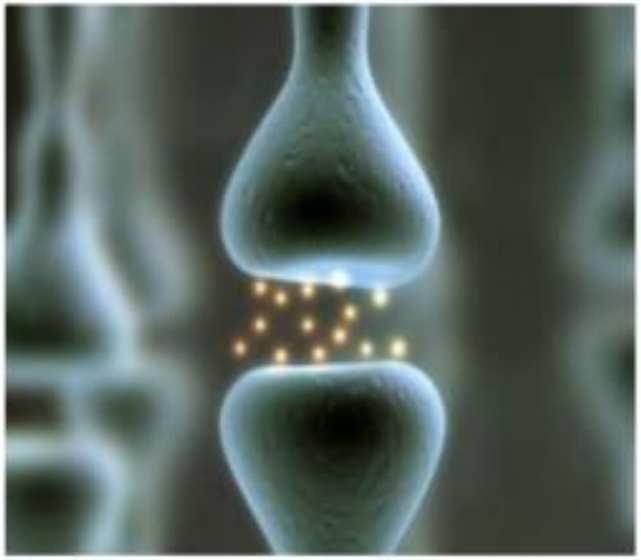

FIGHT or FLIGHT

NEUROTRANSMITTERS
&
THEIR MODE OF ACTION



Dr Saima

Learning Objectives

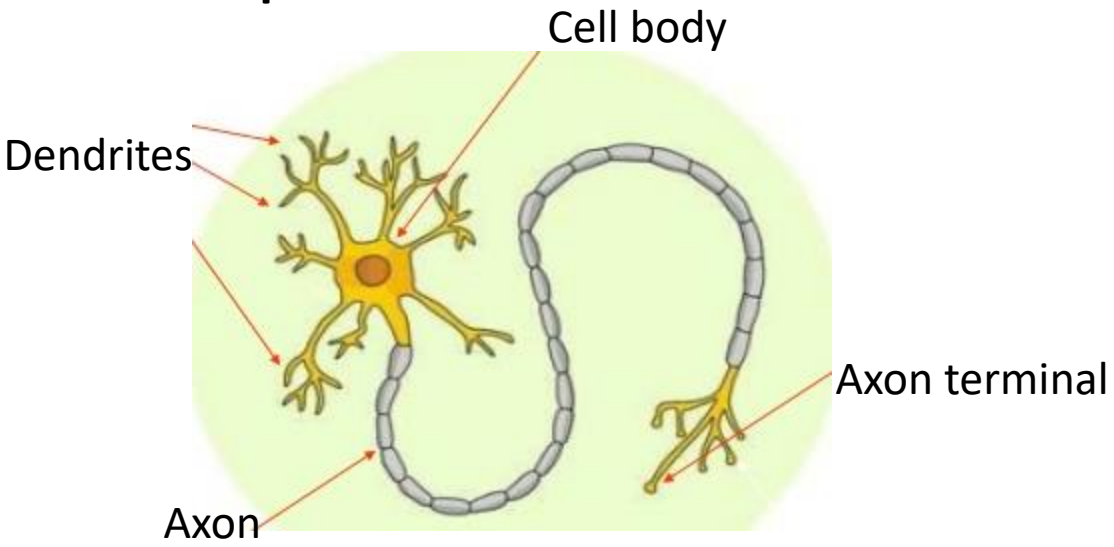
- Define neurotransmitters
- Define neuro modulators
- Describe neurons
- Structure of synapse
- Properties of neurotransmitters
- Classification of neurotransmitters
- Mechanism of release of neurotransmitters
- Regulation of neurotransmitters.

Definition

- A chemical substance which is released at the end of a nerve fibre by the arrival of a nerve impulse and, by diffusing across the synapse or junction, effects the transfer of the impulse to another nerve fibre, a muscle fibre, or some other structure.
- Target cell may be another neuron or some other kind of cell like muscle or glands.

Neurons or nerve cell

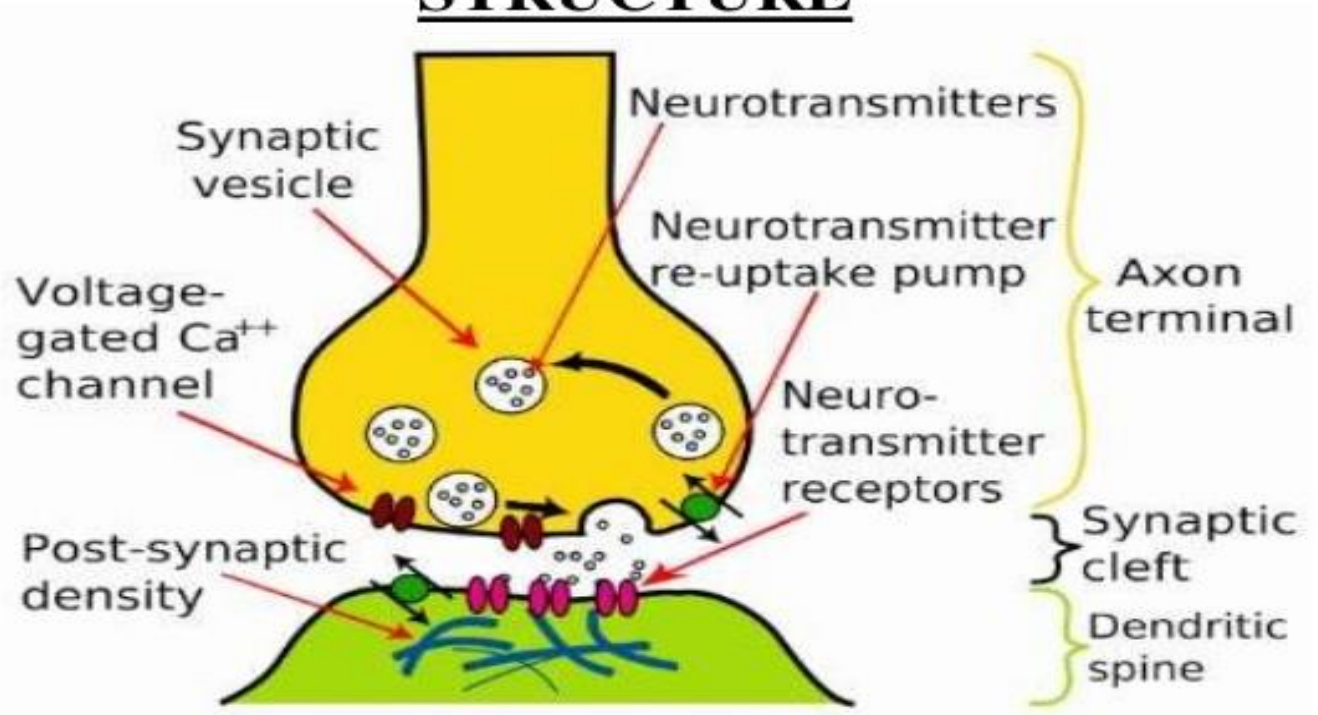
- Neuron is the structural and functional unit of nervous system.
- Function of neuron is production, propagation and transfer of nerve impulses.



Neuromodulators

- Some chemicals released by neurons have little or no direct effects on their own but can modify the effects of neurotransmitters. These chemicals are called Neuromodulators.
  e.g, opioid peptides such as enkephalins, endorphins.

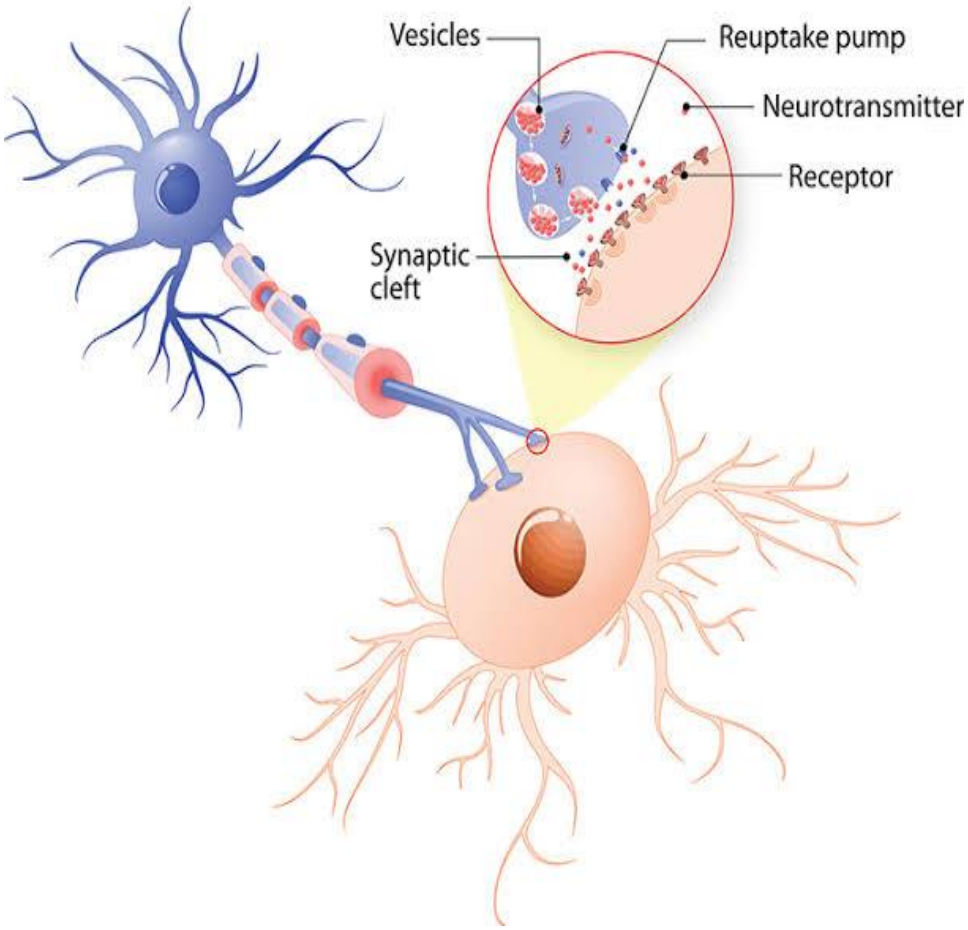
TYPICAL CHEMICAL SYNAPSE - STRUCTURE



- A synapse is a site of functional contact between neurons that facilitate transmission of impulses from one (presynaptic) neuron to another (postsynaptic) neuron or effectors (target) cells such as muscle or glands.

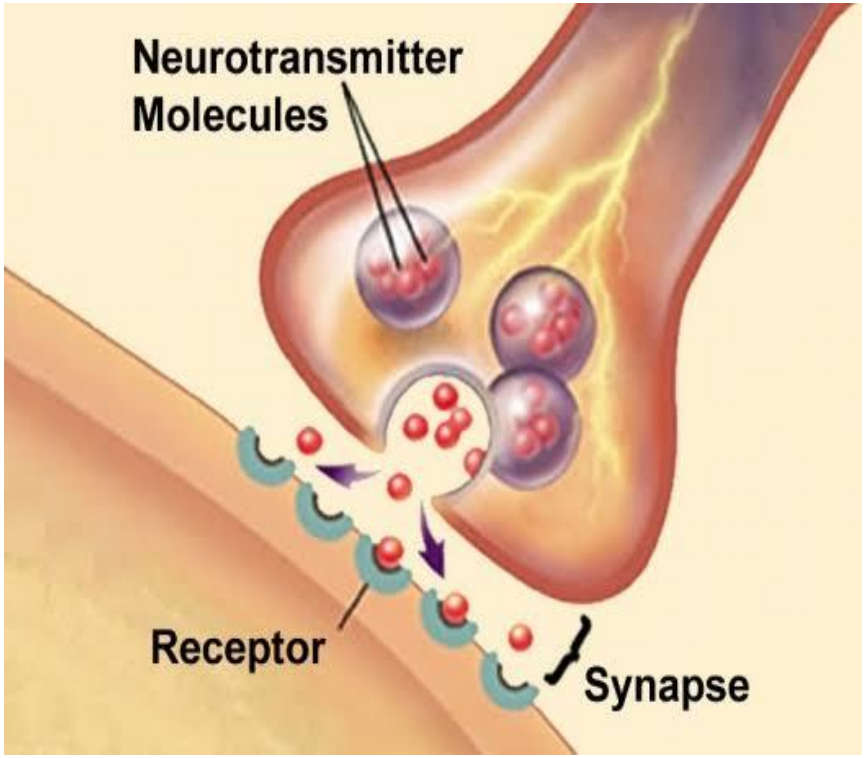
Properties of neurotransmitters

- Synthesized in pre synaptic neuron
- Localized to vesicles in presynaptic neuron
- Released from the presynaptic neurons under physiological conditions
- Rapidly removed from the synaptic cleft by uptake or degradation



- Presence of receptors on the postsynaptic neuron

- Binding to the receptor elicits biological response

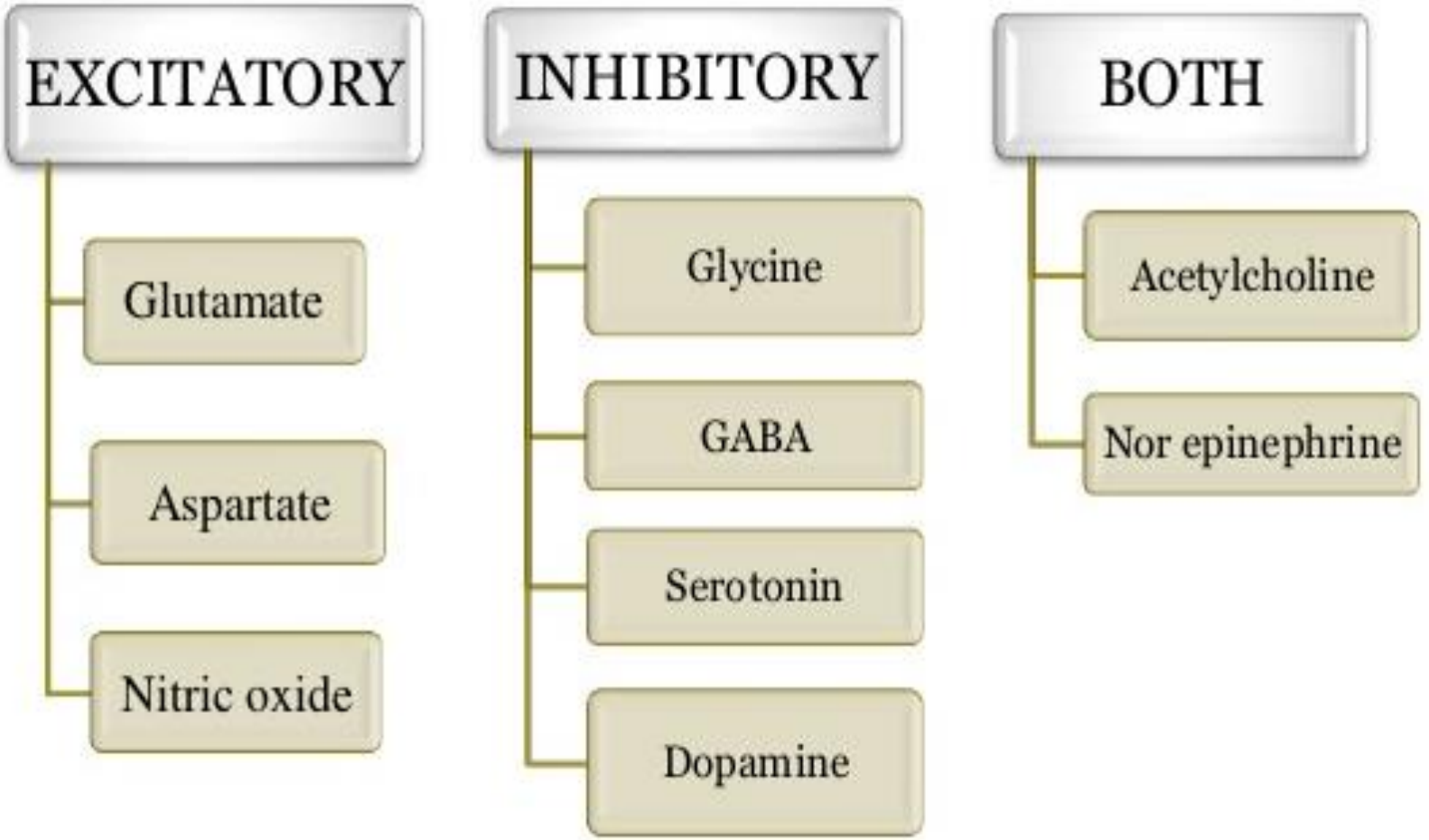


Classification of neurotransmitters

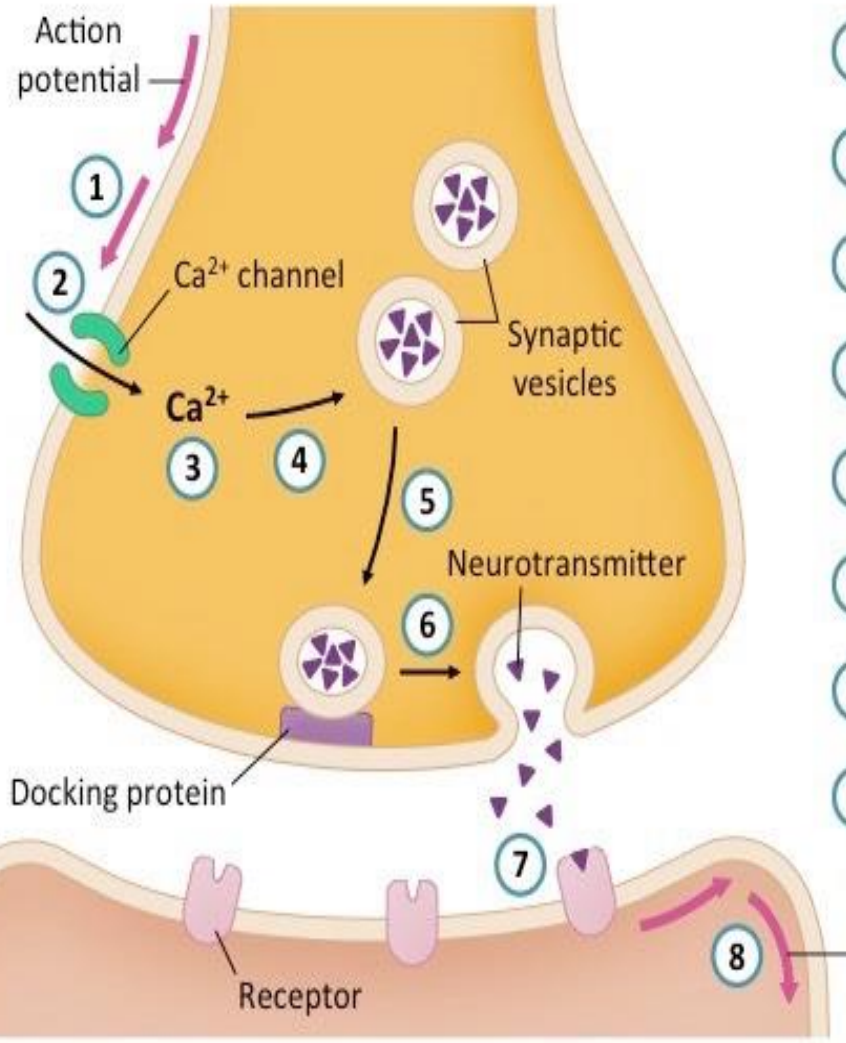
- Depending upon chemical nature

CLASS	EXAMPLE	DERIVED FROM
AMINES	Epinephrine, Norepinephrine Dopamine	Tyrosine
	Serotonin	Tryptophan
	Histamine	Histidine
AMINO ACID AND AMINO ACID DERIVATIVES	Glutamate	
	Aspartate	
	Glycine	
	GABA	Glutamate
PURINES	Adenosine	ATP
	ATP	
GAS	Nitric oxide	Arginine
Miscellaneous	Acetylcholine	Choline

Classification depending upon functions



Flowchart of mechanism of release of neurotransmitter



1. Action potential arrives at axon terminal
2. Voltage-gated Ca^{2+} channels open
3. Ca^{2+} enters the presynaptic neuron
4. Ca^{2+} signals to neurotransmitter vesicles
5. Vesicles move to the membrane and dock
6. Neurotransmitters released via exocytosis
7. Neurotransmitters bind to receptors
8. Signal initiated in postsynaptic cell

Mechanism of release of neurotransmitters

- Various stimuli (physical, chemical or electrical) activate neurons from resting state and cause them to produce nerve impulse

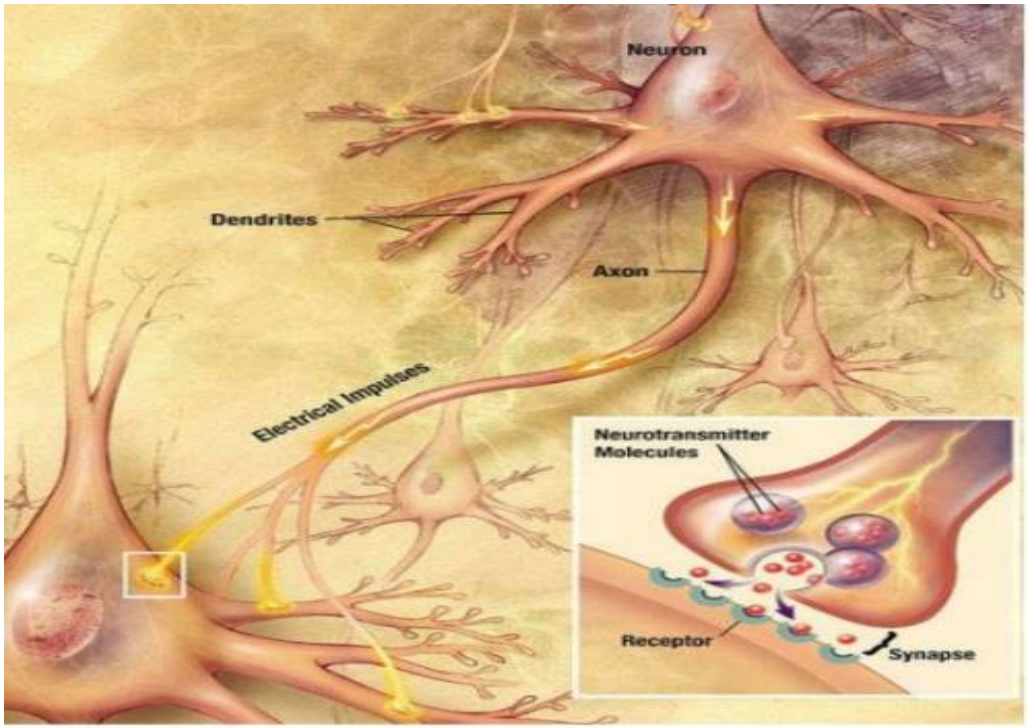
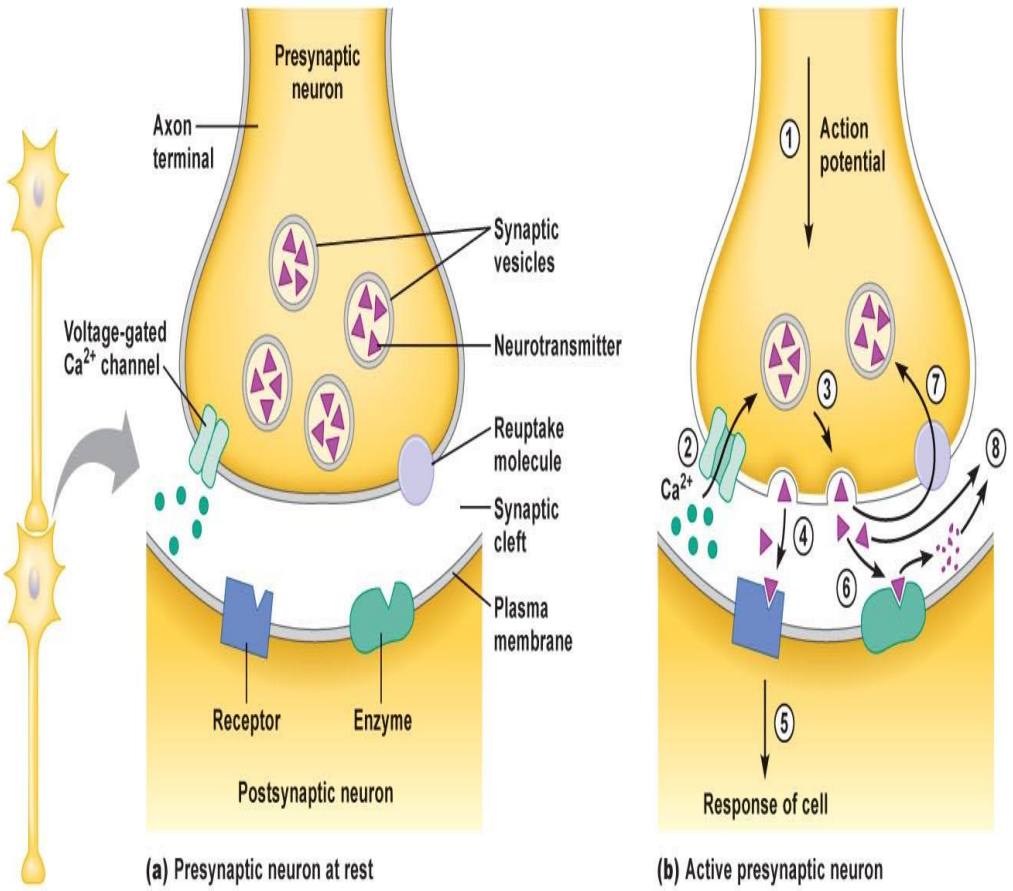
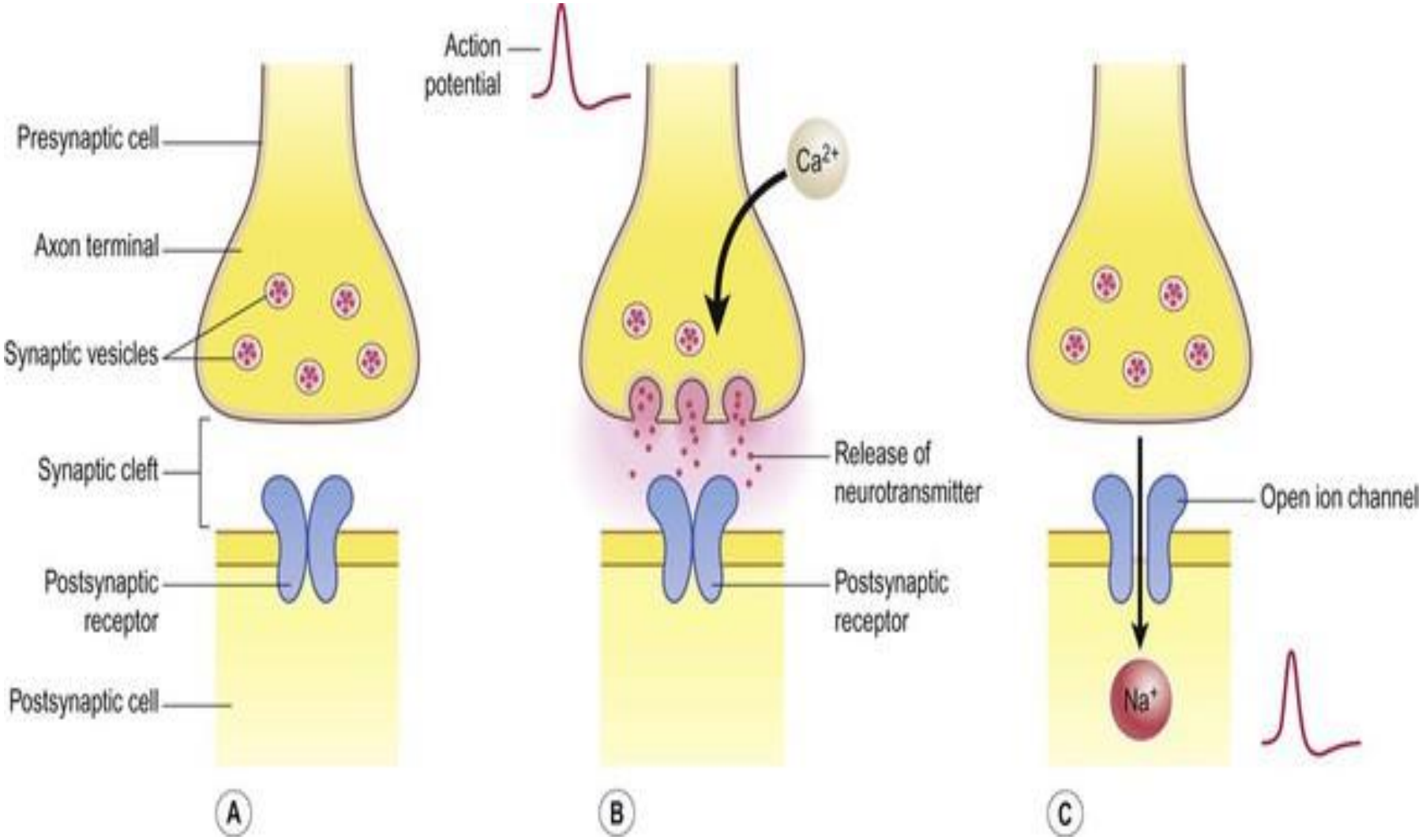


Illustration of the major elements in chemical synaptic transmission.

- Presynaptic membrane contains many voltage gated calcium channels.
- Action potential depolarize pre synaptic membrane and open ca^{+2} channels.
- They bind with release sites in membrane.
- Transmitter vesicles release neurotransmitter in cleft.



Postsynaptic neuron contains large no of receptors



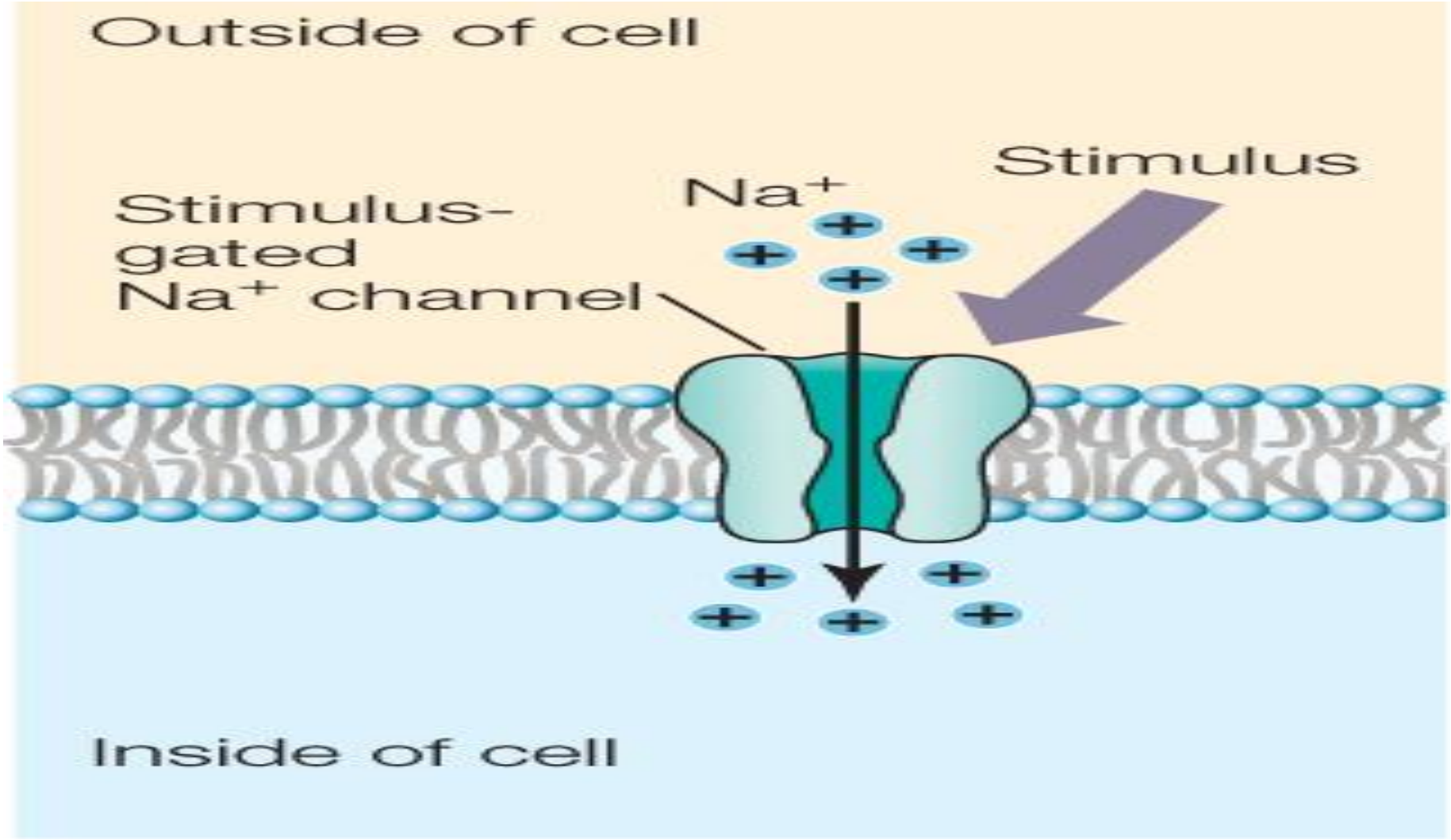
Types of receptors at postsynaptic membrane

- **There are two types of neurotransmitter receptors:**
- Ionotropic receptors (Ligand-gated receptors)
- Metabotropic receptors (G-**protein** coupled receptors).

1)Ligand gated ion channels

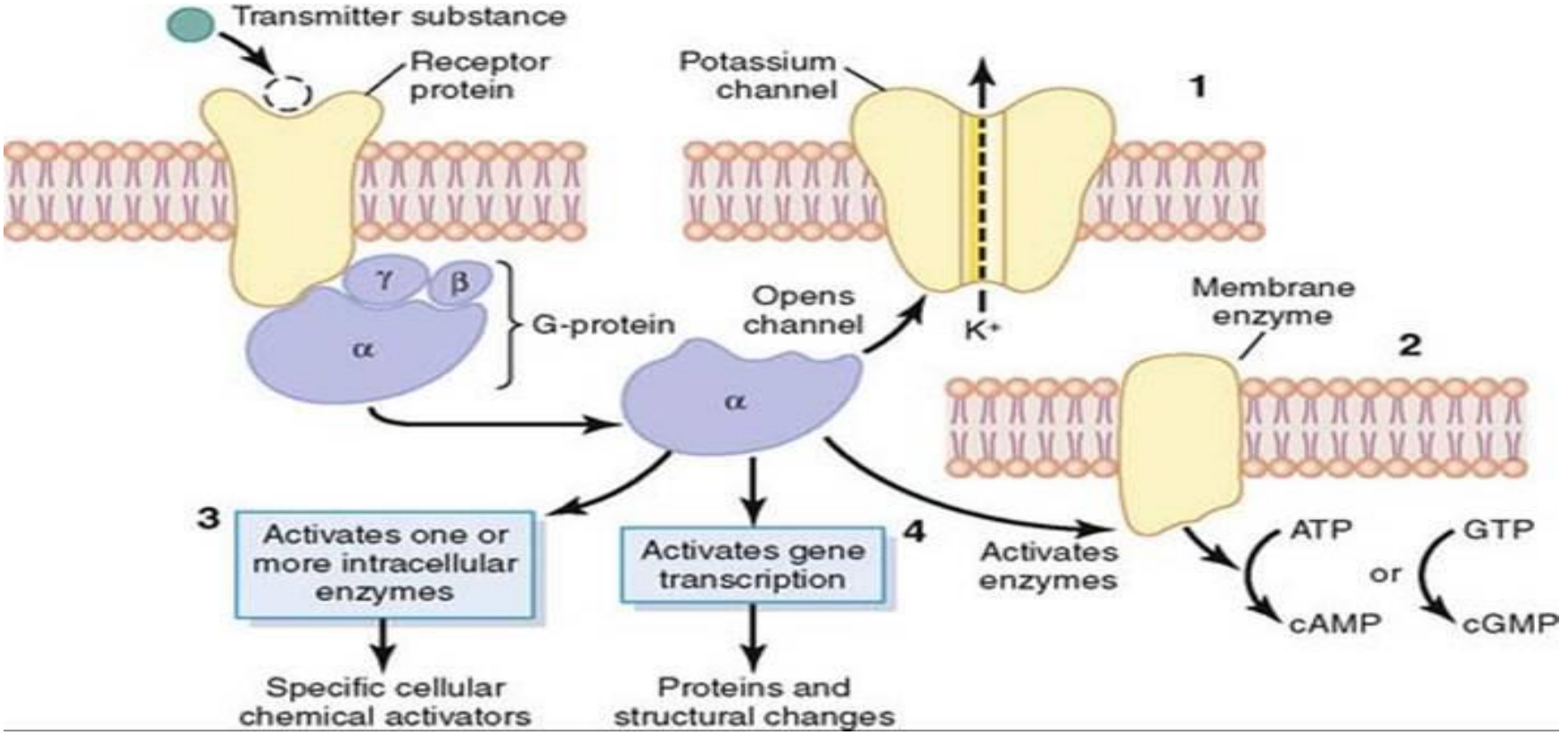
- **Ligand-gated ion channels** (LGICs) are integral membrane proteins that contain a pore which allows the regulated flow of selected **ions** across the plasma membrane. **Ion** flux is passive and driven by the electrochemical gradient for the permeant **ions**.
- **Ligand-gated ion channels** are **activated** upon the binding of a neurotransmitter to the **ion channel** and are involved in fast synaptic transmisssion in the nervous system

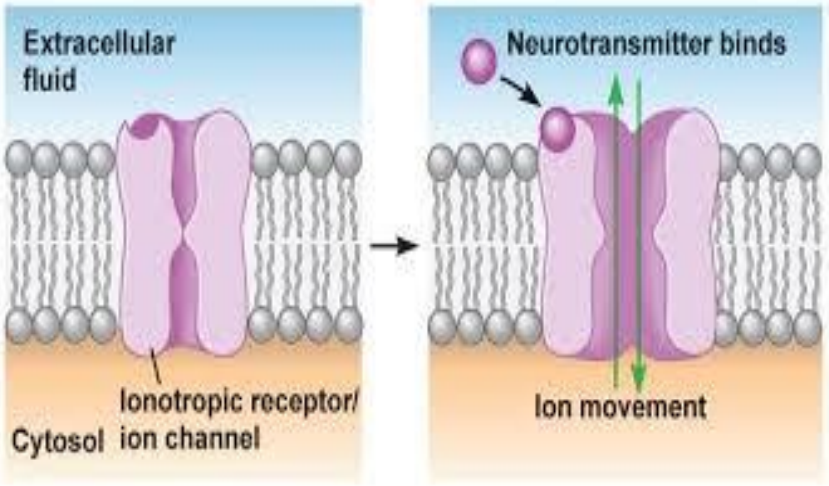
Ligand gated ion channels



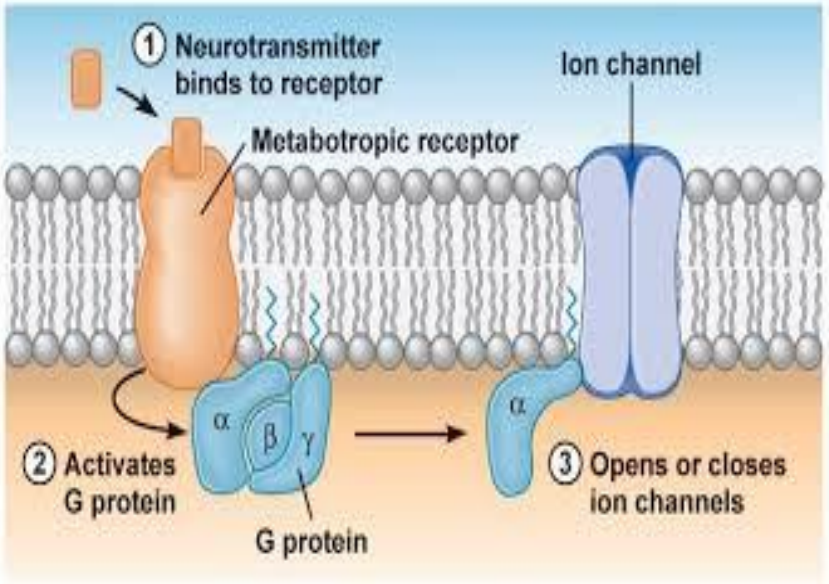
G-coupled receptors

- G-protein coupled receptors have slower, longer lasting and diverse postsynaptic effects. They can have effects that can change the entire cell metabolism.

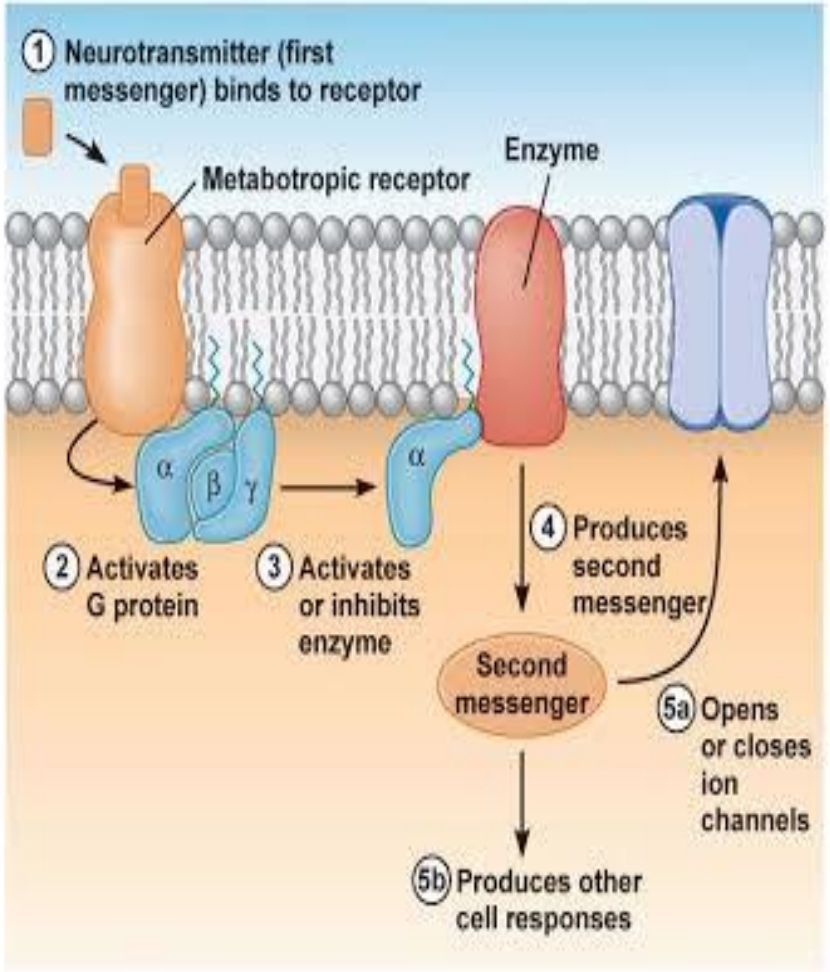




(a) Fast response



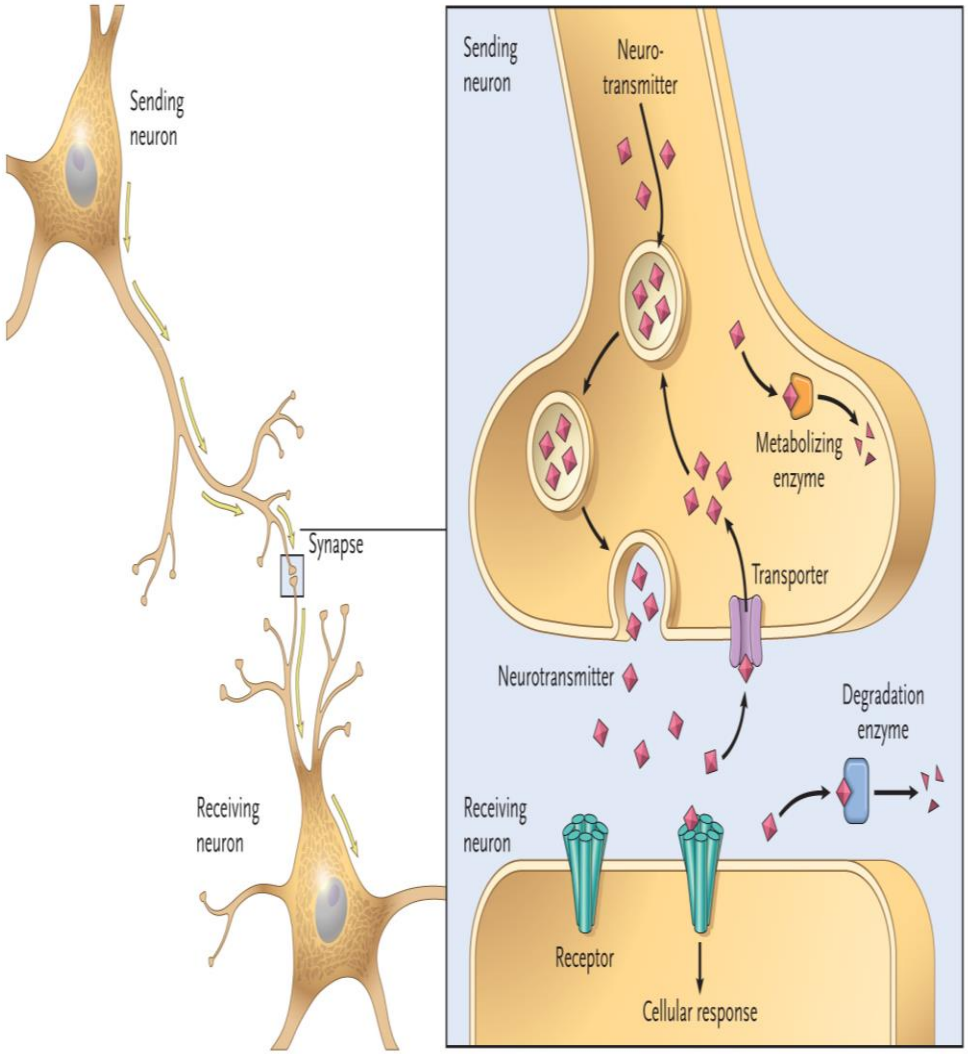
(b) Slow response, direct coupling



(c) Slow response, second messenger system

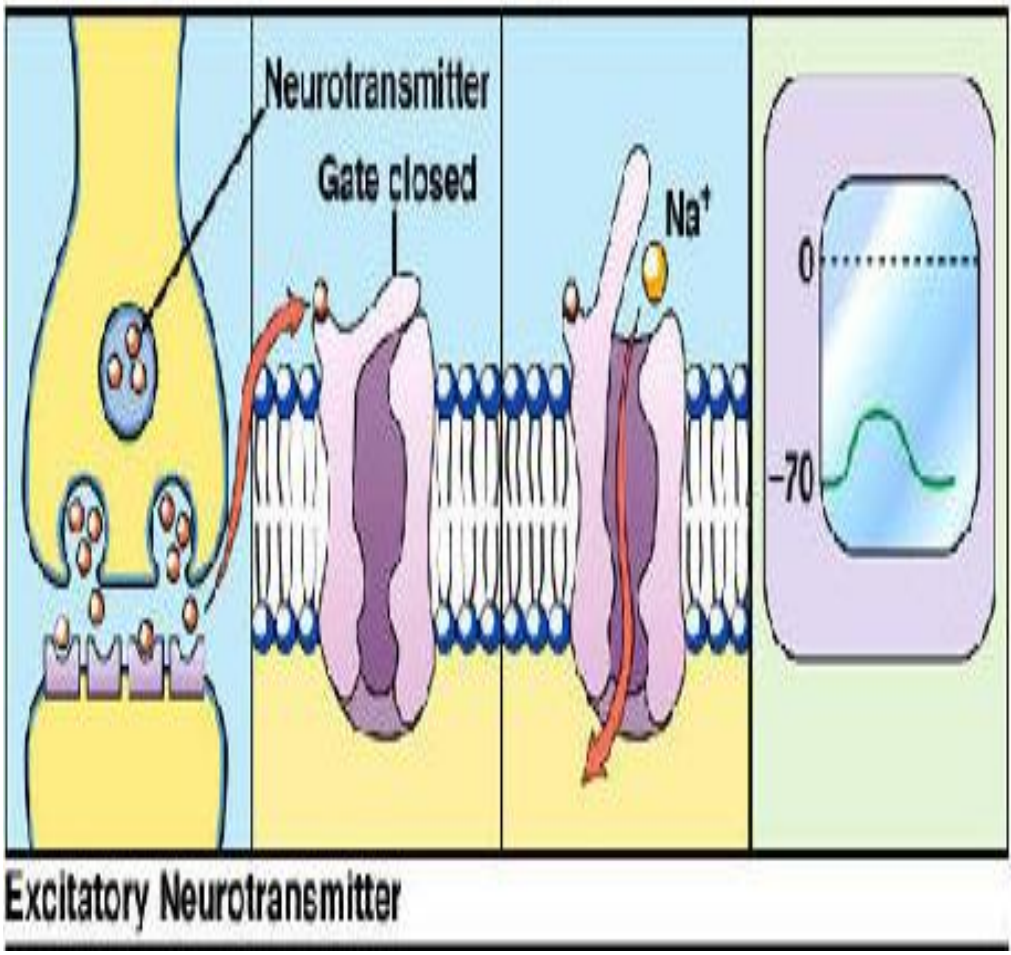
Regulation of neurotransmitters

- It is removed by reuptake into the axon terminals (80%)
- It diffuses out of the synaptic cleft to the area where it has no action
- It is destroyed or disintegrated by specific enzymes
- It is engulfed or removed by astrocytes



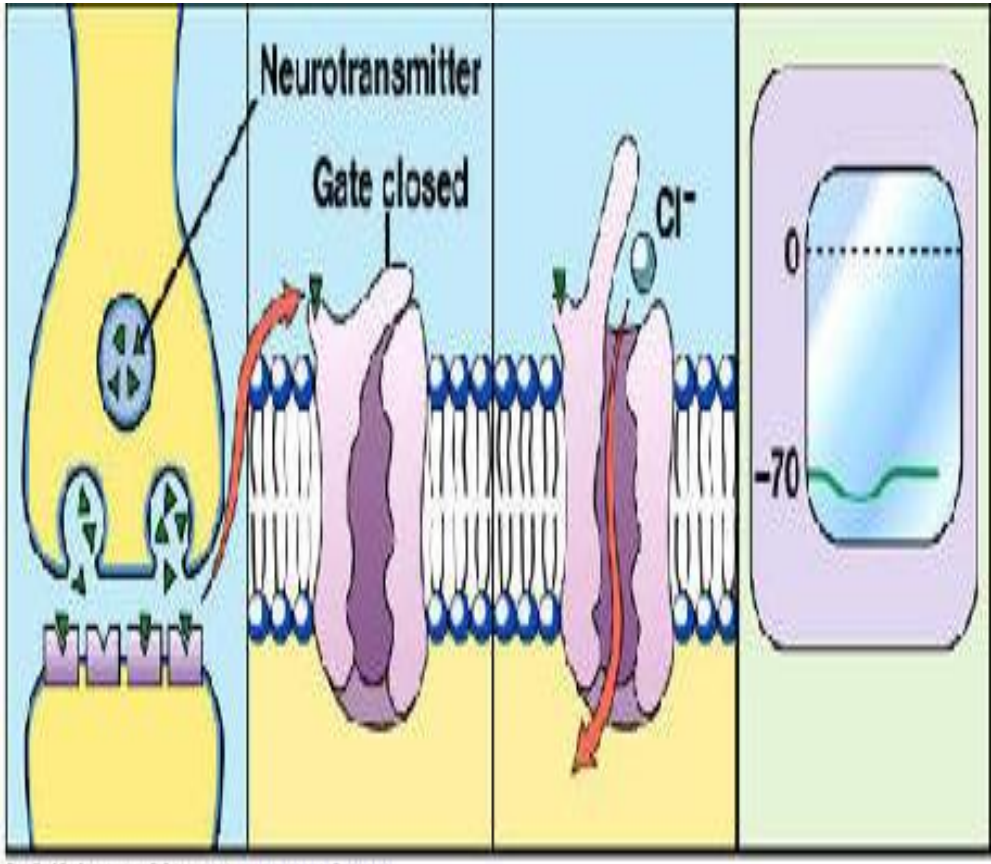
Excitatory neurotransmitter

- They open the cation channels, prompting an influx of Na^+ that causes the local depolarization in the postsynaptic membrane. This leads to initiation of an action potential and generation of a nerve impulse,e.g. acetylcholine, glutamine, serotonin etc



Inhibitory neurotransmitter

- They open anion channels causing Cl^- to enter the cell and hyperpolarize the postsynaptic membrane,making it more negative (i.e making the membrane depolarize) so that the generation of an action potential becomes more difficult and inhibit the production of new impulse e,g GABA or glycine.



Recommended books

- Pankaja Naik
- Guyton


Q&A

- **What happens to excess neurotransmitter produced by presynaptic neurons?**

- It is eliminated by substances contained within the cell body.
- It is removed and taken around the rest of the body.
- All of it is taken up by postsynaptic neurons.
- It is taken back into the presynaptic neuron.
- It is disintegrated by postsynaptic neurons.

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- Neuromodulators
- Action potentials
- Neurotransmitters
- Membrane potentials
- Resting potential

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THANK
YOU
VERY
MUCH