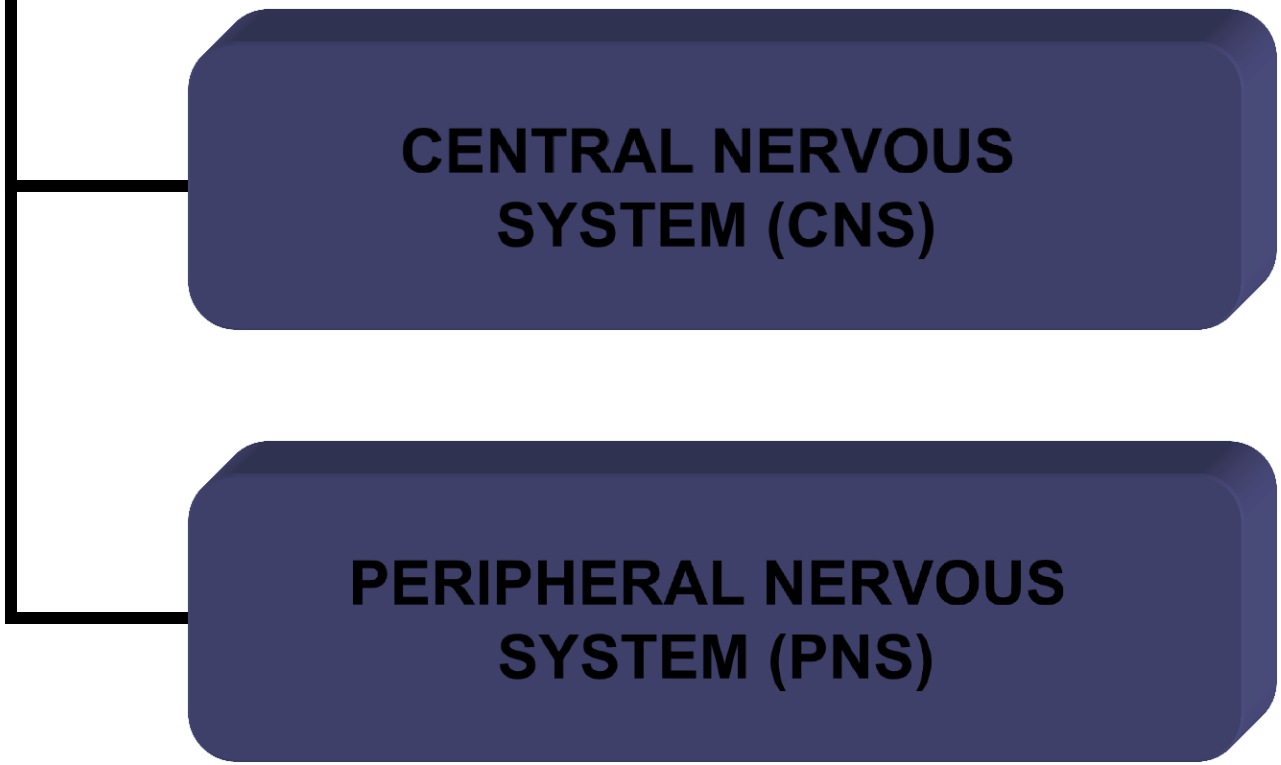
NERVOUS SYSTEM

- The most complex system in the human body
- Formed by network more than 100 million neuron
- Each neuron has a thousand **interconnection** → a very complex system for communication
- Nerve tissue is distribute throughout the body, anatomically divide into : **CNS** & **PNS**
- Structurally consist : **Nerve cells** & **Glial cells**

Anatomically divided in to :

- NERVOUS SYSTEM



Functional Organization of the Nervous System

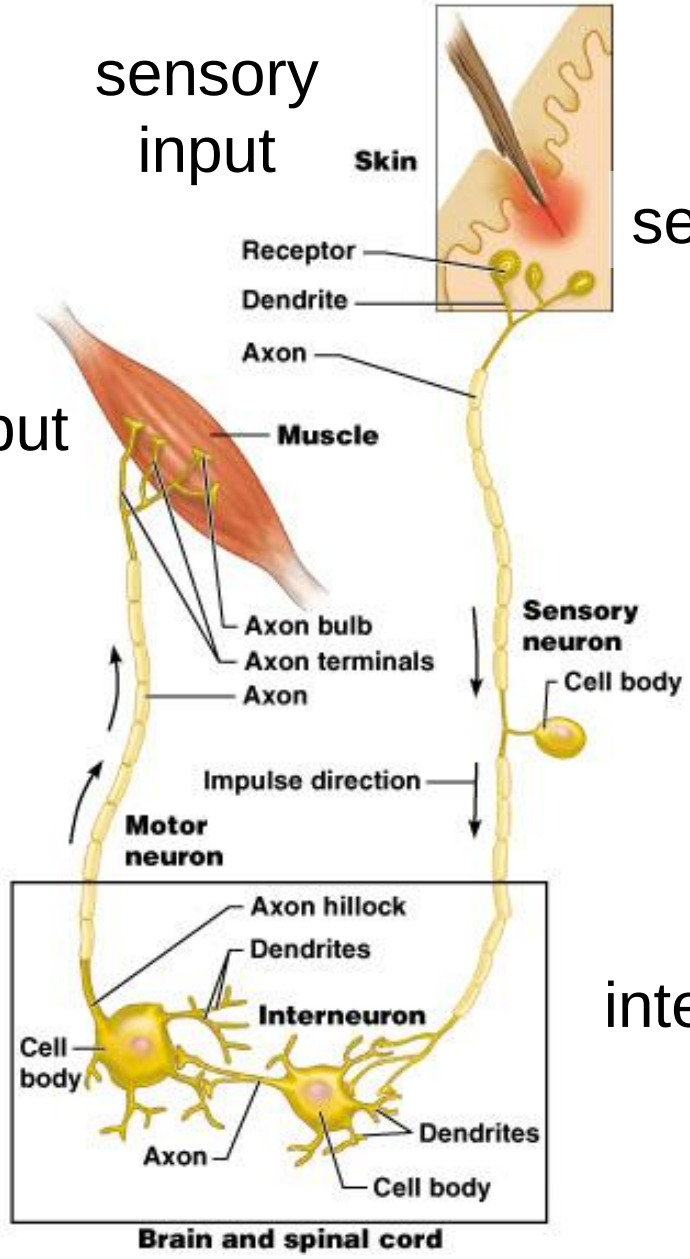
1. **Somatic (conscious afferent* and efferent, voluntary motor control)**
2. **Autonomic (unconscious efferent, involuntary motor control of internal organs to maintain homeostasis)**
   a. **Sympathetic – thoracolumbar division**
   b. **Parasympathetic – craniosacral division**

*** Somatic afferents = sensory fibers from skin, muscle, joints, tendons.**

Visceral afferents = sensory fibers from visceral organs; some result in conscious sensations, but others do not. However, they are not considered part of the autonomic nervous system, which is entirely efferent.

Function of the nervous system

sensory input



sensory receptor

motor input

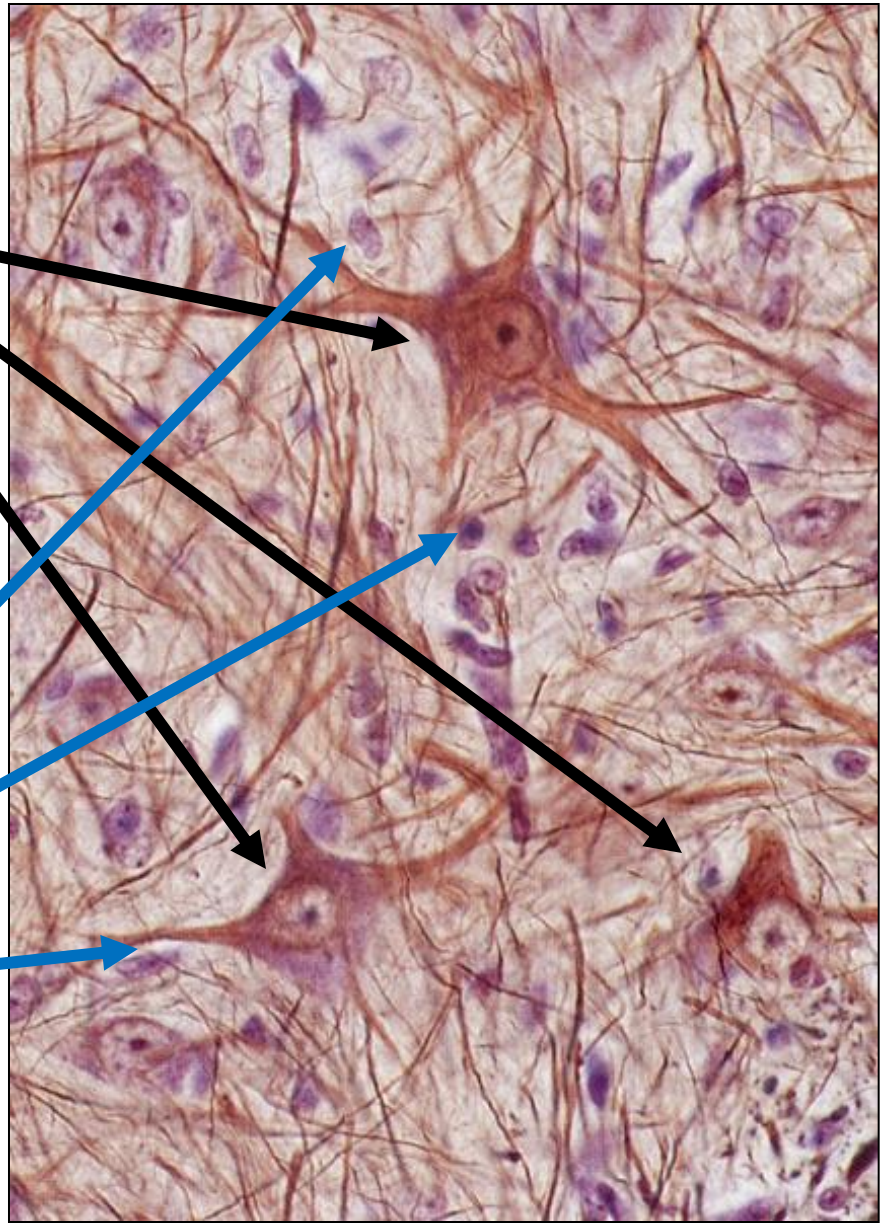
effector

integration

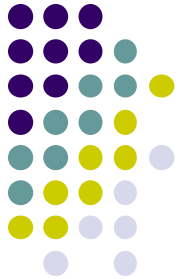
CONTENTS

- Cells of nervous system nerve cells and Neuralgia
- Synaptic communication
- Central nervous system & Peripheral nervous system & associated structure

Cellular Components of the Nervous System



Nervous Tissue: Support Cells

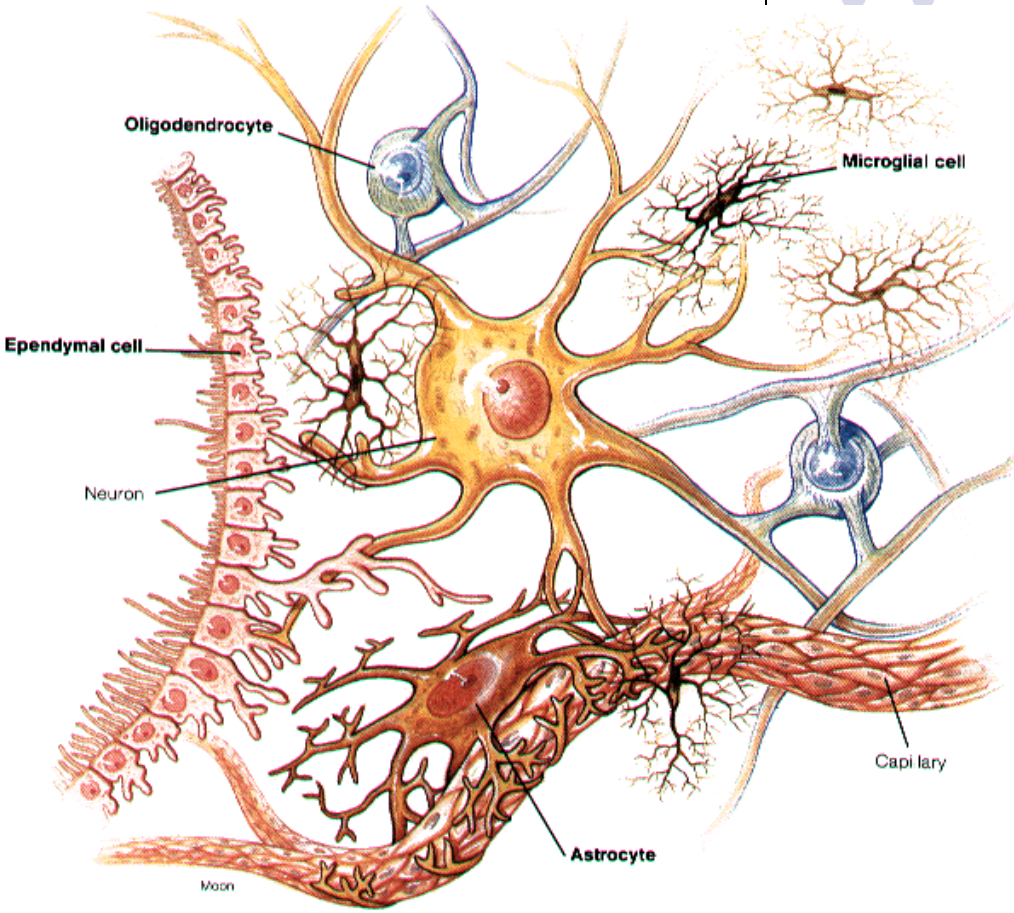


- Support cells in the Central Nervous System (CNS) are grouped together as neuroglia
- Neuroglia literally means “nerve glue”
- The function of neuroglia is to support, insulate, and protect the delicate neurons of the brain

Neuroglial Cells

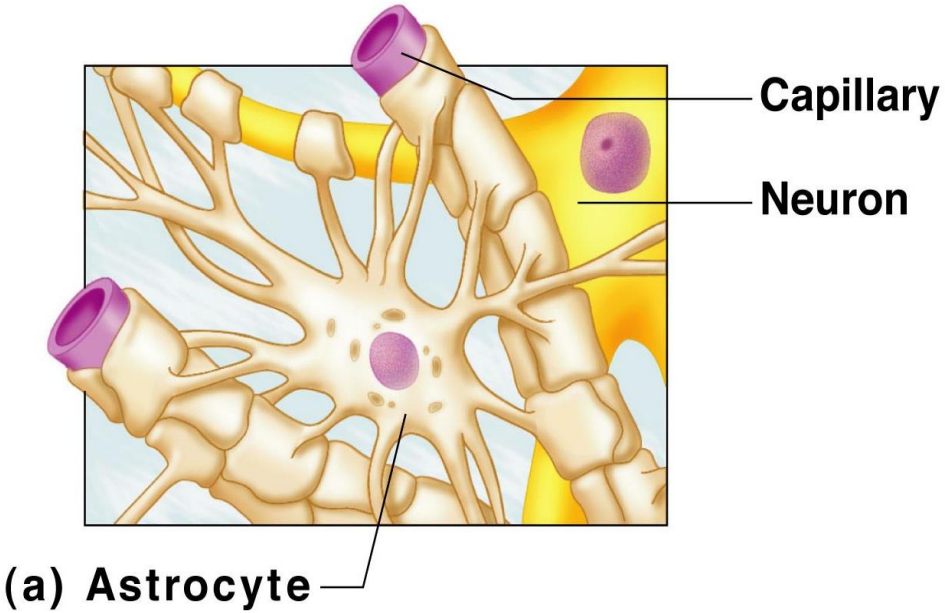
- Half of the volume of the CNS
- Smaller cells than neurons
- 50X more numerous
- Cells can divide
  - rapid mitosis in tumor formation (gliomas)

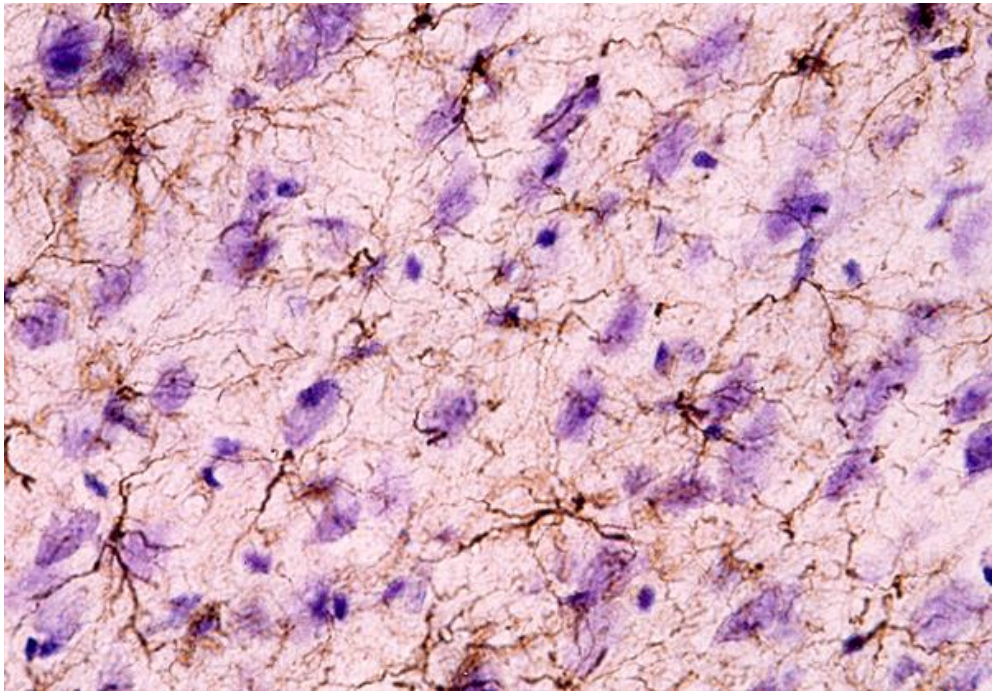
- 4 cell types in CNS
  - Astrocytes
  - Microglia
  - Ependymal
  - oligodendrocytes
- 2 cell types in PNS
  - Schwann
  - satellite cells

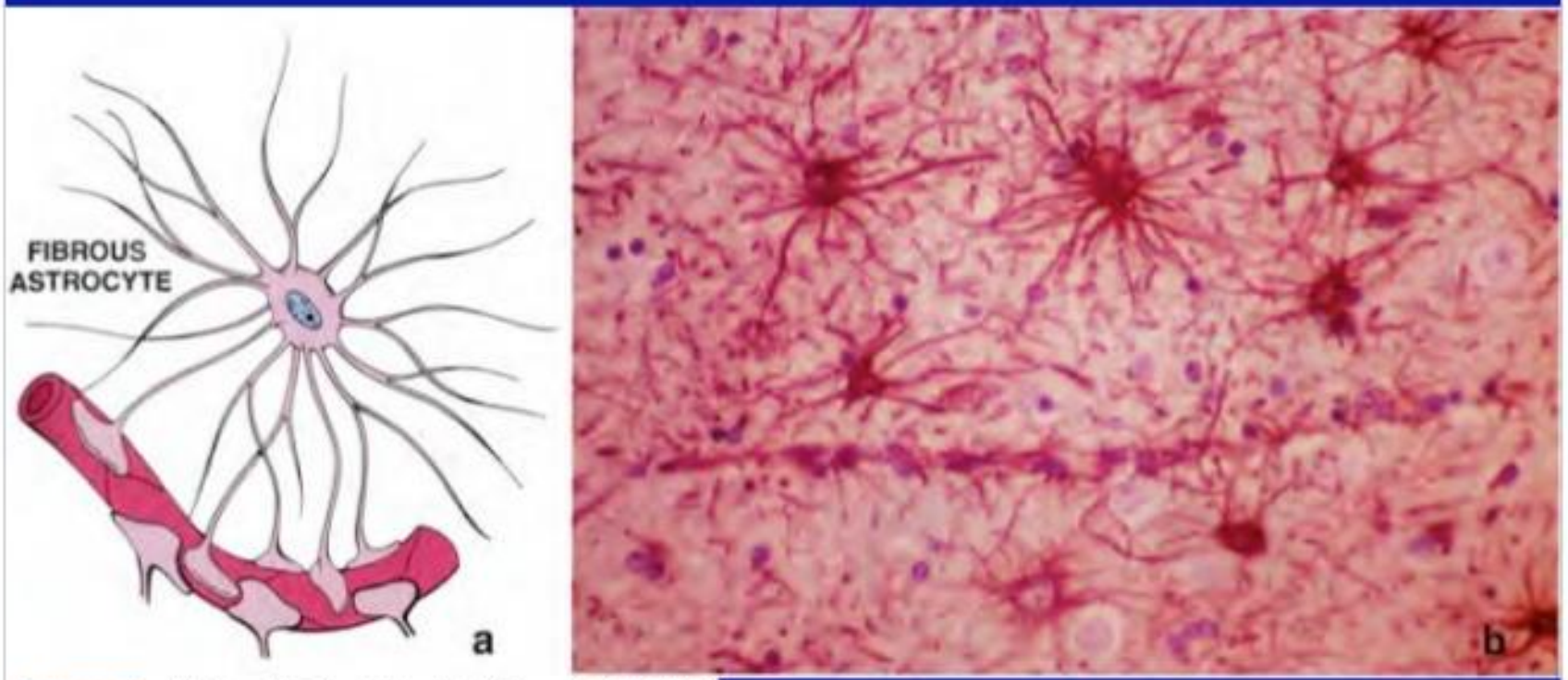


Types of Neuroglia in CNS

- **Astrocytes**
  - Star-shaped cells
  - Half of all brain tissue
  - Brace neurons; they keep the neurons in contact with their blood supply (capillaries)
  - Control the chemical environment of the brain by mopping up leaked ions







Histology-A Text and Atlas 4th ed, Ross et al ; Fig 11.20

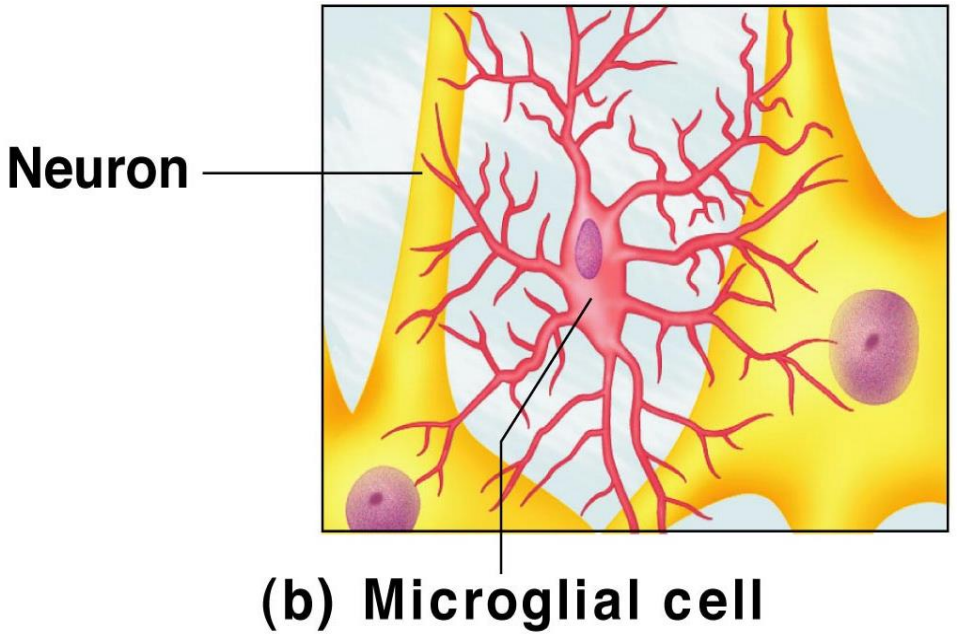
GFAP immunostaining for astrocytes
(Glial Fibrillary Acidic Protein)

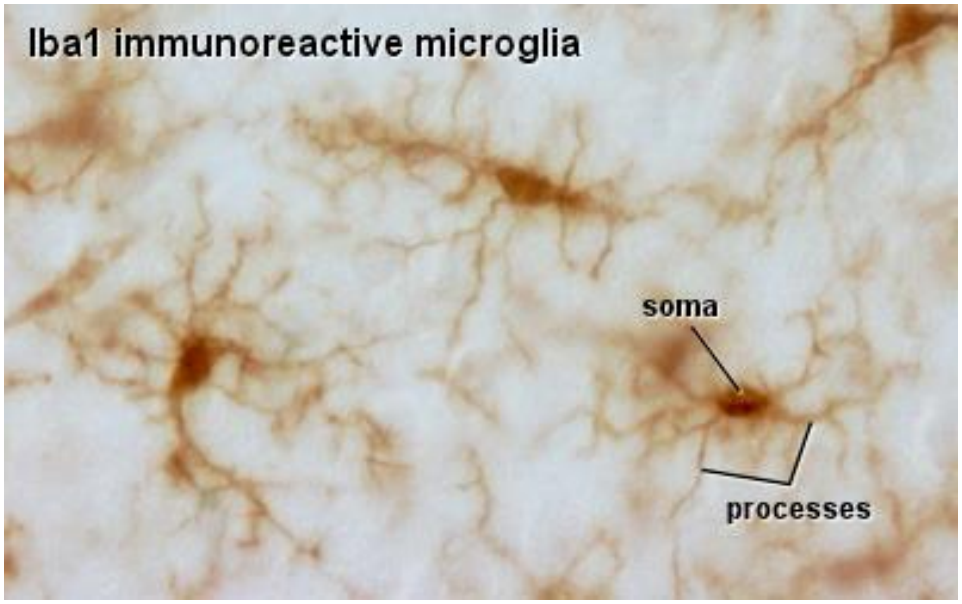
The word astrocyte is derived from the Greek word ἄστρον = astron for star or star-shaped)

We will not deal with differences between fibrous (white matter) and protoplasmic (gray matter) astrocytes.

Types of Neuraglia in CNS

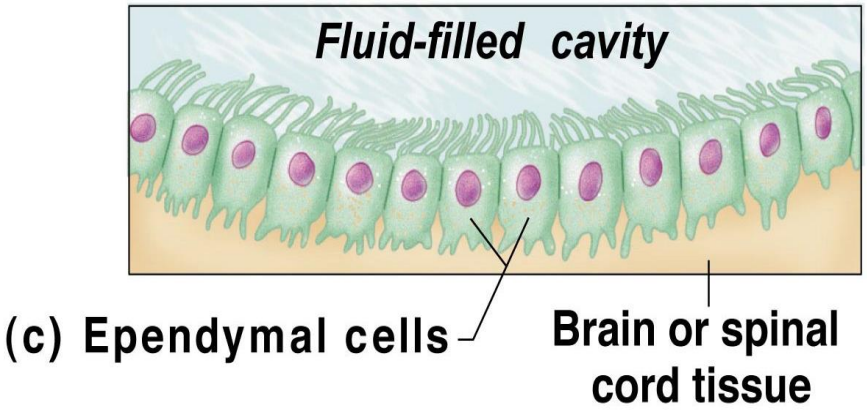
- **Microglia**
  - Spiderlike phagocytes (white blood cells)
  - Dispose of debris like dead brains cells and bacteria

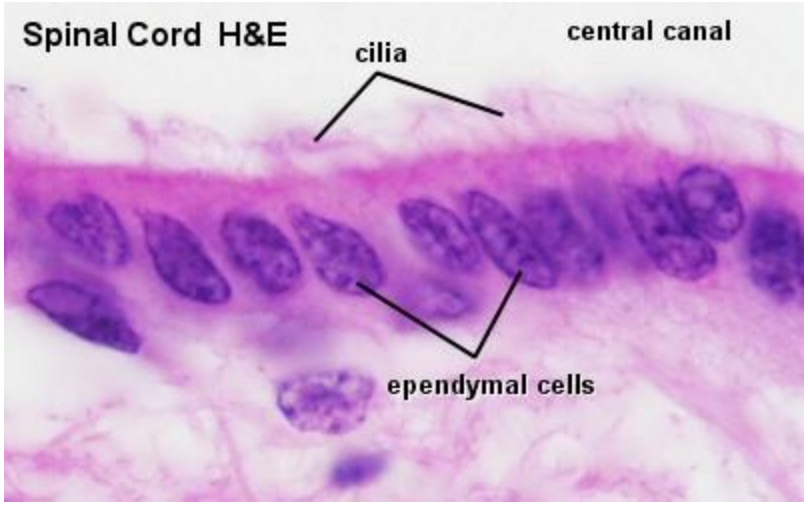




Types of Neuroglia in CNS

- **Ependymal cells**
  - Lines the cavities of the brain and spinal cord
  - Circulate cerebrospinal fluid by beating their cilia
  - Cerebrospinal fluid fills the space the brain does not take up and forms a protective cushion around the brain and spinal chord





EPENDYMAL CELLS

-Forms the epithelial lining of ventricles and spinal cord.

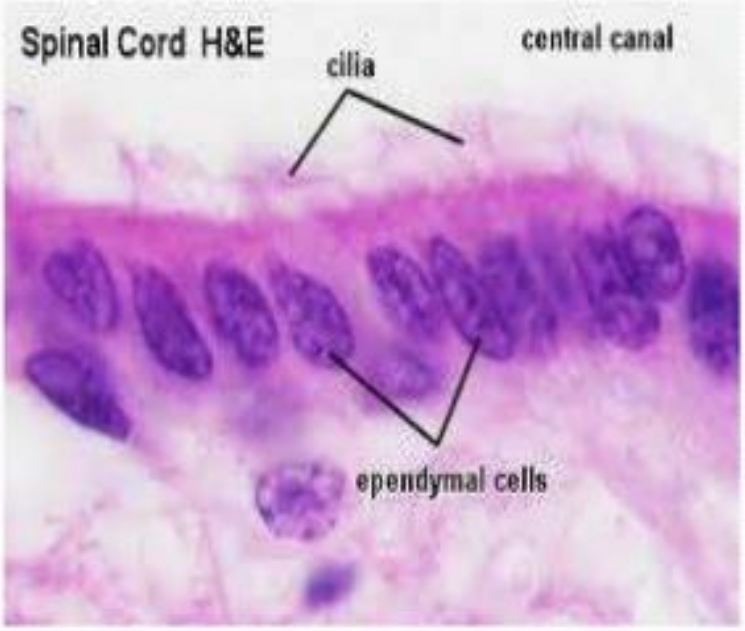
-Cuboidal or low columnar in shape.

-cells are bound at the luminal surface by epithelial junctional complexes.

–The bases of cells taper and break into fine branches which ramify into underlying layer of astrocytic processes.

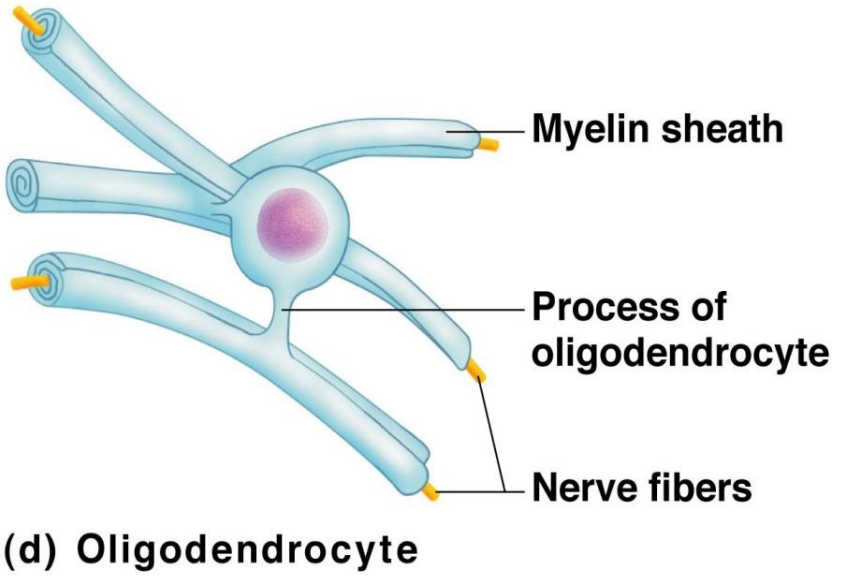
FUNCTIONS

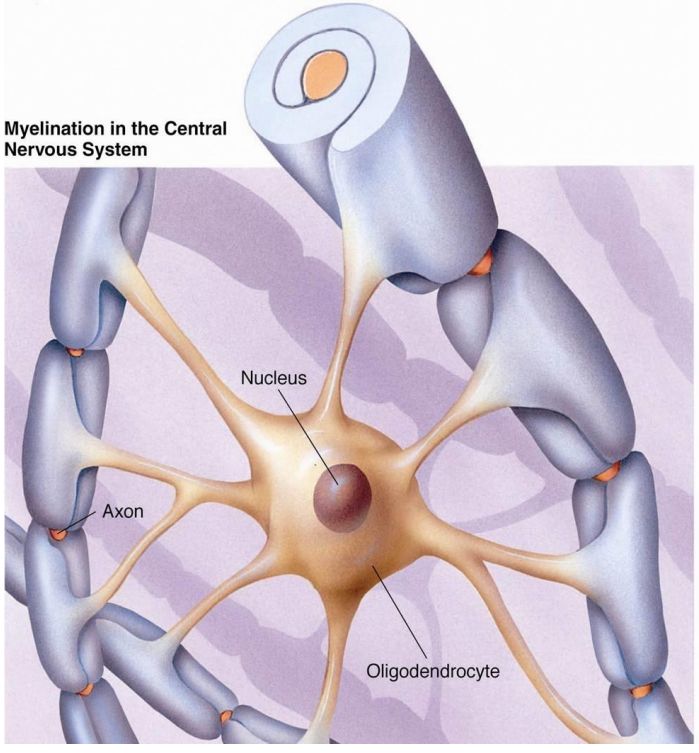
-Protection: Forms lining of the ventricles of the brain and central canal of the spinal cord.
Forms cerebrospinal fluid (CSF).
-Aids circulation of cerebrospinal fluid (CSF).

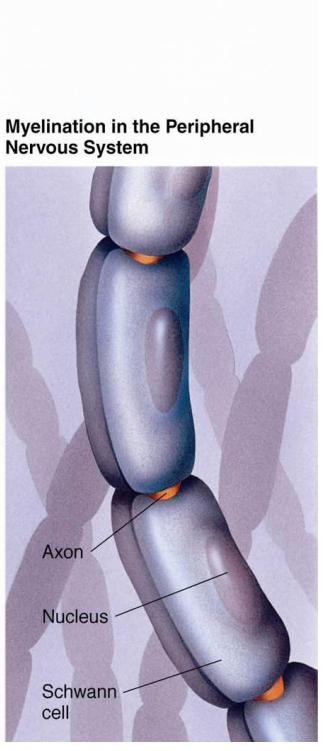


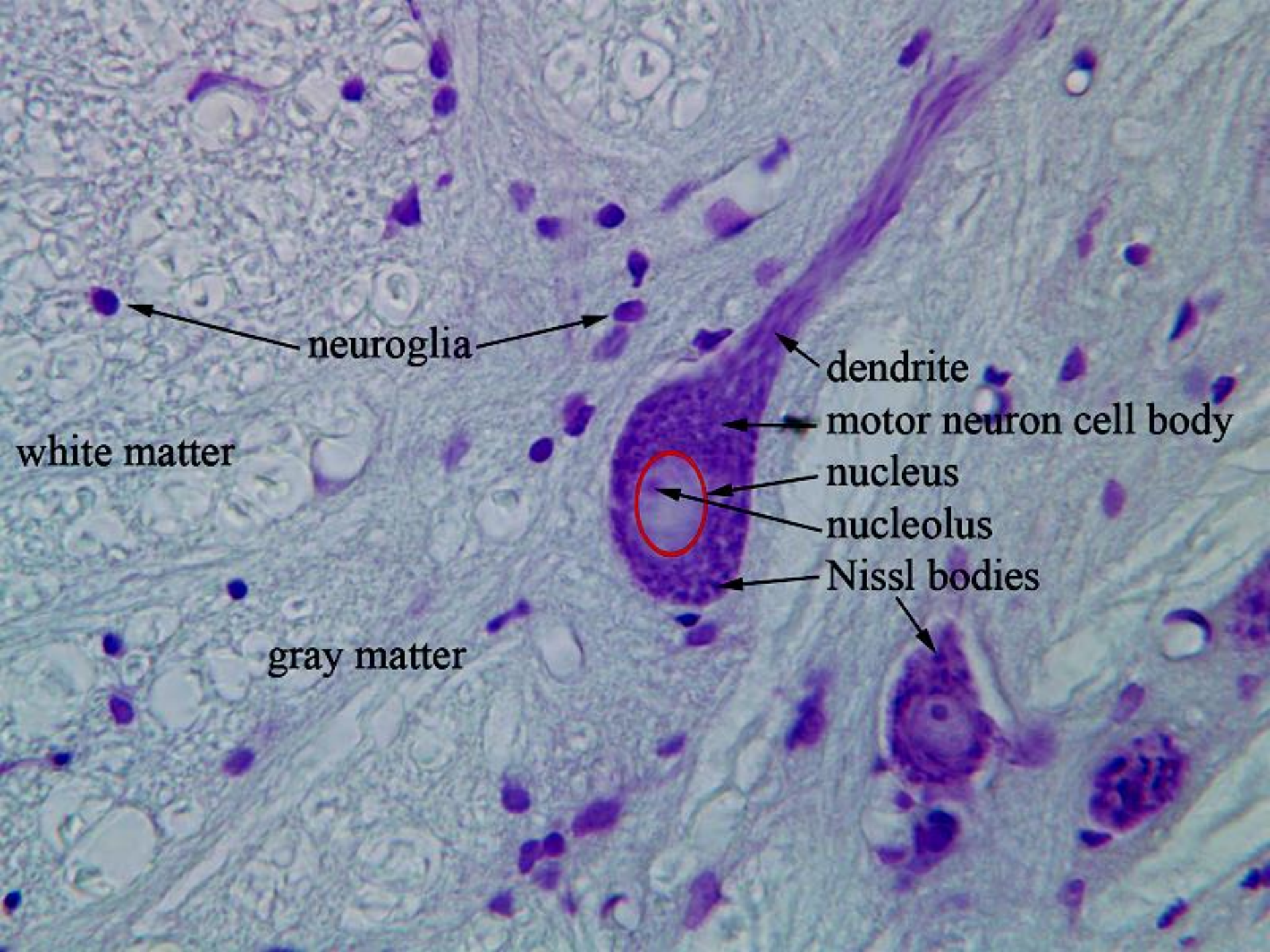
Types of Neuroglia in CNS

- **Oligodendrocytes**
  - Wrap around nerve cells in the brain and spinal chord
  - Produce myelin sheaths
  - Myelin is a fatty, insulation covering the nerve cells; allows for the electrical signal to transmit faster (like wire coating)







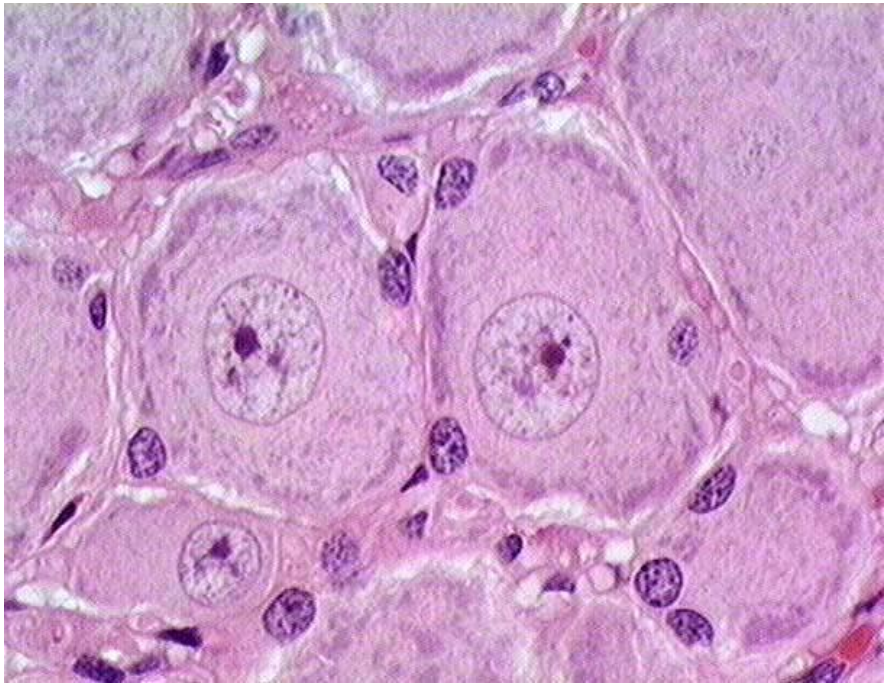

neuroglia
dendrite
motor neuron cell body
white matter
nucleus
nucleolus
Nissl bodies
gray matter

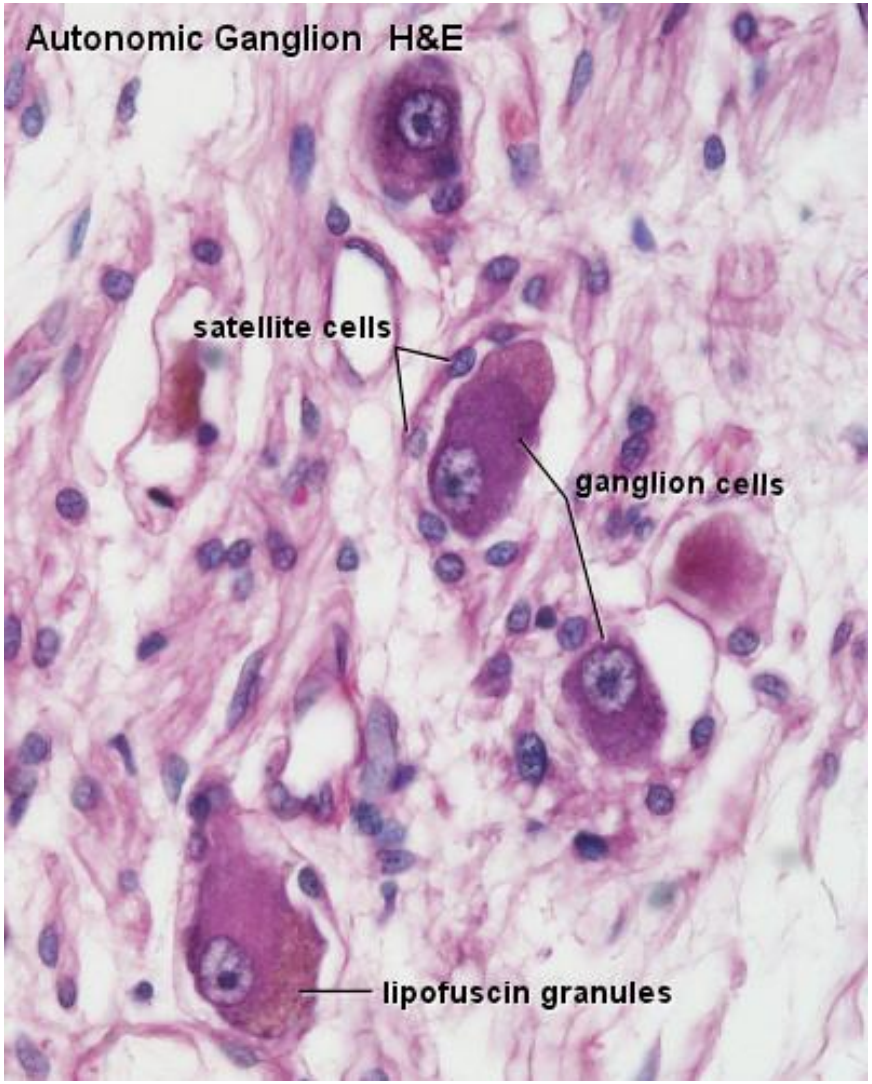
Neuroglial Cells in the PNS

- 2 cell types in PNS
  - Schwann
  - satellite cells

Types of Neurolgia in PNS

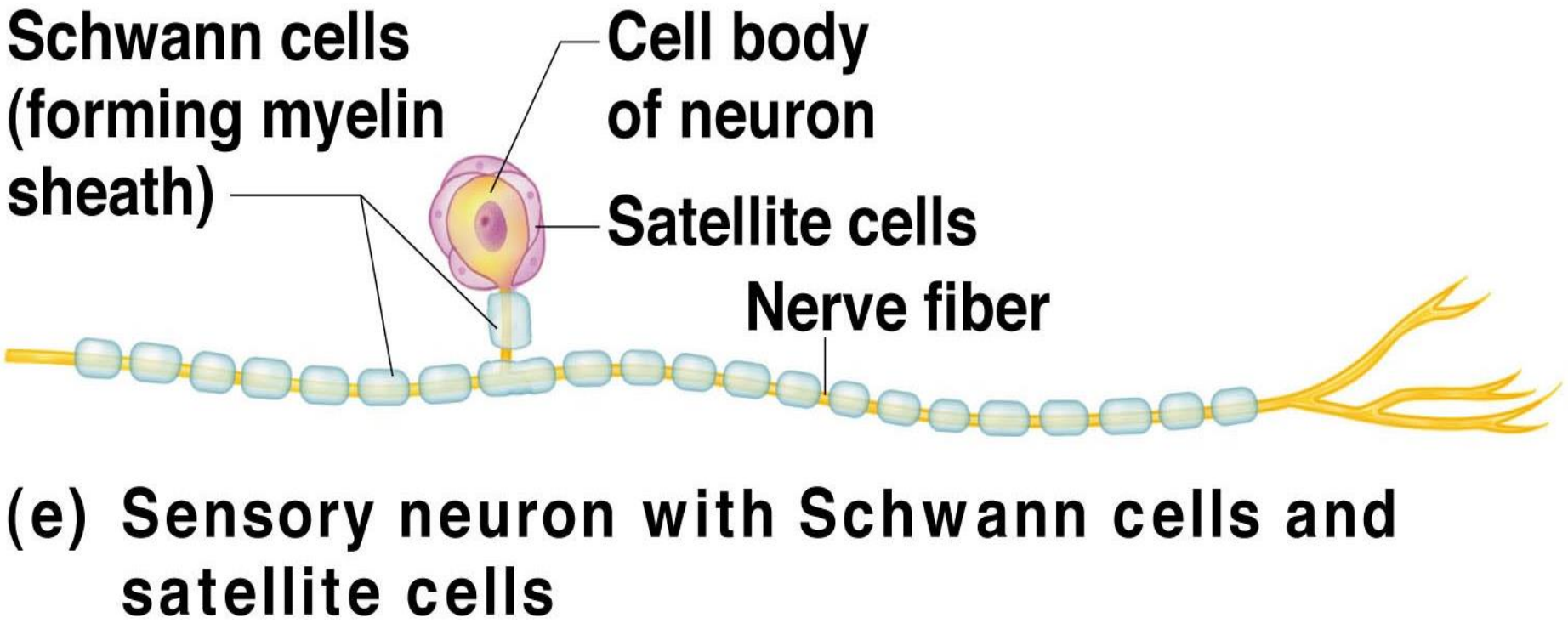
- Satellite cells
  - Protects neuron cell bodies which is where the nucleus of the cell if found



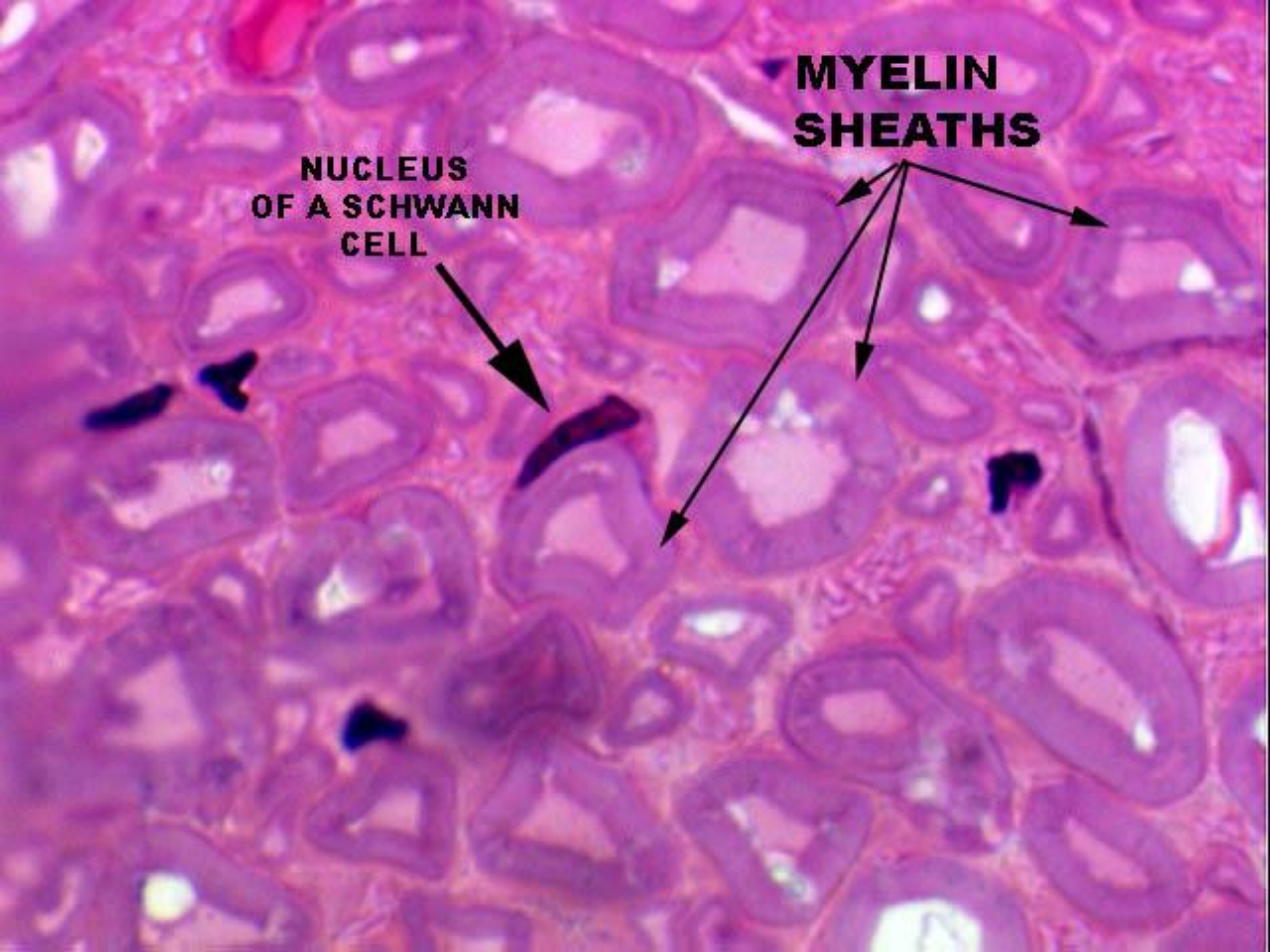


Schwann cells

- Form myelin sheath in the peripheral nervous system (nerves of the body; *not* nerves of the CNS

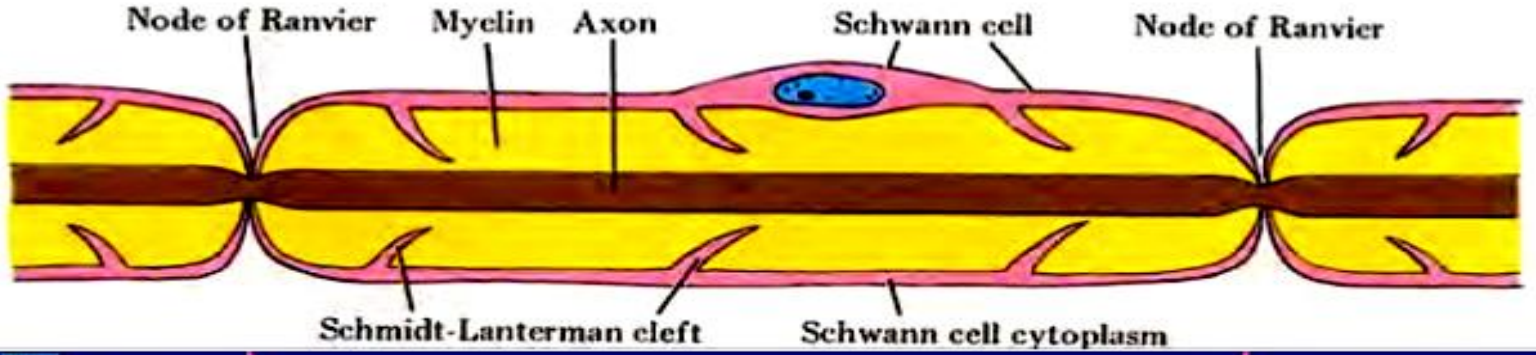


(e) Sensory neuron with Schwann cells and satellite cells


MYELIN
SHEATHS
NUCLEUS
OF A SCHWANN
CELL

Schwann cells

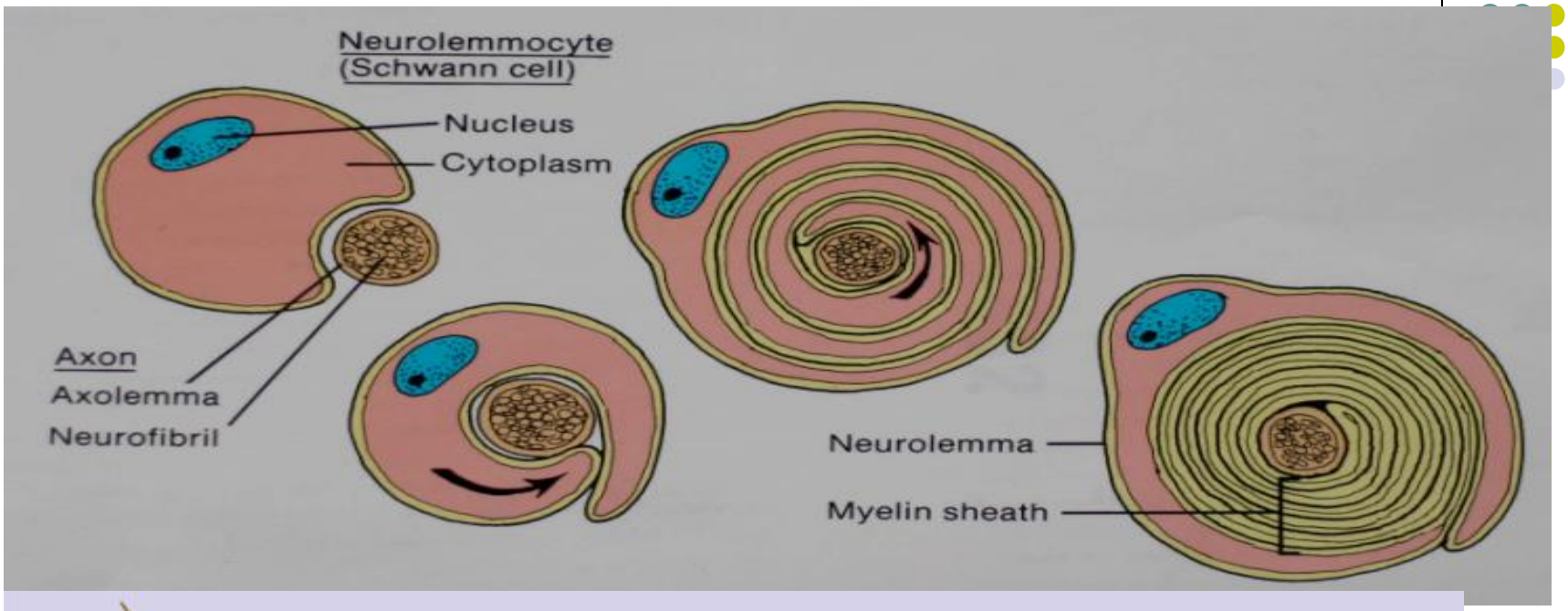
Each Schwann cell myelinates a single internode

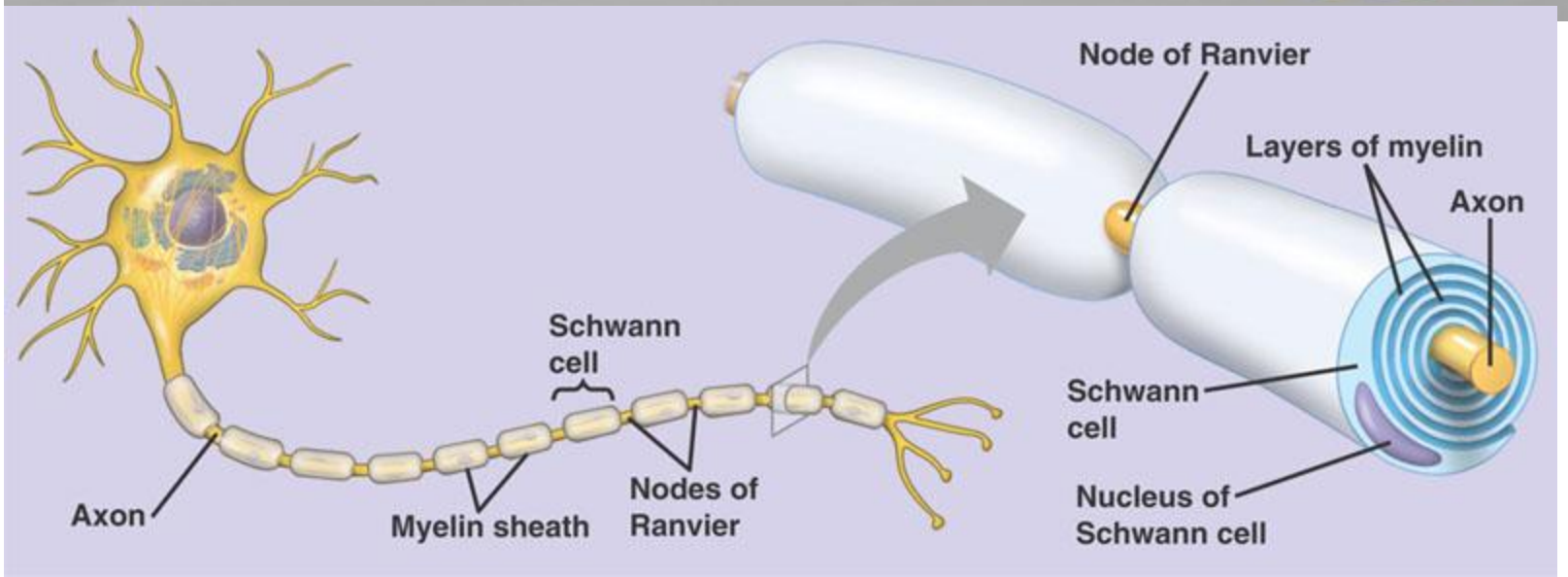


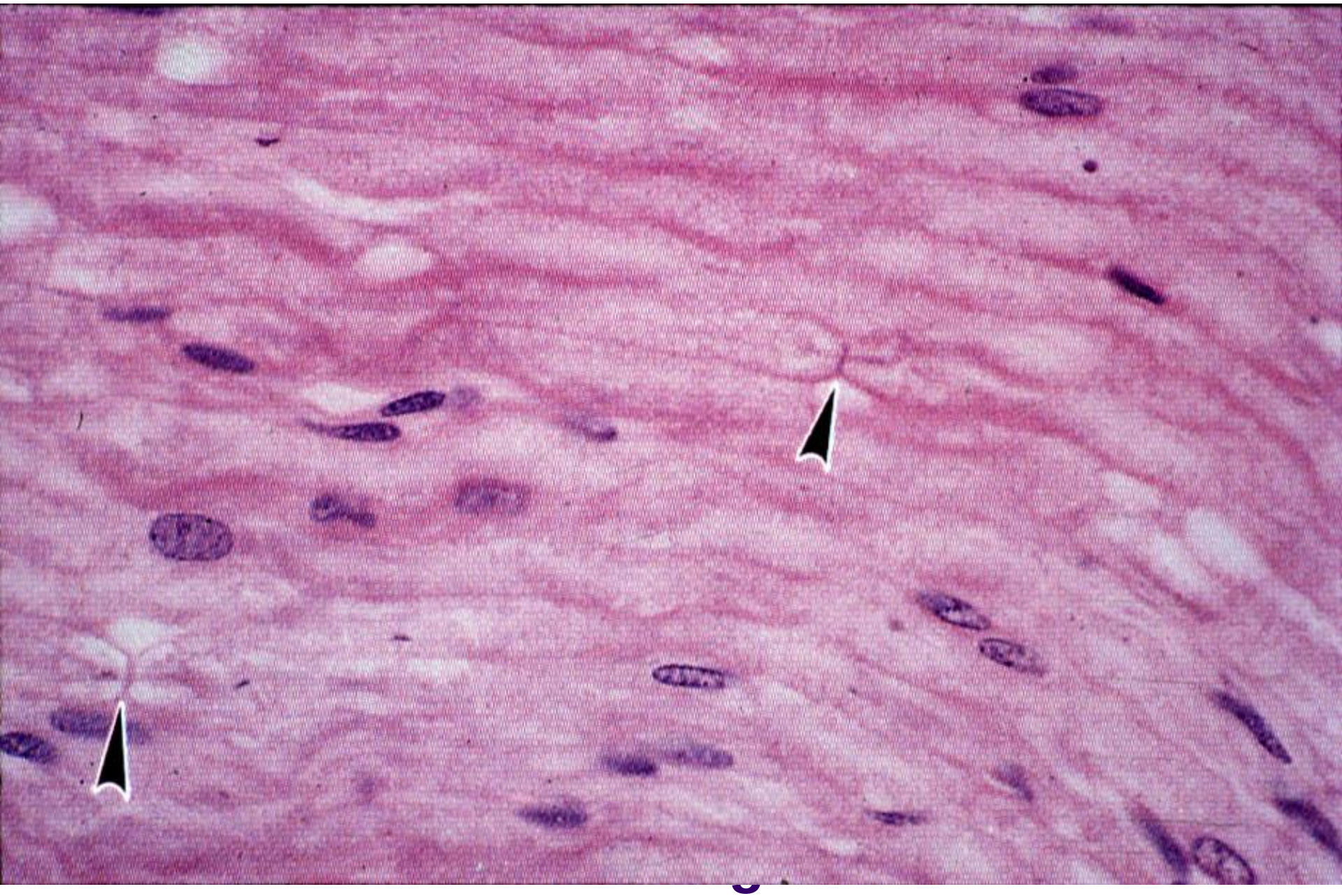
Internode length can be up to 1.5 mm in the largest nerve fibers

- Myelin sheath — whitish, fatty material covering axons
  - protects/insulates the cells and increases the transmission rate of nerve impulses
- Schwann cells — produce myelin
- Nodes of Ranvier — gaps in myelin sheath along the axon

The process of myelination







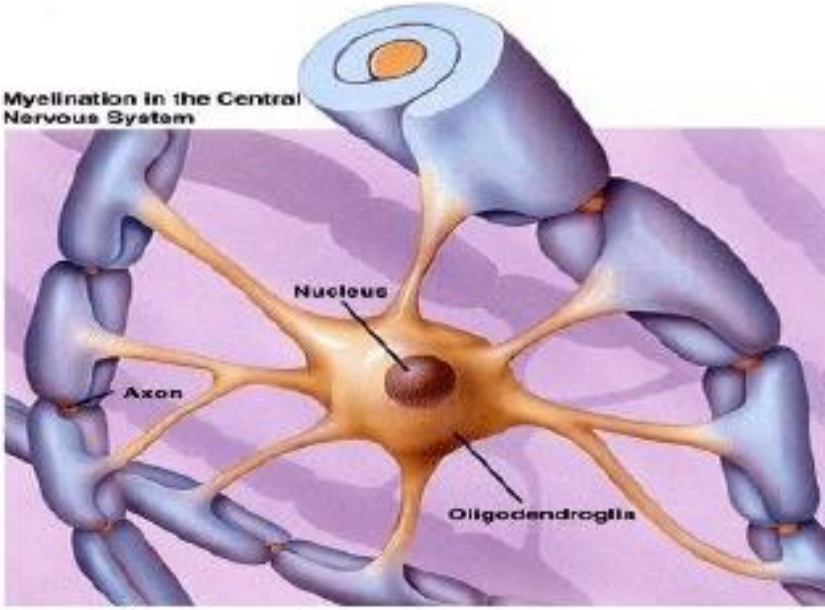
section

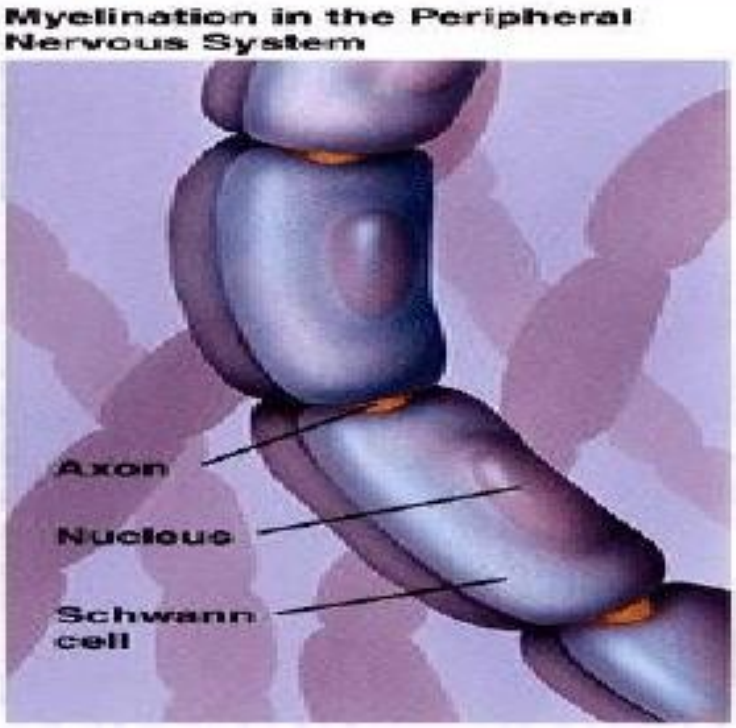
4. Oligo-dendrocytes

- ✓ Produce the **myelin sheath** which provides the electrical insulation for neurons in the CNS

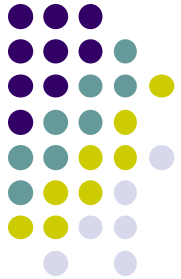
5. Schwann cells

- ✓ Form myelin sheaths around the larger nerve fibers in the PNS.
- ✓ Vital for **neuronal regeneration**





So what's a Neuron?



- Neurons = nerve cells
  - Cells specialized to transmit messages
  - Major regions of neurons
    - Cell body — nucleus and metabolic center of the cell (main part of nerve cell)
    - Processes — fibers that extend from the cell body
      - can be microscopic or up to 3-4 feet in length

So what's a Neuron?

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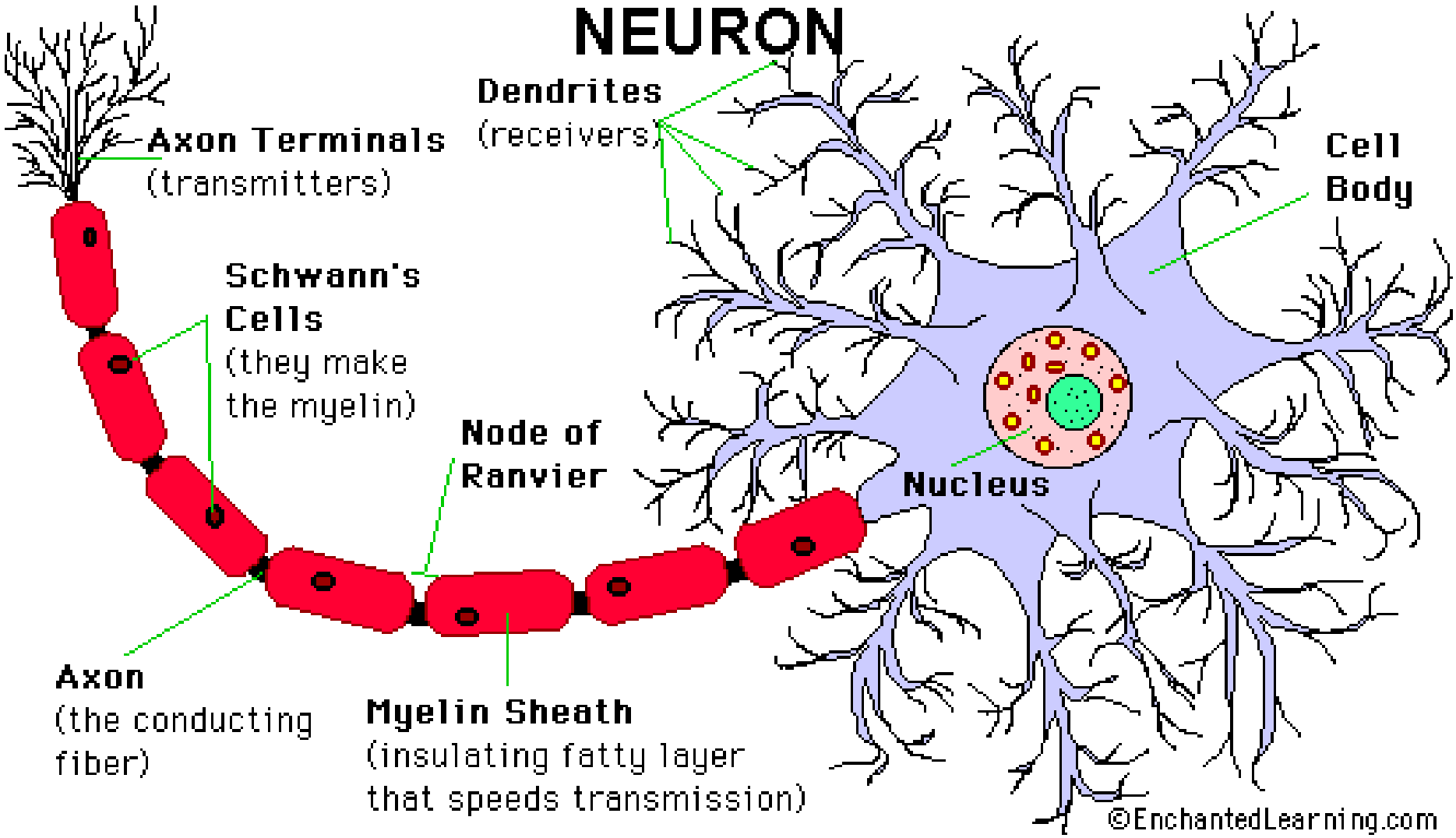
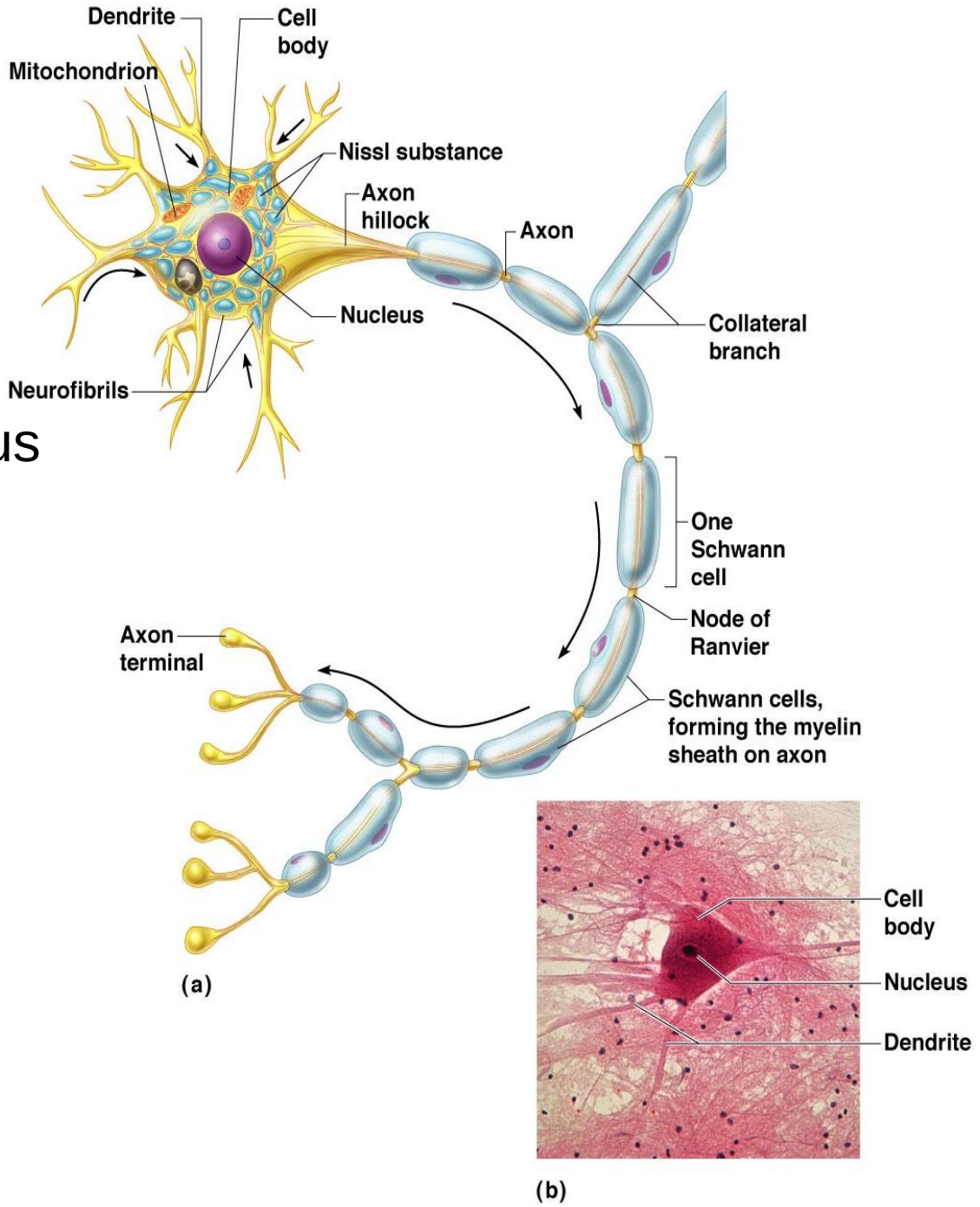

NEURON
Dendrites
(receivers)
Axon Terminals
(transmitters)
Cell
Body
Schwann's
Cells
(they make
the myelin)
Node of
Ranvier
Nucleus
Axon
(the conducting
fiber)
Myelin Sheath
(insulating fatty layer
that speeds transmission)
©EnchantedLearning.com

STRUCTURE OF NEURON

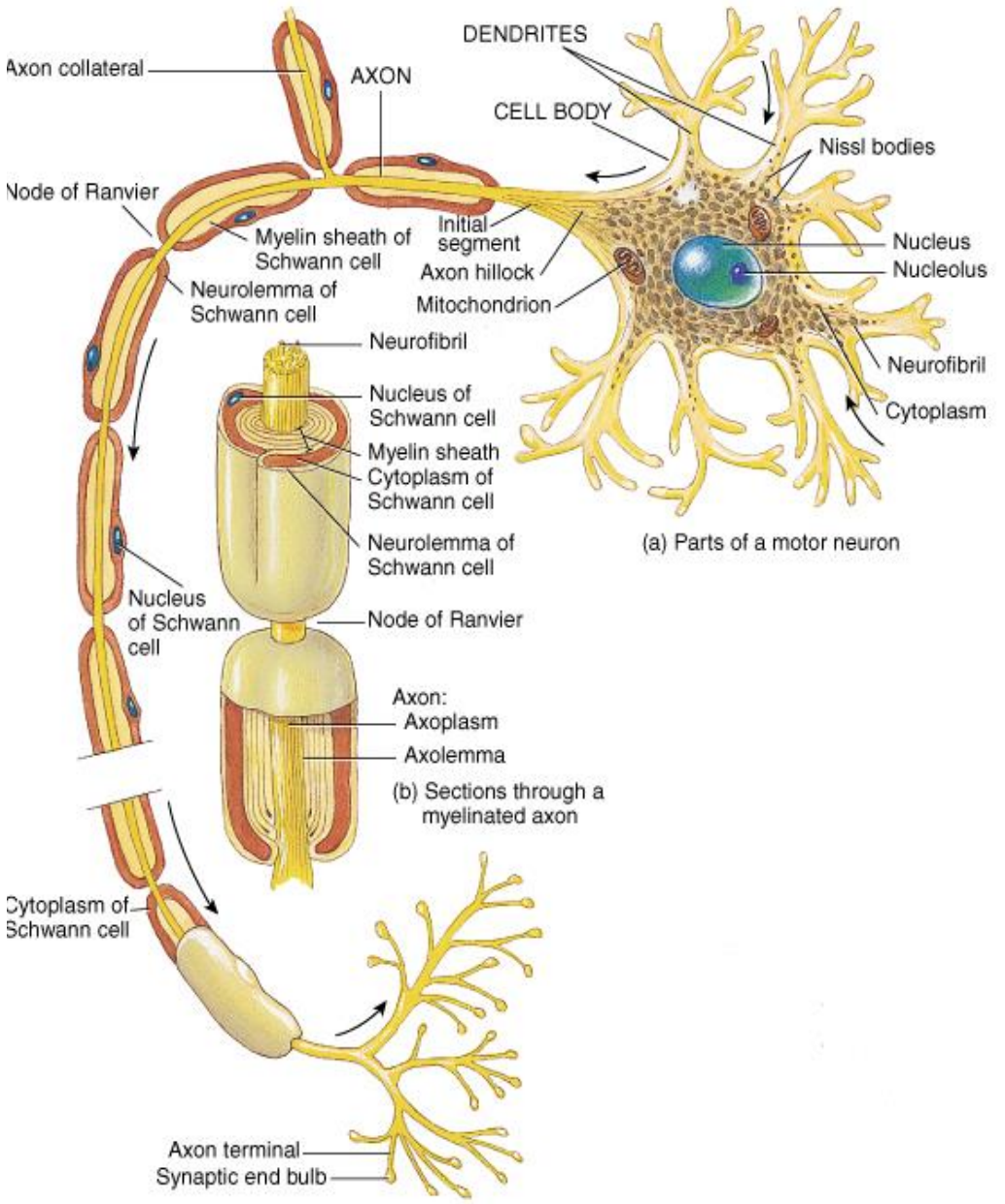
- Principle cells of Nervous Tissue
- **Consist of 3 parts** :
  - **CELL BODY** (perikaryon/soma)
  - **A single AXON**
  - **Multiple DENDRITES**
- ø 5-150 µm



Neurons

- Functional unit of nervous system

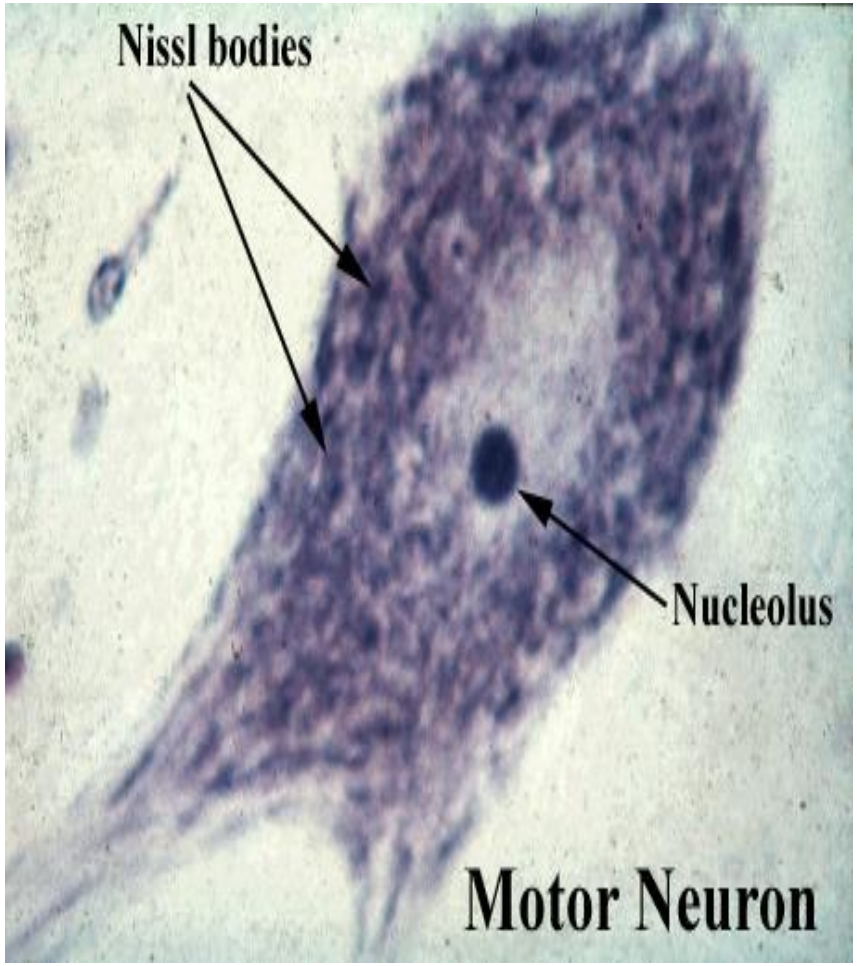
1. Cell body
   a) Nissl bodies
   b) Neurofilaments
   c) Microtubules
   d) Lipofuscin pigment clumps
2. Cell processes
   a) Dendrites
   b) Axons



FUNCTION OF NEURON

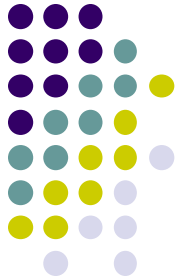
- Receptive
  - Receptor receive stimuli and tranduce into nerve impulse and transferro to other neuron
- Integrative
  - Processing impulse on the higher center
- Motor
  - Initiating motor respons and tranduse impulse to the effector

CELL BODY (PERIKARYON)



- Central portion of the cell
- Generally are polygonal
- Different shape and size → characteristic regions of nervous system
- Contain :
  - Nucleus
  - Perinuclear cytoplasm

ULTRASTRUCTURE OF NEURON



Nucleus :

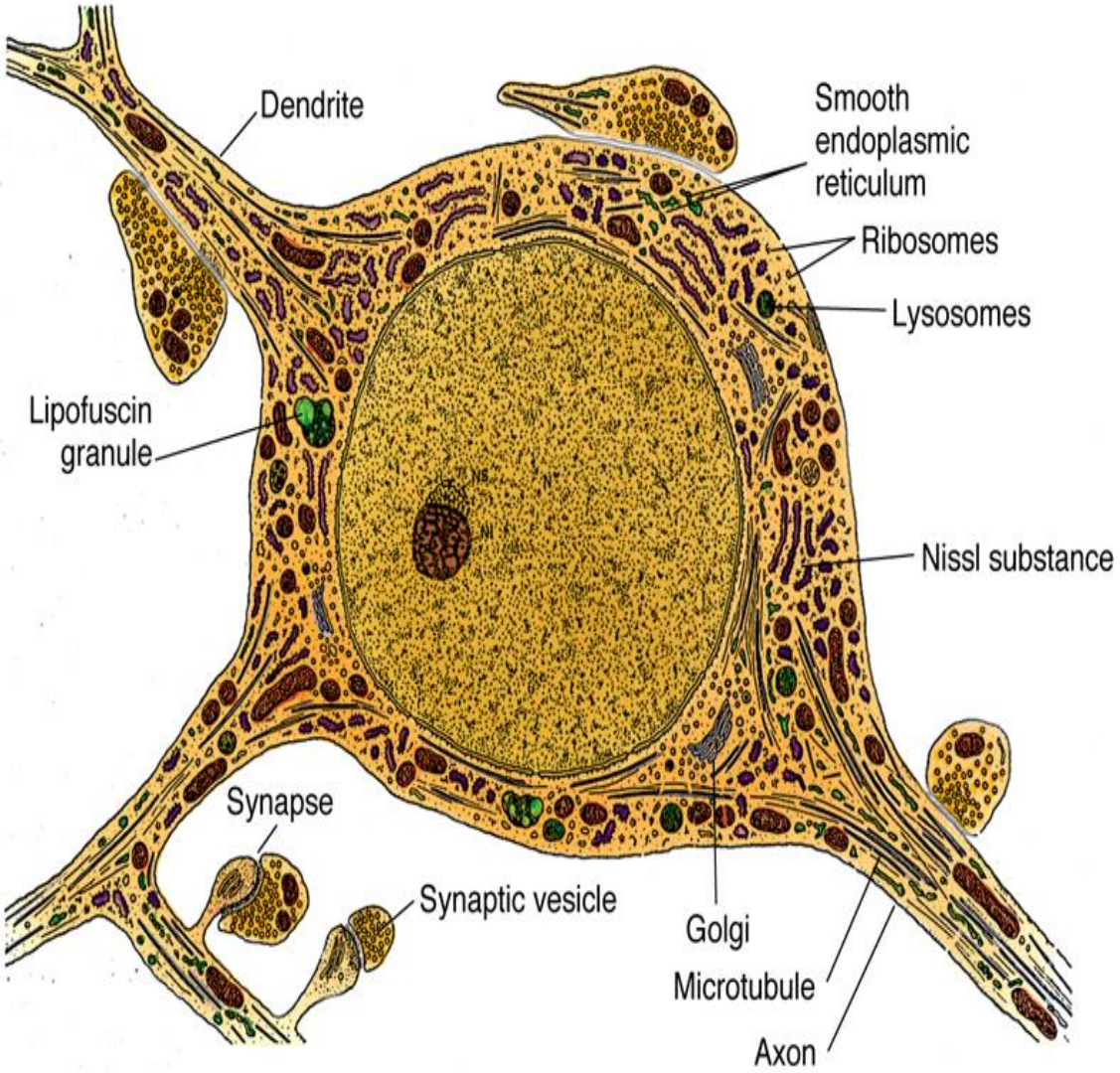
- large, spherical to ovoid and centraly located
- a single prominent nucleolus
- finely dispersed chromatin
- → **trancriptionaly active**

Cytoplasm :

a. Abundant of R.E.R
b. Polyribosomes
c. Basic dyes (a+b) →**Nissl Bodies**
d. lots of S.E.R.
e. Golgi bodies (perikaryon)

→ **protein secreting cell**

ULTRASTRUCTURE OF NEURON

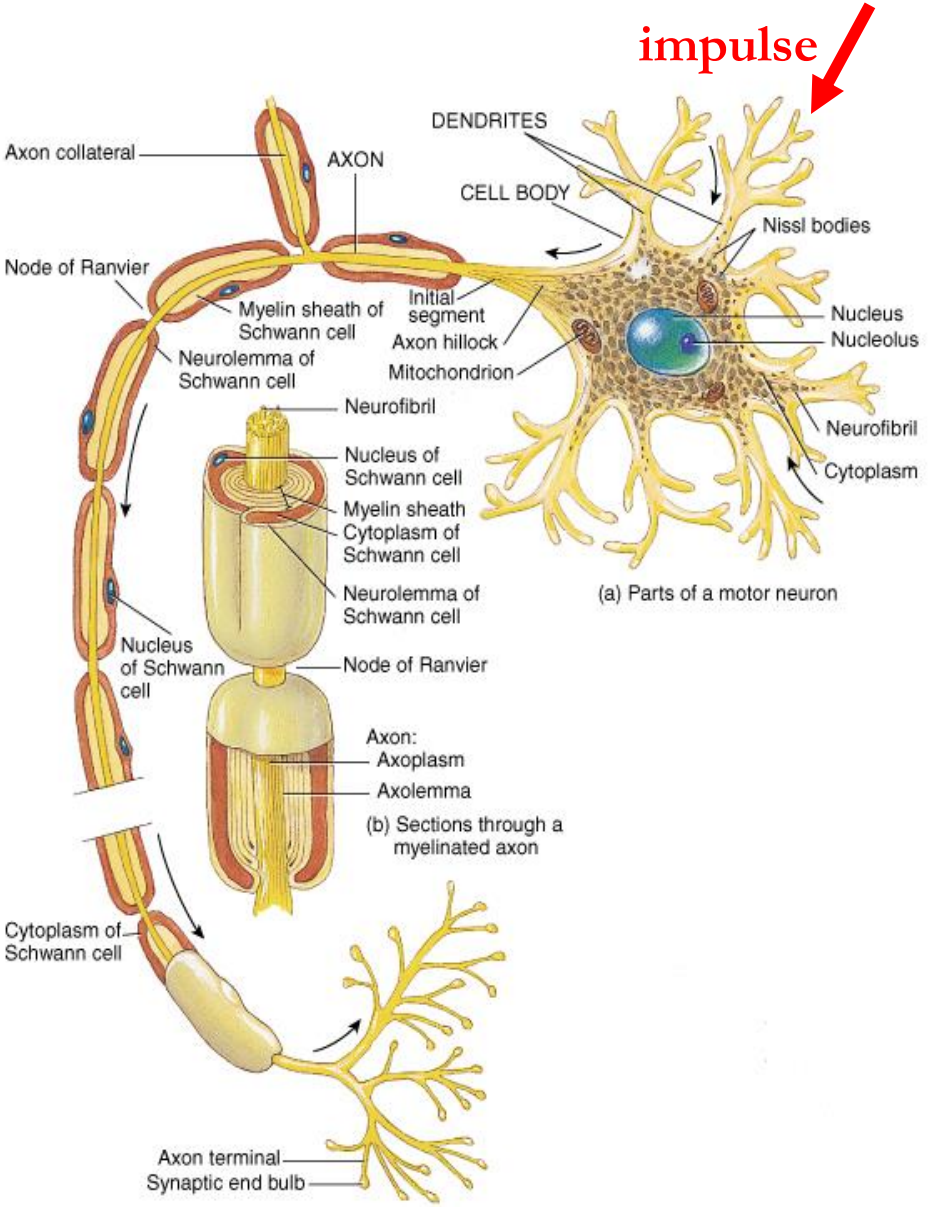


Cytoplasm

a. Many mitochondria, most abundant in axon terminal
b. extensive cytoskeleton → axonal transport
c. One centriole → **do not undergo cell divisions**

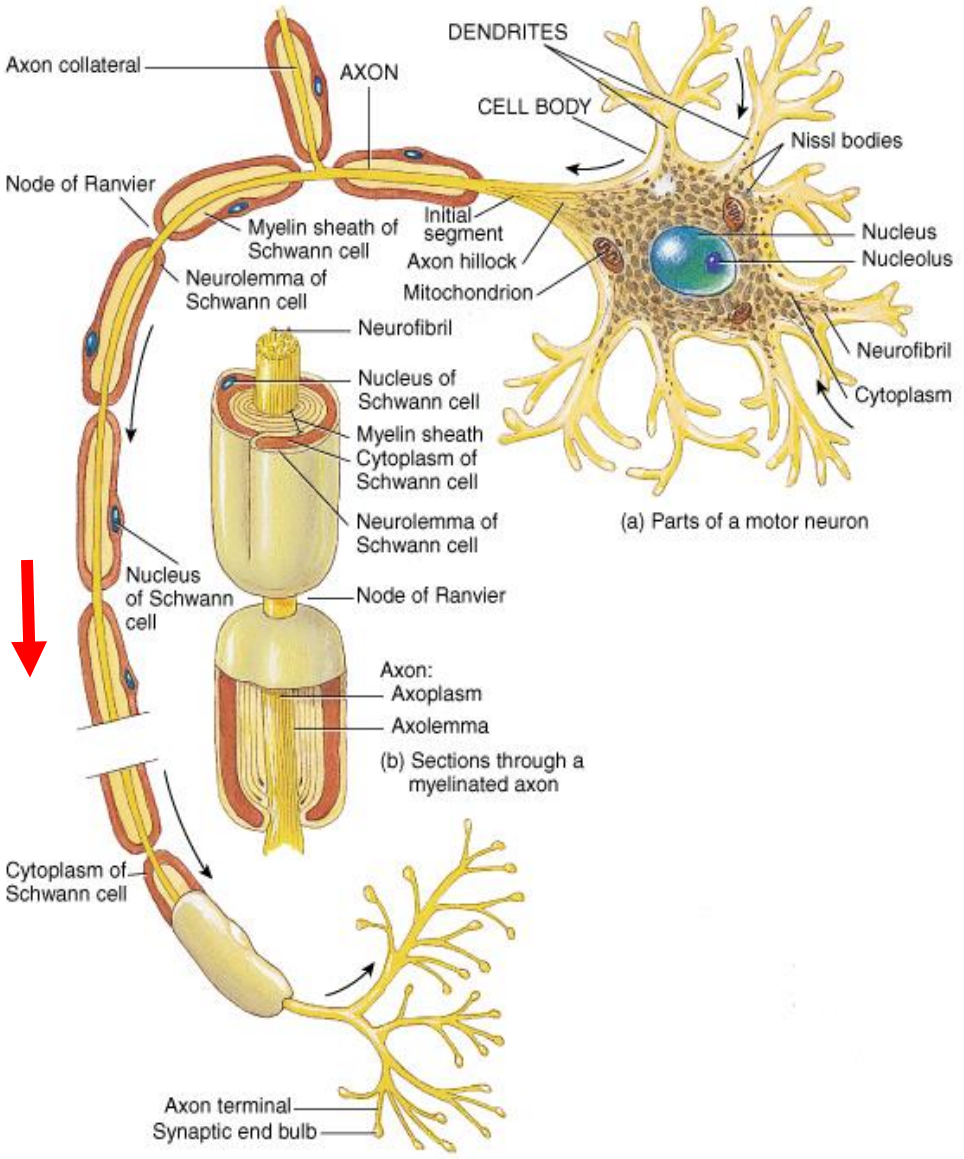
Dendrites

- Conducts impulses towards the cell body
- Typically short, highly branched & unmyelinated
- Surfaces specialized for contact with other neurons
- Contains neurofibrils & Nissl bodies



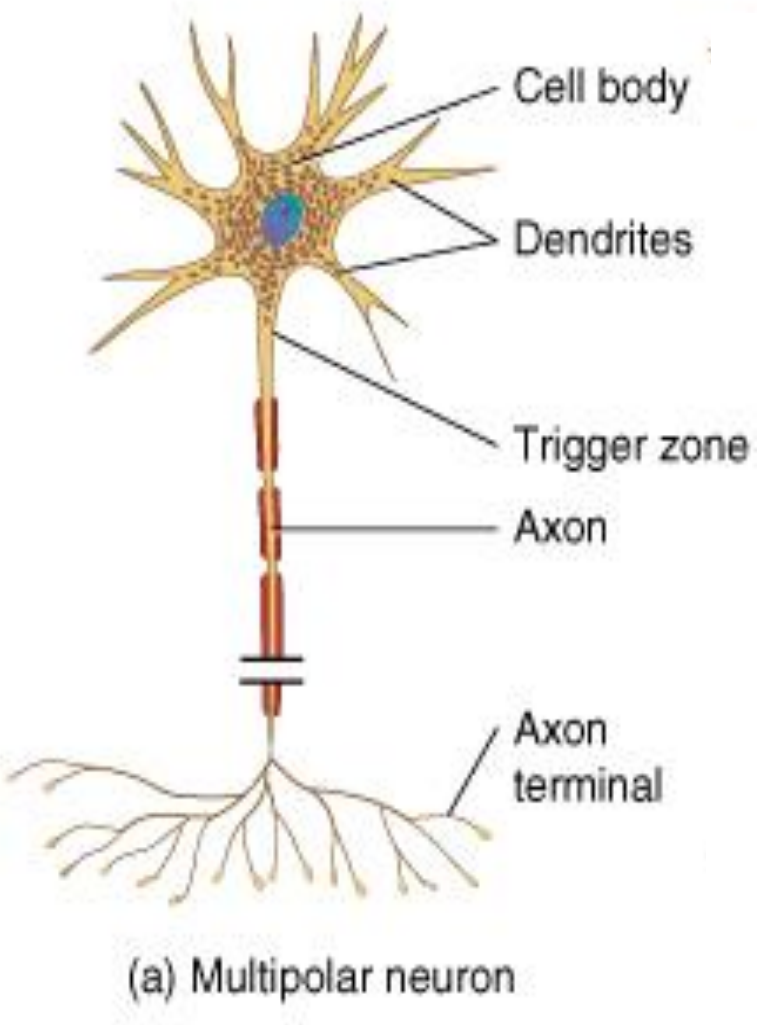
Axons

- Conduct impulses away from cell body
- Long, thin cylindrical process of cell
- Arises at axon hillock
- Impulses arise from initial segment (trigger zone)
- Side branches (collaterals) end in fine processes called axon terminals
- Swollen tips called synaptic end bulbs contain vesicles filled with neurotransmitters

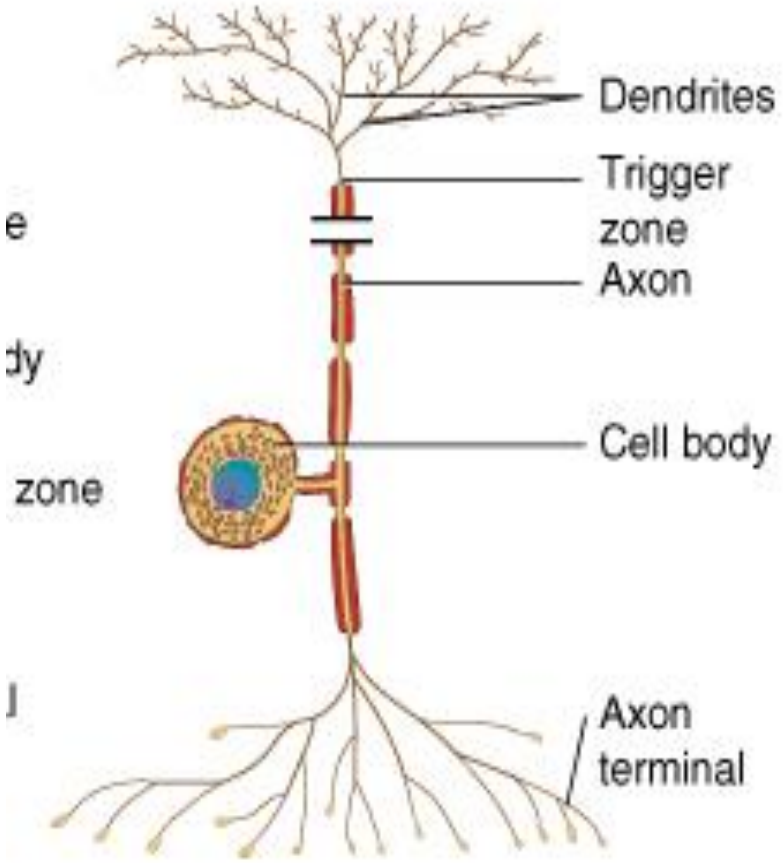


Structural Classification of Neurons

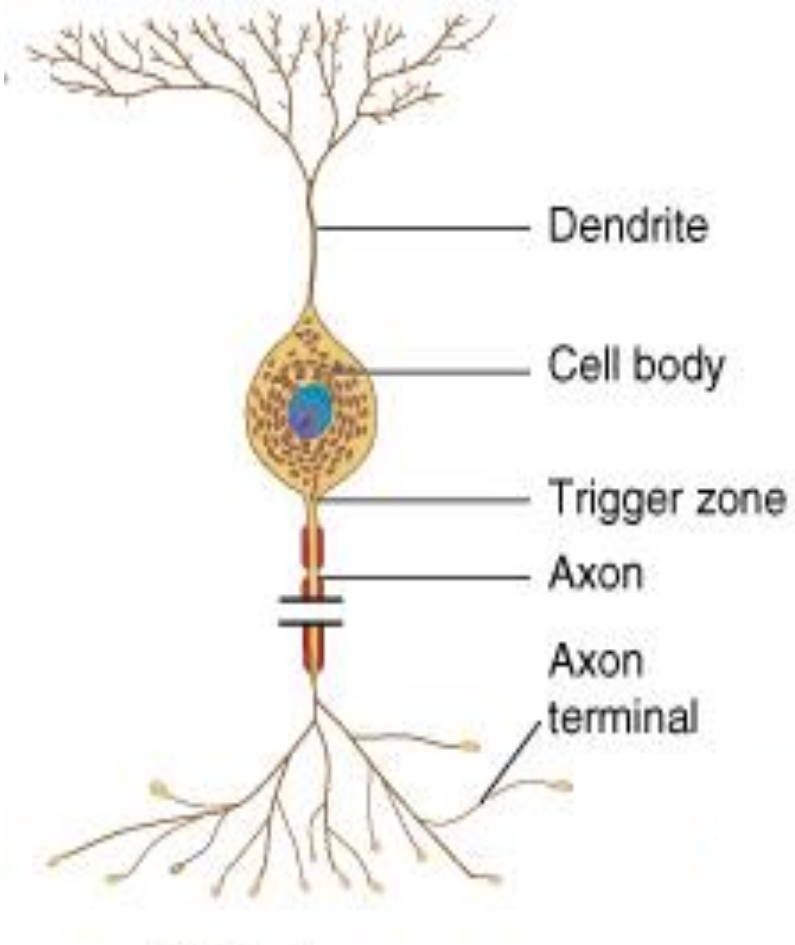
- Based on number of processes found on cell body
  1. **multipolar** = several dendrites & one axon
     - most common cell type
  2. **bipolar** neurons = one main dendrite & one axon
     - found in retina, inner ear & olfactory
  3. **unipolar** neurons = one process only(develops from a bipolar)
     - are always sensory neurons



Structural Classification of Neurons

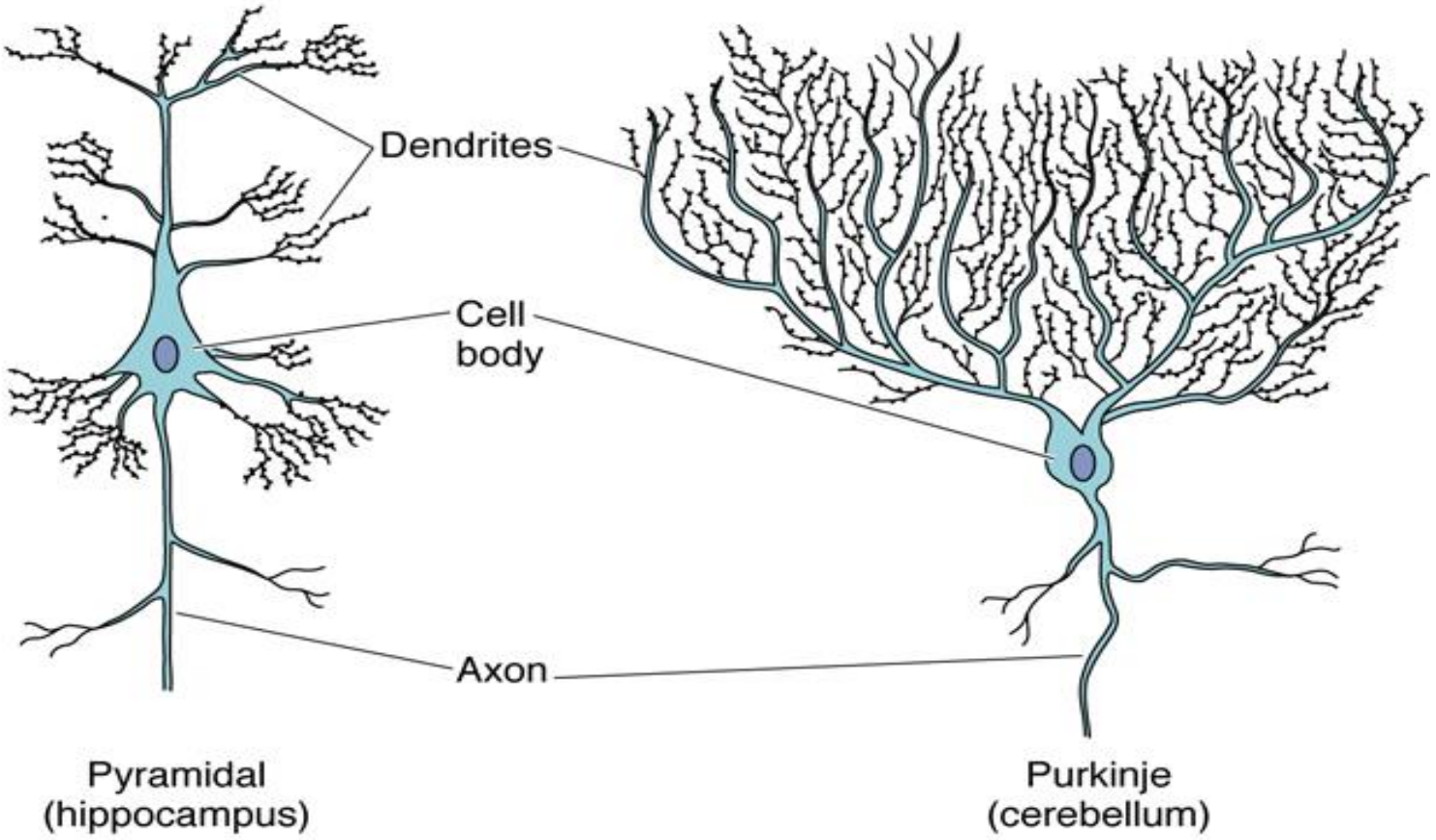


(c) Unipolar neuron



(b) Bipolar neuron

NEURONS CLASSIFICATION :



NEURONS CLASSIFICATION :

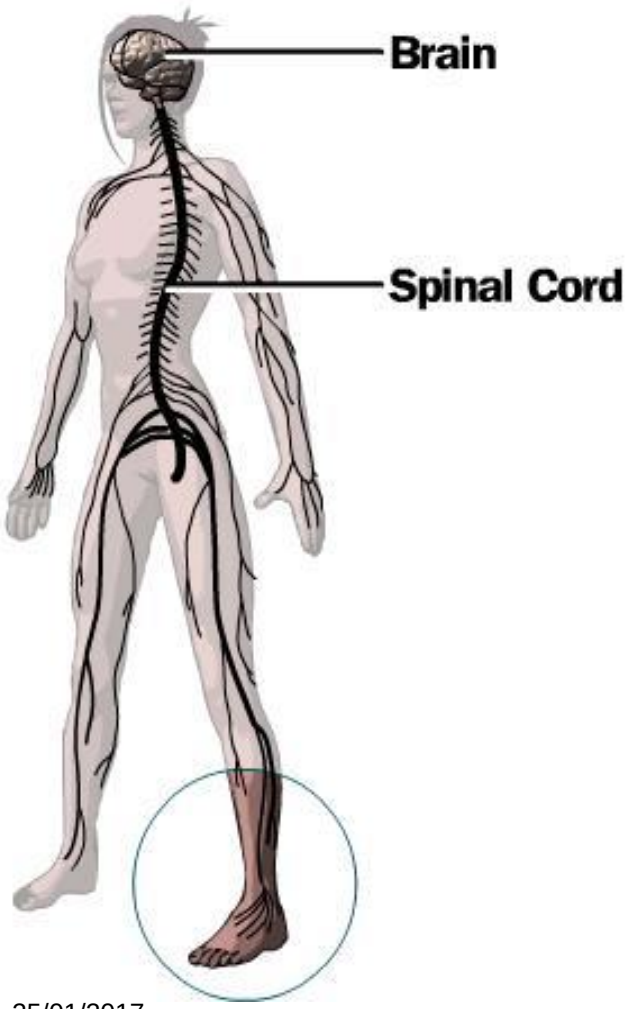
According to their function :

- **Sensory Neuron (afferent)**
  - Receive sensory input → conduct impulses to CNS
- **Motor Neuron (Efferent)**
  - CNS → conduct impulses to muscles, glands and other neurons
- **Interneuron**
  - In the CNS as interconnectors, establish neuronal circuit between sensory and motor neuron

NEURON GROUPING

- CORTEX
  - Neuron form six layers on the cerrebrum
  - Form three layers on the cerrebellum
- NUCLEI
  - In subcortical region (thalamus, midbrain, brainstem and spinal cord) neuron form irregular cluster → nuclei
- GANGLION
  - Cluster of neuron outside the CNS

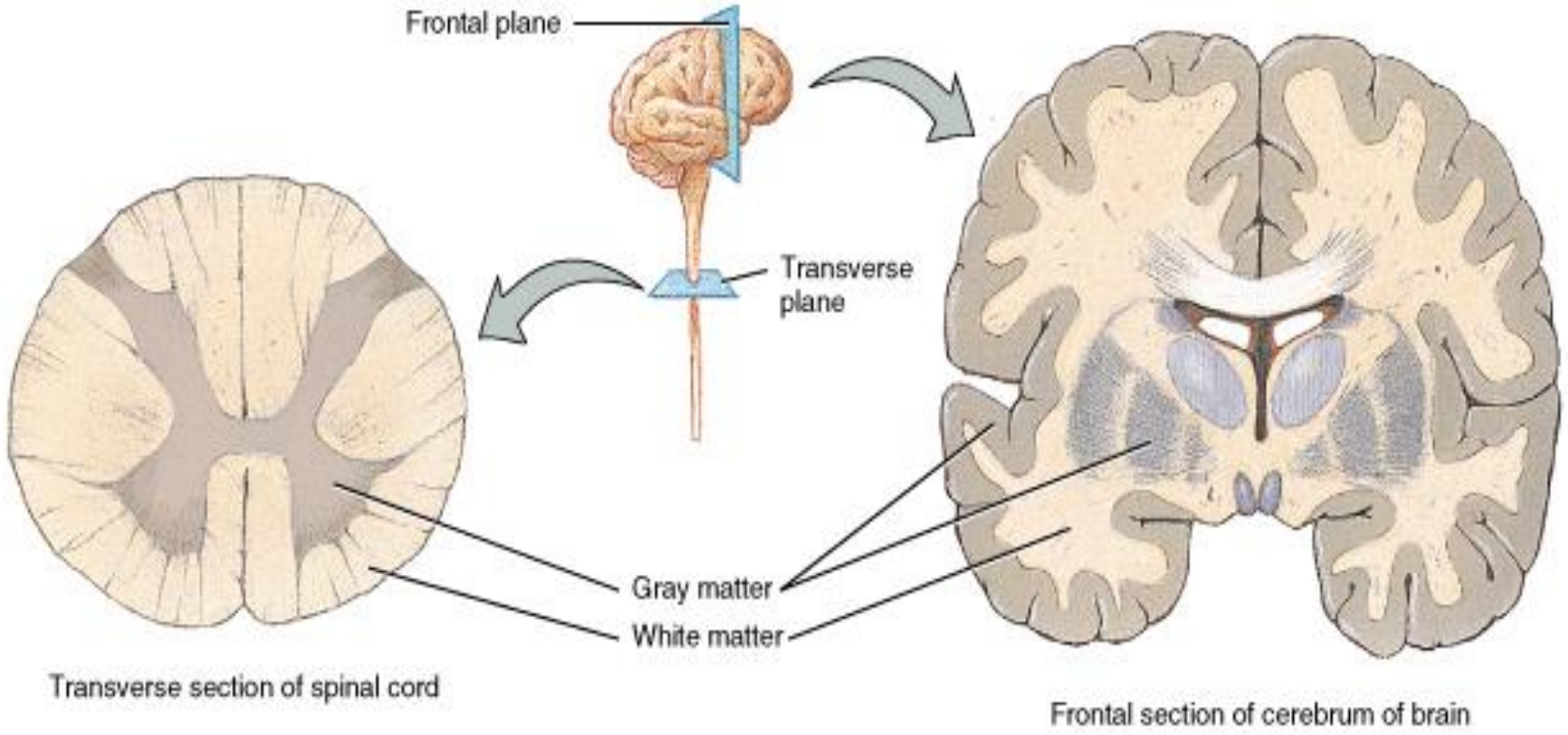
THE CNS



- **Consist of :**
  - Cerebrum
  - Cerebellum
  - Spinal cord
- **No connective tissue→ soft, gel like**
- When sectioned :
  - White matter
  - Gray matter
- Covered by meninges

Gray and White Matter

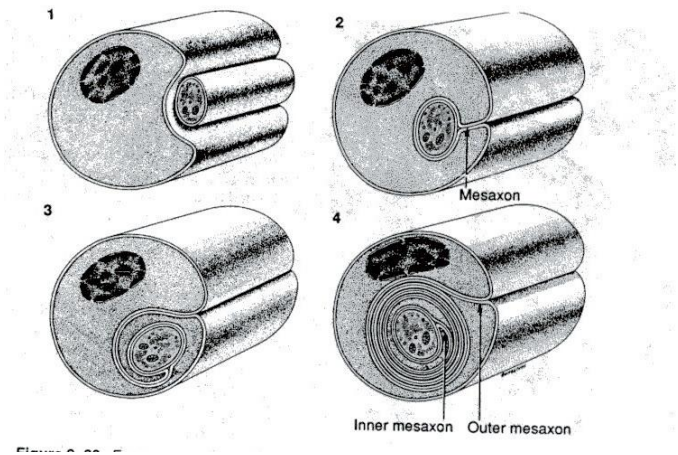
- **White matter** = myelinated processes (white in color)
- **Gray matter** = nerve cell bodies, dendrites, axon terminals, bundles of unmyelinated axons and neuroglia (gray color)

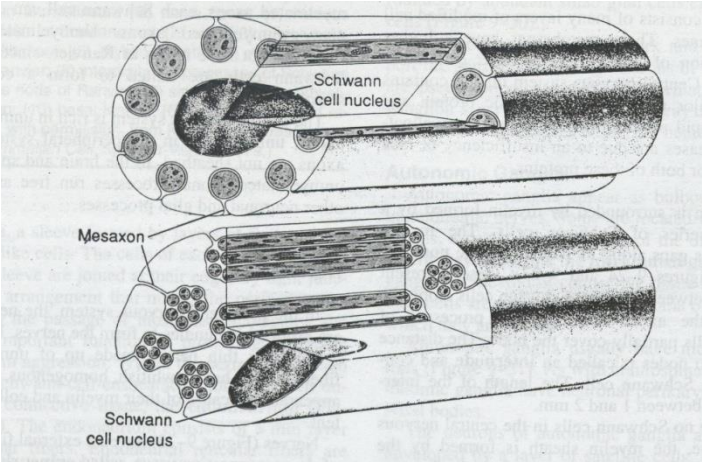


NERVE FIBERS

- Consist of axons enveloped by a special sheath
- Group of fibers constitute the **peripheral nerve**
- Two types :
  - Myelinated fiber
  - Unmyelinated fiber

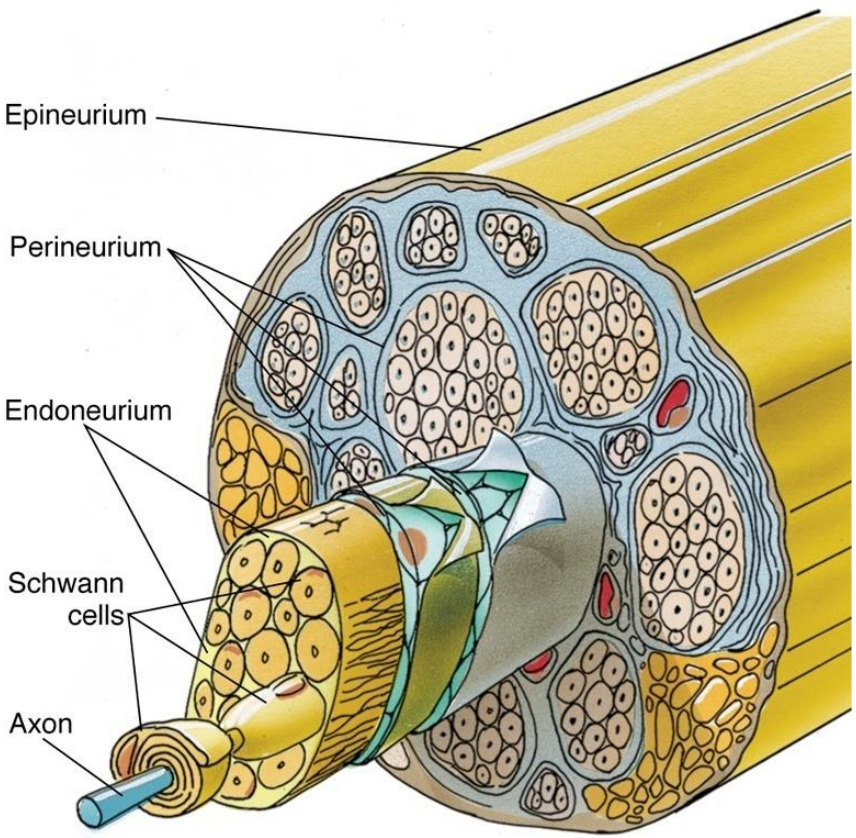
NERVE FIBERS





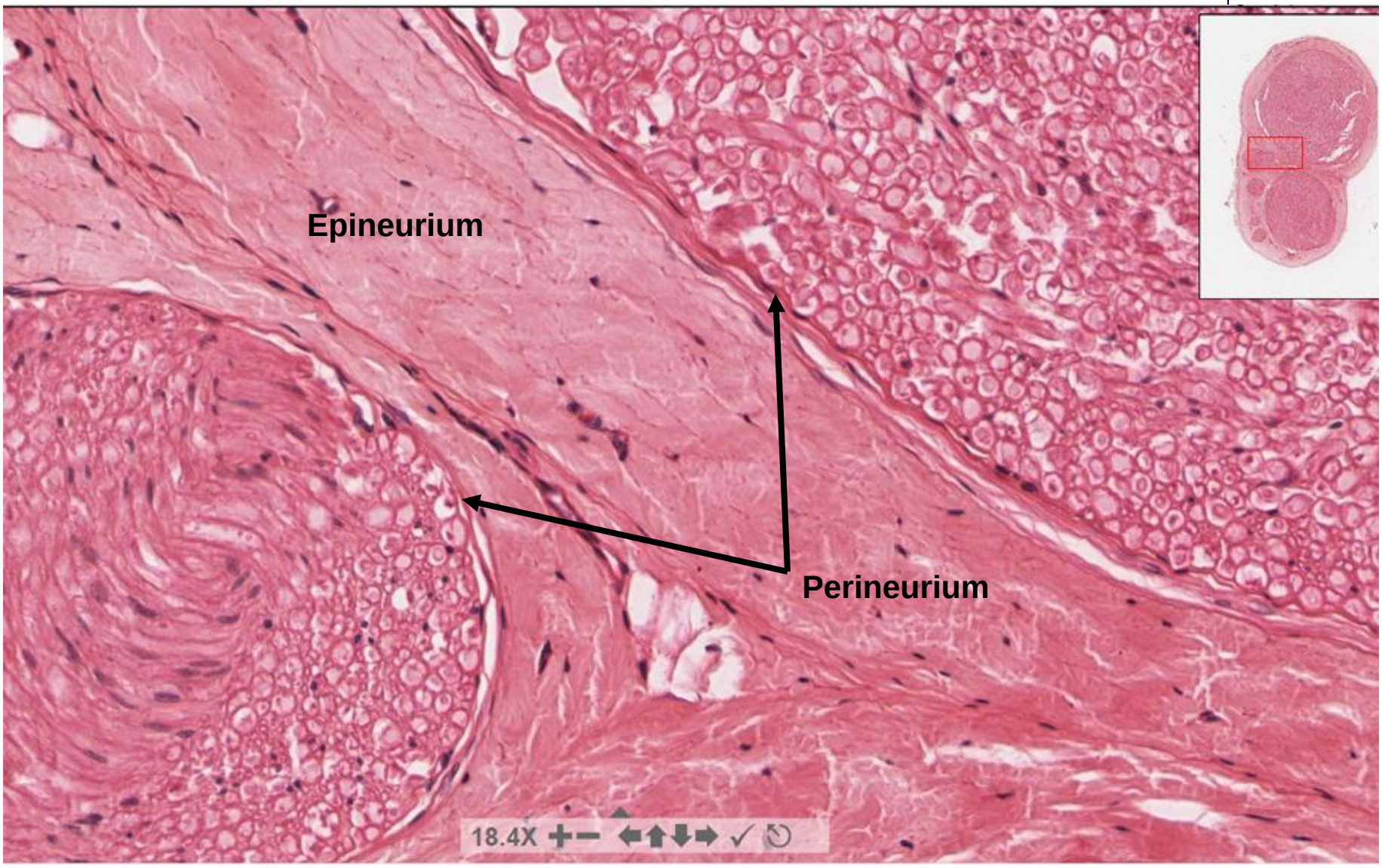
- **Myelinated fibers**
  - A single Schwann cell wraps around single axon→ form myelin sheath → **nodes of Ranvier**
- **Unmyelinated fibers**
  - A single Schwann cell envelopes several axon
  - Fibers enveloped within simple clefts of Schwann cells

CONNECTIVE TISSUE INVESTMENTS

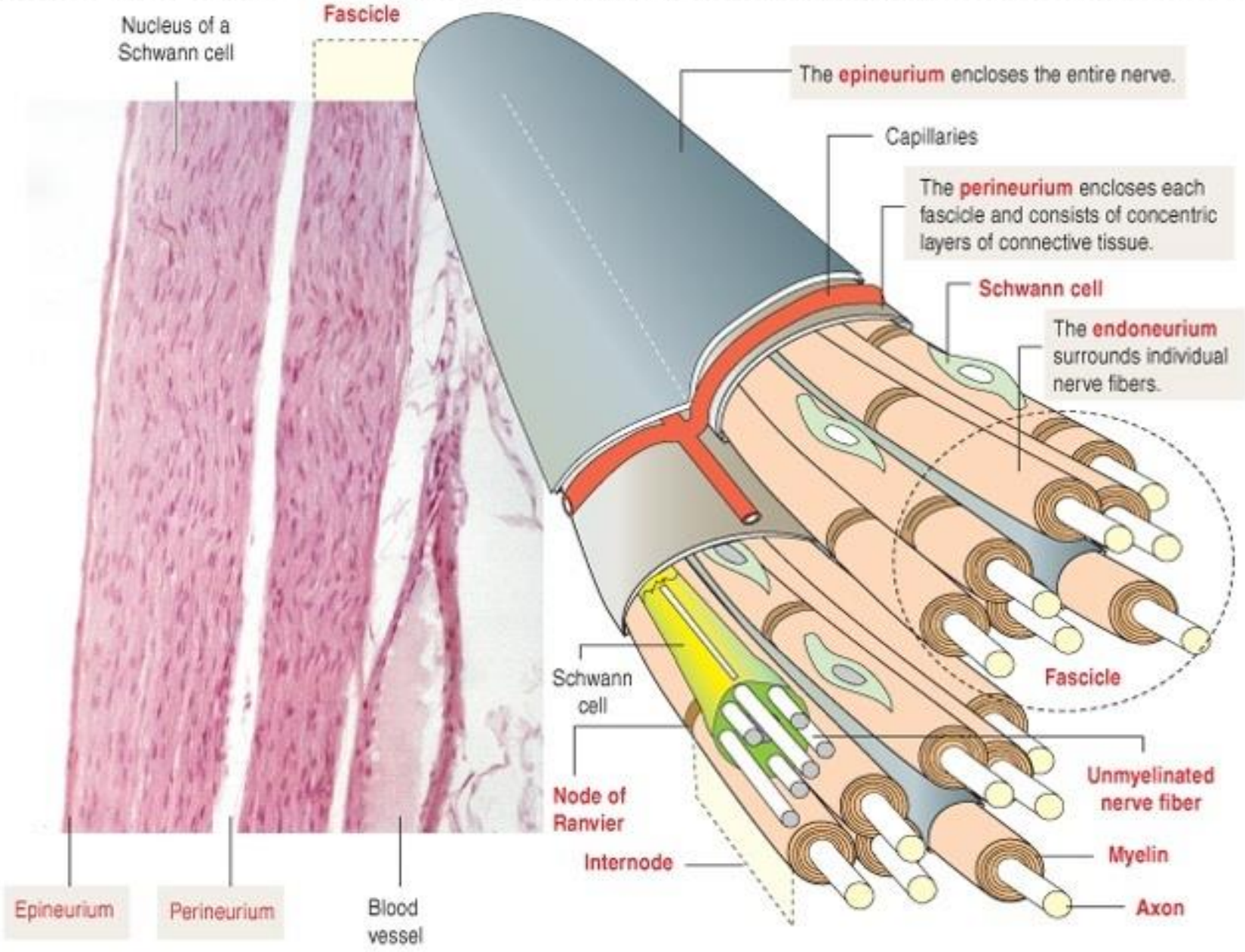


- Epineureum
  - Dense collagenous Con. Tissue with thick elastic fiber
  - Prevent damage by overstreching
- Perineureum
  - Dense con. Tissue
  - Layers of epithelioids
  - Isolates neural environment (blood-nerve barrier)
- Endoneureum
  - Loose con. Tissue
  - Regulation of microenvironment of nerve fiber

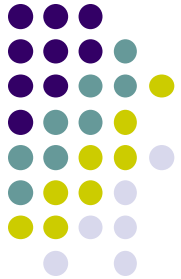
Connective tissue layers in a peripheral nerve. Tight junctions between perineurium cells form a important isolating barrier.



PERIPHERAL NERVE



AUTONOMIC NERVOUS SYSTEM



SYMPHATETIC SYSTEM

- The nuclei located in the thoracic and lumbar segment of spinal cord
- Preganglionic fibers leave the CNS by way of ventral roots
- The chemical mediator postganglionic fibers is **norepinephrine**

PARASYMPHATETIC SYSTEM

- The nuclei located in the medulla and midbrain and in the sacral portion of spinal cord
- Pre ganglionic fibers leave the CNS trough cranial nerve III, VII, IX and X and also trough II, III, IV sacral nerve
- The ganglion located near the effector organs
- The chemical mediator pre and postganglionic fibers is **acethilcholine**