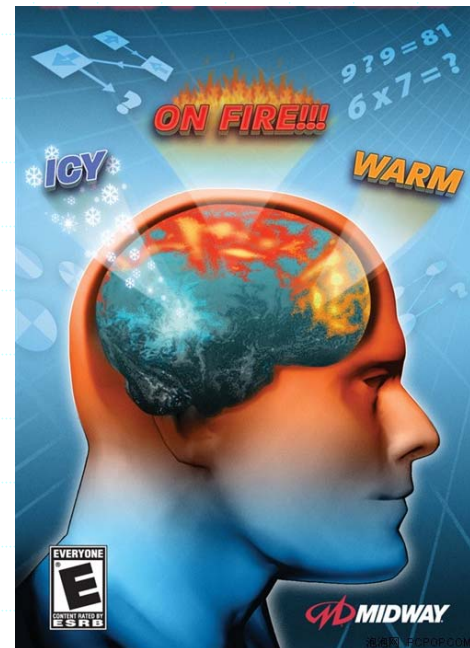


# Chapter 7

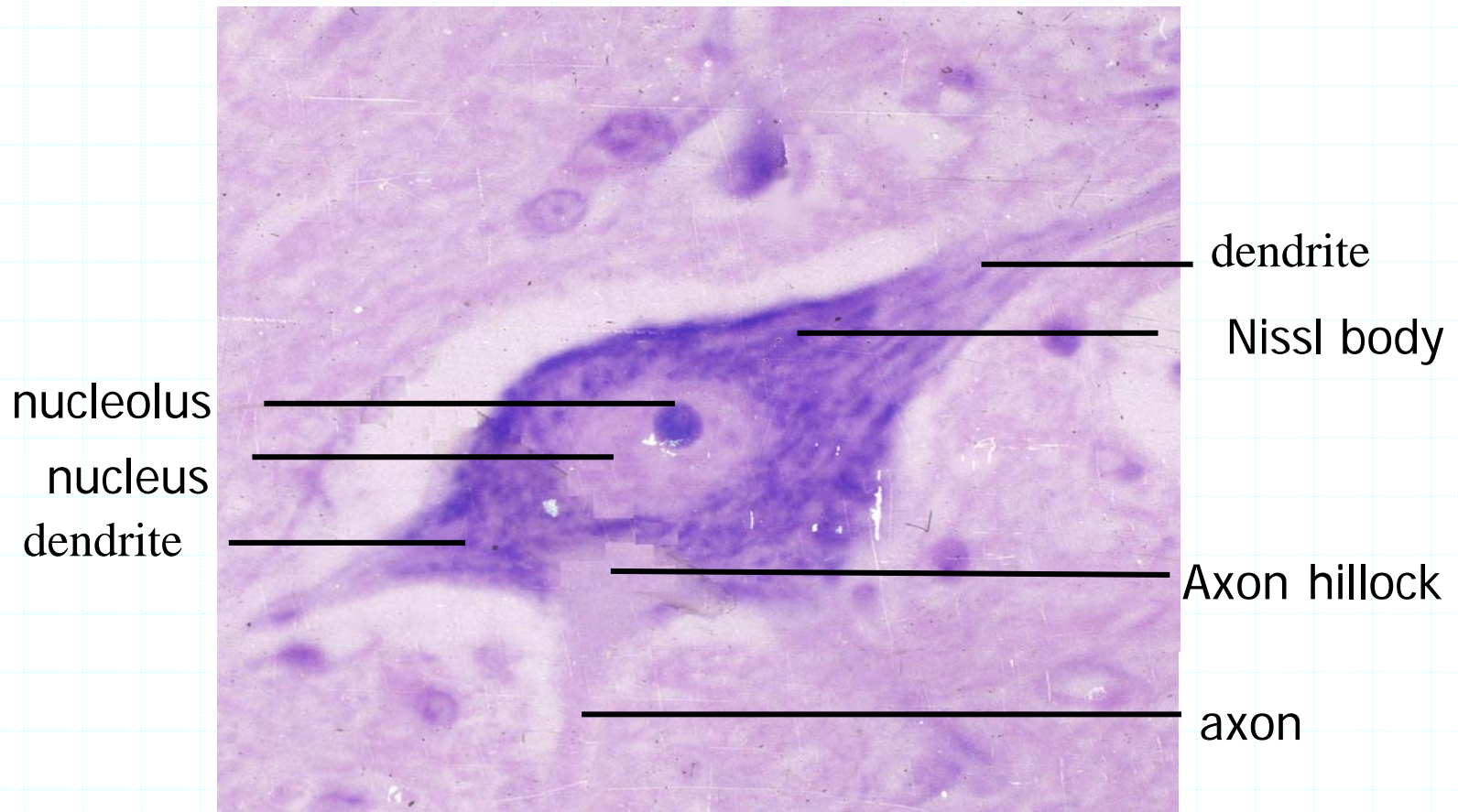
## Nerve tissue 1

Liu Jiamei



# General description:

- **nerve tissue**
  - **nerve cells (neurons):**
    - show numerous long processes
    - receive the stimulation
    - make contact with each other, conduct the nerve impulse to other neurons or effector cells
  - **glial cells (neuroglia)**
    - Support, protect, insulate and nourish neurons
    - Participate in neural activity, and the defense processes of the nervous system.



- a spherical, large, centrally- located, pale-staining nucleus with a large, clear nucleolus.
- Nissl bodies :basophilic granule or mass, abundant in cell bodies and dendrites, but don't exist in axons.



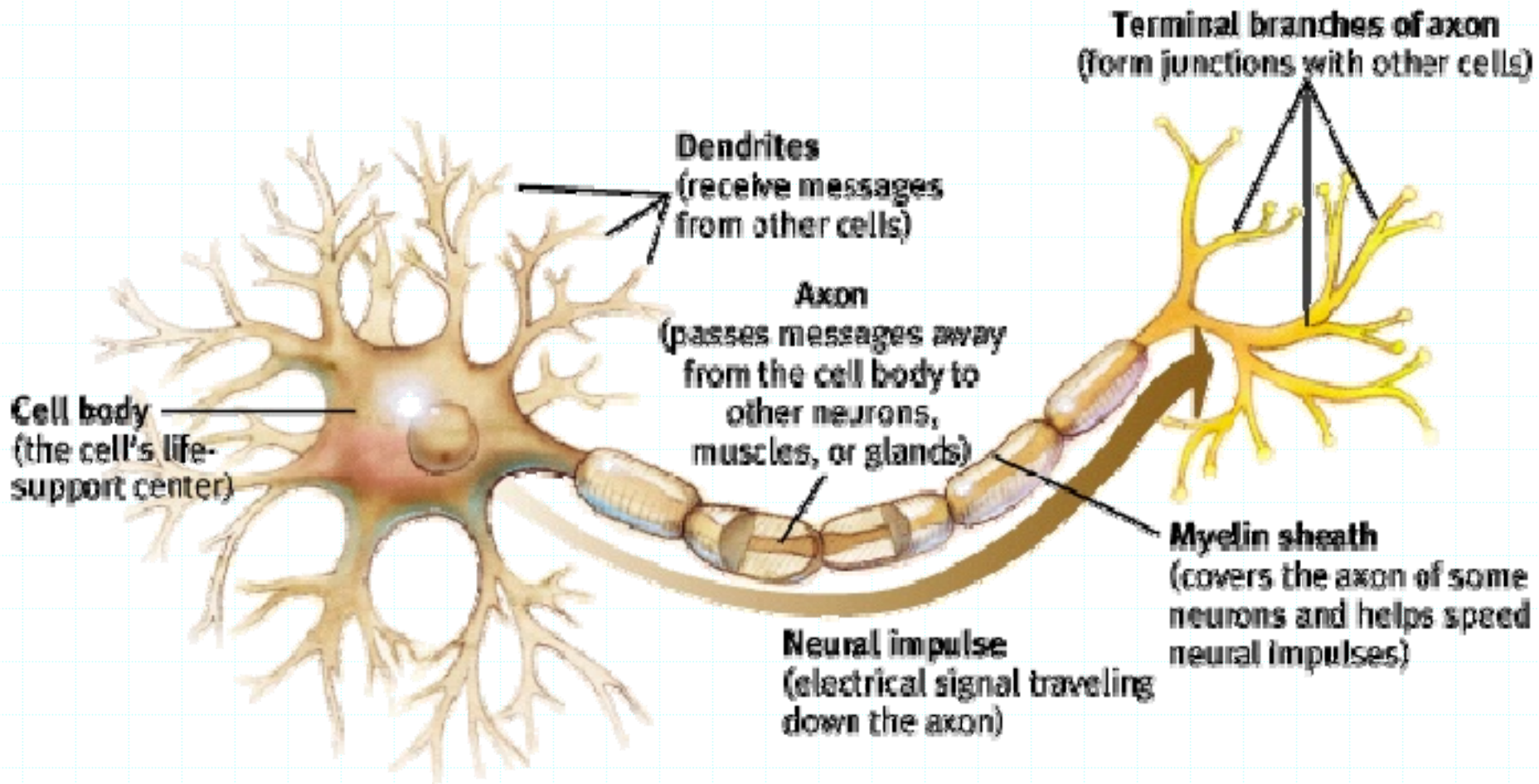
# 1. Neuron

## Neurons consist of 3 parts:

- cell body, or perikaryon:
  - contains nucleus and surrounding cytoplasm
  - the trophic center for the whole nerve cell
  - receive excitatory and inhibitory stimuli generated in other nerve cells
- dendrites:
  - multiple elongated processes
  - receive stimuli
- Axon:
  - a single process with the terminal arborization
  - generate or conduct nerve impulses to other cells.

# 1.1 perikaryon or cell body

- Nucleus
- Rough endoplasmic reticulum  
Nissl bodies
- Golgi apparatus
- Mitochondria
- Neurofilaments & Microtubules  
Neurofibrils)
- Inclusions



**General structure of neuron**





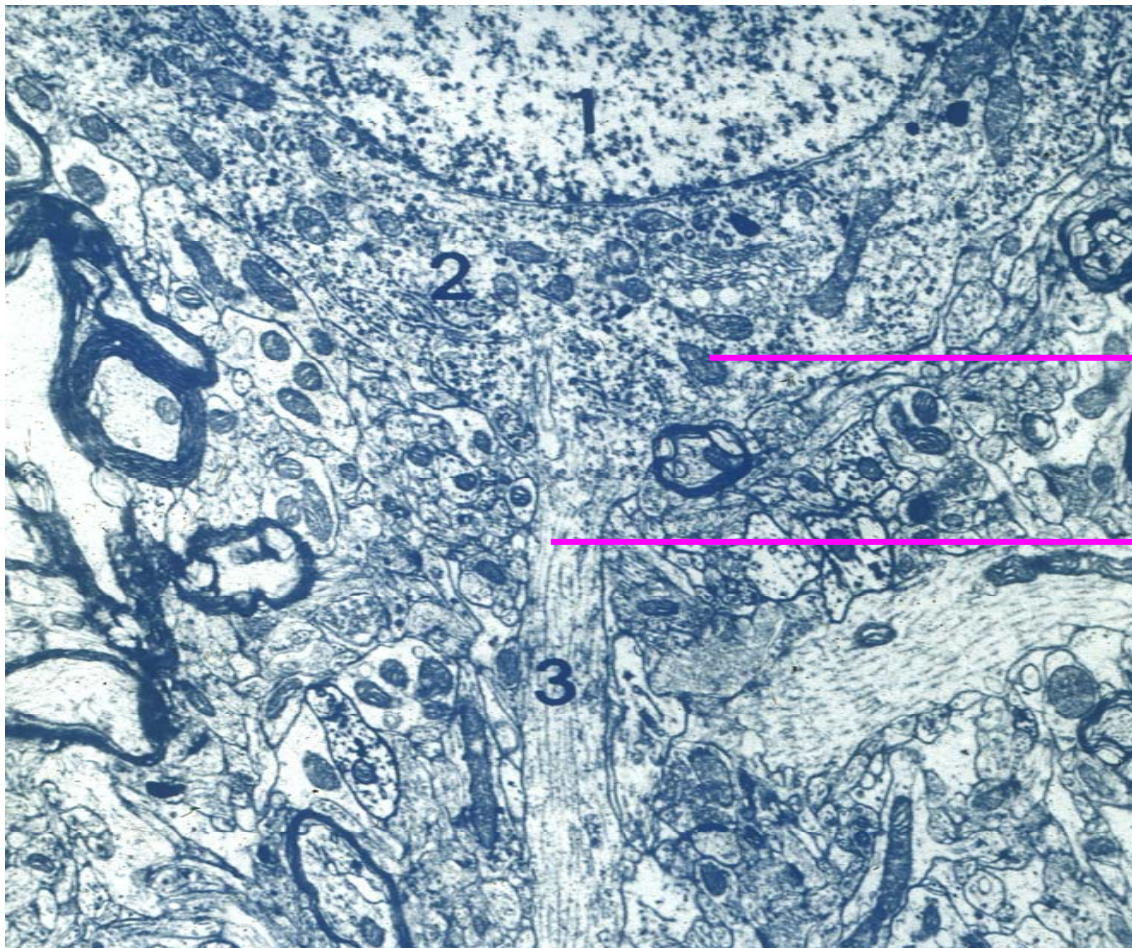
RER

polysomes

- **EM: parallelly-arranged RER and free polyribosomes, Nissle body**
- **synthesize structural proteins and proteins for transport**

Nissl body, rough endoplasmic reticulum, EM





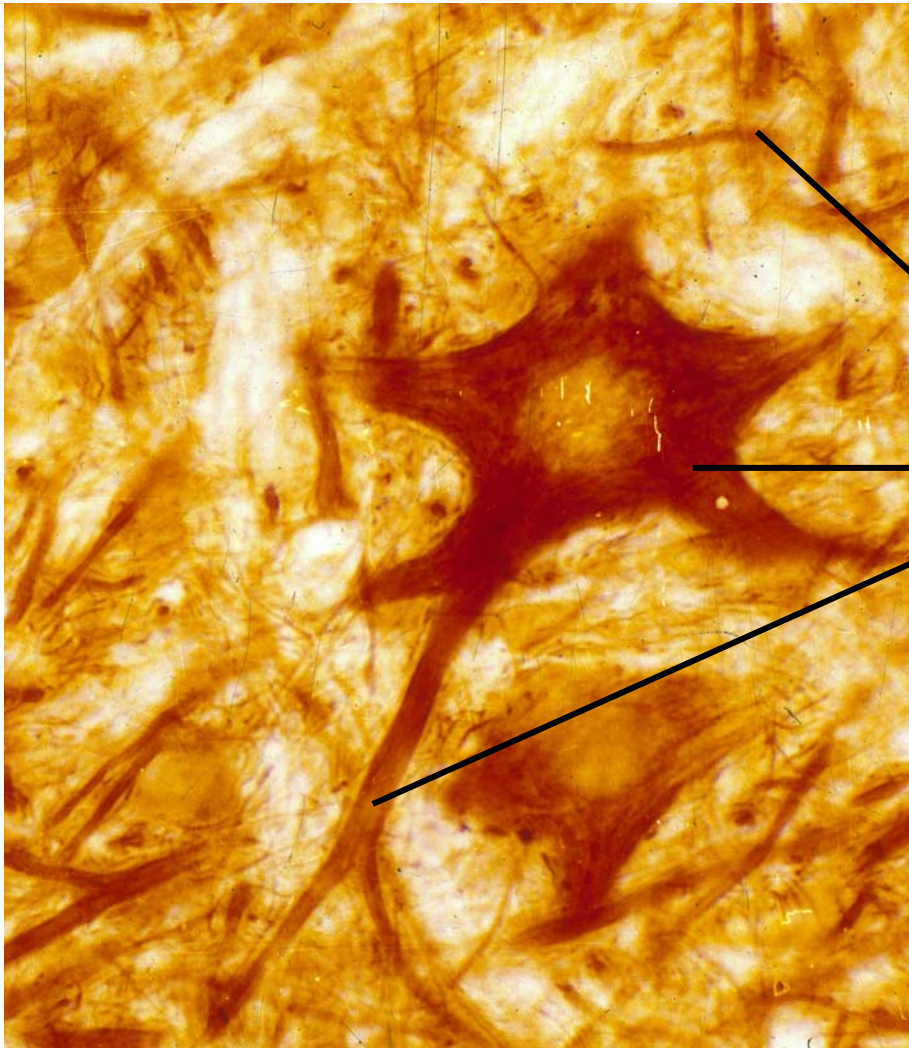
Mitochondria

dendrite

- Golgi apparatus: around the nucleus.
- Mitochondria: scattered throughout the cytoplasm of the perikaryon. A portion of neuron, EM







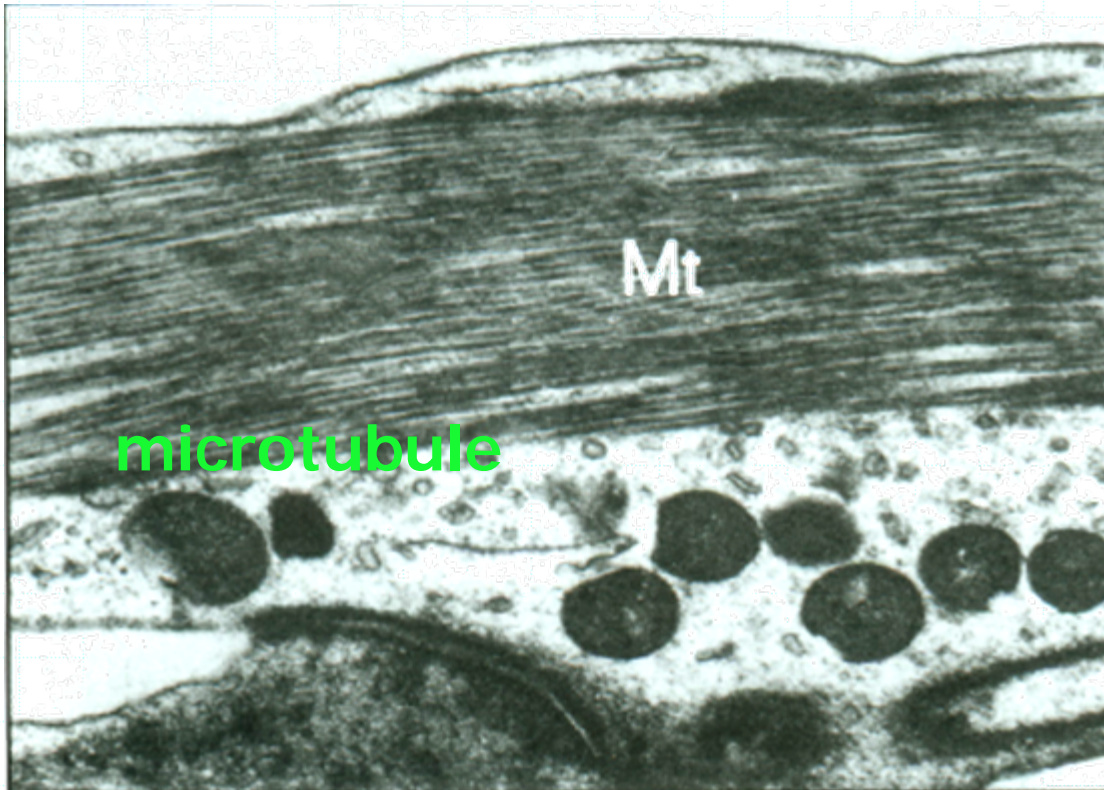
neurofilaments  
Microtubules

## **Neurofibrils**

- abundant in cell bodies, axons, dendrites
- thread-liked dark brown network

Neurofibrils, LM (silver preparation)

- Function:
  - support the neurons as a cell skeleton
  - involve in the transportation of substances



Neurofibrils, EM

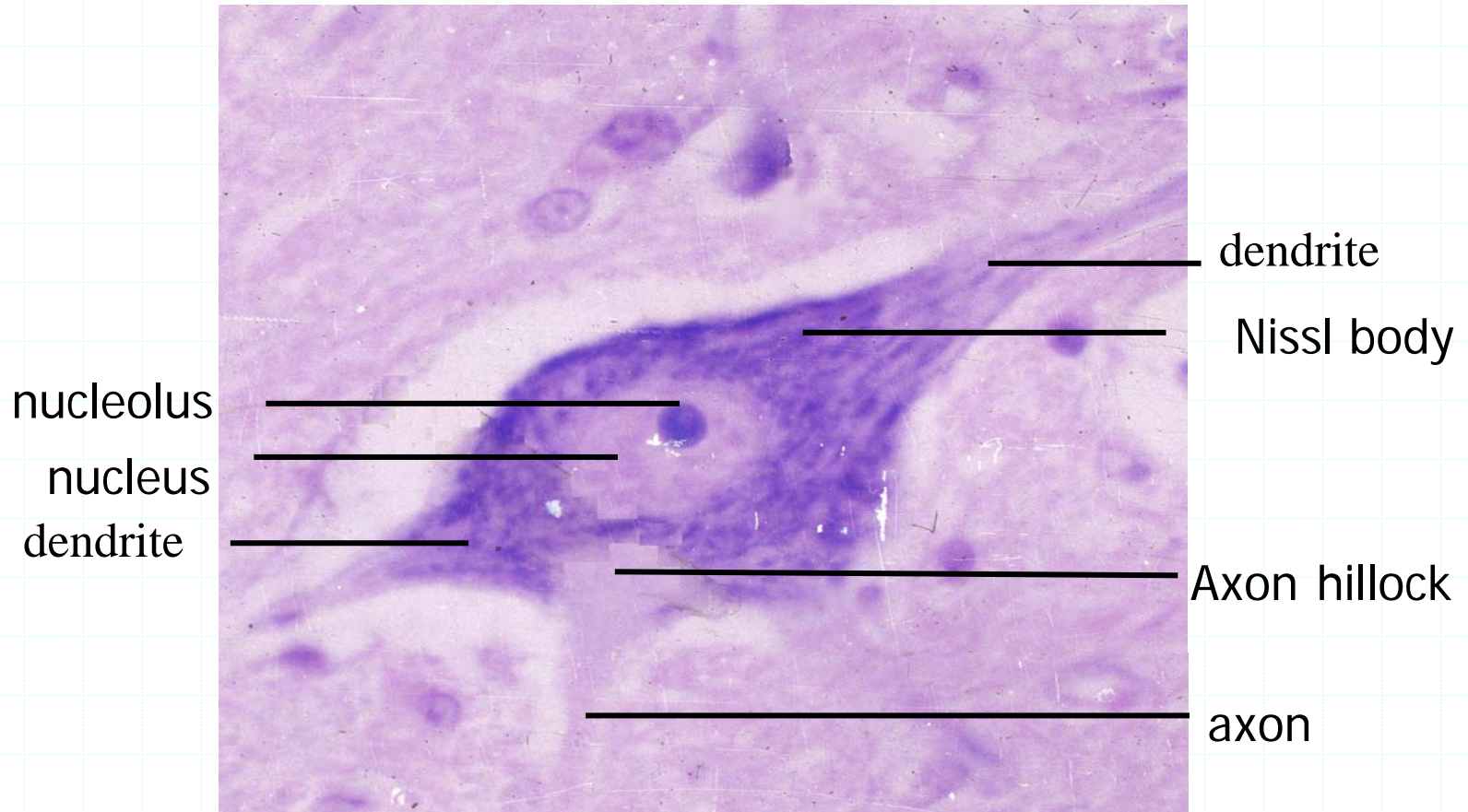


## 1.1.6 Inclusions

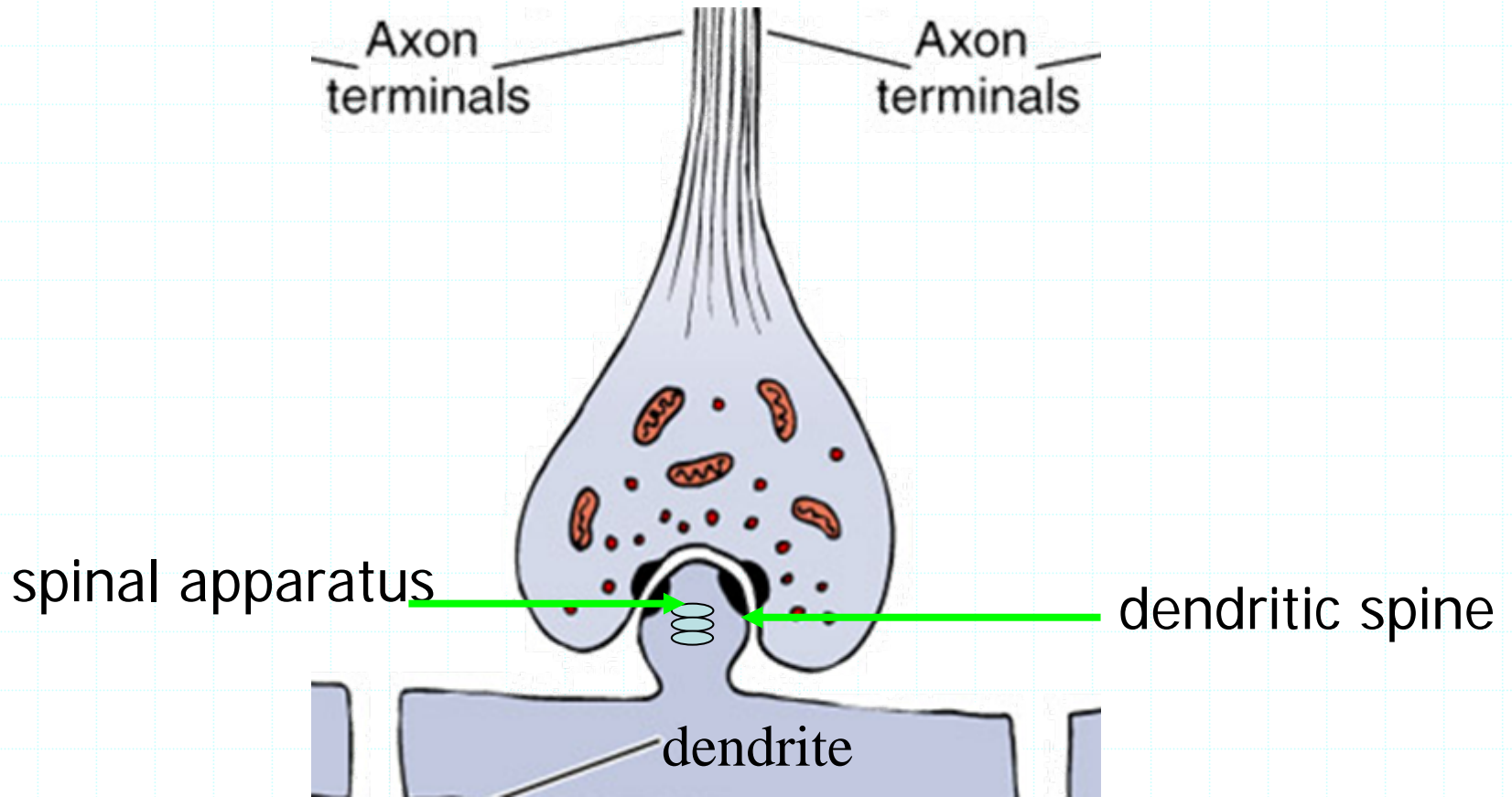
- **melanin pigment:**
  - A kind of dark brown or black granules
- **Lipofuscin:**
  - a light brown lipid-containing pigment
  - a residue of material undigested by lysosomes.



# 1.2 Dendrites



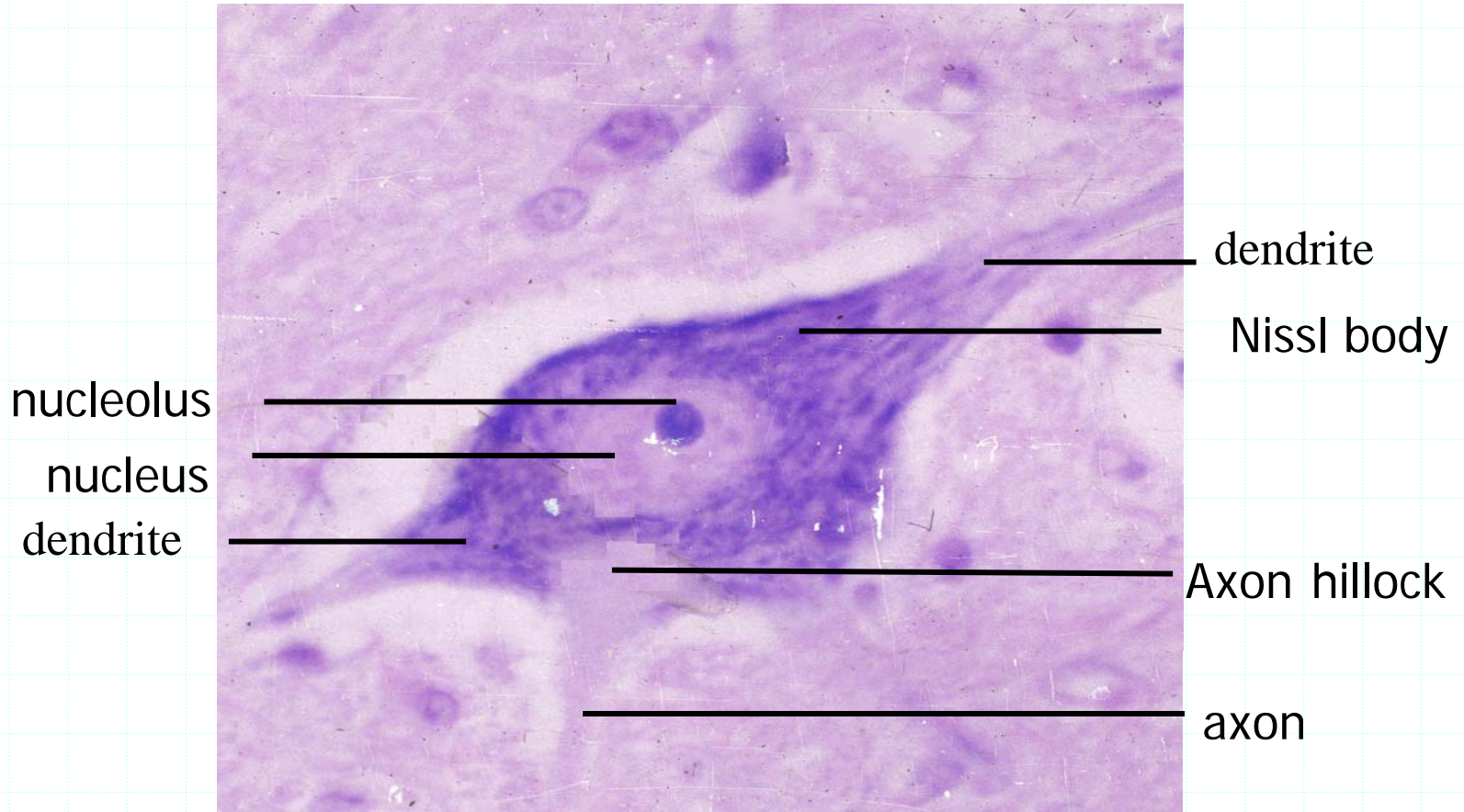
- many, short and more branches, specialized in receiving stimuli from environment, sensory epi. cells and from other neurons
- The composition dendritic cytoplasm is very similar to that of perikaryons, without Golgi apparatus
- Nissl bodies, mitochondria and neurofibrils



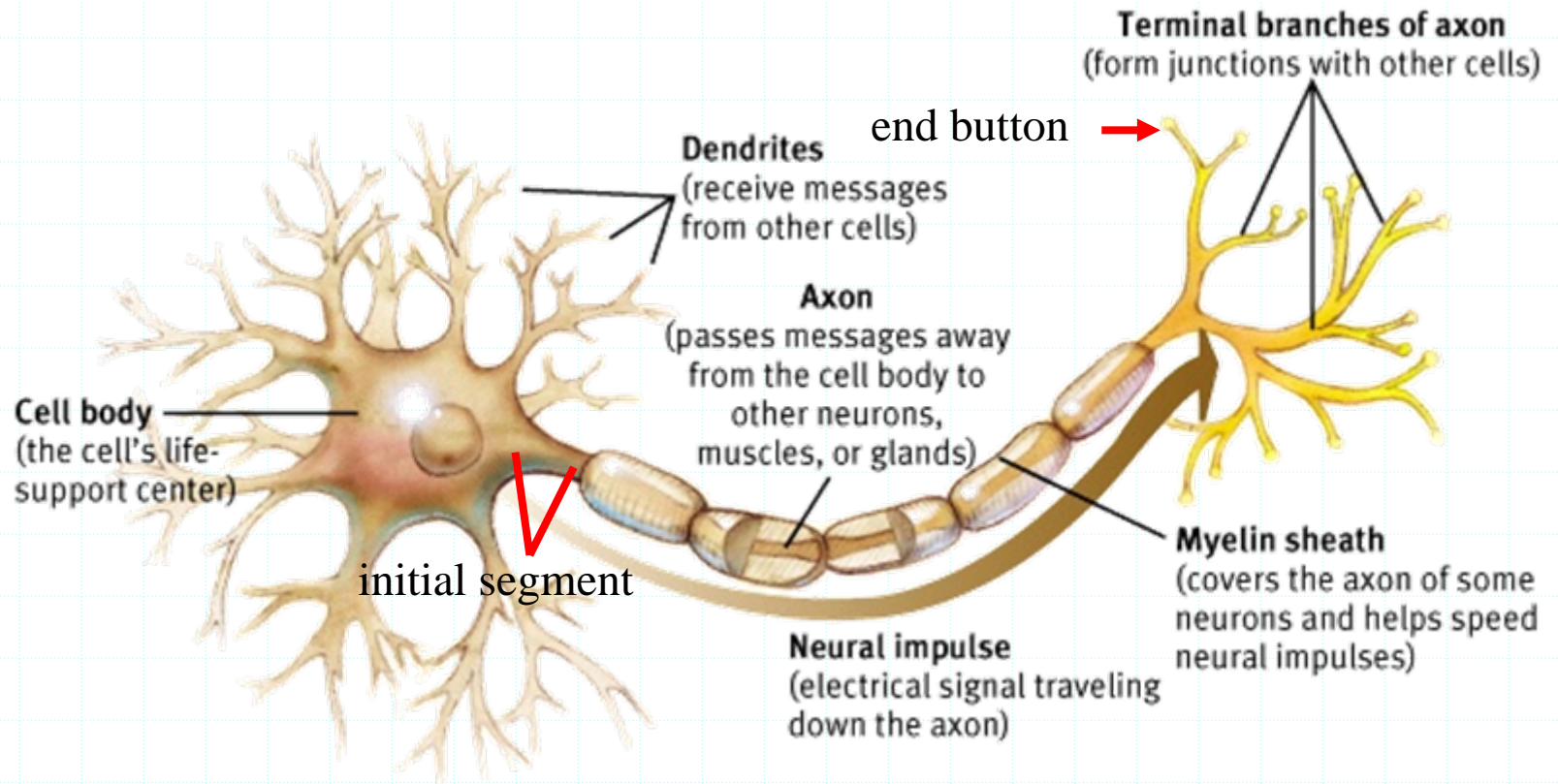
- dendritic spine represent sites of synaptic contact.
- spinal apparatus consisting of flattened, parallel smooth endoplasmic reticulum



# 1.3 Axons



- only one long cylindric process, initiate and conduct the impulse
- axon hillock: the beginning part of axon, a short pyramid-shaped region
- axolemma: the plasma membrane of the axon
- axoplasm: the contents of axolemma (mitochondria, microtubules, neurofilaments)

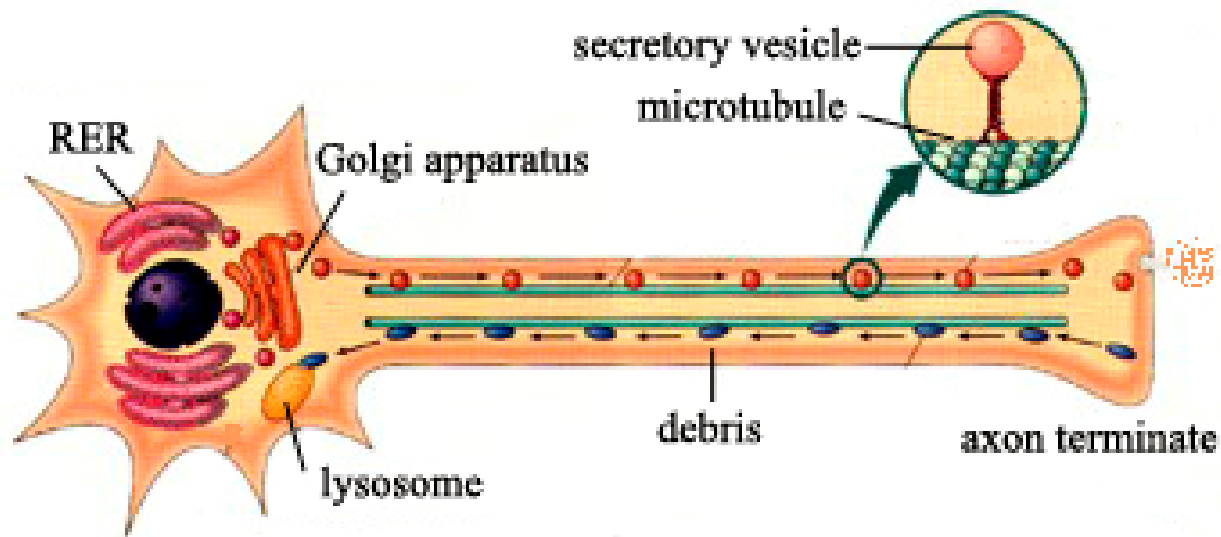


**initial segment** : between the axon hillock and myelinated sheath  
The site where various excitatory and inhibitory stimuli on neurons are summed, resulting in the nerve impulse

**End button**: distal portion of axon, a rounded enlargement

# axoplasmic transport

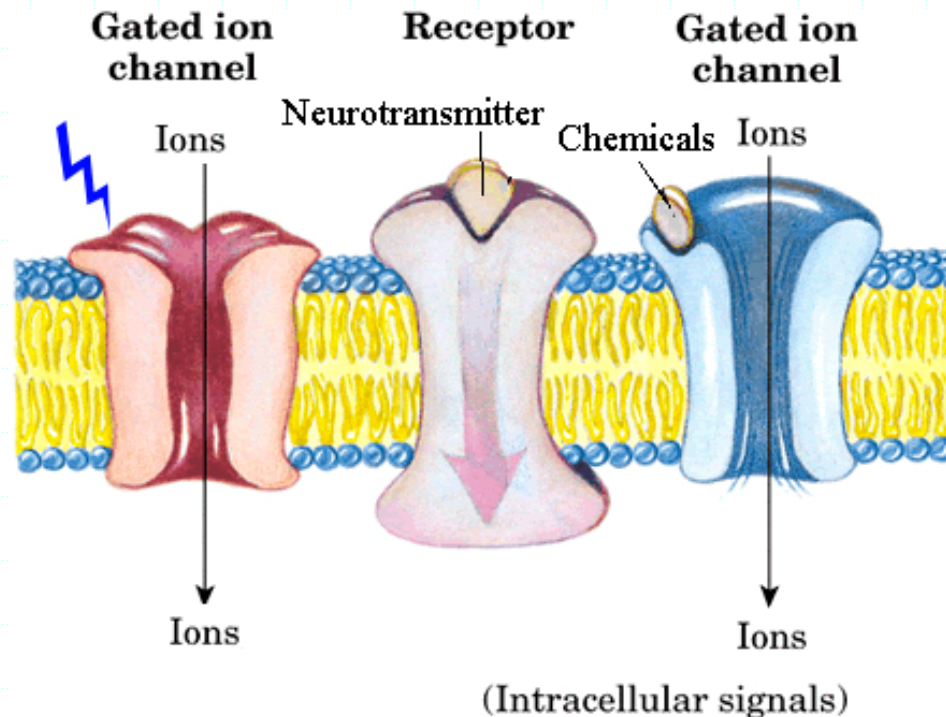
- **anterograde transport :**
  - from the cell body to the axon terminals along the axon
- **retrograde transport :**
  - in the opposite direction





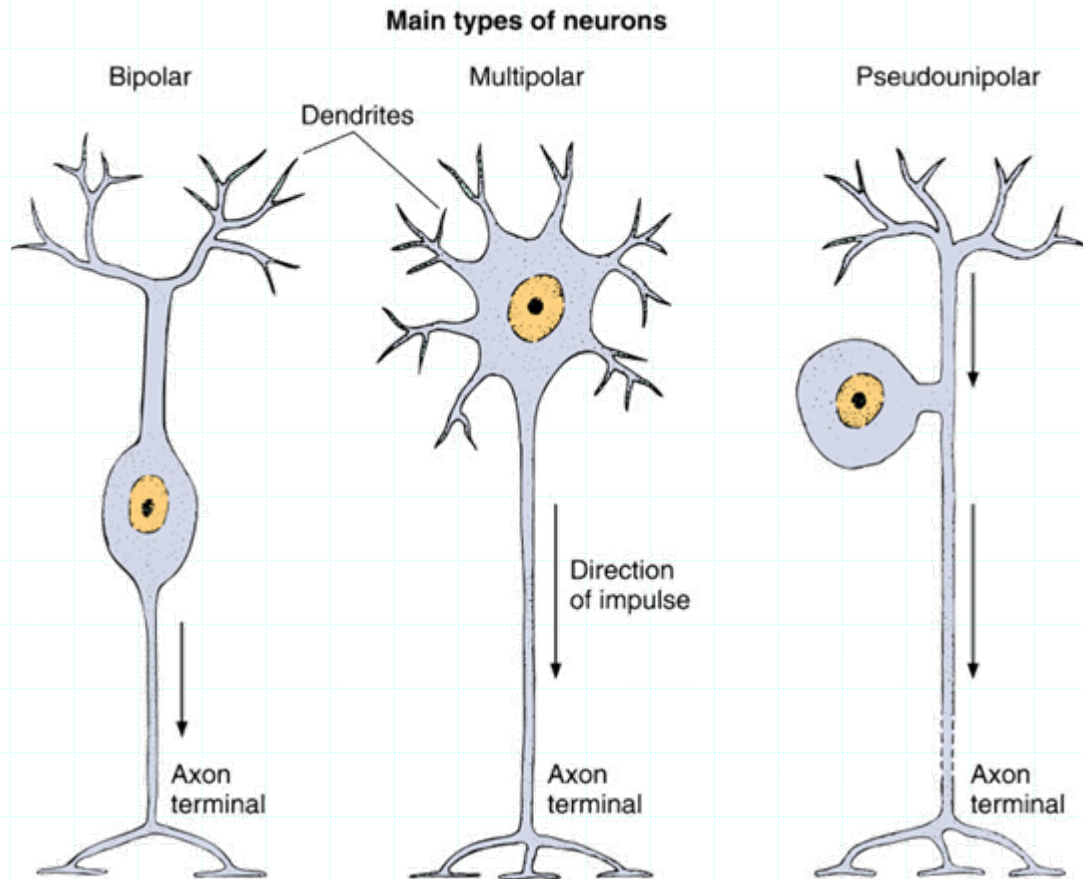
# 1.4 Neuronal membrane and membrane potentials

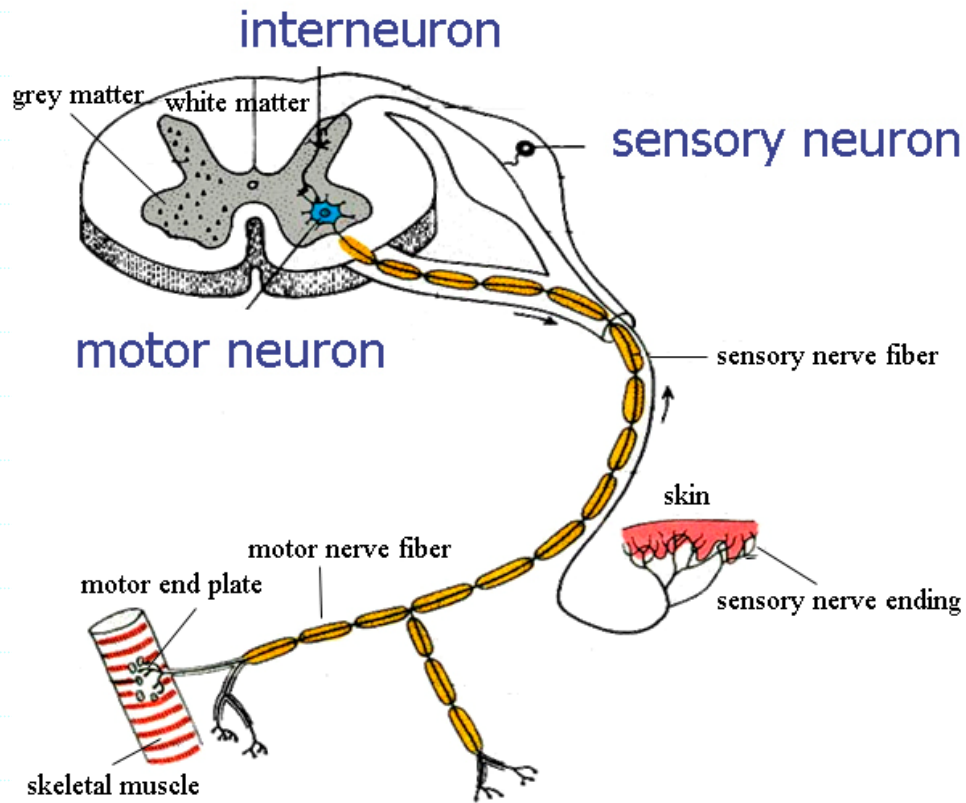
- receptors interact with neurotransmitters
- the opening of ionic channels depend on electrical stimulation or binding of chemicals to the receptor



# 1.5 classification:

- According to number of processes
  - multipolar; bipolar; pseudounipolar neuron





According to function

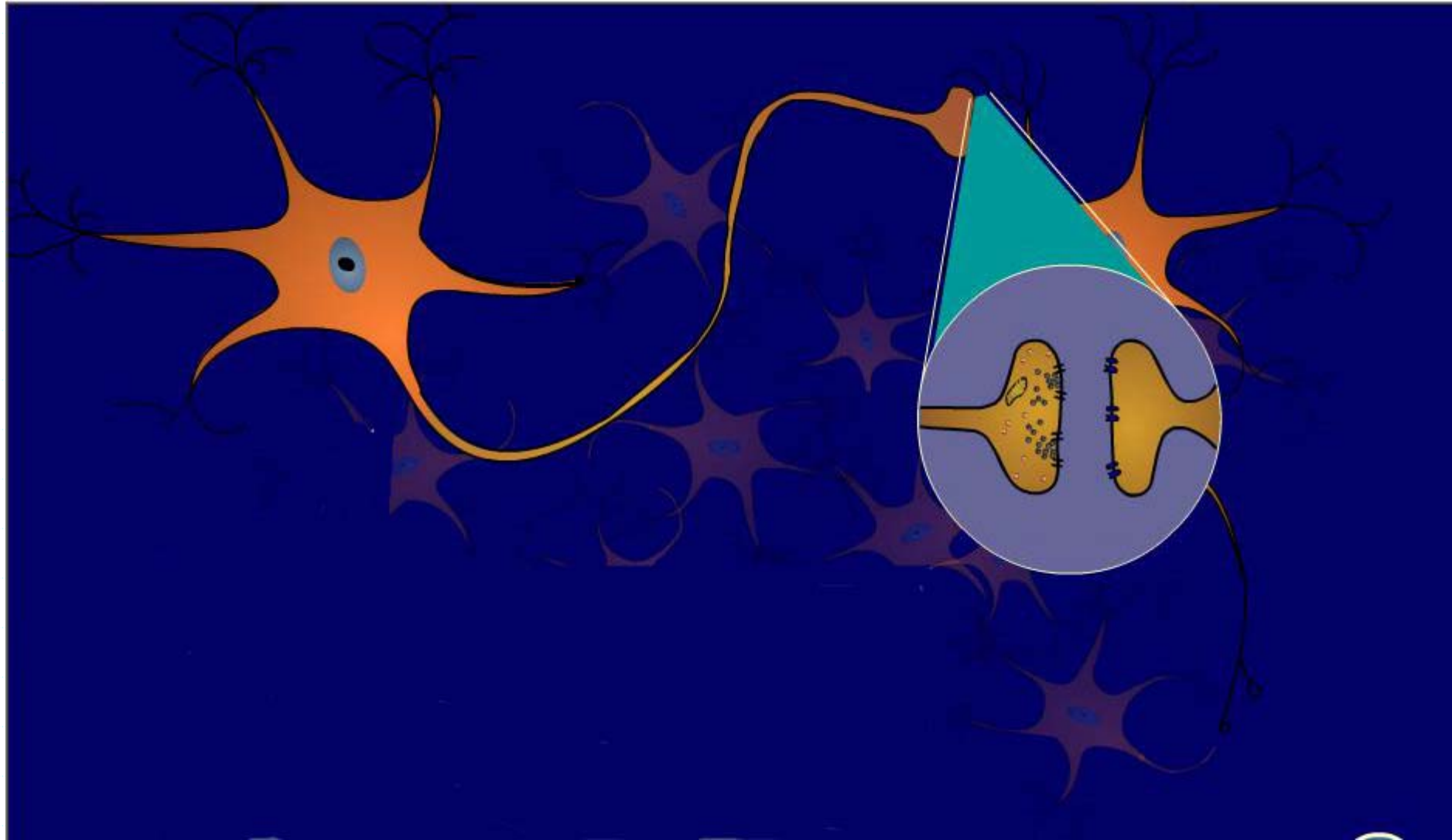
**sensory neuron:** involved in the reception of sensory stimuli from environment and from within the body

**motor neuron:** control effector organs (muscle fibers and glands)

**interneuron:** establish interrelationships among other neurons to form a complex functional network

- **According to the size of cell body and the length of axon**
  - large Golgi type I neurons with long axons
  - small Golgi type II neurons with short axons
- **According to neurotransmitter**
  - cholinergic neurons (acetylcholine)
  - aminergic neurons (adrenaline or noradrenaline, serotonin or dopamine)
  - peptidergic neurons (neuropeptides)
  - amino acidergic neurons (amino acids)

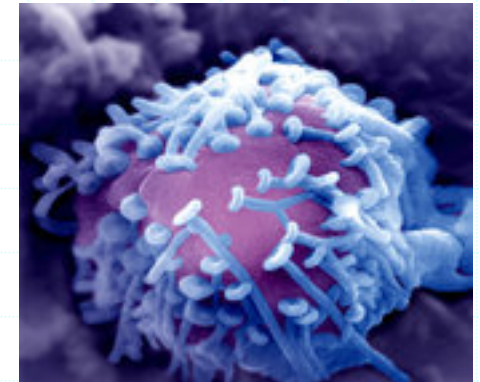
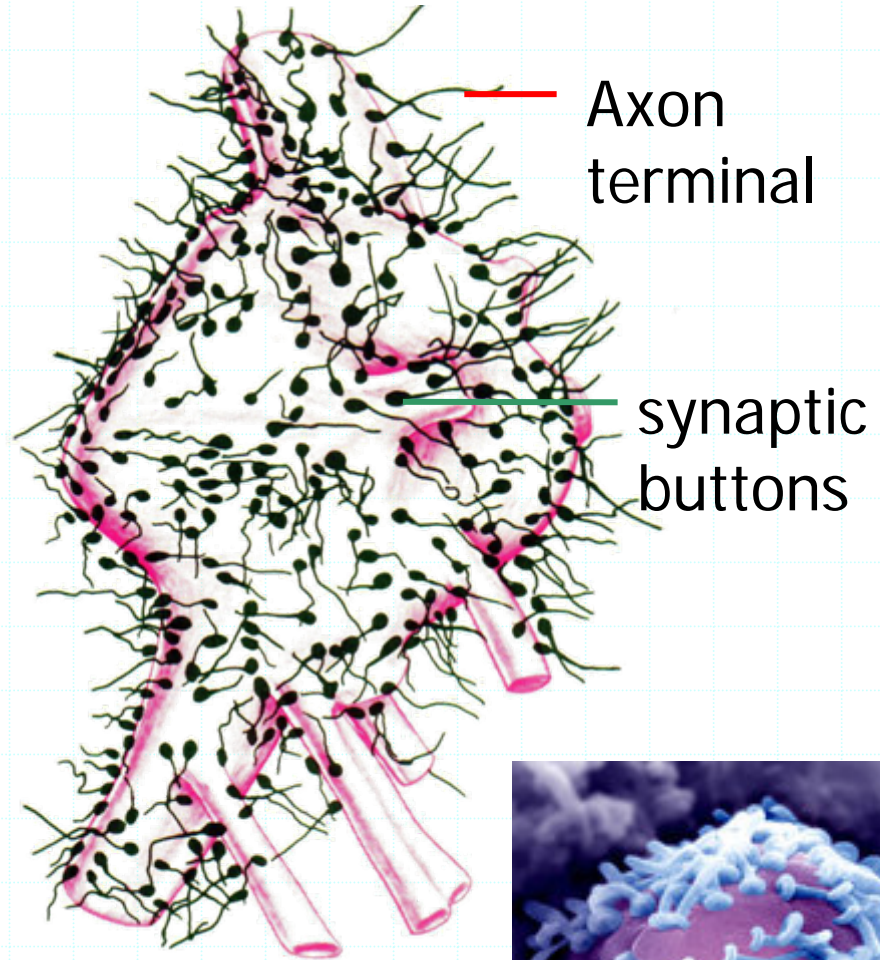


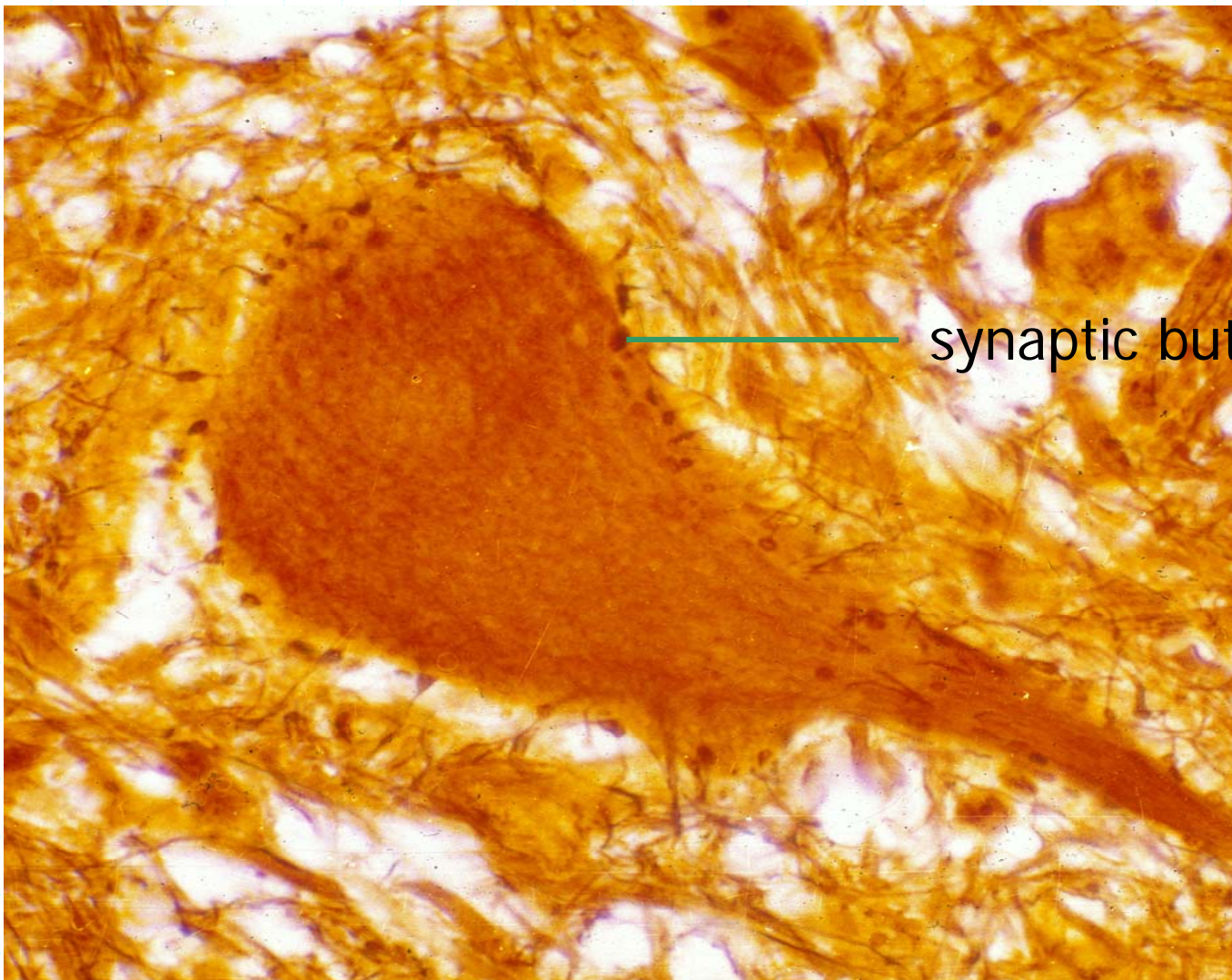


NEURSE  
N

# 2 Chemical Synapse

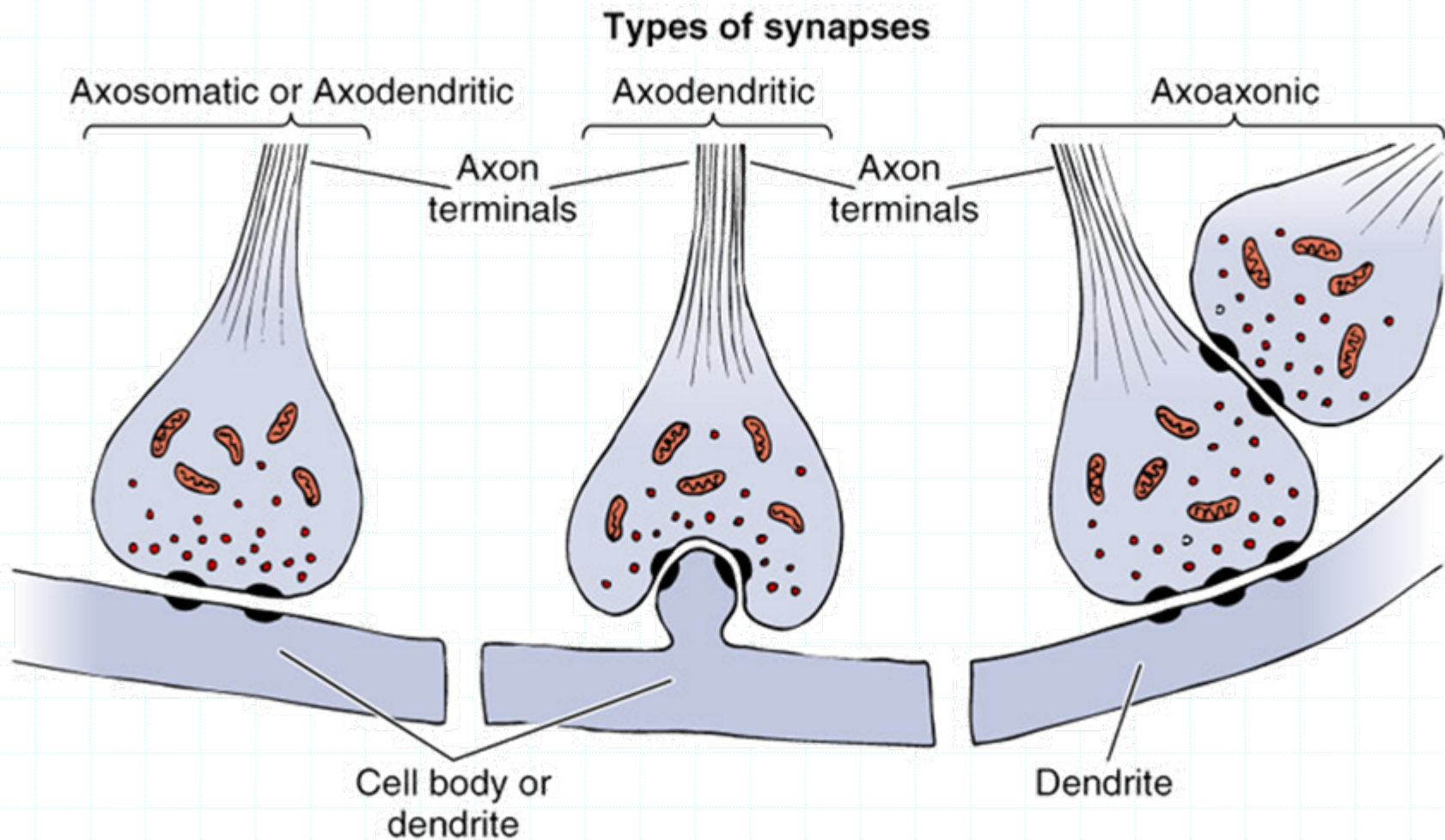
- a specialized the junctions between neurons or neuron and non-nerve cells
- synaptic buttons : bulbous axon terminal





synaptic buttons show as dark brown ovoid bodies by silver staining

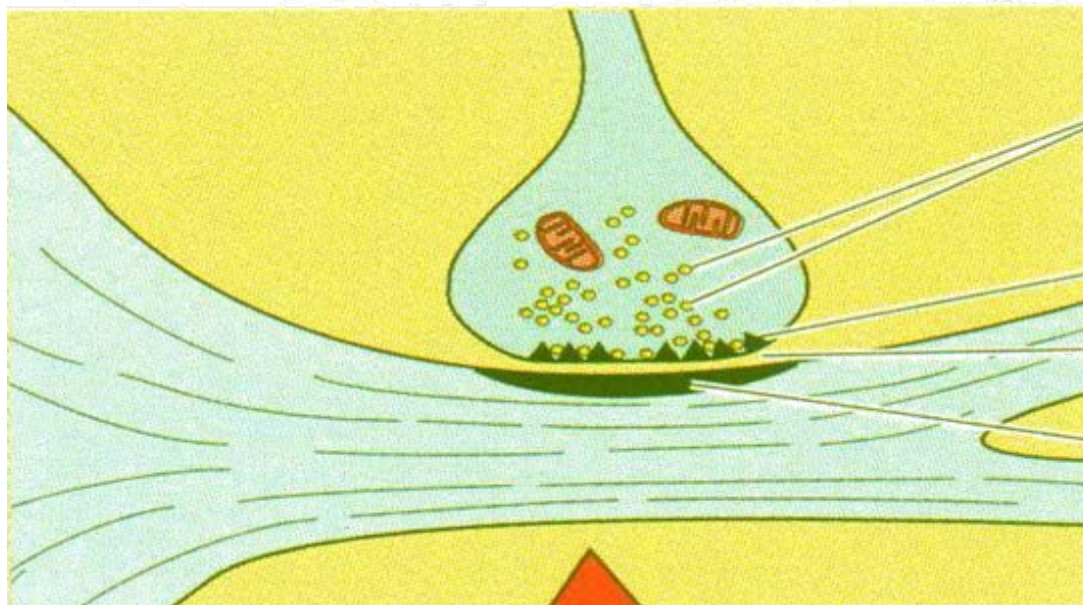
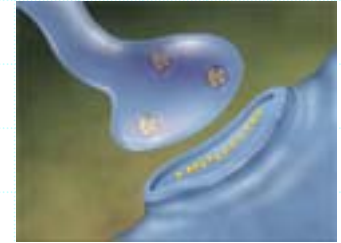
- **classification:**
  - **Axodendritic; Axosomatic; axoaxonic; dendrodendritic synapses**





## structure of synapse( EM )

- **presynaptic element:** axonal terminal
  - presynaptic membrane: thicker, denser
  - synaptic vesicle: neurotransmitters
- **synaptic cleft:** extracellular space
- **postsynaptic element:**
  - postsynaptic membrane : thicker, denser, receptors

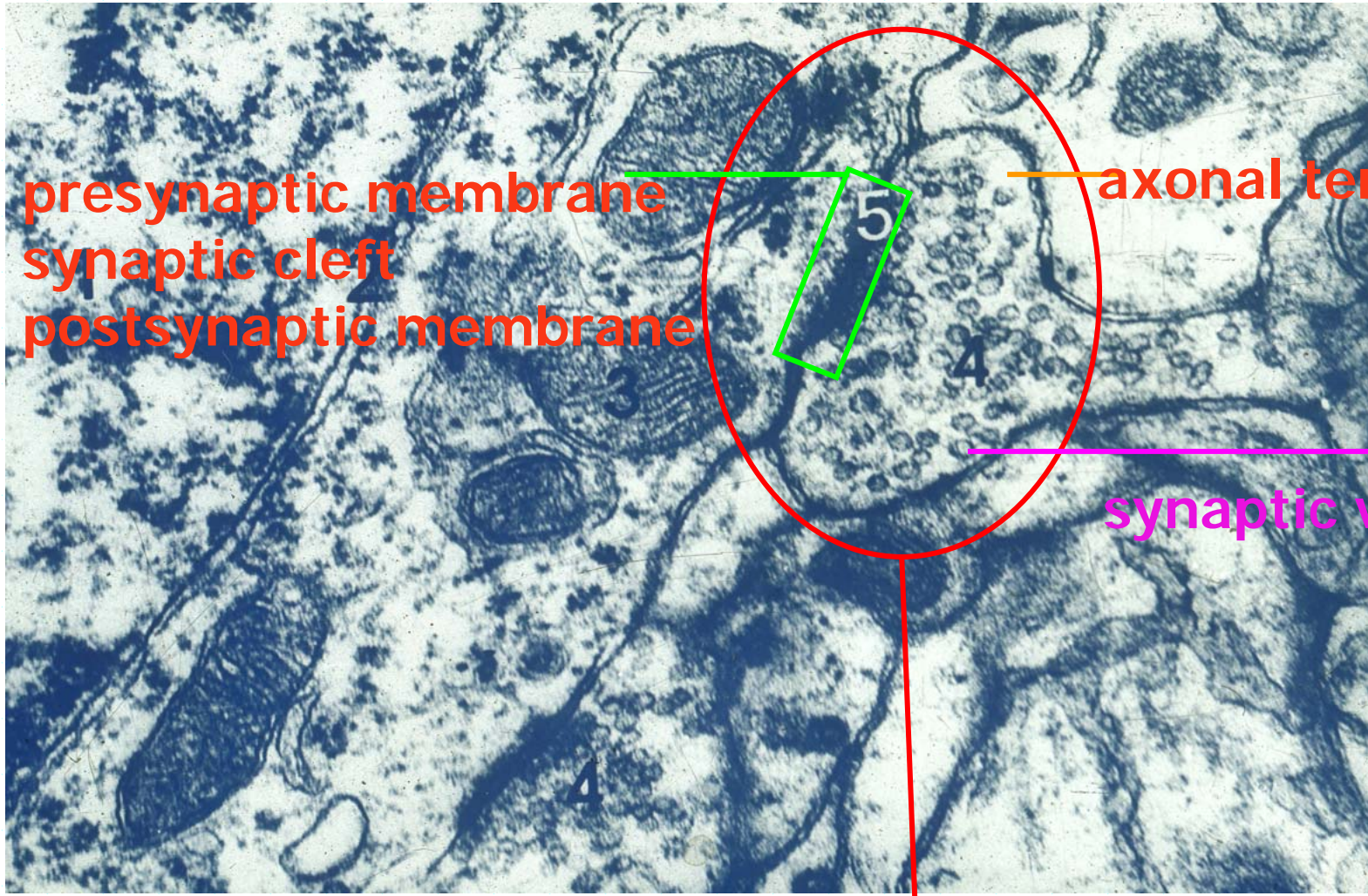


synapse vesicle

presynaptic  
membrane

synaptic cleft

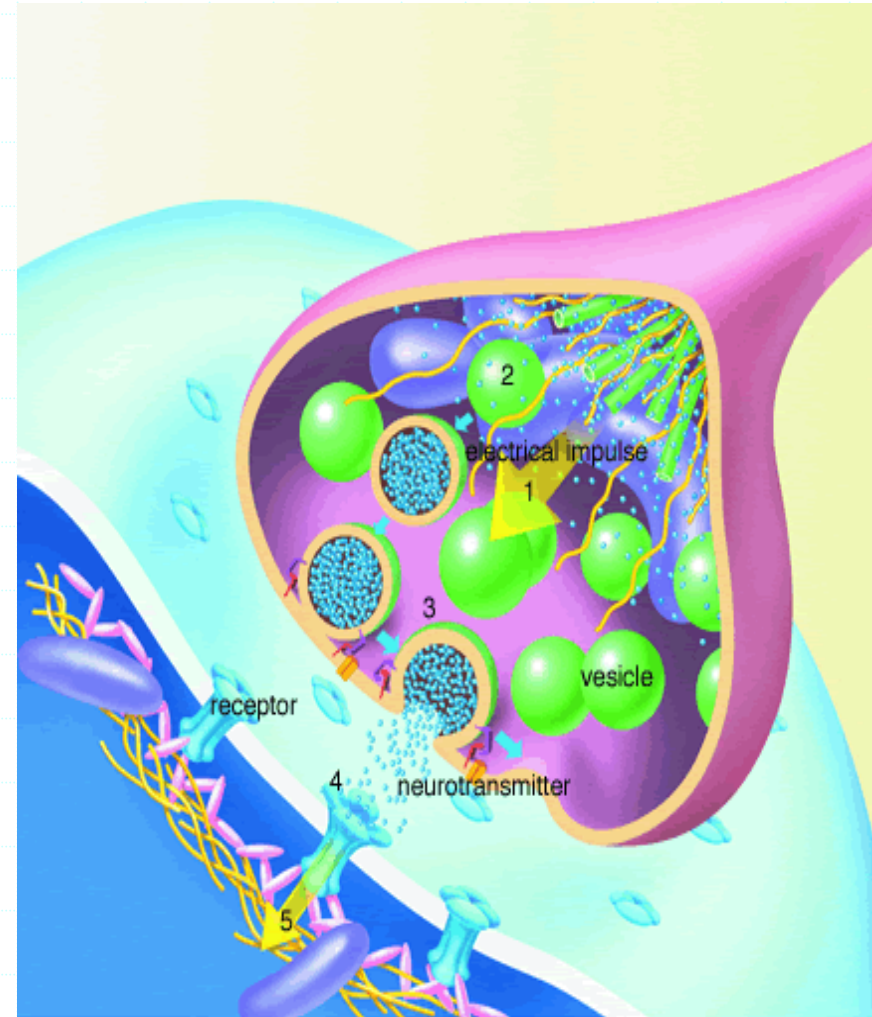
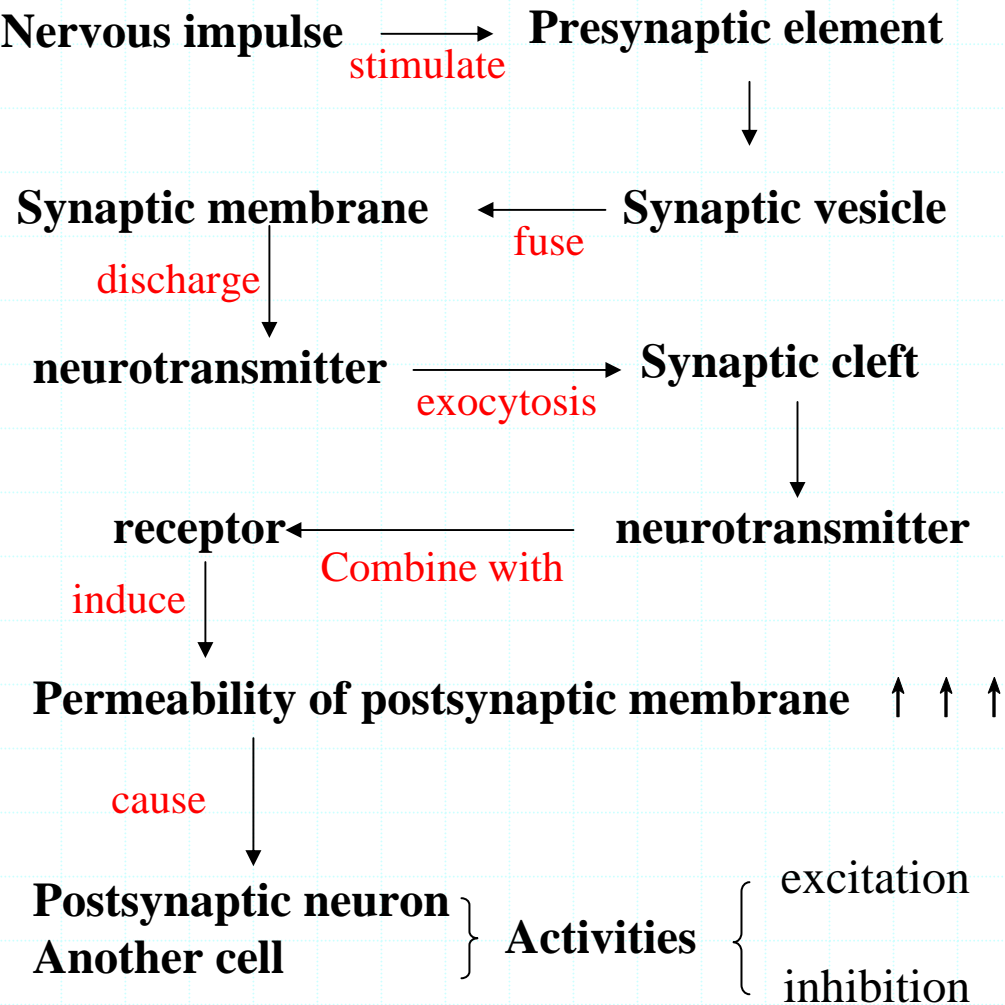
postsynaptic  
membrane



**Synapse**

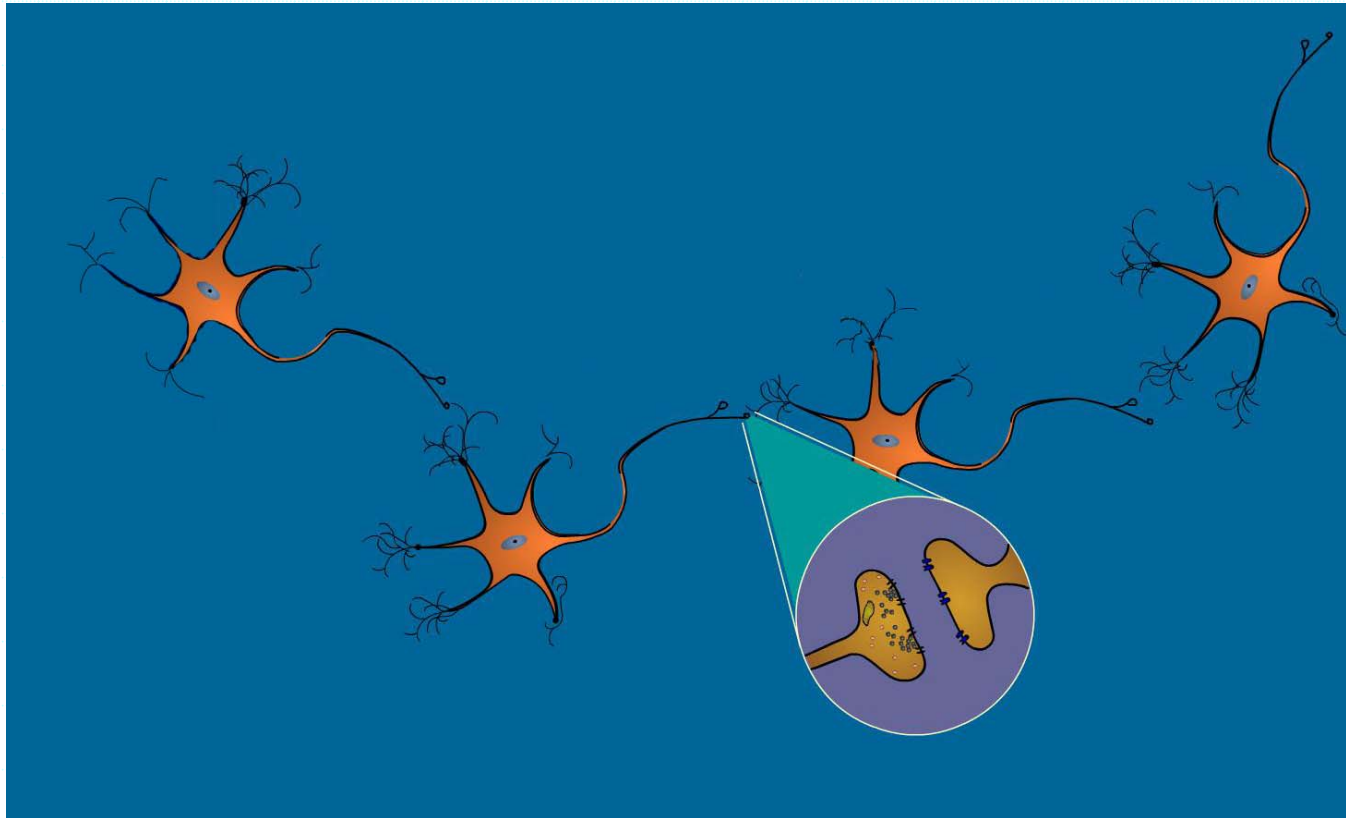
**Synapse (Axosomatic) EM**

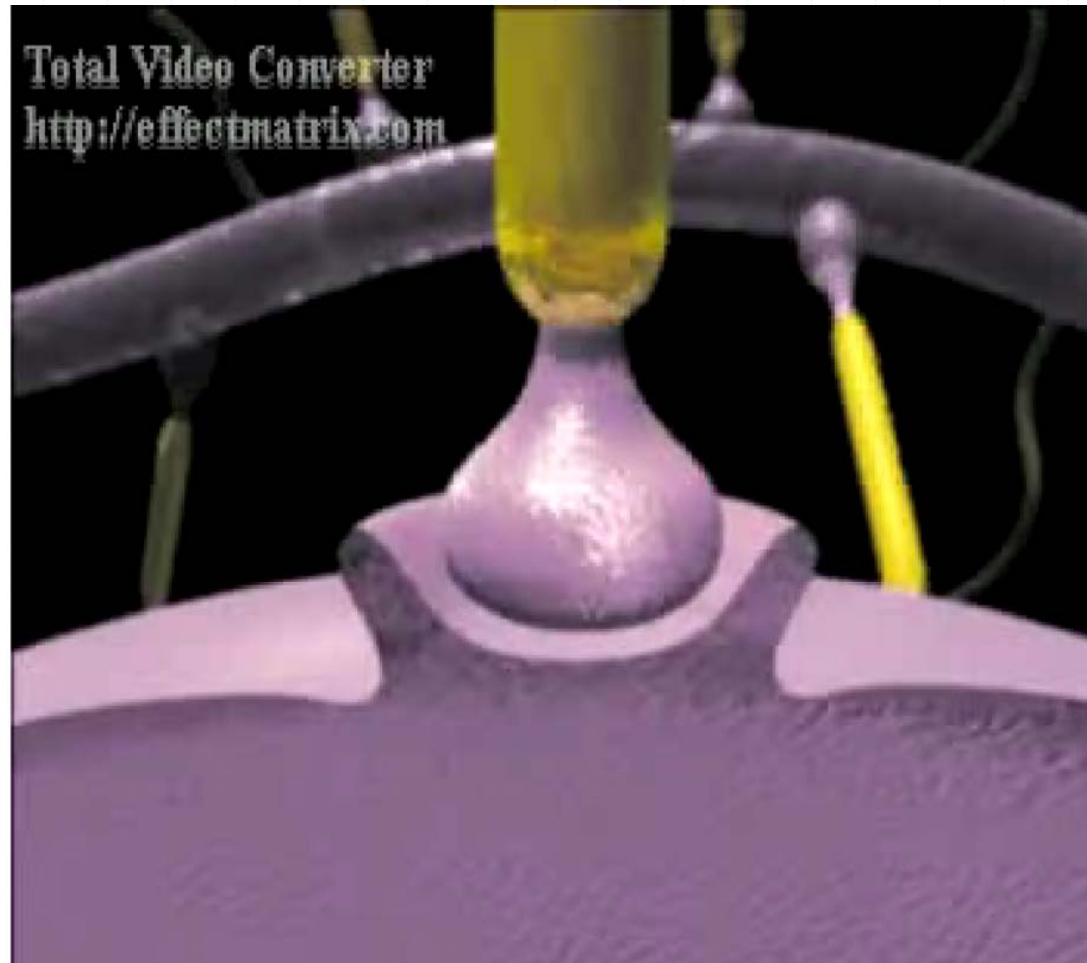
# Function of synapse



# Function

**The function of the synapse is to convert an electrical signal (impulse) from the presynaptic cell into a chemical signal that acts on the postsynaptic cell**

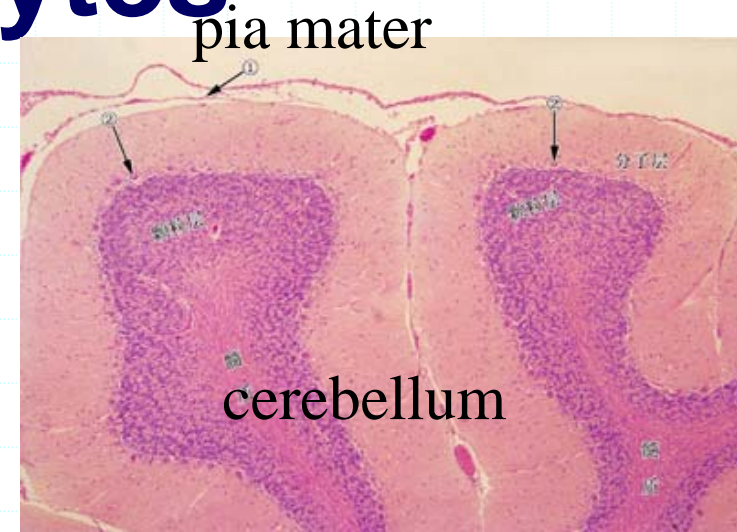
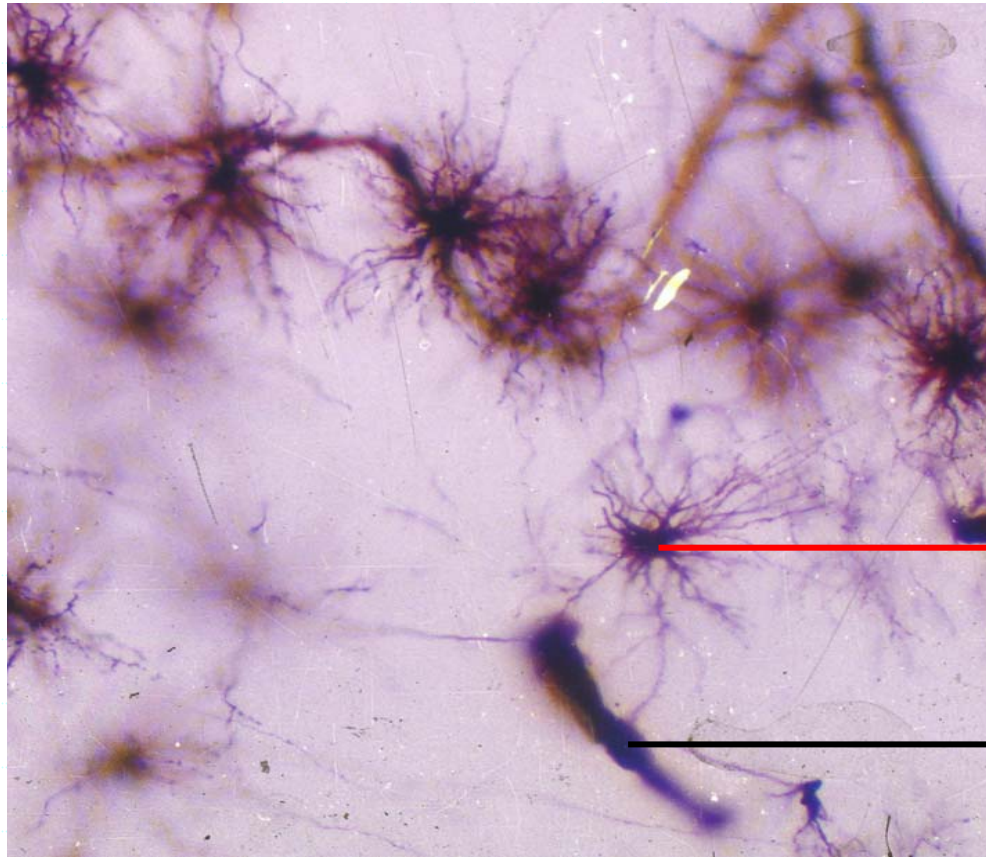




# 3. Neuroglia

- **3.1 Glial cells in central nervous system :**
  - Astrocyte
  - Oligodendrocyte
  - Microglia
  - ependymal cell
- **3.2 Glial cells in peripheral nervous system:**
  - Schwann cell (Neurolemmal cell)
  - satellite cell (capsular cell)
- **function:**
  - supporting, insulating , repairing
  - regulate the environment and movement of neuron
  - secret neurotrophic factor

# 3.1.1 Astrocytes



Astrocytes

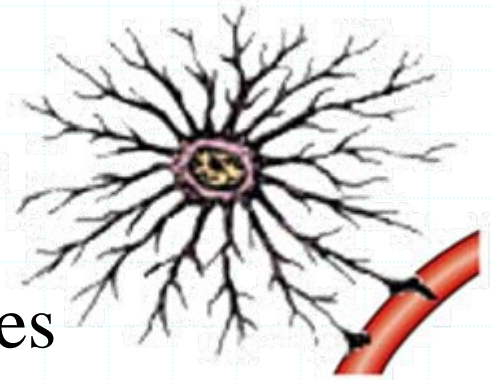
capillary

- the largest neuroglia with numerous long processes
- star-shaped , a spherical, centrally located nucleus
- vascular feet : blood-brain barrier
- Glia limitans along the internal surface of the pia mater
- Glial filament: glial fibrillar acidic protein (GFAP)

## classification

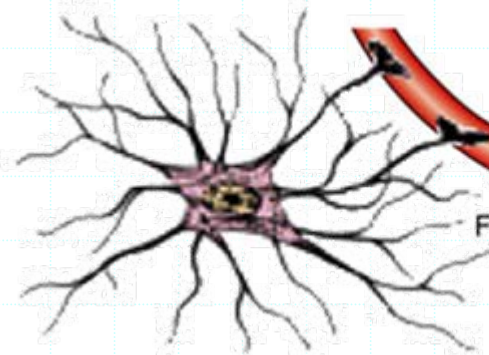
- protoplasmic astrocyte:
  - More short, thick branched processes
  - less glial filament

Protoplasmic astrocyte



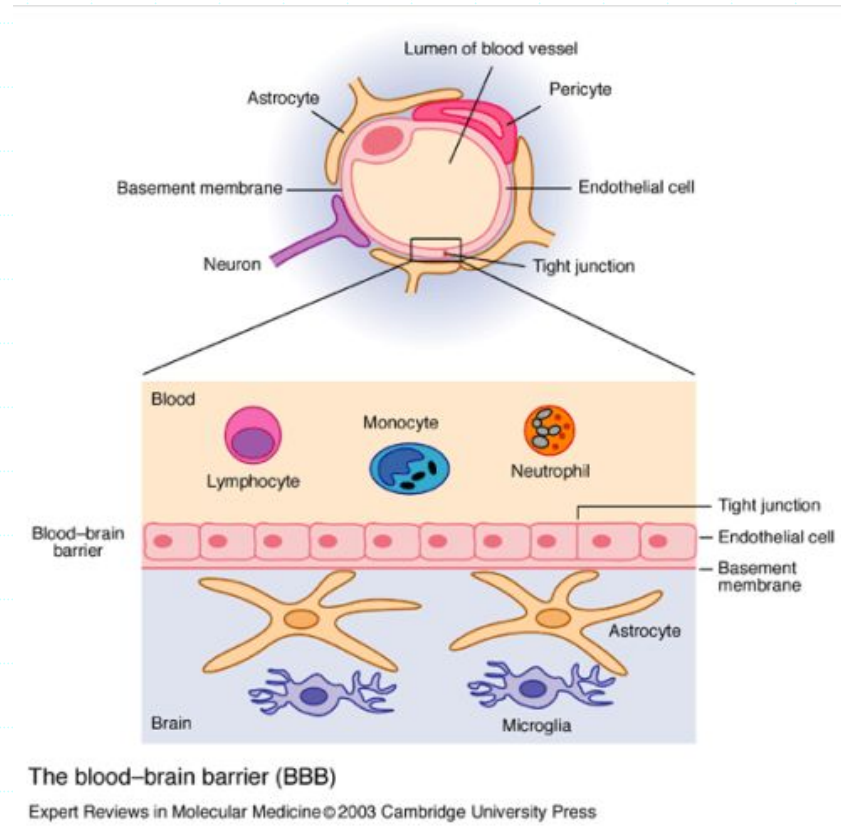
- fibrous astrocytes:
  - Few long, thin and smooth processes
  - more glial filament

Fibrous astrocyte



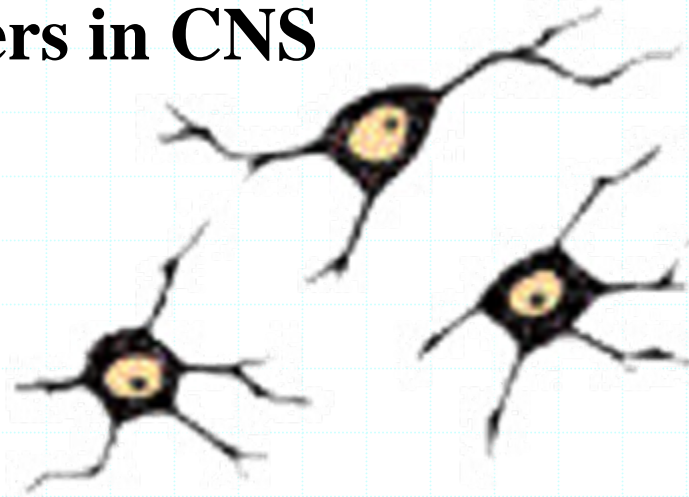


- blood-brain barrier
  - continuous endothelium of capillaries
  - tight junctions between endothelial cells
  - continuous basal membrane around endothelium
  - the vascular feet surrounding the capillaries
- prevent the passage of certain substances from the blood to nerve tissue

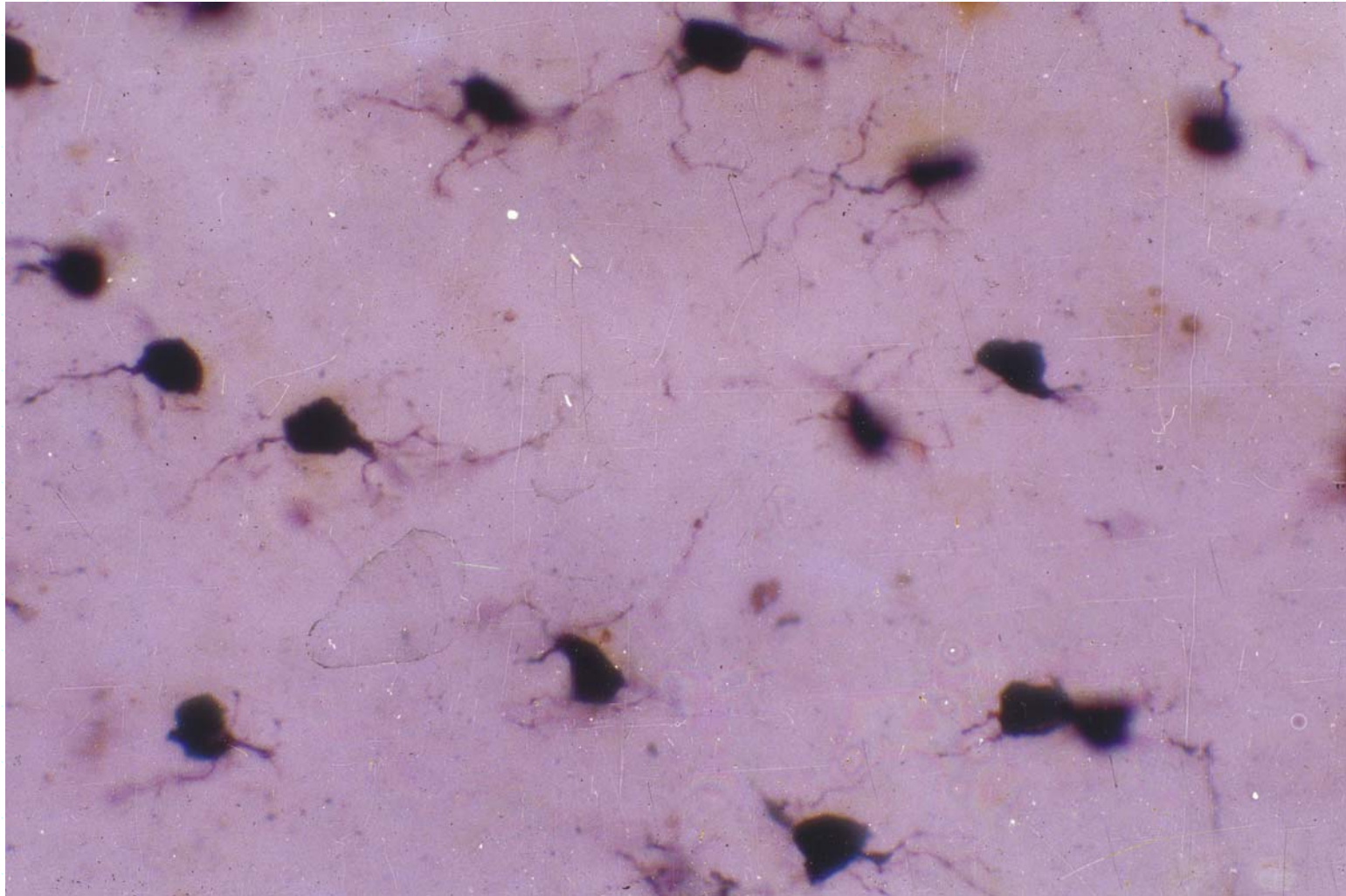


## 3.1.2 Oligodendrocytes

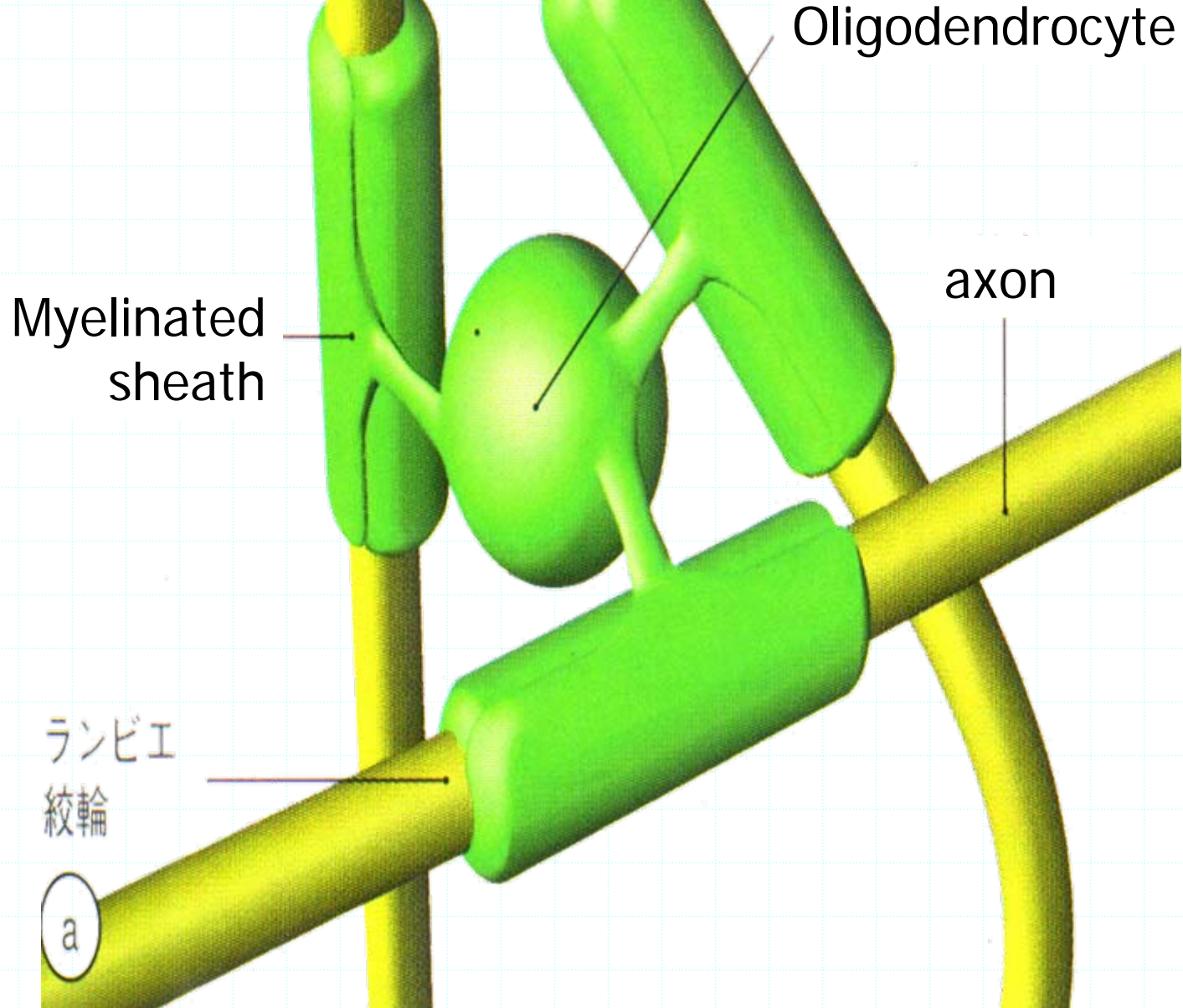
- **Oligodendrocytes**
  - smaller, fewer and shorter process
  - a small round and dark stained nucleus
- **Function:**
  - their processes form myelin-sheath of nerve fibers in CNS



Oligodendrocytes

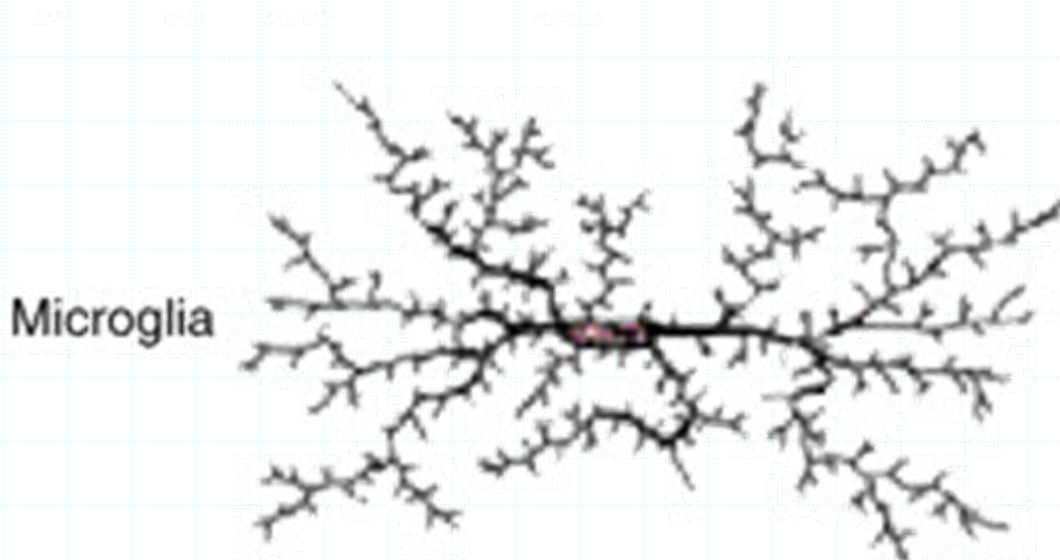


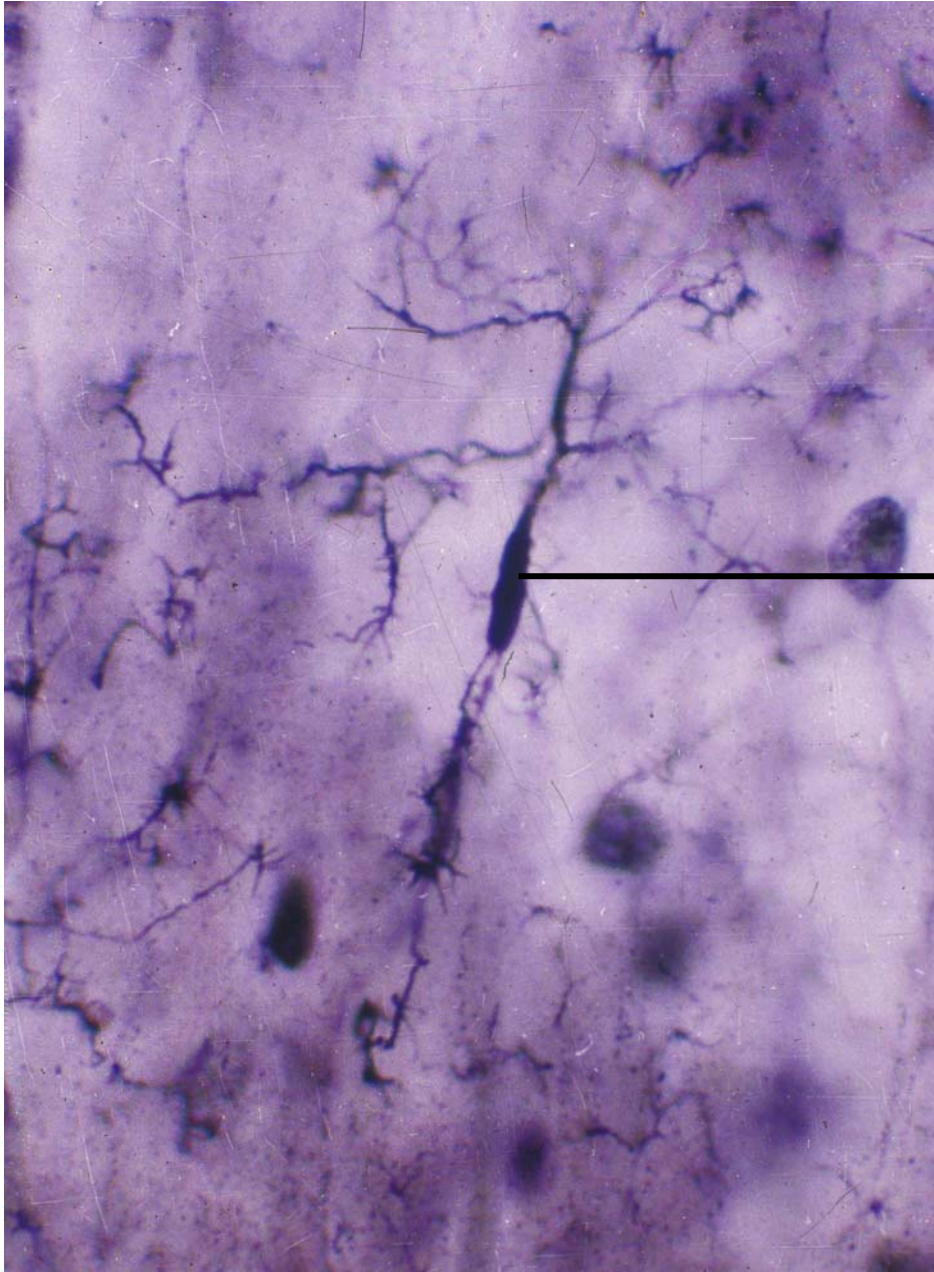
Oligodendrocytes



## 3.1.3 Microglia

- **smallest, elongate shape or ovoid**
- **a small dark nucleus**
- **short processes covered by many small expansions**
- **function: mononuclear phagocyte system;  
involved in the inflammation and repair**





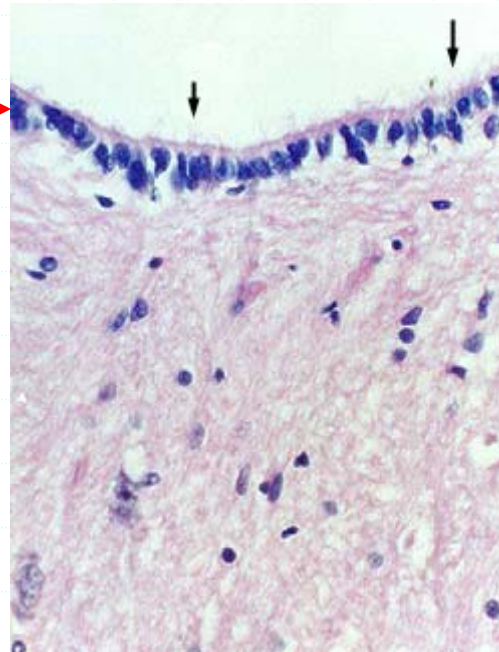
Microglia



# 3.1.4 Ependymal cells

- **simple cuboidal or columnar epithelial cells**
- **distribution: ventricle of brain and central canal of spinal cord**
- **apical: microvilli and cilia**
- **function: produce cerebrospinal fluid**  
**facilitates the movement of cerebrospinal fluid**

Ependymal cells →

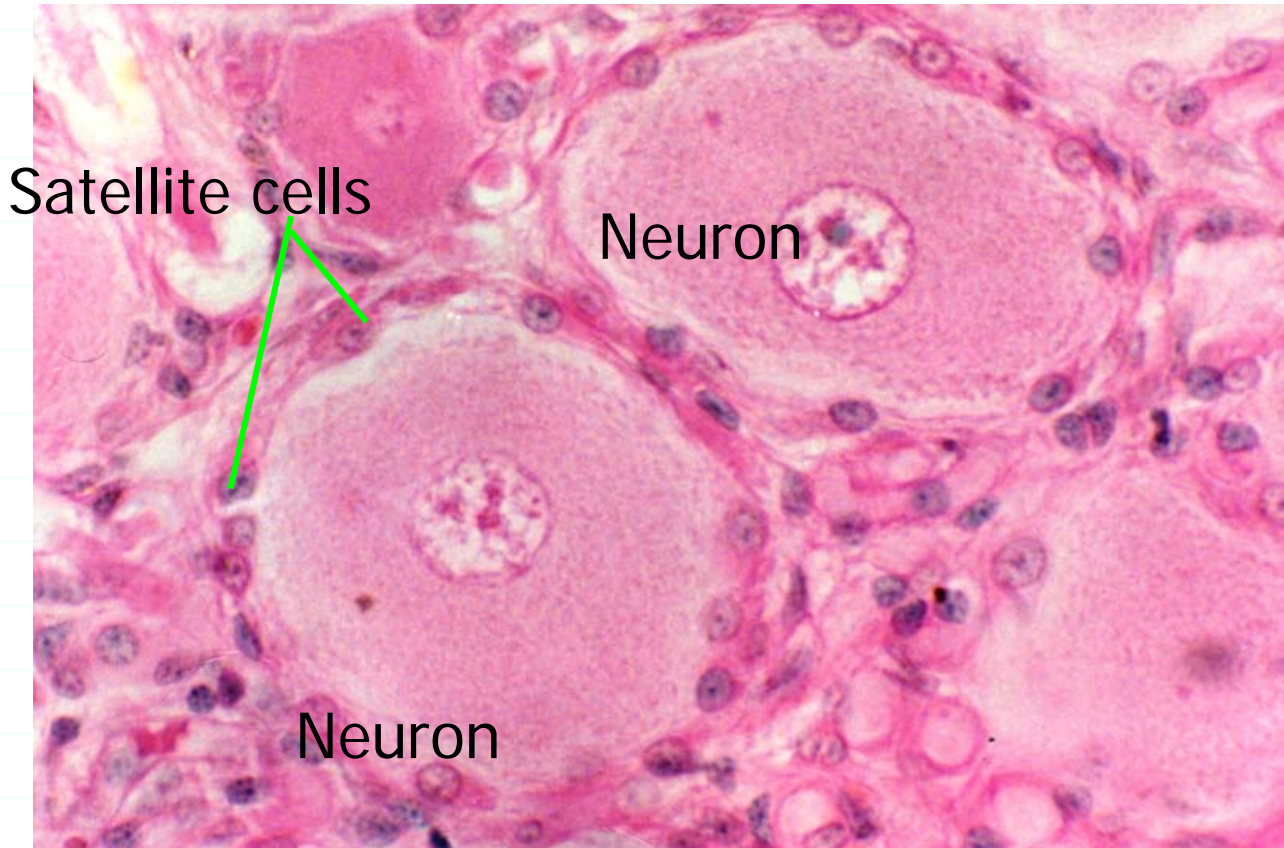


## **3.2.1 Schwann cells or Neurolemmal cells**

- **envelop the axons of neurons**
- **responsible for myelination in the peripheral nervous system.**



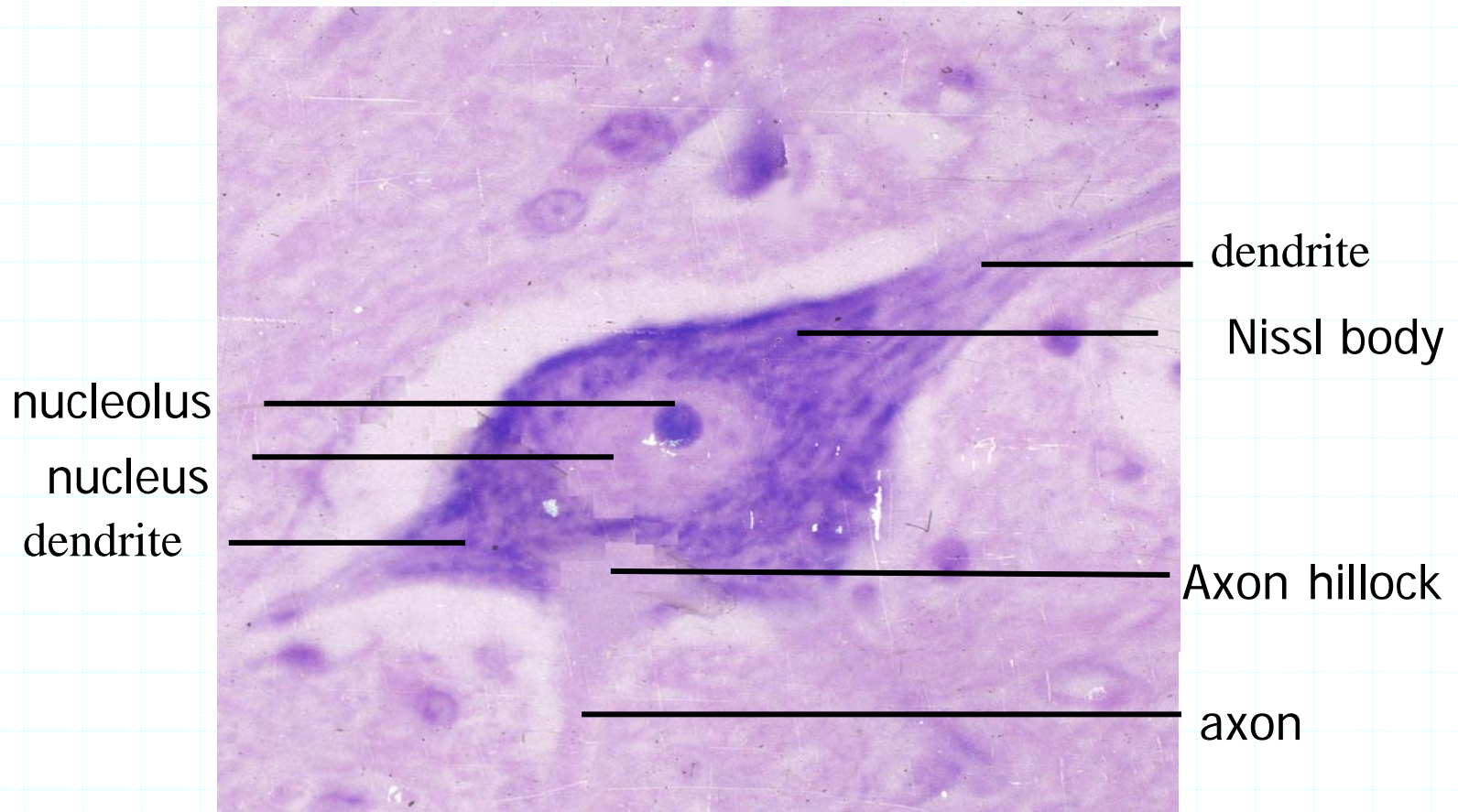
## 3.2.2 Satellite cells or Capsular cells



- **one layer of flattened or cuboidal cell, with round, ovoid and dark nucleus**
- **surrounding the Neuron in ganglion**

# Key points

- The structure of neuron in LM
- The structure of synapse in EM
- The structure of Nissl bodies in LM and EM, and its function
- The structure of Neurofibrils under LM, and its component and function
- The structure and function of blood-brain barrier.



**Nissl bodies :basophilic granule or mass, abundant in cell bodies and dendrites, but don't exist in axons.**

**Highly developed RER organized into parallel cisternae in EM.**

**RER and free ribosomes appear as Nissl bodies in LM.**

