

86 + 11 = 97

Part A – Multiple Choice (20 points) – circle the letter of the correct answer

- ✓ 1. The blood–brain barrier
- a. is a part of the immune system, involving the release of antibodies to protect the brain from infectious agents.
 - ☒ b. is a property of the closely packed cells that build the walls of brain capillaries, preventing large molecules from entering the brain.
 - c. is a property of the blood vessels of the brain that prevents the diffusion of water into the tissue of the brain.
 - d. is a property of neurons that prevents them from accidentally releasing their neurotransmitters into the blood circulation.
- ✓ 2. Which of the following is *Wrong* regarding opiates
- a. there are opioid receptors in the periaqueductal gray
 - b. endogenous substances which activate receptors for opiates are called endorphins
 - ☒ c. THC-9 is synthesized from opium
 - d. at high doses, opiates depress respiration
- ✓ 3. Which of the following is *Wrong* regarding MRI images
- a. Under specific magnetic and radio conditions, different tissues with different physical traits react differently
 - b. Differences in physical reactions of tissues are translated into different colors
 - c. The strength of commonly used MRI scanners is at least 30,000 times the earth's magnetic field
 - ☒ d. In a strong magnetic field hydrogen atoms are randomly aligned
- ✓ 4. fMRI
- a. measures electrical neural activity directly
 - b. is based on the fact that a local increase in neural activity demands increased glucose
 - ☒ c. is based on the Blood Oxygenation Level Dependent signal
 - d. uses a radioactive tracer injected into the bloodstream in order to see changes in neurovascular coupling
- ✓ 5. Cocaine
- a. is mainly a serotonin agonist
 - ☒ b. especially blocks the reuptake of dopamine
 - c. mainly affects the sympathetic system directly
 - d. can produce schizophrenia-like symptoms
- X 6. Split-brain patients:
- a. have difficulty to verbally describe stimuli presented in the left-visual-field
 - ☒ b. have difficulty to verbally describe stimuli presented in the right-visual-field
 - c. both a and b
 - d. neither a or b

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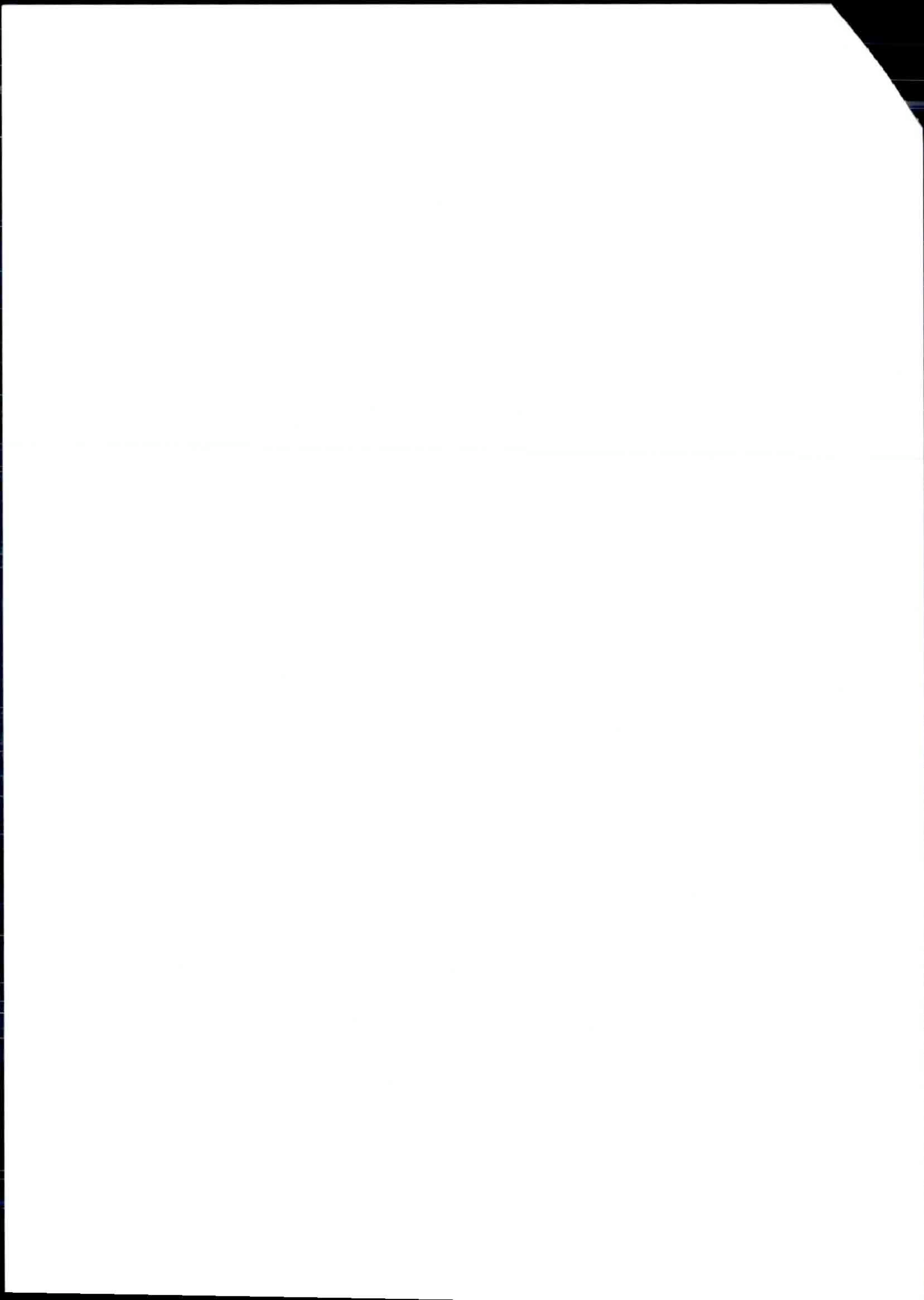
- ✓ 7. In which part of the neuron are synaptic vesicles found?
- a. Cell body
 - b. Dendritic spines
 - c. Axon hillock
 - ☒ d. Axon terminals
- ✓ 8. The major function of Schwann cells is
- a. transmission of nutrients to neurons.
 - ☒ b. myelination of peripheral nerve fibers.
 - c. scavenging of cellular debris.
 - d. myelination of axons in the brain.
- ✗ 9. The sodium–potassium pump is responsible for
- a. removing three sodium ions for every two potassium ions from the cell membrane.
 - b. initiating the action potential.
 - c. returning the membrane potential to the resting state.
 - ☒ d. Both a and c
- ✓ 10. ACh is the main transmitter used at mammalian
- a. cerebral cortical synapses.
 - b. spinal cord synapses.
 - ☒ c. neuromuscular junctions.
 - d. visual system synapses.
- ✓ 11. The specialized presynaptic membrane receptors that remove molecules of transmitter from the synapse are called
- a. translators
 - b. transponders
 - ☒ c. transporters
 - d. ligand-gated channels
- ✓ 12. Which of the following is *not* a consequence of parasympathetic activation?
- a. Increased salivation
 - ☒ b. Increased heart rate
 - c. Decreased blood pressure
 - d. Increased digestion
- ✓ 13. In its common usage, the term *stroke* refers to
- ☒ a. brain lesions caused by a reduction or blockage of blood flow to the brain.
 - b. brain lesions caused by leakage of cerebrospinal fluid.
 - c. brain injury due to head trauma.
 - d. any process that causes a sudden intellectual deterioration.
- ✓ 14. Which of these is *not* a catecholamine neurotransmitter?
- a. Dopamine
 - ☒ b. Serotonin
 - c. Epinephrine
 - d. Norepinephrine

- ✓ 15. For an NMDA receptor channel to open
- a. Both GABA needs to be present and the membrane needs to be depolarized
 - b. Both GABA needs to be present and the membrane needs to be hyperpolarized
 - ☒ c. Both glutamate needs to be present and the membrane needs to be depolarized
 - d. Both glutamate needs to be present and the membrane needs to be hyperpolarized
- ✓ 16. The process of transcription
- ☒ a. is from DNA to RNA, and occurs in the nucleus
 - b. is from DNA to RNA, and occurs in the ribosome
 - c. is from RNA to protein, and occurs in the nucleus
 - d. is from RNA to protein, and occurs in the ribosome
- ✓ 17. RNA
- a. is double stranded
 - ☒ b. is single stranded
 - c. is found only in the nucleus
 - d. is always a template for protein synthesis
- ✓ 18. The phenotype
- a. will always be guided by recessive alleles
 - b. express the genotype only
 - c. will be guided by dominant alleles only if heterozygous
 - ☒ d. is affected by both nature and nurture
- ✓ 19. Crossing over
- ☒ a. creates new combinations of maternal and paternal genes on any given chromosome
 - b. describes the situation when axons from different neurons meet but each continues to a different direction (as in traffic junctions)
 - c. is when the information in a postsynaptic cell from one neuron is being displaced by the information from another neuron
 - d. is a process in which chromosomes exchange equivalent segments of DNA during mitosis
- ✓ 20. Contralateral structures are
- a. one is caudal to the other (which is rostral to the first)
 - ☒ b. on opposite sides of the midline
 - c. lateral to each other
 - d. one is proximal and the other is distal

18
20

Part B – Short Answer (40 points)

- ✓ 1. What disease is related to the degeneration of the substantia nigra?
Parkinson's disease
- ✓ 2. During their absolute refractory period, neurons don't fire an action potential.
- ✗ 3. What characteristic of the neural membrane is responsible for the differential concentrations of ions inside and outside the neuron?
they have ion channels that are SELECTIVE.
- ✓ 4. The neural membrane must become depolarized relative to its resting membrane potential in order for an action potential to occur.
- ✓ 5. Conduction velocity of action potentials is increased in axons with big diameters.
- ✓ 6. True or false? Metabotropic receptors liberate chemical second messengers.
True
- ✓ 7. A gas that is a neurotransmitter is Nitric Oxide.
- ✓ 8. One important way that alcohol alters the functioning of the brain is as an agonist of GABA receptors.
- ✓ 9. Serotonergic neurons are located in the Raphe Nuclei.
- ✓ 10. Mitochondria is the cellular organelle is responsible for cellular respiration.
- ✓ 11. The processes of cell division for growth is called Mitosis.



- ✓ 12. A sequence of 3 nucleotides coding for 1 amino-acid is called a codon.
- ✗ 13. How many neurons does the human brain contain? 300,000.
- ✓ 14. Cells with numerous branching dendrites are called multipolar neurons.
- ✓ 15. The choroid plexus produces the Cerebrospinal Fluid.
- ✓ 16. The primary visual cortex is in the occipital lobe.
- ✗ 17. Receptors that contain channels for sodium or chlorine, e.g., are ion channels; those without channels are ion pumps.
- ✗ 18. Norepinephrine is produced from Locus ^x coeruleus, and Epinephrine ✓ is produced from Norepinephrine.
- ✓ 19. fMRI temporal resolution is in the order of ¹⁻³ 2 seconds.
- ✗ 20. The degree of chemical attraction between a ligand and a receptor is called binding.

31.5
40

Part 3 – Essay Questions (25 points)

Answer 5 out of the following 8 questions (5 points each = 25 points).

You may also answer one more question for 5 bonus points.

At the beginning of your answer, write the number of the question you are answering.

You may continue on the other side of the page if needed.

cam. ✓ 1. Name four types of glial cells, and describe three important functions that glial cells perform.

2. Compare and contrast at least three different human brain imaging technologies through discussion of their technical bases and the types of information each provides.

am. ✓ 3. Explain temporal and spatial summation of IPSPs and EPSPs.

4. List 5 characteristics (properties) of a substance necessary for it to be considered a neurotransmitter.

cam. ✓ 5. Describe up to 5 ways that medicinal drugs or drugs of abuse may affect post-synaptic processes.

✓ 6. Describe the process leading from a gene to the creation of a mature protein – how is a gene recognized, which molecules are involved, what are the names of the sub-processes, where does each sub-process take place, how is the correct protein sequence created.

✓ 7. Describe the production, functions, and structures containing cerebrospinal fluid, and problems that can be caused when the CSF system malfunctions.

8. Describe mitosis and meiosis, when and in which cells does each one occur, and how many chromosomes are in each daughter cell by the end of each process.

5/5 very good!

✓ 1. The macroglia type of glial cells contain the astrocytes, the oligodendrocytes and the schwann cells. The other type is called microglia. The astrocytes keep the neurons isolated in synapse. They also carry nutrients to the neurons and digest dead neurons. Sometimes they cause a scar tissue, which affects the regrowth of the neuron. The oligodendrocytes myelinate the brain and the spinal cord. This is vital for the fast transmission of information and to carry out the main functions of the human being. However it doesn't promote the regrowth of affected neurons. The schwann cell enables it, making it possible to make transplants of artificial body parts and even to gain sensitivity on them. The schwann cells also myelinate but only the peripheral nerves and less than the (*)

5- One way is by reuptake. When the drug promotes the reuptake to the presynaptic neuron, the neuron doesn't receive the chemical and for instance is affected. The other case found with reuptake is that some drugs prevent the reuptake from happening so that the molecules stay in the synaptic cleft and then unless another phenomenon occurs, will have to join the postsynaptic receptors. ✓

Moreover some drugs can act as agonists enhancing the function of the cell or as antagonists by blocking its function. They act like keys that have to match the postsynaptic receptor's "locks" in order to create an effect. ✓

Another effect could be the blocking of certain receptors in the postsynaptic cell that is intended to bind with a neurotransmitter but this one can not bind because there is another one on its place (competitive) when they don't interfere they are denominated non-competitive). This is similar to the previous process you described.

5/5
7- The cerebrospinal fluid is created in the choroid plexus. After it is created it travels along the ventricles that we have in our brain, in the cortex, in the subarachnoid space and in the spinal cord. The functions of this fluid are to cushion the brain from any type of lesions. It protects the central nervous system and irrigates it systematically. New cerebrospinal fluid is created constantly. When the cerebrospinal fluid pathway is blocked a stroke can occur. The plasma-like fluid also can be found abnormally in certain areas, causing the brain problems by keeping it pressed while the head is extending. Fortunately nowadays we can find treatments for this such as introducing a needle in order to remove the extra cerebrospinal fluid that affects only a small portion of the population. The process is called hydrocephalus. Another problem is a leakage which can cause permanent damage.

(Use this page to continue Essay answers if required)

1.5/5
3- EPSPs is the abbreviation of Excitatory Postsynaptic Potential which means that in the Postsynaptic cell the message received is excitatory. In this case the neuron can fire an action potential. The temporal summation ^{always?!} is ^{required} quite fast and the neuron is depolarized when the action potential is fired. A moderate input is enough in this case once the sodium channels are prepared.

IPSPs stands for Inhibitory Postsynaptic Potential which means that the Postsynaptic cell was inhibited with the synapses. In order for an action potential ^{to occur} a very strong input is required because the cell is hyperpolarized as the potassium channels are still open. The process is much slower than the process taken place in the EPSP.

but what about spatial & temporal summation?!

3.5/5
4- A neurotransmitter is a molecule. This kind of molecules need to communicate presynaptic neurons with postsynaptic neurons. They are carried in vesicles that with the help of calcium ~~are~~ then bind to the membrane and this neurotransmitter are released. Neurotransmitters have a function and their special characteristics. They can carry out their functions by reaching the receptors in the postsynaptic receptors. Neurotransmitters need to be released and take part of the synapses. There are fast. They can be prevented from binding to their receptors by reuptake or some enzymes who take the neurotransmitters away from the synaptic cleft.

* or even before reaching them.

The neurotransmitters are found in the axon terminals before release.

① 1 - Oligodendrocytes. The Schwann cell myelinates one axon and the Oligodendrocytes can myelinate up to 15 making the process a more complete one.

The microglia extends its branches to the peripheral spaces and when it detects a dead neuron, these glia travel all the way to that spot and digest the debris. However they also consume healthy cells. The uncontrolled activity of microglia could be a serious problem. It is being studied as one possible contributor to Alzheimer's disease, multiple sclerosis and other degenerative diseases.

⁵
⁵ 2 - The CT (computerized tomography) is a type of technology used to obtain an image of the brain. However it is not very accurate and the ionization that provides is not guaranteed to be safe. We obtain the image through a computer and what we can see is the structure of the brain, not its functions or activities. Colors vary from white to black on a gray scale and the time of resolution is quite slow. A faster and more effective technology is the MRI. This one is also completely safe and people can be exposed to it infinite number of times. The MRI provides a magnetic field to affect the atoms of hydrogen that we have in our brain tissues. After they spin, a radio frequency (high) is targeted so that the molecules find themselves influenced by the magnetic field and resonance field. The different tissues are different and each one will take a different time to return to their normal state. The MRI uses this to obtain an image of the structure of the brain also in a gray scale. The fMRI measures the function of these tissues with different colors regarding the neural activity. The fMRI is based on the idea that neural activity requires ^{oxygen} glucose, increases blood flow and oxygen demand. The neurovascular coupling is measured with the BOLD reflecting the level of activity with a characteristic colour.

19/05/22 22.5 (including bonus)
25+5

(Use this page to continue Essay answers if required)

EPSP → Depolarization
IPSP → Hyperpolarization

neurotransmitter

- transmitted by synapses
- communicate with postsynaptic cell
- be in vesicles
- carry a function

Astrocytes

Oligodendrocytes

- myelinate the CNS
- Don't enable axons to grow again, regrowth.

Schwann cell

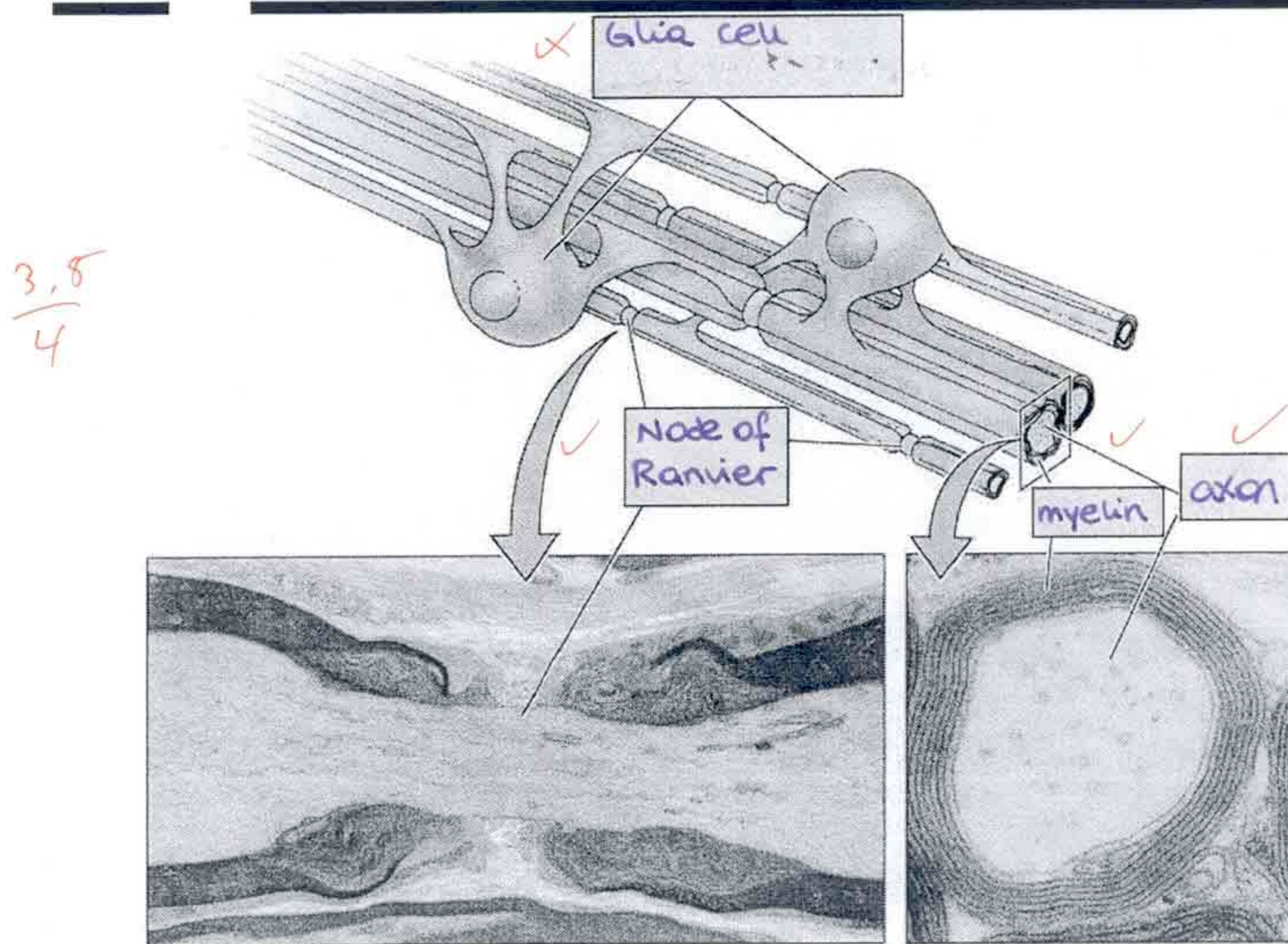
- myelinate the peripheral nerves
- Enables fake arms.

Microglia

- Eat
- reaches the dead neurons with branches
- transport to the core
- Digest it
- But also eat good cells.

Part 4 – Labeling (15 points; 1 point for each label)

(4 points)

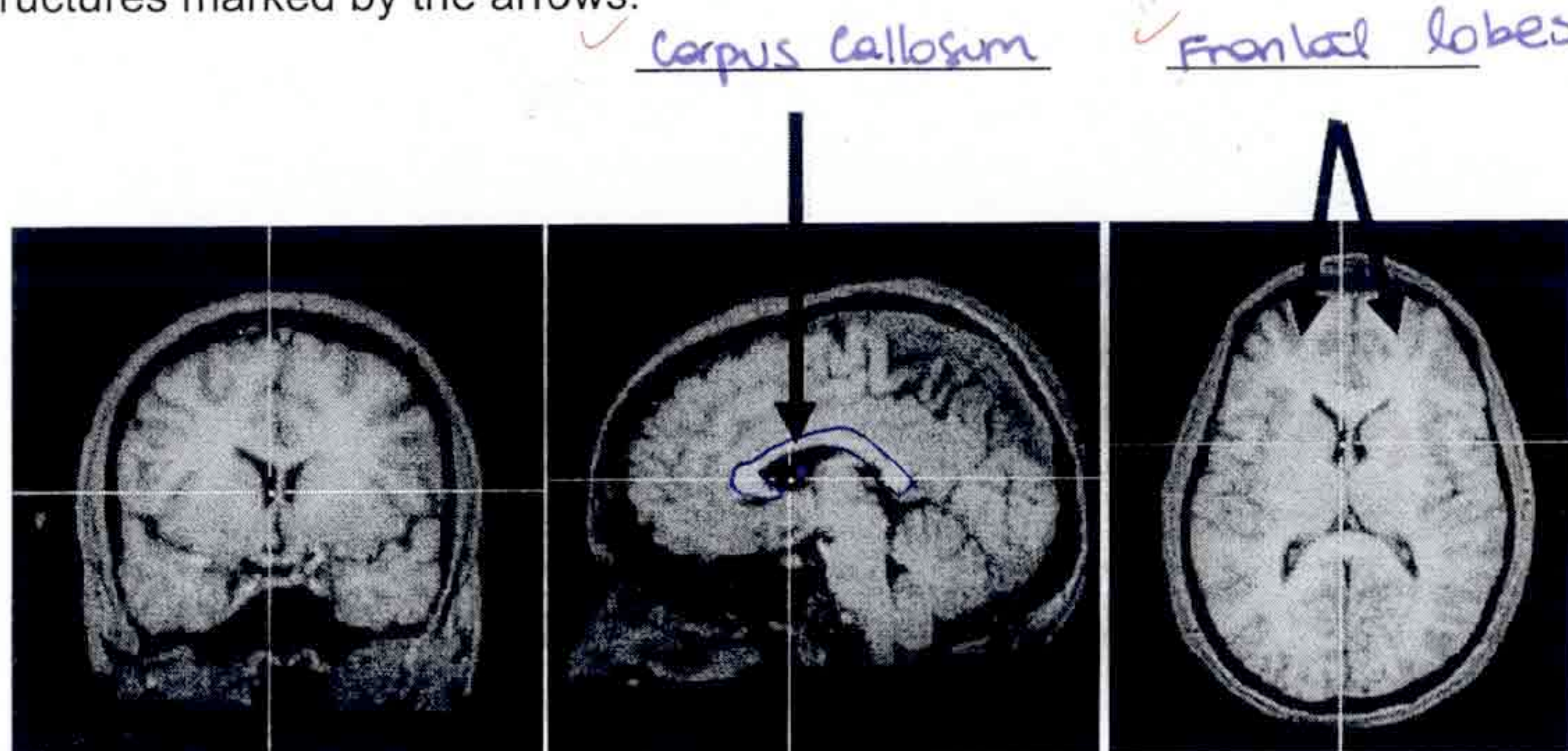


(6 points)

A. The white cross is positioned on the same structure in all the three planes.

X This structure is the Substantia nigra.

5/6 Write the name of each plane under each figure, and fill the name of the structures marked by the arrows.



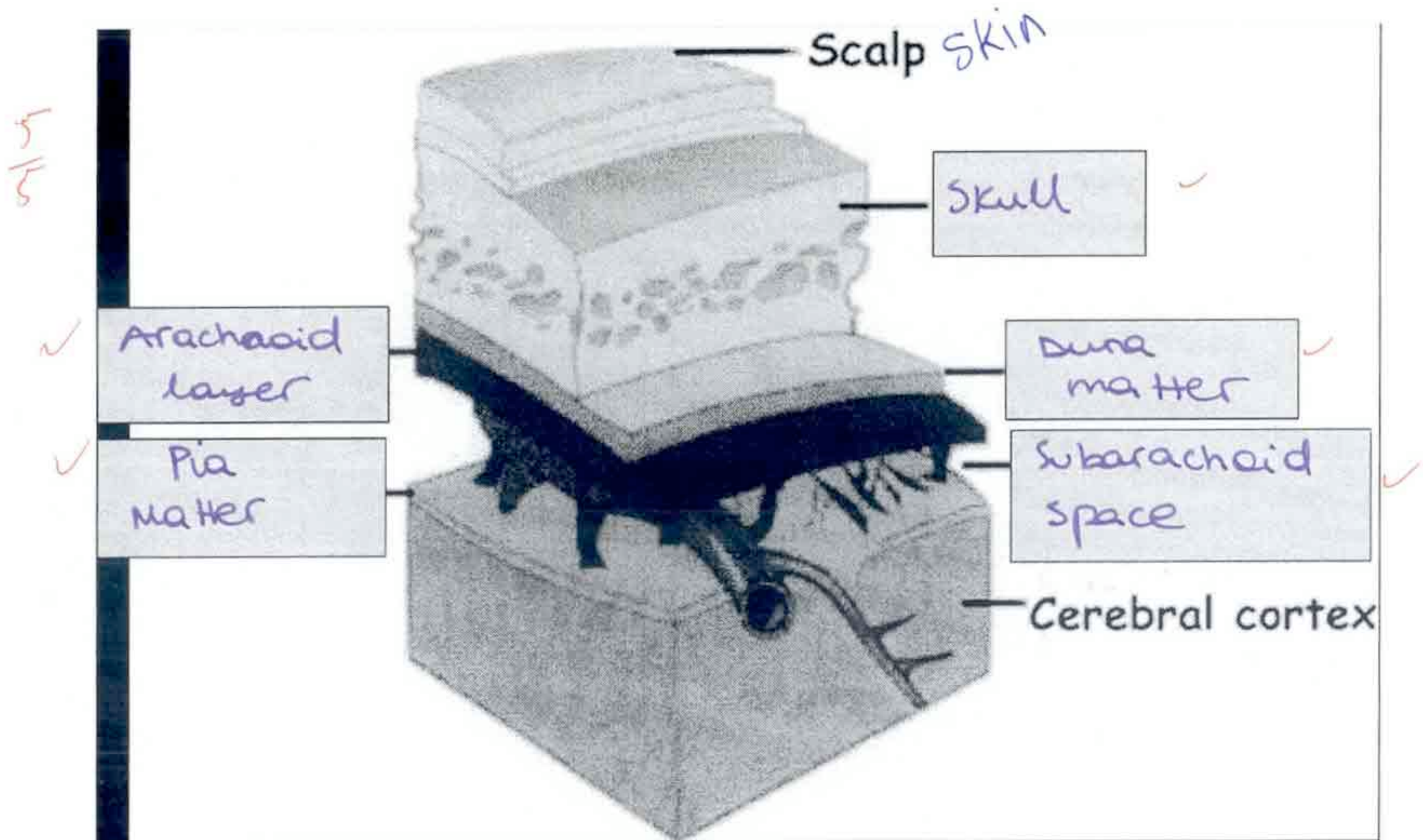
✓ coronal

✓ sagittal

✓ Horizontal

A brain surgeon, who needs to remove a tumor from a sub-cortical structure, will "meet" the following layers on the way:

(5 points)



13.5
15

