9.01 Introduction to Neuroscience
Fall 2007

9.01 Recitation (R02)

RECITATION #3: Tuesday, September 25th

Review of Lecture: 5 (some overlap with 6)
Reading: Chapter 5 of *Neuroscience: Exploring the Brain (3rd edition)*

Outline of Recitation:

I. Previous Recitation:
   a. Finish material from last recitation
   b. Questions on practice exam questions from last recitation?
   c. Questions on previous problem set?
II. Review of Material:
   a. ELECTRICAL SYNAPSE
   b. CHEMICAL SYNAPSE
   c. SYNAPTIC INTEGRATION
III. Practice Exam Questions

Synaptic transmission: the process of information transfer at a synapse

ELECTRICAL SYNAPSES:
Electrical synapses occur at specialized sites called _____.

CHEMICAL SYNAPSES:
History: In the 1920s, Otto Loewi conducted the following experiment that showed synaptic transmission between nerve and heart is chemically mediated (p. 103):

Structure:

Process of Transmission:

Presynaptic cell:
1. Neurotransmitter synthesis
2. Neurotransmitter packaged in vesicles
3. Action potential arrives in terminal and voltage-gated Ca^{2+} channels open
4. In response to increased [Ca^{2+}], synaptic vesicles fuse to membrane and neurotransmitters are released into synaptic cleft
5. Vesicle membrane is recycled and reenters the cycle of transmission

Postsynaptic cell:
6. Neurotransmitters diffuse across cleft
7. Binds to postsynaptic receptors
8. Transmitter is enzymatically destroyed and reuptake occurs

1. Neurotransmitter synthesis

Three types of transmitters:

Amino Acids | Amines | Peptides

* For synthesis of each transmitter, refer to page 143-147.

2. Neurotransmitter packaged in vesicles (p. 113)

Amino Acids and Amines packaging:

Peptides packaging:

3. **Action potential arrives in terminal and voltage-gated Ca^{2+} channels open**
4. **In response to increased [Ca^{2+}], synaptic vesicles fuse to membrane and neurotransmitters are released into synaptic cleft** (p. 113-115)
5. **Vesicle membrane is recycled and reenters the cycle of transmission**

*More info on SNAREs on page 116.

6. **Neurotransmitters diffuse across cleft**
7. **Binds to postsynaptic receptors** (p.115-119)

Transmitter-gated ion channel:

Metabotropic “G-protein-coupled” receptors:

8. Transmitter is enzymatically destroyed or reuptake occurs (p. 119-120)
Neurotransmitters must be cleared from the synaptic cleft to allow another round of synaptic transmission by:

SYNAPTIC INTEGRATION:
Synaptic integration is the process by which multiple synaptic potentials combine with one postsynaptic neuron.

EPSP: Excitatory Postsynaptic Potential
- Influx of _____ in postsynaptic cell

IPSP: Inhibitory Postsynaptic Potential
- Influx of _____ in postsynaptic cell

Integration of EPSP:
- Postsynaptic EPSPs are a given synapse are quantized

Spatial summation:

Temporal summation:

Dendritic Properties of Integration: (p. 125)

$V_X = V_O/e^{x/\lambda}$

V_O = depolarization at the origin
x = distance from the synapse
$V_\lambda = 0.37\ V_O$

Shunting Inhibition:
Inward movement of negatively charged chloride ions = outward positive current flow

PRACTICE EXAM PROBLEMS: From Brown Exam I (2005)

23. Gap Junctions:
a) transform electrical signals into chemical signals
b) are more common in neurons than glial cells
c) let electrical signals pass through, but block the flow of ions
d) all of the above
e) none of the above

24. If a neuron did not have vesicular transporters, synaptic vesicles could not be loaded and therefore
a) the neuron could NOT fire action potentials or release neurotransmitters
b) the neuron could fire action potentials, but NOT release neurotransmitters
c) the neuron could NOT fire action potentials, but could still release neurotransmitters
d) the neuron would still be able to fire action potentials and release neurotransmitters

25. Which of the following are characteristics of peptide neurotransmitters?
a) They are stored in dense core vesicles
b) They are synthesized in the soma
c) They are not released as quickly as amino acid neurotransmitters
d) All of the above
e) None of the above

26. All of the following are criteria for classifying a molecule as a neurotransmitter EXCEPT:
a) It is synthesized and stored in neurons
b) It is released when the presynaptic cell is stimulated
c) It is the only molecule released at the synapse
d) It always evokes the same post-synaptic response
e) It is degraded or removed from the synapse

27. Feedback inhibition in the synthesis of the neurotransmitter norepinephrine:
a) opposes the action of end product inhibition
b) modulates the activity of the rate limiting enzyme, tyrosine hydroxylase
c) is higher if the neuron is more active
d) blocks the production of epinephrine from norepinephrine
e) is an exception to Dale's principle

28. All of the following statements about presynaptic Ca^{++} action are correct EXCEPT:
a) the terminal bouton has a high concentration of Ca^{++} channels
b) Ca^{++} channels open when the membrane depolarizes
c) the Ca^{++} concentration is higher inside than outside the cell membrane
d) Ca^{++} binds to synaptotagmin and consequently SNARES pull vesicles to fuse with the membran
e) with catecholamine neurotransmitters, the Ca^{++} channels are next to presynaptic vesicle docking locations

29. In discovering vagusstoff, Otto Loewi demonstrated that:
a) the vagus nerve releases GABA when stimulated
b) there are exceptions to Dale's principle
c) nerve stimulation causes the release of a chemical transmitter
d) a single neurotransmitter can be both excitatory and inhibitory
e) Kermit has a big loving heart

Answers:

23. a b c d (e)

24. a (b) c d

25. a b c (d) e

26. a b (c) d e

27. a (b) c d e

28. a b (c) d e

29. a b (c) d e