PÁZMÁNY PÉTER CATHOLIC UNIVERSITY

FACULTY OF INFORMATION TECHNOLOGY AND BIONICS

DEPARTMENT OF NEUROSCIENCE

**NEUROBIOLOGY EXAM II.**

18-01-2017

Name: …………………………………………………

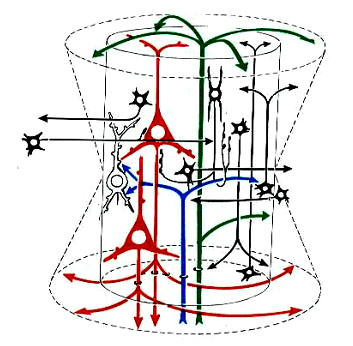
**Points:**

(Maximum: 100 points)

……………………………. …………………………….

Examiner’ signature Student’s signature

**This is a schematic drawing of a cortical module. Name the different cortical layers, and then label the listed elements in the scheme with letters and arrows! *(12 points)***



1. Specific afferents from subcortical centers
2. GABAergic interneuron establishing axo-axonic synapses
3. Neurons establishing large projection pathways
4. Excitatory interneurons
5. Terminal fibers of commissural and associative pathways
6. Apical dendrites establishing „cross-over” synapses

**Complete the text below! *(15 points)***

The most abundant neurotransmitter in the brain is the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_glutamate\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

It is a building block of all proteins, but a high affinity transport system is required to get it through the \_\_\_\_

\_\_\_\_membrane\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, thereby its concentration in brain fluids is also maintained at a fairly constant level. It is also synthetized in the CNS by the enzyme \_\_\_\_\_\_\_glutamase\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

This can occur in the presynaptic neuron or in neighboring glial cells. Itself serves as metabolic precursor for the major inhibitory neurotransmitter \_\_\_\_\_\_\_\_GABA\_\_\_\_\_\_\_\_\_\_, via the action of the enzyme \_\_\_\_

\_\_\_\_GABA-aminotransferase\_\_\_\_\_\_\_\_\_\_\_\_\_\_. It binds to four families of cell surface receptors, which are known as the \_\_\_\_AMPA\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_kainate\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_NMDA\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_G-protein coupled\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The first three receptors are \_\_\_\_\_\_ionotropic\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, whereas the last group of receptors are \_\_\_\_\_metabotropic\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

It is eliminated from the extracellular space by transporter proteins located in the \_\_\_\_\_\_\_axon terminal\_\_\_\_\_

of the neurons and astroglial cells, and the round-shaped \_\_\_\_\_\_\_\_\_\_\_synaptic vesicle\_\_\_\_\_\_\_\_\_. In brain injury or disease, these transporters often work in reverse, and excess of this neurotransmitter can accumulate outside cells, that may lead to pathological accumulation of \_\_\_\_\_\_\_\_\_\_Ca\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (*ion*) inside the cell and ultimately to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_release of the transmitters\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Decide whether the following statements are true (T) or false (F). Give an explanation, why. *(8 points)***

Receptor potentials are graded potentials. \_\_\_\_T\_\_\_\_\_

\_\_\_\_\_Because receptor potential is a graded potential-> transmembrane potential difference\_\_\_\_\_\_\_\_\_

The reflex arc is the simplest neuronal network consisting of a single sensory and motor neuron. \_\_\_\_F\_\_\_\_

\_\_\_\_There are interneurons in the center, that convey the information.\_\_\_\_\_\_\_\_

The stimulus, which activates a reflex arc, is also transmitted towards higher centers. \_\_\_\_T\_\_\_\_\_

\_\_\_\_\_Based on the type of the impulse it can be carried to different parts of the brain (eg. To the brain stem in case of autonomic reflexes)\_\_

The specific stimulus of the knee jerk reflex is the sudden pain caused by the hit on the patella. \_\_\_F\_\_\_\_\_

\_\_\_\_The knee jerk reflex is a stretch reflex, so the stimulus is the stretching of the muscle.\_\_\_\_\_\_\_\_\_\_

Noxious stimuli evoke contraction of flexor muscles, and concurrent relaxation of extensor muscles. \_\_T\_\_

\_\_\_\_\_\_\_\_\_\_The flexor reflex is also called flexor-crossed extensor reflex.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Preganglionic neurons of the sympathetic and parasympathetic reflex arcs are both cholinergic. \_\_\_T\_\_\_\_

\_\_\_\_\_\_\_\_\_They both use acetylcholine to send messages.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A small motor unit consists of a single muscle fiber and 5-6 motoneurons. \_\_\_T\_\_\_\_

\_\_\_\_\_\_Smaller motor units can have less than ten motor fibers.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Interneurons of the spinal cord are located in the posterior horn. \_\_\_T ?\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Identify the major elements, their location and projections in the hippocampal trisynaptic circuit. Labels are scrambled. *(10 points)***

**3**

**2**

**4**

**1**

**5**

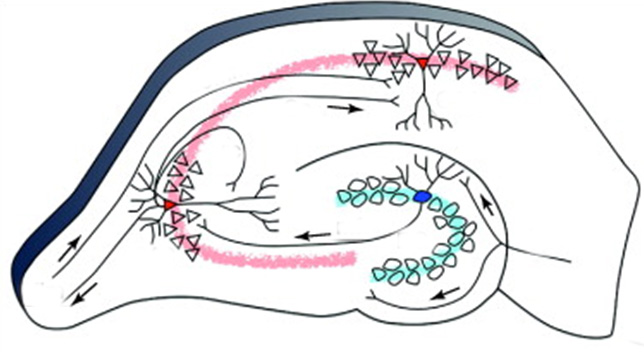
**6**

**B**

**A**

**C**

**D**

****

**A: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_CA1\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ B: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Dentate gyrus\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**C: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_CA1\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ D: \_\_\_\_\_\_\_\_\_\_\_\_\_\_enthorinal cortex\_\_\_\_\_\_\_**

**1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_efferent\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_mossy fiber\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**3: \_\_\_\_\_\_\_granual cell fiber(performant path)\_\_\_\_\_\_\_ 4: \_\_\_\_\_\_\_\_\_\_\_\_afferent\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**5: \_\_\_\_\_\_\_\_\_\_\_\_shaffer collateral\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 6: \_\_\_\_\_\_\_\_\_\_\_axon collateral\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Parameters of the nervous system. Give the number and the unit (if possible) (!). *(8 points)***

Conduction velocity of the naked axon: \_\_\_\_\_\_\_\_\_\_\_\_\_\_0.5-2 m/s\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Duration of an action potential: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_100ms\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Estimated number of synapses in the human brain: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_15\*10^14\_\_\_\_\_\_\_\_\_\_\_\_\_

Diameter of spherical synaptic vesicles: \_\_\_\_\_\_\_\_\_\_\_\_15nm\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Synaptic delay of chemical synapses: \_\_\_\_\_\_\_\_\_\_\_\_\_\_2-5ms\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Estimated number of cortical columns \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_2\*10^6\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Estimated number of synapses established by parallel fibers on a Purkinje cell \_\_\_\_\_\_\_\_\_\_175 000\_\_\_\_

Speed of fast anterograde transport \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**What method would you use to reveal and why:  *(14 points)***

Axon degeneration after peripheral nerve injury \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Explanation:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Burst firing of thalamic relay neurons \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Explanation:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Memory functions in rats \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Explanation:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Connecting neuronal elements in the visual pathway \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Explanation:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The motor speech area in the human brain \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

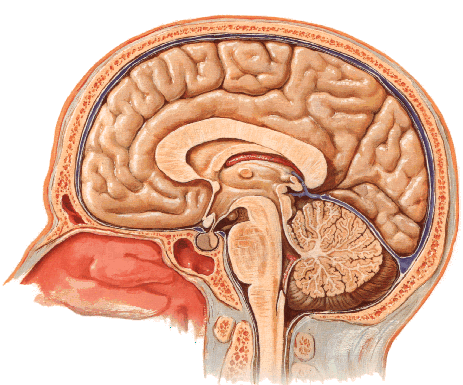
*Explanation:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Number of docking vesicles: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Explanation:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Presence of NMDA receptors in pyramidal cells: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Explanation:* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Identify and provide the name of the structures described by the following statements! Multiple answers are possible! *(10 points)***

**1**

**2**

**3**

**4**

**5**

**6**

**7**

**8**

**9**

**10**

**11**

**12**

**13**

**14**

**15**

**16**

**17**

**18**

**19**

**20**

It is a relay station for a pathway transmitting signals (information) from the cerebral cortex to the cerebellum:

Number: \_\_\_\_\_\_\_\_8\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_tectum mesencephali\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

It receives information from both sides of the visual field:

Number: \_\_\_\_\_\_\_\_4\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_occipital lobe\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

It relays information from all sensory modalities with the exception of olfaction:

Number: \_\_\_\_\_\_\_\_1\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_thalamus\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

It contains fibers connecting corresponding parts of the two hemispheres:

Number: \_\_\_\_\_\_\_\_\_3\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_Corpus Callosum\_\_\_\_\_\_\_\_\_\_\_\_\_

It contains the upper motoneurons for the leg:

Number: \_\_\_\_\_\_\_\_10 Name: \_\_\_\_\_\_\_\_\_\_\_\_\_Frontal lobe\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Central regulator(s) of the endocrine organs:

Number: \_\_\_\_\_\_\_\_2\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_hypotalamus\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

It hosts the motor nuclei of the oculomotor and trochlear nerves:

Number: \_\_\_\_\_14\_\_ Name: \_\_mid brain\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

It is part of the limbic system:

Number: \_\_\_\_\_\_\_\_15\_\_\_\_\_\_\_ Name: \_\_\_\_cingulate gyrus\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

It contains the lower motoneurons for the neck muscles:

Number: \_\_\_\_\_\_\_\_\_5\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_midbrain-spinalchord\_\_\_\_\_\_\_\_\_\_\_\_\_

Origin and the terminal field of the climbing fibers:

Number: \_\_\_\_\_\_13,7\_\_ Name: \_\_\_\_\_\_\_\_inferior olive and cerebellar cortex (purkinje cell layer) \_\_\_\_\_\_\_\_\_\_\_

**Describe the major changes in the given parameters during the defined processes! (*10 points)***

Changes in the intracellular calcium concentration, when the action potential reaches the axon terminal:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_increasing\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Changes in the gap between neighboring cells, if synapses are formed: \_\_\_\_\_\_neurotransmitter concentration is increasing and Ca conc is decreasing\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Changes in the conductance velocity with myelination of axons: \_\_\_\_\_\_\_\_increasing\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Changes of the membrane potential upon binding of GABA to GABA-A receptors\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_decrease\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Changes in the firing rate of motoneurons, if the innervated muscle is suddenly elongated: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_increasing\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Sensory organs. Evaluate the following statements for correctness: *(8 points)***

**Give a short explanation or a few examples supporting your answer.**

Signal amplifiers can be found in most sensory organs. \_\_\_\_\_\_\_\_F\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_It cannot be found in our nose\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Thalamic relay nucleus of the olfactory pathway can be found in the intralaminar nuclei \_\_\_\_\_\_\_\_F\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_The thalamus does not relay olfactory signals\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Thermo-sensation is processed in subcortical areas, such as the striatum. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Decussations characterize all sensory pathways. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The highest proportion of the cerebral cortex that processes visual information. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The auditory information is transmitted via a fast, monosynaptic pathway. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Injury of the optic tract on one side results in blindness in the visual field of both eyes on the side of the injury \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

High frequency tones are detected at the base of the snail, whereas low frequency tones are detected at the top of the snail. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Define the following terms: *(5 points)***

Olfactory glomerulus: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Commissural pathway: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Heteronym hemianopsia: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reticular formation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Second messenger: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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