Other dorsal horn neurons participate in reflexes.Thus, *cutting of dorsal roots* result in loss of **all kinds of sensitivity**: pain, temperature,tactile, and proprioception.

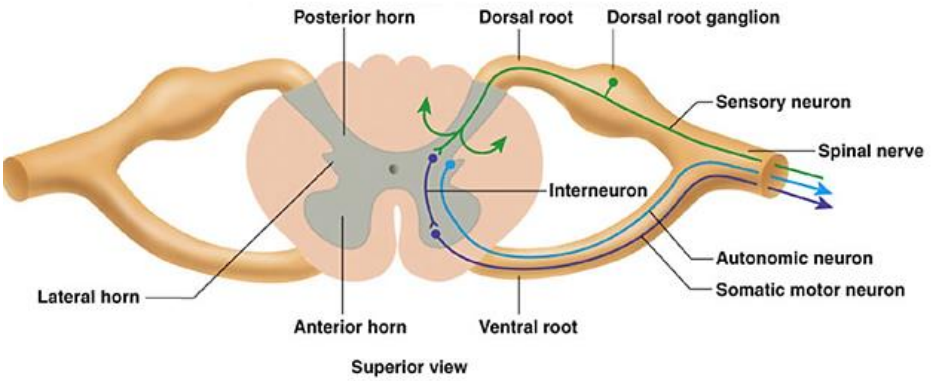



**Figure 16. Sensory function of spinal cord dorsal roots**

**8. Correct answer is E.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 489).*

The **vestibulospinal tract** begins in a brainstem *vestibular nucleus (fig. 17).* The tract passes down the ventral column of the spinal cord and controls *extensor muscles* that maintain antigravity posture and balance.

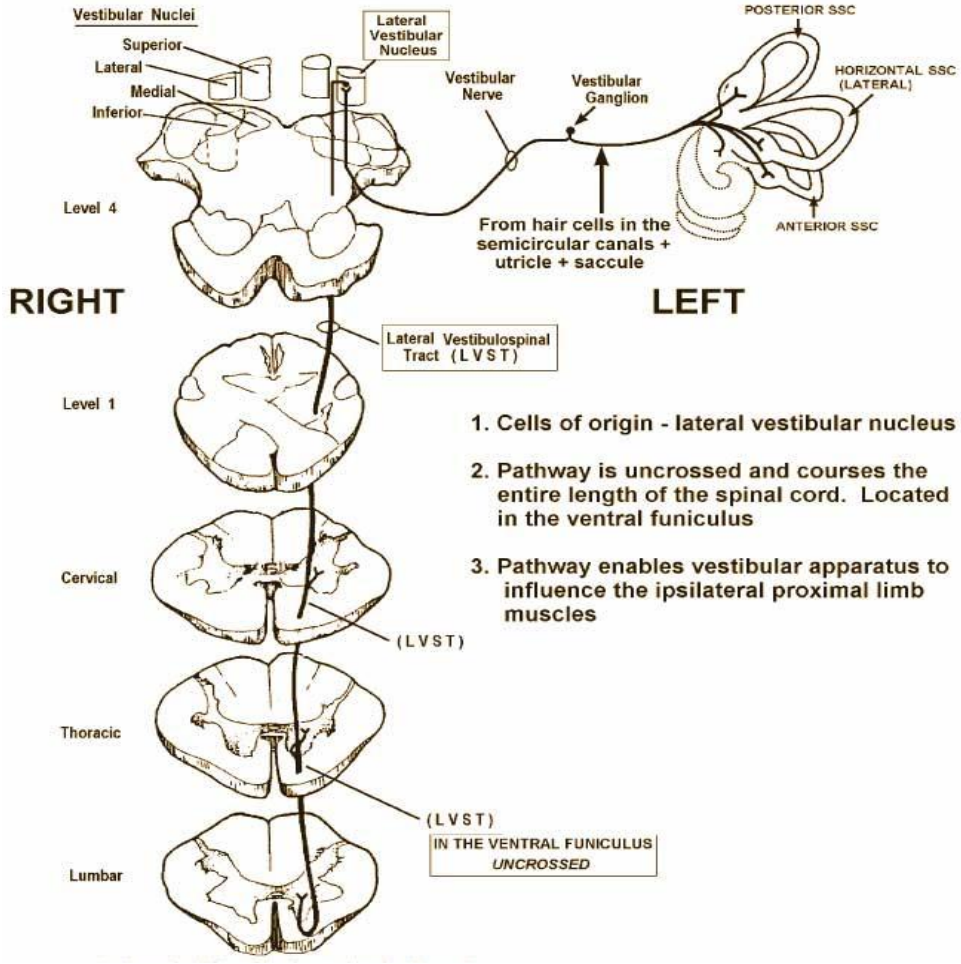



**Figure 17. Vestibulospinal tract**

**9. Correct answer is E.** (*Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).*
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* (*fig. 15*).
**10. Correct answer is B.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 485).*
The ventral horns contain the large somas of the **somatic motor neurons**. Axons from these neurons exit by way of the *ventral (anterior) 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 (fig. 16).*
**11. Correct answer is C.** *(USMLE Step 1 Lecture Notes, Kaplan, 2018. – Anatomy. Part III: Neuroscience. Chapter 4: Spinal Cord, p. 270).*
The muscle *stretch (myotatic) reflex* is the stereotyped contraction of a muscle in response to stretch of that muscle. The stretch reflex is a basic reflex that occurs in all muscles and is the primary mechanism for regulating muscle tone. Muscle tone is the tension present in all resting muscle. Tension is controlled by the stretch reflexes.The best example of a muscle stretch or deep tendon reflex is the knee-jerk reflex (*fig. 18*). Tapping the patellar ligament stretches the quadriceps muscle and its muscle spindles. Stretch of the spindles activates sensory endings (Ia afferents), and afferent impulses are transmitted to the cord. Some impulses from stretchreceptors carried by Ia fibers monosynaptically stimulate the alpha motoneuronsthat supply the quadriceps. This causes contraction of the muscle and a suddenextension of the leg at the knee. Afferent impulses simultaneously inhibitantagonist muscles through interneurons (in this case, hamstrings).Thus, if stretching doesn't lead to reflex contraction, it may be caused by **dysfunction of muscle spindles**.

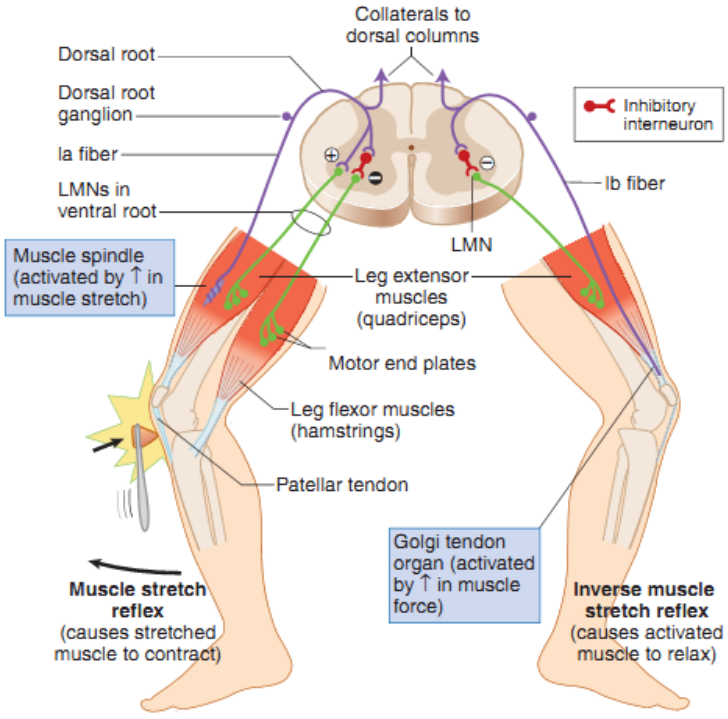



**Figure 18. Schematic presentation of knee-jerk myotatic reflex**

**12. Correct answer is E.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).*
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 limbs and trunk. (Proprioception is a nonvisual sense of the position and movements of the body) (*fig. 15*).

**13. Correct answer is A.** *(Saladin,Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 540).*
The cortex of posterior central 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*(fig. 14, 15).*
**14. Correct answer is C.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 485).*
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 (*fig. 16*).
**15. Correct answer is B.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).*
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 (*fig. 14*). The cortex of this gyrus is the primary somesthetic cortex (somatosensory area).
**16. Correct answer is D.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).*
**The gracilefasciculus** (*fig. 15*) 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. 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.).
**17. Correct answer is A.** ***(****USMLE Step 1 Lecture Notes, Kaplan, 2018. – Anatomy. Part III: Neuroscience. Chapter 4: Spinal Cord, p. 283).*
**Brown-Séquard syndrome**is a half injury of spinal cord (hemisection). Spinal cord hemisection results in a lesion of each of the 3 main neural systems: 1) the principal upper motoneuron pathway of the corticospinal tract, 2) one or both dorsal columns, and 3) the spinothalamic tract. The hallmark of a lesion to these 3 long tracts is that the patient presents with 2 ipsilateral signs and 1 contralateral sign. **I.** *Lesion of the corticospinal tract results in an ipsilateral spastic paresis below the level of the injury.* **II.** *Lesion of the fasciculus gracilis or cuneatus results in an ipsilateral loss of joint position sense, tactile discrimination, and vibratory sensations below the lesion.* **III**. *Lesion of the spinothalamic tract results in a contralateral loss of pain and temperature sensation starting 1 or 2 segments below the level of the lesion*. At the level of the lesion, there will be an ipsilateral loss of all sensation, including touch modalities as well as pain and temperature, and an ipsilateral flaccid paralysis in muscles supplied by the injured spinal cord segments (*fig. 19*). Thus, *as muscle paralysis of the extremities present on the right* (ipsilateral), *lost pain and thermal sensitivity on the left* (contralateral), and partially lost tactile sensitivity on both sides, the patient has **right-hand side of the spinal cord injury.**
**18. Correct answer is B.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 505).*
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 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 (*fig. 18*).
**19. Correct answer is B.** *(Saladin, Chapter 16. The Sense Organs, p. 588).* 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. Receptors adapted to percept specific type of stimulus possess the highest sensitivity towards this stimulus, i.e. *lowest threshold*.

**20. Correct answer is E.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487).*
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 (*fig. 14*).

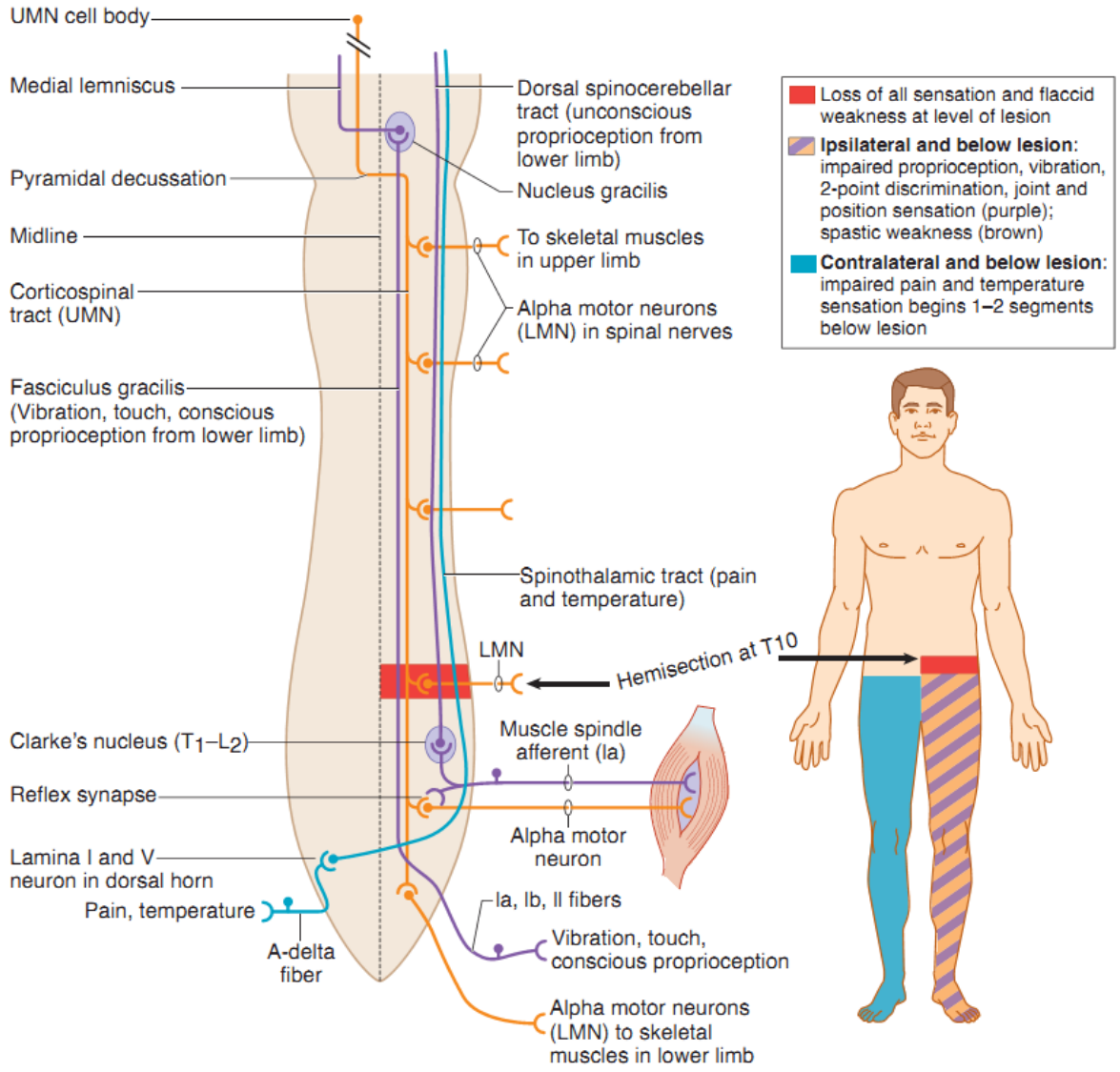



**Figure 19. Schematic presentation of Brown-Séquard syndrome**

**21. Correct answer is B.** ***(****Arthur C. Guyton, John E. Hall, Unit IX The Nervous System: A. General Principles and Sensory Physiology, p. 606).*
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 (*fig. 19*).

## Physiology of brainstem

**22. Correct answer is C.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 528).*
*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.

**23. Correct answer is D.** See explanation **Task 22.**

**24. Correct answer is D.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 526; USMLE Step 1 Lecture Notes, Kaplan, 2018. – Anatomy. Part III: Neuroscience. Chapter 5: Brain Stem, p. 289).*

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).

**25. Correct answer is B.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 528).*

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.

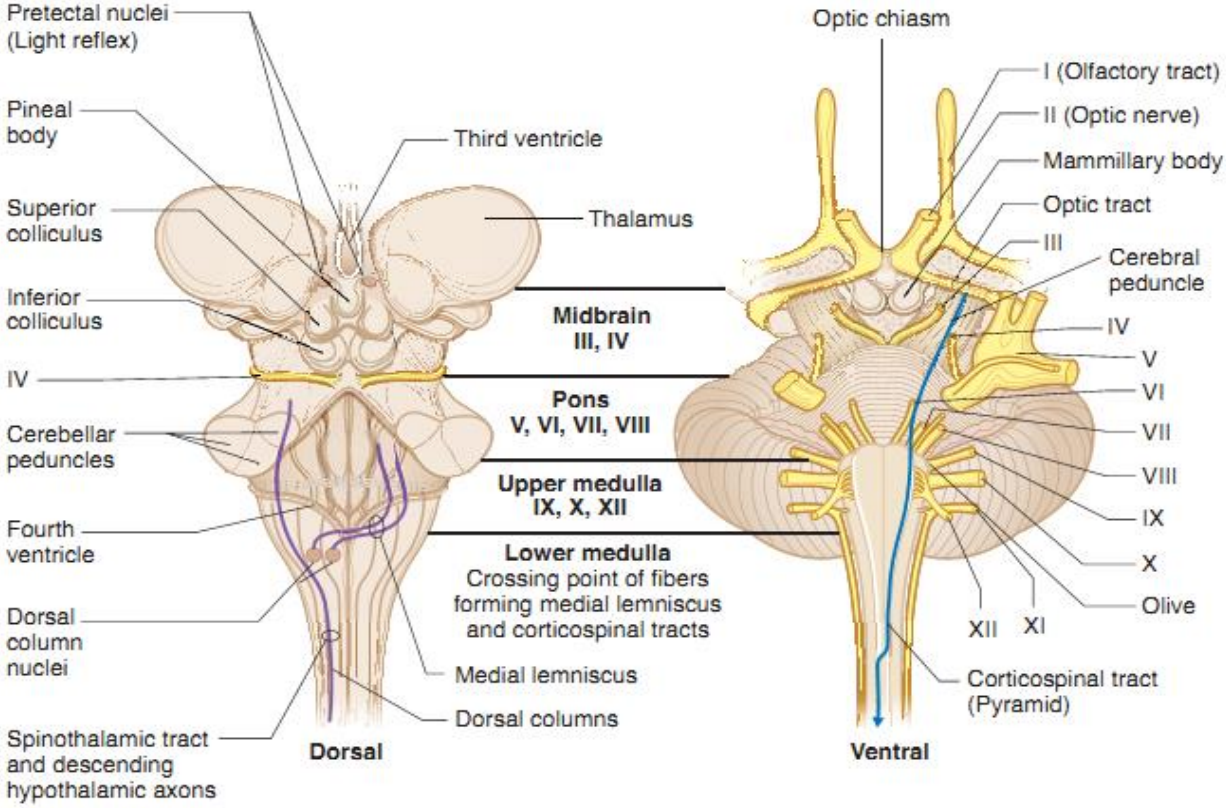



**Figure 20. Cranial nerves localization at the brainstem: medulla, pons, and midbrain**

**26. Correct answer is A.** See explanation **Task 25.**

**27. Correct answer is B.** *(Arthur C. Guyton, John E. Hall, Unit XI The Nervous System: C. Motor and Integrative Neurophysiology, p. 692).*

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.

**28. Correct answer is E.** *(Saladin,Chapter 15. The Autonomic Nervous and Visceral Reflexes, p. 589).*

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.**

**29. Correct answer is D.** *(Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2018. Section IV Neuroscience. Chapter 5: The Brain Stem, p. 300).*

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); palate, pharynx, and larynx (CN X); tongue (CN XII); sternocleidomastoid and trapezius muscles (CN XI). The corticobulbar innervation of cranial nerve lower motoneurons is predominantly bilateral, in that each lower motoneuron in a cranial nerve nucleus receives input from corticobulbar axons arising from both the right and the left cerebral cortex. The major exception is that only some of the LMNs of the facial nerve (CN VII) receive a contralateral innervation.

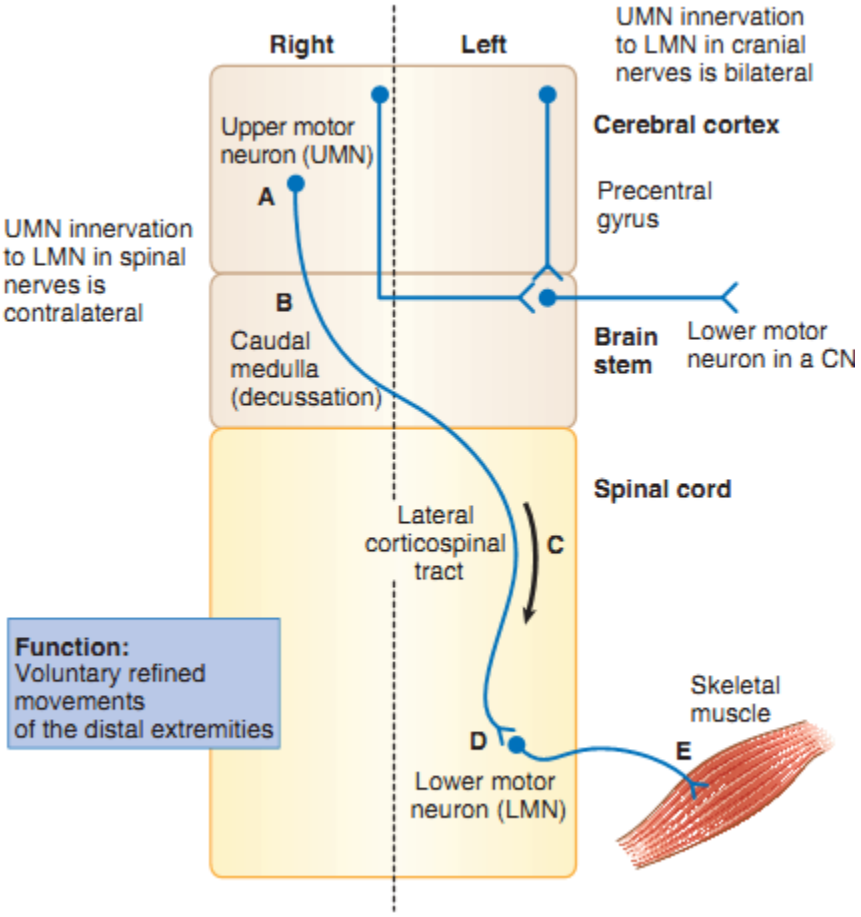



**Figure 21. Corticobulbar vs. corticospinal tract**

**30. Correct answer is C.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 552).*
Functions of the **facial nerve** include major *motor innervation offacial 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 (*fig. 22*).
**31. Correct answer is D.** *(Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2013. Section IV Neuroscience. Chapter 5 The Brain Stem, p. 367).*
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 midbrain 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.

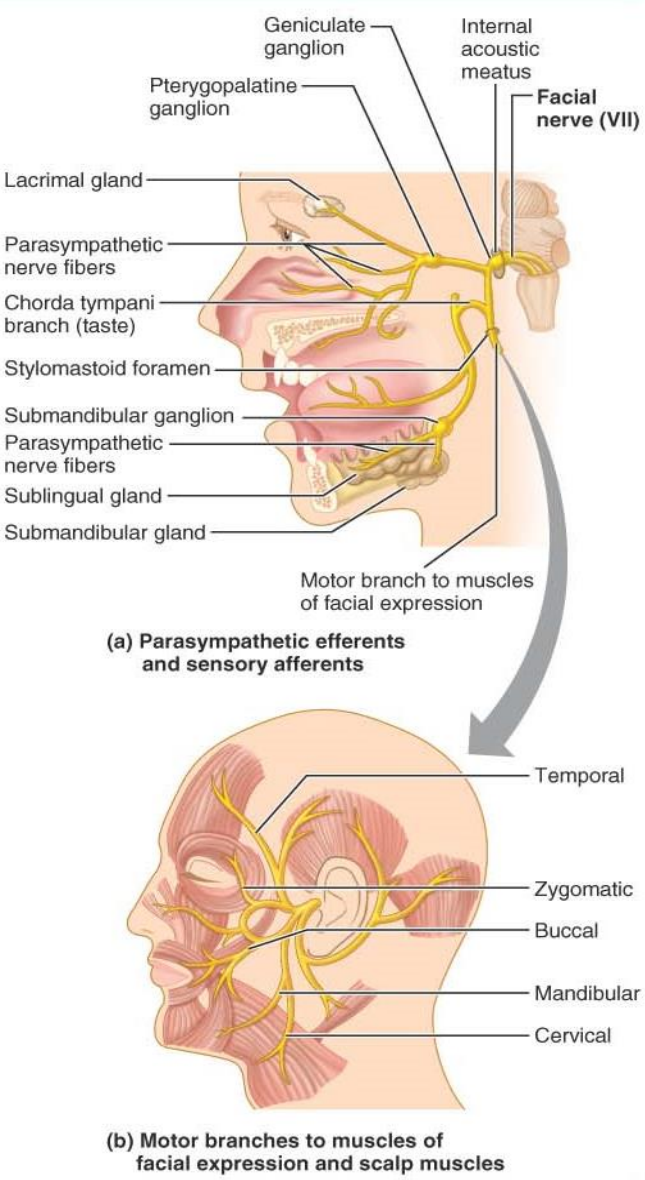



**Figure 22. Functional anatomy of CN VII**

**32. Correct answer is B.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 526)*.
**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.

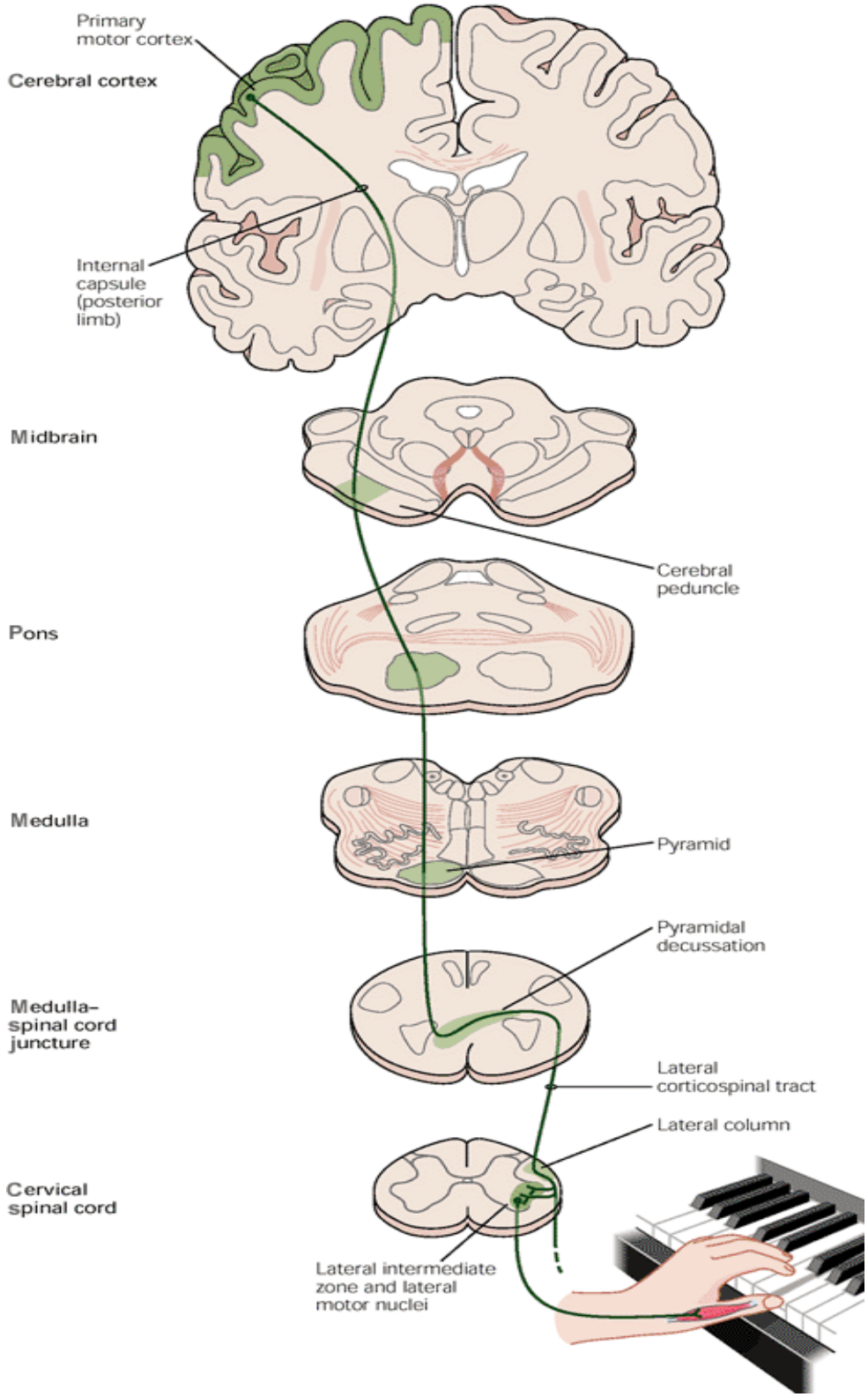



**Figure 23. Corticospinal (pyramidal) tracts**

**33. Correct answer is A.** *(Saladin, Chapter 16, Sense Organs, p. 606).*
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**.

**34. Correct answer is C.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 553).*
**Glossopharyngeal** nerve innervates pharynx, middle and outer ear, *posterior one-third of tongue (including taste buds),* internal carotid arteries. Concerning innervation of tongue, three cranial nerves are involved: CN VII provides innervation of anterior 2/3 of the tongue, CN IX – posterior 1/3, and CN X – boundary with pharynx (*fig. 24*).

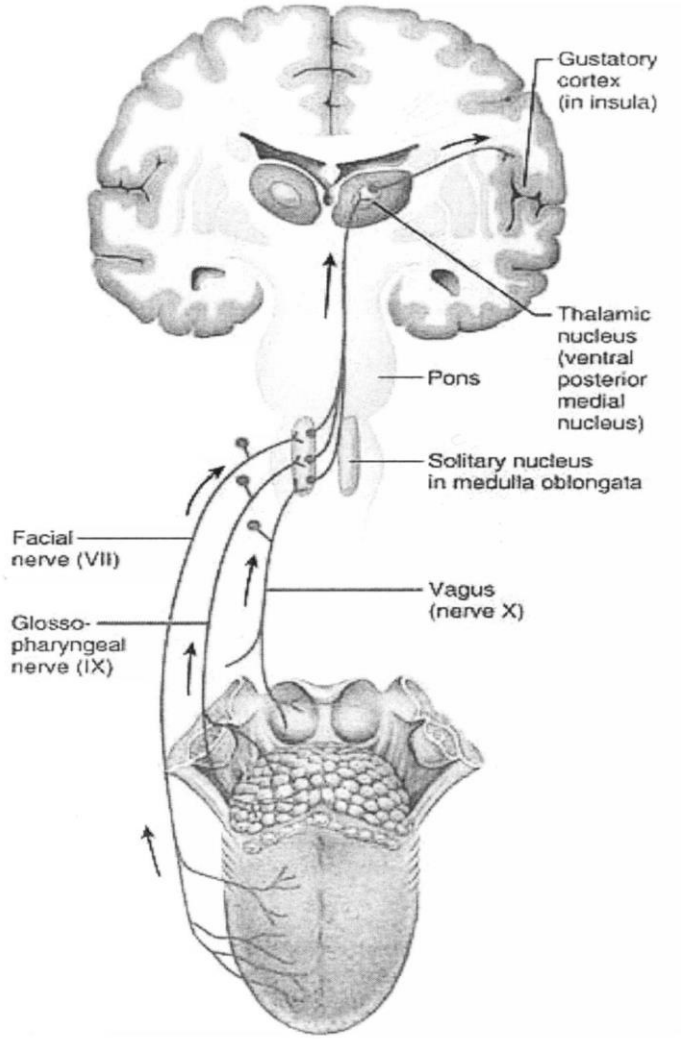



**Figure 24. Sensory innervation of tongue and gustatory sensory system pathways**

**35. Correct answer is B.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 551).*
Trigeminal nerve has three divisions: V1, Ophthalmic Division. Function: main sensory nerve of upper face (touch, temperature, pain); origin: superior region of face, 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, 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 (*fig. 25*).

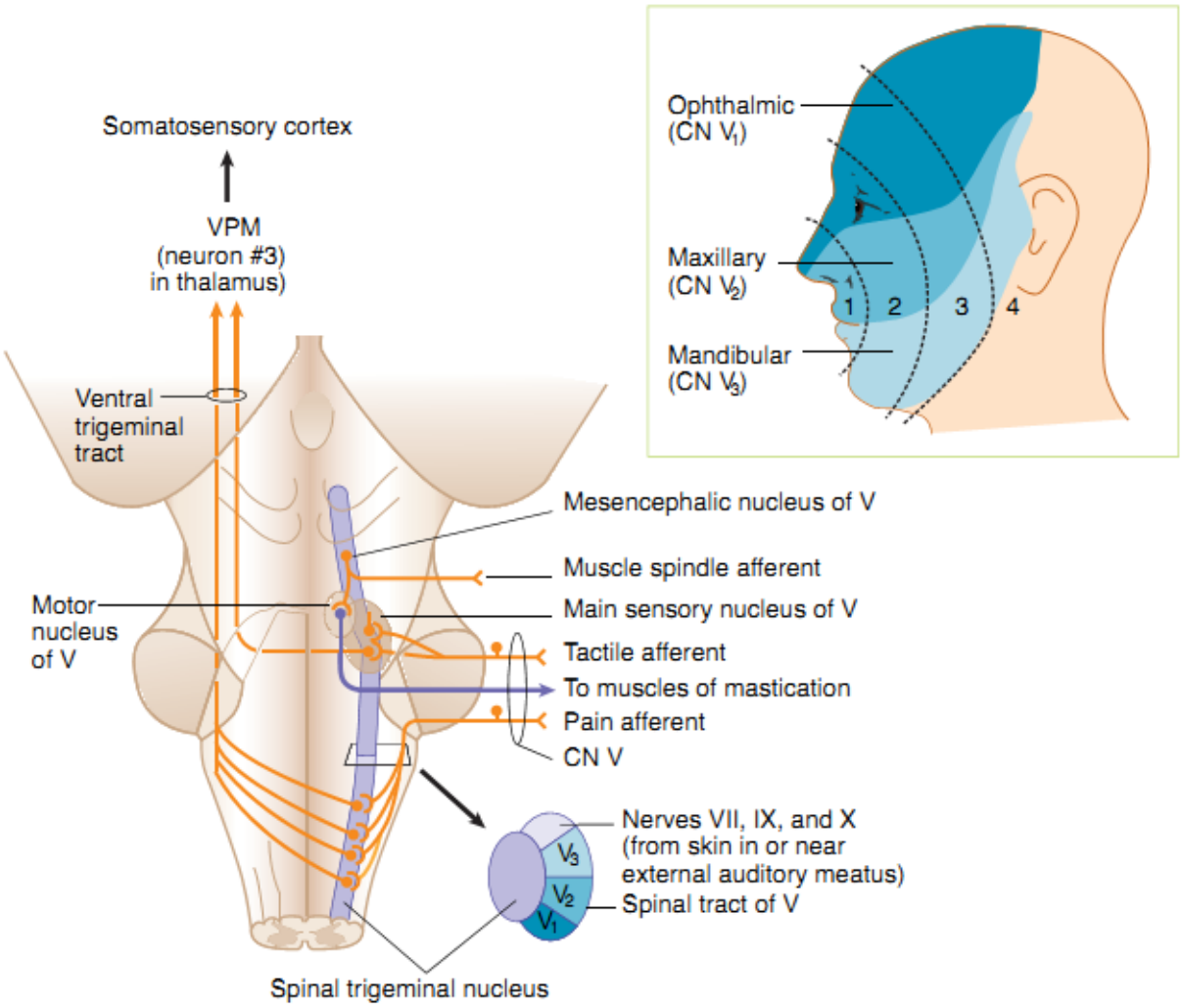



**Figure 25. Sensory and motor functions of trigeminal nerve**

**36. Correct answer is C.***(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 553).*
**Glossopharyngeal nerve** innervates pharynx, middle and outer ear, posterior one-third of tongue (including taste buds), internal carotid arteries *(fig. 24*).

**37. Correct answer is D.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 553).*
Function of **vestibulocochlear nerve** is providing of hearing and *equilibrium*.

**38. Correct answer is A.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 551).*
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, 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 (*fig. 25*).

**39. Correct answer is B.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 526).*
Nuclei of **the medulla oblongata** 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) (*fig. 20*).

**40. Correct answer is D.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 552).*
**Abducent nerve** innervates lateral rectus muscle of eye**.** Function of abducent nerve is providing eye movements to lateral side. *Medial strabismus* which is the inward deviation of eyeballs was caused by damage of the abducent nerve in this case.

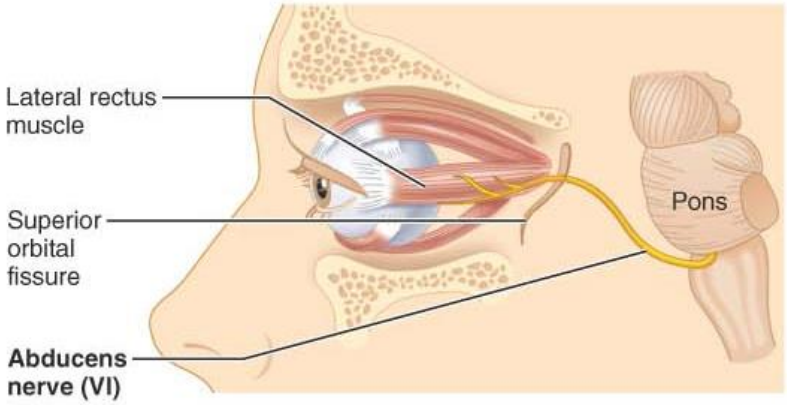



**Figure 26. Innervation of ocular muscles by abducens nerve**

**41. Correct answer is C.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 489).*
**Red nuclei** through the rubrospinal pathways provide tonus of*flexor muscles*. If it increases, tonus of extensor muscles reciprocally decreases.

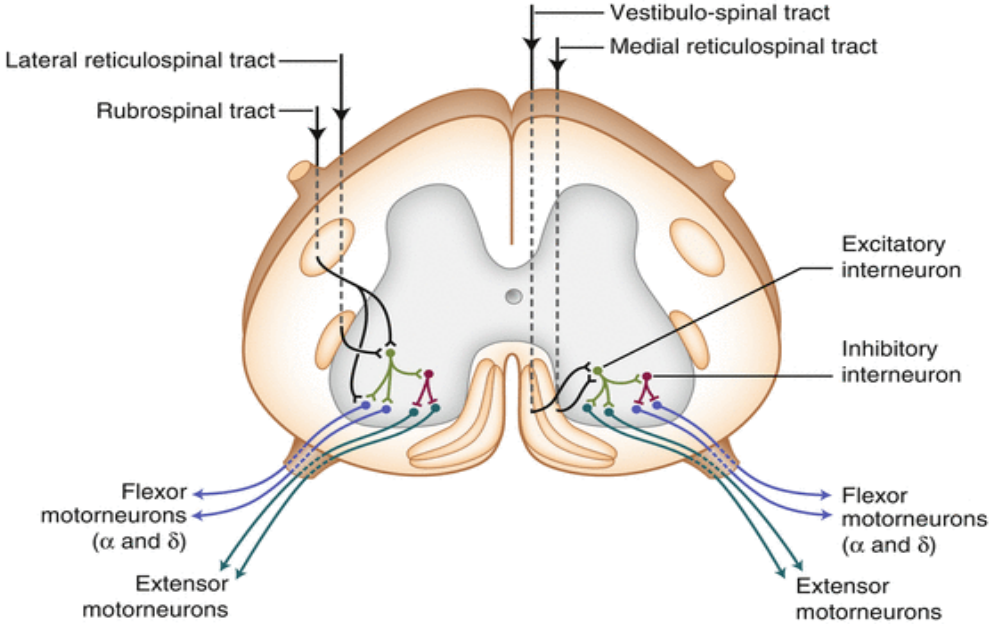



**Figure 27. Topography of descending pathways at the white matter of spinal cord. Pathways of lateral column control flexor-muscles, pathways of ventral columns control extensor-muscles**

**42. Correct answer is E.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 489).*
Rubrospinal and vestibulospinal pathways have reciprocal interconnections. **Vestibular nuclei of Deiters** through the vestibulospinal pathways provide tonus ofextensor muscles (*fig. 27*).

**43. Correct answer is C.** *(Saladin, Chapter 16, Sense Organs, p. 606).*
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.

**44. Correct answer is C.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 551).*
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 (*fig. 25).*

**45. Correct answer is A.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 475, 527).*
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.

**Physiology of cerebellum, basal ganglia and cerebral cortex**

**46. Correct answer is D.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 543–544; Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2018. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 327).*
The cerebellum smooths out 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*) (*table 4*).

**Table 4**

**Symptoms of cerebellum lesion**

| Symptoms | Their manifestation |
|---|---|
| **Lesions that include the hemisphere –** produce a number of dysfunctions, mostly involving distal musculature | |
| **Ataxia** | Errors in the range, rate, force, and direction of movement resulting in loss of muscle coordination in producing smooth movements |
| **Hypotonia** | Usually occurs with an acute cerebellar insult that includes the deep cerebellar nuclei. The muscles feel flabby on palpation, and deep tendon reflexes are usually diminished |
| **Intention tremor** | Is seen when voluntary movements are performed. For example, if a patient with a cerebellar lesion is asked to pick up a penny, a slight tremor of the fingers is evident and increases as the penny is approached. The tremor is barely noticeable or is absent at rest. |
| **Asthenia** | Rapid fatigability of muscles |
| **Asynergy** | Loss of coordination - the components of complex movements occur as a series of simple individual movements. |
| **Dysmetria (past pointing)** | Is the inability to stop a movement at the proper place. The patient has difficulty performing the finger-to-nose test. |

| Symptoms | Their manifestation |
|---|---|
| **Dysdiadochokinesia (adiadochokinesia)** | Is the reduced ability to perform alternating movements, such as pronation and supination of the forearm, at a moderately quick pace. |
| **Scanning dysarthria** | Is caused by asynergy of the muscles responsible for speech. In scanning dysarthria, patients divide words into syllables, thereby disrupting the melody of speech. |
| **Gaze dysfunction** | Occurs when the eyes try to fix on a point: They may pass it or stop too soon and then oscillate a few times before they settle on the target. A nystagmus may be present, particularly with acute cerebellar damage. The nystagmus is often coarse, with the fast component usually directed toward the involved cerebellar hemisphere. |
| **Lesions to the vermal region** | |
| **Disequilibrium** | Difficulties in maintaining posture, gait, or balance. |
| **Abasia (gait ataxia)** | Is impossibility to maintain balance during walking. To keep the balance the patient walks bent forward with feet wide apart, astraddle; they takes irregular steps, like a sailor on a rough sea or someone who is drunk |

**47. Correct answer is D.** See explanation **Task 46** and **Table 4**

**48. Correct answer is E.** See explanation **Task 46** and **Table 4**

**49. Correct answer is C.** *(Arthur C. Guyton, John E. Hall, 2006. Unit X The Nervous System: B. The Special Senses, p. 666).*

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* (*fig. 24*).

**50. Correct answer is C.** *(Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2018. Section IV Neuroscience. Chapter 5 The Brain Stem, p. 301).*

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 is central paralysis**

**51. Correct answer is E.** *(Saladin, Chapter 13. The Spinal Cord, Spinal Nerves, and Somatic Reflexes, p. 487, 540).*

The cortex of *posterior central 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 (*fig. 15*).

**53. Correct answer is C.**See explanation **Task 46** and **Table 4**

**53. Correct answer is B.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 540–541).*

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 (*fig. 28*). 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.

**54. Correct answer is D.** *(Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2018. Section IV Neuroscience. Chapter 10 Cerebral Cortex, p. 363).*
The **supramarginal gyrus** is part of the somatosensory association cortex in posterior parietal association cortex (*fig. 14*), 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).

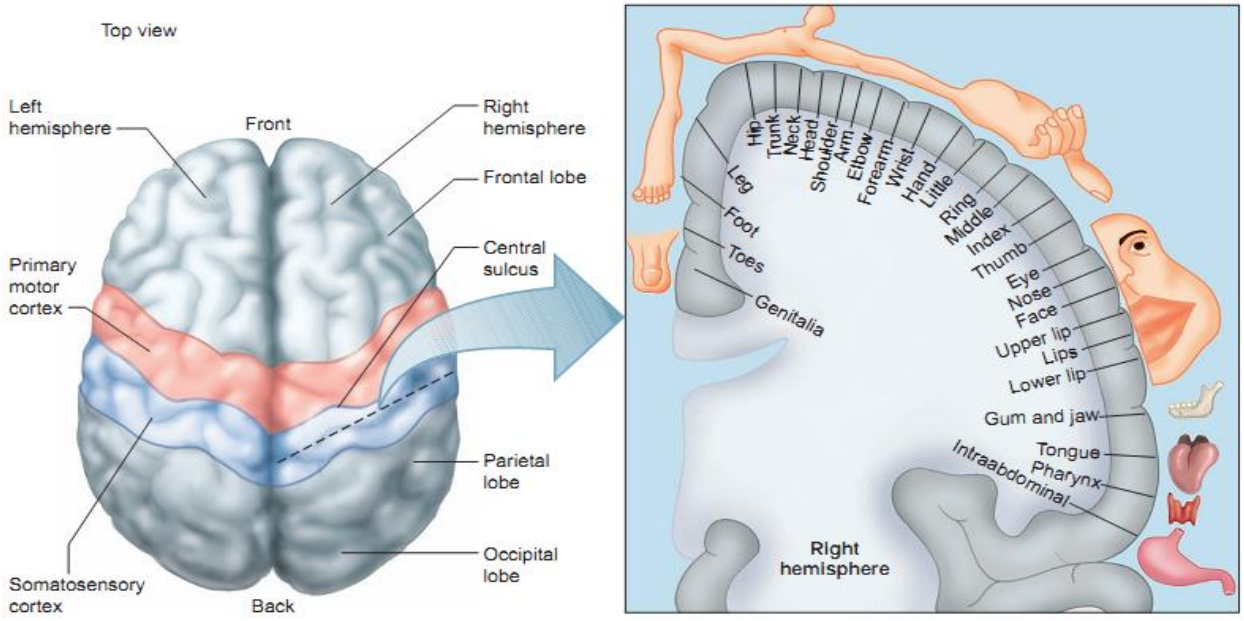



**Figure 28. Sensory homunculus:**
topographic presentation of human body at the posterior central gyrus (primary somatosensory cortex)

**55. Correct answer is B.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 543-544; Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2018. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 327).*
**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). *Atonia* is the absence of muscular tone; *intention tremor* is the trembling which rises during execution of movements, *ataxia* is misbalance of posture and gait; *adiadochokinesis* is inability of rapid opposite movements such as pronation and supination (*table 4*).
**56. Correct answer is A.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 543–44; Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2018. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 327).*
**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). *Intention tremor* is the trembling which rises during execution of movements, *ataxia* is the misbalance of posture and gait; *asynergia is the loss of movements coordination; dysarthria* is the difficulty to articulate (*table 4*).
**57. Correct answer is D.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 543–544; Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2018. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 327).*
**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) (*table 4*).

**58. Correct answer is D.** *(C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learing and Memory, p. 5–261).*
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**.
**59. Correct answer is D.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 489).*
Red nuclei through the rubrospinal pathways provide tonus offlexor 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.
**60. Correct answer is D.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 529).*
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.
**61. Correct answer is E.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 475, 527).*
**The substantia nigra**, a dark gray to black nucleus pigmented with melanin and *dopamine*. Dopamine 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 acetylcholine to dopamine, leading to hyperactivity of the basal nuclei. As a result, a person with PD suffers involuntary muscle contractions.
**62. Correct answer is A.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 543–544; Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2018. Section IV Neuroscience. Chapter 6 The Cerebellum, p. 327).*
**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) (*table 4*).
**63. Correct answer is E.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 475, 527; Kaplan USMLE Step 1 Lecture Notes. Anatomy, 2018. Section IV Neuroscience. Chapter 7Basal Ganglia, p. 329).*
The basal ganglia initiate and provide gross control over skeletal muscle movements. The major components of the basal ganglia include: 1) Striatum, which consists of the caudate nucleus and the putamen (telencephalon), 2) External and internal segments of the globus pallidus (telencephalon), 3) Substantia nigra (in midbrain), 4) Subthalamic nucleus (in diencephalon). 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.*(table 5*).

**Table 5**

**Diseases of basal ganglia**

| Disease | Clinical manifestation | Notes |
|---|---|---|
| **Parkinson disease** | Bradykinesia, cogwheel rigidity, pill-rolling (resting) tremor, shuffling gate, stooped posture, masked face, depression, dementia | **Loss of pigmented dopaminergic neurons from substantia nigra**<br>**Lewy bodies:** intracytoplasmic eosinophilic inclusions,contain α-synuclein<br>Known causes of parkinsonism: infections, vascular, and toxic injuries |

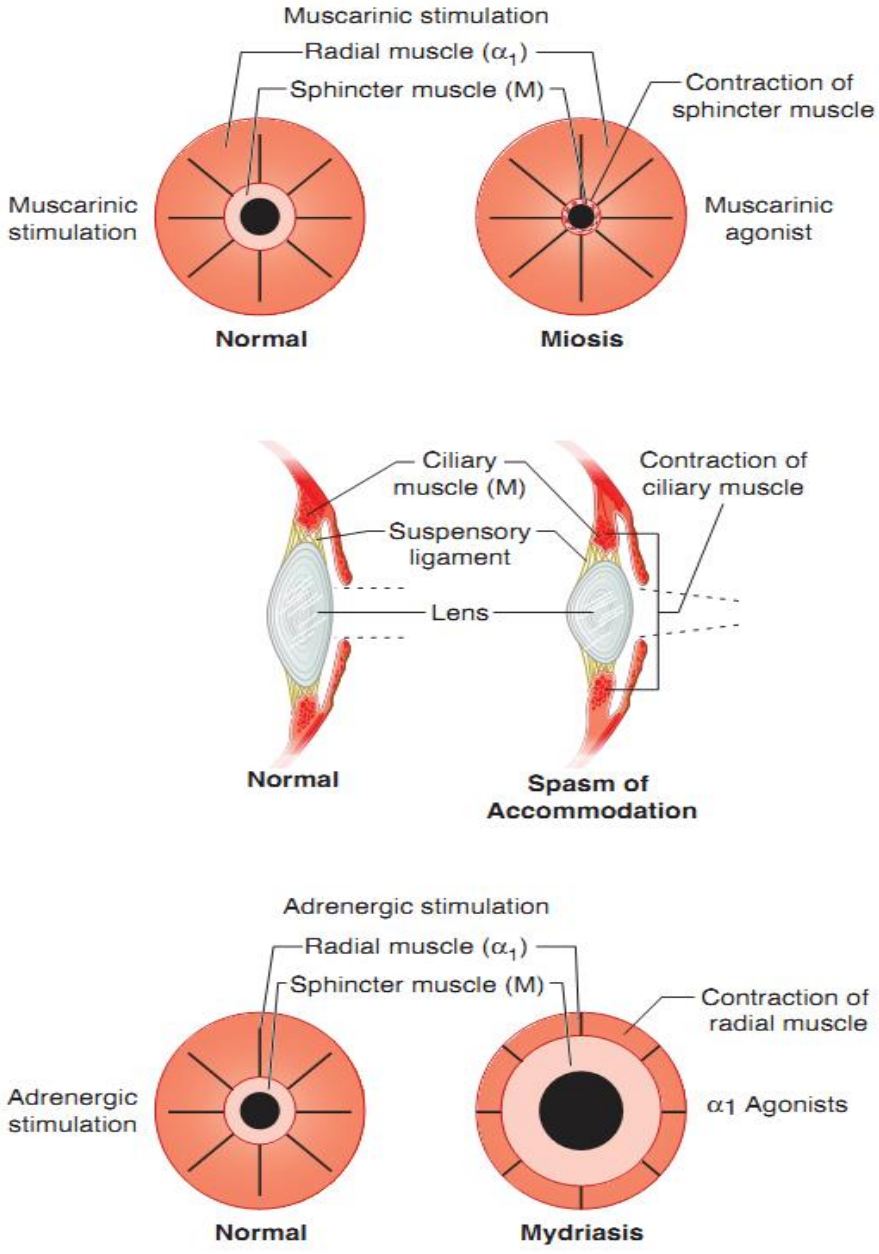
| Disease | Clinical manifestation | Notes |
|---|---|---|
| **Huntington disease** | Chorea (multiple, rapid, random movements), athetosis (slow, writhing movements), personality changes, dementia<br>Onset: 20–40 years | **Degeneration of GABAergic neurons in neostriatum**, causing atrophy of head of caudate nucleus (and ventricular dilatation)<br>**Autosomal dominant**<br>Unstable nucleotide repeat on gene in chromosome 4, which codes for huntingtin protein |
| **Wilson disease (hepatolenticular degeneration)** | Tremor, asterixis, parkinsonian symptoms, chorea, neuropsychiatric symptoms; fatty change, hepatitis, or cirrhosis of liver,<br>tremor may be "wing beating" | **Lesions in basal ganglia (especially putamen)**<br>**Autosomal recessive** defect in copper transport<br>Accumulation of copper in liver, brain, and eye (Descemet membrane, producing Kayser-Fleischer ring) |
| **Hemiballism** | Wild, flinging movements of limbs | **Hemorrhagic destruction of contralateral subthalamic nucleus**<br>Hypertensive patients |
| **Tourette syndrome** | Motor tics and vocal tics (e.g., snorting, sniffing, uncontrolled and often obscene vocalizations) | |

**65. Correct answer is B.** *(Linda. S. Costanzo, Chapter 3:Neurophysiology, Motor Systems, Basal Ganglia, p. 106).*
Diseases of the basal ganglia include Parkinson disease and Huntington disease. In Parkinson disease, cells of the pars compacta of the *substantia nigra* degenerate, reducing inhibition via the indirect pathway and reducing excitation via the direct pathway. The characteristics of Parkinson disease are explainable by dysfunction of the basal ganglia: *resting tremor, slowness and delay of movement, and shuffling gait*. *Treatment of Parkinson disease includes replacement of dopamine* by treatment with **L-dopa** (the precursor to dopamine) or administration of dopamine agonists such asbromocriptine. Huntington disease is a hereditary disorder caused by destruction of striatal and cortical cholinergic neurons and inhibitory GABAergic neurons.The neurologic symptoms of Huntington disease are choreic (writhing) movements and dementia. There isno cure.

**Autonomic regulation of visceral functions**

**66. Correct answer is E.** *(Saladin, Chapter 15. The Autonomic Nervous and Visceral Reflexes, p. 580).*
**Monoamine oxidase** (MAO) is an enzyme that provides breakdown of all monoamine neurotransmitters including*noradrenalin, serotonin and dopamine*.
**67. Correct answer is A.***(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).*
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
**68. Correct answer is B.** *(Saladin, Chapter 15. The Autonomic Nervous and Visceral Reflexes, p. 574, 580).*
Monoamine oxidase (MAO) is an enzyme that provides breakdown of all monoamine neurotransmitters includingnoradrenalin, serotonin and dopamine. **Acetylcholine is broken down by another enzyme called acetylcholine esterase.**
**69. Correct answer is C.** *(Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty – 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).*
*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.**




**Muscarinic stimulation**
1. Miosis
2. Accommodation (near vision)

Muscarinic antagonism
1. Mydriasis
2. Accommodation to far vision, leading to cycloplegia (paralysis of accommodation)

**Adrenergic stimulation (α1-agonists)**
1. Mydriasis
2. No cycloplegia

**Figure 29. Sympathetic and parasympathetic effects on pupil diameter.**
*(Kaplan USMLE Step 1 Lecture Notes, 2018. Pharmacology.*
*Section II Autonomic Pharmacology, Chapter 1Autonomic Nervous system, p. 39)*

**70. Correct answer is D.** *(Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty – 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, 2018. Section II Autonomic Pharmacology, Chapter 2 Cholinergic Pharmacology, p. 41).*
*Pressing on eyeballs* usually causes a reduction of heart rate and respiratory rate; this*unconditioned parasympathetic reflex* **is called oculocardiac or Dagnini-Ashner's reflex.**

**71. Correct answer is C.** *(Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty. – Kharkiv : KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 96).*
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**.
**72. Correct answer is C.** *(Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty. – Kharkiv : KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 98, 100).*
*Corestenomais myosis* (constriction of pupils). Myosis is an unconditioned parasympathetic reflex provided by **parasympathetic stimulation** of ciliary muscle of the eye by parasympathetic fibers of Cranial Nerve III (oculomotor), neurotransmitter – acetylcholine, receptors – M3-cholinergic receptors.
**73. Correct answer is D.** *(Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty. – Kharkiv : KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 98, 100).*
**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 which is present in mushrooms is agonist of M-cholinergic receptors.
**74. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Unit X The Nervous System: B. Special Senses, p. 648).*
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) of the midbrain 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. Therefore, loss of myosis reflex results from the damage of vegetative (visceral) nucleus of CN III.
**75. Correct answer is B.** *(Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty– Kharkiv : KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 101).*
Increased heart rate, mydriatic pupils, and dry mouth are effects of **sympathetic system activation**.

**Table 6**

**Types, localization and effects of adrenergic receptors**

| Receptor type | Effect |
|---|---|
| **$\alpha_1$** | |
| Eye: radial (dilator) muscle | Contraction: mydriasis |
| Arterioles (skin, viscera) | Contraction: ↑ TPR, ↑ diastolic pressure, ↑ afterload |
| Veins | Contraction: ↑ venous return, ↑ preload |
| Bladder trigone and sphincter and prostatic urethra | Contraction: urinary retention |
| Male sex organs | Vas deferens: ejaculation |
| Liver | ↑ glycogenolysis |
| Kidney | ↓ renin release |
| **$\alpha_2$** | |
| Prejunctional nerve terminals | ↓ transmitter release and NE synthesis |
| Platelets | Aggregation |
| Pancreas | ↓ insulin secretion |

| Receptor type | Effect |
|---|---|
| **$\beta_1$** | |
| Heart SA node | ↑ HR (positive chronotropy) |
| AV node | ↑ conduction velocity (positive dromotropy) |
| Atrial and ventricular muscle | ↑ force of contraction (positive inotropy), conduction velocity, CO and oxygen consumption |
| His-Purkinje | ↑ automaticity and conduction velocity |
| Kidney | ↑ renin release |
| **$\beta_2$ (mostly not innervated)** | |
| Blood vessels (all) | Vasodilation: ↓ TPR: ↓ diastolic pressure, ↓ afterload |
| Uterus | Relaxation |
| Bronchioles | Dilation |
| Skeletal muscle | ↑ glycogenolysis: contractility (tremor) |
| Liver | ↑ glycogenolysis |
| Pancreas | ↑ insulin secretion |
| **$D_1$ (peripheral)** | |
| Renal, mesenteric, coronary vasculature | Vasodilation: in kidney ↑ RBF, ↑ GFR, ↑ Na+ secretion |

**Table 6**

**Types, localization and effects of adrenergic receptors**

| Localization | | Receptor type | Effect |
|---|---|---|---|
| **Eye** | Sphincter | $M_3$ | Contraction—myosis |
| | Ciliary muscle | $M_3$ | Contraction—accommodation for near vision |
| **Heart** | SA node | $M_2$ | ↓ Heart rate (HR)—negative chronotropy |
| | AV node | $M_2$ | ↓ Conduction velocity—negative dromotropy<br>No effects on ventricles, Purkinje system |
| **Lungs** | Bronchioles | $M_3$ | Contraction—bronchospasm |
| | Glands | $M_3$ | ↑ Secretion |
| **GI tract** | Stomach | $M_3$ | ↑ Motility—cramps |
| | Glands | $M_1$ | ↑ Secretion |
| | Intestine | $M_3$ | Contraction—diarrhea, involuntary defecation |
| **Bladder** | | $M_3$ | Contraction (detrusor), relaxation (trigone/sphincter), voiding, urinary incontinence |
| **Sphincters** | | $M_3$ | Relaxation, except lower esophageal, which contracts |
| **Glands** | | $M_3$ | ↑ Secretion—sweat (thermoregulatory), salivation, and lacrimation |
| **Blood vessels (endotellium)** | | $M_3$ | Dilation (via NO/endothelium-derived relaxing factor) – no innervation, no effects of indirect agonists |
| **Neuro-muscular junction** | | $N_M$ | Muscle excitation with following contraction |
| **CNS** | | $N_N$ | Synapses in CNS (mainly excitatory) |

**Table 7**

**Mechanism of adrenergic and cholinergic receptors**

| Receptor type | Membrane G proteins | Mechanism |
|---|---|---|
| $\alpha_1$ | Gq coupled | ↑ phospholipase C →↑ IP3, DAG, Ca2+ |
| $\alpha_2$ | Gi coupled | ↓ adenylyl cyclase → ↓ cAMP |
| $\beta_1$, $\beta_2$, $D_1$ | Gs coupled | ↑ adenylyl cyclase → ↑ cAMP |
| $M_1$ and $M_3$ | Gq coupled | ↑ phospholipase C →↑ IP3, DAG, Ca2+ |
| $M_2$ | Gi coupled | ↓ adenylyl cyclase →↓ cAMP |
| $N_N$ and $N_M$ | No 2nd messengers | activation (opening) of Na/K channels |

**Humoral regulation of visceral functions**

***Questions***

**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.*

**Notes:**_____

**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.*

**Notes:**_____

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

**Notes:**_____

**4**. A man because of 1.5 liter 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.*

**Notes:**_____

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

**Notes:**_____

**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. Pancrea. B. Ovaries. C. Adrenal glands. D. Parathyroid glands. E. Thyroid.*

**Notes:**_____

**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.*

**Notes:**_____

**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.*

**Notes:**_____

**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 (cruces cerebri).*
*B. Pons cerebelli.* *D. Hypothalamus.*

**Notes:**_____

**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.*

**Notes:**_____

**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.*

**Notes:**_____

**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 $D_3$.* *B. . Thyrocalcitonin* *C. Parathormone.* *D. Aldosterone.* *E. Vasopressin.*

**Notes:**_____

**13**. 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.*

**Notes:**_____

**14**. 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.*

**Notes:**_____

**15**. 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.*

**Notes:**_____

**16**. 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.*

**Notes:**_____

**17**. 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. Aldosterone increase.* *D. Aldosterone reduction.*
*B. Reduction of atrial natriuretic factor.* *E. Vasopressin reduction.*
*C. Vasopressin increase.*

**Notes:**_____

**18**. 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.*

**Notes:**_____

**19**. 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.*

**Notes:**_____

**20**. 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.*

**Notes:**_____

**21**. 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.*

**Notes:**_____

**22**. 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.*

**Notes:**_____

**23**. 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.*

**Notes:**_____

**24**. 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.* *B. Thyrocalcitonin.* *C. Prolactin.* *D. Vasopressin.* *E. Glucagon.*

**Notes:**_____

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

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

**Notes:**_____

**26**. 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. $B_1$.* *D. A.* *E. $D_3$.*

**Notes:**

**27**. 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.*

**Notes:**

**28**. A 43-eyar-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. Somarotropin.* *C. Aldosterone.* *D. Insulin.* *E. Thyroxine.*

**Notes:**

**29**. 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.*
*B. Insulin hyposecretion.*
*C. Hypersecretion of growth hormone.*
*D. Glucocorticoids hypersecretion.*
*E. Posterior pituitary hormone hypersecretion.*

**Notes:**

**30**. 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.* *B. Aldosterone.* *C. Sex hormones.* *D. Cortisol.* *E. Adrenaline, vasopressin.*

**Notes:**

**31**. 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.*

**Notes:**

**32**. 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.*

**Notes:**_____

**33**. 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.*

**Notes:**_____

**34**. 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 preservations 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.*

**Notes:**_____

**35**. 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.*

**Notes:**_____

**36**. 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.*

**Notes:**_____

**37**. 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.*

**Notes:**_____

**38**. 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.* *B. Adrenaline, vasopressin.* *C. Cortisol.* *D. Sex hormones.* *E. Oxytocin.*

**Notes:**_____

**39**. 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.*
*B. Reduced production of thyroid hormones.*
*C. Increased insulin production.*
*D. Reduced glucagon production.*
*E. Increased mineralocorticoid production.*

**Notes:**_____

**40**. 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.*
*B. Reduced tubular reabsorption of protein.*
*C. Reduced glucose reabsorption.*
*D. Reduced tubular reabsorption of water.*
*E. Acceleration of glomerular filtration.*

**Notes:**_____

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

*A. Hypercorticoid.* *B. Adrenal.* *C. Alimentary.* *D. Somatotropic.* *E. Hypoinsulinemic.*

**Notes:**_____

**42**. 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.* *B. Thymus gland.* *C. Adrenal glands.* *D. Hypophysis.* *E. Thyroid gland.*

**Notes:**_____

**43**. 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.*
*B. Reduced production of parathormone.*
*C. Increased production of thyroxin.*
*D. Increased production of calcitonin.*
*E. Increased production of thyroliberin.*

**Notes:**_____

**44**. 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.*

**Notes:**_____

**45**. 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.*

**Notes:**_____

**46**. 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.*
*B. Adrenal medulla.*
*C. Adenohypophysis.*
*D. Neurohypophysis.*
*E. Islets of Langerhans (pancreatic islets).*

**Notes:**_____

**47**. 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. B. Thyrocalcitonin. C. Parathormone. D. Thyroxin. E. Somatotropic hormone.*

**Notes:**_____

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

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

**Notes:**_____

**49**. 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.*
*B. Vasopressin hyposecretion.*
*C. Glucocorticoid hypersecretion.*
*D. Relative insulin insufficiency.*
*E. Aldosterone hypersecretion.*

**Notes:**_____

**50**. 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.*

**Notes:**_____

**51**. 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.*
*B. Catecholamines.*
*C. . Thyrocalcitonin, parathormone*
*D. Somatoliberin, somatostatin.*
*E. Triiodothyronine, tetraiodothyronine.*

**Notes:**_____

**52**. 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.*

**Notes:**_____

**53**. 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.*

**Notes:**_____

**54**. 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.*

**Notes:**_____

**55**. 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.* *C. Insulin deficiency.* *E. Vitamin D deficiency.*
*B. Hyperthyroidism.* *D. Vitamin C deficiency.*

**Notes:**_____

**56**. 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.*

**Notes:**_____

**57.** Corticosteroid hormonesregulate the adaptation processes of the body as the whole to environment changes and ensure the maintenance of the internal homeostasis. What hormone activates the hypothalamo-pituitary-adrenal axis?

*A. Somotoliberin. B. Corticostatin. C. Thyroliberin. D. Somatostatin. E. Cortocolliberin.*

**Notes:**_____

**58.** On the examination the patient presents with hirsutism, moon-shaped face, stretch marks on the abdomen. BP is 190/100 mm Hg, blood glucose is 17,6 mmole/l. What pathology is such clinical presentation characteristic of?

*A. Adrenocortical hyperfunction.*
*B. Hyperfunction of insular apparatus.*
*C. Hypothyroidism.*
*D. Hyperthyroidism.*
*E. Gonadal hypofunction.*

**Notes:**_____

**59.** During removalof the hyperplastic thyroid gland of 47-year-old woman, the parathyroid gland was damaged. One month after the surgery the patient developed signs of hypoparathyroidism: frequent convulsions, hyperreflexia, laryngospasm. What is the most likely cause of patient's condition?

*A. Hyperchlorhydria.*
*B. Hyponatremia.*
*C. Hypophosphatemia.*
*D. Hyperkalemia.*
*E. Hypocalcemia.*

**Notes:**_____

**60.** On examination the patient is found to have low production of adrenocorticotropic hormone. How would this affect production of the other hormones?

*A. Decrease insulin synthesis.*
*B. Decrease adrenocorticotropic hormone synthesis.*
*C. Increase sex hormone synthesis.*
*D. Increase thyroid hormones synthesis.*
*E. Decrease hormones synthesis in the adrenal medulla.*

**Notes:**_____

**61**. In human organism significant blood loss leads to decreased blood pressure, tachycardia, and weakness. Eventually the sensation of thirst appears. What hormone participates in the development of this sensation?

*A. Serotonon. B. Angiotensin 2. C. Adrenalin. D. Cortisol. E. Dopamine.*

**Notes:**_____

**62**. A patient presents with osteoporosis; hypercalcemia and hypophosphatemia are observed in the patient's blood. What is the cause of this condition?

*A. Inhibited parathormone secretion.*
*B. Increased thyroxin secretion.*
*C. Inhibited corticosteroid secretion.*
*D. Increased parathormone secretion.*
*E. Increased corticosteroid secretion.*

**Notes:**_____

**63**. A patient presents with high content of vasopressin (antidiuretic hormone) in the blood. What changes in the patient's diuresis will occur?

*A. Anuria.* *B. Natriuria.* *C. Polyuria.* *D. Oliguria.* *E. Glycosuria.*

**Notes:**_____

**64**. A 30-year-old woman complains of intense thirst and dryness of the mouth that developed after a severe emotional shock. Laboratory analysis revealed increase of the patient's blood sugar level up to 10 mmol/L. What endocrine gland is affected in the patient?

*A. Pancreas.* *B. Adrenal glands.* *C. Pineal gland.* *D. Thyroid glands.* *E. Gonads.*

**Notes:**_____

**65**. A 40-year-old woman on examination presents with intensified basal metabolic rate. What hormone present in excess leads to such condition?

*A. Aldosterone.* *B. Thyrocalcitonin.* *C. Triiodothyronin.* *D. Somatostatin.* *E. Glucagon.*

**Notes:**_____

**66.** A laboratory rat with chronic renal failure presents with osteoporosis, pathologic calcification of the internal organs, and arterial hypertension. These disturbances are associated with increased activity of the following hormone:

*A. Thyroxin.*
*B. Parathyroid hormone.*
*C. Triiodothyronine.*
*D. Adrenaline.*
*E. Calcitonin.*

**Notes:**_____

**67.** Prolonged vomiting resulted in dehydration of the patient's body. Under these conditions, water retention in the body is ensured primarily due to increased secretion of the following hormone:

*A. Aldosterone.* *B. Adrenaline.* *C. Vasopressin.* *D. Calcitonin.* *E. Natriuretic hormone.*

**Notes:**_____

**68.** On your physiology class, the professor asked you to report about the effect of various body hormones and neurotransmitters on the metabolism of glucose. You begin your report with the statement that the use of glucose by cells is preceded by absorption through the plasma membrane

from the extracellular matrix into the cell. Which of the following hormones is most likely responsible for the glucose uptake by cells?

*A. Insulin.* *B. Thyroxine.* *C. Epinephrine.* *D. Aldosterone.* *E. Glucagon.*

**Notes:**_____

**69.** A 45-year-old woman comes to her physician with complaints of excessive fatigue and weakness. She says that these symptoms have been present for the past month. On further questioning, she admits having lost 3 kilograms in the last 2 weeks. On physical examination, she is a tired-appearing thin woman. Hyperpigmentation is present over many areas of her body, most prominently over her face, neck back of hands (areas exposed to light). Increased production of which of the following hormones is the most likely cause of hyperpigmentation in this patient?

*A. Growth hormone (GH).*
*B. β-Lipotropin.*
*C. Gonadotropins.*
*D. Thyroid-stimulating hormone (TSH).*
*E. Melanocyte-stimulating hormone (MSH).*

**Notes:**_____

**70.** A 54-year-old woman thyroidectomy for papillary thyroid carcinoma. 11 hours after operation she complains on tingling around her mouth. On physical examination, the Trousseau's sign and Chvosteck's sign are present. Her condition rapidly deteriorates with laryngospasm and local seizures. The surgeon suggests surgical distraction of parathyroid glands. Which of the following is the most likely cause of patient's neurologic abnormality?

*A. Hypercalcemi.* *C. Hypocalcemi.* *E. Hyponatremia.*
*B. Hyperchloremi.* *D. Hypophosphatemia.*

**Notes:**_____

**71.** A group of researchers aimed to study cardiac physiology found that overstretching of atria in the heart leads to decreased sodium reabsorption in distal convoluted tubules and increase glomerular filtration rate. Which of the following is the most likely cause of physiologic effects discovered by researchers?

*A. Renin.* *B. Angiotensin.* *C. Antidiuretic hormone.* *D. Natriuretic peptide.* *E. Aldosterone.*

**Notes:**_____

**Humoral regulation of visceral functions**

***Answers***

**1. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 944).*

*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.

**2. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 940).*

The general effect of thyroid hormones (thyroxin and triiodothyronine) 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**.

**3. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 928; Linda S. Costanzo, Chapter 9. Endocrine physiology, p.395; Kim E. Barret. Section III: Endocrine and Reproductive Physilogy, Chapter 17:Hypothalamic regulation of hormonal function, p.414).*

The posterior lobe of the pituitary gland secretes two neuropeptides: *arginine vasopressin ( or antidiuretic hormone – ADH) and oxytocin*. The cell bodies of ADH- and oxytocin-secreting neurons are located in *supraoptic* and *paraventricular nuclei* within the hypothalamus. Although both hormones are synthesized in both nuclei, ADH is primarily associated with supraoptic nuclei and oxytocin is primarily associated with paraventricular nuclei. Because one of its principal physiologic effects is the retention of water by the kidney, vasopressin is often called the antidiuretic hormone (ADH). It increases the permeability of the collecting ducts of the kidney so that water enters the hypertonic interstitium of the renal pyramids. The urine becomes concentrated and its volume decreases. The overall effect is therefore retention of water in excess of solute. **In the absence of vasopressin (for example, in case of trauma in and around supraoptical nuclei), the urine is hypotonic to plasma, urine volume is increased (polyuria), and there is a net water loss.**

**4. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 929).*

**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.

**5. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 972).*

In healthy organism blood glucose content is 3.8–6.1 mmol/l and glucose in urine is absent. Hyperglycemia (blood glucose level > 6.1 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*.

**6. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 940).*

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 excessive production of thyroid hormones – **hyperthyroidism**.

**7. Correct answer is E.** *(Saladin, Chapter 17 The Endocrine System, p. 645).*
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**
**8. Correct answer is C.** *(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).*
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 which is produced by parathyroid glands and has the effect to increase calcium level in blood.
**9. Correct answer is D.** *(Saladin, Chapter 14 The Brain and Cranial Nerves, p. 530–531).*
Mentioned 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*
**10. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 961, 963, 972).*
*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)
**11. Correct answer is A.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 991).*
*Hyperparathyroidism* (hyperfunction of parathyroid glands) causes the hyperproduction of parathyroid hormone that increases calcium level (**hypercalcemia**) 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*.
**12. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 987).*
**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*.
**13. Correct answer is D. (***Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 976).*
The normal blood glucose level is 3.8–6.1 mmol/l (So, options A, B, C are irrelevant because glucose concentrations are within the normal range). *Clonic seizures and loss of consciousness* are likely to occur in case od severe hypoglycemia as the blood glucose level falls to 1,1–2,8 mmol/l, or 20 to 50 mg/100 ml (option D). 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. Option E is mild hyperglycemia, thus, it's irrelevant as well.
**14. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 948).*
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*

**15. Correct answer is D.** *(Saladin, Chapter 17 The Endocrine System, p. 647).*
Restoration of normal composition of white blood cells in the peripheral blood (leukogram) 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**
**16. Correct answer is C.** *(Saladin, Chapter 17 The Endocrine System, p. 647).*
The primary effect of thyroid hormones (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**
**17. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 950).*
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. Therefore, the *increased concentration of sodium ions in blood after injection of sodium chloride* will cause the **decreased secretion of aldosterone**.
**18. Correct answer is A.** *(Saladin, Chapter 17 The Endocrine System, p. 652).*
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**.
**19. Correct answer is E.** *(Linda S. Costanzo. Chapter 4. Cardiovascular Physiology; Regulation Of Arterial Pressure, p 165).*
When there is an *increase in blood volume*, the resulting *increase in venous and atrial pressure is detected by the cardiopulmonary baroreceptors*. The function of the cardiopulmonary baroreceptors is then coordinated to return blood volume to normal, primarily by increasing the excretion of $Na^+$and water**. Atrial natriuretic peptide (ANP)** is secreted by the atria in response to increased atrial pressure as it happens, for instance, in the case of their overstretching by excessive blood volume. ANP has multiple effects, but the most important is to cause relaxation of vascular smooth muscle, which results in vasodilation and decreased total peripheral resistance (TPR). In the kidneys, this vasodilation leads to *increased $Na^+$ and water excretion*, thereby decreasing total body Na+ content, extracellular fluid (ECF) volume, and blood volume.
**20. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 952).*
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
**21. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 949).*
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. **Aldosteronegreatly 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.
**22. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 992).*
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**.

**23. Correct answer is B.** *(Saladin, Chapter 17 The Endocrine System, p. 667).*

**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*

**24. Correct answer is C.** *(Saladin, Chapter 17 The Endocrine System, p. 642).*

Prolactin (PRL) is secreted by lactotropes (mammotropes) of anterior pituitary, which increase greatly in size and number duringpregnancy. PRL level rises during pregnancy, but it hasno effect until after a woman gives birth. Then, it stimulatesthe mammary glands to synthesize milk. Deficit of PRL can be the cause of lactation absence.

**25. Correct answer is D.***(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 985–987).*

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*.

**26. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 985–985; Kim E. Barret, Section III Endocrine and Reproductive Physiology, Chapter 21 Hormonal Control of Calcium & Phosphate Metabolism & the Physiology of Bone, p.494.).*

The term “vitamin D” refers to a group of closely related sterols produced from certainprovitamins. Vitamin $D_3$, which is also called cholecalciferol, is produced in the skin from 7-dehydrocholesterol by the action of sunlight. Vitamin $D_3$ and its hydroxylated derivatives aretransported in the plasma bound to a globulin, vitamin D–binding protein (DBP). Vitamin $D_3$is also ingested in the diet. In the liver, vitamin $D_3$is converted to 25-hydroxycholecalciferol (calcidiol, 25-$OHD_3$). 25-Hydroxycholecalciferolis converted in the proximal tubules of the kidneys to the more active metabolite 1,25-dihydroxycholecalciferol (calcitriol or 1,25-$(OH)_2D_3$).**Vitamin $D_3$** (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 (*fig. 30*)

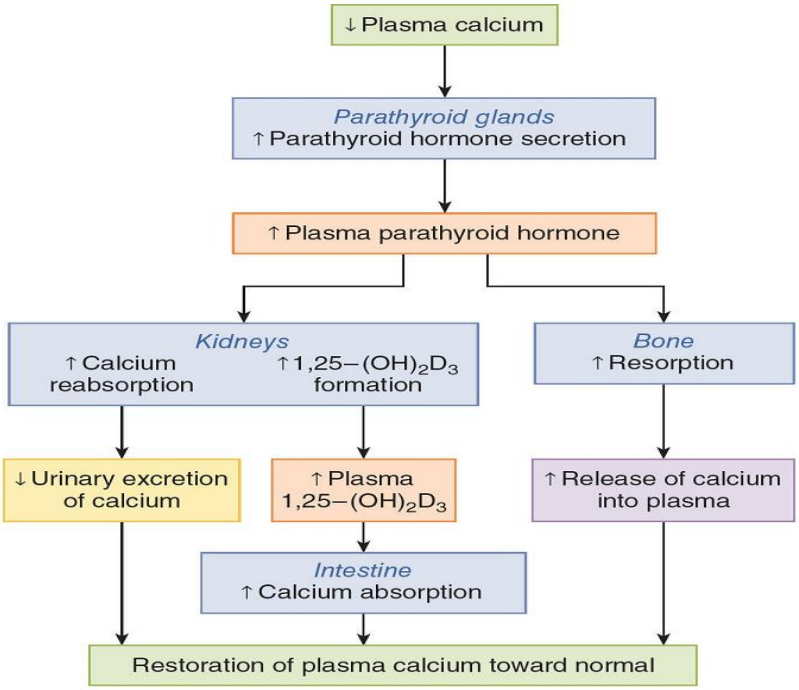



**Figure 30. Effects of PTH and 1,25-dihydroxycholecalciferol on whole body calcium homeostasis**

**27. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 976).*
The normal blood glucose level is 3.8–6.1 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
**28. Correct answer is E.** *(Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 940).*
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).
**29. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 923, 927).*
*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).
**30. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 60 Autonomic Nervous System and Adrenal Medulla, p. 755; Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 929).*
*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
**31. Correct answer is B.** *(Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 942).*
*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.
**32. Correct answer is D.** *(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; Kim E. Barret. Sectin, Chapter 21: Hormonal Control of Calcium &Phosphate Metabolism &the Physiology of Bone, p. 491).*
Humans usually have four parathyroid glands *embedded* in the poles of the thyroid gland. Therefore, during thyroid surgery parathyroid glands cannot be separated, so that they are removed along with thyroid glands resulting in lack of parathyroid hormone. This can have serious consequences as PTH is essential for life. After parathyroidectomy, there is a steady decline in plasma $Ca^{2+}$. *Signs of neuromuscular hyperexcitability appear, followed by full-blown tetany*. Plasma phosphate levels usually rise as the plasma $Ca^{2+}$ level falls. Thus, fibrillary twitching of muscles, tetany and convulsions are the symptoms of *hypocalcemia*. Introduction of **parathyroid hormone** leads to disappearance of listed symptoms
**33. Correct answer is C.***(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 987).*
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.
**34. Correct answer is E.** *(Saladin, Chapter 17 The Endocrine System, p. 670).*
*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, i.e. **hyperfunction of adrenal medulla.**

**35. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 948).*
Aldosterone is the hormone produced by adrenal cortex that cause increased renal tubule reabsorption of sodium and secretion of potassium. **Hypersecretion of aldosterone** causes *increased amount of sodium in blood and elevated level of potassium in urine*.
**36. Correct answer is D.** *(Saladin, Chapter 17 The Endocrine System, p. 644).*
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.
**37. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 959).*
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.
**38. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 60 Autonomic Nervous System and Adrenal Medulla, p. 755; Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 929).*
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.
**39. Correct answer is A.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 958; Linda. S. Costanzo, Chapter 9: Endocrine Physiology; Adrenal Medulla and Cortex, p. 423; USMLE Step 1 Lecture Notes, Kaplan, 2018. –Physiology. Part VII: Endocrinology. Chapter 42: Adrenal Cortex, p. 281).*
*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 (*fig.* 32)
**40. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 75 Pituitary Hormones and Their Control by the Hypothalamus, p. 928).*
Vasopressin (ADH) increases *the reabsorption of water in collecting tubules and ducts of kidneys* thus decreasing the diuresis (daily production of secondary urine). **Reduction** or absence **of vasopressin** leads to polyuria and dehydration; that state is called *diabetes insipidus.*
**41. Correct answer is B.** *(Saladin, Chapter 17 The Endocrine System, p. 670).*
*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.**
**42. Correct answer is D.***(Saladin, Chapter 17 The Endocrine System, p. 638).*
*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.**
**43. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 987, 990).*
*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.
**44. Correct answer is A.***(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 988-989).*

**Calcitonin**(antagonizes parathyroid hormone) inhibits bone 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*.

**45. Correct answer is A.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 81 Female Physiology Before Pregnancy and Female Hormones, p. 1015).*

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**.

**46. Correct answer is D.** *(Saladin, Chapter 17 The Endocrine System, p. 666).*

*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**.

**47. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 985, 992).*

*Abnormal formation of tooth enamel and dentin* as a result of *low calcium concentration in blood* probably is caused by **deficiency of parathormone,** which has the specific effect to increase blood calcium level and decrease phosphate level by resorption of bones and teeth.

**48. Correct answer is E.***(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 942).*

*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**.

**49. Correct answer is B.** *(Saladin, Chapter 17 The Endocrine System, p. 666).Excessive thirst, frequent urination, increased diuresis with decreased relative density of urine* (N = 1,010 – 1,025) and *no qualitative alterations* of urine composition are the symptoms of diabetes insipidus that is caused by **hyposecretion of vasopressin** (ADH).

**50. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 942).*

*Cretinism* is caused by extreme **deficiency of thyroxin** during fetal life, infancy, or childhood and is characterized by *failure ofbody growth* and by *mental retardation*.

**51. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 936, 942).*

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.**

**52. Correct answer is C.***(Saladin, Chapter 17 The Endocrine System, p. 666).*

*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

**53. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and Teeth, p. 987, 990).*

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**.

**54. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 77 Adrenocortical hormones, p. 958).*

**Glucocorticoids**, especiallycortisol, 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*.

**55. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 79 Parathyroid Hormone, Calcitonin, Calcium and Phosphate Metabolism, Vitamin D, Bone, and*

*Teeth, p. 985-985; Kim E. Barret, Section III Endocrine and Reproductive Physiology, Chapter 21 Hormonal Control of Calcium & Phosphate Metabolism & the Physiology of Bone, p.494.).*
Vitamin D increases calcium absorption in intestines, kidneys and bones and enhances the mineralization of teeth and bones (*fig. 30*). Therefore, the deficiency of vitamin D can lead to delayed growth, disrupted ossification process and decalcification of teeth. Vitamin D deficiency causes defective calcification of bone matrix and the disease called *rickets* in children and osteomalacia in adults. Even though 1,25-dihydroxycholecalciferol is necessary for normal mineralization of bone matrix, the main defect in this condition is failure to deliver adequate amounts of $Ca^{2+}$ and $PO_4^{3-}$ to the sites of mineralization. The full-blown condition in children is characterized by weakness and bowing of weight-bearing bones, dental defects, and hypocalcemia.
**56. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 78 Insulin, Glucagon and Diabetes Mellitus, p. 963).*
*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.
**57.Correct answer is E.** *(E. Widmaier, Chapter 11: Endocrine system. Section B: The Hypothalamus and pituitary gland, p.333; USMLE Step 1 Lecture Notes, Kaplan, 2018. –Physiology. Part VII: Endocrinology. Chapter 2: Hypothalamic-anterior pituitary system, p. 257).*

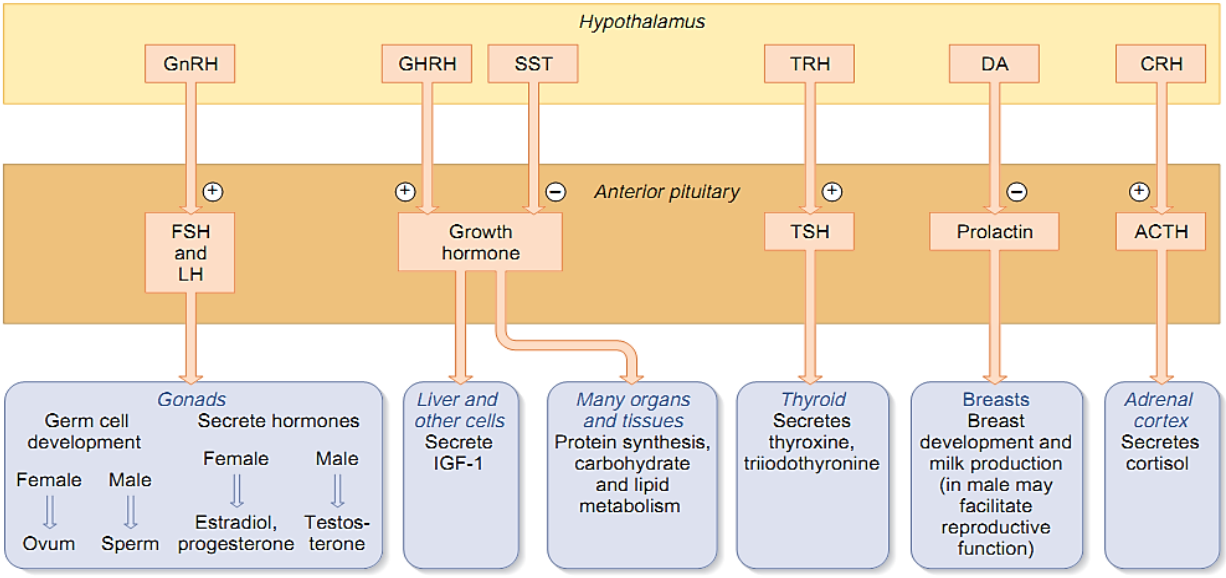


**Figure 31**. Summary of the hypothalamic–anterior pituitary-target endocrine gland system

*"Hypothalamo-pituitary-adrenal axis!* is the term reflecting functional connection and hierarchy between hypothalamus, anterior lobe of pituitary gland (adenohypophysis) and cortex of adrenal glands. There can be also defined hypothalamo-pituitary-thyroid and hypothalamo-pituitary-gonadal axes.Principally, hypothalamus provides overall control of adenohypophyseal hormones synthesis by secretion of releasing-hormones (or liberins) and inhibitory hormones (or statins) into hypothalamic-hypophysial portal blood vessels. The hypothalamic hormones are synthesized in the neuron cell body, packaged in vesicles, and transported down the axon to be stored and released from the nerve terminals. The hypothalamic hormones, thyrotropin-releasing hormone (TRH), corticotropin-releasing hormone (CRH, or **corticoliberin**), growth hormone–releasing hormone (GHRH), somatostatin (SST), and dopamine are synthesized in neuronal cell bodies in the arcuate and paraventricular nuclei; gonadotropin-releasing hormone (GnRH) is synthesized in the preoptic nucleus. The nerve endings all come together in the median eminence region of the hypothalamus. Upon stimulation the hormones are secreted into the hypophyseal-portal system and transported to the anterior pituitary, bind to receptors on corresponding cells of the anterior pituitary and modify (stimulate or inhibit) the secretion of thyroid-stimulating hormone (TSH) (thyrotropin), corticotropin (ACTH), luteinizing hormone (LH), follicle-stimulating hormone (FSH), growth hormone (GH), and prolactin, which delivers them to their target tissues.

**58. Correct answer is A.***(Linda. S. Costanzo, Chapter 9: Endocrine Physiology; Adrenal Medulla and Cortex, p. 423; USMLE Step 1 Lecture Notes, Kaplan, 2018. –Physiology. Part VII: Endocrinology. Chapter 42: Adrenal Cortex, p. 281).*

Disorders involving **overproduction of glucocorticoids** are known as *Cushing syndrome* and *Cushing disease*. In spite of different pathogenesis, the symptoms of either Cushing syndrome or Cushing disease result from excessive glucocorticoids and adrenal androgens. Excess cortisol causes *hyperglycemia (in the case – 17.6 mmole/l)*, increased proteolysis and muscle wasting, increased lipolysis and thin extremities, central obesity, round face, supraclavicular fat, buffalo hump, poor wound healing, osteoporosis, and striae that arecaused by a loss of connective tissue (*stretch marks on the abdomen*). Hypertension (in the case – *BP is 190/100 mm Hg*) occurs because cortisol has weak mineralocorticoid activity and because cortisol increases the responsiveness of arterioles to catecholamines (by up-regulating α1 receptors). Excess androgens cause virilization and menstrual disorders in females (*hirsutism – abnormal growth of hair on a person's face and body, esp. on a woman)*

**Figure 32. Drawing of a woman with Cushing disease. Note the central obesity, buffalo hump, muscle wasting, and striae**

**59. Correct answer is E.** *(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; Kim E. Barret. Section III, Chapter 21: Hormonal Control of Calcium &Phosphate Metabolism &the Physiology of Bone, p. 491).*

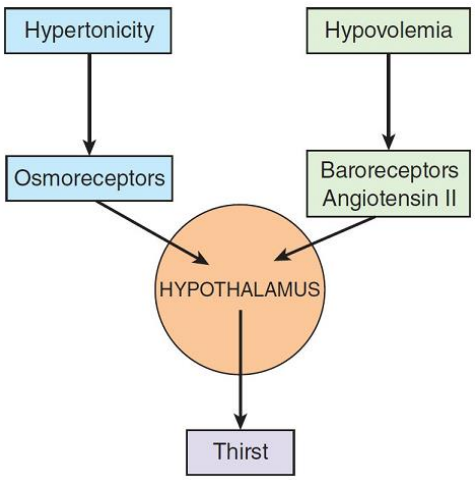
Having been damaged during thyroid surgery, parathyroid glands lost the capability to synthesize sufficient amount of parathyroid hormone, which principal function is regulation of $Ca^{2+}$ concentration in blood plasma *frequent convulsions, hyperreflexia, laryngospasm* are the symptoms of **hypocalcemia** caused by decreased level of parathormone (*hypopapathyroidism*).

**60. Correct answer is B.** *(Ackerman - Physiology / Basic Sciences: p. 52).*

Adrenocorticotropic hormone controls the adrenal cortex by membrane receptor–mediated mechanisms that activate adenylate cyclase by way of a G protein and, thereby, increase cytosolic [cAMP]. A **decline** in the concentration of **ACTH** in the blood leads to a **reduction** in the secretion of adrenal hormones, resulting in adrenal insufficiency (hypoadrenalism). Adrenal insufficiency leads to weight loss, lack of appetite (anorexia), weakness, nausea, vomiting, and low blood pressure (hypotension).

**61. Correct answer is B.***(Kim E. Barret, 2018. Section III Endocrine and Reproductive Physiology, Chapter 17: Hypothalamic regulation of Hormonal Functions, p.417).*

The mechanism thirst is under hypothalamic control. Water intake is increased by 3 main ways: 1) increased effective osmotic pressure of the plasma, 2) decreases in extracellular fluid (ECF) volume, and 3) by psychological and other factors. Osmolality acts via osmoreceptors in the anterior hypothalamus. Decreases in ECF volume can stimulate thirst by a pathway independent of that mediated by increased plasma osmolality. Thus, hemorrhage causes increased drinking even if there is no change in osmolality. The effect of volume depletion is mediated in part via the renin–angiotensin system. Baroreceptors in the heart and blood vessels are also involved. Renin secretion is increased by hypovolemia and results in an increase in circulating angiotensin II. The angiotensin II acts on the subfornical organ, a specialized receptor area in the diencephalon, to stimulate the neural areas concerned with thirst. Some evidence suggests that it acts on the organum vasculosum of the lamina terminalis (OVLT) as well. These areas are highly permeable and are two of the circumventricular organs located



outside the blood–brain barrier

**62. Correct answer is D.** *(USMLE Step 1 Lecture Notes, Kaplan, 2018. – Physiology. Part VII: Endocrinology. Chapter 7: Hormonal Control of Calcium and Phosphate, p. 317)*

Hypercalcemia is the main symptom of primary hyperparathyroidism (increased parathhormone secretion). Consequences include increased plasma calcium (hypercalcemia), decreased plasma phosphate (hypophosphatemia), polyuria, hypercalciuria, and decreased bone mass.

**63. Correct answer is D.** *(USMLE Step 1 Lecture Notes, Kaplan, 2018. – Physiology. Part VII: Endocrinology. Chapter 3: Posterior Pituitary, p. 265; Linda. S. Costanzo, Chapter 9: Endocrine Physiology; Hypothalamo-pituitary relationships, p. 405)*

Excessive production of vasopressin is known as a syndrome of inappropriate ADH (SIADH). *Excess of vasopressin* is usually secreted from an autonomous site (e.g., small cell carcinoma of the lung). High levels of ADH cause excess water reabsorption by the collecting ducts, which dilutes the body fluids (e.g., decreases plasma osmolarity and Na+ concentration) with simultaneous reduction of daily diuresis (**oliguria**). The urine is inappropriately concentrated (i.e., too hypertonic in respect to the blood plasma).

**65. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 76 Thyroid metabolic hormones, p. 936, 942).*

Thyroid hormones (**triiodothyronine and tetraiodothyronine)** increase metabolism in almost all cells of the body, therefore intensified basal metabolic rate is caused by **excessof triiodothyronine.**

**66. Correct answer is B.** *(Kim E. Barret, 2018. Section III Endocrine and Reproductive Physiology, Chapter 21: Hormonal Control of Calcium &Phosphate Metabolism & thePhysiology of Bone, p. 498; USMLE Step 1 Lecture Notes, Kaplan, 2018. – Physiology. Part VII: Endocrinology. Chapter 7: Hormonal Control of Calcium and Phosphate, p. 326)*

In conditions such as chronic kidney disease and rickets, in which theplasma $Ca2^{+}$ level is chronically low, stimulation of the parathyroid glands causescompensatory parathyroid hypertrophy and secondary hyperparathyroidism. The plasma$Ca^{2+}$ level is low in chronic kidney disease primarily because the diseased kidneys losethe ability to form 1,25-dihydroxycholecalciferol.Loss of nephrons prevents kidneys from excreting phosphate (Pi), and elevated Pi lowers free $Ca2^{+}$, which in turn increases PTH. Thus, **increased concentration of parathyroid hormone** results in: 1) intensified bone resorption – *osteoporosis*, 2) elevated $Ca^{2+}$*–pathologic calcification of the internal organs*, 3) hypercalcemia increases excitability of cardiac muscle and smooth muscles of vessels – *arterial hypertension.*

**67. Correct answer is C.** *(Kim E. Barret, 2018. Section VII Renal Physiology, Chapter 38: Regulation of Extracellular Fluid Composition & Volume, p.877; USMLE Step 1 Lecture Notes, Kaplan, 2018. – Physiology. Part VII: Endocrinology. Chapter 3: Posterior Pituitary, p. 261).*

The defense of the tonicity of the extracellular fluid (ECF) is primarily the function of the **vasopressin-secreting** and thirst **mechanisms** (*fig. 33*). The total body osmolality is directly proportional to the total body sodium plus the total body potassium divided by the total body water, so that changes in the osmolality of the body fluids occur when a mismatch exists between the amount of these electrolytes and the amount of water ingested or lost from the body (for instance, *dehydration resulting from vomiting* or diarrhea). When the effective osmotic pressure of the plasma rises, vasopressin secretion is increased and the thirst mechanism is stimulated; water is retained in the body, diluting the hypertonic plasma; and water intake is increased. Conversely, when the plasma becomes hypotonic, vasopressin secretion is decreased and "solute-free water" (water in excess of solute) is excreted. In this way, the tonicity of the body fluids is maintained within a narrow normal range. In health, plasma osmolality ranges from 280 mOsm/kg of $H_2O$ to 295 mOsm/kgof $H_2O$, with vasopressin secretion maximally inhibited at 285 mOsm/kg and stimulated at higher values.

**68. Correct answer is A.** *(Kim E. Barret, 2018. Section III Endocrine and Reproductive Physiology, Chapter 21: Endocrine Functions of thePancreas & Regulation ofCarbohydrate Metabolism, p. 540; USMLE Step 1 Lecture Notes, Kaplan, 2018. – Physiology. Part VII: Endocrinology. Chapter 6: Endocrine Pancreas, p. 303).*

Glucose enters cells by facilitated diffusion. In muscle, adipose, and some other tissues, **insulin***stimulates glucose entry into cells* by increasing the number of glucose transporters (GLUTs) in the cell membranes.

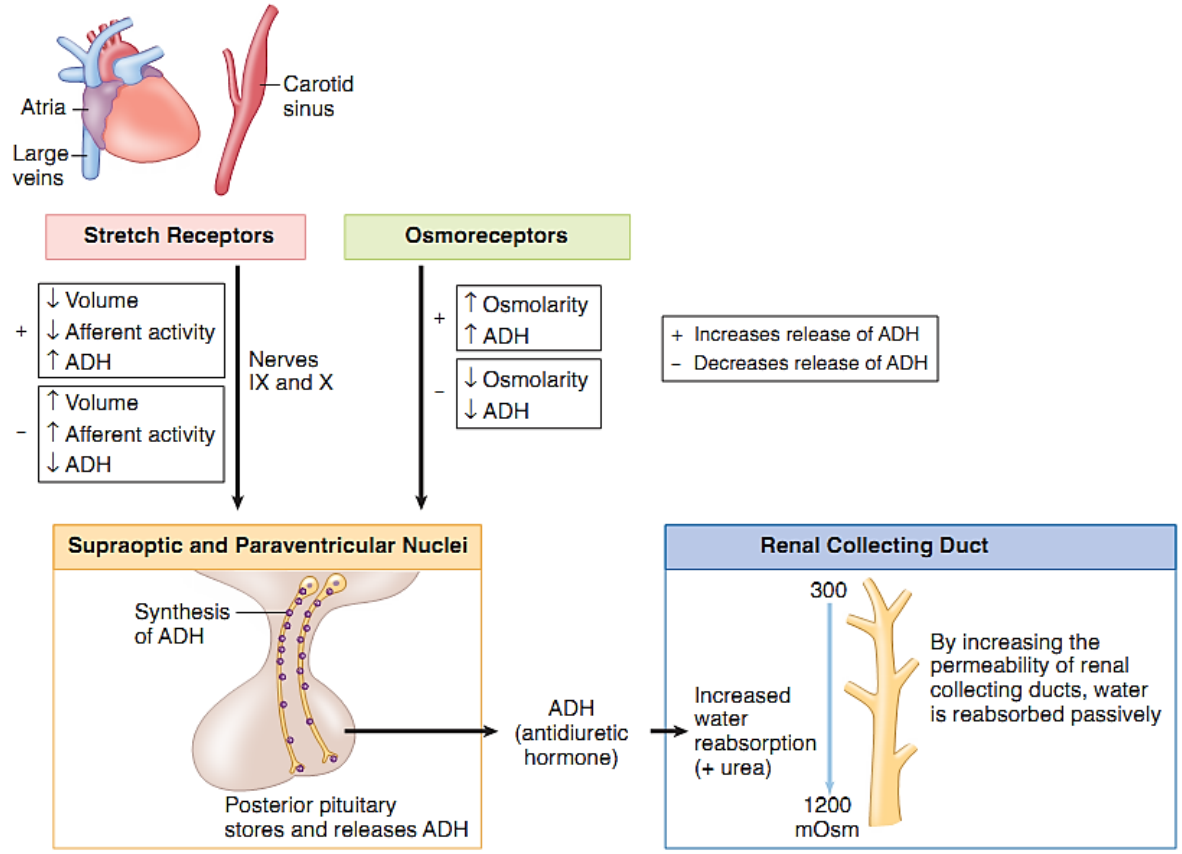



**Figure 33. Regulation of ECF osmolarity & blood volume via vasopressin mechanism**

**69. Correct answer is E.** (*Linda. S. Costanzo, Chapter 9: Endocrine Physiology; Adrenal Medulla and Cortex, p. 424;USMLE Step 1 Lecture Notes, Kaplan, 2018. – Physiology. Part VII: Endocrinology. Chapter 4: Adrenal cortex, p. 276; Kim E. Barret, 2018. Section III Endocrine and Reproductive Physiology, Chapter 20: Adrenal Medulla&Adrenal Cortex, p. 486).*

Addison disease, or primary adrenocortical insufficiency, is commonly caused by autoimmune destruction of all zones of the adrenal cortex. In this disease, there is decreased synthesis of all adrenocortical hormones, resulting in decreased circulating levels of cortisol, aldosterone, and adrenal androgens. The symptoms of Addison disease can be predicted on the basis of the known physiologic effects of these hormones. The *loss of glucocorticoids* (cortisol) produces *hypoglycemia, anorexia, weight loss, nausea and vomiting, and weakness*. The loss of mineralocorticoids (aldosterone) produces hyperkalemia, metabolic acidosis, and hypotension (due to decreased ECF volume). In women, the loss of the adrenal androgens, DHEA and androstenedione, results in decreased pubic and axillary hair and decreased libido. Addison disease also is characterized by ***hyperpigmentation***.The diffuse tanning of the skin and the spotty pigmentationcharacteristic of chronic glucocorticoid deficiency are due, at least in part, to the **melanocyte-stimulating hormone**

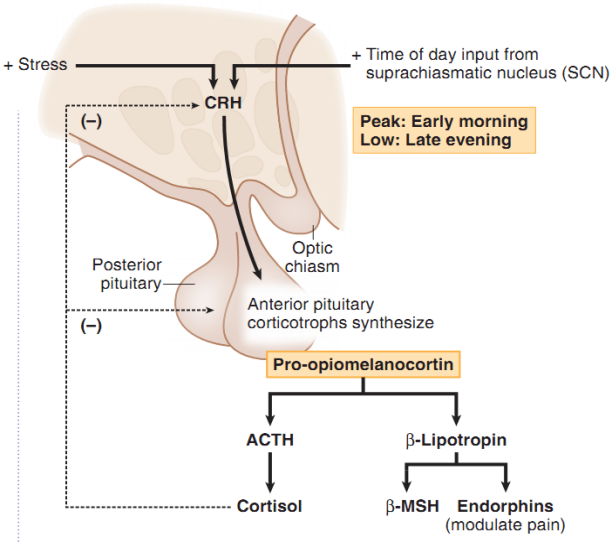



**Figure 34. Control of adrenocortical hormones synthesis**

**(MSH)** activity of the ACTH in the blood (*fig. 34*). Pigmentation of skin creaseson the hands and the gums are common.

**70. Correct answer is C.***Kim E. Barret, 2018. Section III Endocrine and Reproductive Physiology, Chapter 21: Hormonal Control of Calcium &Phosphate Metabolism & thePhysiology of Bone, p.497).*
Occasionally, inadvertent parathyroidectomy occurs in humans during thyroid surgery. This can have serious consequences as PTH is essential for life. After parathyroidectomy, there is a steady decline in plasma $Ca^{2+}$ (**hypocalcemia**). Signs of *neuromuscular hyperexcitability* appear, followed by full-blown tetany. Plasma phosphate levels usually rise as the plasma $Ca^{2+}$ level falls. The signs of tetany in humans include *Chvostek sign, a quick contraction of the ipsilateral facial muscles elicited by tapping over the facial nerve at the angle of the jaw,* and *Trousseau sign, a spasm of the muscles of the upper extremity that causes flexion of the wrist and thumb with extension of the fingers*. In individuals with mild tetany in whom spasm is not yet evident, Trousseau sign can sometimes be produced by occluding the circulation for a few minutes with a blood pressure cuff.
**71. Correct answer is D.***Kim E. Barret, 2018. Section VII Renal Physiology, Chapter 38: Regulation of Extracellular Fluid Composition & Volume, p.883).*
Two natriuretic hormones are secreted by the heart. The muscle cells in the atria and, to amuch lesser extent in the ventricles, contain secretory granules that increase in number whenNaCl intake is increased and ECF expanded.The first natriuretic hormone isolated from the heart was ANP. ANP was subsequentlyisolated from other tissues, including the brain. A second natriuretic polypeptide BNP (alsoknown as brain natriuretic peptide) is also present in the brain, but more is present in thehuman heart, including the ventricles. ANP and BNP act on the kidneys to increase Na+ excretion. They appear to produce thiseffect by dilating afferent arterioles and relaxing mesangial cells. Both of these actionsincrease GFR. In addition, they act on the renal tubules to inhibit Na+ reabsorption. Otheractions include an increase in capillary permeability, leading to extravasation of fluid and adecline in blood pressure. In addition, they relax vascular smooth muscle in arterioles andvenules. These peptides also inhibit renin secretion and counteract the pressor effects of catecholamines and angiotensin II.

## PHYSIOLOGY OF SENSORY SYSTEMS AND HIGHEST NERVOUS ACTIVITY

***Questions***

### Sensory systems

**1.** A man having a hearing loss after a head trauma was delivered to the neurosurgery department. The cause of the hearing loss might be the damage of the following lobe of cerebral cortex:

*A. Postcentral gyrus.* *B. Parietal.* *C. Occipital.* *D. Frontal.* *E. Temporal.*

**Notes:**_____

**2.** 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.* *C. Venous sinus.* *E. Posterior corneal epithelium.*
*B. Ciliary body.* *D. Choroid.*

**Notes:**_____

**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.*

**Notes:**_____

**4.** 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.*

**Notes:**_____

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

**Notes:**_____

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

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

**Notes:**_____

**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.*

**Notes:**_____

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

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

**Notes:**_____

**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.*
*B. Receptor adaptation.*
*C. Development of the fibrous tissue.*
*D. Abnormality of the epidermis structure.*
*E. Abnormality of the receptor structure.*

**Notes:**_____

**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.*

**Notes:**_____

**11.** 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. Mechanoreceptors of foot skin.*
*B. Photoreceptors of retina.*
*C. Proprioreceptors.*
*D. Vestibuloreceptors of utricle and saccule.*
*E. Vestibuloreceptors of semicircular ducts.*

**Notes:**_____

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

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

**Notes:**_____

**13.** 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.*
*B. Contraction of m. tensor tympani.*
*C. Relaxation of m. stapedius.*
*D. Relaxation of m. auricularis anterior.*
*E. Relaxation of m. tensor tympani.*

**Notes:**_____

**14.** 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.*

**Notes:**_____

**15.** 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.*

**Notes:**_____

**16.** A 42-eyar-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.*

**Notes:**_____

**17.** 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.*

**Notes:**_____

**18.** 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.*

**Notes:**_____

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

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

**Notes:**_____

**20.** 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.*

**Notes:**_____

**21.** 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.*

**Notes:**_____

**22.** 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.*
*B. Main cochlea membrane near the oval window.*
*C. Eustachian tube.*
*D. Middle ear muscles.*
*E. Tympanic membrane.*

**Notes:**_____

**23.** 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.*
*B. Left and right halves of the right eye retina.*
*C. Left and right halves of both eyes retina.*
*D. Left half of both eyes retina.*
*E. Right half of both eyes retina.*

**Notes:**_____

**24.** 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.*
*B. Papillae foliatae.*
*C. Papillae filiformes.*
*D. Papillae vallatae.*
*E. Papillae conicae.*

**Notes:**_____

**25.** 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.*
*B. Corti's organ – closer to the oval foramen.*
*C. Corti's organ – closer to helicotrema.*
*D. Muscles of the middle ear.*
*E. Eardrum.*

**Notes:**

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

*A. Bipolar neurons.*
*B. Rod cells.*
*C. Cone cells.*
*D. Ganglionic nerve cells.*
*E. Horizontal cells of retina.*

**Notes:**

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

*A. Precentral gyrus. B. Postcentral gyrus. C. Temporal lobe. D. Occipital lobe. E. Cerebellum.*

**Notes:**

**28.** 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.*
*B. Anterior central gyrus.*
*C. Occipital region.*
*D. Posterior central gyrus.*
*E. Frontal cortex.*

**Notes:**

**29.** 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.*

**Notes:**

**30.** 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.*
*B. Left middle ear.*
*C. Right inner ear.*
*D. Right middle ear.*
*E. Right external ear.*

**Notes:**

**31.** 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.*

**Notes:**_____

**32.** 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.*

**Notes:**_____

**33.** 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.*

**Notes:**_____

**34.** A 25-year-old woman complains of visual impairment. Examination revealed disturbed eye accommodation, the pupil is dilated and unresponsive to light. What muscles are functionally disturbed in this case?

*A. Iris sphincter muscle, ciliary muscle.*
*B. Superior oblique muscle, ciliary muscle.*
*C. Iris sphincter and iris dilator muscle.*
*D Lateral rectus muscle, Iris sphincter muscle. .*
*E. Iris dilator muscle, ciliary muscle.*

**Notes:**_____

**35.** A person becomes less receptive to pain in physically and emotionally straining situations due to activation of:

*A. Nociceptive system.* *B. Antinociceptive system.* *C. Adrenals glands functions.* *D. Thyroid glands function.* *E. Parasympathetic nervous system.*

**Notes:**_____

**36.** 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.*

**Notes:**_____

**37.** 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.*

**Notes:**_____

**38.** Human brain produces endogenous peptides that are similar to morphine and can reduce pain perception. Name these peptides:

*A. Statins.* *B. Endorphins.* *C. Vasopressin.* *D. Oxytocin.* *E. Liberins.*

**Notes:**_____

**39.** A 39-year-old man presents with hyperkeratosis, disturbed twilight vision, and high risk of infectious processes. What vitamin preparation should be prescribed?

*A. Ergocalciferol.* *C. Retinol acetate.* *E. Tocopherol acetate.*
*B. Pyridoxine hydrochloride.* *D. Riboflavin.*

**Notes:**_____

**40.** A 20-year-old female comes to the clinic after missing her last 2 periods. Her cycles are usually regular, occurring at 28–30 day interval with moderate bleeding and some abdominal discomfort. She also complains of progressively diminishing peripheral vision. Her doctor reveals loss of vision in the lateral halves of both eyes. Involvements of what of the following structures would you most likely expect to be the reason of bitemporal hemianopsia?

*A. Optic chiasm.* *B. Right optic tract.* *C. Left optic tract.* *D. Right optic nerve.* *E. Left optic nerve.*

**Notes:**_____

***Higher nervous activity***

**1.** 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. –.*

**Notes:**_____

**2.** 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.*

**Notes:**_____

**3.** 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.*

**Notes:**_____

**4.** 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.*

**Notes:**_____

**5.** 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.* *C. Monotony of work.* *E. Social inefficiency of labor.*
*B. Increased responsibility.* *D. State of "operating rest".*

**Notes:**_____

**6.** 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.*

**Notes:**_____

**7.** 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.* *C. Parietal lobe on both sides.* *E. Occipital lobe on both sides.*
*B. Occipital lobe on one side.* *D. Temporal lobe on one side.*

**Notes:**_____

**8.** A students 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.*

**Notes:**_____

**9.** A 60-year-old man after cerebral hemorrhage felt asleep for a long time. Damage of what structure caused this state?

*A. Cortex of the large hemispheres.* *D. Nuclears of the cerebral nerves.*
*B. Black substances.* *E. Hippocampus.*
*C. Reticular formation.*

**Notes:**_____

**10.** 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.*

**Notes:**_____

11. 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.*

**Notes:**_____

**12.** 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. –.*

**Notes:**_____

**13.** 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.*

**Notes:**_____

**14.** 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.*

**15.** In an experiment a laboratory rat was subjected to a stress factor (electric current), which resulted in muscular hypotonia, arterial hypotension, hypothermia, and hypoglycemia in the animal. What period of general adaptation syndrome is it?

*A. Resistance stage.* *B. –.* *C. Exhaustion stage.* *D. Antishock phase.* *E. Shock phase.*

**Notes:**_____

***Physiology of sensory systems and highest nervous activity***

**Answers**

***Sensory systems***

**1. Correct answer is E (***USMLE Step 1 Lecture Notes, Kaplan, 2018. – Anatomy. Part III: Neuroscience. Chapter 5: The Brainstem, p. 303).*

**The primary auditory cortex** located on the posterior portion of the transverse **temporal gyrus** (Heschl's gyrus; Brodmann areas 41 and 42) (*fig. 35*). The adjacent auditory association area makes connections with other parts of the cortex, including Wernicke's area, the cortical area for the comprehension of language.

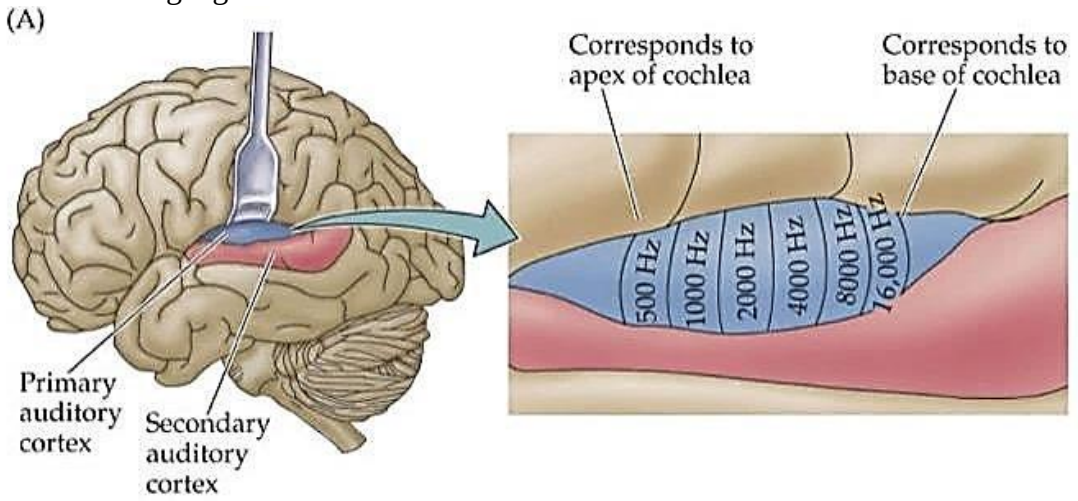



**Figure 35. Auditory cortex and its tonotopic map (recognition of sound frequencies)**

**2. Correct answer is C.** *(Saladin, Chapter 16. Sense Organs, p. 613-614).*

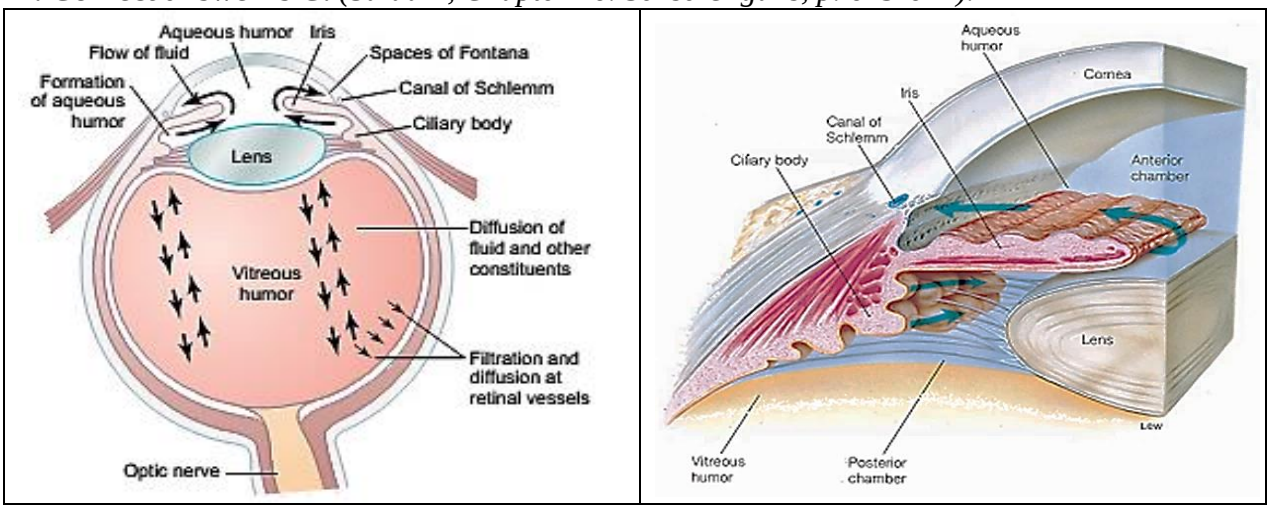



**Figure 36. Formation and flow of fluid in the eye**

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*.

**3. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 656).*

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**.

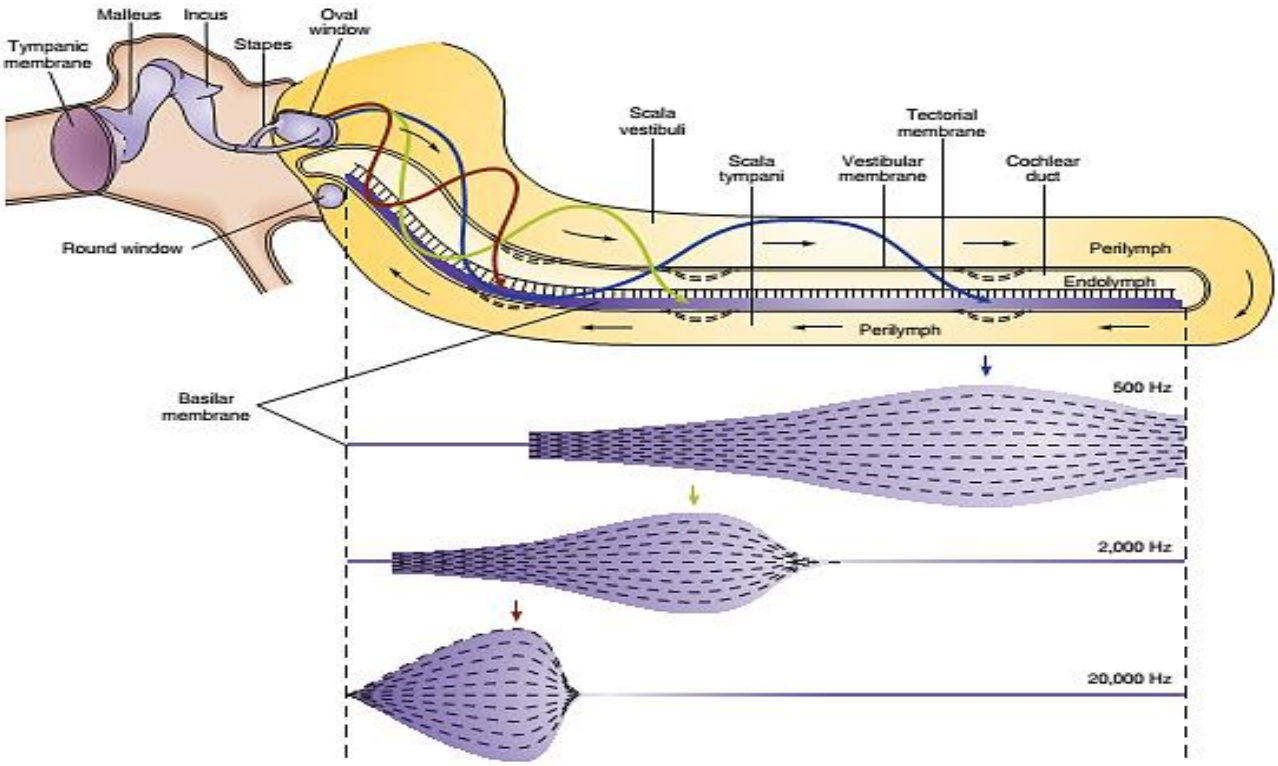



**Figure 37. "Place principle" of sounds perception in the cochlea**

**4. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 47 Somatic Sensations: I. General Organization, the Tactile and Position Senses, p. 589).*
Posterior central gyrus is the primary somatosensory area concerned with perception and interpretation of somatosensory signals including skin (tactile, pain, temperature) and proprioceptive sensitivity (*fig. 14*).
**5. Correct answer is D.***(Saladin, Chapter 16. Sense Organs, p. 618).*
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 (details at the *fig. 38*).

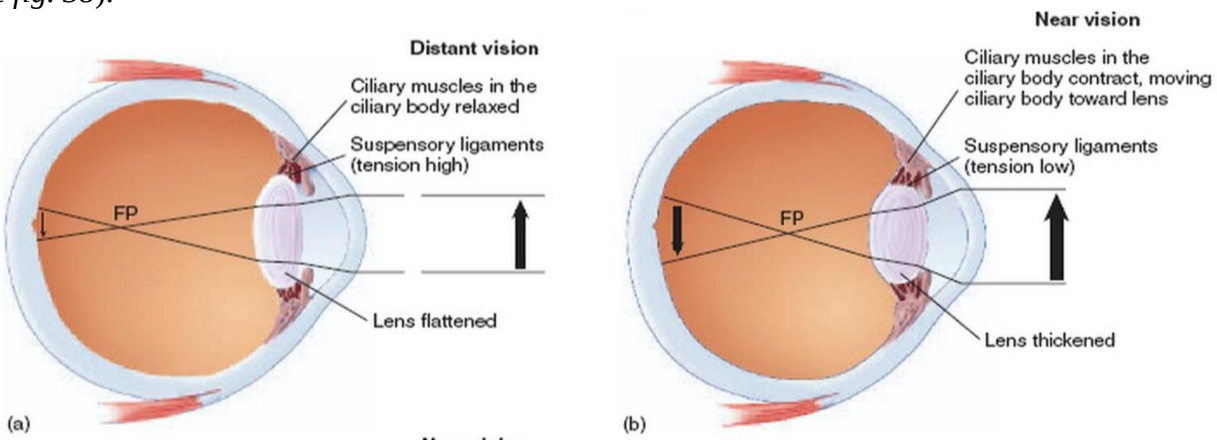



**Figure 38. Crystalline lens accommodation:** a) Distant vision, b) Near vision

**6. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 47 Somatic Sensations: I. General Organization, the Tactile and Position Senses, p. 589).*
*Posterior central gyrus* is the primary somatosensory area concerned with perception and interpretation of somatosensory signals including **skin and proprioceptive sensitivity**(*fig. 28*).
**7. Correct answer is E.** *(S.I. Fox, Human Physiology, © The McGraw−Hill Companies, 2016. Ch. 10 Sensory Physiology, p. 282).*
*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).

**8. Correct answer is C.** *(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).***Vestibulocochlear nerve (VIII pair of cranial nerves)** provides transmission of signals for *hearing and equilibrium*(*fig. 20*). Damage of vestibulocochlear nerve can lead to nerve deafness, *dizziness*, nausea, loss of balance, and nystagmus

**9. Correct answer is B.** *(Saladin, Chapter 16. Sense Organs, p. 587).*

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 **adaptationof tactile receptors** in that specific place

**10. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 656).*

According to the place principle of sound frequency determination (*fig. 37*), 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)**.

**11. Correct answer is D.***(S.I. Fox, Human Physiology, © The McGraw−Hill Companies, 2016. Ch. 10 Sensory Physiology, p. 280).*

*Inclination of surface* is movement with linear acceleration that is detected by **vestibular receptors of the utricle and saccule (otolothic receptors)**.

**12. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 55 Cortical and Brain Stem Control of Motor Function p. 692).*

Signals from vestibular apparatus are transmitted by way of VIII cranial nerve to vestibular nuclei in medulla oblongata (*fig. 17*). 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.

**13. Correct answer is B.** *(Saladin, Chapter 16. Sense Organs, p. 602).*

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 or attenuation) reflex that muffles the transfer of vibrations from the eardrum to the oval window (*fig. 39*).

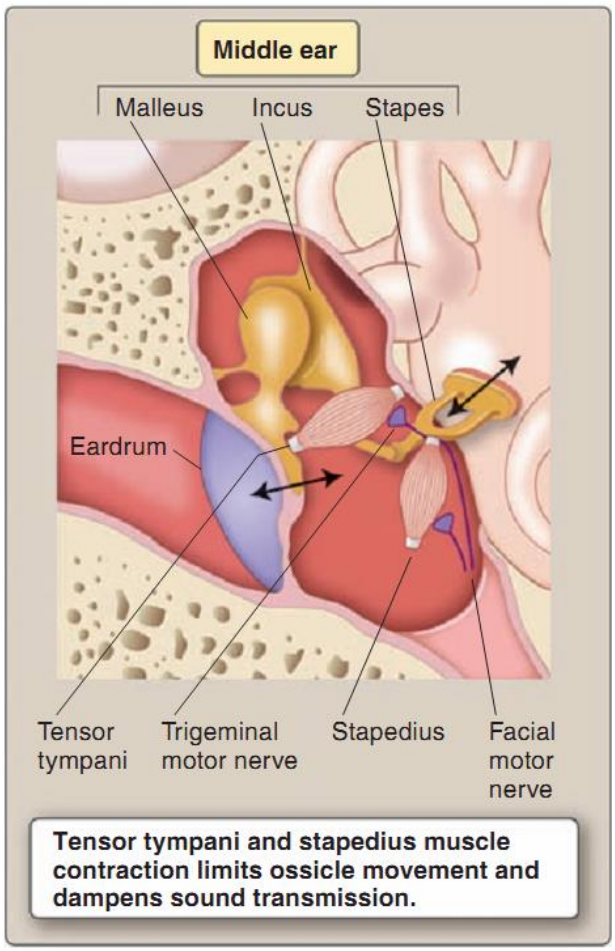



**Figure 39. Structure of middle ear & attenuation reflex**

**14. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 53 Chemical Senses, p. 669; Saladin, Chapter 16. Sense Organs, p. 596).*

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 (*fig. 40*).

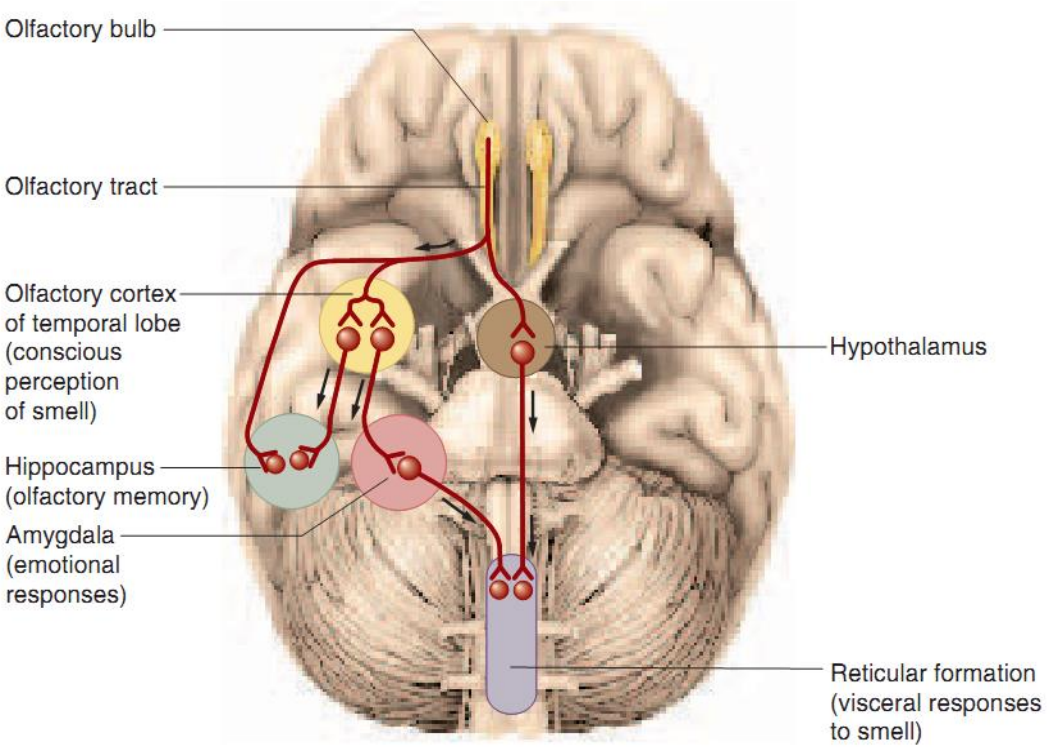



**Figure 40. Olfactory projection pathways in the brain**

**15. Correct answer is E.***(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 51 The Eye, p. 642).* 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) (*fig. 41*).

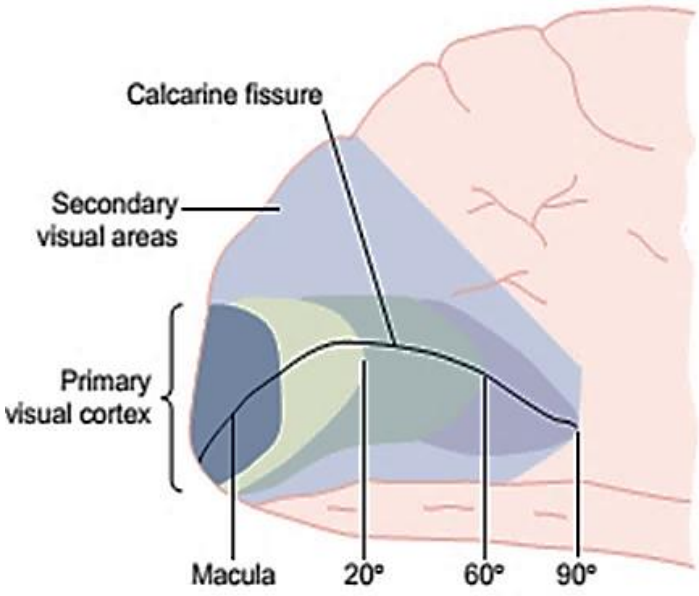
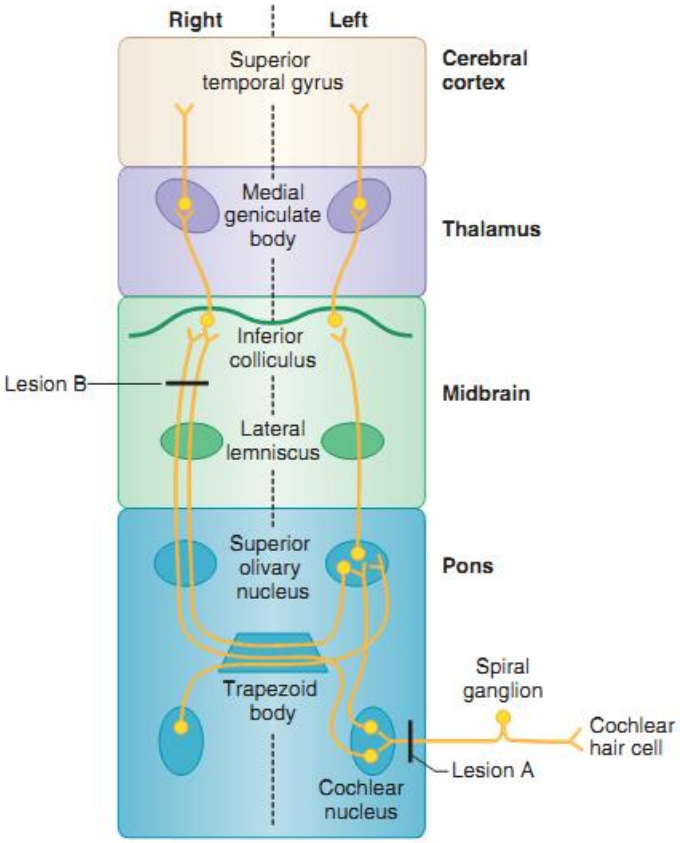



**Figure 41. Visual cortex**

**16. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 655; USMLE Step 1 Lecture Notes, Kaplan, 2018. – Anatomy. Part III: Neurosciense. Chapter 5: The Brainstem, p. 304).*
*First-order neurons of auditory analyzer* are located in the **spiral ganglion of Corti**, which lies in the modiolus (center) of the cochlea (*fig. 42*).




**Lesions Causing Hearing Loss**

- Lesions of the cochlear part of the eighth nerve or cochlear nuclei inside the brain stem at the pontomedullary junction result in a profound unilateral sensorineural hearing loss (A).
- All other lesions to auditory structures in the brain stem, thalamus, or cortex result in a bilateral suppression of hearing and a decreased ability to localize a sound source (B).
- If a patient presents with a significant hearing loss in one ear, the lesion is most likely in the middle ear, inner ear, eighth nerve, or cochlear nuclei, and not at higher levels of the auditory system.

**Figure 42. Auditory pathways**

**17. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 53 Chemical Senses, p. 666).*
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 (*fig. 24*).
**18. Correct answer is B.** *(Saladin, Chapter 16. Sense Organs, p. 619).*
Lenticular lenses (convex) have high refractive power, thus are used for correction of hyperopia (*table 6, fig. 43*).

**Table 6**

**Common visual defects**

| | |
|---|---|
| **Presbyopia** | Reduced ability to accommodate for near vision with age because of declining flexibility of the lens. Results in difficulty in reading and doing close handwork. Corrected with bifocal lenses. |
| **Hyperopia** | Farsightedness – a condition in which the eyeball is too short. The retina lies in front of the focal point of the lens, and the light rays have not yet come into focus when they reach the retina. Causes the greatest difficulty when viewing nearby objects. Corrected with convex lenses, which cause light rays to converge slightly before entering the eye. |
| **Myopia** | Nearsightedness – a condition in which the eyeball is too long. Light rays come into focus before they reach the retina and begin to diverge again by the time they fall on it. Corrected with concave lenses, which cause light rays to diverge slightly before entering the eye. |
| **Astigmatism** | Inability to simultaneously focus light rays that enter the eye on different planes. Focusing on vertical lines, such as the edge of a door, may cause horizontal lines, such as a tabletop, to go out of focus. Caused by a deviation in the shape of the cornea so that it is shaped like the back of a spoon rather than like part of a sphere. Corrected with cylindrical lenses, which refract light more in one plane than another |

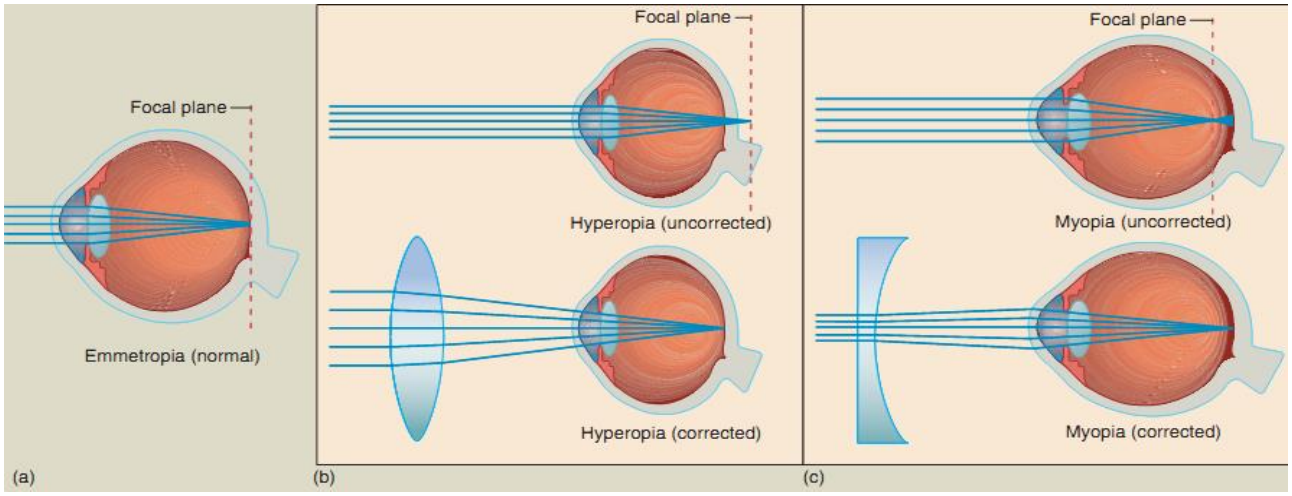



**Figure 43. Two common visual defects and the effects of corrective lenses.**a) The normal emmetropic eye, with light rays converging on the retina. b) Hyperopia (far-sightedness) and the corrective effect of a convex lens. (c) Myopia (near-sightedness) and the correctiveeffect of a concave lens

**19. Correct answer is A. (***Linda S. Costanzo, PhD, Physiology, FIFTH EDITION, p. 73-74)*
If a stimulus doesn't act on receptor for some time, receptor's sensitivity to it increases because threshold of receptor decreases
**20. Correct answer is C.** *(Saladin, Chapter 16. Sense Organs, p. 612).*
Muscle that elevates upper eye-lid is innervated by oculomotor nerve (III).
**21. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 53 Chemical Senses, p. 666).*
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. 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 (*fig. 24*).
**22. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 656).*
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 (*fig. 37*).
**23. Correct answer is D.** *(Kim E. Barret, Section IICentral & Peripheral Neurophysiology, Chapter 9Vision, p.264; Saladin, Chapter 16. Sense Organs, p. 626).*
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** (*fig. 44 C*).
**24. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 53 Chemical Senses, p. 665).*
**Circumvallate (vallate) papillae** form a *V line on the border of the median and posterior third of the tongue.*
**25. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 656).*
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** (*fig. 37*).

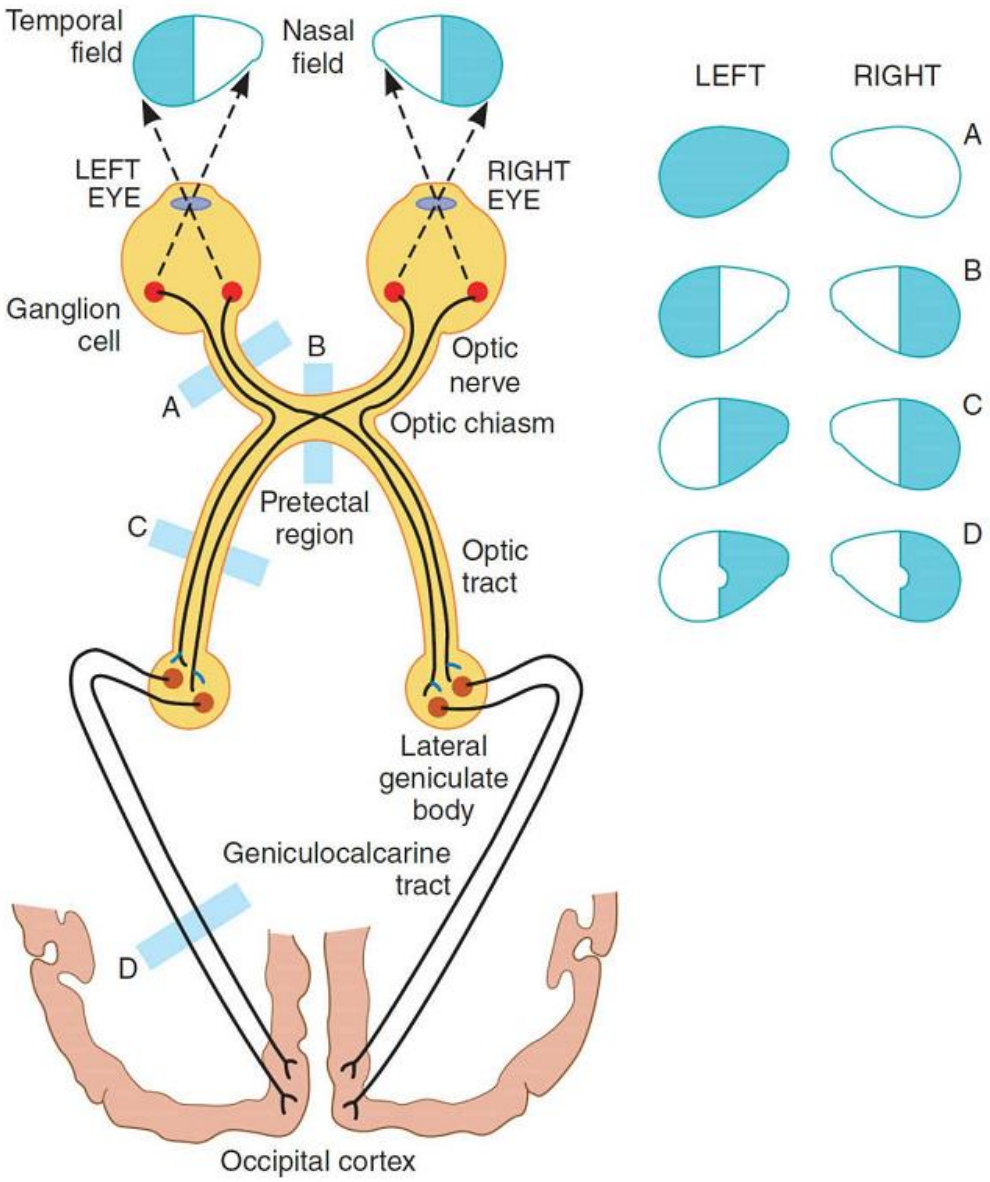



**Figure 44. Visual pathways.**

Transection of the pathways at the locations indicated by the letterscauses the visual field defects shown in the diagrams on the right. The fibers from the nasal half of eachretina decussate in the optic chiasm, so that the fibers in the optic tracts are those from the temporal halfof one retina and the nasal half of the other.

***A*** – A lesion that interrupts one optic nerve causes blindness in that eye – *anopia*.

***B*** – Lesions affecting the opticchiasm destroy fibers from both nasal hemiretinas and produce a heteronymous (opposite sides of the visual fields) *hemianopia*.

***C*** – A lesion in one optic tract causes blindness in half of the visual field and is called*homonymous* (same side of both visual fields) *hemianopia* (half-blindness).

***D*** – Occipital lesions may spare the fibers from the macula becauseof the separation in the brain of these fibers from the others subserving vision – *homonymous hemianopia with macular sparing*

**26. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 50 The Eye II, p. 629).*

*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.

**27. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 47 Somatic Sensations: I. General Organization, the Tactile and Position Senses, p. 589).*

Posterior central gyrus is the primary somatosensory area concerned with perception and interpretation of somatosensory signals including skin (tactile, pain, temperature) and proprioceptive sensitivity (*fig. 14*).

**28. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 47 Somatic Sensations: I. General Organization, the Tactile and Position Senses, p. 589).*

Posterior central gyrus is the primary somatosensory area concerned with perception and interpretation of somatosensory signals including skin (tactile, pain, temperature) and proprioceptive sensitivity (*fig. 14*).

**29. Correct answer is E.** *(Medical physiology (eleventh edition) / Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 53 Chemical Senses, p. 669).*

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 (*fig. 40*).

**30. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 655; USMLE Step 1 Lecture Notes, Kaplan, 2018. –Anatomy. Part III: Neurosciense. Chapter 5: The Brainstem, p. 304).*

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) (*fig. 42*).

**31. Correct answer is E.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 657; USMLE Step 1 Lecture Notes, Kaplan, 2018. – Anatomy. Part III: Neurosciense. Chapter 5: The Brainstem, p. 304).*

Almost all auditory fibers relay in **inferior colliculi of quadrigeminal plate in midbrain**, from which they pass to medial geniculate bodies of thalamus (*fig. 42*).

**32. Correct answer is A.** *(Saladin, Chapter 16. Sense Organs, p. 614).*

**The crystalline lens** is a transparent structure inserted in a capsule that is *suspended behind the pupil by a ring of fibers of the Zinn's zonul*e called the suspensory ligament, which *attaches it to the ciliary body.*

**33. Correct answer is A.** *(Kim E. Barret, Section IICentral & Peripheral Neurophysiology, Chapter 9Vision, p.264; Saladin, Chapter 16. Sense Organs, p. 626).*

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* (*fig. 44*).

**34. Correct answer is A.** *(USMLE Step 1 Lecture Notes, Kaplan, 2018.– Anatomy. Part III: Neurosciense. Chapter 9: Visual Pathways, p. 339).*

Two reflexes are impaired in the patient: accommodation reflex (*fig. 38*) and pupillary light reflex (*fig. 45*). **Accommodation reflex:** Parasympathetic fibers contract the **ciliary muscle**, which relaxes suspensory ligaments, allowing the lens to increase its convexity (become more round). This increases the refractive index of the lens, thereby focusing a nearby object on the retina.**Pupillary constriction:** Parasympathetic fibers contract the pupillary **sphincter muscle** → miosis. Thus, muscles are functionally disturbed in the case: iris sphincter muscle and ciliary muscle.

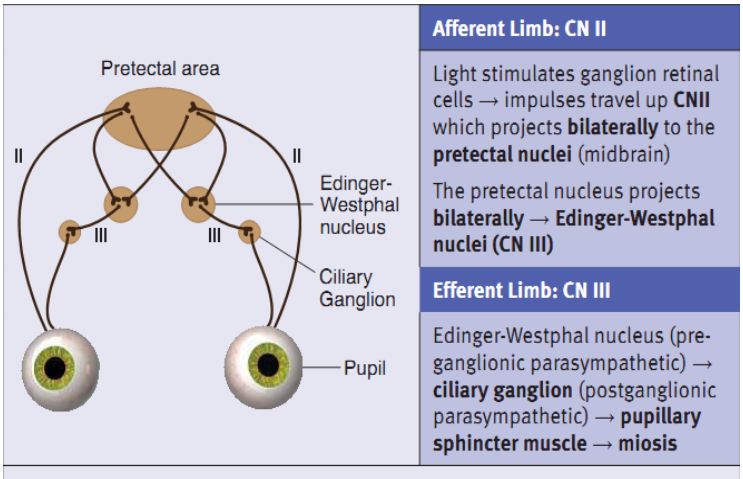



**Figure 45. Reflex arch of pupillry light reflex**

**35. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 48Somatic Sensations:II. Pain, Headache, and Thermal Sensations, p. 602).*
A person's physical and mental state can greatly affect his or her perception of pain. The central nervous system has ***analgesic*** (antinociceptive) mechanisms. Antinociceptive system consists of two major parts: 1) brain's *descending analgesia control*, 2) brain's *opiate system*.
**36. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 657; USMLE Step 1 Lecture Notes, Kaplan, 2018. – Anatomy. Part III: Neurosciense. Chapter 5: The Brainstem, p. 304).*
Almost all auditory fibers relay in inferior colliculi of quadrigeminal plate in midbrain, from which they pass to **medial geniculate bodies of thalamus**(*fig. 42*).
**37. Correct answer is B.** *(Kim E. Barret, Section IICentral & Peripheral Neurophysiology, Chapter 8SomatosensoryNeurotransmission: Touch, Pain,& Temperature, p.227; Saladin, Chapter 16. Sense Organs, p. 626; Saladin, Chapter 16. Sense Organs, p. 590).*
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 archispinotalamic 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.

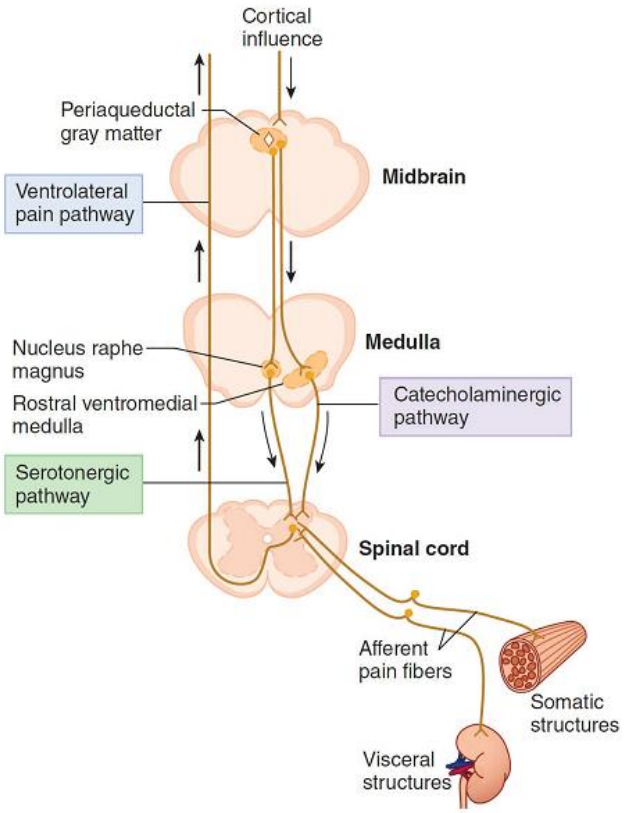



**Figure 46. Schematic illustration of the convergence-projection theory for referred pain and descending pathways involved in pain control.** The basis for referred pain may be convergence ofsomatic and visceral pain fibers on the same second-order neurons in the dorsal horn of the spinal cordthat project higher brain regions. The periaqueductal gray is a part of a descending pathway thatincludes serotonergic neurons in the nucleus raphe magnus and catecholaminergic neurons in the rostral ventromedial medulla to modulate pain transmission by inhibition of primary afferent transmission inthe dorsal horn.

**38. Correct answer is B.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 48 Somatic Sensations: II. Pain, Headache, and Thermal Sensations, p. 602; Kim E. Barret, Section IICentral & Peripheral Neurophysiology, Chapter 8SomatosensoryNeurotransmission: Touch, Pain,& Temperature, p. 241).*

In the organism there are so-called "morphine receptors" and *endogenous* opiate-like substances which can stimulate these receptors and causes analgesia effects. The most important of these opiate-like substances are: *1) β-endorphin, 2) met-enkephalin, 3) leukoenkephalin, 4) dynorphyn.* Opioids exert their analgesic effects at various places in the CNS, including the spinal cordand dorsal root ganglia. *Endogenous opioid peptides* (e.g., **enkephalin**,dynorphin) are released from interneurons to act on the terminals of nociceptive fibers and ondendrites of dorsal horn neurons. Activation of the postsynaptic opioid receptorshyperpolarizes the dorsal horn interneuron by causing an increase in $K^+$ conductance.Activation of the presynaptic opioid receptors decreases $Ca^{2+}$ influx, resulting in a decreasein release of glutamate and substance P. Together these actions reduce the duration of theEPSP in the dorsal horn neuron. Activation of opioid receptors on dorsal root ganglia cellbodies also contributes to reduced transmission from nociceptive afferents.

**39. Correct answer is C.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 50 The Eye II, p. 629).*

*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.

**40. Correct answer is A.** *(Kim E. Barret, Section IICentral & Peripheral Neurophysiology, Chapter 9Vision, p.264; Saladin, Chapter 16. Sense Organs, p. 626).*

The reason of*bitemporal hemianopsia* is damage of the optic chiasm (*fig. 44*).

### *Higher nervous activity*

**1. Correct answer is C.** *(Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty. – Kharkiv : KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 98, 100).*

If there is a direct stimulation of specific receptors (chemoreceptors of carotid and aortic bodies stimulated by accumulation of CO2 and deficiency of $O_2$ in case of breath-holding), it's an unconditioned reflex. Increase of HR and BP are sympathetic responses.

**2. Correct answer is D.** *(C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learing and Memory, P. 5–261).*

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.

**3. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 59 The States of Brain Activity, p. 743).*

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.

**4. Correct answer is E.** *(C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learing and Memory, P. 5–261; Physiology of biological regulation of organism's functions: manual for second-year students of medical faculty. – Kharkiv : KhNMU, 2015. – Chapter 7. The role of autonomic nervous system in control of visceral functions, p. 98, 100).*

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.

**5. Correct answer is C.** *(C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learing and Memory, P. 5–261).*

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.

**6. Correct answer is A.** *(Saladin, Chapter 16. Sense Organs, p. 616).*

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. Reduction of illumination is the stimulus which acts directly on photoreceptors of retina. Therefore, when a person steps from a light room into a dark one, pupils dilation is **sympathetic unconditioned reflex.**

**7. Correct answer is A.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 52 The Sense of Hearing, p. 658).*

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.

**8. Correct answer is C.** ***(The need-informational theory of emotions,*** *Pavel V.Simonov,* ***International Journal of Psychophysiology****, Volume 1, Issue 3, March 1984, Pages 277–289)*

As an evolvement of Pavlov ideas on higher nervous (psychic) activity 'the need-informational theory of emotions' was suggested by the author in 1964. According to it an emotion is a function of two major factors: (1) power and quality of actual need (or drive, or motivation) and (2) estimation of probability (possibility) of need satisfaction on the basis of phylo- and ontogenetic experience. In the process of experimental testing of 'the need-informational theory of emotions' the role of different cerebral structures (frontal neocortex, hippocampus, amygdala, hypothalamus) in the genesis of emotional states and in the organization of goal-directed behavior was elucidated. The experimental data showed that these 4 brain structures play the major role in estimation of signals coming from environment and in the choice of subject's reactions. The individual characteristics of the interaction between the 4 brain structures must be taken into consideration in discussing neurophysiological backgrounds of different types of the higher nervous activity (temperaments), parameters of extra-introversion and neurotism (emotionality), the formation of main types of neurosis.

Emotions, realized by a special nervous apparatus, are manifested with a lack of accurate information and ways to achieve vital needs. Such an idea of the nature of emotion allows us to form its informational nature in the following form (P.V. Simonov): E = —P (N — S), where E is emotion (a certain quantitative characteristic of the emotional state of the organism, usually expressed by important functional parameters of the physiological systems of the body, for example, heart rate, blood pressure, adrenaline level in the body, etc.); P - a vital need of the body (food, defensive, sexual reflexes), aimed at the survival of the individual and the continuation of the race, in humans, additionally determined by social motives; H - information necessary to achieve the goal, satisfy this need; C - information owned by the body and which can be used to organize targeted actions.

**9. Correct answer is C.** *(Saladin, Chapter 14. The Brain and Cranial Nerves, p. 529).*

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.

**10. Correct answer is C***(C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learing and Memory, P. 5–261).*

**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.

**11. Correct answer is D.** *(Arthur C. Guyton, John E. Hall. – Elseveier, 2006. Chapter 51 The Eye: III. Central Neurophysiology of Vision, p. 642).*

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**.

**12. Correct answer is B.** According to Hippocrates (460–370 BC), there are 4 types of HNA – sanguine, phlegmatic, melancholic and choleric. Pavlovian classification of human types of higher nervous activity (HNA) is based on the properties of main neural processes in the CNS (excitation and inhibition): 1) strength of main processes, 2) balance between them, and 3) ability to switch from one to another (*fig. 47*).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.

**13. Correct answer is B. (***C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learing and Memory, P. 5–259–260)*

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 (irrelevant A and E), zwieback (type of snack) and meat are US for salivation (irrelevant C and D), and only **moderately loud sound** fulfills all the requirements.

**14. Correct answer is C.** *(C.C. Chatterjee, Human Physiology, Ch. 5 Nervous System, Learing and Memory, P. 5–261).*

**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

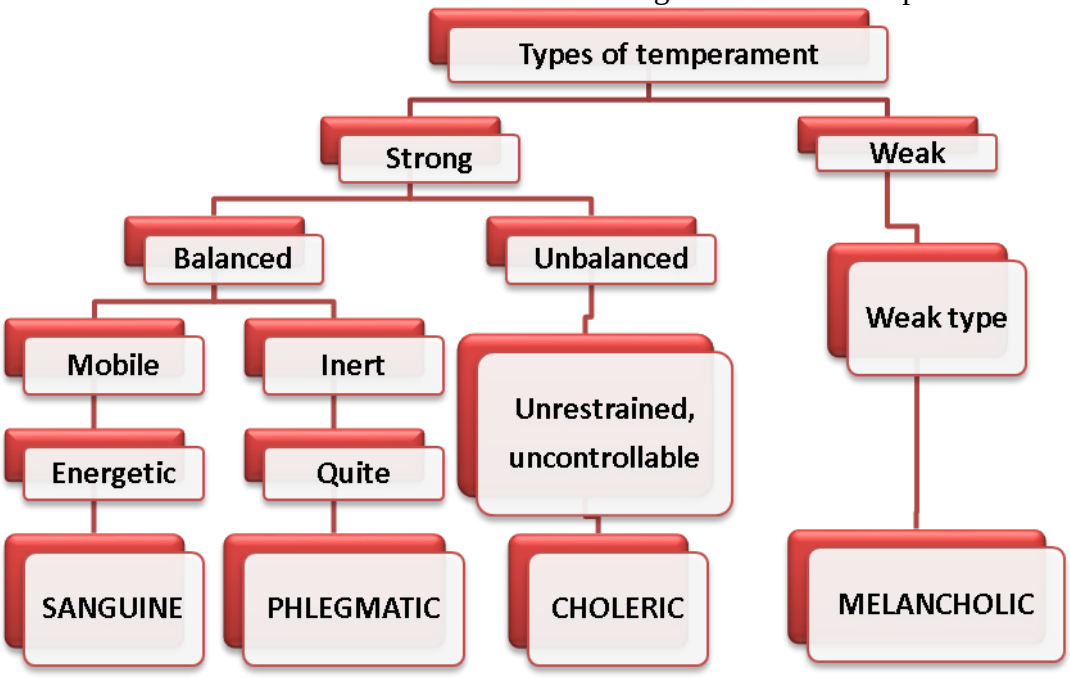


**Figure 47. Human types of HNA (by I.P. Pavlov)**

**15. Correct answer is C**. *(Stress and the General Adaptation Syndrome, Hans Selye, Br Med J. 1950 Jun 17; 1(4667): 1383–1392).*

Hans Selye (1907–1982) described three predictable stages the body uses to respond to stressors, called general adaptation syndrome (GAS). The first stage is the *alarm stage* – upon perceiving a stressor, the body reacts with a "fight-or-flight" response and the sympathetic nervous system is stimulated as the body's resources are mobilized to meet the threat or danger (tachycardia, hypertension, hyperglycemia). In the second stage, known as the *resistance stage*, the body resists and compensates as the parasympathetic nervous system attempts to return many physiological functions to normal levels while body focuses resources against the stressor and remains on alert (normalization of heart rate, blood pressure, blood glucose). The last stage is known as the *exhaustion stage* – if the stressor factor continue beyond the body's capacity, the resources become exhausted and the body is susceptible to disease and death (*arterial hypotension, hypothermia, and hypoglycemia*). Thus, highly likely the experimental rat is in **exhaustion stage** of GAS.

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*Навчальне видання*

# Частина І. «Загальна фізіологія. Вищі інтегративні функції та сенсорні системи»

# Тренувальні тести в форматі «Крок 1» для самостійної підготовки студентів з англомовною формою навчання з відповідями та поясненнями (для медичних та стоматологічного факультетів).

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Комп'ютерна верстка О. Ю. Лавриненко, О. О. Кучеренко

Формат А5. Ум. друк. арк. 6,2. Зам. № 20-33960.

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Свідоцтво про внесення суб'єкта видавничої справи до Державного реєстру видавництв, виготівників і розповсюджувачів видавничої продукції серії ДК № 3242 від 18.07.2008 р.