Name: Bailey Scott and Colin Quinn

**Week 10: Nervous System, Action Potentials, and the Eye (Chapters 14 Nervous System and Chapter 15, section 4 on the Sense of Vision in your textbook)**

**Part 1: Neurons and The Nervous System**

**A. Introduction:** **The following questions are derived from** **section 14.1 in your book.**

1. What are the two major divisions of the nervous system (figure 14.2)?

Central nervous system and peripheral nervous system

2. What does each division consist of (figure 14.2)?

Central nervous system: brain and spinal cord

Peripheral nervous system: sensory and motor nerves

3. Draw and give a description of the following, using figure 14.3 from section 14.1 in your book.

Sensory neuron:

 Nerve cell that transmits nerve impulses to the central nervous system after a sensory receptor has been stimulated

Interneuron:



Neuron located within the central nervous system that conveys messages between parts of the central nervous system

Motor neuron:

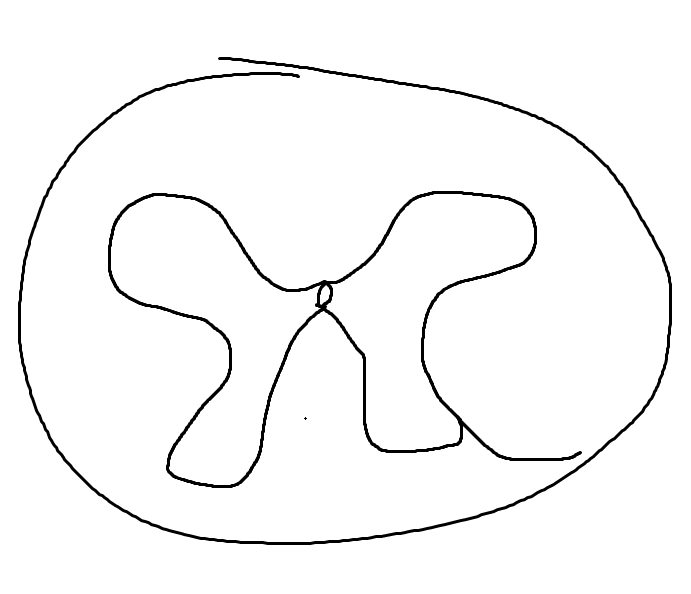


Nerve cell that conducts nerve impulses away from the central nervous system and innervates effectors such as muscles, glands, and organs

**B. Central Nervous System Anatomy**

**i. Spinal Cord Anatomy**

1. Use Figure 14.8a to draw a cross section of the spinal cord.



2. What is contained in the gray matter of the spinal cord?

Neuronal cell bodies and unmyelinated axons.

3. What is contained in the white matter of the spinal cord?

Myelin and glial cells

**ii. Brain Anatomy: For this section, please view the dissection of a sheep brain here:** [**https://www.biologycorner.com/anatomy/sheepbrain/sheep\_dissection**.html](https://www.biologycorner.com/anatomy/sheepbrain/sheep_dissection.html) . You may also find it helpful to consult your textbook, section 14.2, pages 288-290.

1. Observe the external anatomy of the sheep brain. Below is a ventral view of the brain from the website. Please label the following: right and left cerebral hemisphere, cerebellum, temporal lobe of cerebrum, midbrain, medulla oblongata and spinal cord.



2. Observe the external anatomy of the sheep brain as seen in https://www.biologycorner.com/anatomy/sheepbrain/sheep\_dissection.html. Using the lateral view presented from the website of a human brain here: https://www.kenhub.com/en/library/anatomy/topography-of-the-cerebral-hemispheres, label the following: frontal lobe, cerebellum, occipital lobe, parietal lobe, central sulcus, medulla oblongata, spinal cord and temporal lobe.



3. View the longitudinal section of the brain on the website; the image is included here. Label the following: cerebrum, cerebellum, third and fourth ventricle, spinal cord, pons, midbrain, pineal body, thalamus, hypothalamus, corpus callosum, and lateral ventricle.



4. Use your textbook (pages 288- 292 of chapter 14.2) to complete the table below with the functions of the different parts of the human brain.

|  |  |
| --- | --- |
| **Part** | **Major Functions** |
| Cerebrum | The last center to receive sensory input. Communicates with and coordinates the activities of the other parts of the brain. |
| Cerebellum | Receives sensory input from the eyes, ears, joints, and muscles about the present position of body parts. |
| Thalamus | Central hub for relaying sensory information to the brain, regulates sleep and anger/aggression. |
| Hypothalamus | Links to the nervous system and endocrine systems. Produces hormones. |
| Midbrain | Serves motor movement, more specifically movement of eyes and aids in visual/audio processing. |
| Pons | Assists the medulla oblongata in regulation of breathing. |
| Medulla oblongata | Regulates heartbeat, blood pressure, breathing, and other vital functions. |

5. What lobe you find the area for taste (section 2)?

Parietal lobe

6. What lobe would have areas for motor and olfactory sensation (section 2)?

Cerebral cortex

7. What lobe would have the area for visual stimuli (section 2)?

Occipital Lobe

8. What lobe is associated with containing the primary motor area?

Frontal Lobe

9. What is the role of the prefrontal area of the frontal lobe?

Planning and performing motor movements, taking initiative, motivation, control of emotions

10. What are Wernicke’s area and Broca’s areas? Where are these located in the brain?

Temporal lobe, Wernicke’s is used for language development and Broca’s is used to produce speech.

**C: Peripheral Nervous System**

This section corresponds with section 14.4 of your textbook.

1. What is a reflex?

Automatic, involuntary response of an organism to a stimulus

2. Consult figure 14.7 of your textbook. What are the components of the spinal reflex pathway that are excited when a pin punctures the skin, leading to pulling back the hand from the source of stimulation?

Sensory receptor in skin, dendrite of sensory neuron, cell body of sensory neuron, dendrites, interneuron, dendrites, cell body of motor neuron, ventral root, axon of motor neuron, effector (muscle)

3. How many pairs of cranial nerves project from the inferior surface of the brain in the peripheral nervous system?

Twelve Pairs

4. How many pairs of spinal nerves emerge from either side of the spinal cord?

Thirty-One pairs

5. What parts of the brain would work together to achieve good eye-hand coordination? (overarching question integrating all of chapter 2)

Cerebrum and cerebellum

**Part 2: Connect Virtual Labs:**

1. Take notes on the Connect virtual lab “nervous system: demonstrate monosynaptic reflexes"

* Reflexes are triggered by a stimulus and result in a predictable response.
* Reflexes are fast and involuntary, which means we are not aware and not in control.
* Reflexes have four to five main components. The components are listed below:
  + Receptor: A receptor detects the appropriate stimulus.
  + Afferent (sensory) neuron: The afferent neuron conducts the signal from the receptor to the spinal cord.
  + Interneuron: An interneuron may be located within the spinal cord to receive the signal from the afferent neuron. The presence of an interneuron indicates a polysynaptic reflex.
  + Efferent (motor) neuron: The efferent neuron receives a signal from either the afferent or interneuron and carries the signal to the effector. If the signal passes directly from the afferent neuron to the efferent neuron, it is a monosynaptic reflex.
  + Effector: The effector executes the response of the reflex. In the spinal reflexes tested in this activity, the effectors are skeletal muscles.
* Stretch reflexes need not be learned, as they are pre-programmed. They do not change but can be overridden by the central nervous system.

2. Take notes on the Connect virtual lab “skeletal muscle: electrical stimulation”.

* Electrical impulses from a data acquisition unit can trigger the action potentials generated by nerves that stimulate skeletal muscles in animals.
* The threshold stimulus is the minimum stimulus required to cause a skeletal muscle to contract.
* As the magnitude of stimulation increases, a skeletal muscle will contract with increased force due to an increased number of muscle fibers contracting.
* At maximal stimulus, skeletal muscle contracts at full force and will not contract with any more force even if a greater stimulus is applied.

------------------------------------------------------------------------------------------------------------------------

**Part 3: Action Potential PhET simulation**

Computer Activity: Stimulation of a Neuron and the Resulting Action Potential (to be completed after you clean up your lab station)

**Directions**: Go to this site and download the neuron activity.<https://phet.colorado.edu/en/simulation/neuron>

Start the simulation and answer the following questions.

1. Before starting the simulation, be sure the following items are selected:

a. Normal speed

b. Show all ions

c. Concentrations

d. Put the zoom selector (upper left) in the middle

2. BEFORE clicking “Stimulate” – what ions are moving and in which direction?

Sodium ions are moving in and out of sodium leak channels while potassium ions are moving in and out of potassium leak channels.

3. BEFORE clicking “Stimulate” – what are the concentrations of each ion?

K+ inside: 140 mM

Na+ outside: 145 mM

K+ outside: 4 mM

Na+ inside: 10 mM

4. Click “Stimulate” and describe what happens.

Potassium ions are moving into the neuron at a very fast rate while sodium ions are moving somewhat fast out of the neuron

5. Press “refresh.” Click “Stimulate” and this time select “Potential Chart” and observe.

6. Click “Stimulate” and pause at 2.5 milliseconds. (The time can be adjusted back and forth in case you miss).

At what phase of the action potential is this illustrating?

The spike

What are the concentrations of each ion?

K+ inside: 140 mM

Na+ inside: 10 mM

K+ outside: 4 mM

Na+ outside: 144.99998 mM

7. How do the ion concentrations compare from resting to 2.5 milliseconds?

The ion concentrations are vastly similar, with the only difference being a lower Na+ concentration outside of the neuron

8. What is happening from 2.5 to 4 milliseconds?

The action potential is decreasing rapidly back to the resting potential

What are the concentrations of each ion at 4 ms?

K+ inside: 139.99942 mM

Na+ inside: 10.00009 mM

K+ outside: 4.00001 mM

Na+ outside: 144.99837 mM

9. Using the graph below, sketch the entire action potential from resting to 40 milliseconds.

+

10. Choose “Show Charges” and run the simulation fast this time. What charge is normally outside the membrane? \_\_\_\_\_\_\_\_\_\_\_\_\_\_ What charge is normally inside the membrane? \_\_\_\_\_\_\_\_\_\_\_\_ At what phase is this reversed?

1. Positive. 2. Negative 3. The peak

11. When do the sodium gated channels get opened? When are they closed?

They open as the potential rises to the peak and they close after the potential goes back to resting.

12. When do the potassium gated channels get opened? When are they closed?

The potassium gated channels open at the peak and they close at around 5 ms

13. When are the sodium and potassium leak channels open?

They are always open

14. The action potential is a transient change in the resting membrane potential from -70 mV to +30 mV, then back to -70 mV. This change is caused by the opening of first \_\_\_\_\_ then \_\_\_\_\_ voltage-gated channels.

Sodium gated channels then potassium gated channels

15. What area(s) of the neuron generate signals that open the voltage-gated channels in the first part of the axon, thus causing an action potential?

Dendrites and cell body

16. After an action potential, the membrane becomes more negative than -70 mV. This period is called:

hyperpolarization

17. After a neuron has generated an action potential, it cannot generate another one for a while. This period is called:

Absolute refractory

18. If sodium and potassium ions are both positively charged, what causes the negative membrane potential in a resting neuron?

There are more sodium ions outside than the potassium ions inside

Link: https://courses.lumenlearning.com/wm-biology2/chapter/resting-membrane-potential/

-----------------------------------------------------------------------------------------------------------------------------

**Part 4 The Sense of Vision**

**For this section, you will utilize the link indicated (only for question 1) as well as your textbook, Chapter 15, section 4 The Human Eye to complete your exercises.**

**A. Eye dissection: Examine the dissected cow eye at** [**https://www.biologycorner.com/worksheets/cow\_eye\_dissection\_virtual.html**](https://www.biologycorner.com/worksheets/cow_eye_dissection_virtual.html) **. Also consult figure 15.6 in your textbook.**

1. Draw and label on 3 separate pictures. Include a description of the color/appearance of each structure as seen in the cow eye dissection.

A) the external features of the eye (optic nerve, sclera, cornea)



Cornea: White, grey color

Optic Nerve: White

Sclera: Blue-ish grey color

B) the anterior segment of the eye (cornea, pupil, aqueous humor, iris, lens, ciliary body) and



Pupil: Hole within the iris

Lens: Hard and sphere-shaped

Cornea: White, grey color

Iris: Black, oval-shaped

C) the posterior segment of the eye (optic nerve, sclera, choroid, retina, vitreous humor, hyaloid fossa)



2. Complete the following table for functions of eye components. This corresponds to Table 15.2 in your textbook.

|  |  |  |
| --- | --- | --- |
| **Part** | **Location** | **Function** |
| Sclera | Front of the eye | Protects and supports the eye |
| Cornea | Front of the eye | Refracts light rays |
| Choroid | Behind the iris | Absorbs stray light |
| Retina | Surrounded by choroid | Contains photoreceptors for sight |
| Fovea centralis | Bump behind the posterior compartment | Contains mostly cones for acute vision |
| Lens | Attached to the ciliary body | Refracts and focuses light rays |
| Ciliary body | Surrounding the retina | Holds lens in place, accomodation |
| Iris | In front of the choroid | Regulates light entrance |
| Pupil | Center of the iris | Admits light |
| Aqueous and vitreous humors | Aqueous: within the cornea  Vitreous: Inside posterior compartment | Transmit light rays and support the eye |
| Optic nerve | Back of eye structure | Transmits impulses to the visual cortex. |

3. What is visual accommodation—what does it achieve? When do you lose ability to accommodate?

The ability of the eye to focus at different distance by changing the curvature of the lens. This allows us to see at different distances. Typically, the ability to accommodate is lost after the age of 40 or after someone works with computers a lot.

4. Describe the flatness/roundedness that is associated with the lens of the eye when looking at something that is close versus far away. Consult Figure 15.7.

Near object: Lens rounded

Distant object: Lens flat

5. What is the role of rod cells? In 2-3 sentences, how do they work?

Rod cells respond to dim light. When light is absorbed by a rod, rhodopsin splits into opsin and retinal. A cascade of reactions and the closure of ion channels triggers signals, which leads to the light response.

6. What is the role of cone cells? In 2-3 sentences, how do they work?

Cone cells respond to bright light and detect color and provide visual acuity. When bright light hits the eyes, the cones are activated. There are three pigments within the cones which account for the way we process color.

7. What is the reason that you have a blind spot? Perform the exercise on page 316 to determine where your blind spot is.

There are no rods and cones where the optic nerve exits the retina

8. Make a line diagram to trace the pattern of visual signal transduction from the absorption of light on the photoreceptors of the retina to the processing that occurs in the visual cortex of the cerebrum.

Absorption of light -> nerve impulses carried by optic nerves -> optic chiasma -> optic nerves continue as optic tracts -> fibers from right half of each retina converge and continue together in the right optic tract and nerve fibers from the left half of each retina join to form the left optic tract, traveling together to the brain -> optic tracts sweep around hypothalamus -> fibers synapse with neurons in nuclei within the thalamus -> axons from the thalamic nuclei form optic radiation to take nerve impulses to the visual cortex within occipital lobe -> image is split in visual cortex and processed

9. What is the most common cause of being nearsighted? How is this corrected?

-Eyeball is longer than normal

-Wear concave lenses to spread the light rays

10. What is the most common cause of being farsighted? How is this corrected?

-Eyeball is shorter than normal.

-Wear convex lenses to increase bending of light rays

11. What is the most common cause of astigmatism? How is this corrected?

-irregular curvature of cornea/lens

-unevenly ground lens to compensate for uneven cornea

12. What is a cataract, and how is it fixed?

A cataract is when the lens becomes cloudy. This can be fixed by surgically removing the cloudy lens and replacing it with a clear plastic lens.

13. What is glaucoma, and how can it be managed?

Glaucoma is a buildup of fluid pressure inside the eye. This can be managed by eyedrops and oral medications. If these do not help, surgery is an option.