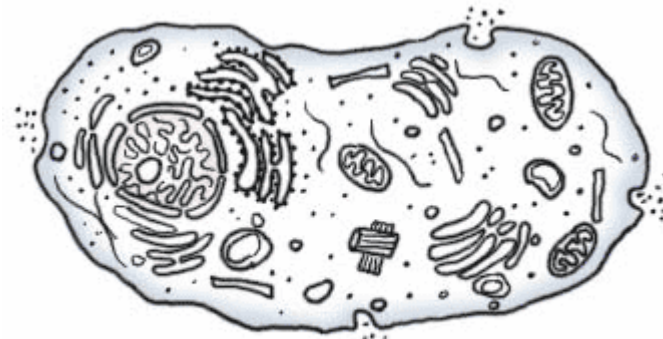


# Chapter 2

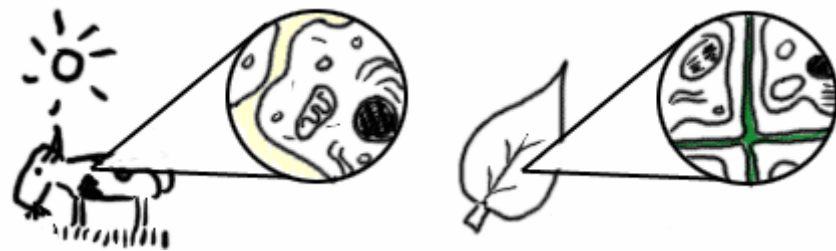
Structure and functions of cells of  
the nervous system

# Cell

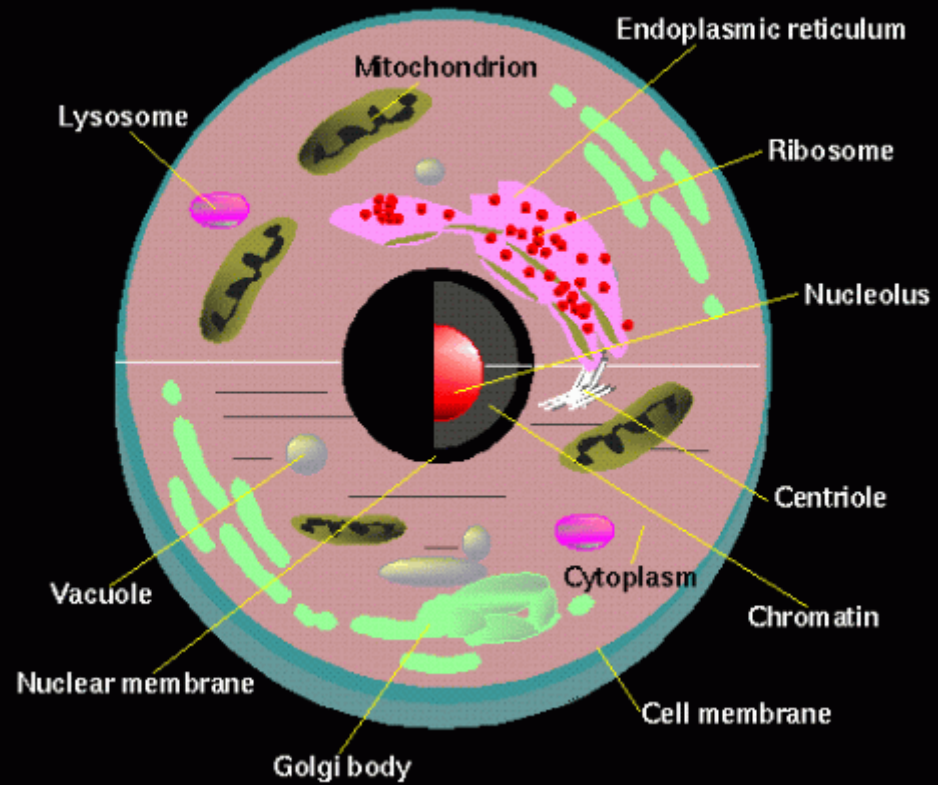
- Organelles—  
cells—tissues--  
systems
- Cell-- Small  
compartments  
that hold all the  
biological  
equipment  
necessary to  
keep an  
organism alive  
and successful  
on earth



AN ANIMAL CELL

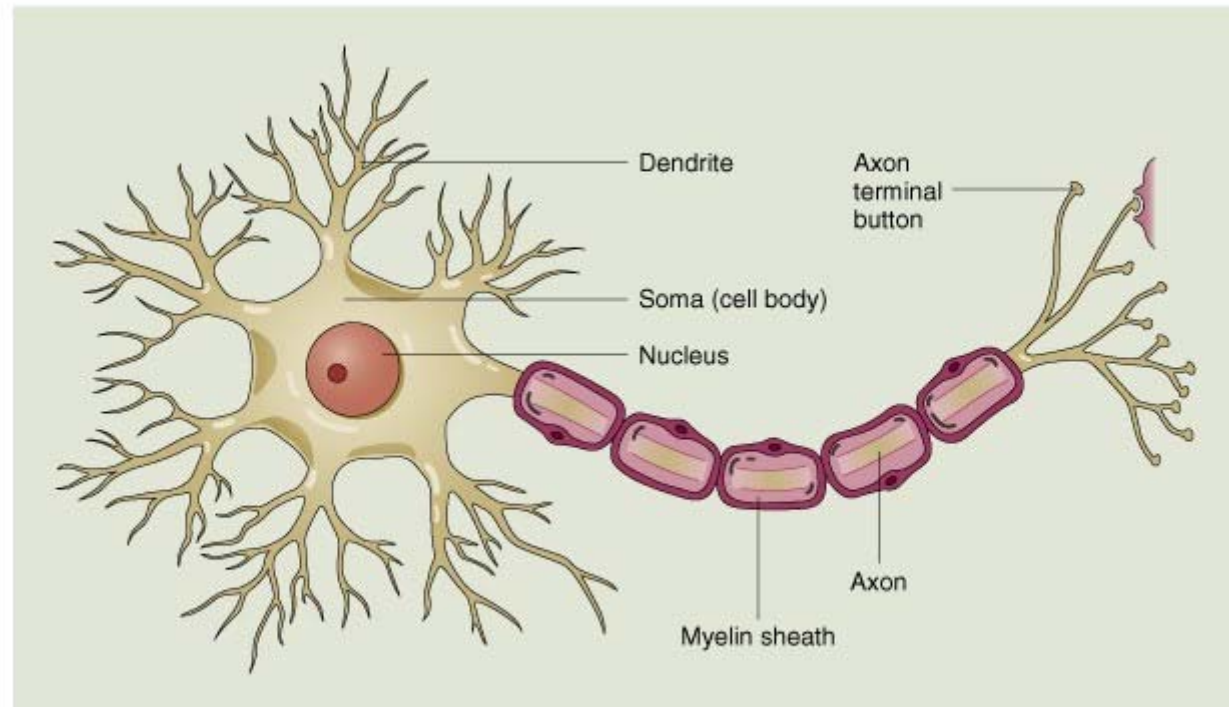


## Structure of the cell



# Cells in nervous system-neurons

- Structure
  - Body (soma)
  - Axon
  - Dendrite
  - Terminal button

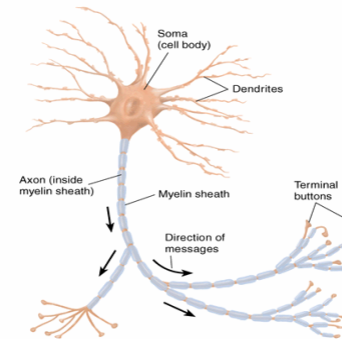


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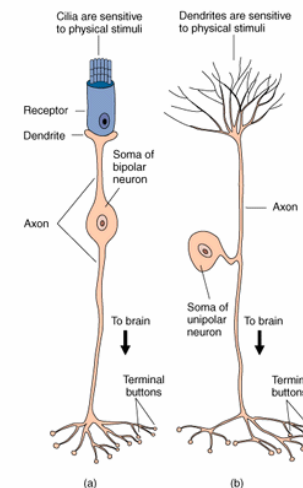
# Types of neurons

- By shape
  - Multipolar neurons—most common type
  - Bipolar neurons—retinal/olfactory
  - Monopolar neurons—touch
- By size (10-100um in vertebrate nerve cell bodies)
  - Small—granule, spindle, stellate
  - Large—pyramidal, golgi type I and Purkinje
- By function
  - Motoneurons—send information to muscles and glands
  - Sensory neurons—receive information from environment
  - Interneurons—receive and send, entirely in the central nervous system

► Multipolar Neuron

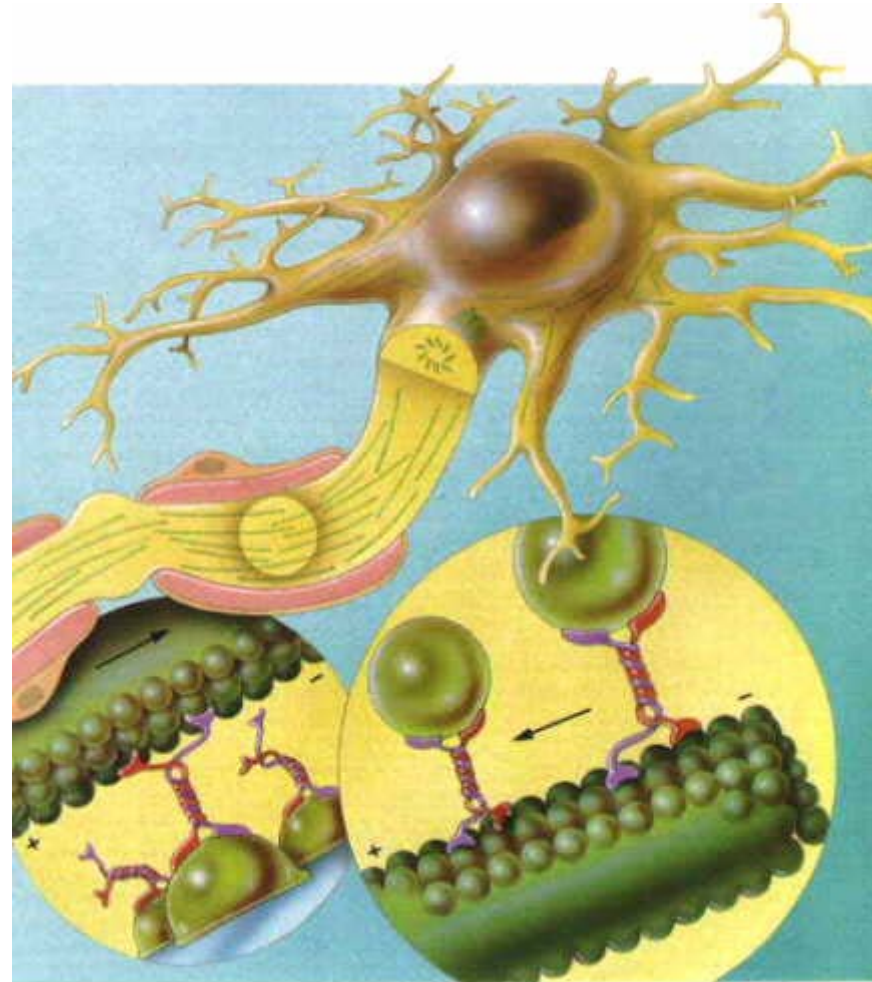


► Bipolar and Unipolar Neurons



# Axon transport

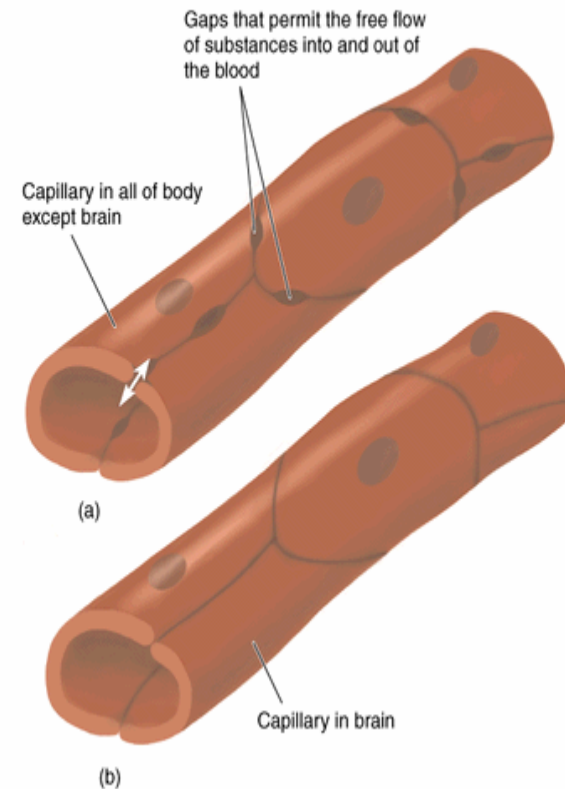
- Microtubules and kinestins



# Blood-brain barrier

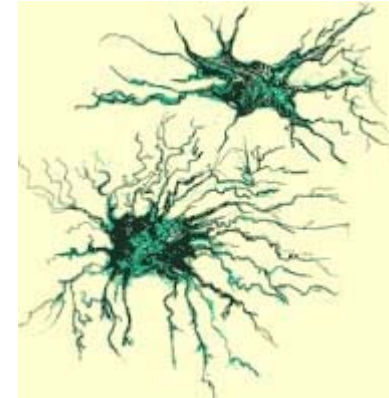
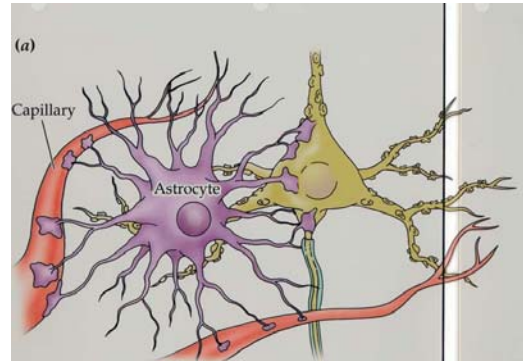
- Abbreviated **BBB**, not to be confused with the blood-cerebrospinal fluid barrier, a function of the choroid plexus
- A membrane that controls the passage of substances from the blood into the central nervous system. It is a physical barrier between the local blood vessels and most parts of the central nervous system and stops many substances from travelling across it.
- **Area postrema**
  - A region of the medulla where the blood-brain barrier is weak; poisons can be detected there and can initiate vomiting.

## ► The Blood–Brain Barrier

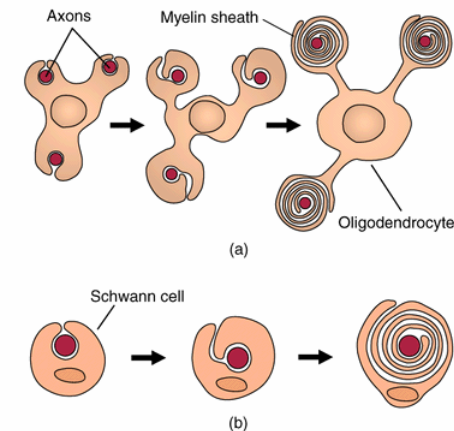


# Cells in nervous system-Glia

- Four main classes and functions
  - Astrocyte—star
    - support, nutrition, phagocytosis
  - Microglial cell
    - Phagocytosis, immune system, inflammatory reaction
  - Oligodendrocytes
    - myelin in Central nervous system (Brain and spinal cord)
  - Schwann cells
    - myelin in Peripheral nervous system (outside of brain and spinal cord)
- Node of Ranvier
- A naked portion of a myelinated axon, between adjacent oligodendroglia or Schwann cells

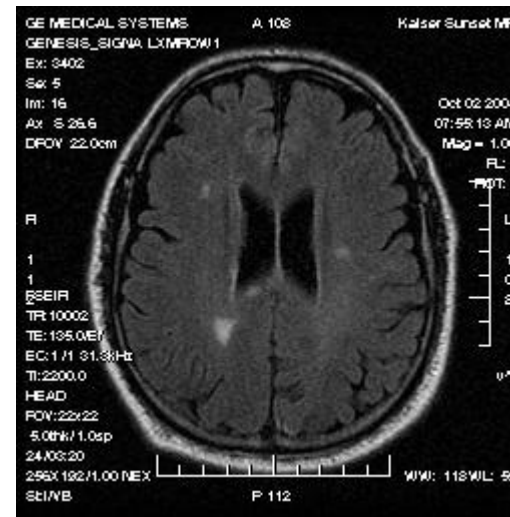


## ► Formation of Myelin



# Demyelinating disease

- Multiple sclerosis
  - A chronic, inflammatory disease that affects the central nervous system (CNS).
  - Can cause a variety of symptoms, including changes in sensation, visual problems, muscle weakness, depression, difficulties with coordination and speech, severe fatigue, and pain.



# Forces

- Diffusion
- Electrostatic pressure

# Action potential

- Saltatory conduction
  - Conduction of action potentials by myelinated axons. The action potential appears to jump from one node of Ranvier to another

# Action potential

- Review factors in action potential
  - Diffusion is the effect that the random movement of molecules have that causes the movement of molecules from a region of high concentration to low concentration. Diffusion will stop (that is the change in the relative levels of concentration) when the concentration of the substance in solution is equal at all points.
  - Electrical Charge and Attraction
  - Voltage and the Axon
  - Depolarization
- Steps of action potential
- The spread of action potential on an axon

# The membrane potential

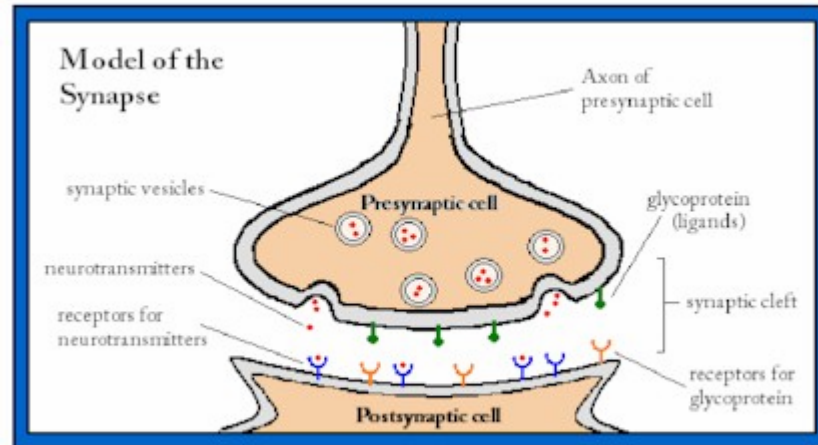
- The Goldman equation  $E_m = 58 \log \left( \frac{P_K [K]_o + P_{Na} [Na]_o + P_{Cl} [Cl]_i}{P_K [K]_i + P_{Na} [Na]_i + P_{Cl} [Cl]_o} \right)$
- Permeability = the ability of an ion to reach equilibrium
- Gets us to -67
- The Sodium Potassium Pump
  - 3 Na/2K
  - gets us to -70
  - Uses energy

- Cable properties
  - The passive conduction of electrical current, in a decremental fashion, down the length of an axons
- Saltatory conduction
  - Conduction of action potentials by myelinated axons. The action potential appears to jump from one node of Ranvier to another

**Which way is faster?**

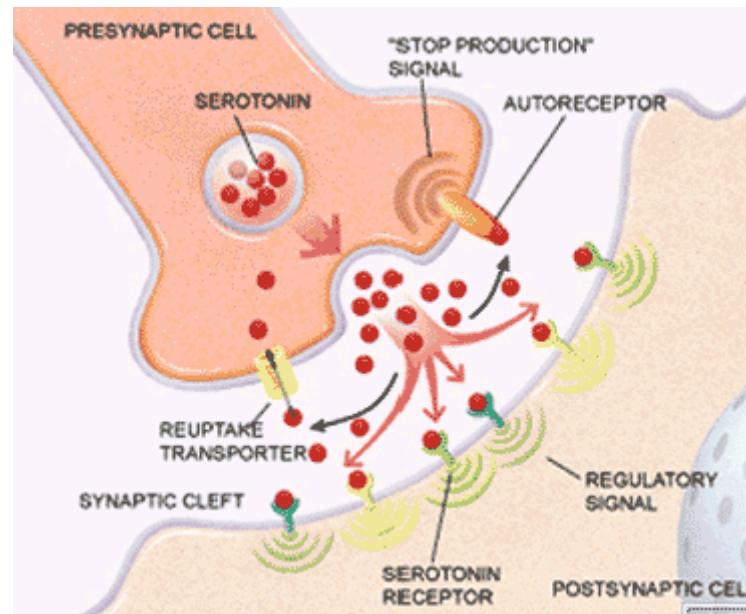
**Thought question?**

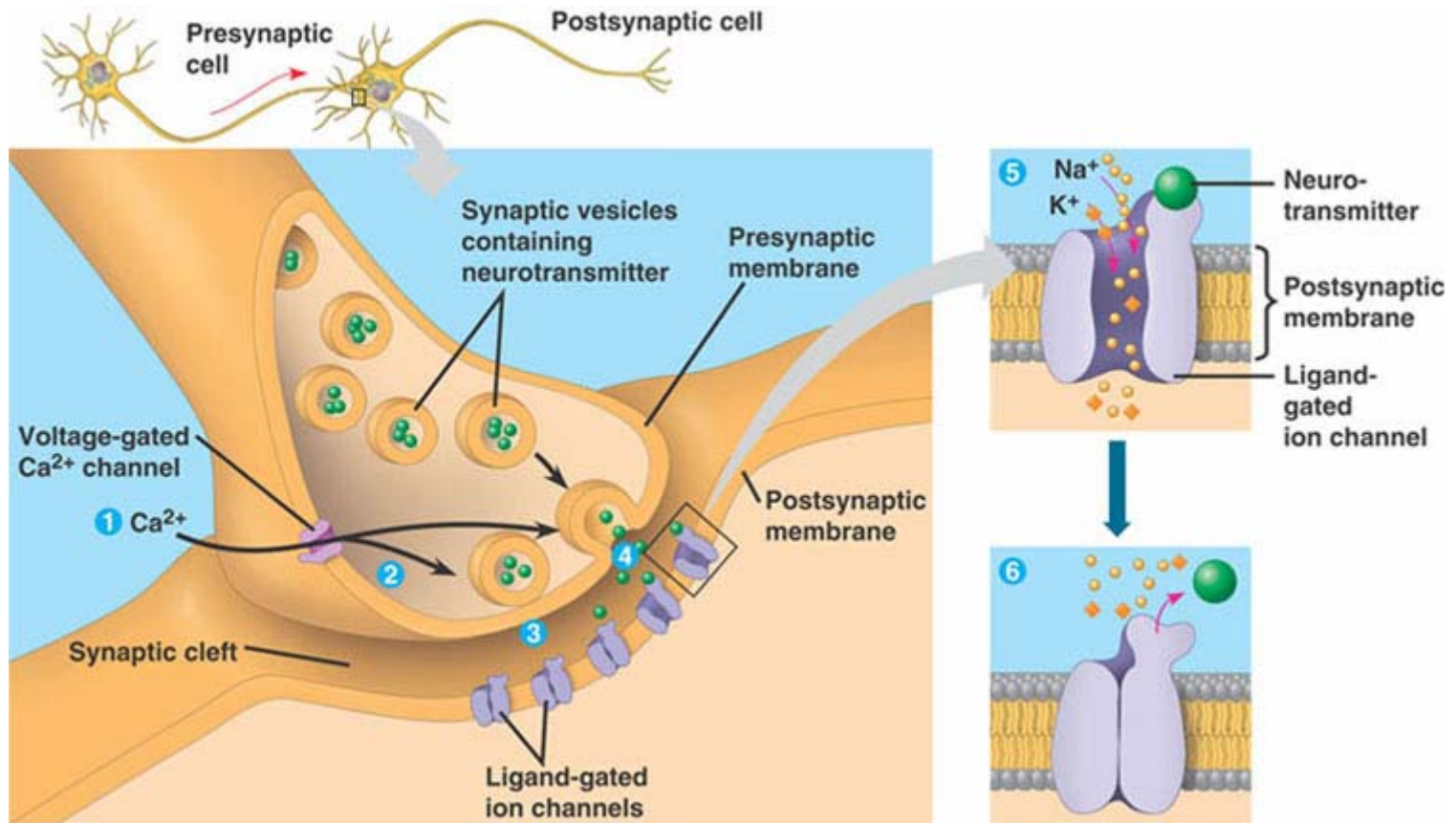
- Types of synapses
  - Axodentritic, axosomatic axoaxonic
- Components of a synapse
  - Presynaptic membrane
  - Postsynaptic membrane
  - Synaptic cleft
  - Synaptic vesicles
  - Release zone



# The releasing of neurotransmitter

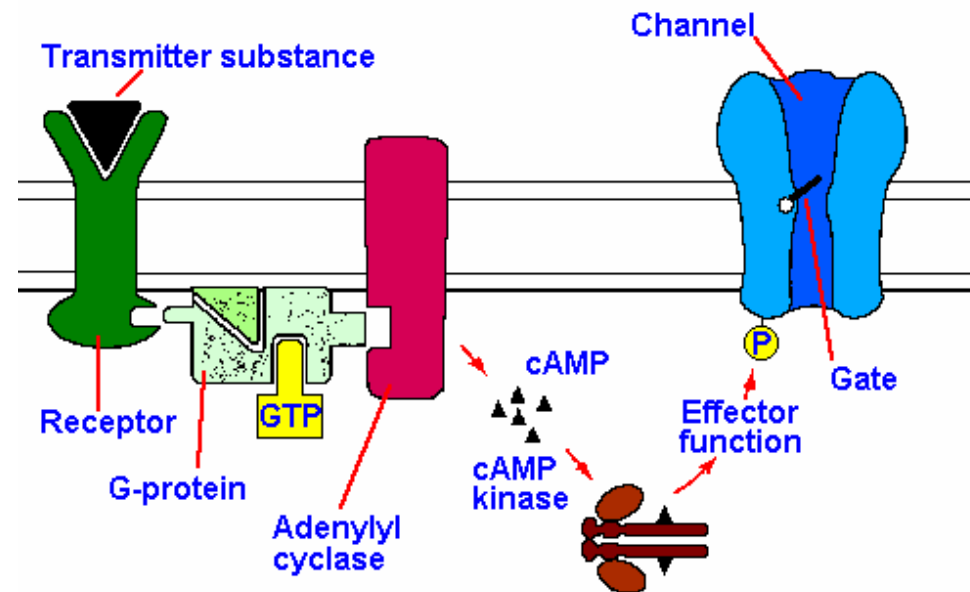
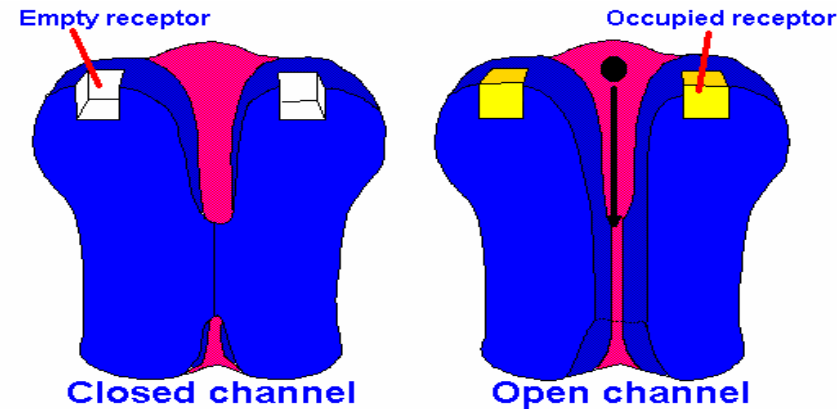
- Docking of synaptic vesicles
  - Ligand
- Action potential
- $Ca^{2+}$ 
  - Voltage-dependent  $Ca^{2+}$  channel
- Fusing
  - Entry of calcium opens fusion pore
- Releasing
  - Kiss and stay
  - Kiss and leave
  - Merge and recycle
- Turn off signal
  - Diffusion
  - Reuptake
  - Enzymatic deactivation
  - Autoreceptors





# The activation of receptor

- Neurotransmitter-dependent ion channel
- Ionotropic receptor
  - Ligand-gated ion channels
- Metabotropic receptor
  - G protein
  - Second messenger
    - cAMP



# Postsynaptic potentials

- Excitatory postsynaptic potentials (EPSP)
  - Depolarization
- Inhibitory postsynaptic potentials (IPSP)
  - hyperpolarization
- Na+?
- K+?
- Cl-?
- Ca<sup>2+</sup>?
- Neural integration
  - The summation of EPSP and IPSP

# Termination of postsynaptic potentials

- Decrease the concentration of neurotransmitter in synaptic cleft
- Reuptake
- Enzymatic deactivation
  - Acetylcholine (ACh) and Acetylcholinesterase (AChE)

- Other types of synapses
  - Axoaxonic synapses
    - Not contribute to neural integration, Presynaptic inhibition/facilitation
  - Dendrodendritic synapses
    - Gap junction--Direct communication by electrical coupling, common in invertebrate
- Nonsynaptic chemical communication
  - Travel farther and disperse more widely
  - Neuromodulators
    - Peptides, modulating neurons activity
  - Hormones
    - Peptides hormones—metabotropic transfer of information
    - Steroid hormones—fat soluble, direct pass the membrane

