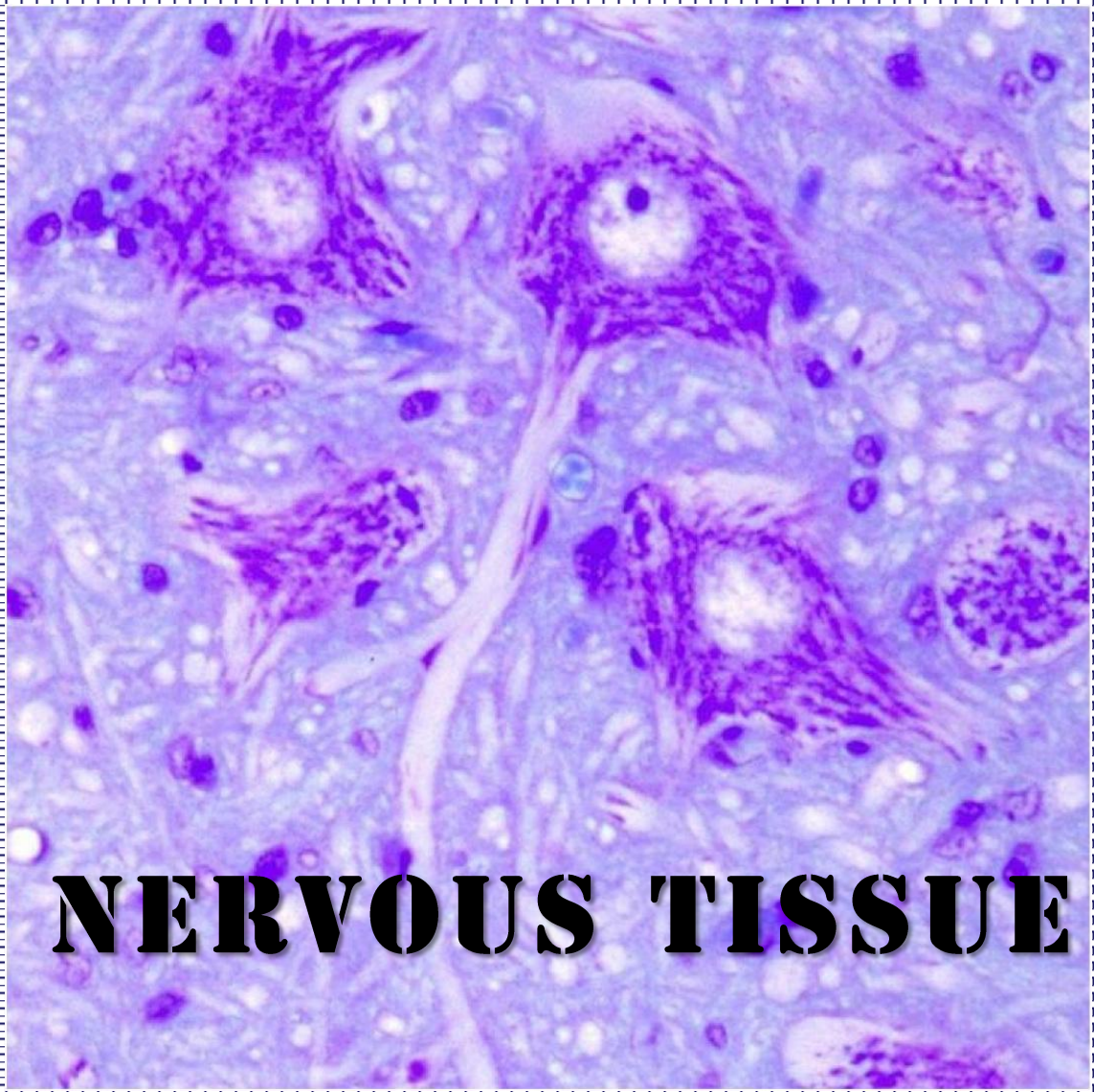

NERVOUS TISSUE

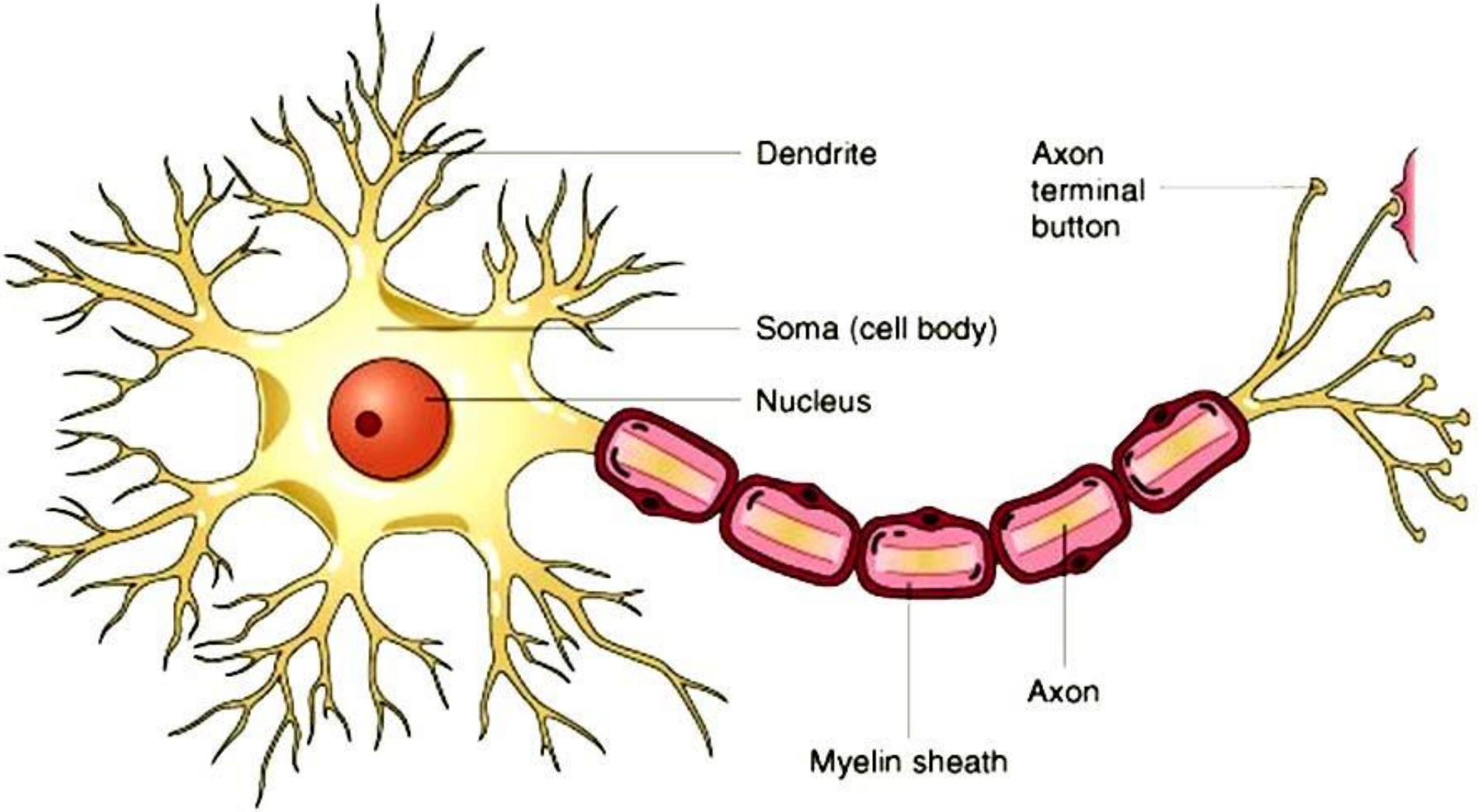
Nervous Tissue consists of **2 types** of cells

- **1 - Neurons** – main cells (basic functional units), specialized to
- perception of sensory stimuli,
- processing received information and
- transmission it further to other neurons in form of nerve impulses
- **2 - Neuroglia-(glial cells) (supporting cells)**
- they support,
- nourish and
- protect neurons

Neuron Structure

- 1. Cell body = perikaryon = contains nucleus and is the metabolic center of the cell
- 2. Processes – that extend from the cell body (dendrites and axon)
- 3. Nerve endings (synapses, special receptors)

Neuron


Dendrite
Axon terminal button
Soma (cell body)
Nucleus
Axon
Myelin sheath

- Cell body has:
- Nucleus with large nucleolus
  - Neurofibrils
  - "Nissl bodies" (chromophilic substance)

Neurofibrils are present in the perikaryon, dendrites and axon and are unique to neurons. = “Skeleton” of the neurons

Nissl bodies

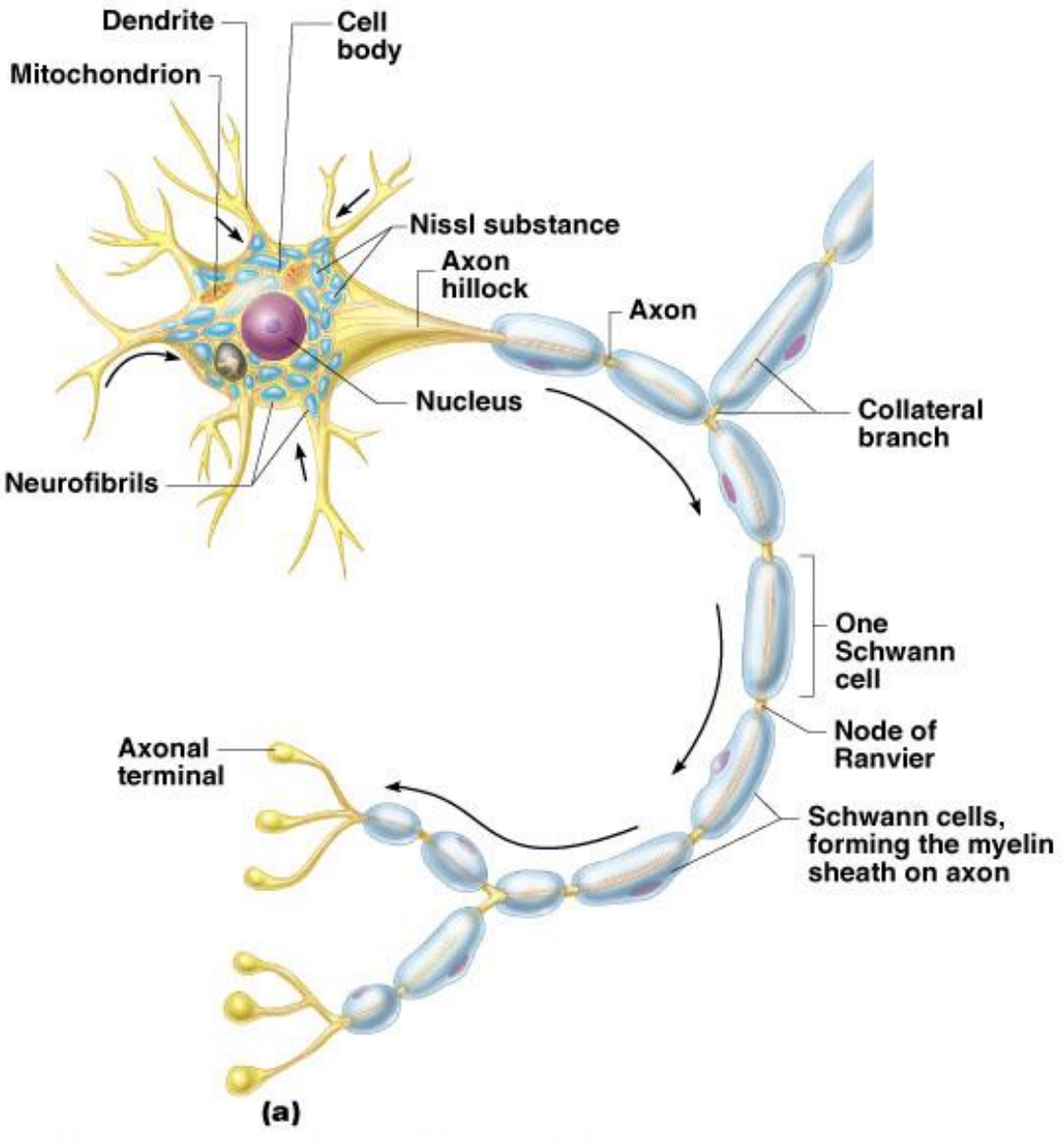
- large clumps of basophilic material around the nucleus,

an aggregation of many parallel cisternae of the **rough endoplasmic reticulum** with the rosettes of free polisomal ribosomes

Function – protein synthesis (neurotransmitters)

Neuron processes - Extensions outside the cell body

- Dendrites – conduct impulses toward the cell body
- Axons – conduct impulses away from the cell body (usually only 1!)
- All processes end with the nerve endings



- Axons are covered with a fatty material called myelin.
- Axons in the PNS are heavily myelinated.
- This is done by the Schwann Cells
- These Schwann cells layer around the axions and squeeze their cytoplasm out creating many layers of plasma membrane tissues (proteins/lipids) surrounding the axion. This is the Myelin sheath.
- Areas of neuron not covered are called Nodes of Ranvier.
- Myelin insulates the nerve fibers and greatly increases the speed of neurotransmission by nerve fibers.

- Each axon terminal (synaptic knob) is seperated from the cell body or dendrites of the next neuron by a tiny gap…synaptic cleft.
- Neurotransmitters are released into the synaptic cleft and diffuse across to bind to membrane receptors on the next neuron..initiating an electrical surrent or synaptic potential.

Axonal Transport

- many proteins made in soma must be transported to axon and axon terminal
  - to repair axolemma, serve as gated ion channel proteins, as enzymes or neurotransmitters
- axonal transport – two-way passage of proteins, organelles, and other material along an axon
  - anterograde transport – movement down the axon away from soma
  - retrograde transport – movement up the axon toward the soma
- microtubules guide materials along axon
  - motor proteins (kinesin and dynein) carry materials “on their backs” while they “crawl” along microtubules
    - kinesin – motor proteins in anterograde transport towards outside
    - dynein – motor proteins in retrograde transport towards center

(1) Structural Classification of Neurons - *According to amount of processes*

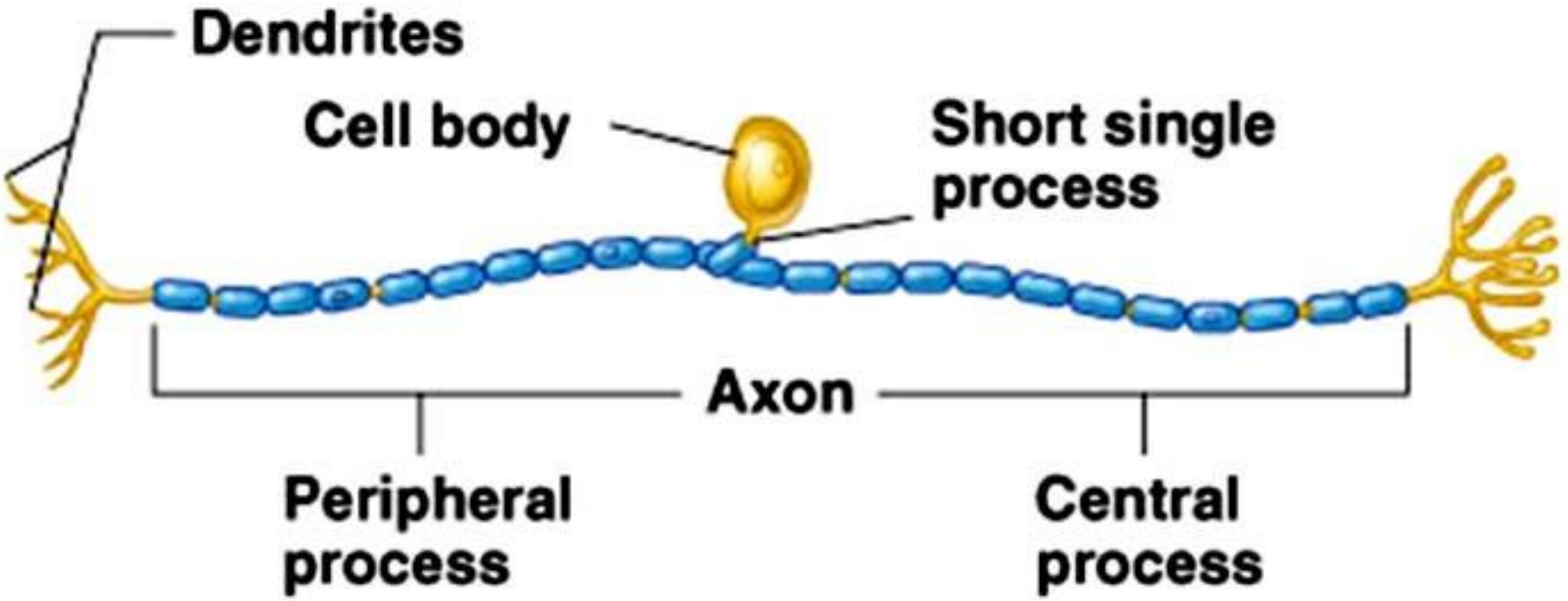
- 1. **Unipolar** neurons – are found during early embryogenesis. They have one axon

(1) Structural Classification of Neurons

- 2. **Bipolar** neurons – one axon and one dendrite

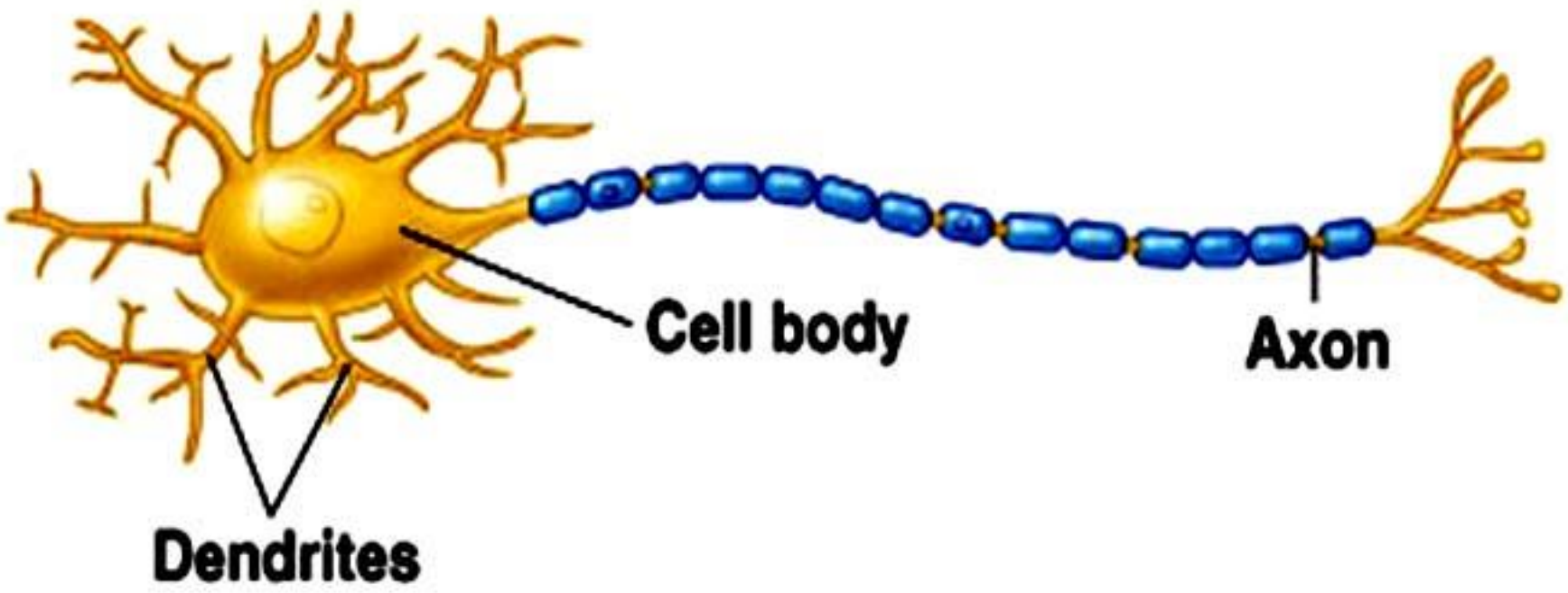
(1) Structural Classification of Neurons

- 3. **<u>Pseudounipolar</u>** neurons – have a short single process leaving the cell body



(1) Structural Classification of Neurons

- 4. **<u>Multipolar</u>** neurons – many extensions from the cell body



(2) Functional Classification of Neurons

- 1. Sensory (afferent) neurons

  Carry impulses from the sensory receptors to the cell body

- 2. Motor (efferent) neurons

  Carry impulses from cell body which lie in the central nervous system to effector cells

- 3. Interneurons (=association neurons) - 99,9% in the central nervous system

  Connect sensory and motor neurons

Supporting Cells

(Neuroglia or Glia) =

Macroglia + Microglia

Glial cells of the CNS=

Astrocytes

Oligodendrocytes…myelination

Microglial

Ependymal cells

Supporting cells (glial cells) of the PNS

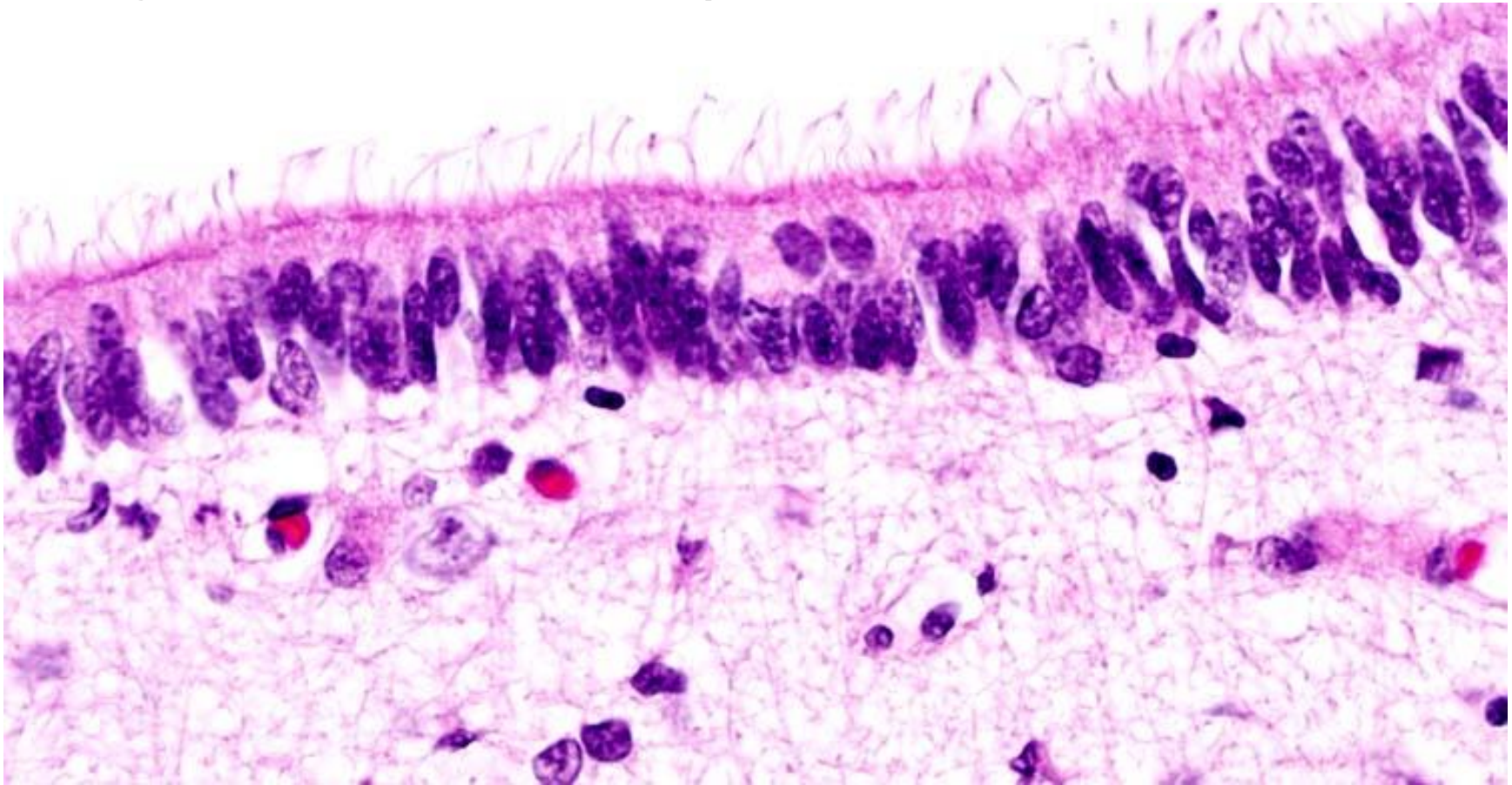
- Schwan cells
- Satelite cells
- These supporting “glial” brace and protect the fragil neuron cells
- Act as phagocytes
- Control the chemical environment around the nerve cells.
- More about supporting cells later

Neuroglial Cells

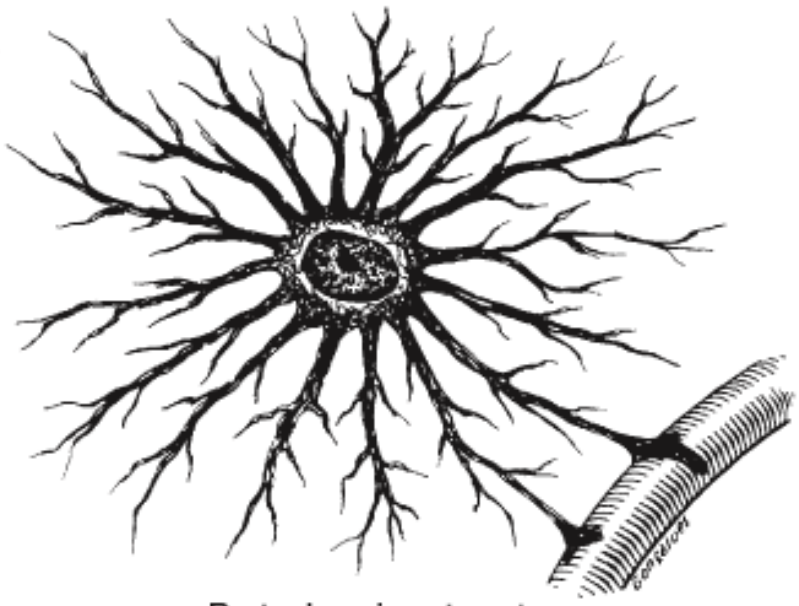
- about a trillion (10^{12}) neurons in the nervous system
- neuroglia outnumber the neurons by as much as 50 to 1
- neuroglia or glial cells
  - support and protect the neurons
  - bind neurons together and form framework for nervous tissue
  - in fetus, guide migrating neurons to their destination
  - if mature neuron is not in synaptic contact with another neuron is covered by glial cells
    - prevents neurons from touching each other
    - gives precision to conduction pathways

Macroglia in the **CNS**

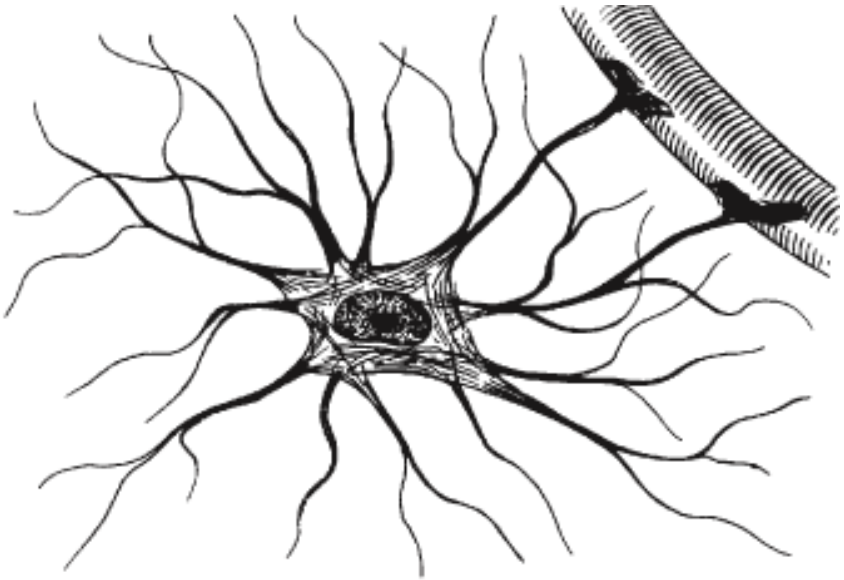
- 1. **Ependymal** cells
  - Line cavities of the brain and spinal cord
    Synthesize cerebrospinal fluid



- 2. **Astrocytes**
- **most abundant glial cell in CNS**
  - Star-shaped cells
  - Support neurons
  - Form barrier between capillaries and neurons (BBB)
  - Control the chemical environment of the brain (CNS)
  - 2 types: Protoplasmic
  - and Fibrous



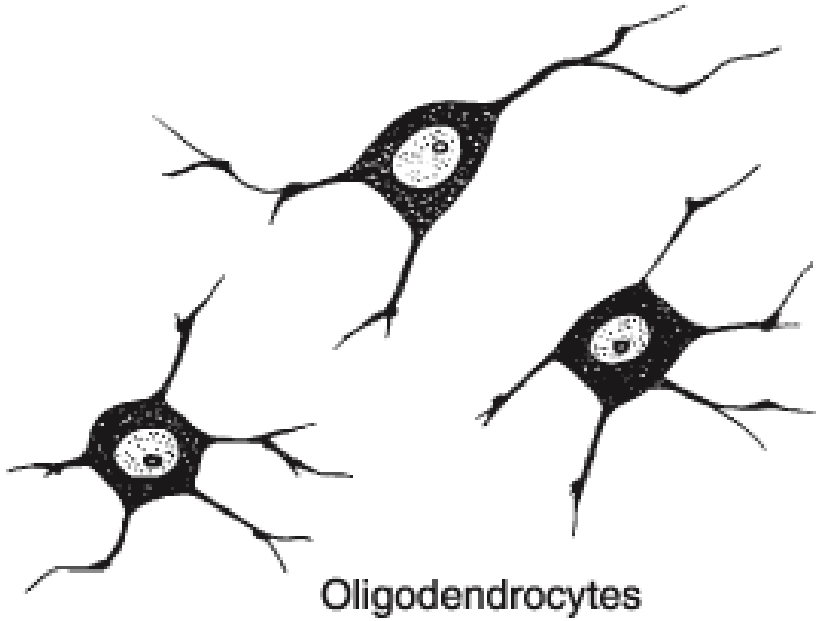
Protoplasmic astrocyte



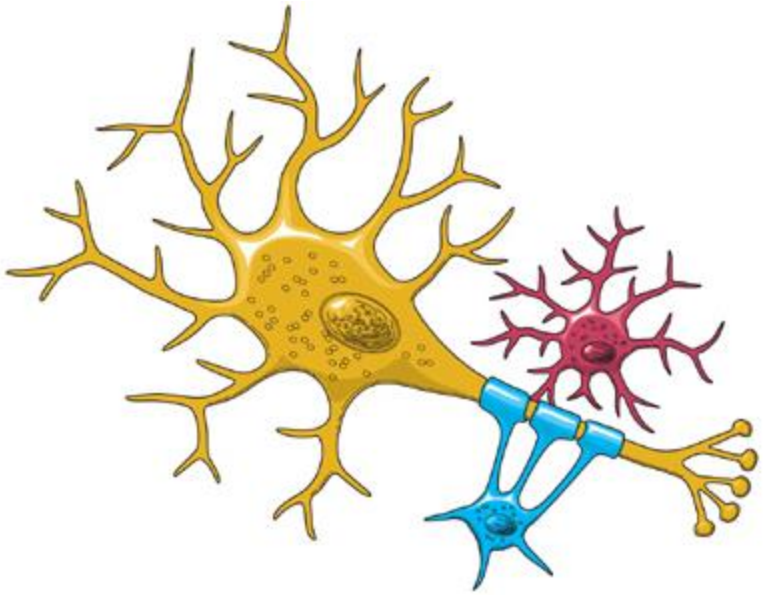
Fibrous astrocyte

- 3. ***Oligodendrocytes***

Produce myelin sheath around nerve fibers in the central nervous system

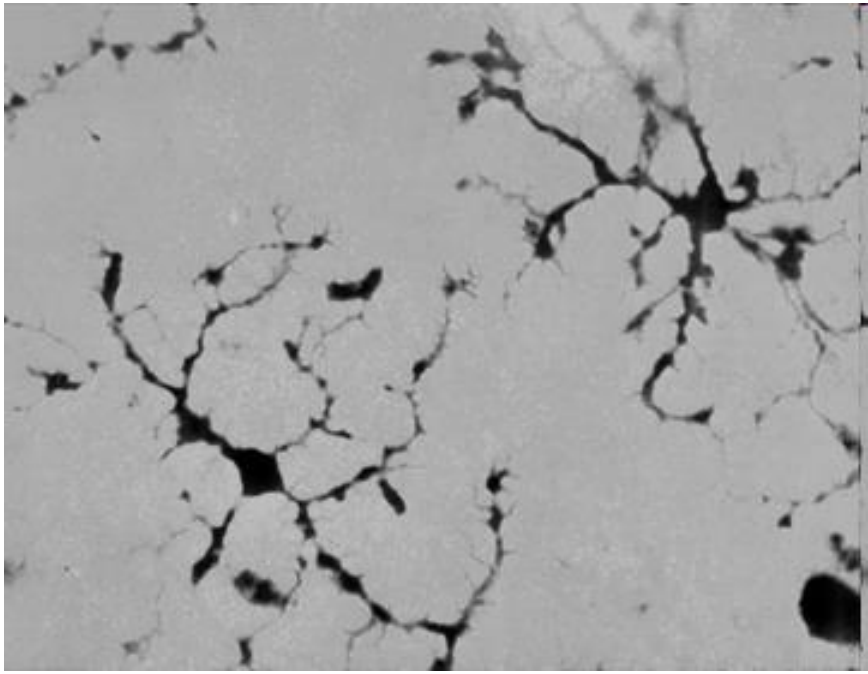


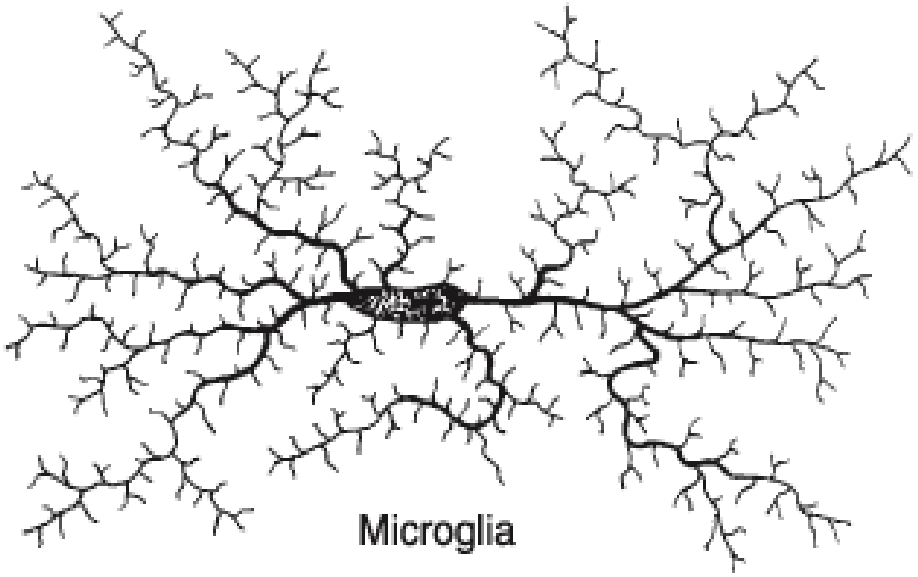
- Nourish neurons



Microglia

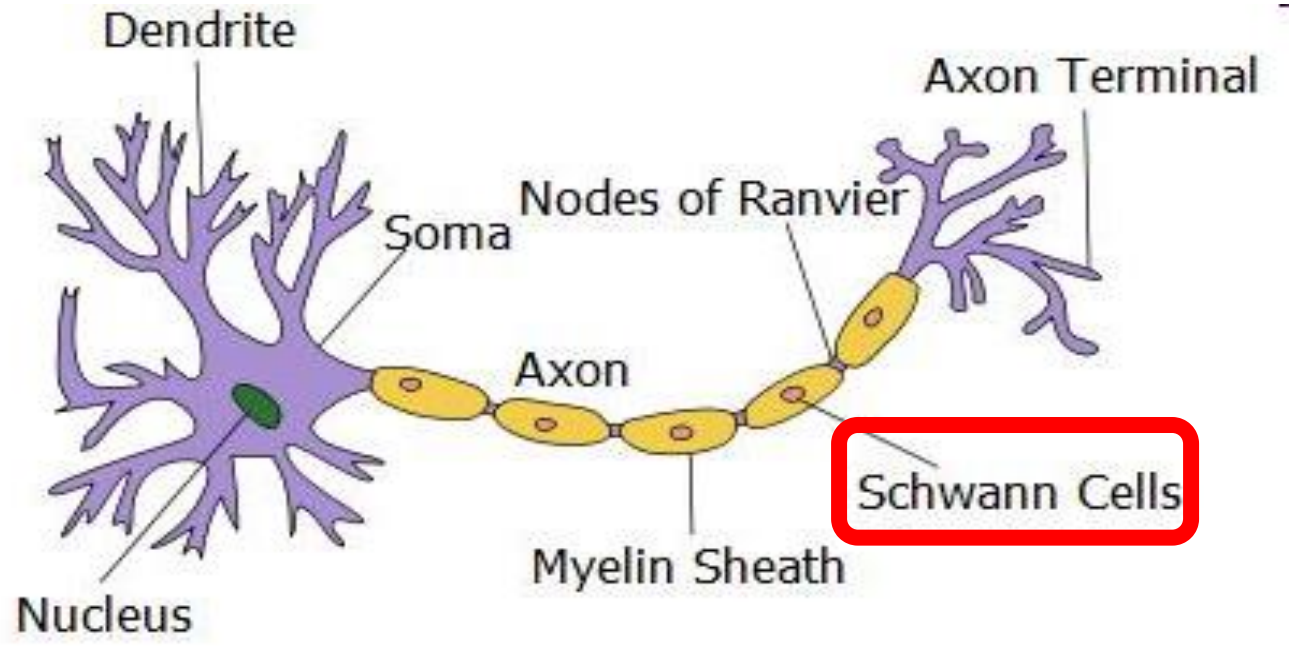
- - arise from monocytes of the blood,
  - Spider-like
  - Phagocytes
  - Checked up brain tissue
  - Dispose of debris





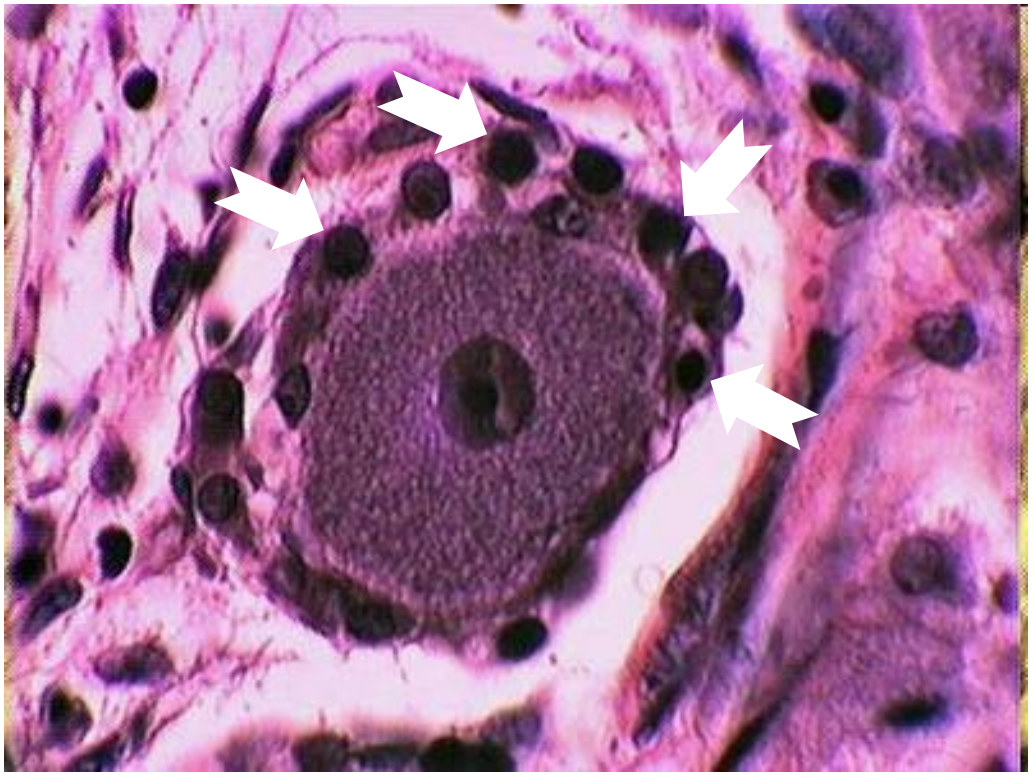
Supporting Cells of the PNS

- Schwann cells - form myelin sheath in the *peripheral nervous system*
- *envelope nerve fibers in PNS*
- *assist in the regeneration of damaged fibers*



Supporting Cells of the PNS

- Satellite cells – surround cell bodies of neurons in sensory ganglia
- provide electrical insulation around the soma
- regulate the chemical environment of the neurons



Nerve fibers

1. Unmyelinated

2. Myelinated

Myelin

- in PNS, Schwann cell spirals repeatedly around a single nerve fiber
  - lays down as many as a hundred layers of its own membrane
  - no cytoplasm between the membranes
  - neurilemma – thick outermost coil of myelin sheath
    - contains nucleus and most of its cytoplasm
    - external to neurilemma is basal lamina and a thin layer of fibrous connective tissue – endoneurium
- in CNS – oligodendrocytes reaches out to myelinate several nerve fibers in its immediate vicinity
  - anchored to multiple nerve fibers
  - cannot migrate around any one of them like Schwann cells
  - must push newer layers of myelin under the older ones
    - so myelination spirals inward toward nerve fiber
  - nerve fibers in CNS have no nemma or endoneuriumeuril

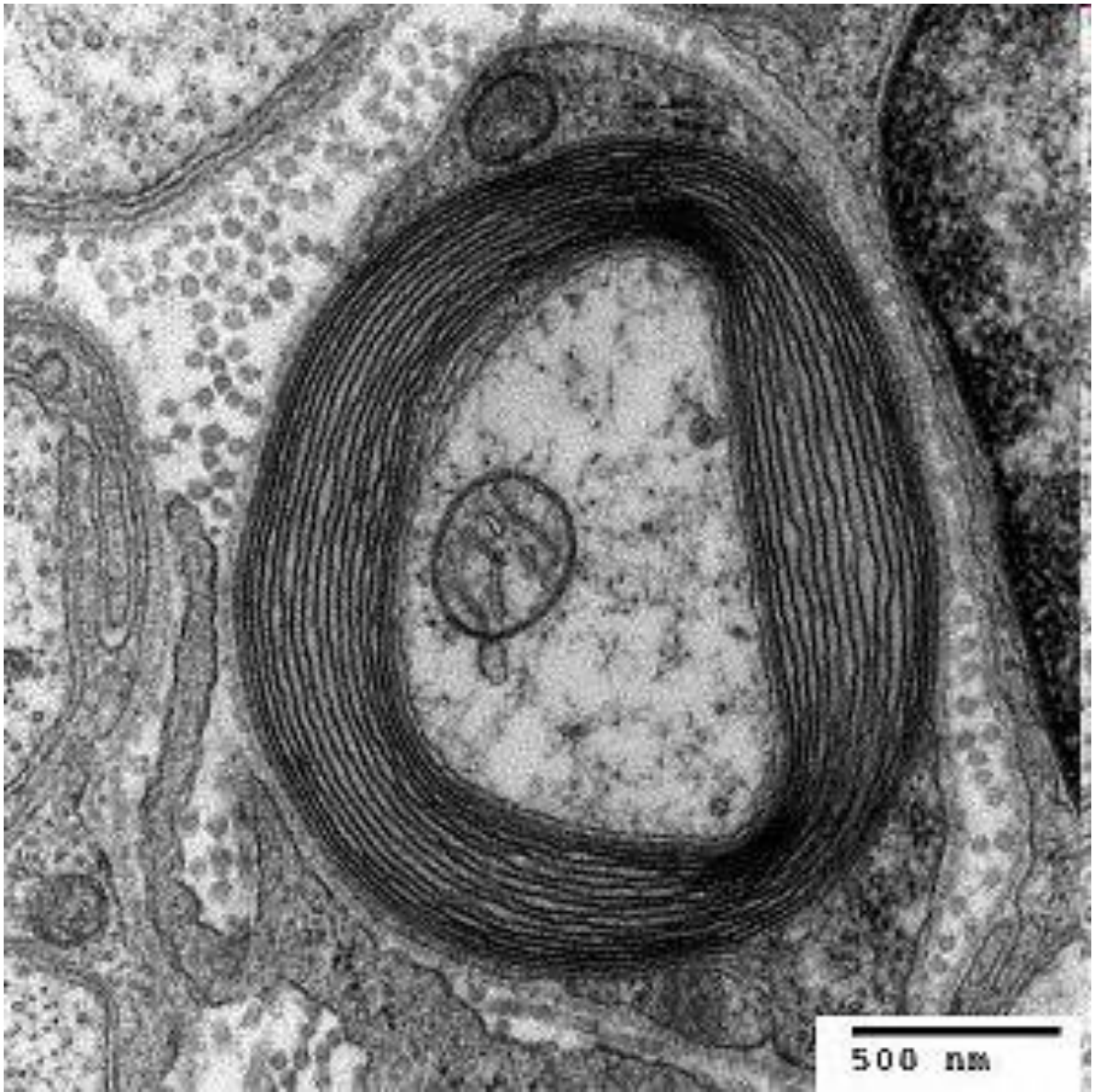
Myelin

- many Schwann cells or oligodendrocytes are needed to cover one nerve fiber
- myelin sheath is segmented
  - **nodes of Ranvier** – gap between segments
  - internodes – myelin covered segments from one gap to the next
  - initial segment – short section of nerve fiber between the axon hillock and the first glial cell
  - trigger zone – the axon hillock and the initial segment
    - play an important role in initiating a nerve signal

Unmyelinated nerve fiber:

Axones and dendrites are invaginated in Schwann cell cytoplasm

Myelinated nerve fibers



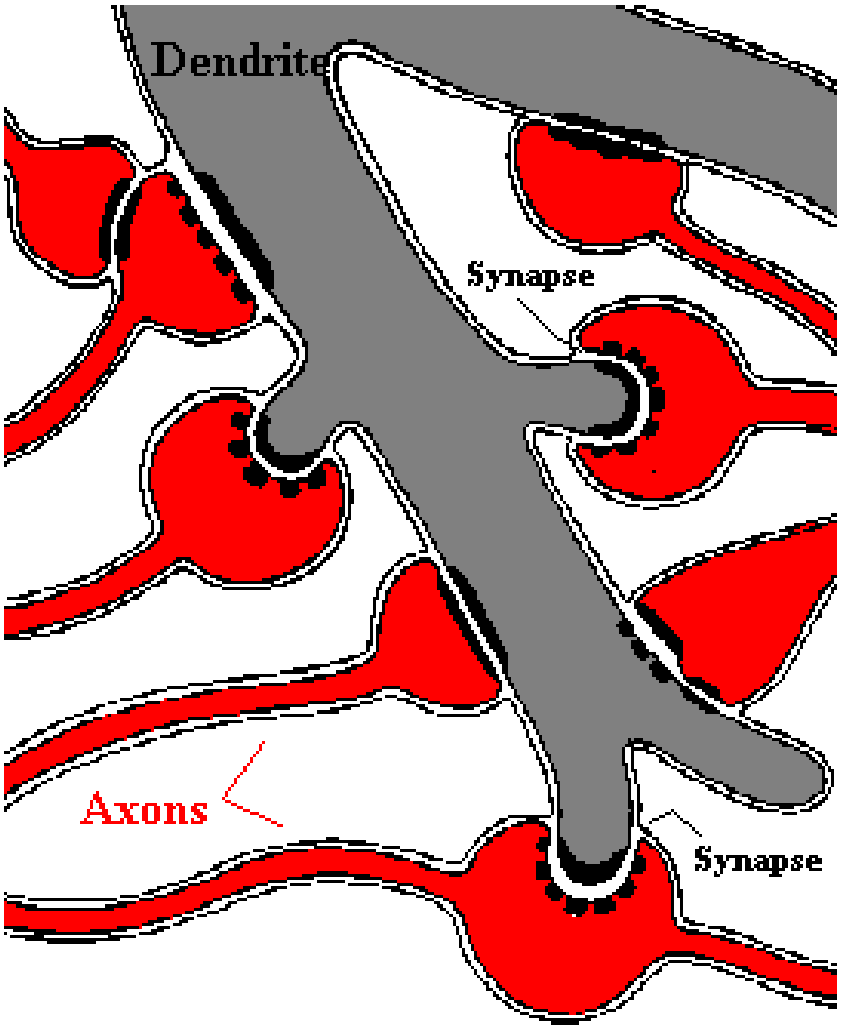
Myelinated nerve fiber structure

Nodes of Ranvier – spaces between 2 Schwann cells – free from myelin

- Nodes of Ranvier provide saltatory conduction of nerve impulse

Synapse

The specialized region of contact between 2 neurons



Classification of synapses:

by nature:

- chemical synapse
- electrical synapse

by localisation

- axodendritic synapse
- axosomatic synapse
- axoaxonic synapse

By action:

- excitatory synapse
- inhibitory synapse

Sensory Nerve endings (afferent neurons receptors)

Classifications:

By location:

1. Exteroceptors,
2. Interoceptors,
3. Proprioceptors

By type of stimuli:

1. Chemoreceptors,
2. Mechanoreceptors,
3. Photoreceptors,
4. Thermoreceptors

Sensory nerve endings (afferent neuron receptors)

Classification:

By type of the structure:

1. **A. Free nerve endings**

   B. Hair follicle nerve ending

   C. Merkel nerve endings (Merkel's disk)

2. **Encapculated:**

   Tactile corpuscle of Meissner

   Corpuscle of Pacini

   Ruffini endings

3. **Muscle spindle**

1. A. **Free nerve endings –** pain, thermal receptors

1. B. Hair follicle nerve endings – respond to very light touch

1. C. **Merkel nerve endings** – light touch receptors

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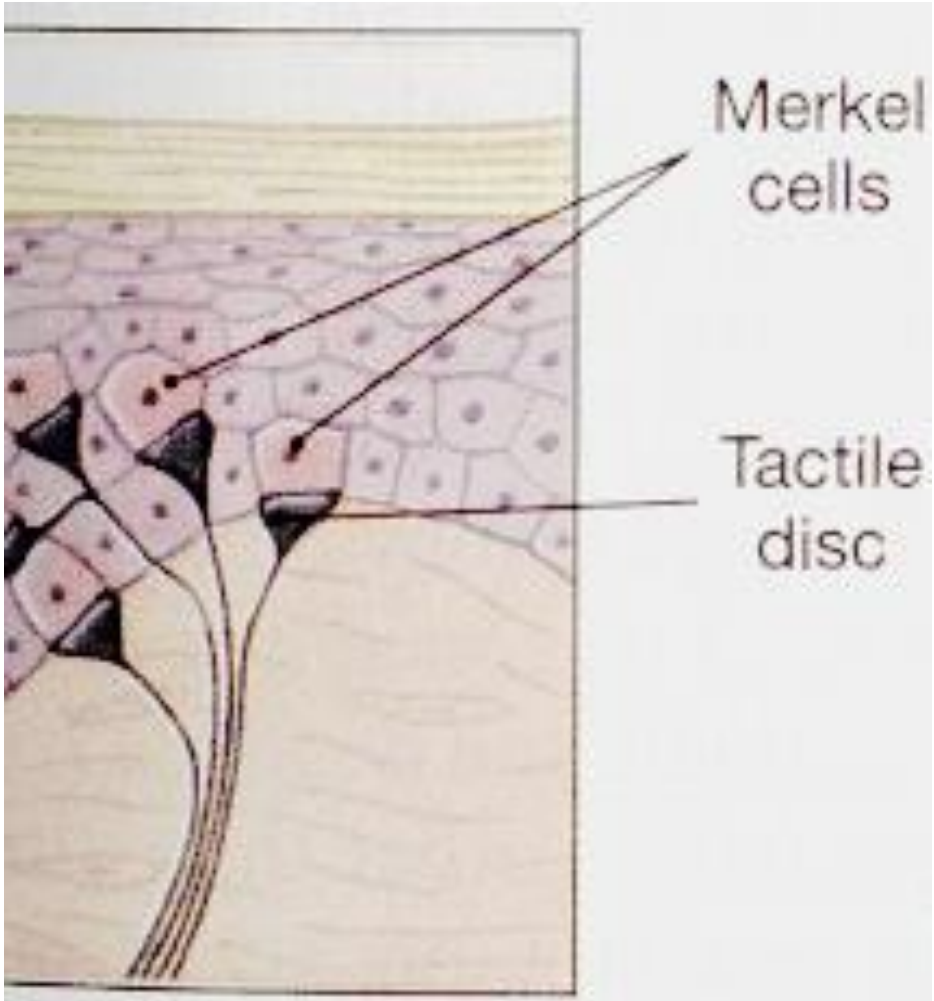

Merkel cells and tactile discs

2. Encapsulated = Tactile corpuscle of Meissner

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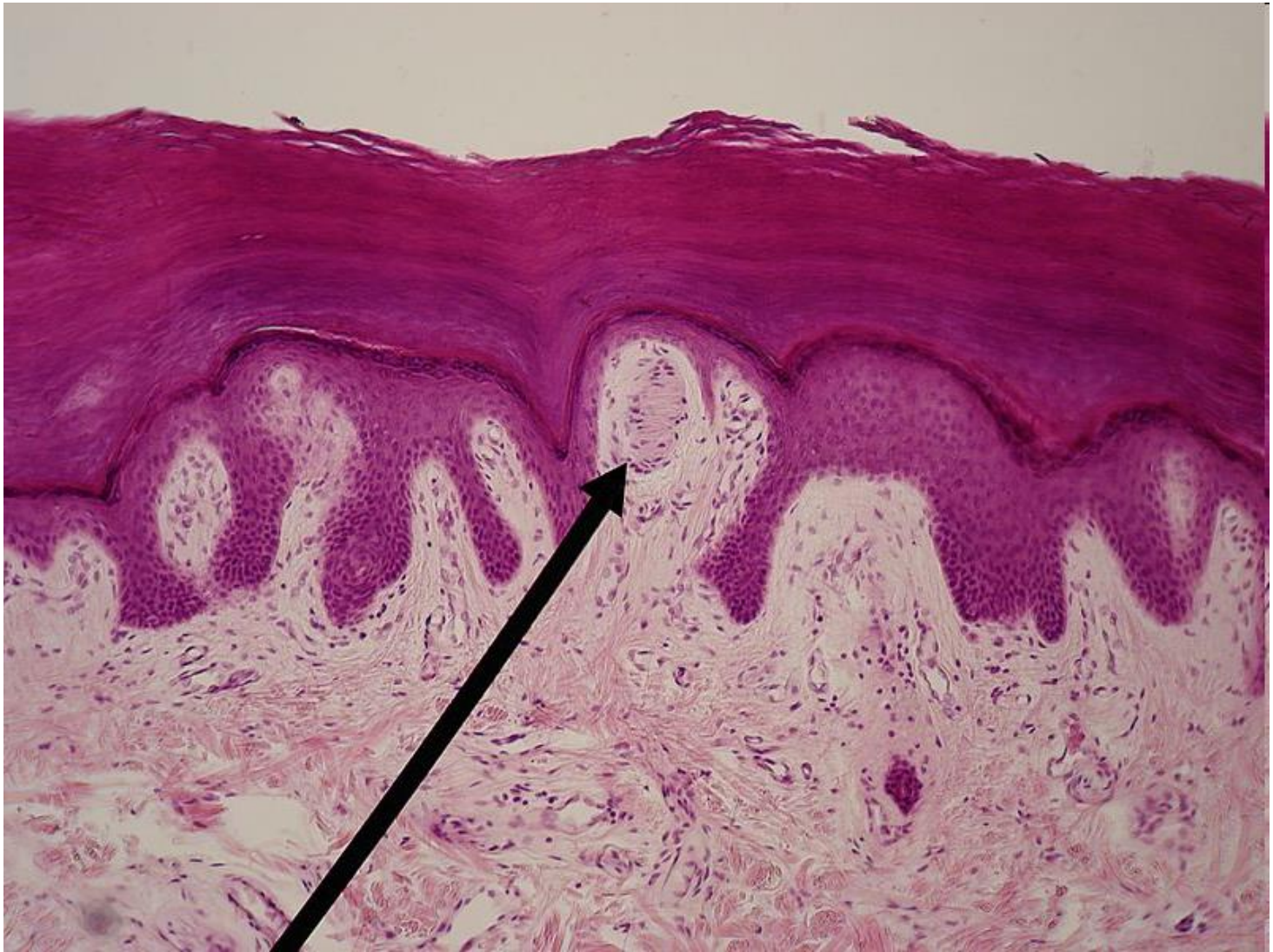

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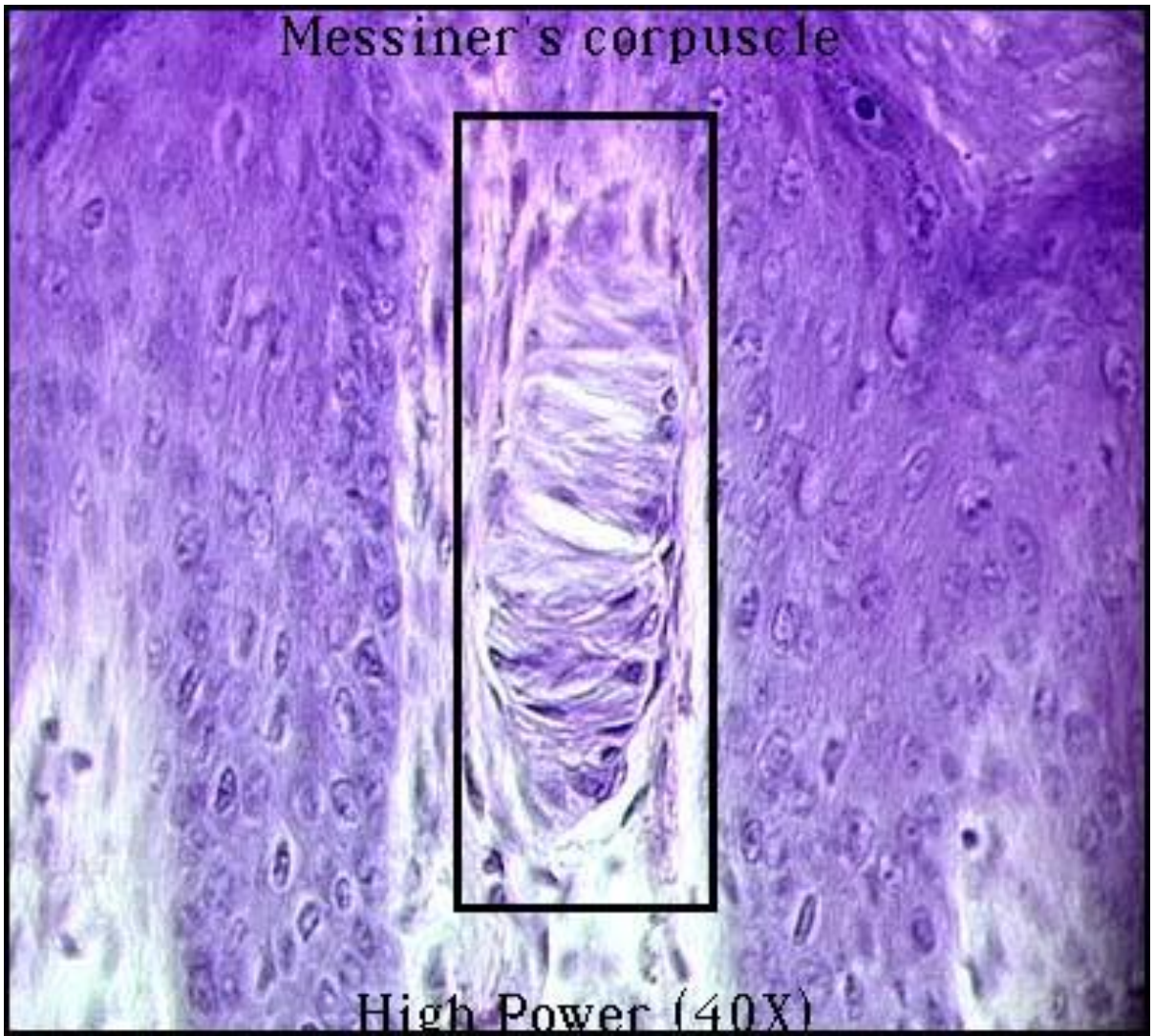
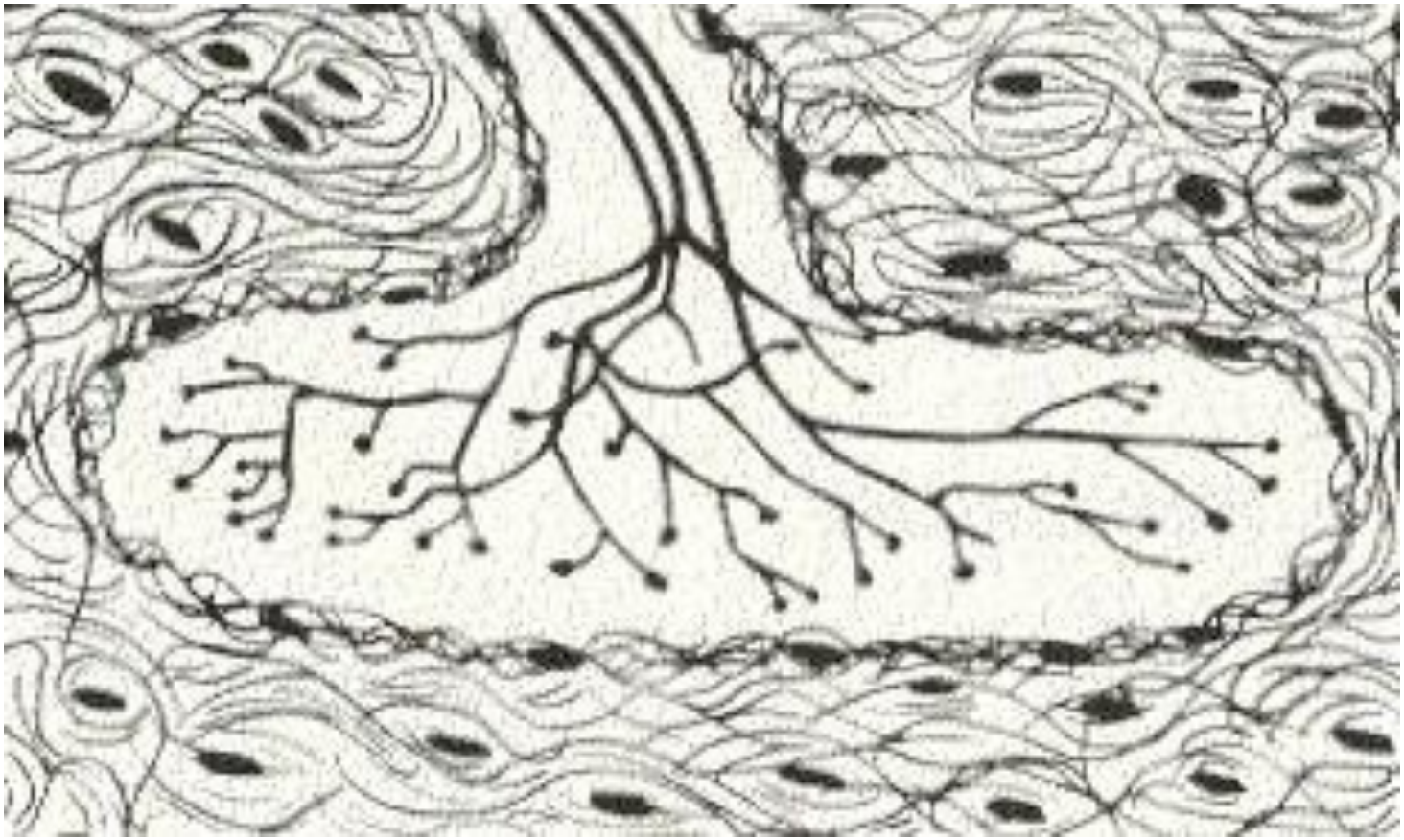


2. Encapsulated. Corpuscle of Pacini (lamellar body) is specialized to detect gross pressure changes and vibration

2. Encapsulated. Corpuscle of Pacini lamellar body are specialize to detect vibration

2. Encapsulated. Ruffini ending

Dense branches of nerve-endings encapsulated in connective tissue. Is sensitive to skin stretch



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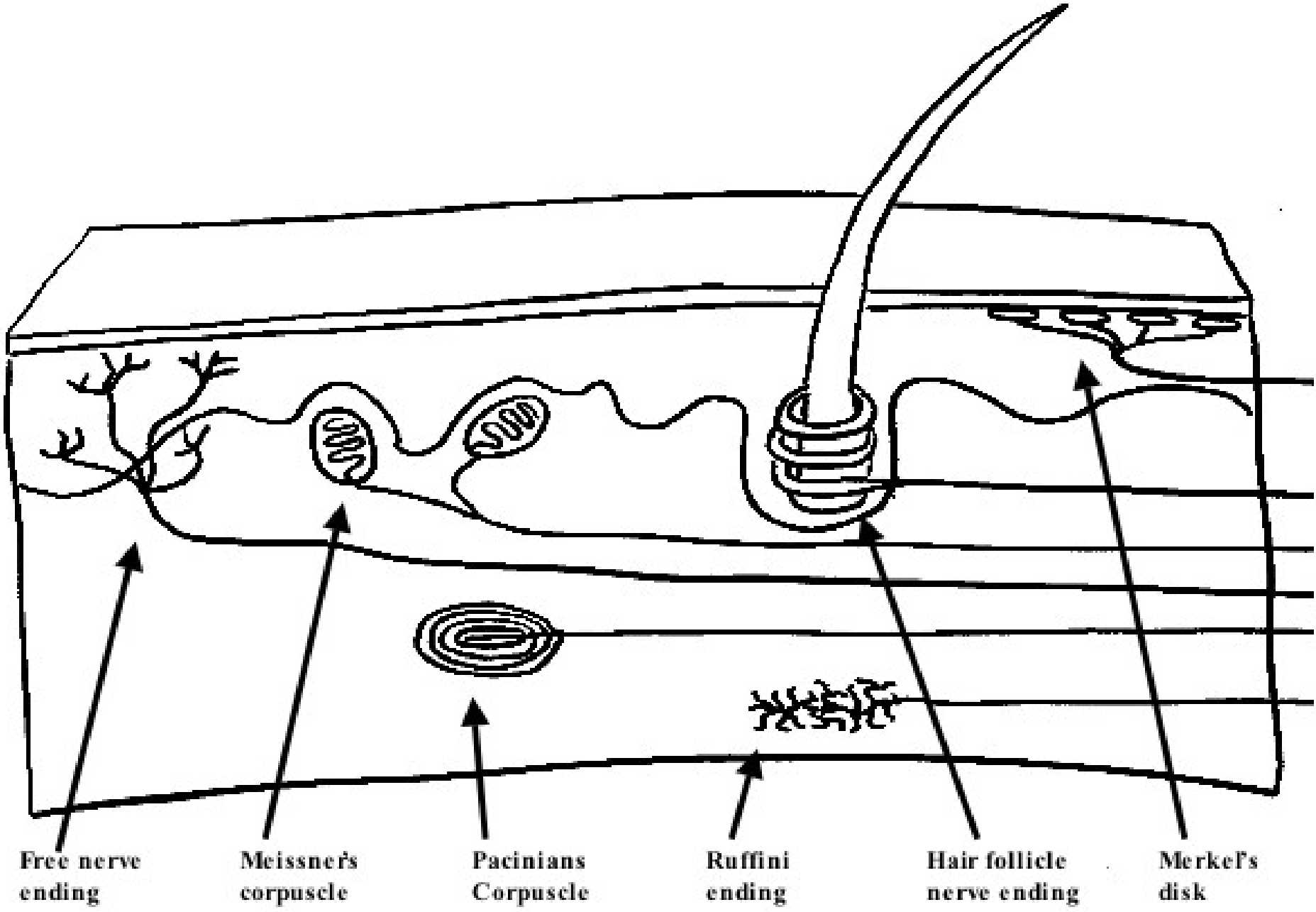
Free nerve ending
Meissner's corpuscle
Pacinians Corpuscle
Ruffini ending
Hair follicle nerve ending
Merkel's disk