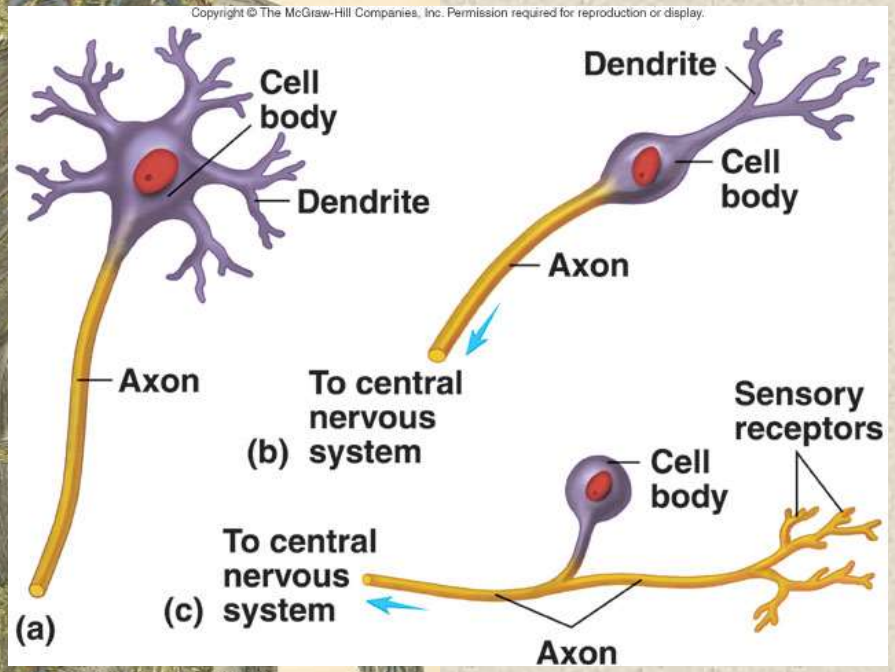
Functional Organization of Nervous Tissue

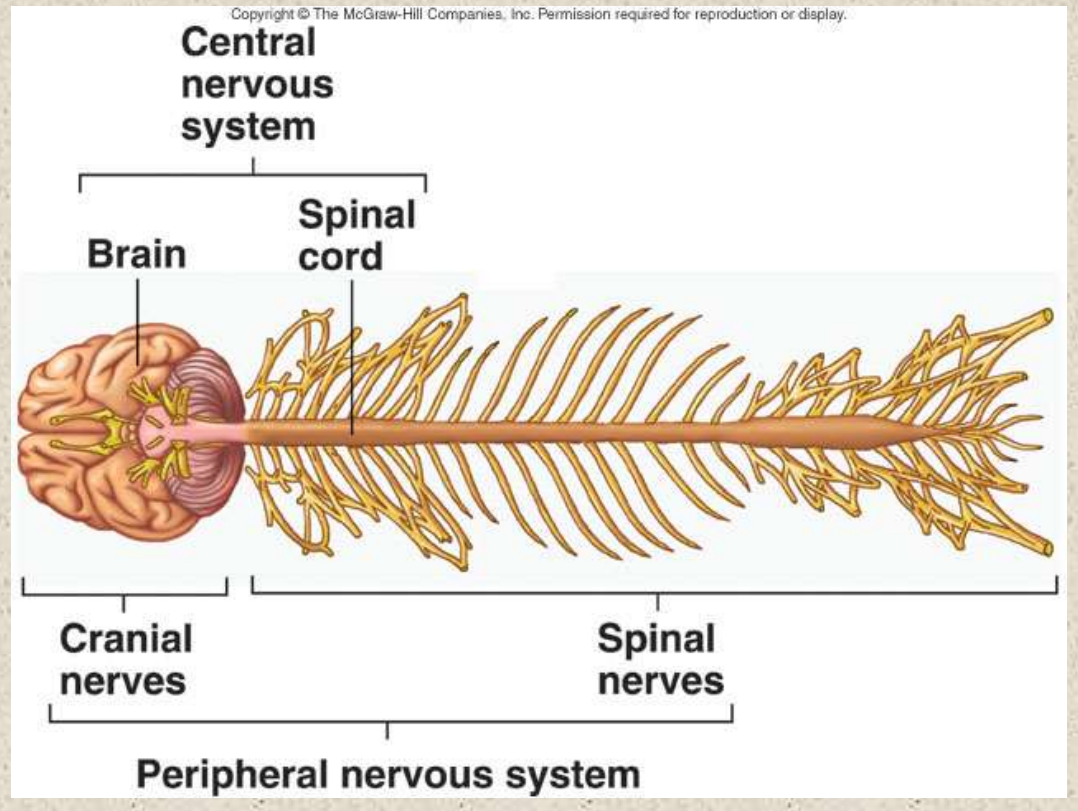


Dr. Moch. Bahrudin, Sp.S

The Nervous System

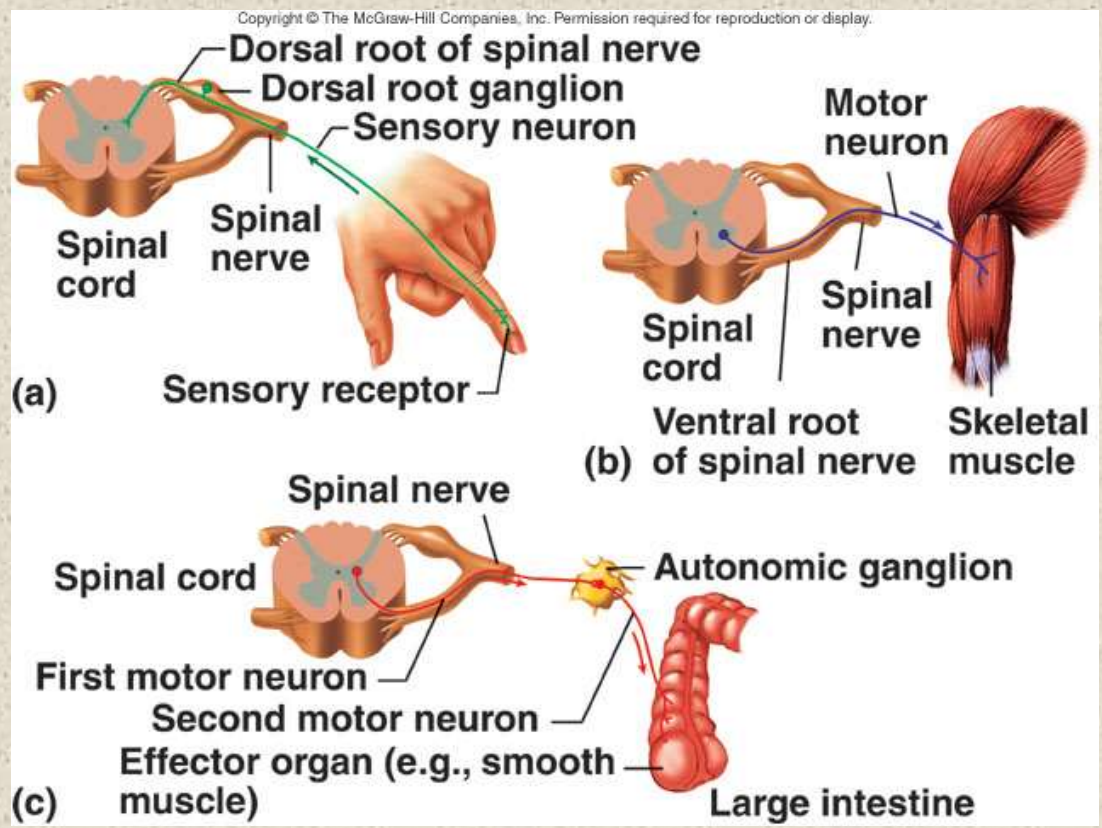
- Components
  - Brain, spinal cord, nerves, sensory receptors
- Responsible for
  - Sensory perceptions, mental activities, stimulating muscle movements, secretions of many glands
- Subdivisions
  - Central nervous system (CNS)
  - Peripheral nervous system (PNS)

Central Nervous System



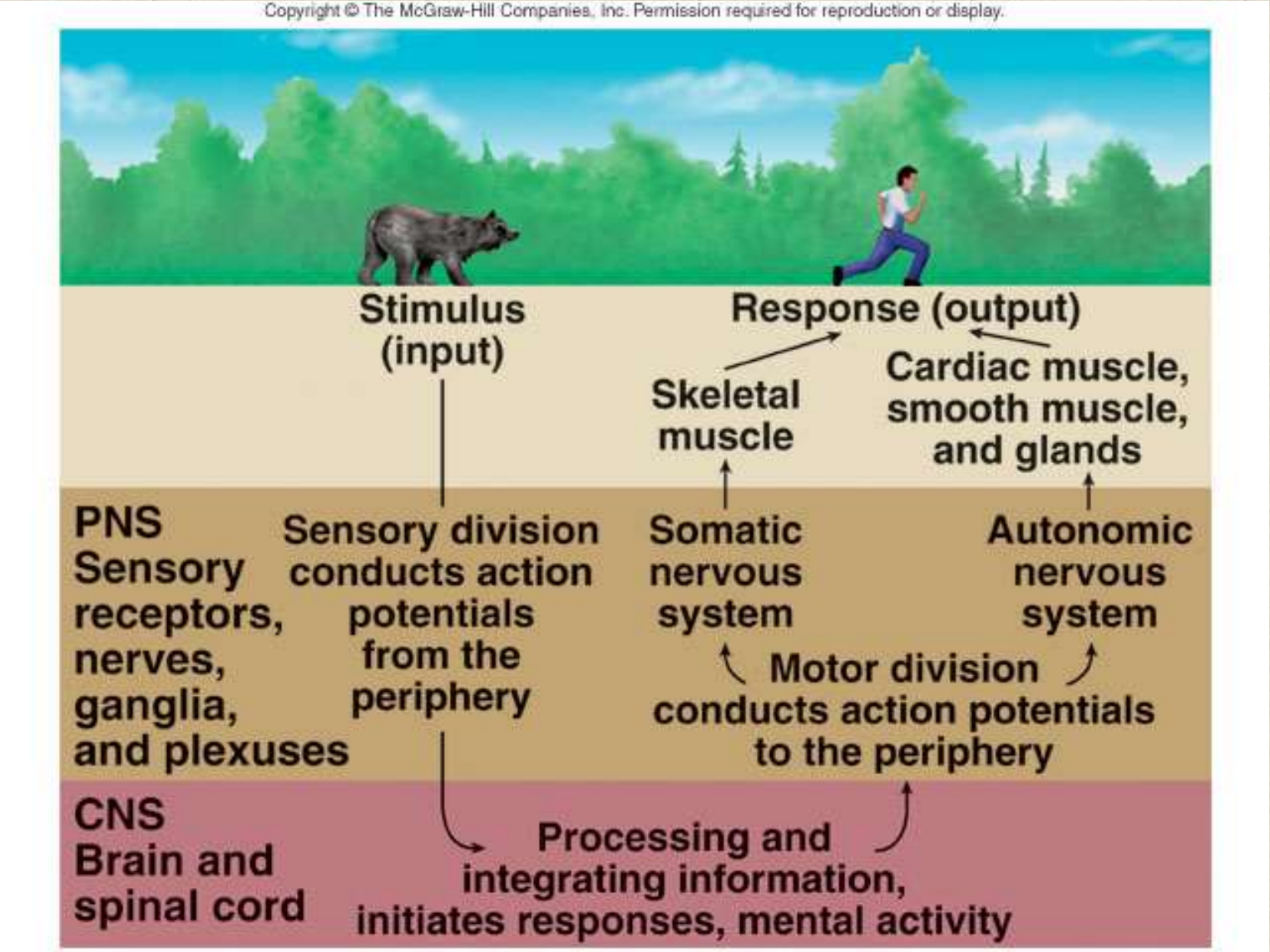
- Consists of
  - Brain
    - Located in cranial vault of skull
  - Spinal cord
    - Located in vertebral canal
- Brain and spinal cord
  - Continuous with each other at foramen magnum

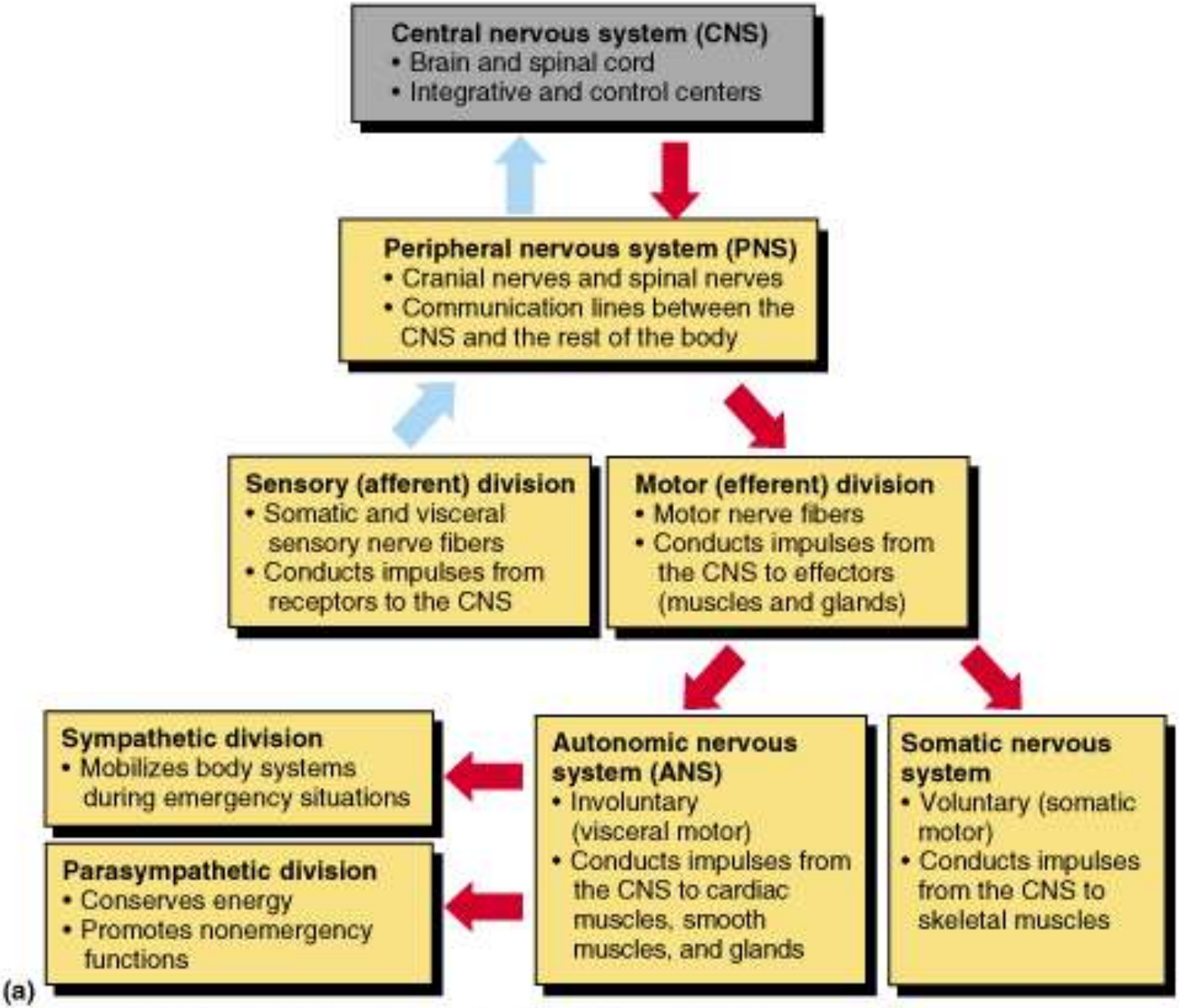
Peripheral Nervous System



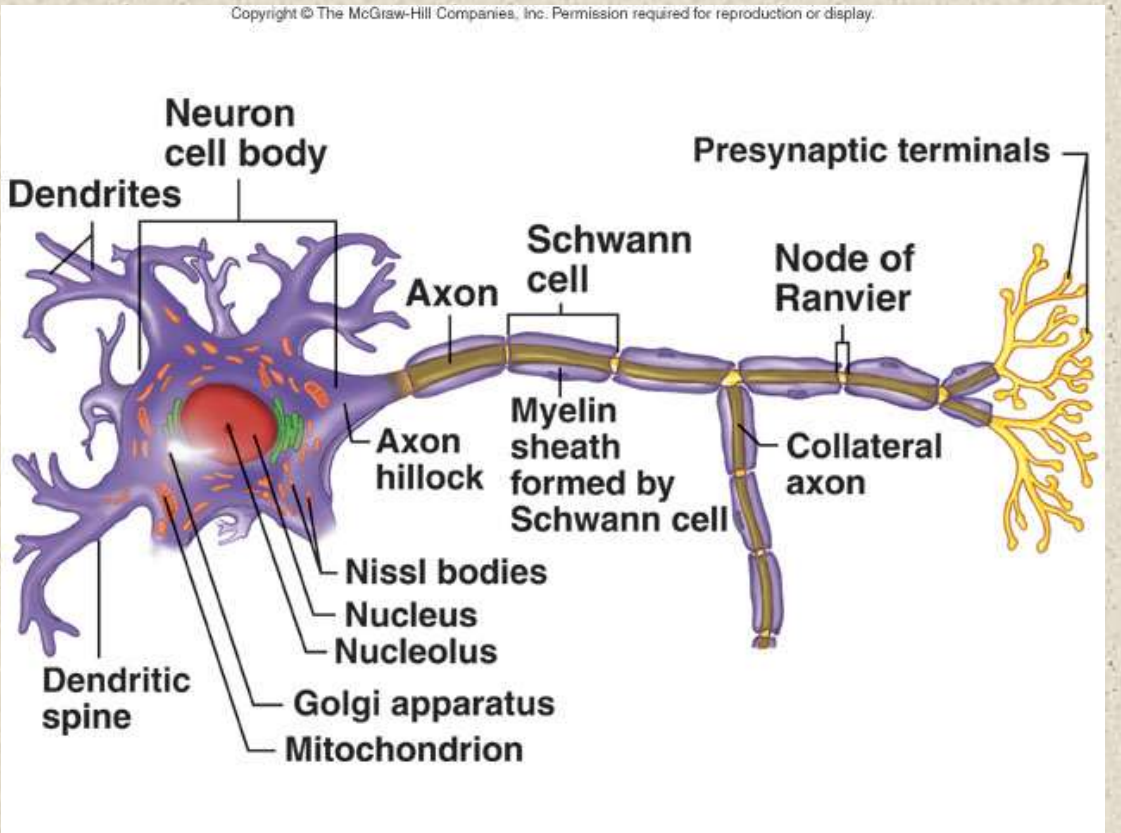
- Two subcategories
  - Sensory or afferent
  - Motor or efferent
    - Divisions
      - Somatic nervous system
      - Autonomic nervous system (ANS)
        - » Sympathetic
        - » Parasympathetic
        - » Enteric

Nervous System Organization





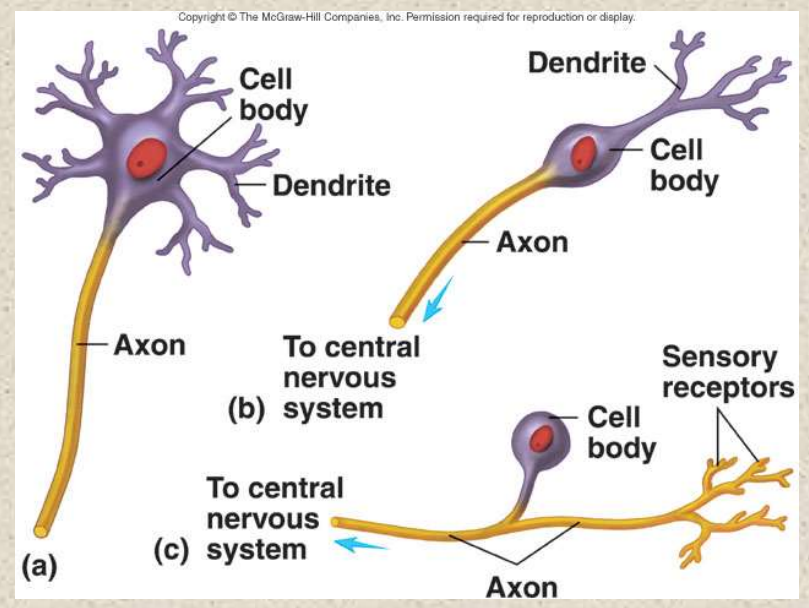
Cells of Nervous System



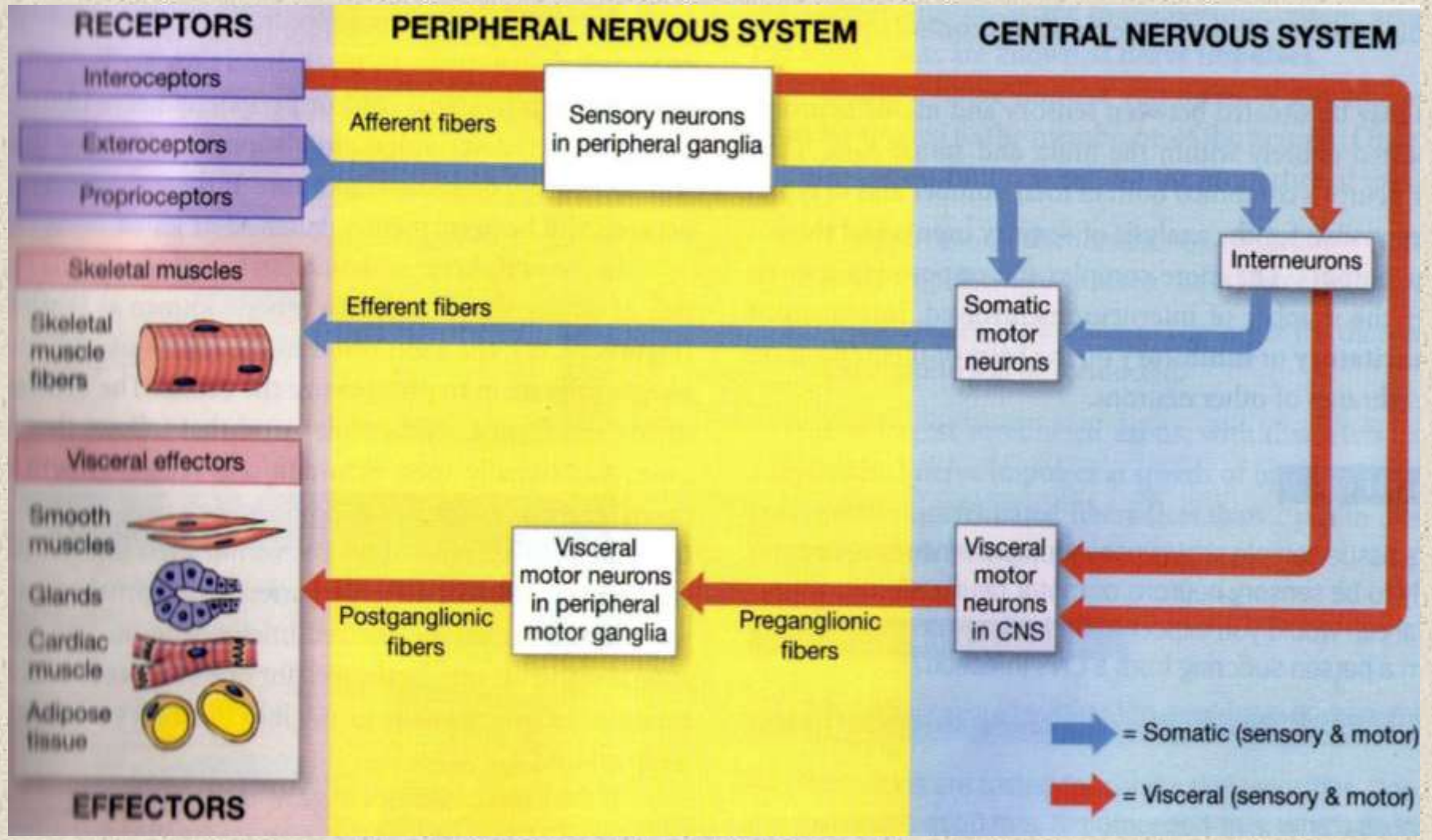
- Neurons or nerve cells
  - Receive stimuli and transmit action potentials
  - Organization
    - Cell body or soma
    - Dendrites: Input
    - Axons: Output
- Neuroglia or glial cells
  - Support and protect neurons

Types of Neurons

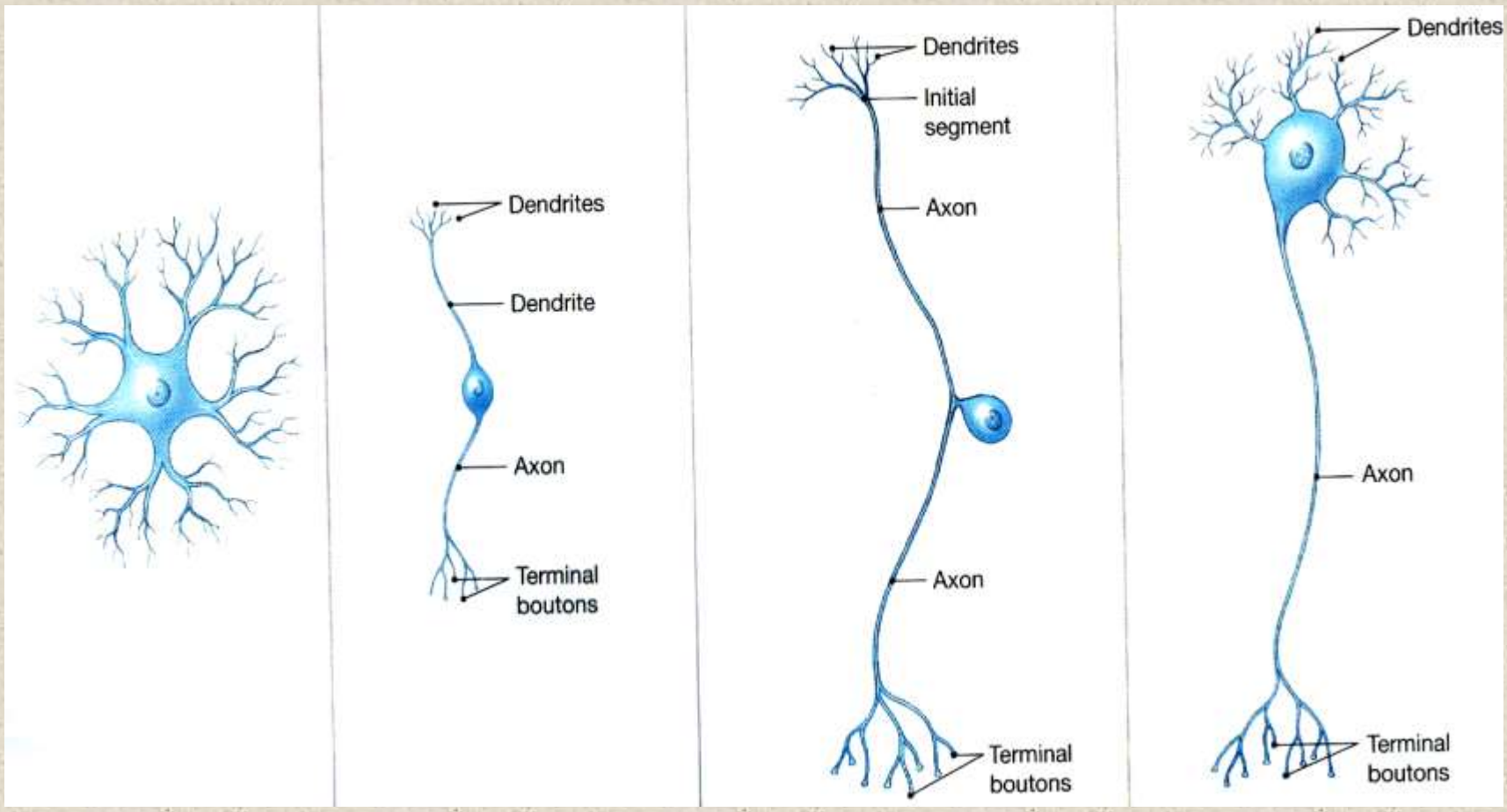
- Functional classification
  - Sensory or afferent: Action potentials toward CNS
  - Motor or efferent: Action potentials away from CNS
  - Interneurons or association neurons: Within CNS from one neuron to another
- Structural classification
  - Multipolar, bipolar, unipolar



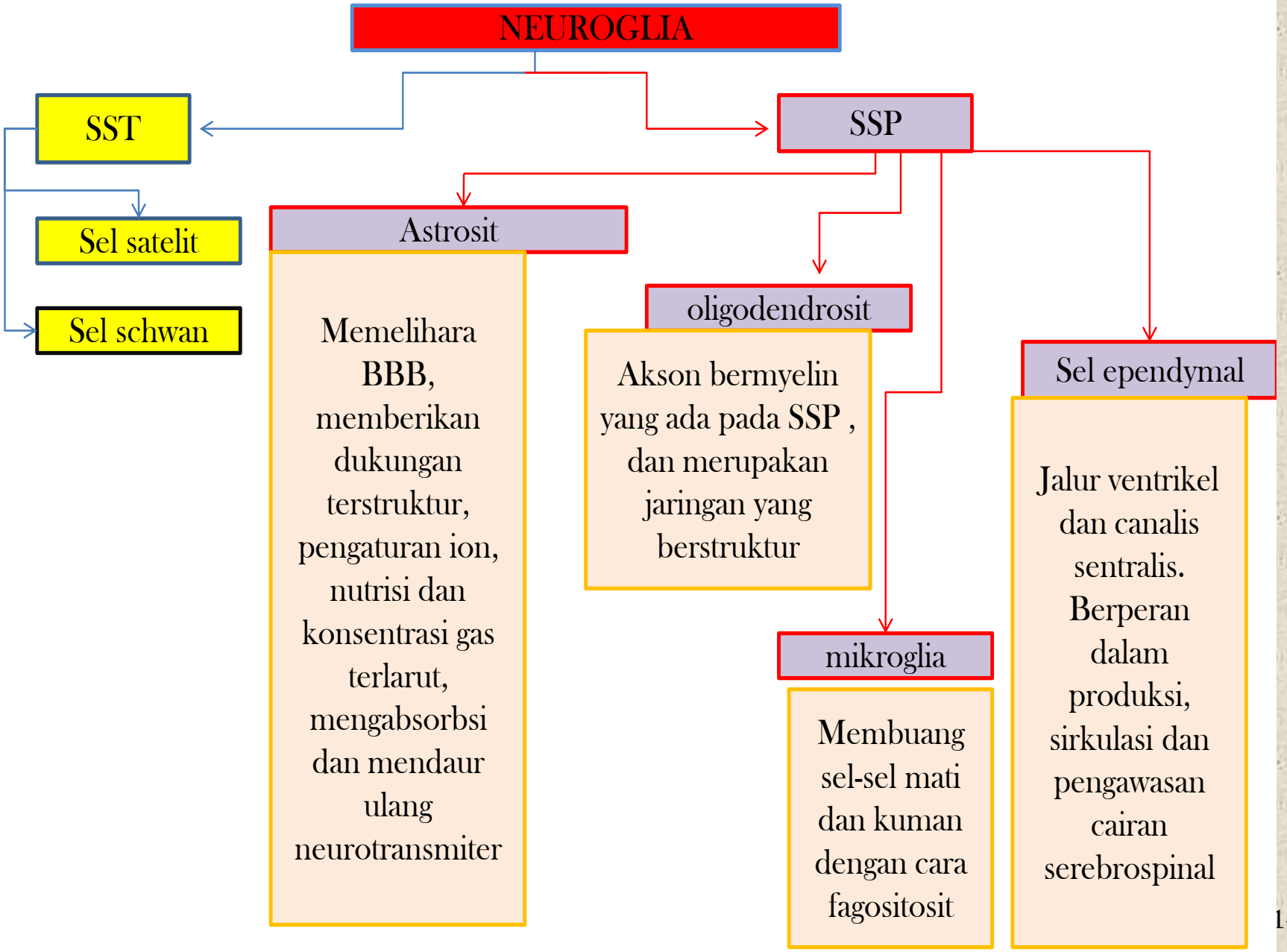
Functional classification



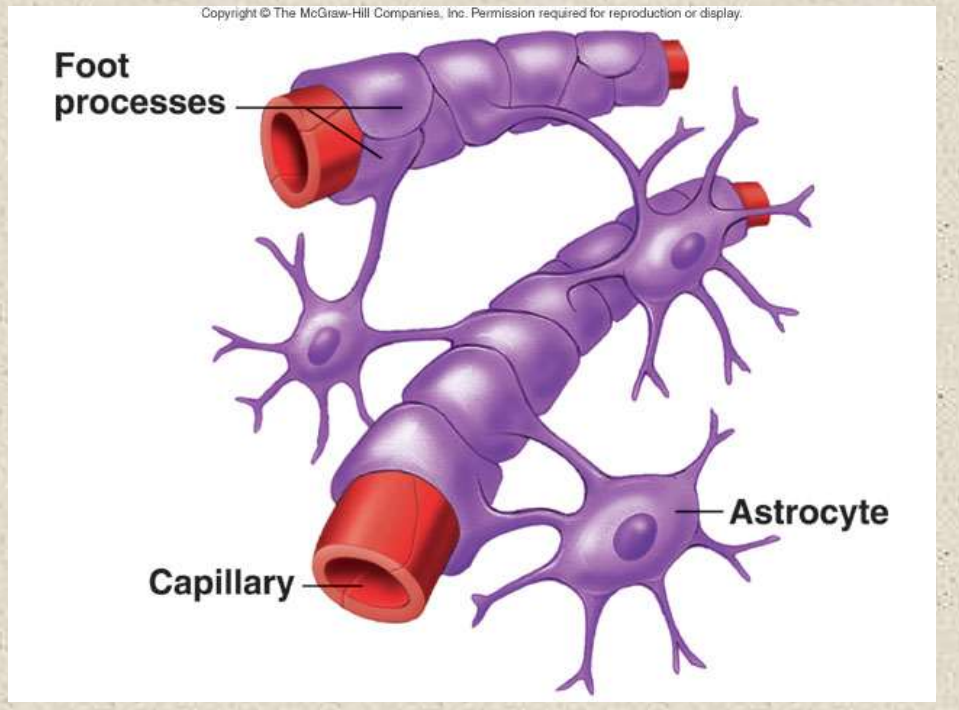
1.Anaksonic Neurons b. Bipolar Neuron c. Pseudounipolar Neuron d. Multipolar Neuron

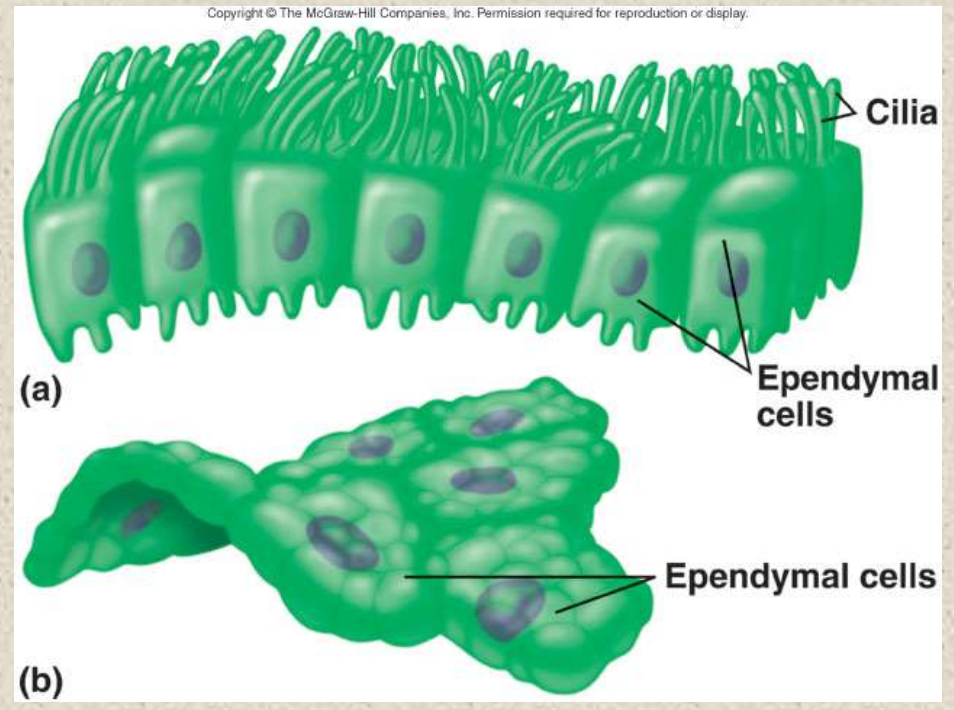


Structural classification


NEUROGLIA
SST
Sel satelit
Sel schwan
SSP
Astrosit
Memelihara BBB, memberikan dukungan terstruktur, pengaturan ion, nutrisi dan konsentrasi gas terlarut, mengabsorbsi dan mendaur ulang neurotransmiter
oligodendrosit
Akson bermyelin yang ada pada SSP , dan merupakan jaringan yang berstruktur
mikroglia
Membuang sel-sel mati dan kuman dengan cara fagositosit
Sel ependymal
Jalur ventrikel dan canalis sentralis. Berperan dalam produksi, sirkulasi dan pengawasan cairan serebrospinal

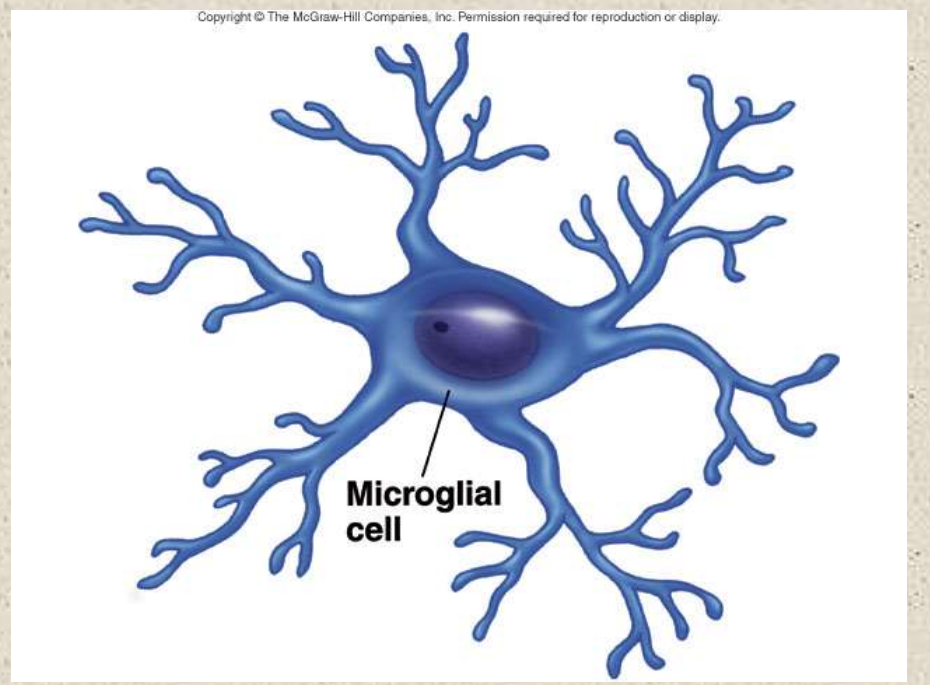
Neuroglia of CNS

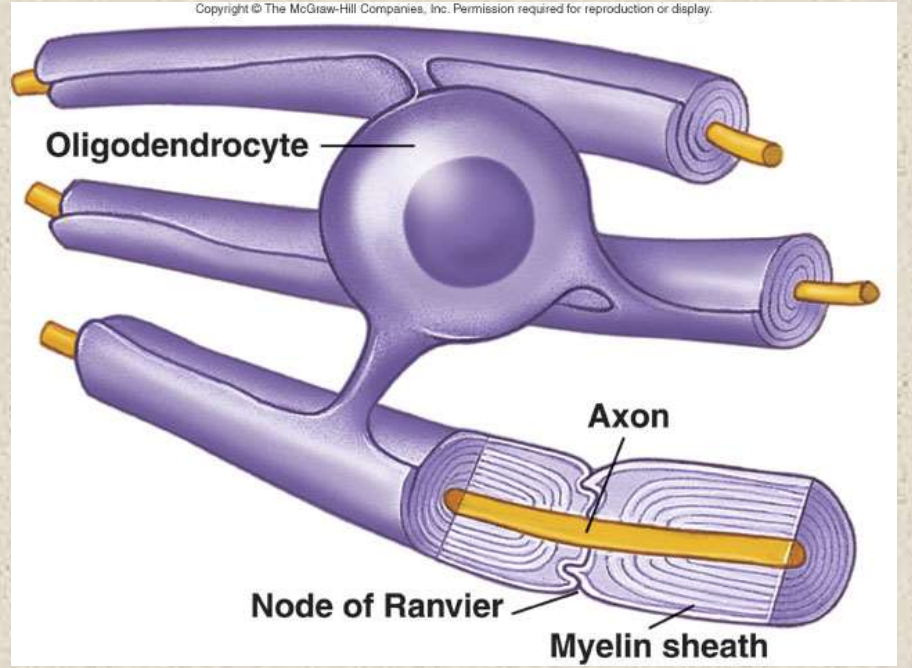




- Astrocytes
  - Regulate extracellular brain fluid composition
  - Promote tight junctions to form blood-brain barrier
- Ependymal Cells
  - Line brain ventricles and spinal cord central canal
  - Help form choroid plexuses that secrete CSF

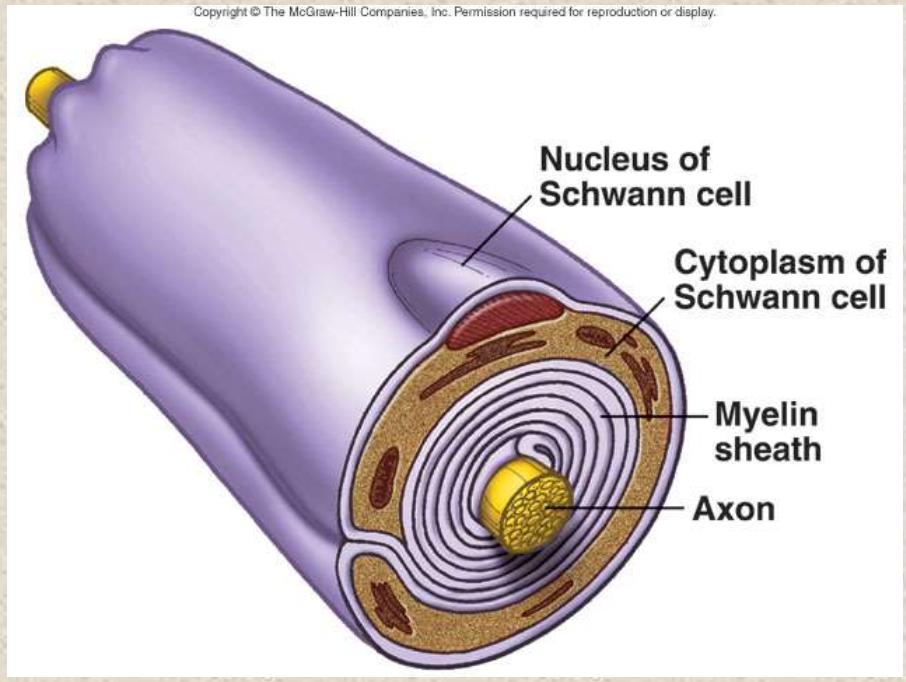
Neuroglia of CNS

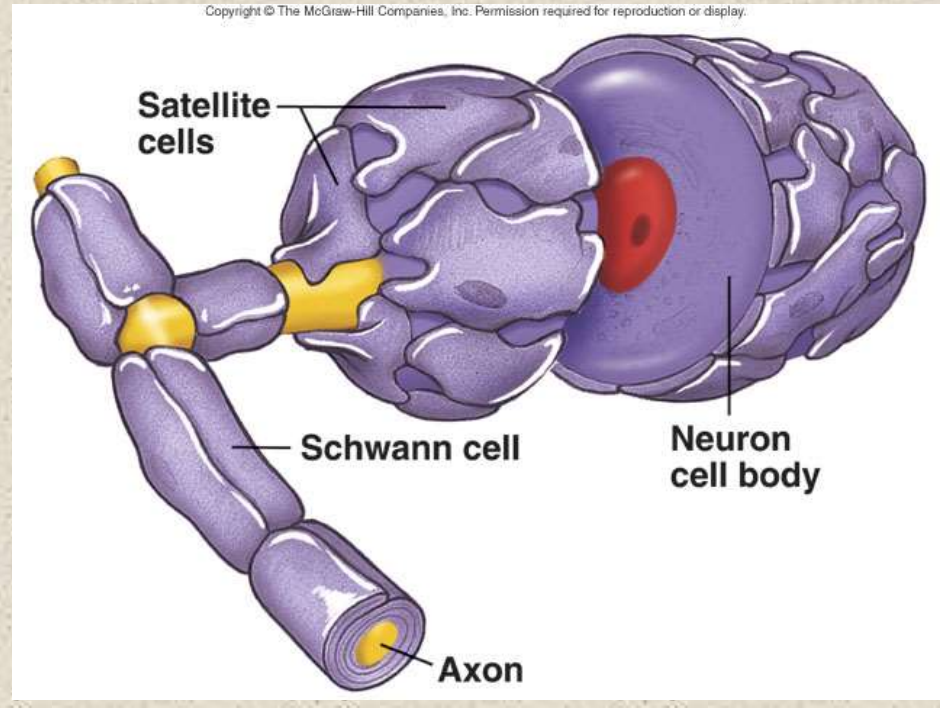




- Microglia
  - Specialized macrophages
- Oligodendrocytes
  - Form myelin sheaths if surround axon

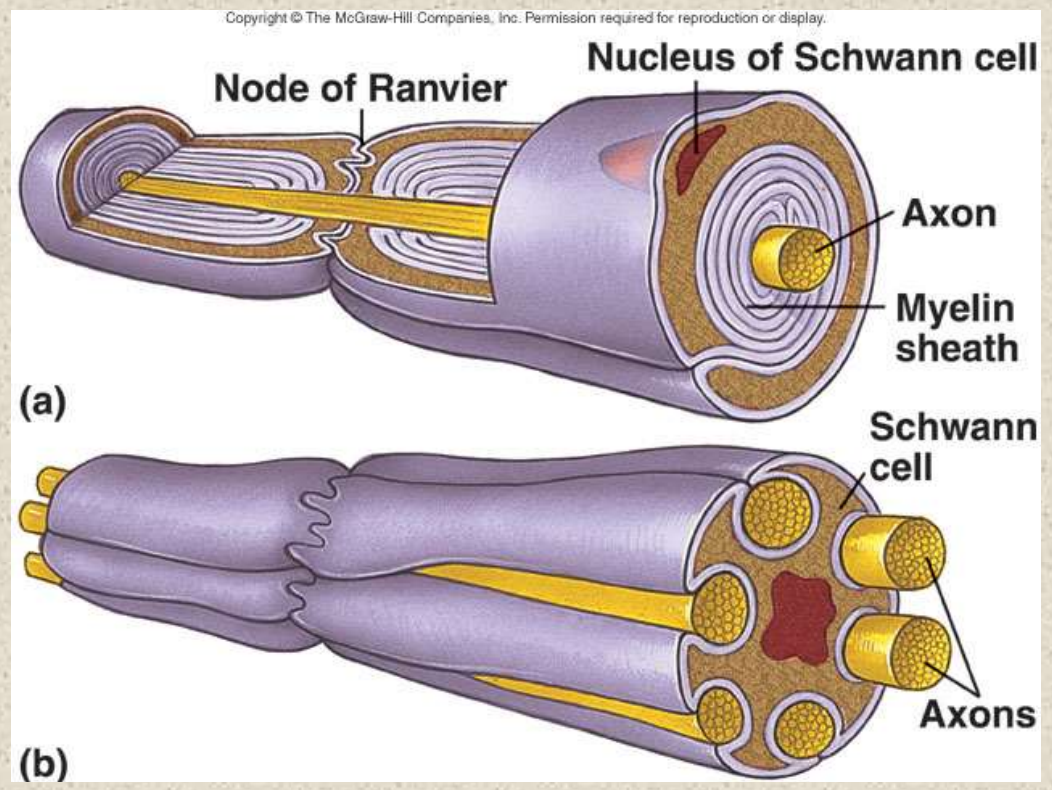
Neuroglia of PNS



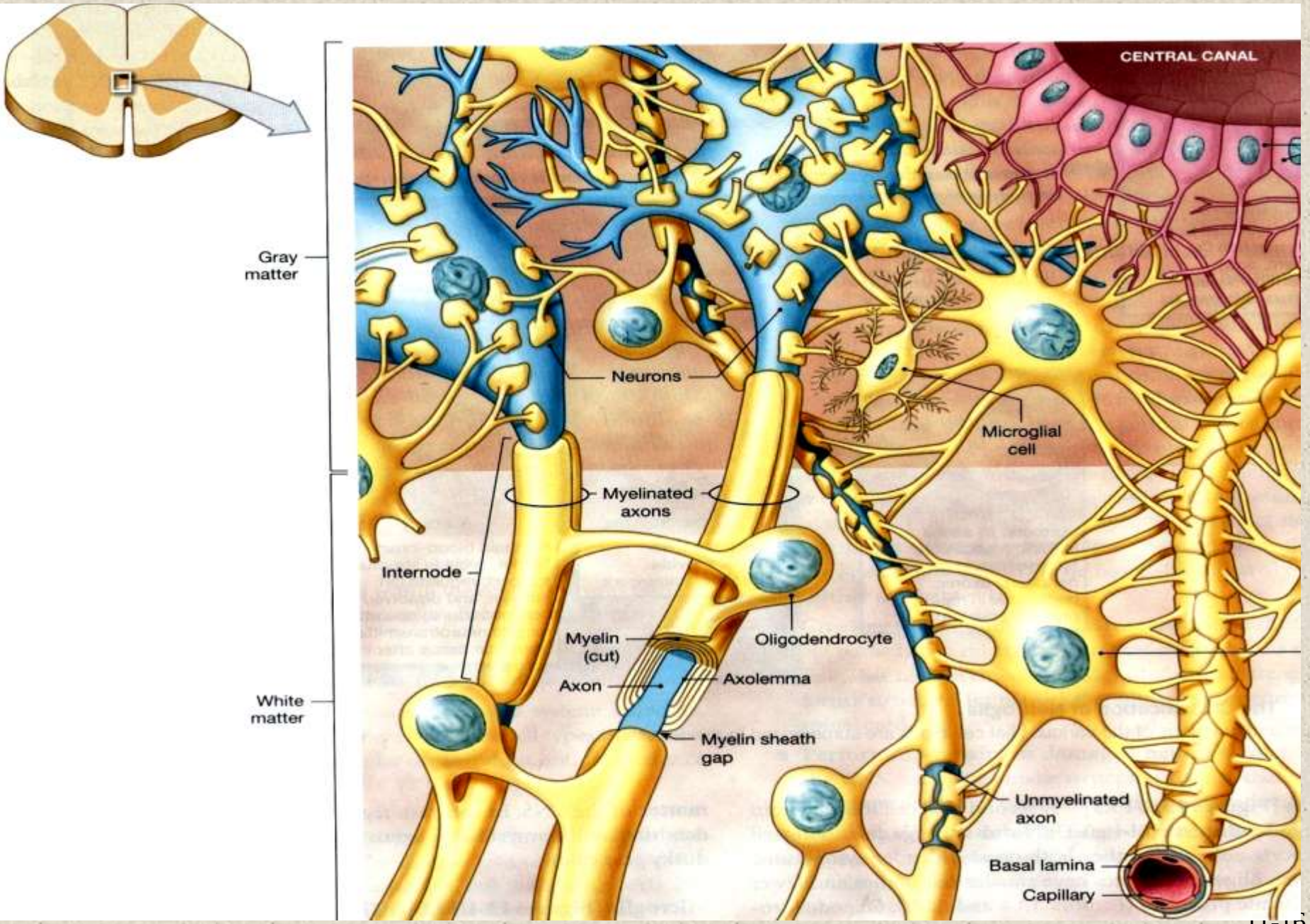


- Schwann cells or neurolemmocytes
  - Wrap around portion of only one axon to form myelin sheath
- Satellite cells
  - Surround neuron cell bodies in ganglia, provide support and nutrients

Myelinated and Unmyelinated Axons



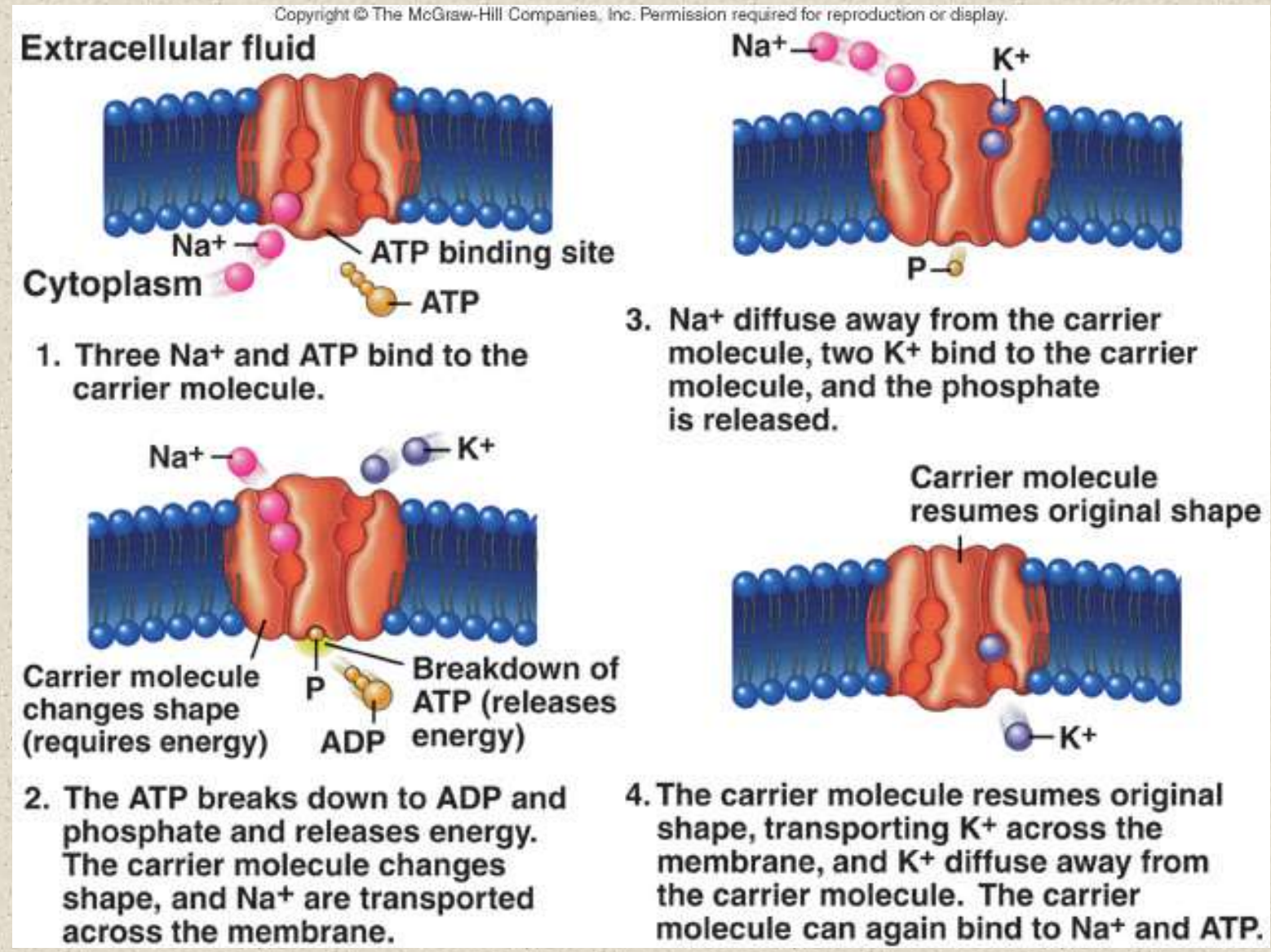
- Myelinated axons
  - Myelin protects and insulates axons from one another
  - Not continuous
    - Nodes of Ranvier
- Unmyelinated axons


Gray matter
White matter
CENTRAL CANAL
Neurons
Microglial cell
Myelinated axons
Internode
Myelin (cut)
Oligodendrocyte
Axon
Axolemma
Myelin sheath gap
Unmyelinated axon
Basal lamina
Capillary

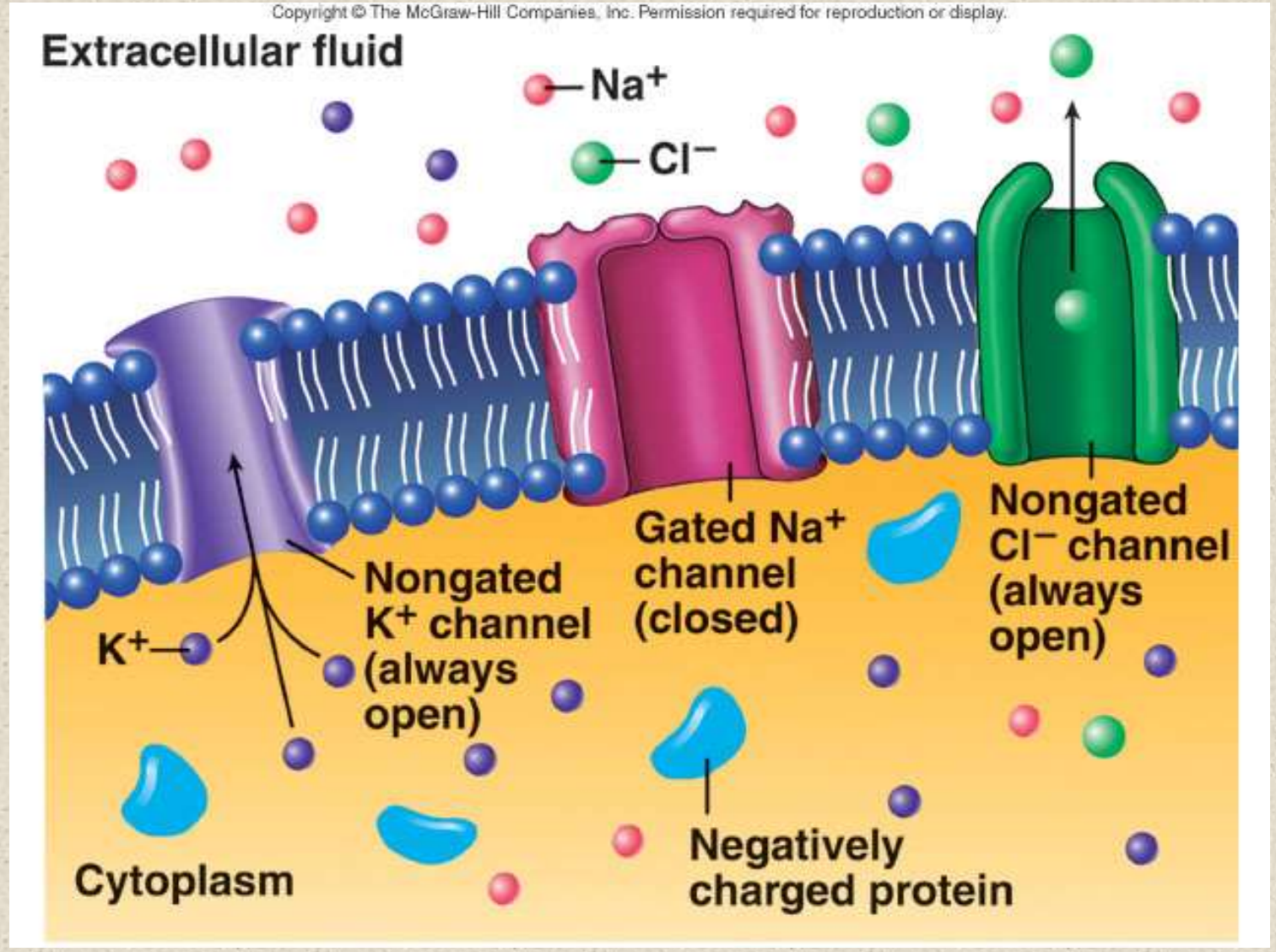
Electrical Signals

- Cells produce electrical signals called action potentials
- Transfer of information from one part of body to another
- Electrical properties result from ionic concentration differences across plasma membrane and permeability of membrane

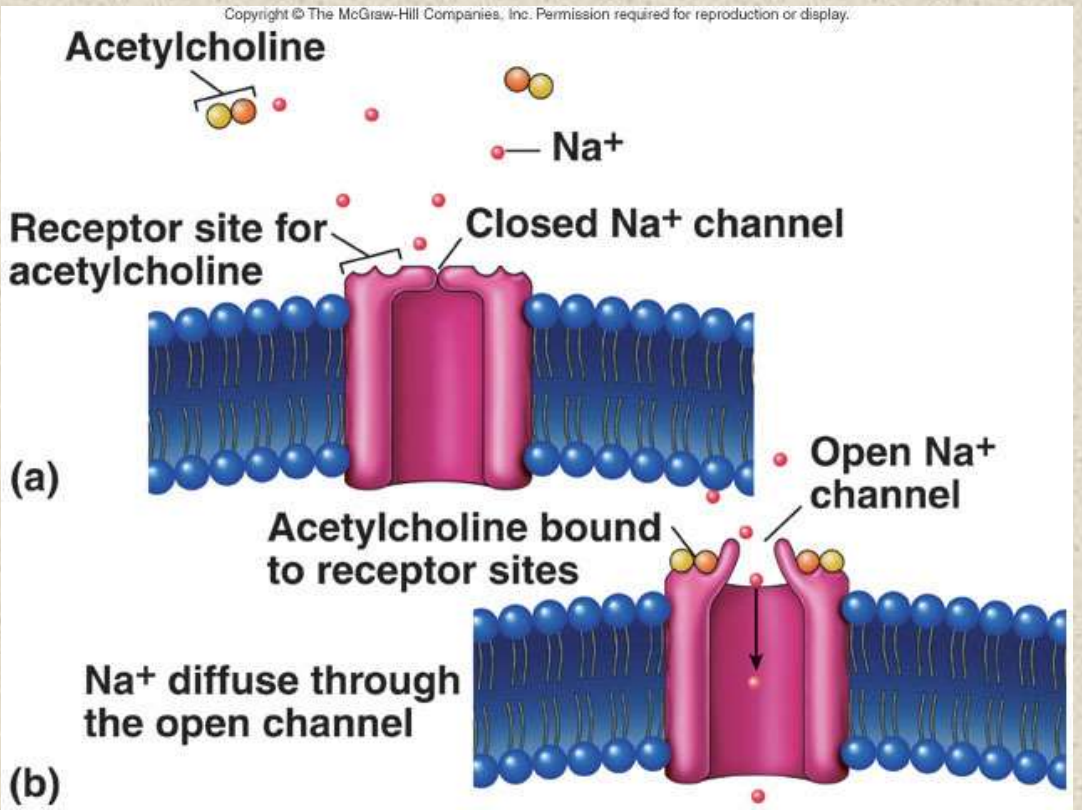
Sodium-Potassium Exchange Pump



Membrane Permeability

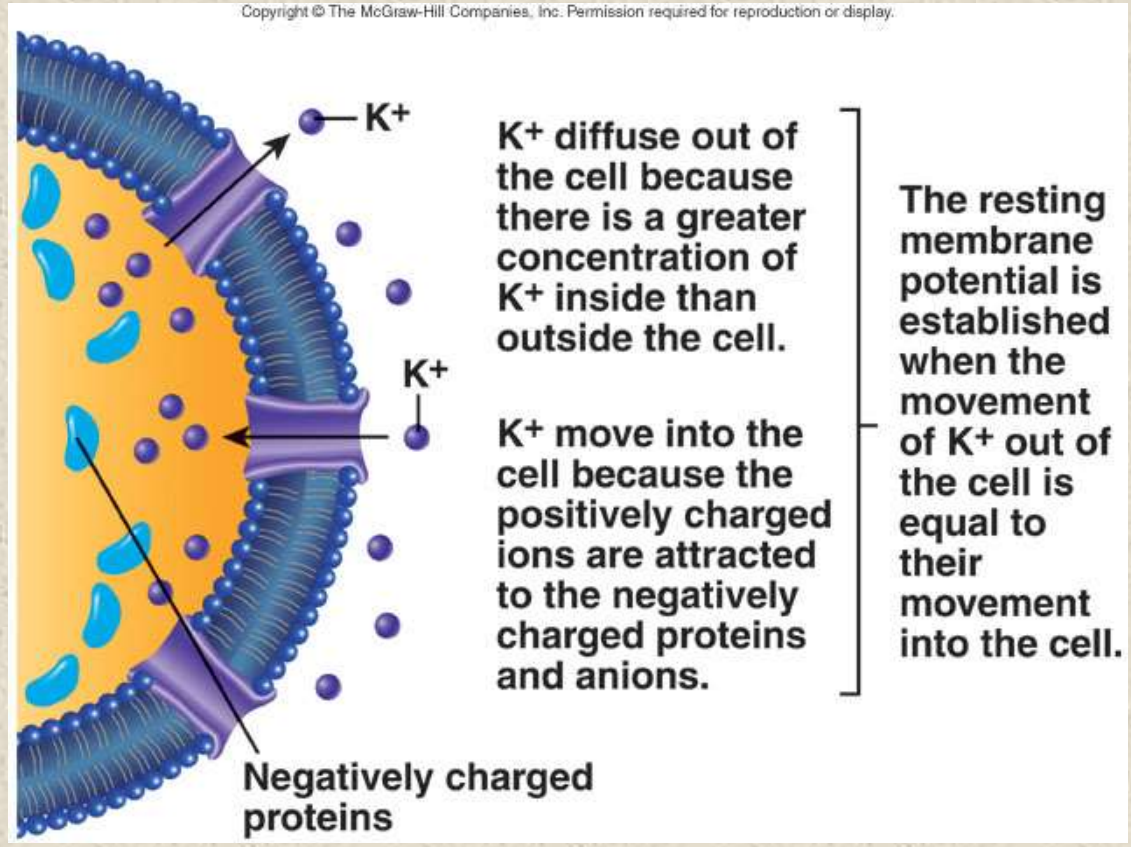


Ion Channels



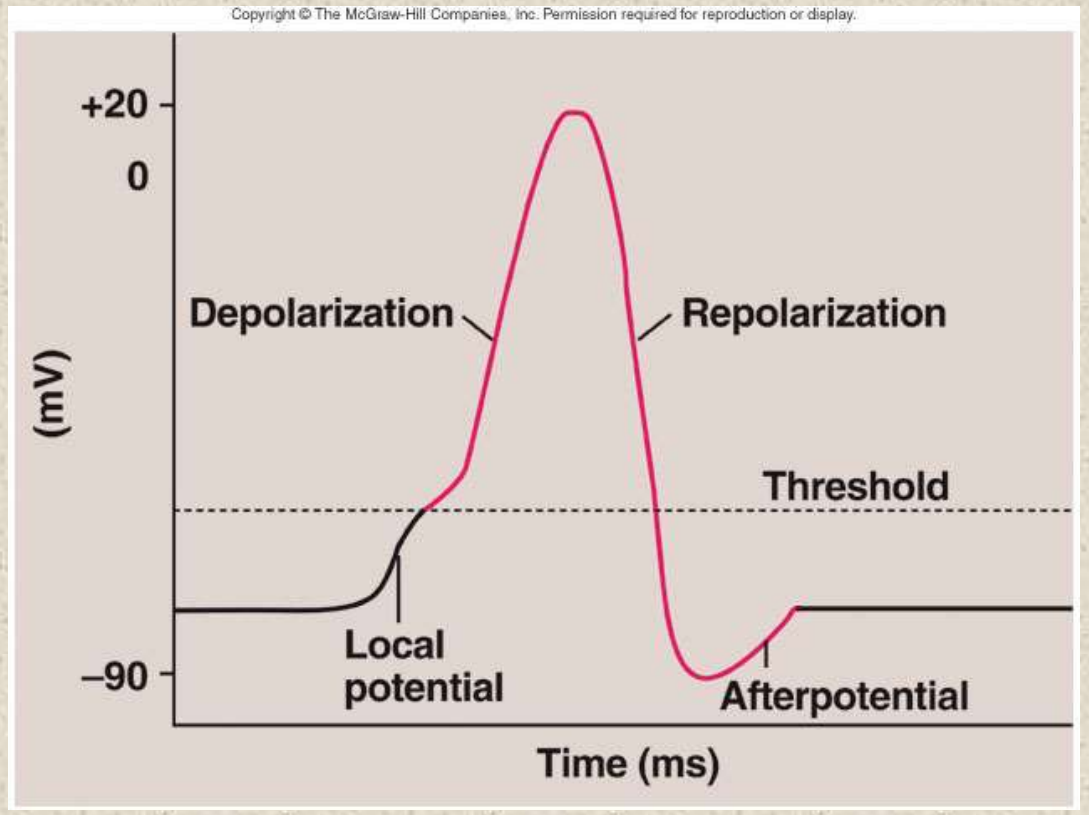
- Nongated or leak channels
  - Always open and responsible for permeability
  - Specific for one type of ion although not absolute
- Gated ion channels
  - Ligand-gated
    - Open or close in response to ligand binding to receptor as ACh
  - Voltage-gated
    - Open or close in response to small voltage changes

Resting Membrane Potential



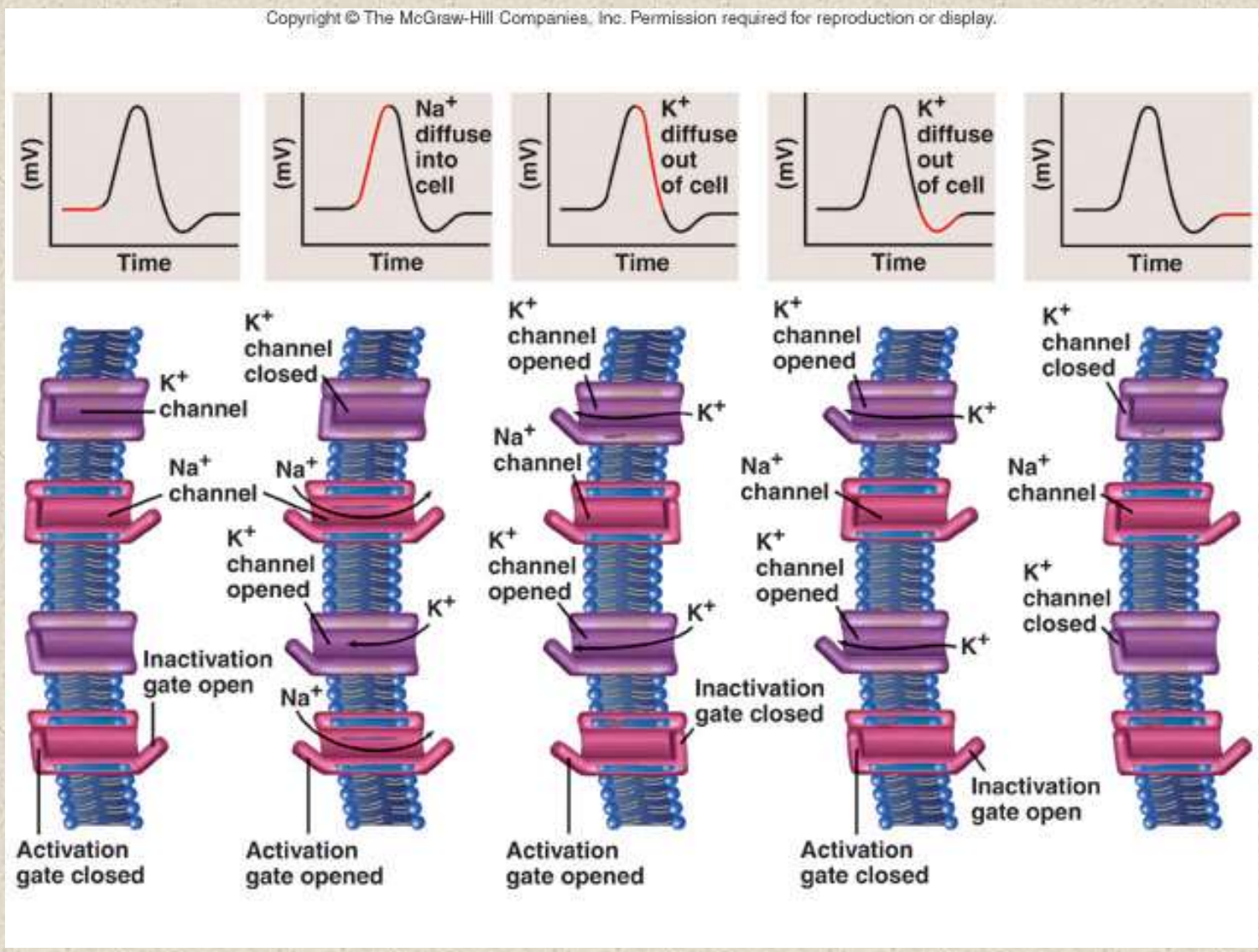
- Characteristics
  - Number of charged molecules and ions inside and outside cell nearly equal
  - Concentration of K^+ higher inside than outside cell, Na^+ higher outside than inside
  - At equilibrium there is very little movement of K+ or other ions across plasma membrane

Action Potentials

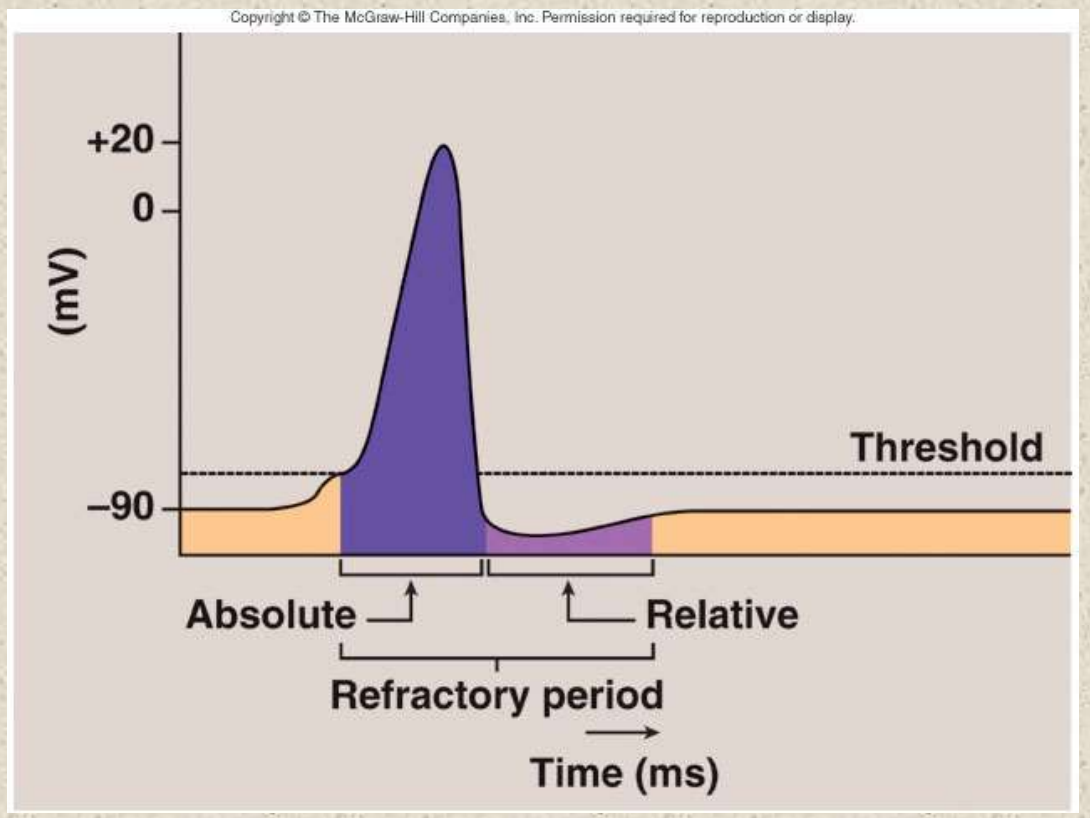


- Series of permeability changes when a local potential causes depolarization of membrane
- Phases
  - Depolarization
    - More positive
  - Repolarization
    - More negative
- All-or-none principle
  - Camera flash system

Action Potential

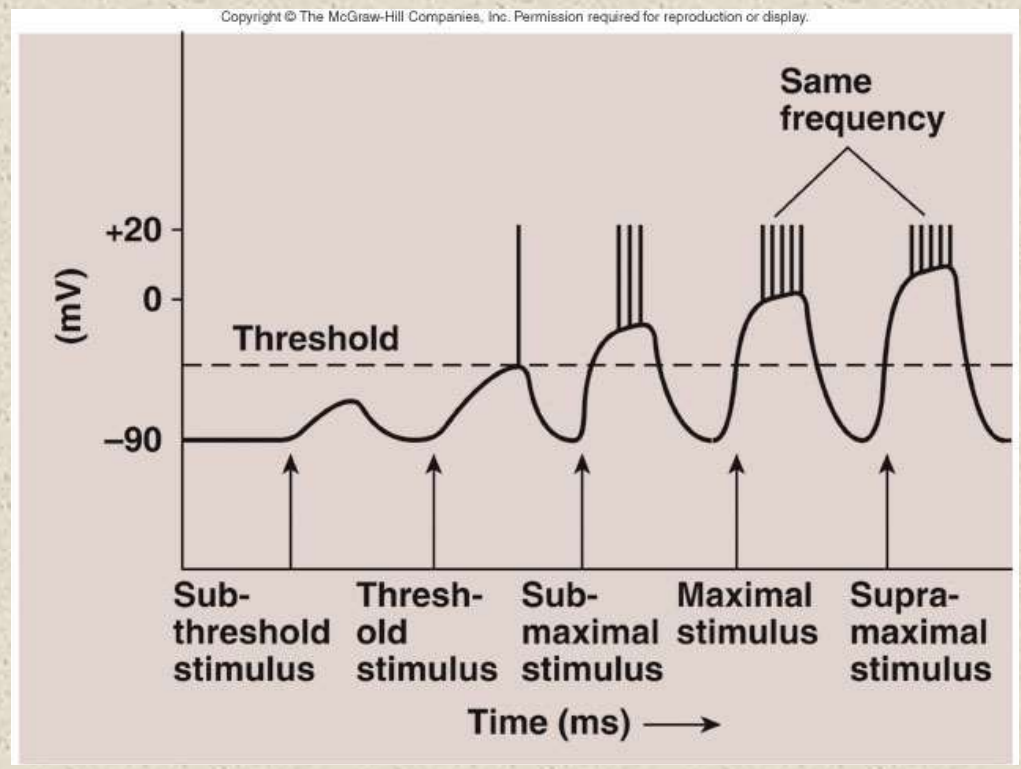


Refractory Period



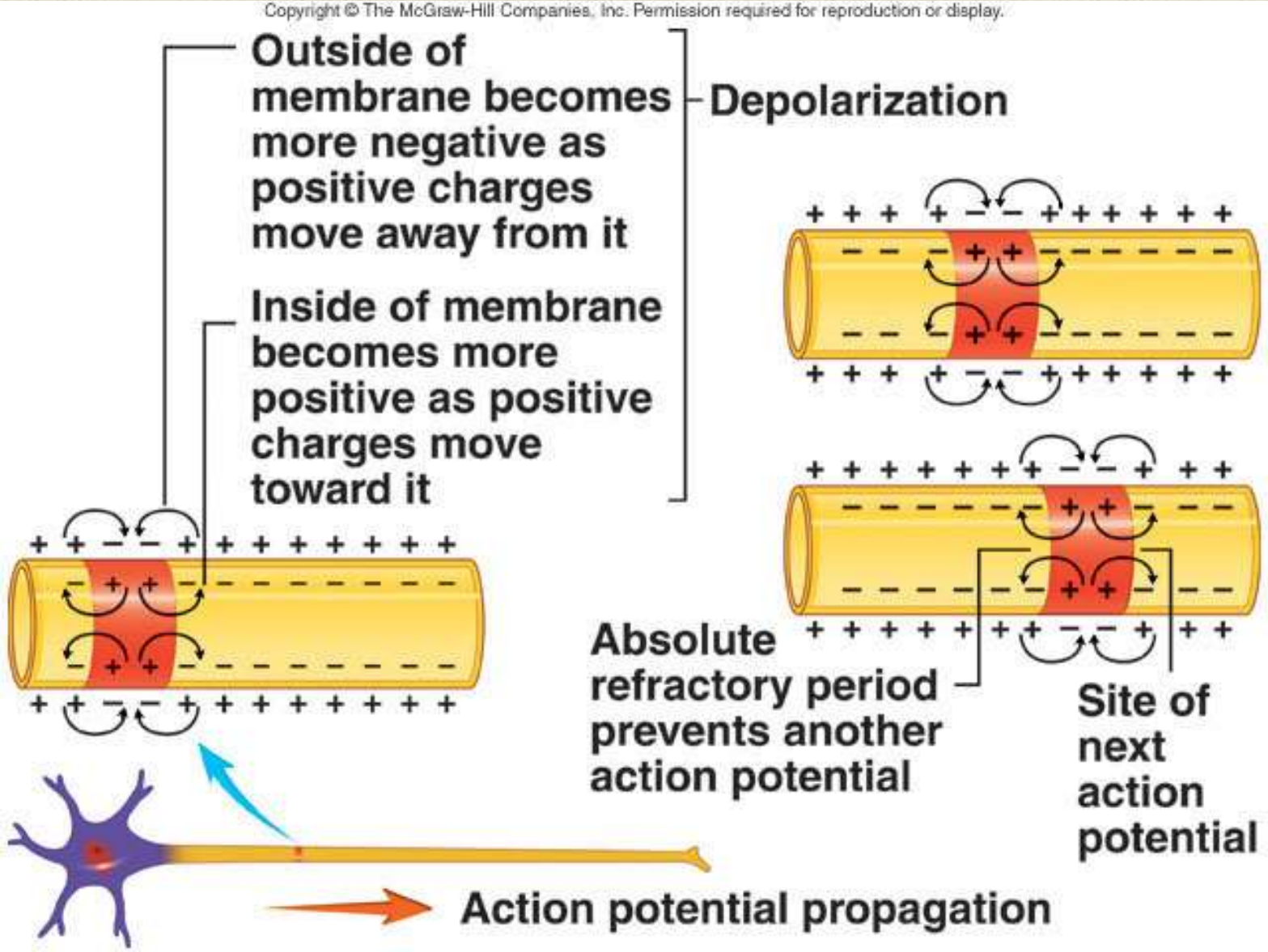
- Sensitivity of area to further stimulation decreases for a time
- Parts
  - Absolute
    - Complete insensitivity exists to another stimulus
    - From beginning of action potential until near end of repolarization
  - Relative
    - A stronger-than-threshold stimulus can initiate another action potential

Action Potential Frequency

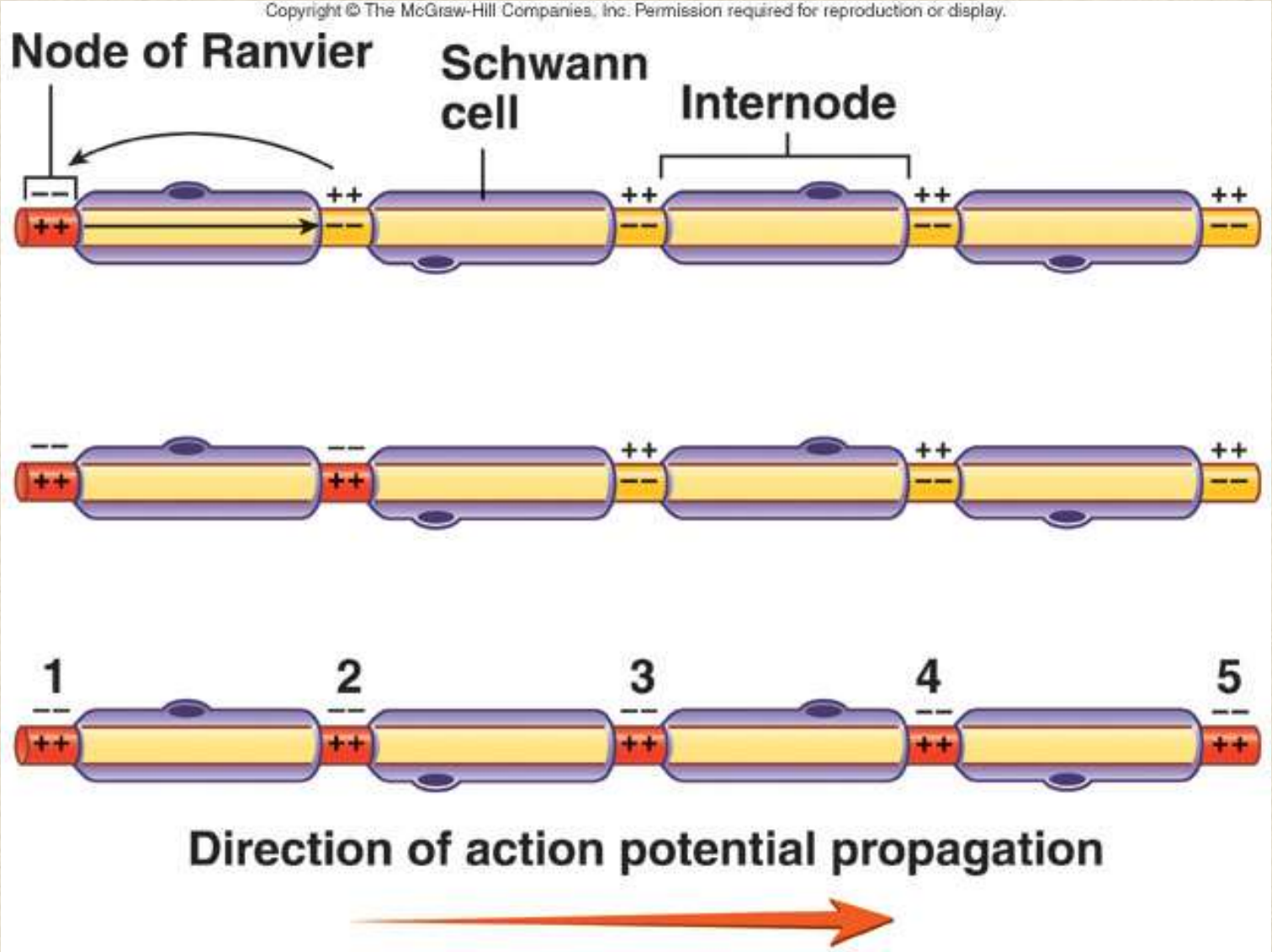


- Number of potentials produced per unit of time to a stimulus
- Threshold stimulus
  - Cause an action potential
- Maximal stimulus
- Submaximal stimulus
- Supramaximal stimulus

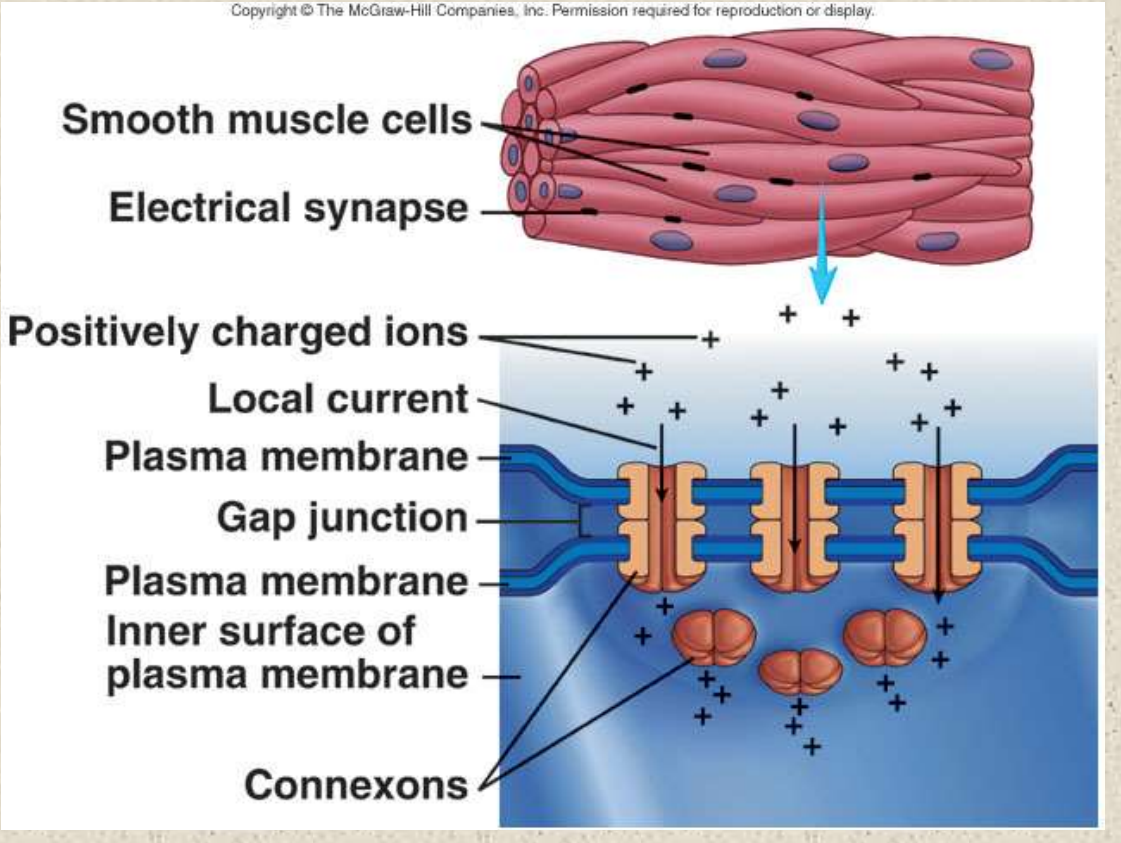
Action Potential Propagation



Saltatory Conduction

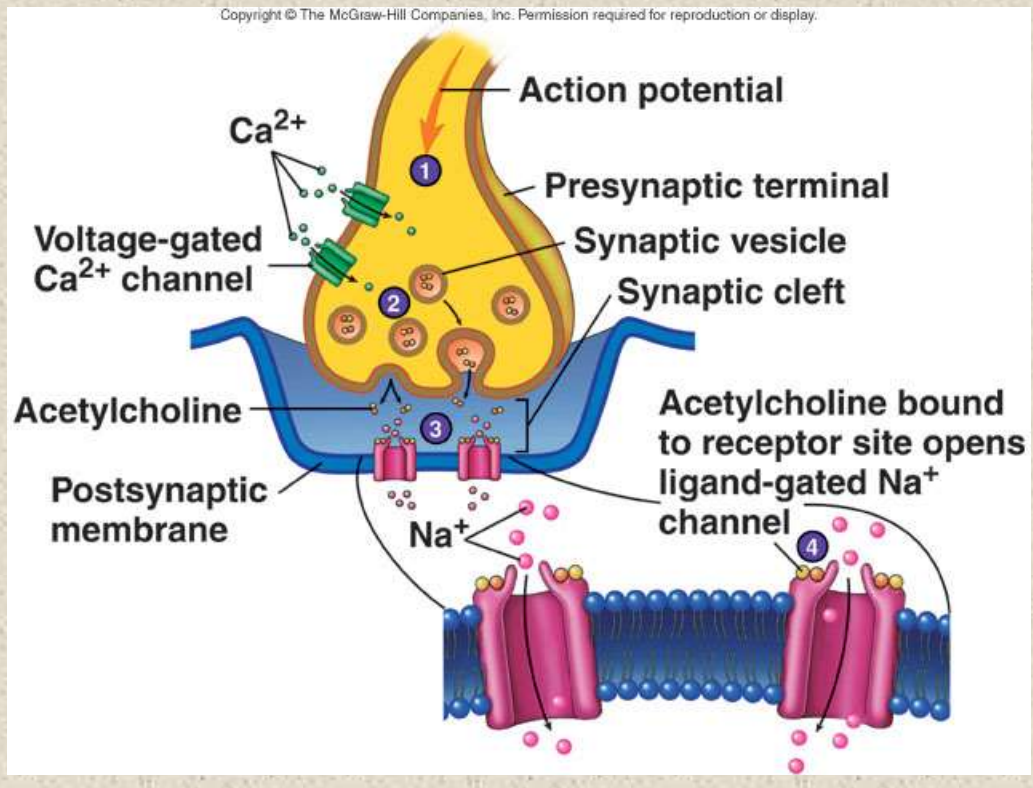


The Synapse



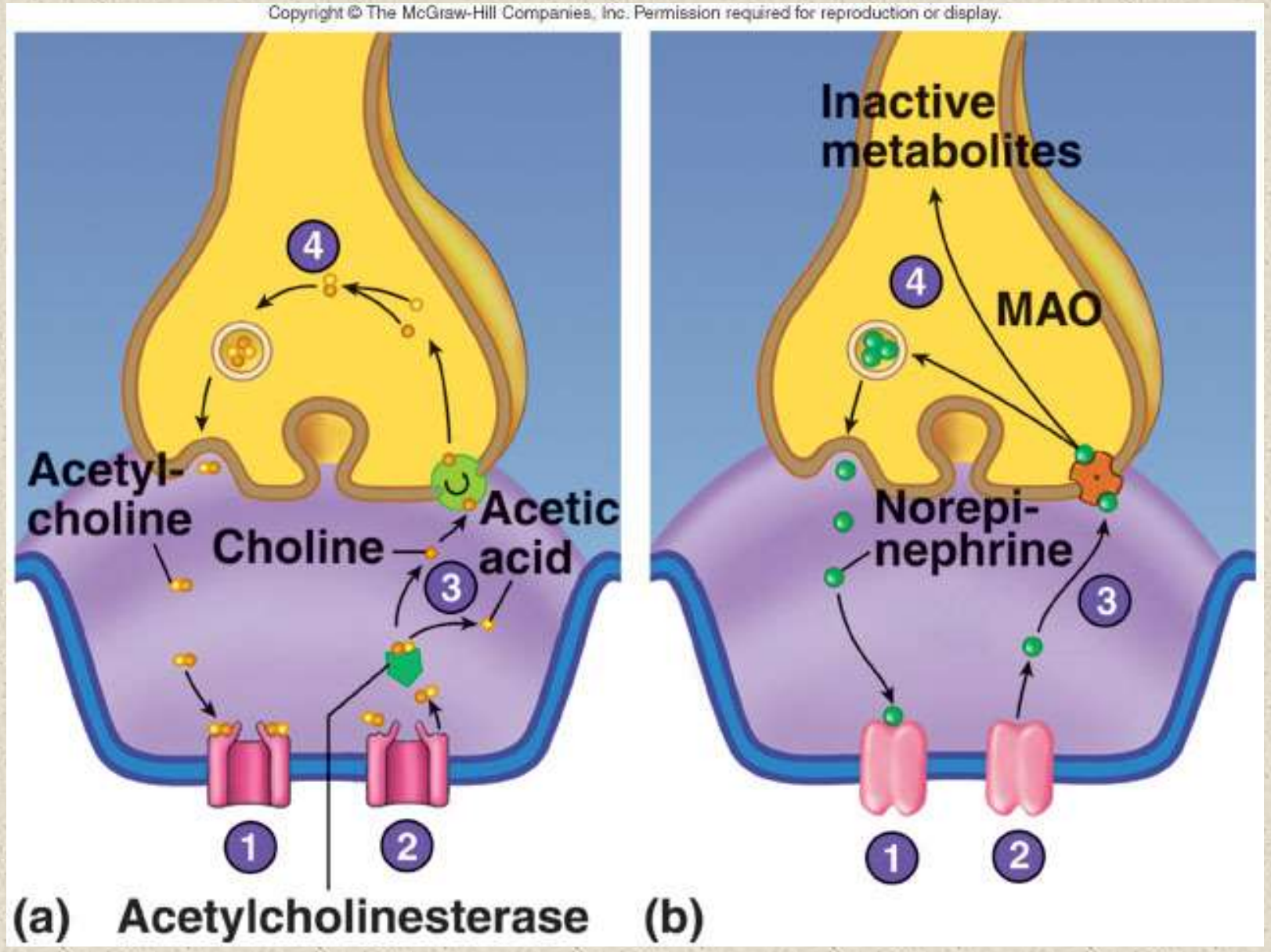
- Junction between two cells
- Site where action potentials in one cell cause action potentials in another cell
- Types
  - Presynaptic
  - Postsynaptic

Chemical Synapses

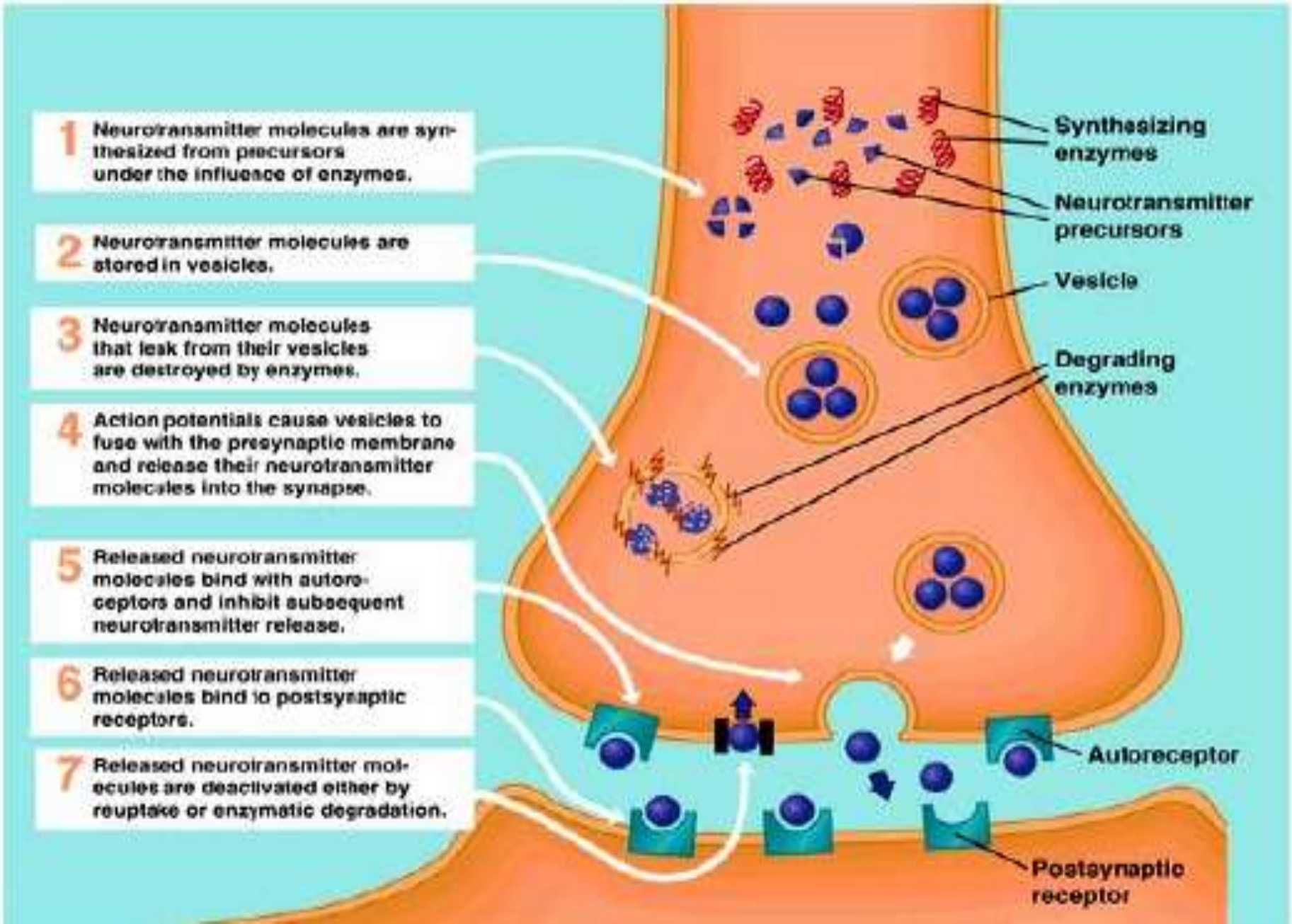


- Components
  - Presynaptic terminal
  - Synaptic cleft
  - Postsynaptic membrane
- Neurotransmitters released by action potentials in presynaptic terminal
  - Synaptic vesicles
  - Diffusion
  - Postsynaptic membrane
- Neurotransmitter removal

Neurotransmitter Removal



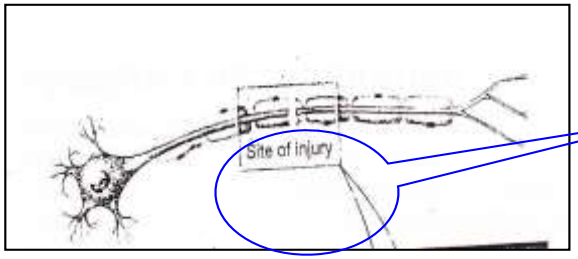
Seven Processes in Neurotransmitter Action

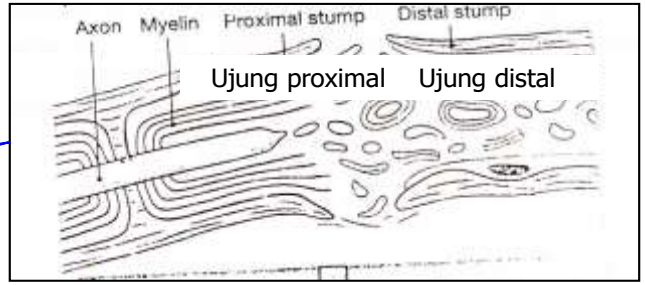


Mekanisme Regenerasi Neuron pada SST

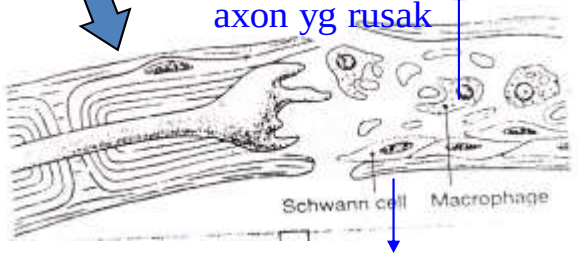
wallerian degeneration

Kerusakan di sel neuron ➔ memutus axon

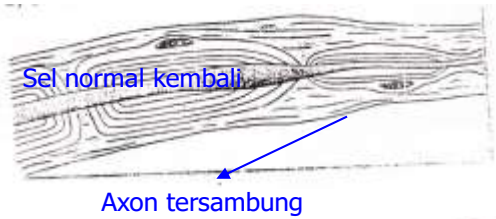




Makrofag memfagositosis axon yg rusak

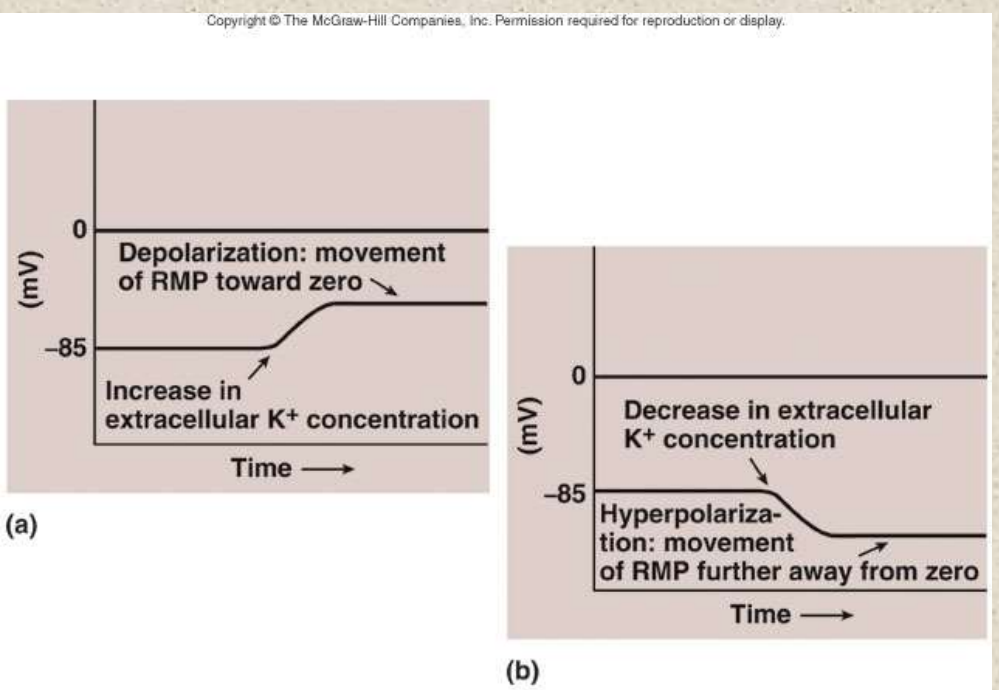


Schwan cell di area yang putus membentuk jaringan padat memanjang yang menyambung pada bagian axon



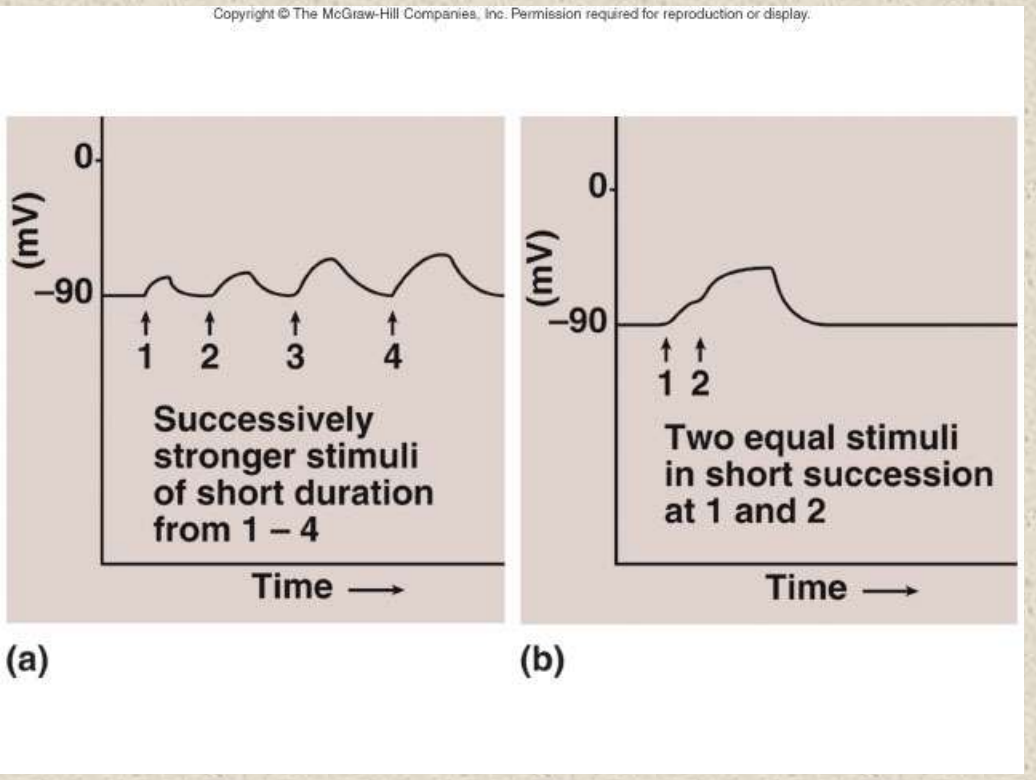

TerimaKasih
SEMOGA BERMANFAAT

Changes in Resting Membrane Potential



- K^+ concentration gradient alterations
- K^+ membrane permeability changes
  - Depolarization or hyperpolarization: Potential difference across membrane becomes smaller or less polar
  - Hyperpolarization: Potential difference becomes greater or more polar
- Na^+ membrane permeability changes
- Changes in Extracellular Ca^{2+} concentrations

Local Potentials



- Result from
  - Ligands binding to receptors
  - Changes in charge across membrane
  - Mechanical stimulation
  - Temperature or changes
  - Spontaneous change in permeability
- Graded
  - Magnitude varies from small to large depending on stimulus strength or frequency
- Can summate or add onto each other

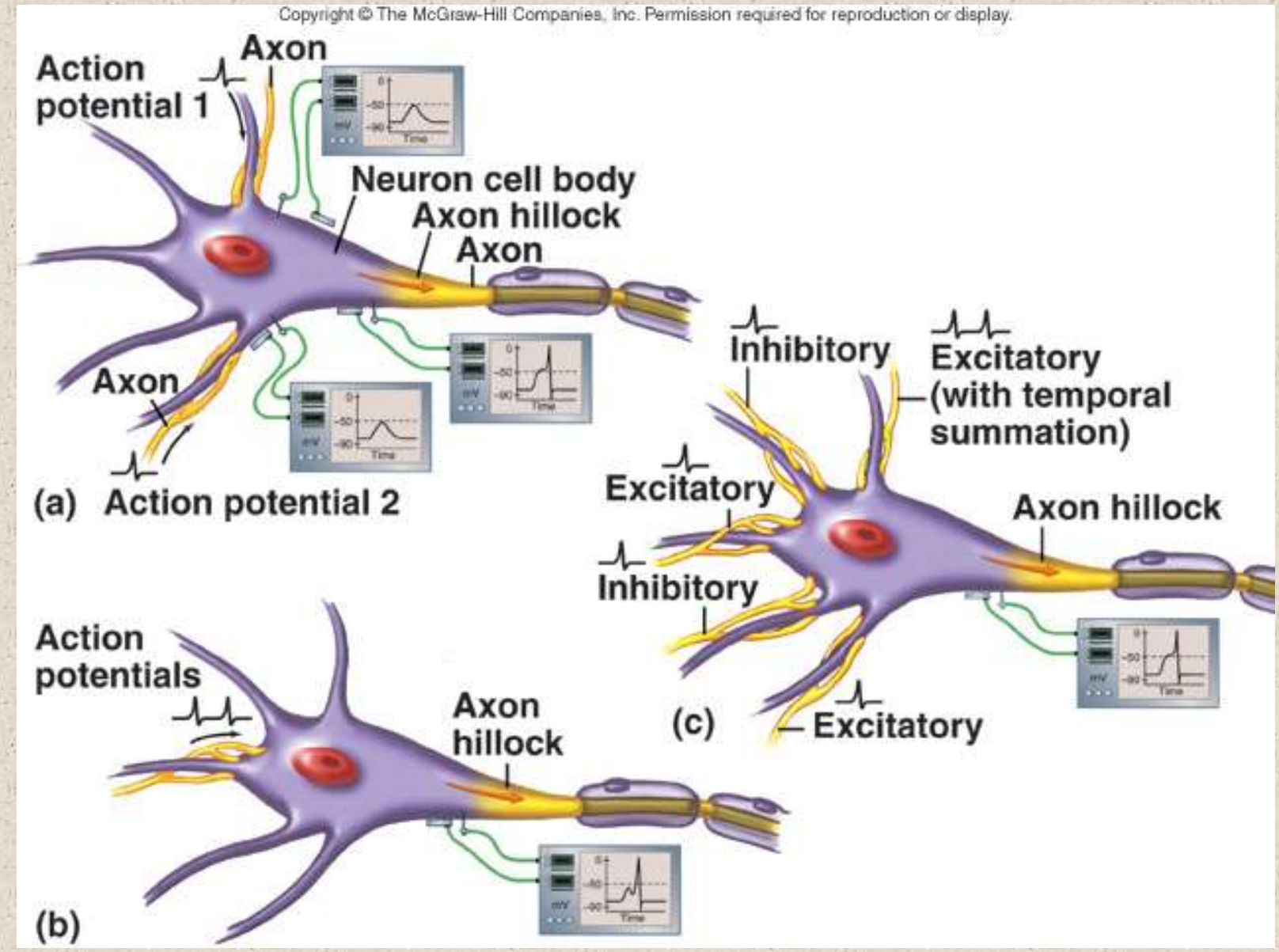
PRE TEST (Sistem somatomotorik)

1. Sebutkan jaras yang terpenting pada sistem saraf somato motorik
2. Jelaskan perjalanan jaras tersebut dengan ringkas
3. Apakah yang dimasud dengan UMN dan jaras ini berjalan dari mana, sampai mana ?
4. Apakah yang dimasud dengan LMN dan jaras ini berjalan dari mana, sampai mana ?
5. Jelaskan bagaimana otot dapat bergerak

PRE TEST (Sistem somatosensorik)

1. Jelaskan ada berapa macam sensorik ?
2. Sebutkan jaras – jara pada sistem saraf somato sensorik
3. Jelaskan perjalanan jaras tersebut dengan ringkas
4. Jelaskan bagaimana system sensorik itu bekerja.

Summation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Action potential 1
Axon
Neuron cell body
Axon hillock
Axon
Axon
(a) Action potential 2
Inhibitory
Excitatory (with temporal summation)
Excitatory
Axon hillock
Inhibitory
(c)
Excitatory
Action potentials
Axon hillock
(b)