

SYNAPSES AND SYNAPTIC TRANSMISSION

Done by:

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Objective Summary: Quick Review

❖ Define synapses ?

A junction where the axon or some other portion of one cell (= presynaptic cell) terminates on the dendrites, soma, or axon of another neuron (postsynaptic cell).

❖ Structure of synapses

1. **Synaptic cleft (gap)** : space between the axon terminal and sarcolemma.
2. **Synaptic knobs** (presynaptic terminal).
3. **postsynaptic** : it has receptors for neurotransmitters or ion channel.

❖ Types of synapses

- **Anatomical:** Axodendritic – Axosomatic – Axoaxonic – Dendrodendritic – Dendrosomatic.
- **Functional:**
 1. Chemical synapse : secretes a chemical substance called neurotransmitter.
 2. Electrical Synapses : gap junctions forms.
 3. Conjoint synapse : Both electrical and chemical.

❖ Synaptic transmission & neurotransmitters

AP > NT release > Binding to postsynaptic receptors > (inhibition or excitation) of the postsynaptic membrane.

❖ Fate of neurotransmitters (After a transmitter substance is released at a synapse, it must be removed by) :

1. Diffusion out of synaptic cleft.
2. Enzymatic destruction.
3. Active transport back into pre-synaptic

❖ Electrical events at synapses (EPSPs & IPSPs)

a- Resting membrane potential (RMP) of neuronal soma;

- about -65 millivolts
- If the voltage is less negative → the neuron is excitable.

b- Excitatory postsynaptic potential (EPSPs):

- Excitatory neurotransmitter binds to its receptor → partial depolarization (increase Na influx).
- If this potential rises enough to threshold level → AP will develop and excite the neuron.
- about +20 mv.

c- Inhibitory postsynaptic potentials (IPSPs):

- inhibitory neurotransmitter binds to its receptor → Increases membrane permeability to Cl (hyperpolarization)
- Decrease excitability and membrane potential (more negative).
- about -5mv.

❖ Properties of synaptic transmission

a- **One-way conduction** : from pre-synaptic to post-synaptic neuron.

b- **Synaptic delay** : Is the minimum time required for transmission across the synapse. It is 0.5 ms.

c- Synaptic inhibition;

- **Direct inhibition**: when an inhibitory neuron (releasing inhibitory substance)
- **Indirect Inhibition**: inhibitory synaptic knob lie directly on the termination of a presynaptic excitatory fiber.
- **Reciprocal inhibition** : Inhibition of antagonist activity is initiated in the agonist muscle.
- **Inhibitory interneuron (Renshaw cells)**: Negative feedback inhibitory interneuron of a spinal motor neuron .

d- Summation :

- Spatial summation: When EPSP occurs in more than one synaptic knob at the same time.
- Temporal summation : If EPSPs in a pre-synaptic knob are successively repeated without significant delay

e- Convergence and divergence:


- Convergence: When many presynaptic neurons converge on any single postsynaptic neuron.
- Divergence : Axons of presynaptic neurons divide into many branches that diverge to end on many postsynaptic neurons.

f- **Fatigue** : It is due to exhaustion of neurotransmitter.

❖ Factors affecting synaptic transmission:

- factors Increases neuronal excitability: Alkalosis & drug (caffeine).
- factors Depresses neuronal activity : Acidosis & hypoxia.

Check your understanding!

1- Between two neurons, a microscopic gap exists which is contact point of neurons called:		2- When EPSP occurs in more than one synaptic knob at the same time to achieve the threshold :	
A	node of ranvier	A	Temporal
B	neuron bridges	B	Spatial
C	synapse	C	Divergence
D	gaps	D	Convergence
3-Which of the following is not a neuron-neuron synapse?		4-What's the fate of neurotransmitters?	
A	neuromuscular junction	A	Inactivated by enzymes.
B	axosomatic synapse	B	Reuptake to synaptic knob.
C	axoaxonic synapse	C	Absorbed through postsynaptic membrane.
D	dendrodentritic synapse	D	A & B
5-Metabotropic receptors :		6- The point at which the terminal button and another neuron communicate is called _____; communication here is made possible by the release of _____.	
A	Mediate rapid PSPs	A	Presynaptic membrane; neurotransmitter
B	Linked directly to ion channels.	B	Synapse; neurotransmitters
C	Has intracellular domain that binds to G-protein.	C	Synapse; hormones
D		D	Axon hillock; hormones
7-Neurotransmitters are excitatory or inhibitory depends on:		8- An EPSP:	
A	Receptors it binds to.	A	is an inhibitory hyperpolarization.
B	Its concentration in synaptic cleft.	B	is the transient postsynaptic depolarization due to neurotransmitter release.
C	Number of vesicles in synaptic knob.	C	may bring the membrane close to threshold for an action potential.
D	Type of synapse.	D	b, c
9- Which of the following is a true statement :		10- Excitation of inhibition induced in the postsynaptic	

terminal can be terminated by:

A	One vesicle can contain one or more type of neurotransmitters.	A	Diffusion of neurotransmitter away from synaptic cleft
B	Glycine is an example of small-molecule neurotransmitters.	B	Reuptake of neurotransmitter by the presynaptic neuron and surrounding glia.
C	A single presynaptic terminal can cause large voltage change that reaches threshold.	C	Degradation of neurotransmitter in the synaptic cleft.
D	Alkalosis increases neuronal excitability.	D	All of the above

Answers :

1- A	2- B	3- A	4- D	5- C	6- B	7- A	8- D	9- D	10- D
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