

Chapter 11: Functional Organization of Nervous Tissue

I. Functions of the Nervous System

A. List and describe the five major nervous system functions:

1. _____

2. _____

3. _____

4. _____

5. _____

II. Divisions of the Nervous System

A. The Central Nervous System

1. What does the CNS consist of? _____ & _____
2. At what point are the two components of the CNS continuous? _____

B. The Peripheral Nervous System

1. What does the PNS consist of?
 - a. _____
 - b. _____
 - c. _____
 - d. _____
2. What are sensory receptors? _____ or _____

3. Where are sensory receptors located?
 - a. _____
 - b. _____
 - c. _____
 - d. _____
 - e. _____
4. What is a nerve? _____
5. Where do cranial nerves originate? _____
 - a. How many pairs of cranial nerves are there? _____
6. Where do spinal nerves originate? _____
 - a. There are how many pairs of spinal nerves? _____
7. A ganglion is a _____
8. What is a plexus? _____
9. Functionally the sensory or afferent division _____
 - a. The cell bodies of sensory neurons are located in:
 1. _____ or
 2. _____
10. Functionally the motor or efferent division _____
11. The motor division is divided into the:
 - a. _____ &
 - b. _____
12. What is a synapse? _____
13. The somatic nervous system transmits _____ from _____
to _____
 - a. Is this voluntary or involuntary (subconscious) control? _____
14. The autonomic nervous system transmits _____ from _____
to _____, _____, and _____
 - a. Is this voluntary or involuntary (subconscious) control? _____
15. The ANS is subdivided into the:
 - a. _____
 - b. _____

- c. _____
16. Functionally the sympathetic division: _____
17. Functionally the parasympathetic division: _____

18. The enteric nervous system consists of: _____
- a. Why is it considered to be part of the ANS? _____

III. Cells of the Nervous System

A. Neurons

1. Functionally neurons or nerve cells _____
2. Structurally neurons are organized _____
3. Each neuron consists of a:
 - a. _____ or _____
 - b. And two types of processes:
 1. _____
 2. _____
4. Neuron Cell Body
 - a. Contains normal cellular organelles including:
 1. Nucleus which is _____
 2. Extensive _____
 3. _____ apparatuses
 4. Moderate _____
 5. Randomly arranged _____ & _____
 - a. These increase as _____
 6. Large numbers of _____ & _____
 7. What are Nissl bodies? _____
5. Dendrites
 - a. Describe the structure of a dendrite _____

 - b. What are dendritic spines? _____

- c. When stimulated dendrites _____
6. Axons
- a. Describe the structure of an axon hillock? _____
 - 1. What arises at the axon hillock? _____
 - b. The beginning of an axon is called the _____
 - c. Branches of an axon are called _____ or _____
 - d. What is axoplasm? _____
 - e. What is an axolemma? _____
 - f. Enlarged structures on the terminal end of an axon are called _____ or _____
 - 1. These structures contain numerous _____
 - g. Functionally neurotransmitters _____
 - h. What is a trigger zone and what does it do? _____

B. Types of Neurons

- 1. Functional classification is based on the direction of action potentials:
 - a. Neurons that carry action potentials toward the CNS are _____
 - b. Neurons that carry action potentials away from the CNS to muscles or glands are _____ or _____
 - c. Neurons that carry action potentials within the CNS are _____ or _____
- 2. Structural classification is based on the number of processes:
 - a. Describe the structure of a multipolar neuron: _____
 - 1. Where would you find multipolar neurons? _____
 - b. Describe the structure of a bipolar neuron: _____
 - 1. Where would you find bipolar neurons? _____
 - c. Describe the structure of a unipolar neuron: _____

1. Where would you find unipolar neurons? _____

C. Neuroglia of the CNS

1. Astrocytes

a. Astrocytes are-star shaped because _____

b. What is a foot process? _____

c. What do foot processes cover?

1. _____

2. _____

3. _____

d. The extensive cytoskeleton of microfilaments allow them to _____

e. Functionally astrocytes play a role in _____

1. What is the blood-brain barrier? _____

2. Functionally the blood-brain barrier:

a. Protects _____

b. Allows _____

c. Prevents _____

3. Astrocytes also regulate the concentration of _____ & _____
and _____ & _____ neurotransmitters

2. Ependymal Cells

a. Where do you find ependymal cells? _____

b. What is a choroid plexus composed of? _____

1. Where would you find a choroid plexus? _____

c. Functionally a choroid plexus? _____

d. What do the cilia on ependymal cells do? _____

e. What do the long processes of ependymal cells do? _____

3. Microglia

a. Functionally microglia are _____ in the CNS

- b. In response to inflammation they become _____ & _____
 - 4. Oligodendrocytes
 - a. Oligodendrocytes have _____ that can _____ axons
 - b. If they wrap around axons many times it forms _____
 - c. One oligodendrocyte can form _____ axons
- D. Neuroglia of the PNS
 - 1. Schwann cells or neurolemmocytes _____ axons
 - a. If they wrap around the axon many times it forms _____
 - b. Each Schwann cell wraps around _____ axon
 - 2. Where are satellite cells found? _____
 - a. Functionally satellite cells _____
- E. Myelinated and Unmyelinated Axons
 - 1. Myelin _____ and _____ axons
 - 2. Action potentials travel fastest in _____
 - 3. Structurally how is a myelin sheath formed? _____

 - 4. What is the myelin sheath composed of? _____
 - 5. Interruptions in the myelin sheath are called _____
 - 6. The myelinated segments are known as _____
 - 7. How is an unmyelinated axon associated with an oligodendrocyte or a Schwann cell? _____

IV. Organization of Nervous Tissue

- A. White matter is composed of _____
 - 1. The white color is due to the presence of _____
- B. Gray matter is composed of _____
- C. What are nerve tracts? _____
- D. Functionally the gray matter of the CNS _____

9. Gated Ion Channels

- a. Open and close in response to _____
- b. Opening and closing changes the _____ of the membrane
- c. Ligand-gated ion channels open or close in response to _____

 - 1. What is a ligand? _____
 - 2. What is a receptor? _____
- d. What four substances do ligand-gated ion channels exist for?
 - 1. _____ 2. _____ 3. _____ 4. _____
- e. Voltage-gated ion channels open and close in response to _____

 - f. What three substances do voltage-gated ion channels exist for?
 - 1. _____ 2. _____ 3. _____
 - g. Other-gated ion channels respond to stimuli such as:
 - 1. _____ of the skin in touch receptors
 - 2. _____ changes in the skin

B. The Resting Membrane Potential

- 1. What is the potential difference? _____
- 2. In skeletal muscle fibers and nerve cells the potential difference is equal to _____
 - a. Why is this reported as a negative number? _____
 - b. What does "resting membrane potential" refer to? _____
- 3. Establishing the Resting Membrane Potential
 - a. The resting membrane potential results from the:
 - 1. Permeability _____ &
 - 2. Difference _____
 - b. Why is the membrane permeable to K^+ ? _____

 - c. Why do K^+ move through the membrane? _____
 - d. What is too big to move through the membrane? _____

- e. Together the movement of K^+ and the ions that do not move make the membrane _____ inside the cell and _____ outside the cell
- f. Why is the resting membrane potential at equilibrium? _____

- g. What other ions have a small influence on the resting membrane potential? 1. _____ 2. _____ 3. _____
- h. Why does K^+ play the major role? _____

- i. What mechanism keeps the concentration of Na^+ high outside the cell and the concentration of K^+ high inside the cell? _____
1. Does this play a role in the resting membrane potential? _____

C. Local Potentials

- 1. What is a local potential? _____
- 2. Local potentials can result from:
 - a. _____
 - b. _____
 - c. _____
 - d. _____
 - e. _____
- 3. The change in the membrane may be depolarization or hyperpolarization:
 - a. If a stimulus opens Na^+ channels _____
 - b. If a stimulus opens K^+ channels _____
- 4. Why are local potentials referred to as "graded"? _____

- 5. What happens when local potentials "summate"? _____

- 6. What happens to the intensity of a local potential as it spreads? _____

D. Action Potentials

- 1. What is a threshold level? _____

2. An action potential is _____

3. For each of the following indicate if they may generate an action potential:
 - a. Depolarizing local potentials _____
 - b. Hyperpolarizing local potentials _____
 - c. Small local potentials _____
 - d. Large local potentials _____
4. Describe what is meant by the "all" part of the all-or-none principle: _____

5. Describe what is meant by the "none" part of the all-or-none principle: _____

6. Depolarization Phase
 - a. List the events that occur after a threshold depolarization is reached:
 1. Many _____
 2. Na^+ _____
 3. Resulting _____
 4. More _____
 5. Causing _____
 6. In turn _____
 - a. This is a _____ feedback cycle that continues until

 - b. When the plasma membrane is at rest:
 1. Which gate on the voltage-gated Na^+ channel is closed? _____
 2. Which gate on the voltage-gated Na^+ channel is open? _____
 - c. When threshold is reached the _____ to open and allows _____ into the cell
 - d. When the plasma membrane is at rest voltage-gated K^+ channels are _____
 - e. When threshold is reached the voltage-gated K^+ channels begin to _____
 1. But because the channels open _____ little K^+ moves out of cell

7. Repolarization Phase

a. List the events that occur at maximum depolarization:

1. Change in _____
 2. Causes _____
 - a. So the permeability _____
 3. Voltage-gated K^+ channels continue _____
 4. As a result the membrane permeability to:
 - a. _____ decreases
 - b. _____ increases
 5. The decreased diffusion of _____ and increased diffusion of _____ causes repolarization
- b. At the end of repolarization the voltage-gated Na^+ channels are returned to their resting state by:
1. Closing _____
 2. Opening _____

8. Afterpotential (Hyperpolarization)

- a. What causes the afterpotential? _____

- b. All the action potentials produced by a cell are identical because they all:
1. Take _____
 2. Exhibit _____

E. Refractory Period

1. What is the refractory period? _____

2. The absolute refractory period is:
 - a. From _____
 - b. Until _____
3. The absolute refractory period guarantees that:
 - a. Once an action potential is begun _____
 - b. A strong stimulus cannot _____
4. The relative refractory period follows _____

5. During the relative refractory period an action potential can be initiated by _____

F. Action Potential Frequency

1. The action potential frequency is _____

2. How many action potentials will each of the following stimuli produce:

a. Subthreshold stimulus _____

b. Threshold stimulus _____

c. Maximal stimulus _____

3. Submaximal stimulus includes all stimuli between _____ & _____

4. What is a supramaximal stimulus? _____

5. What determines the maximum frequency of action potentials in a cell? _____

6. Frequency of action potentials provides information about stimulus strength:

a. A weak stimulus generates _____

b. A strong stimulus generates _____

7. Is there a difference in the magnitude of action potentials produced by weak or strong stimuli? _____

8. Frequency of action potentials determines response of muscle or gland:

a. Less secretion or contraction is stimulated by _____

b. More secretion or contraction is stimulated by _____

G. Propagation of Action Potentials

1. Propagate refers to the spread _____

a. This is accomplished because an action potential at one location _____

2. In an unmyelinated axon, when an action potential is produced:

a. Inside of the membrane _____

b. On the outside positively _____

c. On the inside positively _____

1. The movement of positively charged ions is called _____

2. As a result of the ion movement the membrane immediately adjacent to the action potential is _____

- a. When it reaches threshold an _____
3. In a myelinated axon, an action potential is conducted from _____ to _____ in a process called _____
- a. The lipids of the myelin sheath act as _____
- b. An action potential at one node of Ranvier generates local currents that _____
4. Action potentials travel faster in myelinated axons because:
- a. They are formed _____
- b. Instead of being _____
5. Does an action potential move faster through a large-diameter axon or a small-diameter axon? _____
6. Complete the following data table:

Nerve Fiber	Diameter	Myelination	Speed
Type A			
Type B			
Type C			

7. Type A fibers are used for _____
8. Type B and C fibers are used for _____

VI. The Synapse

A. Terminology

1. What is a synapse? _____
2. Define presynaptic cell: _____
3. Define postsynaptic cell: _____

B. Electrical Synapses

1. Electrical synapses are gap junctions that allow _____
- _____
2. What are connexons? _____
3. Movement of ions through the connexons can _____
- a. Therefore an action potential in one cell _____

4. Where would you find electrical synapses?

a. _____

b. _____

C. Chemical Synapses

1. Describe the three essential components of a chemical synapse:

a. Presynaptic terminal _____

b. Synaptic cleft _____

c. Postsynaptic membrane _____

1. These are typically _____, _____, or _____

2. Neurotransmitter Release

a. List the events that occur when an action potential arrives at the presynaptic terminal:

1. Voltage- _____

2. Ca^{2+} _____

3. Synaptic vesicles _____

4. Release _____

b. When neurotransmitters are released:

1. Diffuse _____

2. Bind _____

c. Depending on the receptor, the binding produces:

1. _____ or

2. _____

3. Neurotransmitter Removal

a. There are three primary methods of removing neurotransmitter:

1. Neurotransmitter is broken down by _____

a. An example of this is acetylcholine being broken down by

2. Neurotransmitter is actively transported _____

and repackaged into _____

3. Diffusion of neurotransmitter molecules _____

and into _____

4. Receptor Molecules in Synapses

a. Receptor molecules in synapses are:

1. Membrane _____
2. Ligand _____
3. Highly _____

b. How many different neurotransmitters can bind to one type of receptor?
_____ Why? _____

c. Neurotransmitters only affect cells _____

d. Different types of receptors for the same neurotransmitter results in

- _____
1. One type of norepinephrine receptor will cause _____
 2. Another type of norepinephrine receptor will cause _____

5. Neurotransmitters and Neuromodulators

a. Some neurons can secrete more than one type of _____

1. The physiological significance is _____

b. What is the function of a neuromodulator? _____

6. Excitatory and Inhibitory Postsynaptic Potentials

a. What is an excitatory postsynaptic potential? _____

b. EPSP's are important because _____

c. What is an excitatory neuron? _____

d. Generally an EPSP occurs because of an increase _____

e. What is an inhibitory postsynaptic potential? _____

f. IPSP's are important because _____

g. What is an inhibitory neuron? _____

h. An IPSP occurs because of an increase _____

7. Presynaptic Inhibition and Facilitation

- a. What is an axoaxonic synapse? _____
- b. Neuromodulators released in an axoaxonic synapse can alter _____

- c. In presynaptic inhibition _____

- d. Functionally endorphins inhibit neurons by _____
 - 1. This prevents _____
- e. In presynaptic facilitation _____

D. Spatial and Temporal Summation

- 1. A single presynaptic action potential does not reach _____
and produce an _____ in the postsynaptic membrane.
- 2. What is summation? _____

- 3. What is the trigger zone? _____
- 4. The concentration of Na⁺ channels at the trigger zone is _____
- 5. Spatial summation occurs when two action potentials arrive _____
at _____ that synapse with _____
 - a. The local depolarizations in the postsynaptic neuron summate at the
_____ and if it reaches threshold _____
- 6. Temporal summation occurs when two or more action potentials arrive _____
_____ at a single presynaptic terminal
 - a. Although local depolarizations are short lived if the action potentials arrive
close enough together they can _____
 - b. If the summated local depolarization reaches _____ at the
_____ then _____ in the postsynaptic neuron
- 7. If a postsynaptic neuron is receiving EPSP's and IPSP's at the same time
what determines if an action potential will be created in the postsynaptic
neuron? _____

VII. Neuronal Pathways and Circuits

- A. In convergent pathways _____
1. If some presynaptic neurons are inhibitory and some are excitatory _____

- B. In divergent pathways _____
1. Describe the simplest divergent pathway _____

- C. Oscillating circuits have neurons arranged in _____
1. This allows _____
 - a. This response is called _____
 2. Oscillating circuits are similar to _____
 3. What causes an oscillating circuit to stop?
 - a. _____ or
 - b. _____