# Anatomy Review:
# Synaptic Potentials and Neurotransmitters



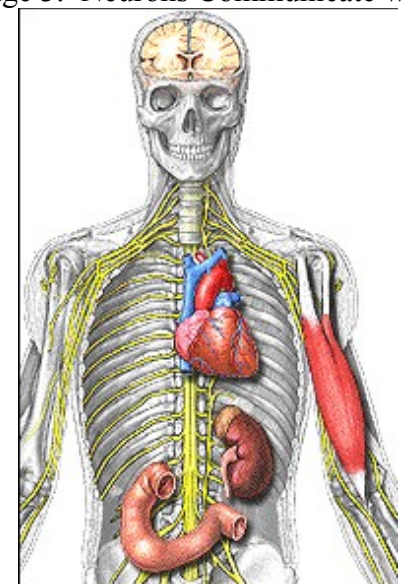
**Page 1. Introduction**

- Neurons communicate with other cells at junctions called synapses.
- Neurons form synapses with muscles, glands, and other neurons.

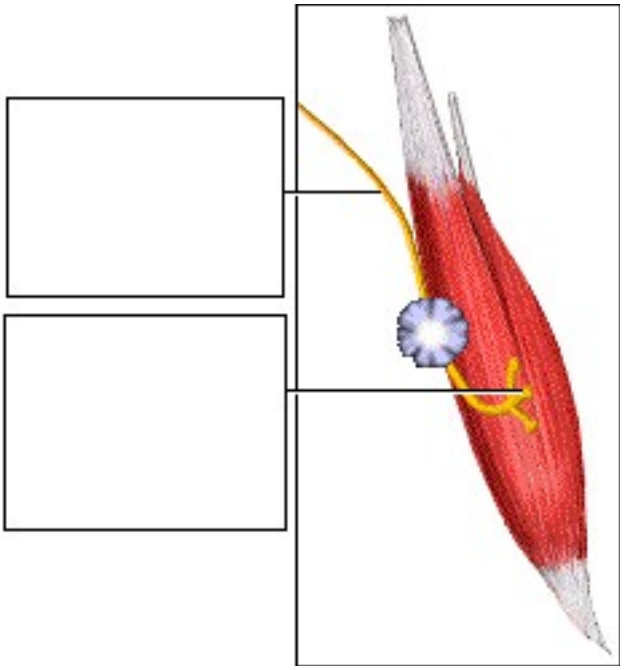
**Page 2. Goals**

- To learn that neurons synapse with muscle cells. gland cells, and each other.
- To know that there are both electrical and chemical synapses.
- To understand the structural components of a chemical synapse.

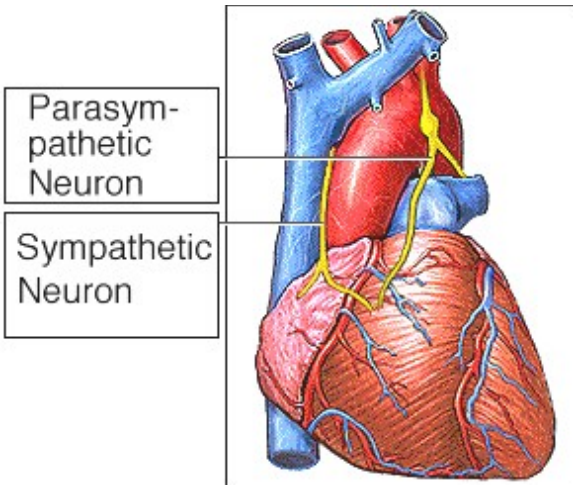
Page 3. Neurons Communicate with Effector Organs at Synapses



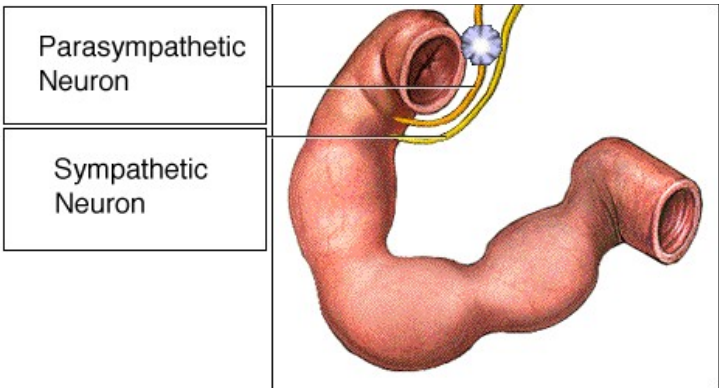
- Skeletal muscle is activated by neurons of the somatic nervous system.
- Cardiac muscle, smooth muscle, and glands receive signals from neurons of the autonomic nervous system.



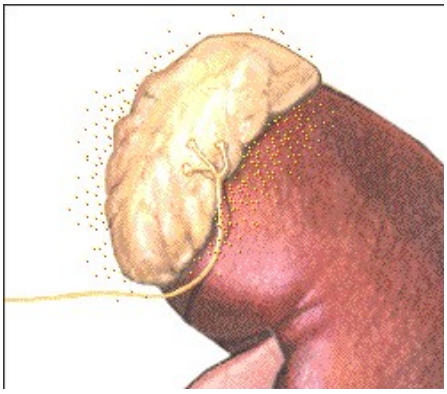
- Somatic motor neurons from the central nervous system project directly to skeletal muscle.
- A synapse between a somatic motor neuron and a skeletal muscle fiber is called a neuromuscular junction.
- When an action potential arrives at a neuromuscular junction, it initiates a series of events which excite the underlying muscle fiber, causing it to contract.




- Signals in the autonomic nervous system travel over a two-neuron chain to their effector organ.
- The second neuron, or autonomic motor neuron, contacts the organ.
- Signals from some autonomic motor neurons cause the heart rate to increase.
- Signals from other neurons slow the heart.
- Action potentials to the heart may excite or inhibit it.

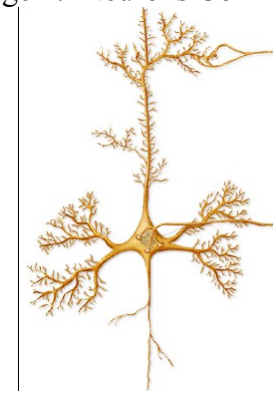



- Signals from some autonomic motor neurons cause smooth muscle to contract.
- Signals from other neurons cause smooth muscle contractions to slow or stop.
- Action potentials to smooth muscle may excite or inhibit it.



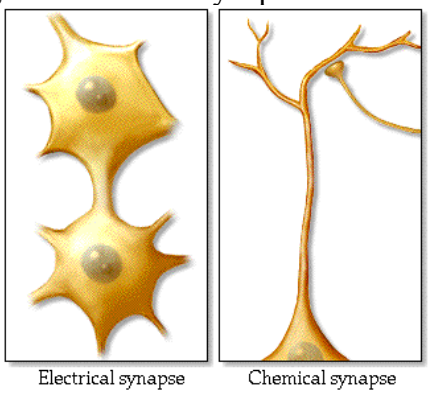
- Signals from the central nervous system can cause glands to secrete.

Page 4. Neurons Communicate with Other Neurons

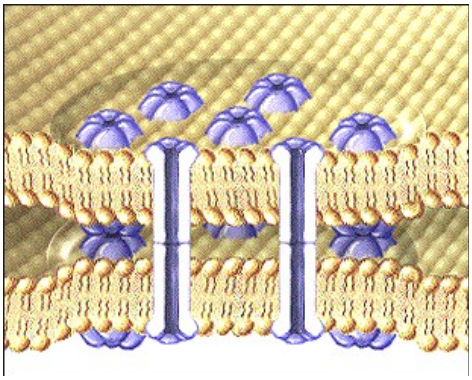


- In addition to sending signals to effector organs, neurons send signals to each other.
- Neurons can excite or inhibit other neurons.
- The neuron that synapses on the dendrites of this cell excites it and causes it to generate an action potential.
- In this case, the neuron synapsing on the soma inhibits the cell and prevents it from generating an action potential.

Page 5. Electrical Synapses

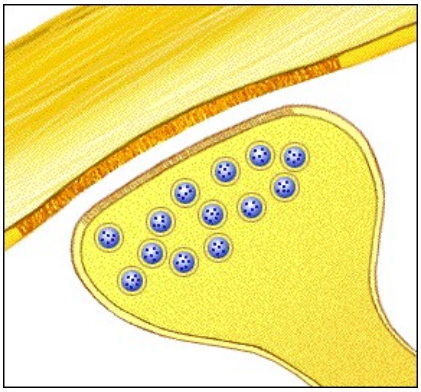



- There are two types of synapses, electrical and chemical. Both are found in similar locations on neurons.
- These neurons depolarize and generate action potentials simultaneously.



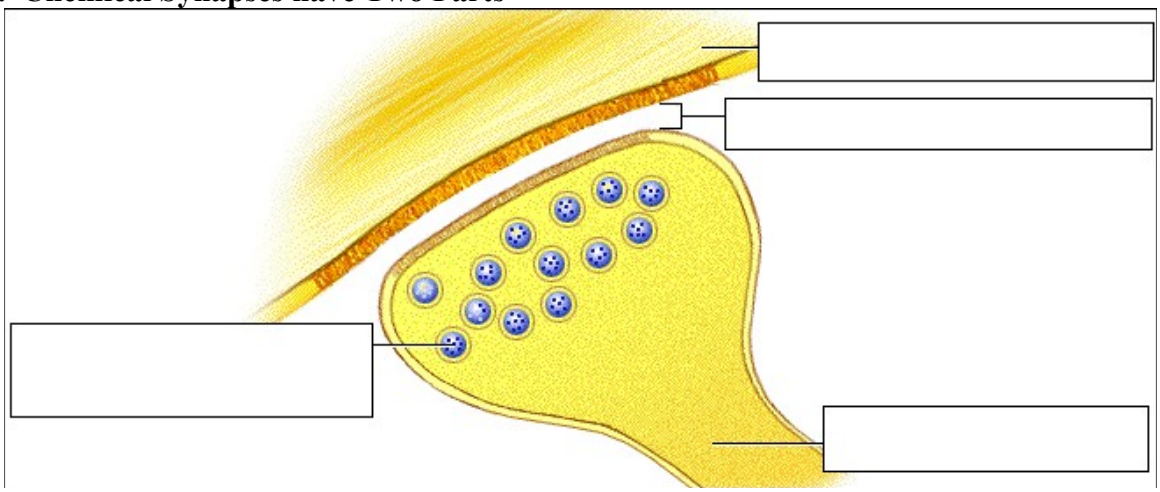
- When one neuron forms a gap junction with another neuron, an electrical synapse is made.
- Electrical current, in the form of ions, flows directly from one neuron to the other through the gap junction.
- These synapses are always excitatory.
- Electrical synapses have these advantages:
  - fast signal transmission between neurons
  - and signal transmission to a group of electrically coupled neurons can synchronize their activity.

Page 6. Chemical Synapses

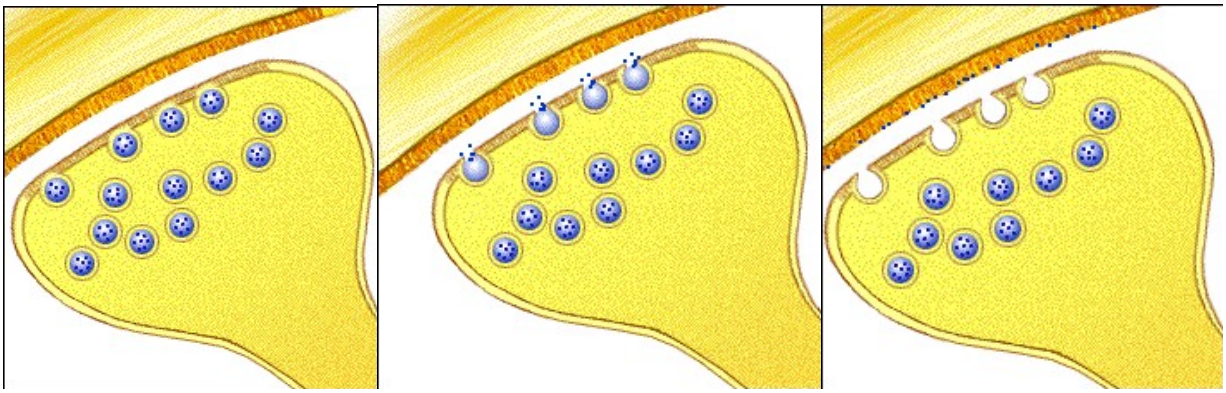


- At a chemical synapse, neuronal membranes are separated by a gap called the synaptic cleft.
- Electrical current cannot flow directly from one neuron to the other.
- A chemical, called a neurotransmitter, is released from the sending axon and carries the signal to the next neuron.
- Chemical synapses transmit signals more slowly than electrical synapses but the signal may be either excitatory or inhibitory, and the signal can be modified as it passes from one neuron to the next.
- Chemical synapses are the most common type of synapse, and they are associated with the most complex human behaviors, including learning and memory.

**Page 7. Chemical Synapses have Two Parts**



- Chemical synapses have two parts: an axon terminal of one neuron, and the cell membrane of another neuron.
- The neuron conducting an action potential toward the synapse is called the presynaptic neuron.
- The axon terminal of the presynaptic neuron contains membranous sacs called synaptic vesicles which are filled with neurotransmitter.
- The gap separating the cells is the synaptic cleft.
- The presynaptic and postsynaptic neurons are separated by a gap of 30 - 50 nanometers.
- An action potential that reaches the axon terminal causes synaptic vesicles to fuse with it, releasing neurotransmitter into the synaptic cleft.
- The neurotransmitter then diffuses across the synaptic cleft and binds to receptors on the postsynaptic neuron.



- The neuron receiving the signal is called the postsynaptic neuron.
- When activated, receptors on the postsynaptic neuron open ion channels.
- The movement of ions across the neuronal membrane creates an electrical signal called a synaptic potential.
- Synaptic potentials vary in amplitude and travel only a short distance.
- Thus they are very different from action potentials.

**Page 8. Summary**

- Neurons communicate with muscles, glands, or other neurons at junctions called synapses.
- Electrical synapses are rapid, excitatory only, and can synchronize the activity of postsynaptic cells. Chemical synapses are slower, may be excitatory or inhibitory, and are more flexible than electrical synapses.

- The presynaptic neuron and postsynaptic neuron, separated by the synaptic cleft, make up a chemical synapse.

## Notes on Quiz Questions:

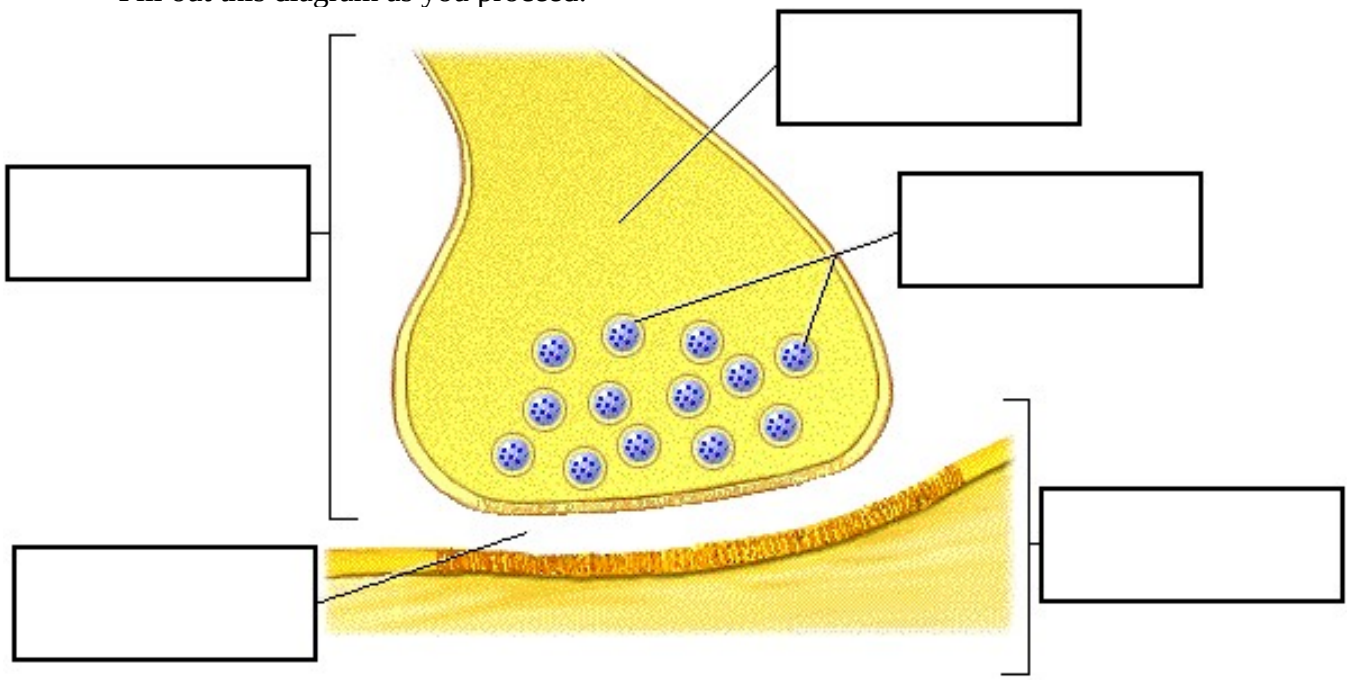
**Quiz Question #1: Characteristics of Synapses**

- This question asks you to determine differences between electrical and chemical synapses.
- Fill out this diagram as you proceed:

| | SPEED | CHARACTERISTICS |
|---|---|---|
| ELECTRICAL SYNAPSES | | |
| CHEMICAL SYNAPSES | | |

**Quiz Question #2: The Chemical Synapses**

- This question asks you to label the parts of a chemical synapse.
- Fill out this diagram as you proceed:



## Study Questions on Anatomy Review:

1. (Page 1.) Neurons communicate with other cells at junctions called _____.
   a. neurotransmitters b. synapses c. autonomic nervous system

2. (Page 1.) Neurons form synapses with _____, _____, and _____ _____.
   a. muscles b. glands c. neurons
   d. glands, and other neurons e. muscles, glands, and other neurons

3. (Page 3.) Skeletal muscle is activated by neurons of the _____ _____ _____.
   a. somatic nervous system b. autonomic nervous system

4. (Page 3.) Cardiac muscle, smooth muscle, and glands receive signals from neurons of the _____ _____ _____.
   a. somatic nervous system b. autonomic nervous system

5. (Page 3.) A synapse between a somatic motor neuron and a skeletal muscle fiber is called a _____ _____.
   a. neuroglandular junction b. neuromuscular junction

6. (Page 3.) When an action potential arrives at a neuromuscular junction, it initiates a series of events which excite the underlying muscle fiber, causing it to _____.
   a. secrete b. contract c. relax

7. (Page 3.) Label the diagram on page 3.

8. (Page 3.) Signals in the autonomic nervous system travel over a ____ _____ _____ to their effector organ. The second neuron, or autonomic motor neuron, contacts the organ.
   a. one neuron chain b. two neuron chain c. three neuron chain

9. (Page 3.) Signals from some autonomic motor neurons cause the heart rate to _____.
   a. increase b. decrease c. stay constant

10. (Page 3.) Signals from some neurons _____ or _____ cause the heart rate to contract.
    a. slow or stop b. increase or speed up c. stay constant

11. Signals from some autonomic motor neurons cause smooth muscle to _____. Signals from other neurons cause smooth muscle contractions to _____ or _____.
    a. contract, slow or stop b. relax, slow or stop

12. (Page 3.) Action potentials to smooth muscle may _____ or _____ ____.
    a. activate or deactivate it b. excite or inhibit it

13. (Page 3.) Signals from the central nervous system can cause glands to _____.
    a. stop secreting b. secrete

14. (Page 4.) In addition to sending signals to _____ _____, neurons send signals to each other.
    a. effector organs b. various tissues

15. (Page 4.) Neurons can excite or inhibit other _____.

a. glands b. muscles c. neurons

16. (Page 4.) The neuron that synapses on the dendrites of this cell excites it and causes it to generate an _____ _____.
a. action potential b. synaptic potential

17. (Page 4.) The neuron synapsing on the soma inhibits the cell and prevents it from generating an _____ _____.
a. action potential b. synaptic potential

18. (Page 5.) There are two major types of synapses, _____ and _____.

19. (Page 5.) Electrical synapses depolarize and generate action potentials simultaneously. When one neuron forms a gap junction with another neuron, an _____ _____ is made.
a. chemical synapse b. electrical synapse

20. (Page 5.) Electrical current, in the form of ions, flows directly from one neuron to the other through the _____ _____.
a. tight junction b. gap junction

21. (Page 5.) Electrical synapses are always _____.
a. inhibitory b. excitatory

22. (Page 5.) Electrical synapses have two advantages. List these advantages.

23. (Page 6.) At a chemical synapse, neuronal membranes are separated by a gap called the _____ _____.
a. synaptic cleft b. presynaptic neuron c. postsynaptic neuron

24. (Page 6.) Electrical current cannot flow directly from one neuron to the other. A chemical, called a _____, is released from the sending axon and carries the signal to the next neuron.
a. synapse b. ion c. neurotransmitter

25. (Page 6.) Chemical synapses transmit signals more slowly than _____ _____ but the signal may be either _____ or _____, and the signal can be modified as it passes from one neuron to the next.
a. electrical synapses, excitatory, inhibitory b. chemical synapses, excitatory, inhibitory

26. (Page 6.) Chemical synapses are the most common type of _____, and they are associated with the most complex human behaviors, including _____ and _____.
a. synapse, learning and memory b. junction, learning and memory

27. (Page 7.) Label the diagram on page 7.

28. (Page 7.) What are the two parts of a chemical synapse?

29. (Page 7.) The neuron conducting an action potential toward the synapse is called the _____ _____ .
a. presynaptic neuron b. postsynaptic neuron

30. (Page 7.) The axon terminal of the presynaptic neuron contains membranous sacs called _____ _____ which are filled with _____.
a. axon terminal, synaptic vesicles b. synaptic vesicles, neurotransmitter

31. (Page 7.) The gap separating the cells is called the _____ _____.

a. synaptic cleft b. presynaptic neuron c. postsynaptic neuron

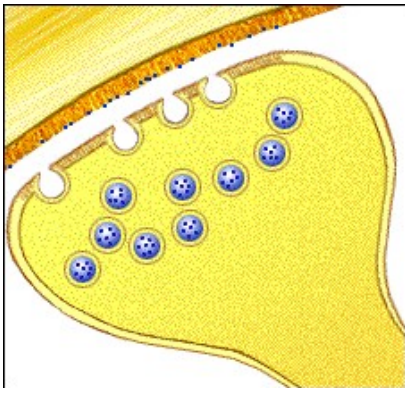
32. (Page 7.) An action potential that reaches the axon terminal causes synaptic vesicles, to fuse with it, releasing _____ into the _____ _____.
a. acetyl choline, postsynaptic neuron b. neurotransmitter, synaptic cleft

33. (Page 7.) The neuron receiving the signal is called the postsynaptic neuron. When activated, receptors on the postsynaptic neuron open ____ _____.
a. ion channels b. voltage-gated receptors c. passive channels

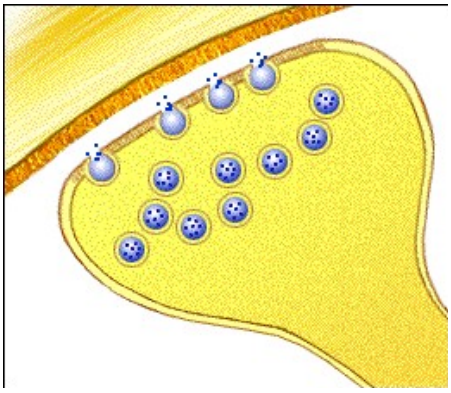
34. (Page 7.) The movement of ions across the neuronal membrane creates an electrical signal called a _____ _____. _____ _____ vary in amplitude and travel only a short distance. Thus they are very different from action potentials.
a. synaptic potential, Synaptic potential b. action potential, action potential

35. (Page 7.) Place the following pictures in the order they belong in.

a.



b.



c.