Anatomy Review

Page 1. Introduction

- The structure of neurons reflects their function.
- One part of the cell receives incoming signals.
- Another part generates outgoing signals.

Page 2. Goals

- To understand the basic anatomical features of neurons and the function of each anatomical region.
- To understand information flow in neurons and the structural basis for communication between neurons.

Page 3. Neurons Can Communicate

- Because of their unique anatomical design, and because they are excitable, neurons can communicate.
- Neurons communicate with:
  1. each other
  2. muscles
  3. glands

Page 4. Neurons Have Three Characteristic Structural Features

- Neurons come in many different shapes and sizes. In this module we will examine the most common central nervous system neuron, the multipolar neuron.
- All neurons have three characteristic structural features:
  1. a cell body
  2. a receptive portion
  3. a transmitting portion
- In most neurons, the cell body, or soma, is located centrally.
- Multiple similar processes, called dendrites, extend from the soma, forming a structure resembling the branches of a tree.
- A thin single process, called the axon, also extends from the soma.

Page 5. Neuron Structure is Related to Function

- How the structural features of a typical neuron are related to its function.

- **Dendrites.** Receptive and integrative region of the neuron.
  - The branched dendrites receive signals coming in from other cells and send them toward the axon.
  - Sum up, or integrate, the incoming signals.
- **Cell Body.** Receptive and integrative region of the neuron.
  - The cell body is the main nutritional and metabolic region of the neuron.
  - Receives signals from other cells and sends them toward the axon.
  - Sum up, or integrate, the incoming signals.
- **Axon.** The transmitting or conductive region of the neuron.
  - The axon generates an action potential, an outgoing signal also called a nerve impulse, and conducts it to the next cell.

- Label the parts of this neuron:

- Neurons receive and integrate signals at one location and transmit an action potential at another location.

Page 6. Information Flow In Neurons Is Directional

- Information flow in neurons is directional.
- The incoming signals are integrated, and if the summed signal is large enough, an outgoing signal, or action potential, is generated.
- The action potential is conducted along the axon toward the target cell.
- With arrows, label the input and output on this neuron:

Page 7. Signals Are Received At Synapses

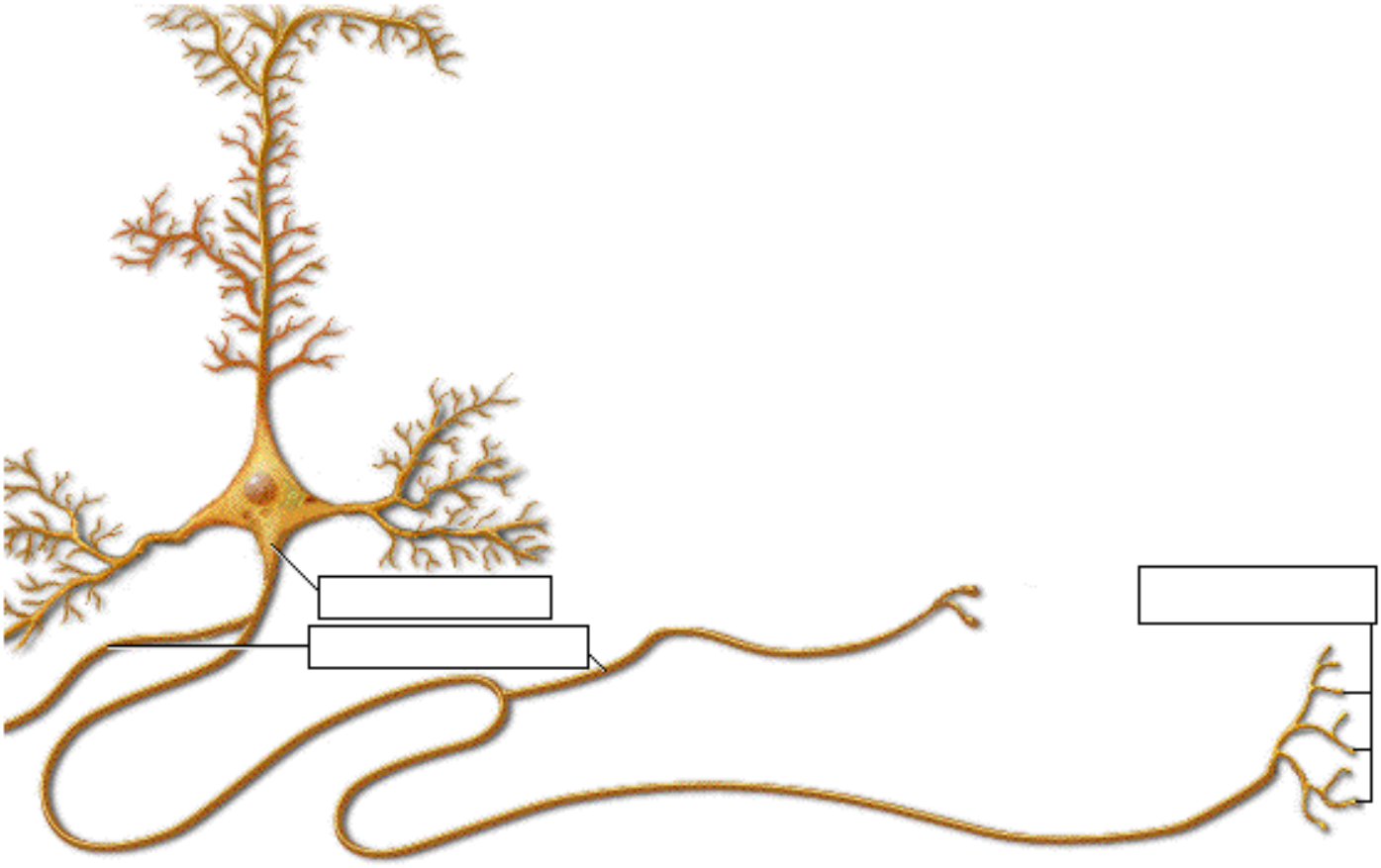
- The dendrites and cell body provide a large surface area for communication with other neurons.
- Signals from other neurons are received at synapses, the junctions between neurons.
- Label the synapse in this diagram:

Page 8. Axons Vary In Length

- Axons vary in length. They can be short, just 1 or 2 millimeters, communicating only with cells in their immediate vicinity. If a neuron has a cell body 50 microns in diameter, its axon would be only about 1 millimeter long.
- Axons can also be very long, more than a meter, and communicate over long distances. For example, the axon of some spinal cord neurons can reach all the way to the muscles of the big toe. In such neurons, the axon makes up most of the volume of the cell.
- In general, the longest axons are associated with the largest cell bodies.

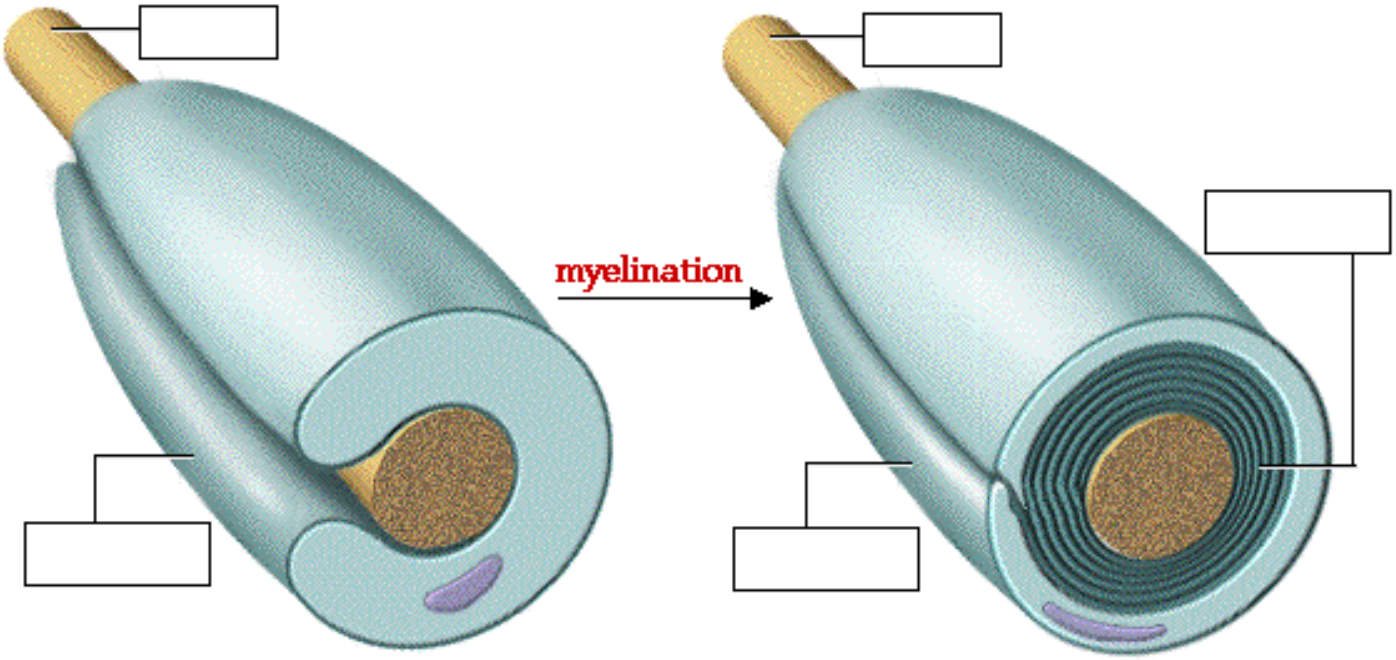
Page 9. Signals Are Sent Out Along The Axon

- Each neuron has a single axon, which arises from the cell body at a region called the axon hillock.
- Axons can branch, forming axon collaterals.
- At their terminal ends, axons can branch profusely, forming thousands of endings called axon terminals.
- The action potential, or outgoing signal, is generated at the axon hillock and conducted along the axon to the axon terminals.
- Label the diagram on the next page:



** Now is a good time to go to quiz questions 1-2:
- Click the Quiz button on the left side of the screen.
- Work through all parts of question 1 and question 2.
- After answering question 2, click the Back to Topic button on the left side of the screen.
- To get back to where you left off, click on the scrolling page list at the top of the screen and choose "10. Some Axons are Myelinated".

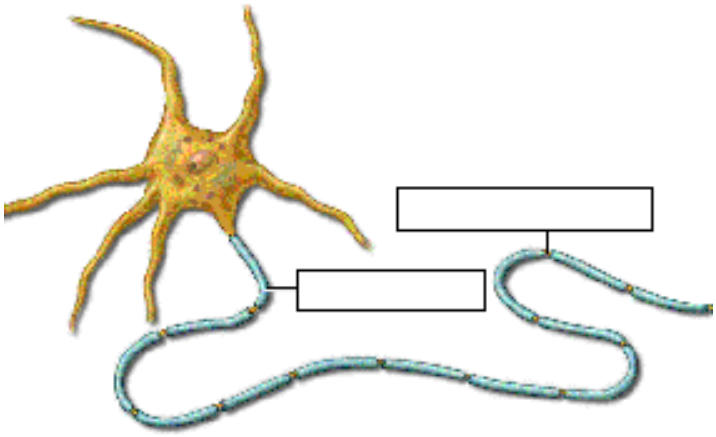
Page 10. Some Axons are Myelinated



- Some axons are covered with an insulating material called myelin sheath, which is produced by the support cells of the nervous system.
- Schwann cells are support cells in the peripheral nervous system which produce myelin.
- As a Schwann cell wraps around and around the axon in the process of myelination, its cytoplasm is squeezed out. The tightly wound cell membrane becomes the actual insulation.

Page 11. Many Schwann Cells Insulate An Axon

- Because Schwann cells are small compared to the length of an axon, it takes many of them to insulate a single axon.
- Neighboring Schwann cells do not touch each other, so there are gaps in the myelin sheath where the axon membrane is exposed to the extracellular space. These gaps, called the nodes of Ranvier, are essential for conduction of the action potential.
- Label this diagram:



Page 12. Summary

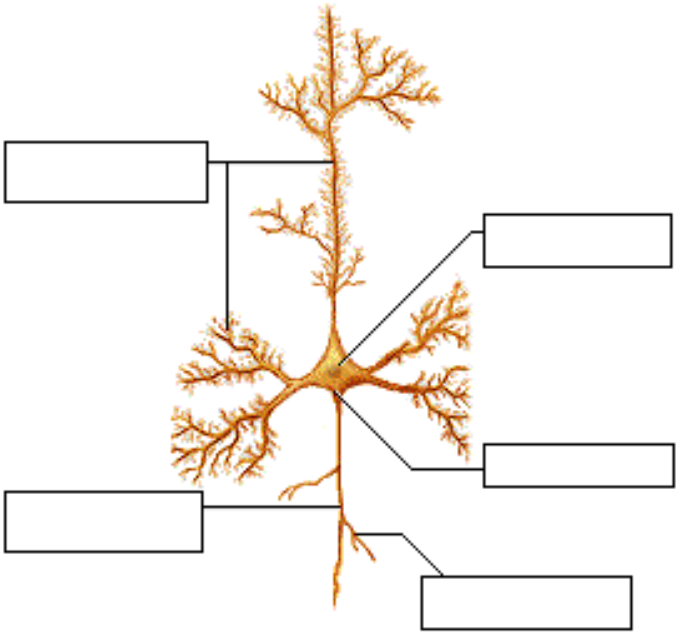
- Neurons have receptive and integrative regions, the dendrites and cell body, which receive and integrate incoming signals.
- Neurons also have a conductive region, the axon, which generates and transmits an outgoing signal.
- Axons vary in length from 1 or 2 millimeters to more than 1 meter.
- Some axons are insulated with myelin sheath.

** Now is a good time to go to quiz questions 3-4:
- Click the Quiz button on the left side of the screen.
- Click on the scrolling page list at the top of the screen and choose "3. The Truth About Dendrites".
- Work through quiz questions 3-4.

Notes on Quiz Questions:

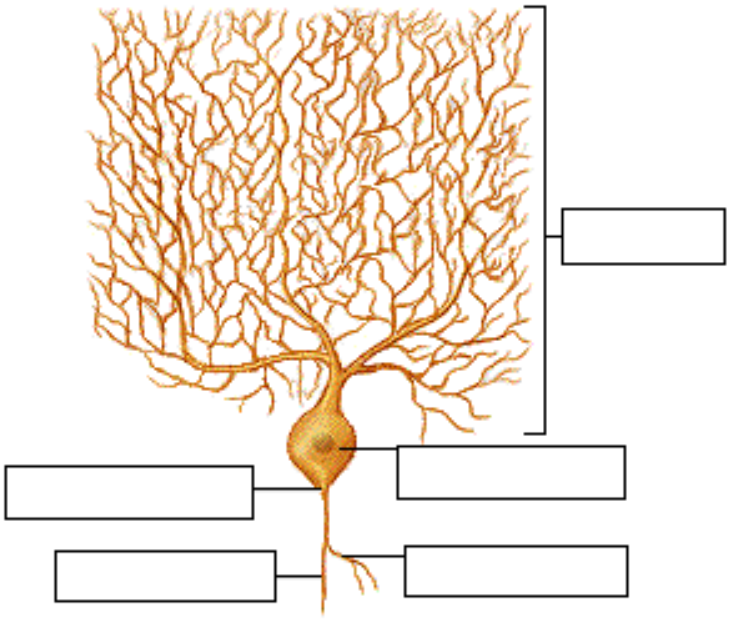
Quiz Question #1a: Parts of the Neuron: Pyramidal Cell

- This question asks you to label the parts of this neuron:



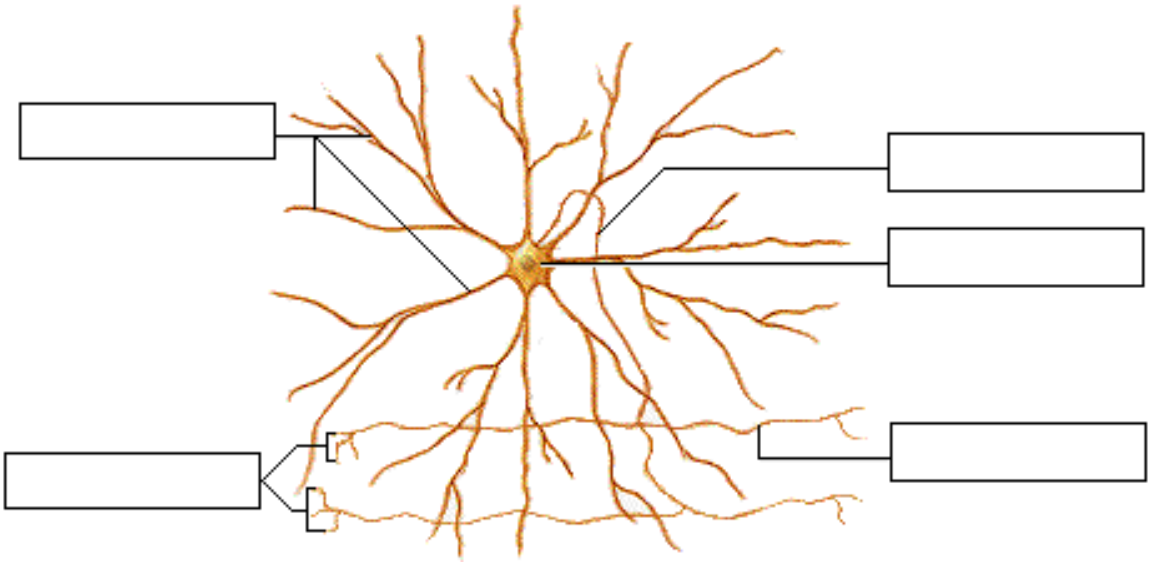
Quiz Question #1b: Parts of the Neuron: Purkinje Cell

- This question asks you to label the parts of this neuron:



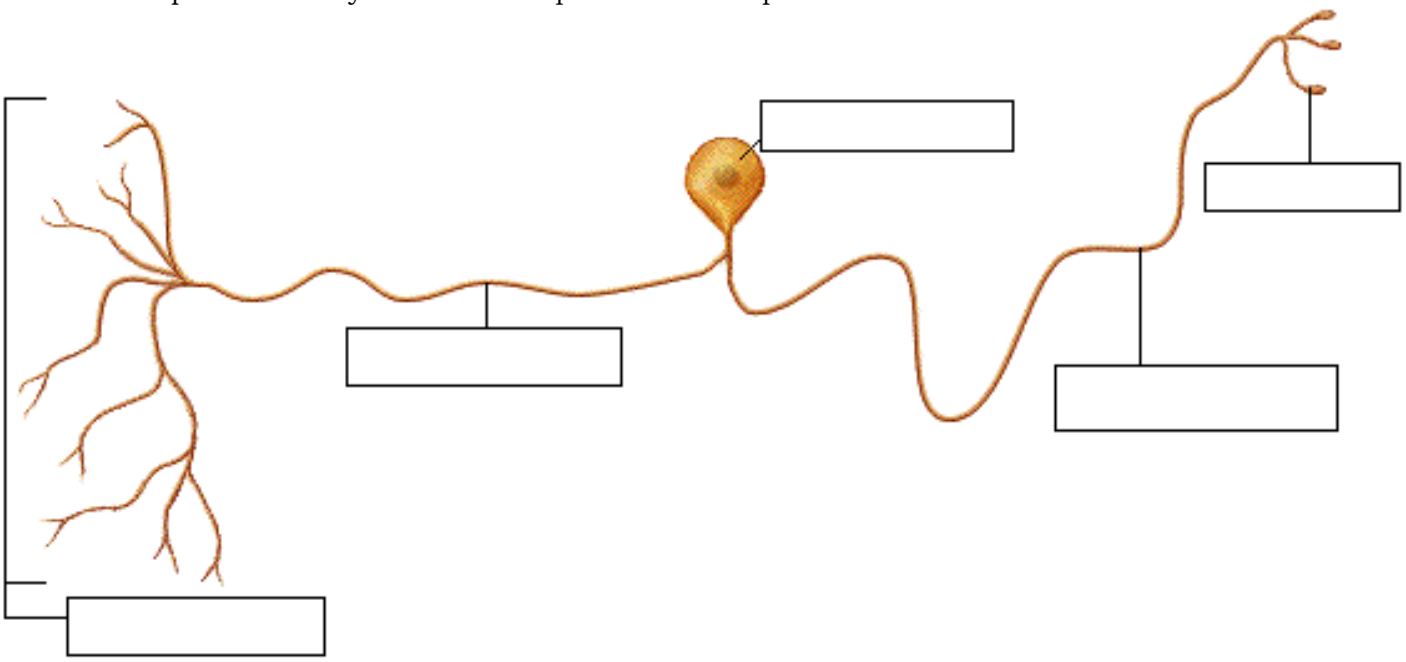
Quiz Question #1c: Parts of the Neuron: Unipolar Cell

- This question asks you to label the parts of this neuron:



Quiz Question #1d: Parts of the Neuron:

- This topic emphasizes multipolar neurons. The neuron on this screen is a unipolar neuron. This question asks you to label the parts of this unipolar neuron.



Quiz Question #2: Neuron Structure and Function

- This question asks you to associate various functions of neurons with the appropriate region of the neuron. It also allows you to identify the direction of information flow in and out of the neuron.

Quiz Question #3: The Truth About Dendrites

- This question asks you to choose the true statements about dendrites.

Quiz Question #4: The Truth About the Axon

- This question asks you to choose the true statements about axons.

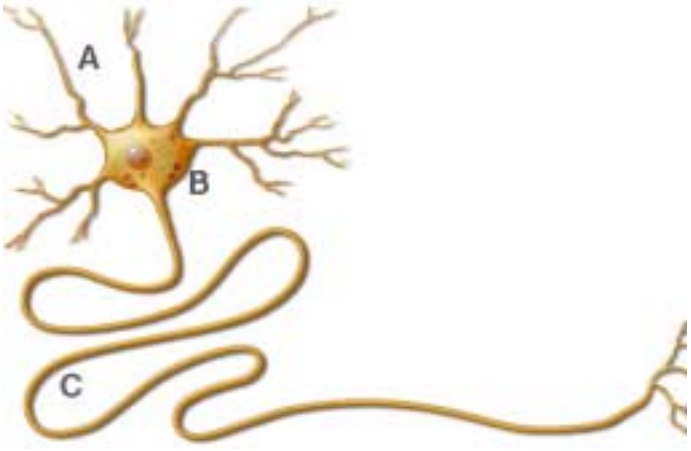
Study Questions on Anatomy Review:

1. (Page 3.) Give two reasons why neurons can communicate.

2. (Page 3.) What do neurons communicate with?

3. (Page 4.) What three characteristic structural features do all neurons have?

4. (Page 5.) How many dendrites and axons there on a multipolar neuron?
5. (Page 5.) Label the dendrites, cell bodies, and axons of this neuron:



6. (Page 5.) Tell if the following are characteristic of dendrites, cell bodies, and/or axons:
   a. Receptive and integrative region of the neuron.
   b. Receives signals from other cells and sends them toward the axon.
   c. Sum up, or integrate, the incoming signals.
   d. generates an action potential
   e. The main nutritional and metabolic region of the neuron.
   f. The transmitting or conductive region of the neuron.

7. (Page 6.) What are outgoing signals on neurons called?

8. (Page 6.) On what part of the neuron are action potentials conducted? In which direction do they go?

9. (Page 6.) How are action potentials generated?

10. (Page 7.) What are the junctions between neurons called?

11. (Page 8.) What is the relationship between the length of an axon and the size of its cell body?

12. (Page 9.) Label the diagram on p. 9.

13. (Page 9.) What terms are used for the following?
   a. The region of the cell body that the axon arises from.
   b. Branches of axons.
   c. Profuse branches at the end of axons.

14. (Page 9.) Describe where action potentials are generated and where they travel.

15. (Page 9.) Label the diagram associated with quiz question 1a.

16. (Page 9.) Label the diagram associated with quiz question 1b.

17. (Page 9.) Label the diagram associated with quiz question 1c.

18. (Page 9.) Label the diagram associated with quiz question 1d.

19. (Page 10.) Label the diagram on page 10.

20. (Page 10.) What terms are used to describe the following:
   a. The insulating material that some axons are covered with.
   b. support cells in the peripheral nervous system which produce myelin.
   c. The process of the formation of the myelin sheath.

21. (Page 10.) What is the myelin sheath made of in the peripheral nervous system?

22. (Page 11.) Label the diagram on p. 11.

23. (Page 11.) What are the gaps in the myelin sheath called?