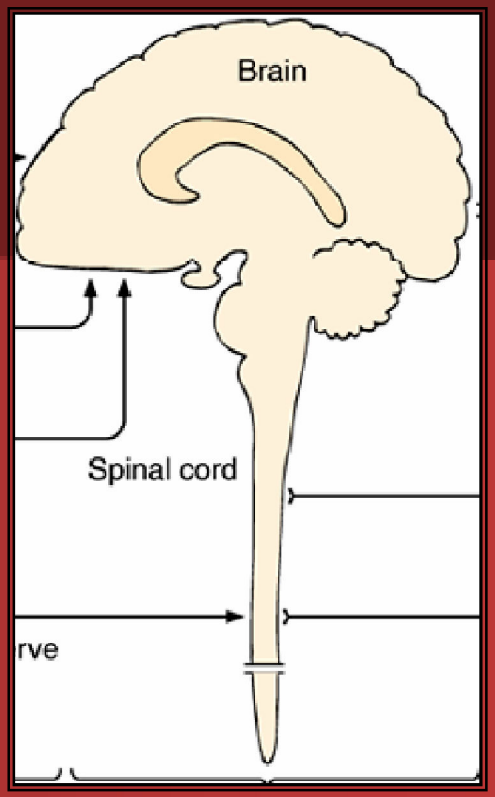
THE NERVOUS TISSUE

-**CNS:** brain & spinal cord.

-**PNS:** nerve fibres, ganglia & nerve endings.



-Two cell types:

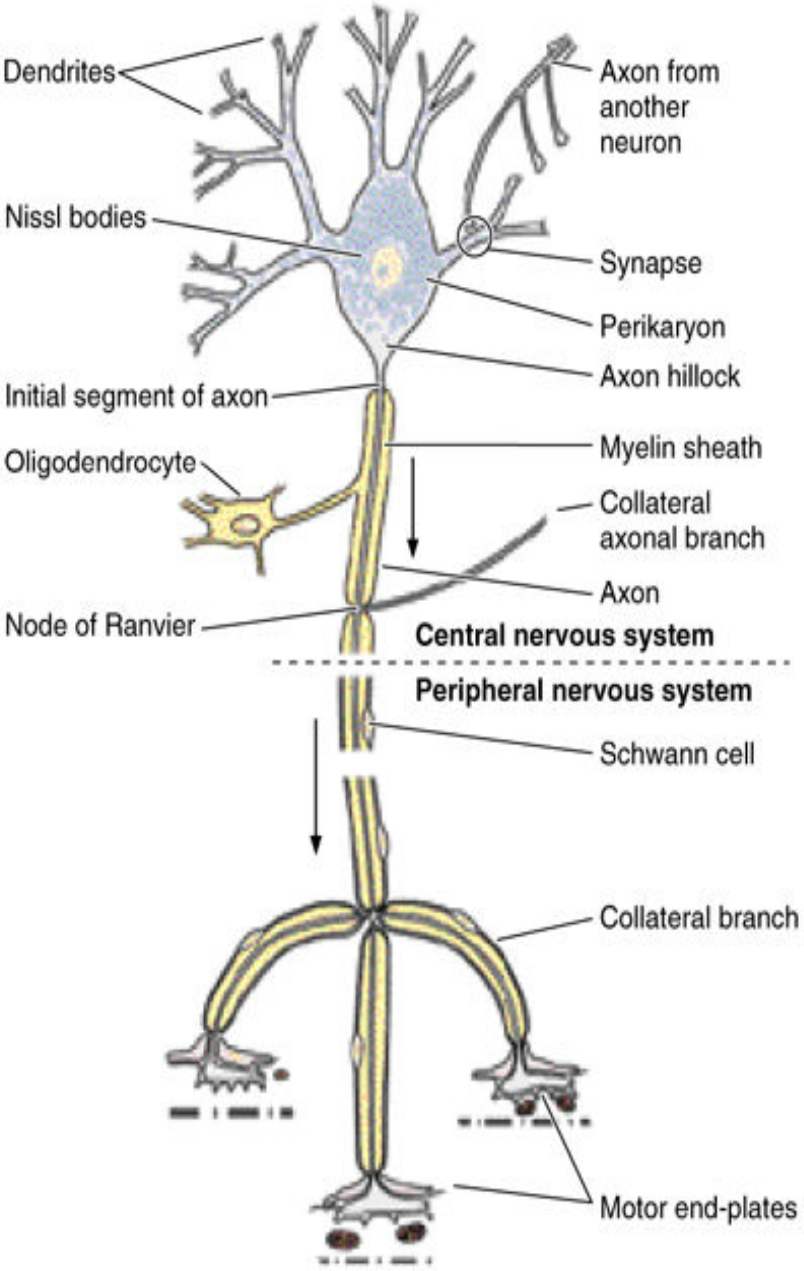
*Neurons → functioning cells

*Glial cells →supporting cells

- **NEURONS**
- **which are responsible for the receptive, integrative, and motor functions of the nervous system;**
- Most of neurons consist of;
- The **cell body** (perikaryon),
- &its processes which are:

1-The **dendrites** which are multiple process

2-The **axon** which is a single process.



Structure of neurons:

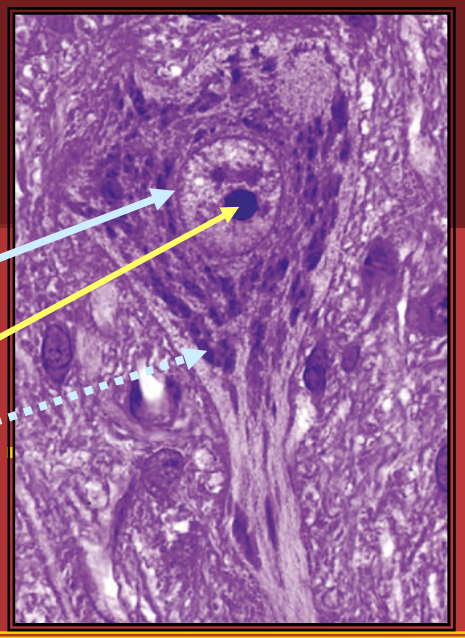
1-Perikaryon (cell body):

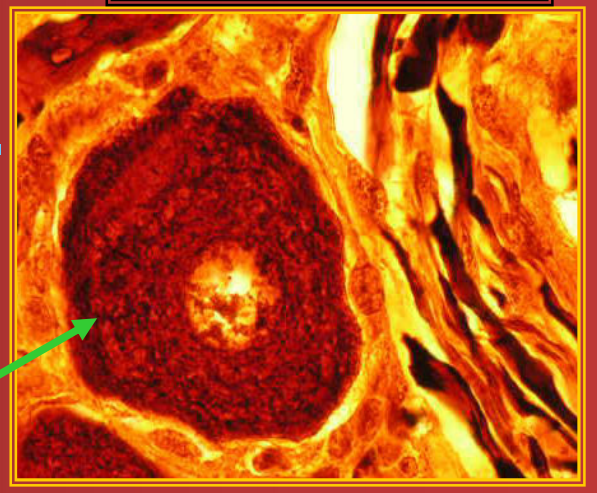
-Variable in size & shape.

-Nucleus: large rounded central pale nucleus with prominent nucleolus.

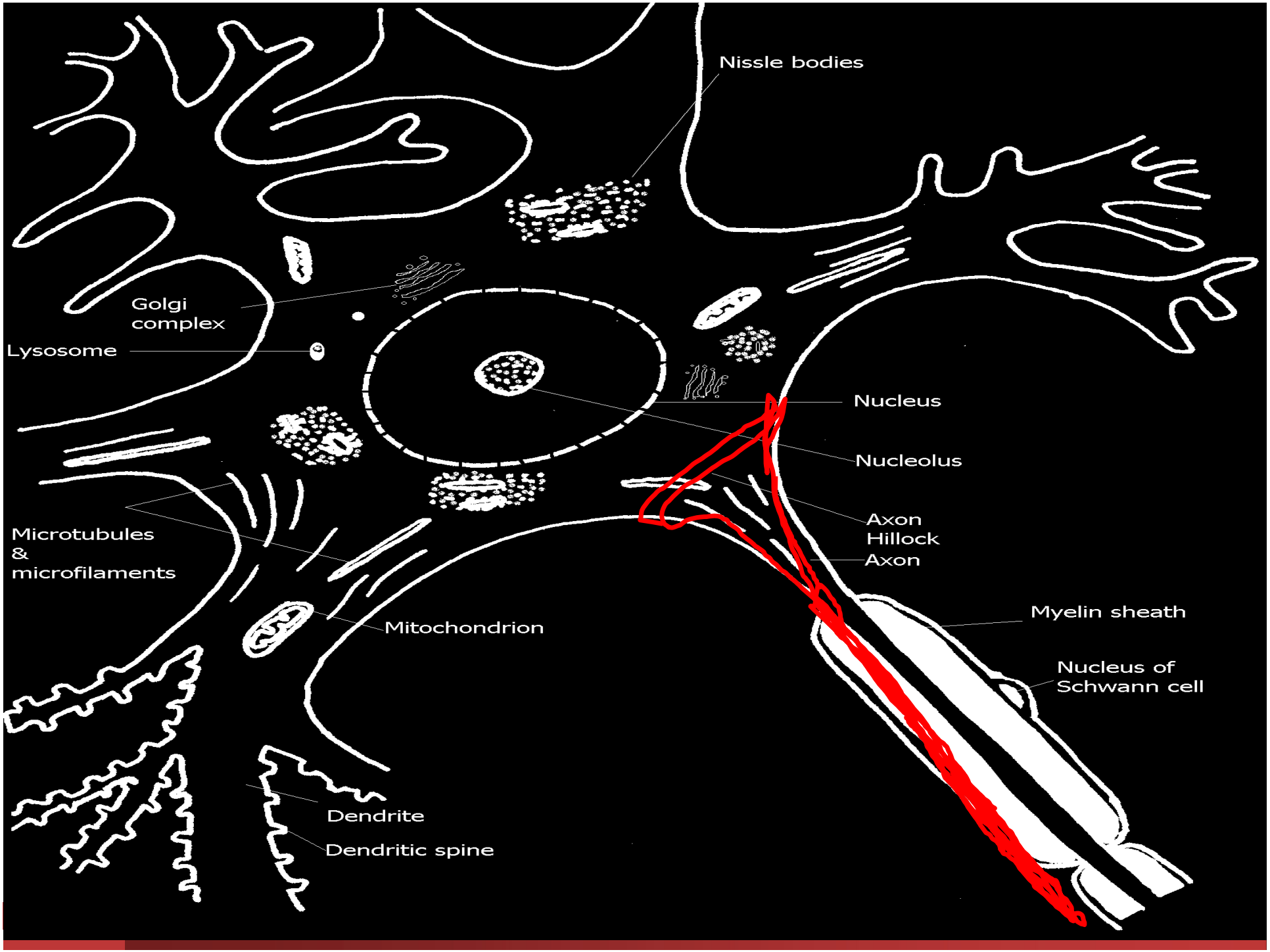
-Cytoplasm:

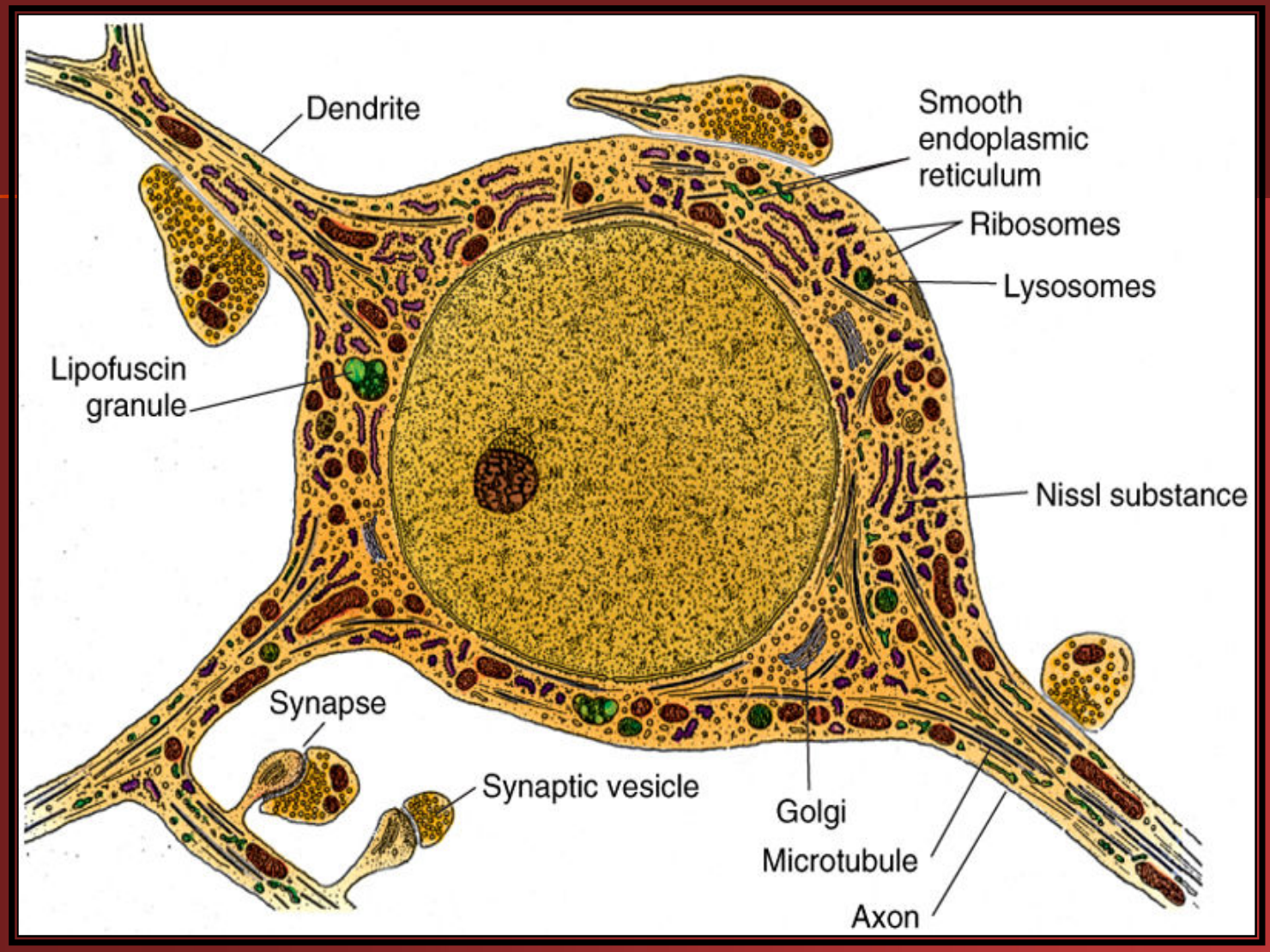
- **Nissl bodies**
  - → spotty basophilic granules (LM).
  - → in cell body & dendrites.
  - → rER & polyribosomes (EM).
- **Golgi** → around the nucleus.





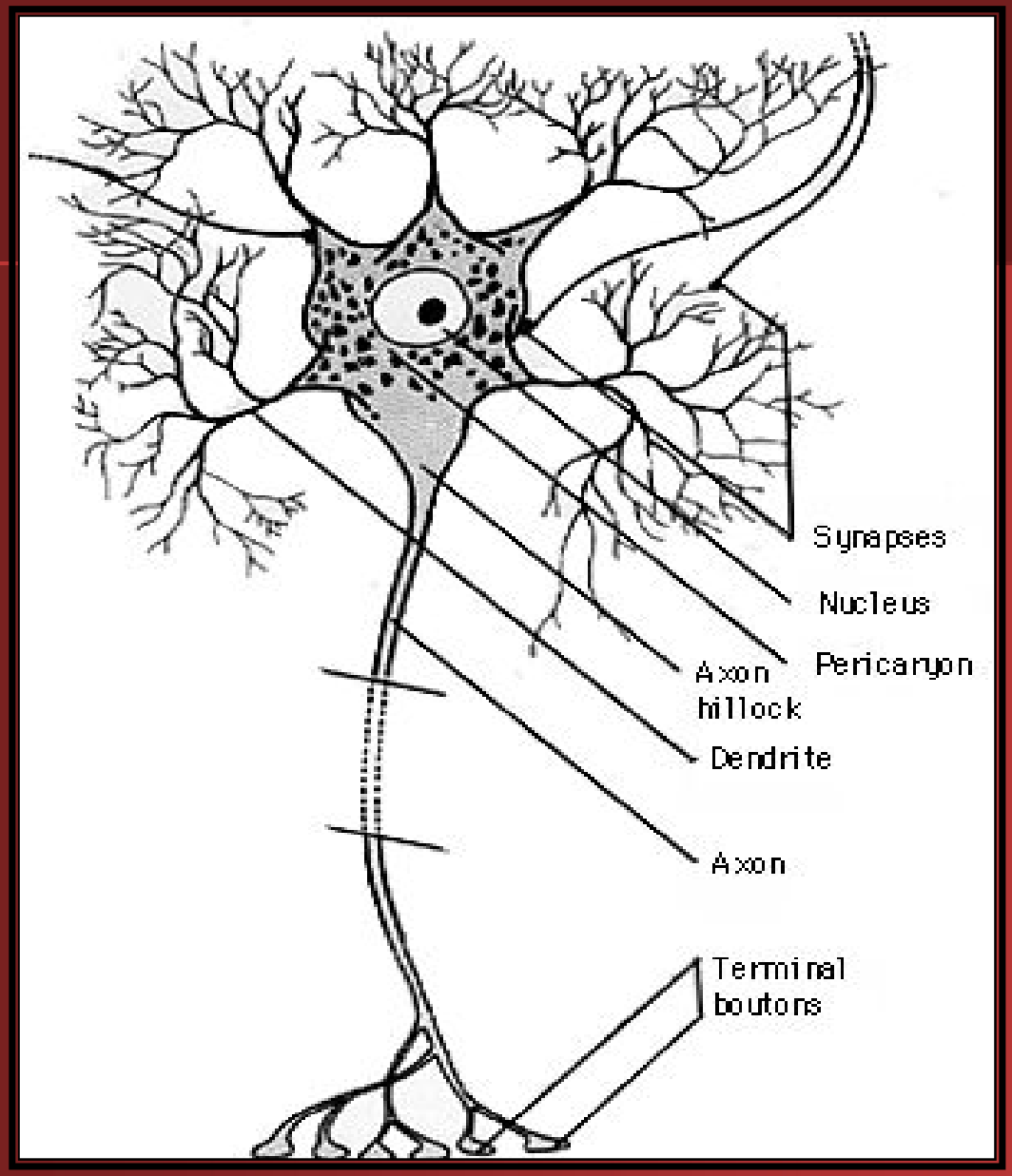
- **↑Mitochondria (axon terminal).**
- **Neurofilaments & neurofibrils**
  → structural support
  → stained by Ag.
  → in cell body, dendrite & axons.
- **Microtubules**
  → in cell body, dendrite & axon.
  → for intracellular transport.
- **Centrioles** → absent (no division).
- **Inclusions:**
  → Lipofuscin pigments (↑ with age).
  → Melanin (eg. in substatia nigra).
  → Lipid droplets.


Nissle bodies
Golgi complex
Lysosome
Nucleus
Nucleolus
Axon Hillock
Axon
Microtubules & microfilaments
Mitochondrion
Myelin sheath
Nucleus of Schwann cell
Dendrite
Dendritic spine


Dendrite
Smooth endoplasmic reticulum
Ribosomes
Lysosomes
Lipofuscin granule
Nissl substance
Synapse
Synaptic vesicle
Golgi
Microtubule
Axon

2-Processes

Dendrites	Axon
Usually numerous	Single
Short.	Long.
Thick.	Thin.
Branching like a tree.	Not branching except at the end arborizations (may give collaterals).
Become thinner at the end	Has a constant diameter
Contain Nissl granules	No Nissl granules
Covered by spine like processes	No spines.
Carry nerve impulses to the cell body.	Carries nerve impulses away from the cell body.


Synapses
Nucleus
Pericaryon
Axon hillock
Dendrite
Axon
Terminal boutons

Classification of Neurons:

A-According to number of processes:

1-Unipolar (pseudo): single process → T shape.

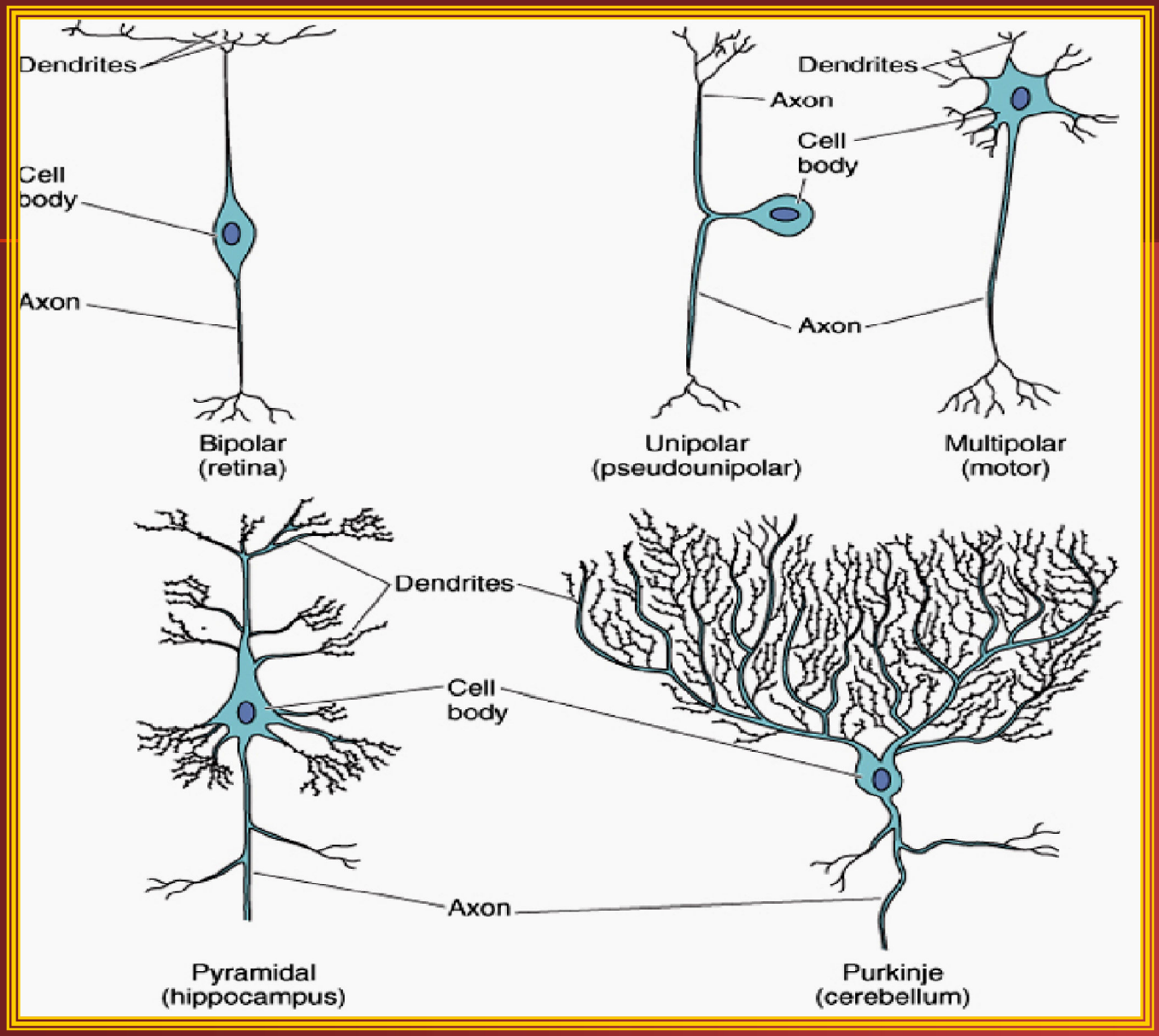
eg.in spinal ganglia.

2-Bipolar: 1 dendrite & 1 axon.

eg. in retina.

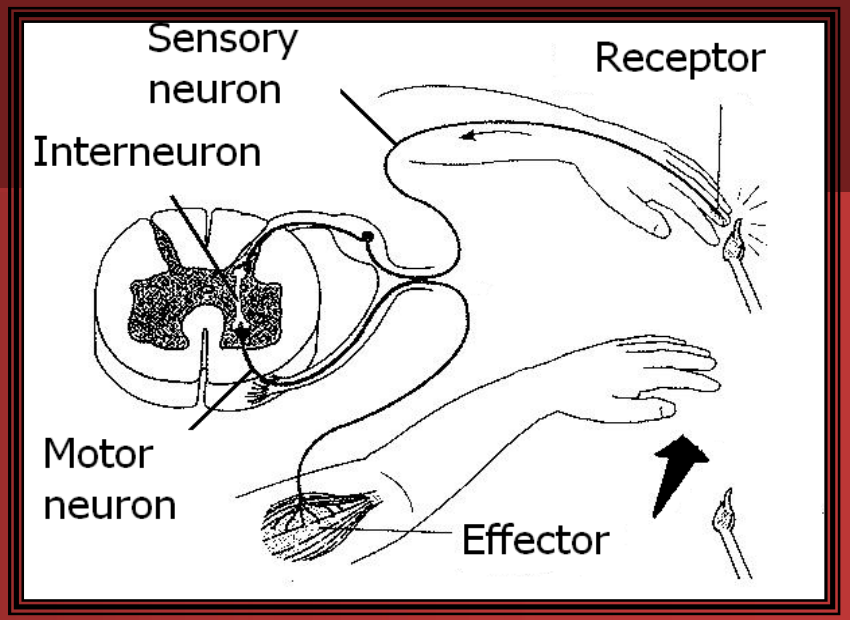
3-Multipolar: Many dendrites & 1 axon.

- **Stellate** → AHCs of spinal cord.
- **Pyramidal** → Cerebrum.
- **Pyriform** → cerebellum (Purkinje cells).


Dendrites
Cell body
Axon
Bipolar (retina)
Dendrites
Axon
Cell body
Axon
Unipolar (pseudounipolar)
Multipolar (motor)
Dendrites
Cell body
Axon
Pyramidal (hippocampus)
Purkinje (cerebellum)

B-According to function:

1-Sensory (afferent)



2-Motor (efferent)

3-Interneurons

C. According to length of axon:

- **Golgi type 1:** long axon → pyramidal cells.
- **Golgi type 2:** short axon → interneurons.

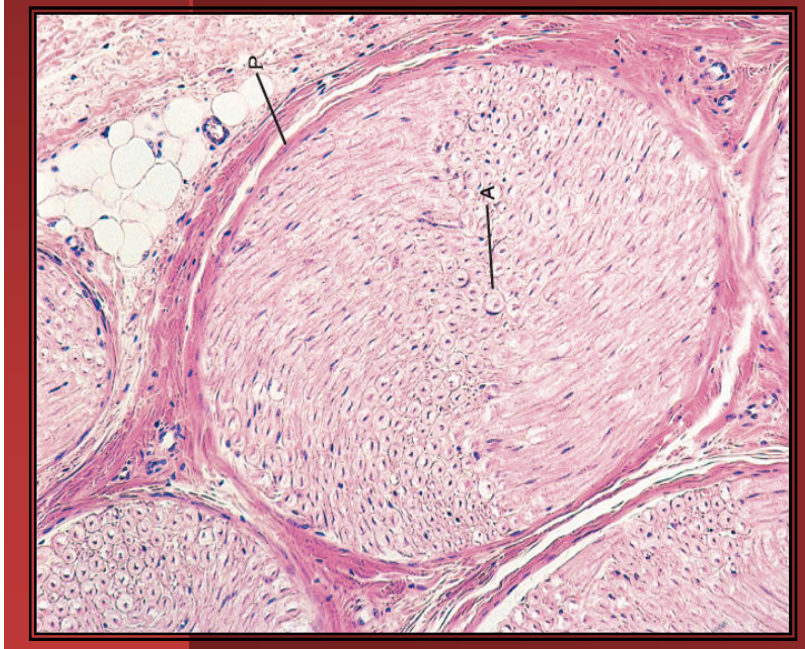
Peripheral nervous system

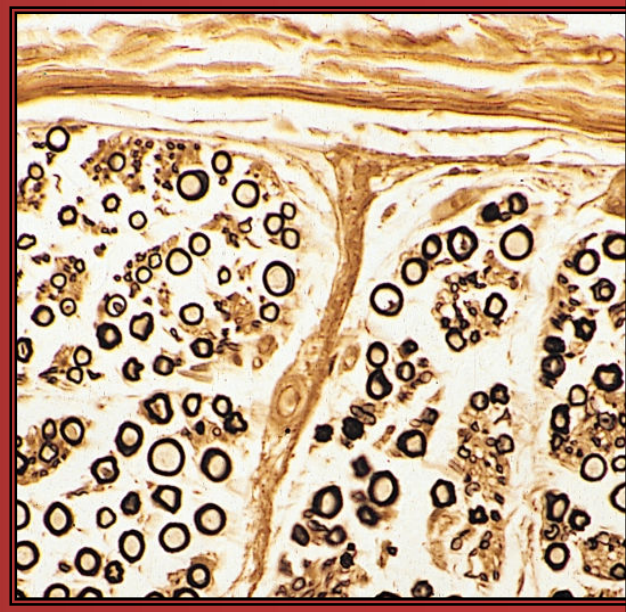
Peripheral nerve

1-Epineurium → surrounding whole nerve trunk.

2-Perineurium → surrounding each bundle.

3-Endoneurium (sheath of Henle)→ in between axons.



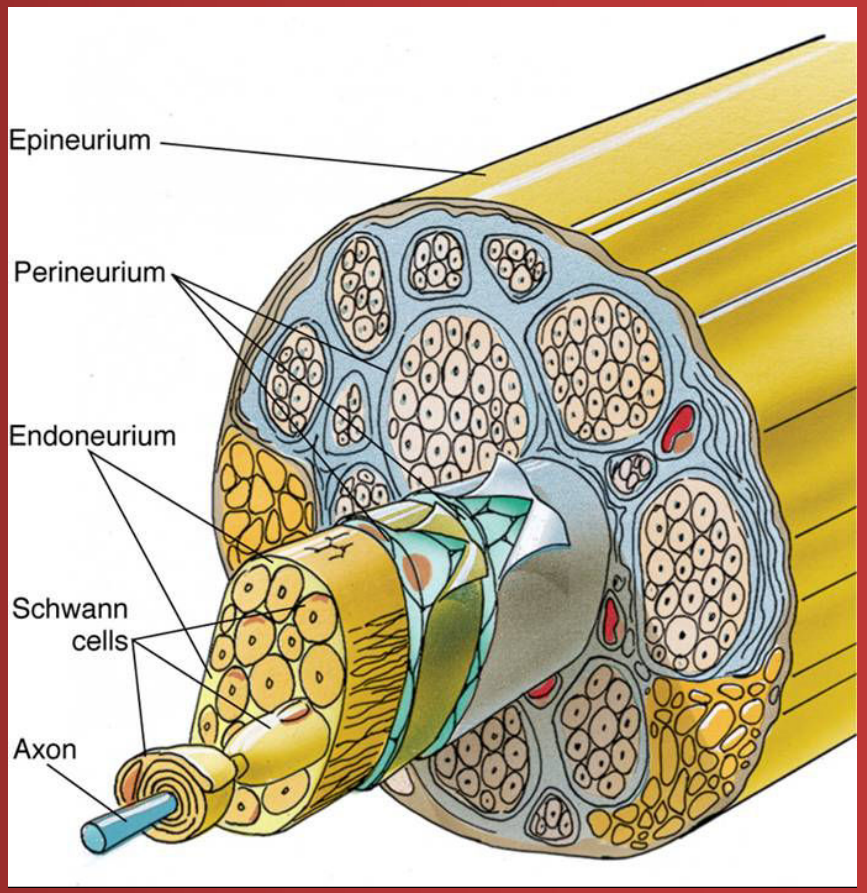


Nerve fiber:

- It is the axon (axolemma & axoplasm), arising at axon hillock.

Connective Tissue Investments

- Connective tissue investments of peripheral nerves include the epineurium, perineurium, and endoneurium



Schwann cells

-Forming the neurolemmal sheath around myelin.

-Flat cells with flat nuclei & few organelles.

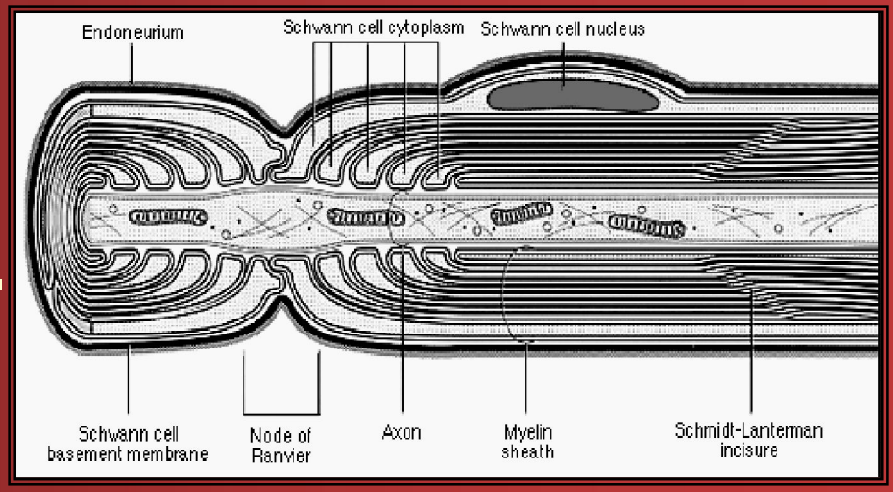
Functions:

-Essential for function of axon.

-Formation of myelin.

-Electric insulation.

-Regeneration of axons.



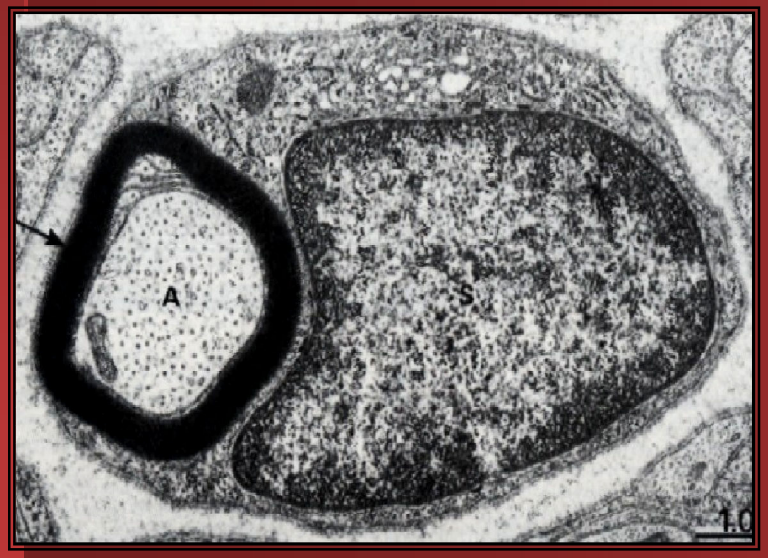
Myelin Sheath

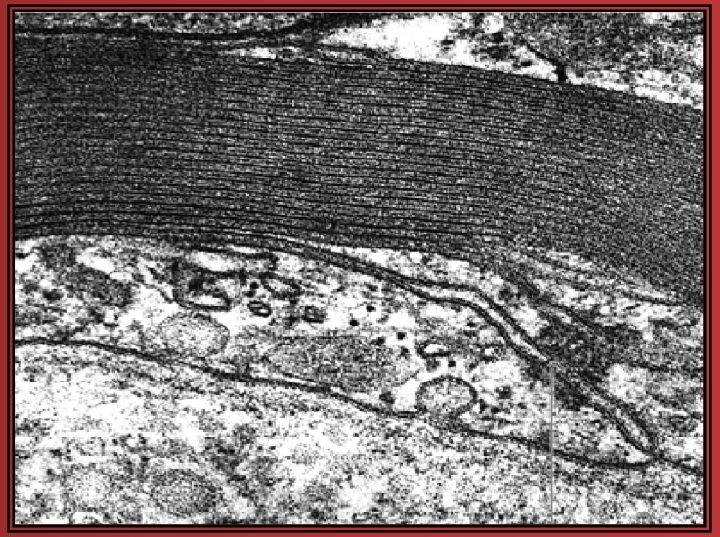
- Lipoprotein (layers of plasmalemma)
  → osmic acid (black).

*In CNS → by oligodendroglia (many axons)

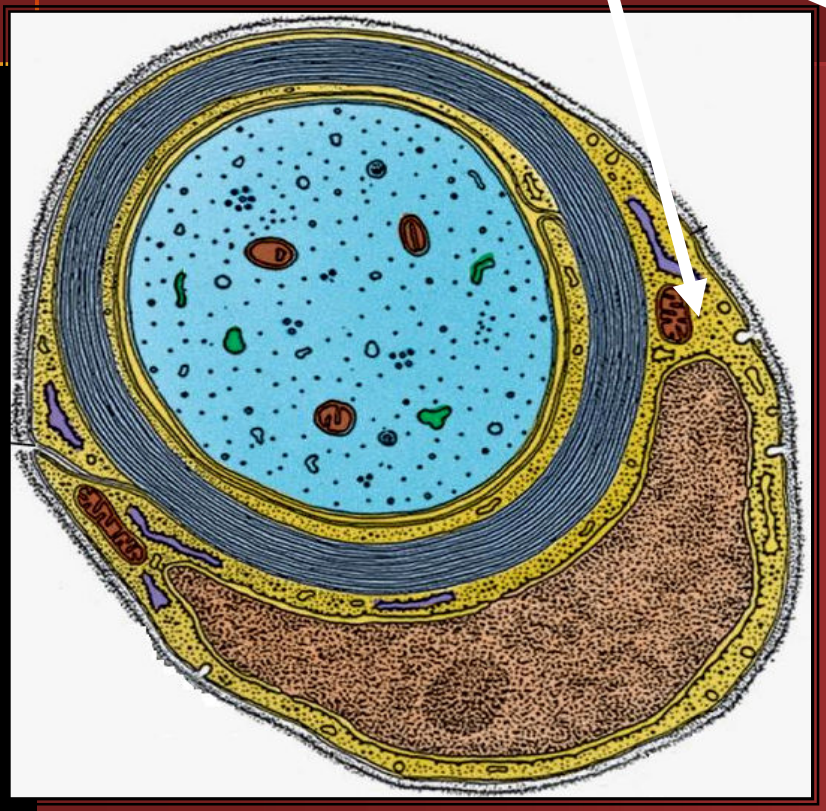
*In PNS → by Schwann cell (one axon).

- Divided into segments (internodal segments)
  → by **nodes of Ranvier**

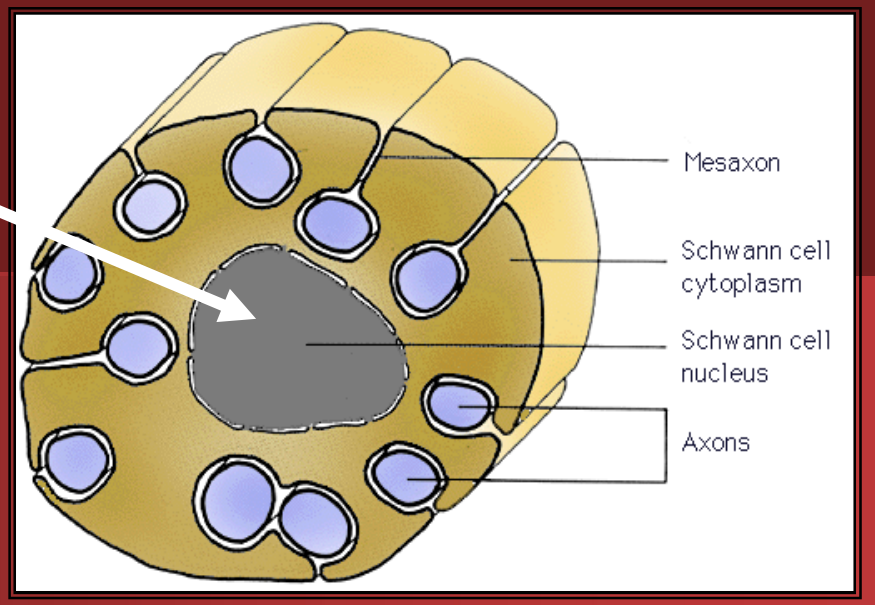




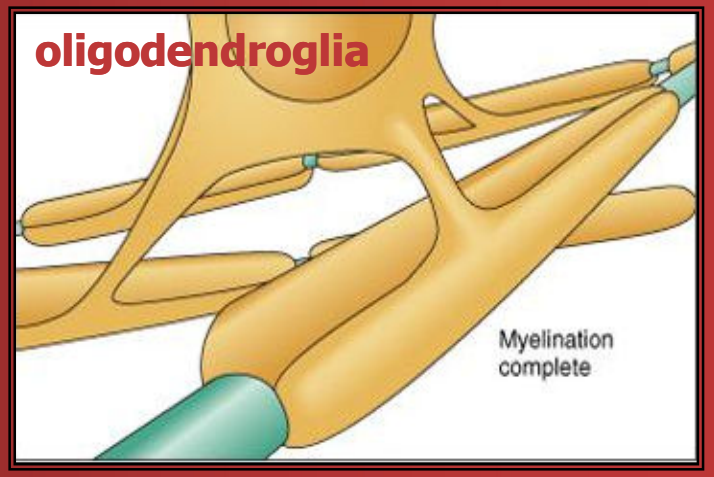
Schwann cell



Myelinated axon with neurolemma in PNS

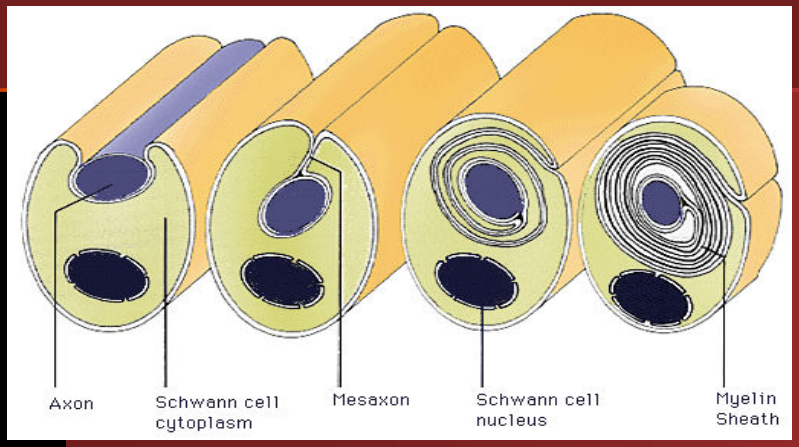


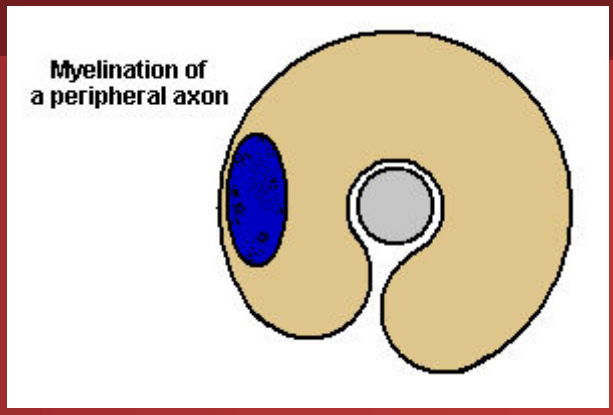
Unmyelinated axon with neurolemma in PNS



Myelinated axon in CNS

Stages of myelinization





Functions of myelin sheath:

-↑speed of nerve impulse.
-Assuring continuity of conduction.
-Nutrition of axon.

Types of nerve fibres:

1-Unmyelinated:

* Without neurolemma → in grey matter
* With neurolemma → in post ganglionic sympathetic nerves.

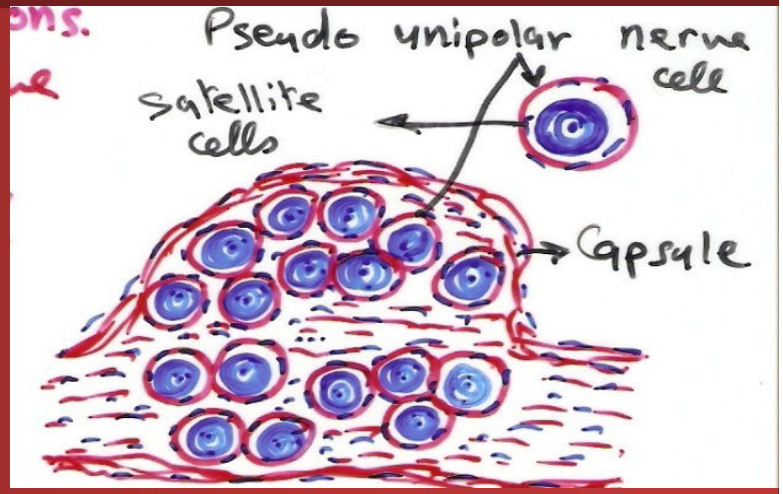
2- Myelinated:

* Without neurolemma → in white matter
* With neurolemma → In peripheral nerves

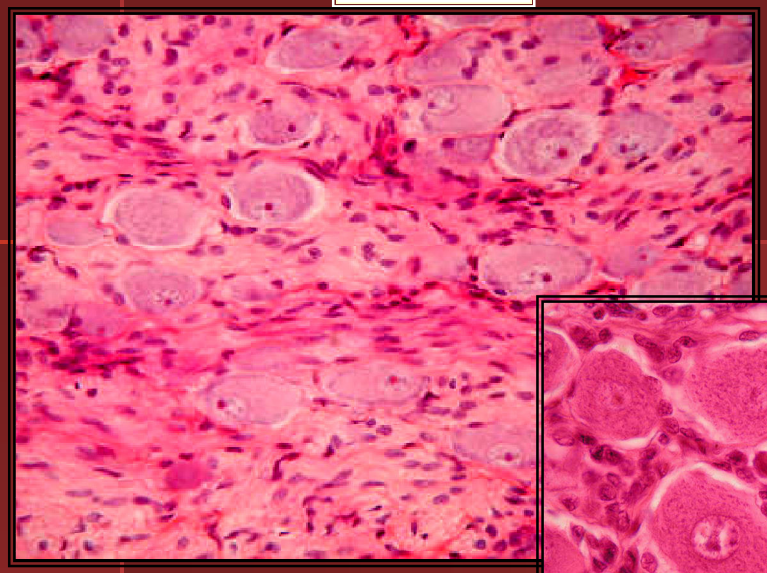
Ganglia

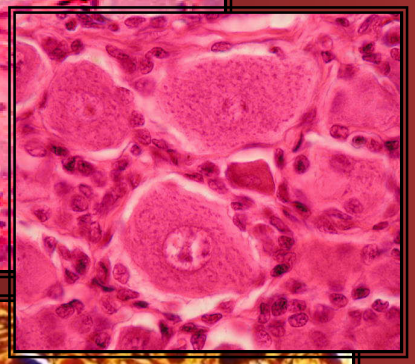
(Capsulated collection of nerve cells & nerve fibers outside CNS)

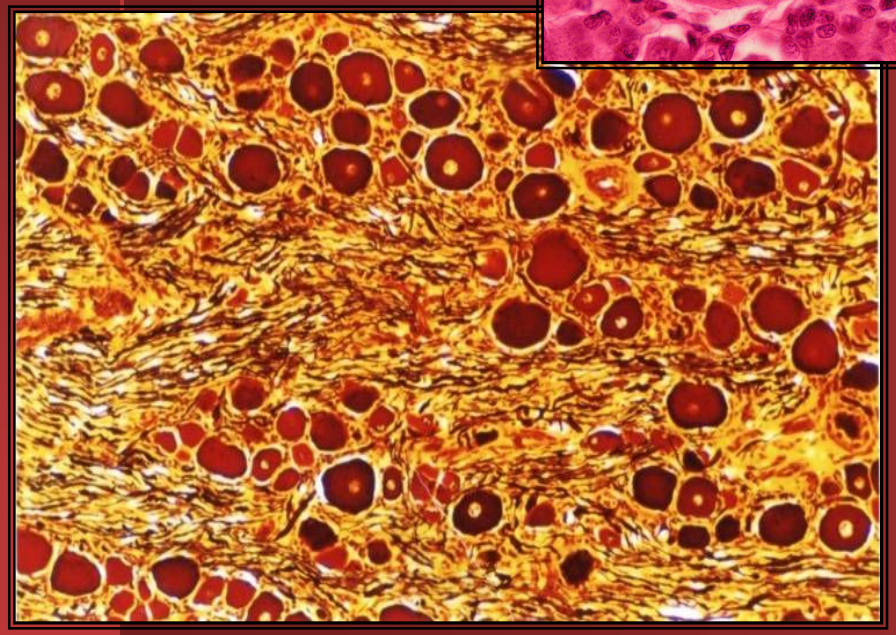
Spinal G.	Sympathetic G.
Thick C.T. capsule	Thin
Unipolar cells	Stellate multipolar
Glomeruli	No glomeruli
Cells are variable in size	Uniform
Large cells	Small
↑ satellite cells	Few
Cells in groups or rows	Scattered
Myelinated nerve fibres	Unmyelinated fibres



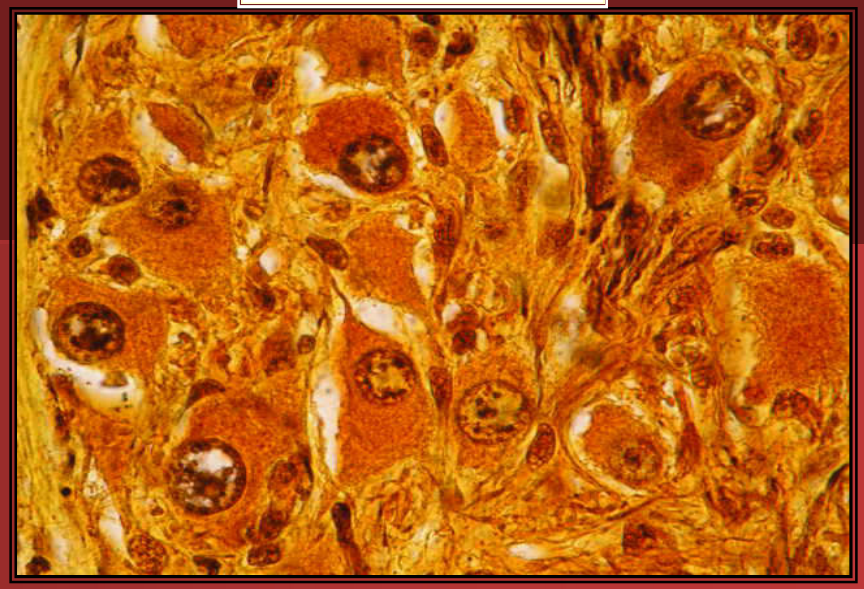
Spinal

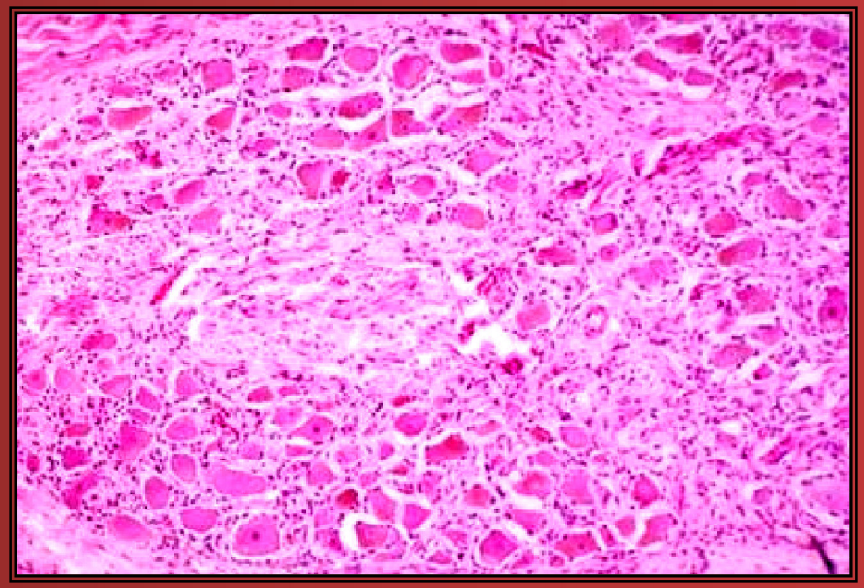






Sympathetic





Synapse

- Site of contact between neurons or neurons & effector cells.
- Formed of:

1-Presynaptic side :

→ ↑ mitochonria & vesicles of neurotransmitter.

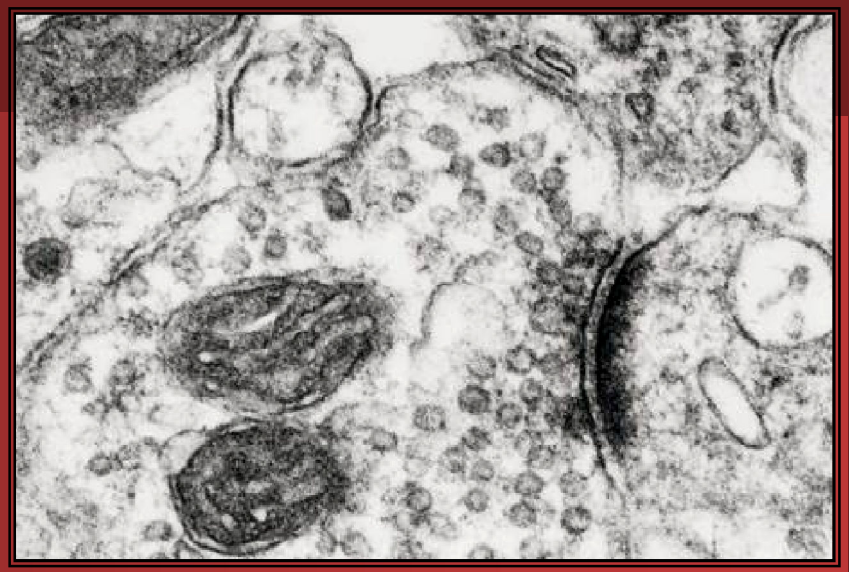
→ Zones of dense cytoplasm → active zone.

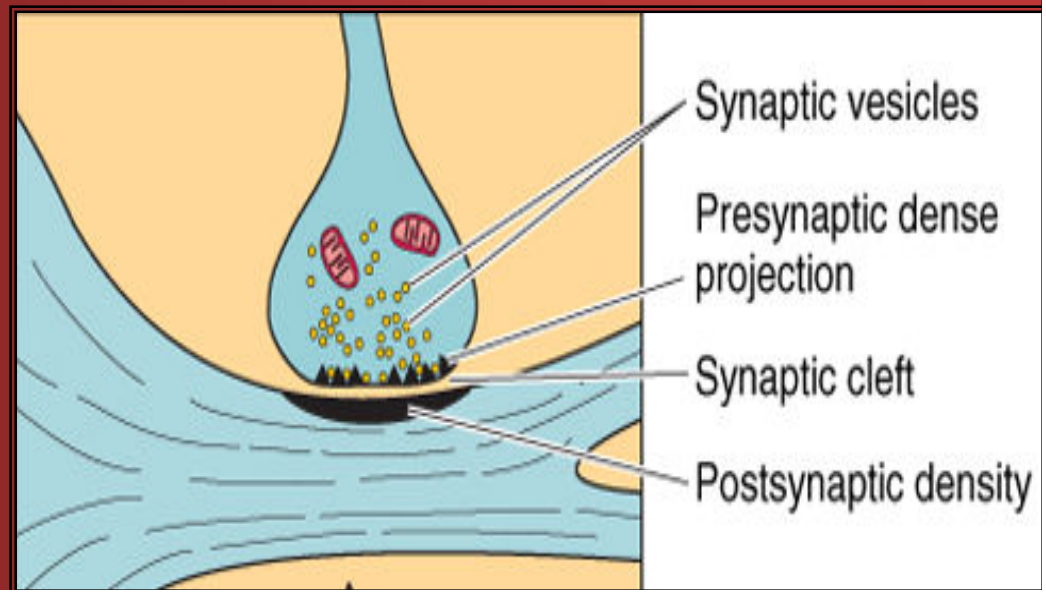
2-Synaptic cleft (20-30nm)

3-Postsynaptic side:

→ Receptors of neurotransmitter.

→ continuous zone of dense cytoplasm & synaptic web.





Classified according to:

A. Method of transmission:

1-Chemical (most common)

Electrical impulse → chemical signal.

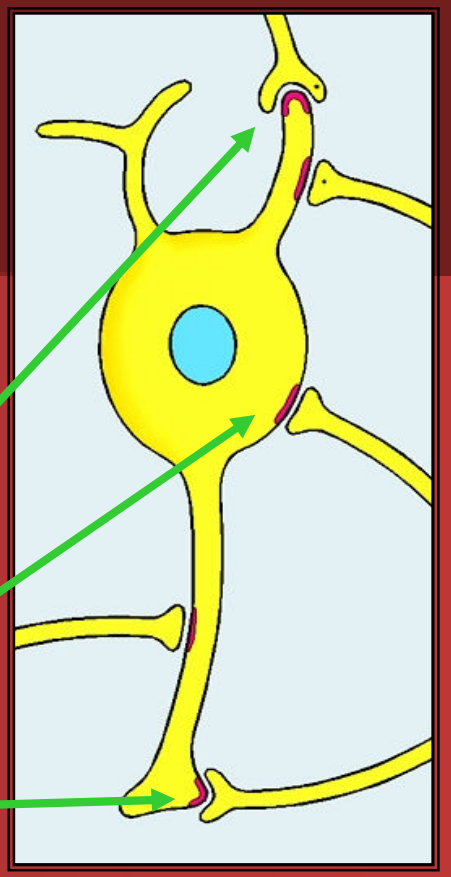
2-Electrical → through gap junction.

B. Site of contact of axon:

1-Axodendritic: axon → dendrite.

2-Axosomatic: axon → cell body.

3-Axoaxonic: axon → axon.



C. Thickness of pre & postsynaptic densities:

1-Asymmetric : Post > Pre , cleft 30nm.

2-Symmetric : Post = Pre , cleft 20nm.

Neuroglia

Routine stains: only the nuclei could be seen
EM or immunohistochemistry to demonstrate the cells
Functional interdependence of neuroglia and neurons

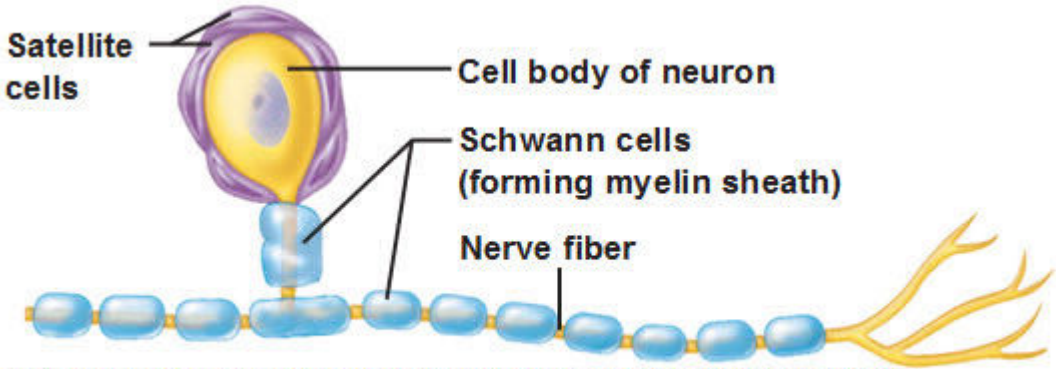
Central neuroglia

Astrocytes
Oligodendrocytes
Microglia
Ependymal cells

Peripheral neuroglia

Schawnn cells & Satellite cells

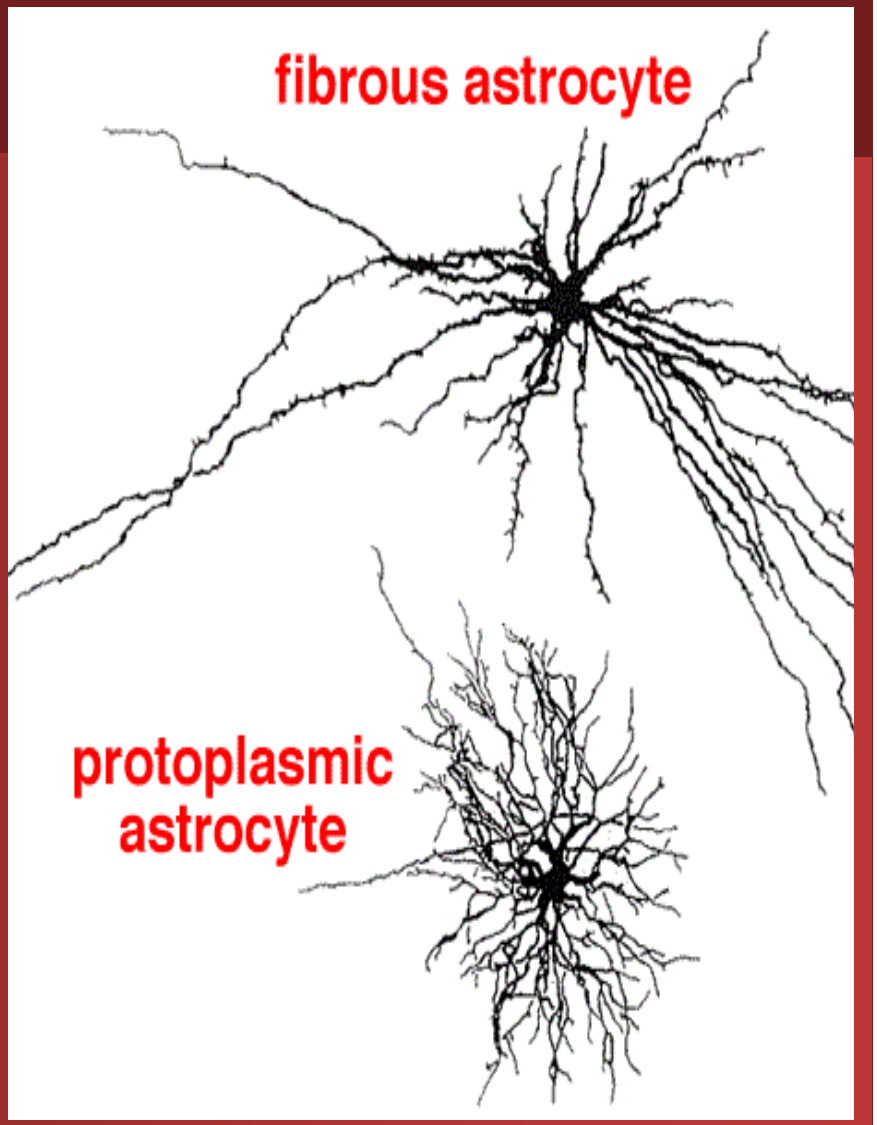
Satellite cells
Form complete layer around the cell body.
They help to establish a controlled microenvironment around the cell bodies



(e) Satellite cells and Schwann cells (which form myelin) surround neurons in the PNS.

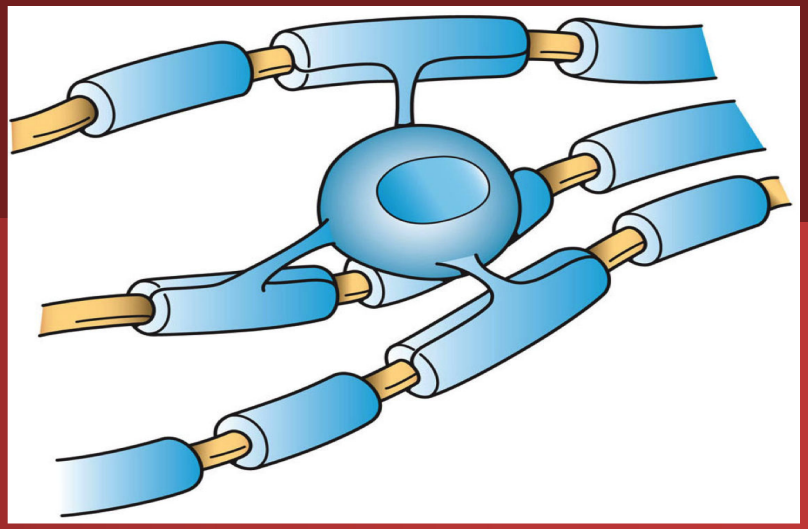
Astrocytes

- Largest of neuroglial cells
- Protoplasmic: grey matter, numerous short branching processes
  Fibrous: white matter, fewer long straight processes
  GFAP intermediate filaments
  Fibrous astrocytomas: 80% of adult primary brain tumors
  Blood brain barrier

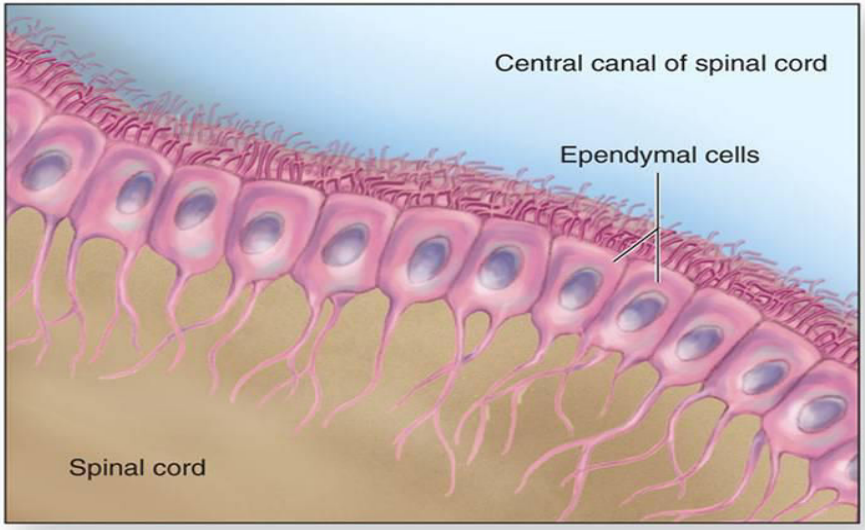


Microglia

Oligodendrocytes

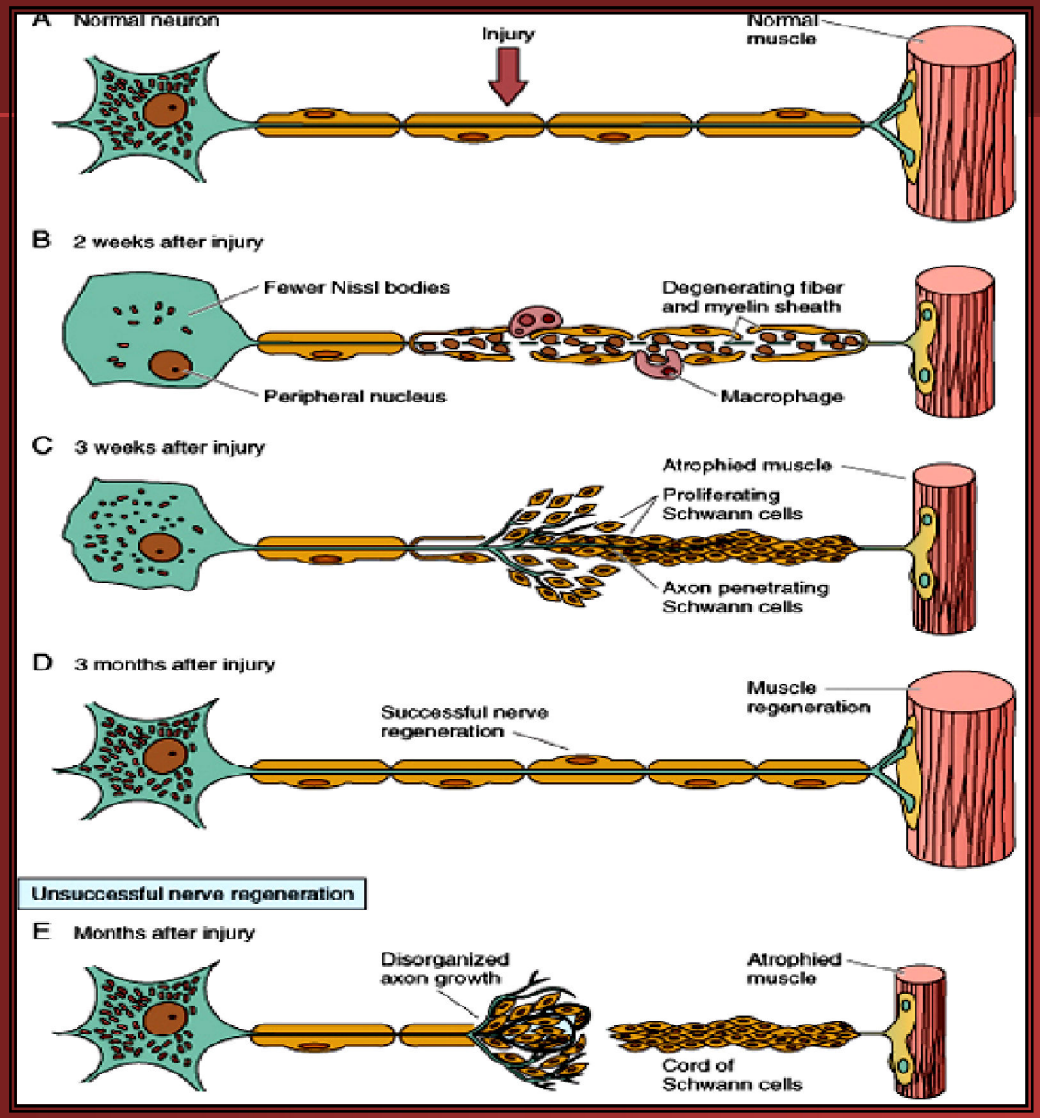


Ependymal cells



(b) Ependymal cells

Degeneration & Regeneration of nervous tissue



* In an injured nerve → 2 types of changes

I=Retrograde degeneration

(In nerve cell& proximal part of nerve fibre)

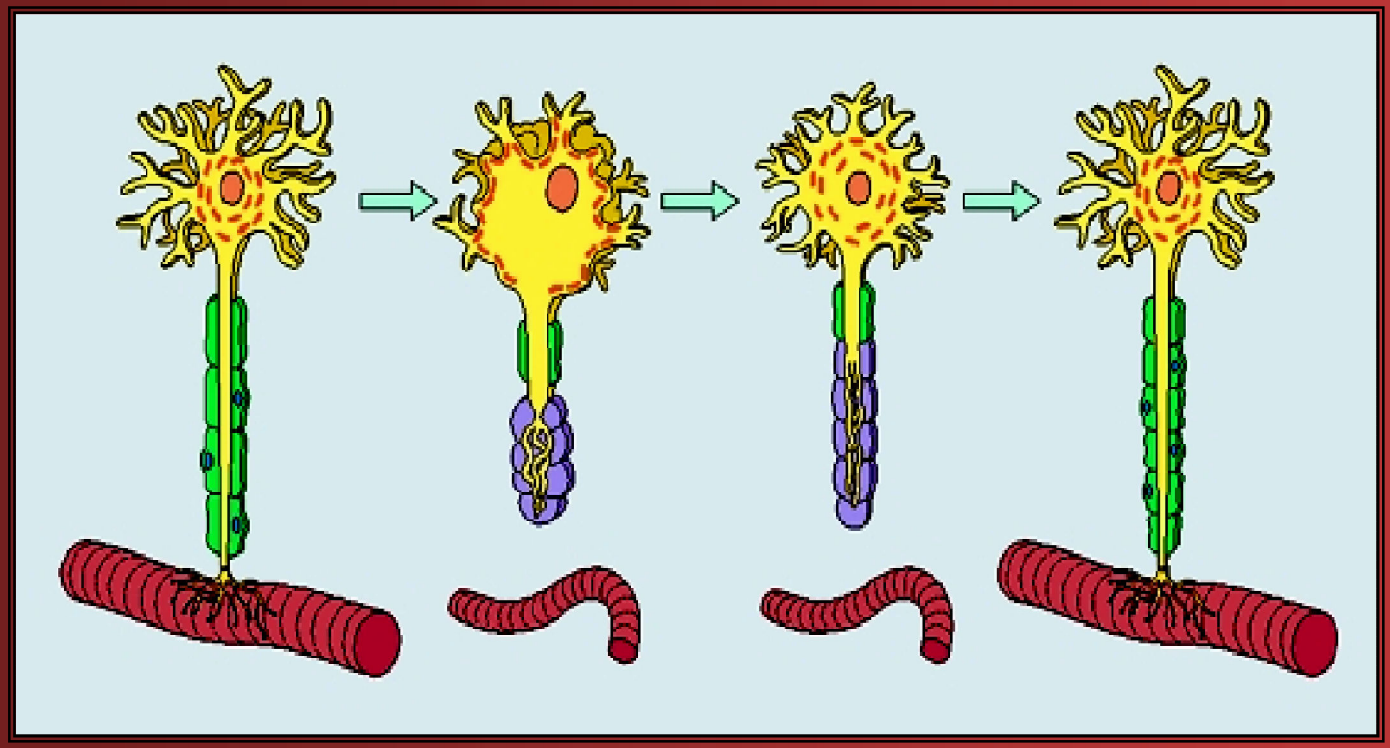
- Chromatolysis: disappearance of Nissl's granules (↓basophilia)
- ↑ perikaryon & loss of dendrites.
- Nucleus → peripheral
- Disappearance of Golgi and mitochondria.
- Fragmentation of neurofibrils
- ↑ Lyzosomes

II=Wallerian degeneration

(distal part of nerve fibre):

- **Axon:** Neurofibrils → beaded → segmented → granular → disappear
- **Myelin sheath:** Wide nodes of Ranvier. → internodal segments →fermentation chambers (fat →FA)
- **Schwann cell:** Proliferate → cellular columns (guide for axonal growth)
- Transneuronal degeneration: similar changes in neurons having synapse with the injured neuron.

- **Regeneration:**
  - **Macrophages:** remove debris & stimulate Schwann cells (interleukin1) → ↑ nerve growth
  - **Growth of axon:** → in columns of Schwann cells



- **Stains of degeneration:**
  - **Silver:** GA & neurofibrils
  - **Osmic acid:** Myelin sheath
  - **Basic stains:** Nissl's granules
  - **Weigert-Pal stain:** Normal tracts in white matter
  - **Marchi stain:** (myelinated nerves)

    -Potassium dichromate for normal tracts only -Osmium for early degenerated tracts.


THANK YOU