Ronnie Li
Last updated: 07/26/2021

NEUR0010 Exam 1 Review

You have a lot of multiple choice questions to practice from, but do you truly understand the concepts behind what you're studying? Test yourself here, for starters.

Some of these questions are more food-for-thought **(FFT)** questions than test questions, but they do have reasonable and unreasonable answers.

Neurons and Glia

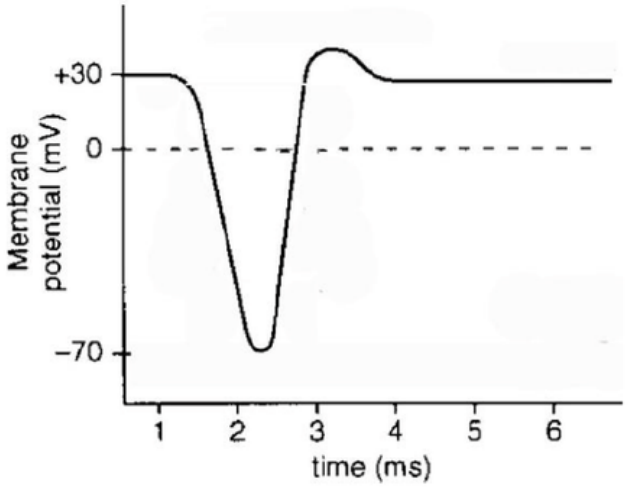
1. The guy who proposed the Reticular Theory was not completely wrong. Some neurons are actually physically connected. What are these connections called? **FFT:** It turns out that these connections are very prevalent in astrocytes, a glial cell type in the brain. Although they don't fire action potentials, overactivation of astrocytes can be dangerous and contribute to seizures. How might these connections play a role?

2. Abnormalities in axoplasmic transport can have serious consequences. Besides neurotransmitter, name one other major class of macromolecules that needs to travel along the axon. What is one function performed by this class of macromolecules?

3. **FFT:** Recall how things go wrong in Alzheimer's disease (AD). You're a genius synthetic organic chemist and pharmacologist, and you are able to synthesize a drug to perform any function you want. How might you go about treating AD in terms of the cellular processes you might target?

Resting Membrane Potential and Action Potential

1. All credit goes to Dr. Ken Miller, Dr. John Stein, and Jody Hall, who teach BIOL0200, for this diagram and question. You are instructed to design an upside-down action potential that resembles the diagram below. Assume you have the ability to manipulate any feature in the cell you want, such as the relative concentrations of ions inside and outside, the gating and opening of ion channels, and so on.



   a. Keep the relative concentrations of Na+ and K+ the same inside and outside of the cell. With that in mind, design an action potential that would look like this. Make sure you address: (i) relative permeability to ions at rest, (ii) what ion channels open and when they open, and (iii) the state of ion channels at each phase of this action potential.

   b. **Reverse** the relative concentrations of Na+ and K+ inside and outside of the cell. Keep in mind that these are relative concentrations; you do not need specific numbers in order to do this problem. Now, design an action potential that would look like this. Make sure you address: (i) relative permeability to ions at rest, (ii) what ion channels open and when they open, and (iii) the state of ion channels at each phase of this action potential.

2. Credit also goes to the instructors of BIOL0200 for this question. As you might recall from high school biology, a proton (H+) gradient along the mitochondrial inner membrane is necessary for ATP synthesis. At normal body temperature, suppose there are 1,000 times more protons (H+) on the outside of the membrane (intermembrane space) than on the inside (mitochondrial matrix). What is the equilibrium potential for H+? Please give a numerical answer.

3. What phase of the action potential most closely correlates with the absolute refractory period? Why? What phase of the action potential most closely correlates with the relative refractory period? Why?

4. **FFT:** You can get an action potential to travel "backwards" from the axon to the soma if you electrically stimulate the end of the axon — this is called backpropagation. Suppose you stimulate the end of the axon at the same time as the neuron fires its own naturally occurring action potential. When these two action potentials collide, what will happen and why?

Synaptic Transmission

1. Parkinson's disease (PD) is largely caused by degeneration of dopamine neurons in the substantia nigra of the brain. In his seminal book *Awakenings*, neurologist Oliver Sacks documents that delivering a drug could bring people out of a Parkinsonian state. Sacks could not give these patients dopamine or tyrosine because neither molecule can cross the blood brain barrier. What molecule did Sacks give these patients?

2. Botulinum toxin (Botox) is a drug that prevents the release of acetylcholine at the neuromuscular junction. It is commonly used for cosmetic purposes, but it also has medicinal uses. Botulinum toxin inhibits neurotransmitter release by directly inhibiting presynaptic vesicle fusion. Based on this information alone, what is the likely target of Botox?

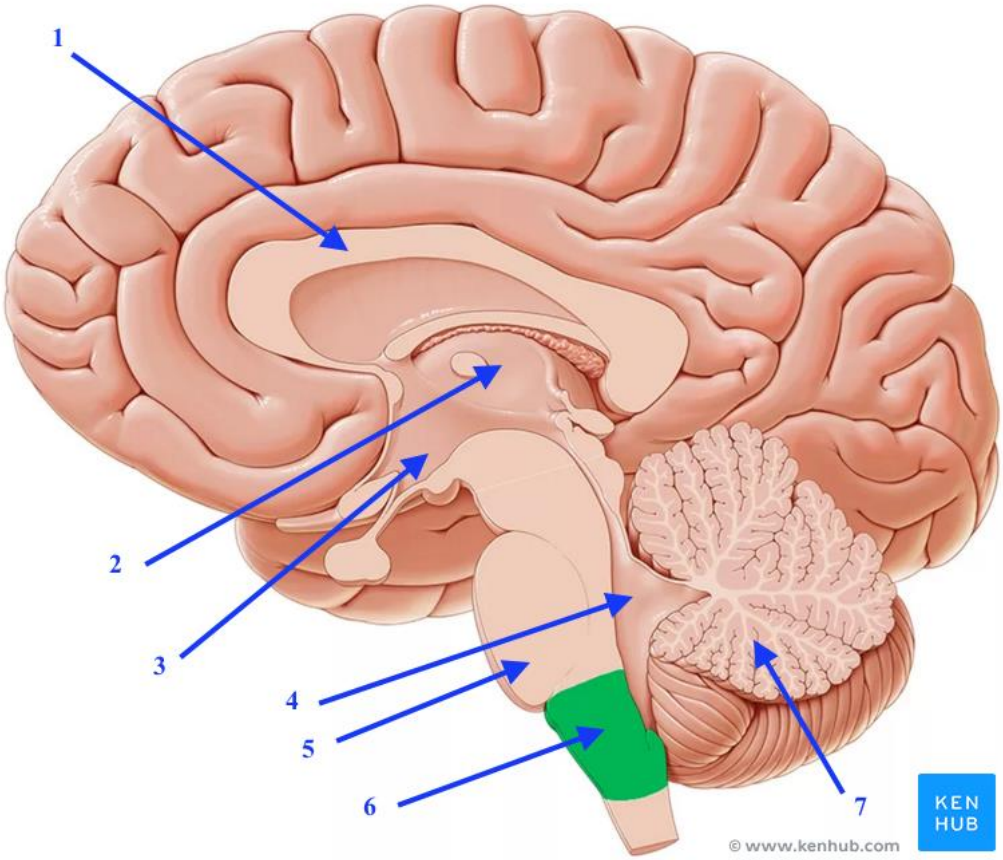
3. You are informed that one of your patients has a disease in which his PIP_2 pathway is overactive. Using your remarkable knowledge of synthetic chemistry and pharmacology, you try to make a drug that will most effectively inhibit this pathway. You have four choices: you can (a) inhibit phospholipase C, (b) block IP_3 receptors in the smooth endoplasmic reticulum, (c) inhibit protein kinase C, or (d) inhibit calcium/calmodulin-dependent protein kinase. Which choice most would effectively shut down the overactive pathway and why?

Neurodevelopment and Neuroanatomy

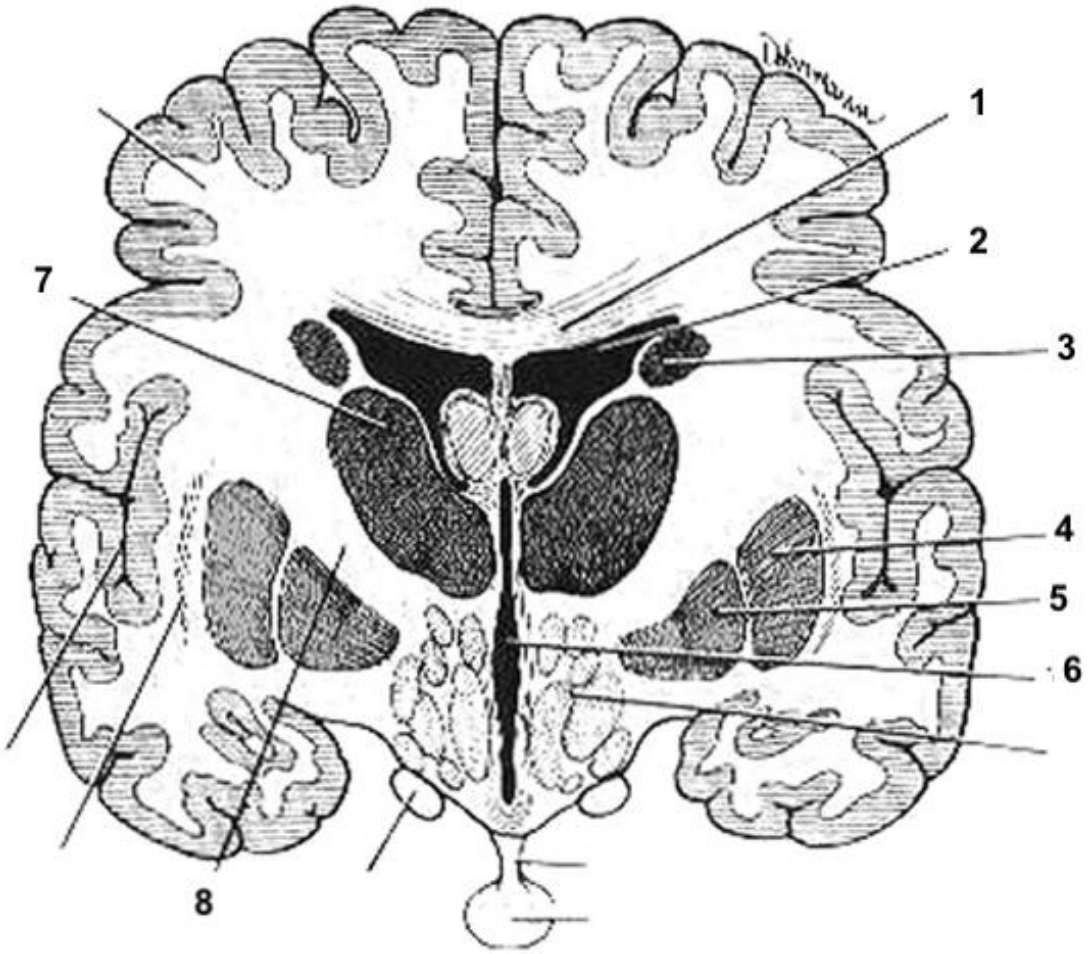
1. **FFT:** You inject a drug intraperitoneally (into the abdominal cavity) into a mouse, thinking it will have some effect on the mouse's behavior. However, you don't observe any changes, and you think that the drug might not have gotten to the brain. What experimental approach can you take, without having to kill the mouse, to see whether or not the drug has gotten into the brain?

2. **FFT:** Many of the structures, like the caudate nucleus and lateral ventricles, have a C-shape to them. Why do you think this makes sense from an evolutionary perspective?

3. For each adult structure, name the embryonic division from which it is derived. The choices are telencephalon (T), diencephalon (D), mesencephalon (M), metencephalon (Me), or myelencephalon (My). Only one choice is valid for each structure.
    a. Anterior nuclei of the thalamus
    b. Internal capsule
    c. Corpus callosum
    d. Hypothalamus
    e. Cerebral aqueduct
    f. Substantia nigra
    g. Medullary pyramids
    h. Pons
    i. Lateral ventricles
4. Name structures 1-7 on the following diagram. What plane of section is this?



5. Name structures 1-8 on the following diagram. What plane of section is this?



6. Name the structures as specifically as possible:
    a. I am the structure following the lateral wall of the lateral ventricles
    b. I am the white matter tract connecting the two hemispheres of the brain
    c. I am the large structure surrounding the third ventricle
    d. I am the structure on the dorsal side of the cerebral aqueduct
    e. I am the fluid-filled structure anterior to the cerebellum
    f. I am the space that contains the majority of the cerebrospinal fluid in the central nervous system

Good luck on the exam! Feel free to reach out to me with questions. My contact information is below.

Email: ronnieli0114@gmail.com
Phone: (516) 987-2885
Website: www.ronnieli.com/neur0010