بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

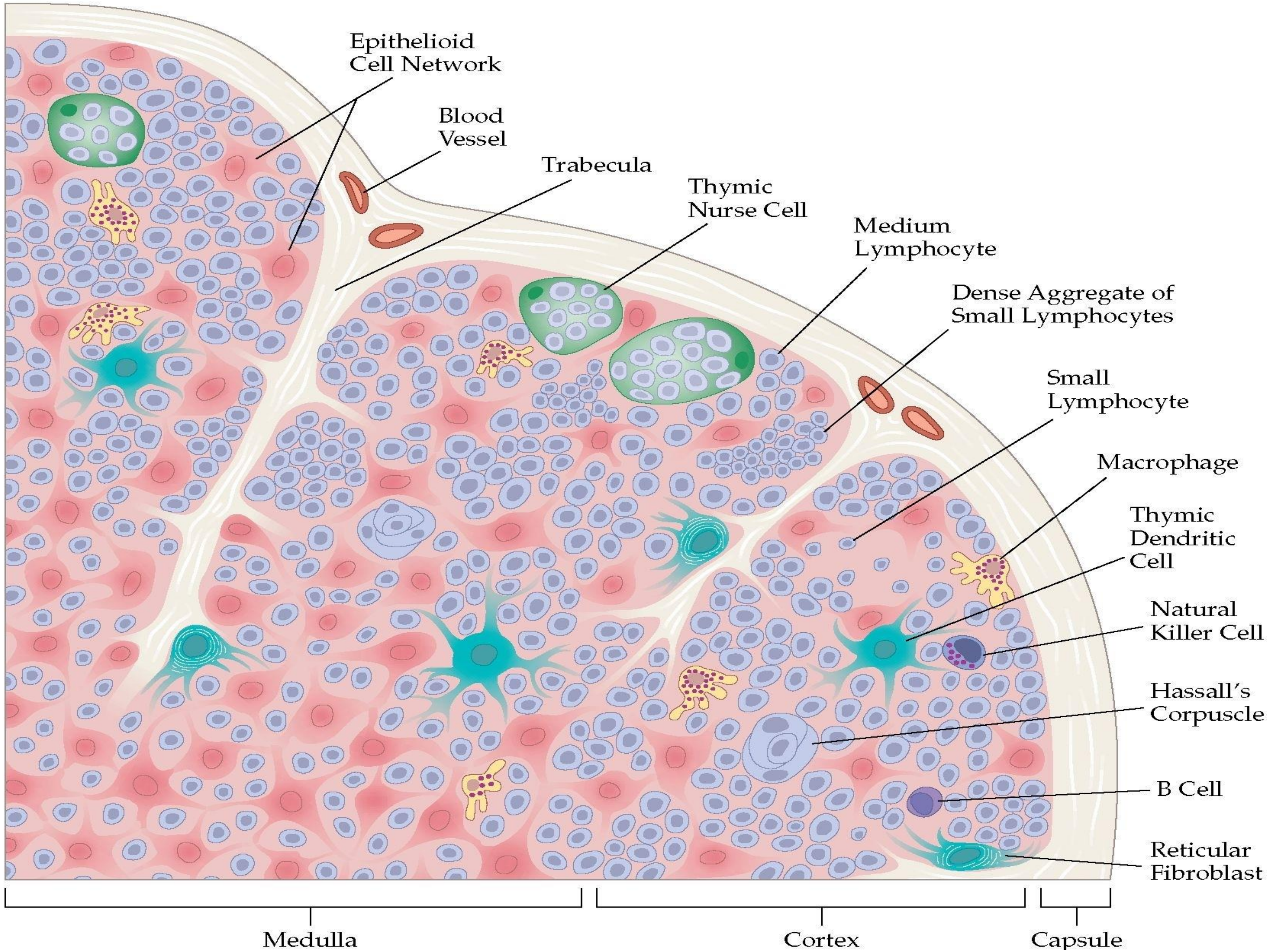
Lymphoid Tissues

- **Types of immune cell**
- **Lymphocytes** (B and T).
  Plasma cells - which secrete antibodies, derived from B-cells
  Macrophage - which engulfs micro-organisms and presents antigens on its surfaces to lymphocytes.

- **Dendritic cell** - presents antigens to lymphocytes on its surface.
  Neutrophil - phagocytic cell
  Reticular cell - also a dendritic cell, which presents antigens.
  Mast Cell - derived from the bone marrow, release histamine, heparin,etc. Have receptors for IgE antibodies on their surface. Involved in allergic reactions.
- This also includes discrete organs such as the spleen, thymus and lymph nodes, as well as more diffuse aggregations of lymphocytes.

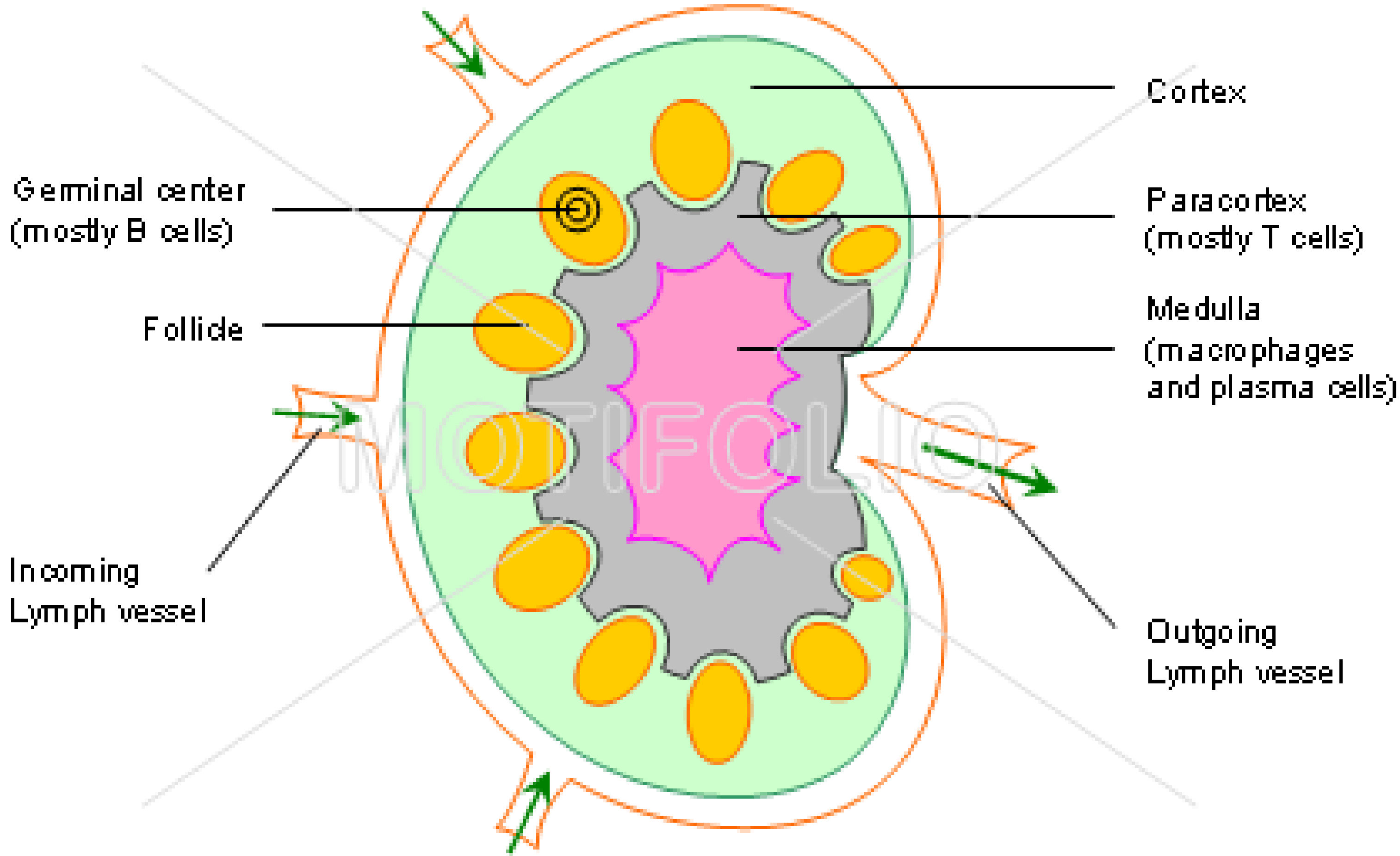
- **Primary** lymphatic organs are where **lymphocytes** are **formed and mature**. They provide an environment for stem cells to divide and mature into B- and T- cells:

- There are two primary lymphatic organs: the red bone marrow and the thymus gland. The development of white blood cells (haemopoesis was covered briefly in the section on blood.
- Both T-cell and B-cells are 'born' in the bone marrow.
- However, whereas B cells also mature in the bone marrow, T-cells have to migrate to the thymus, which is where they mature in the thymus.

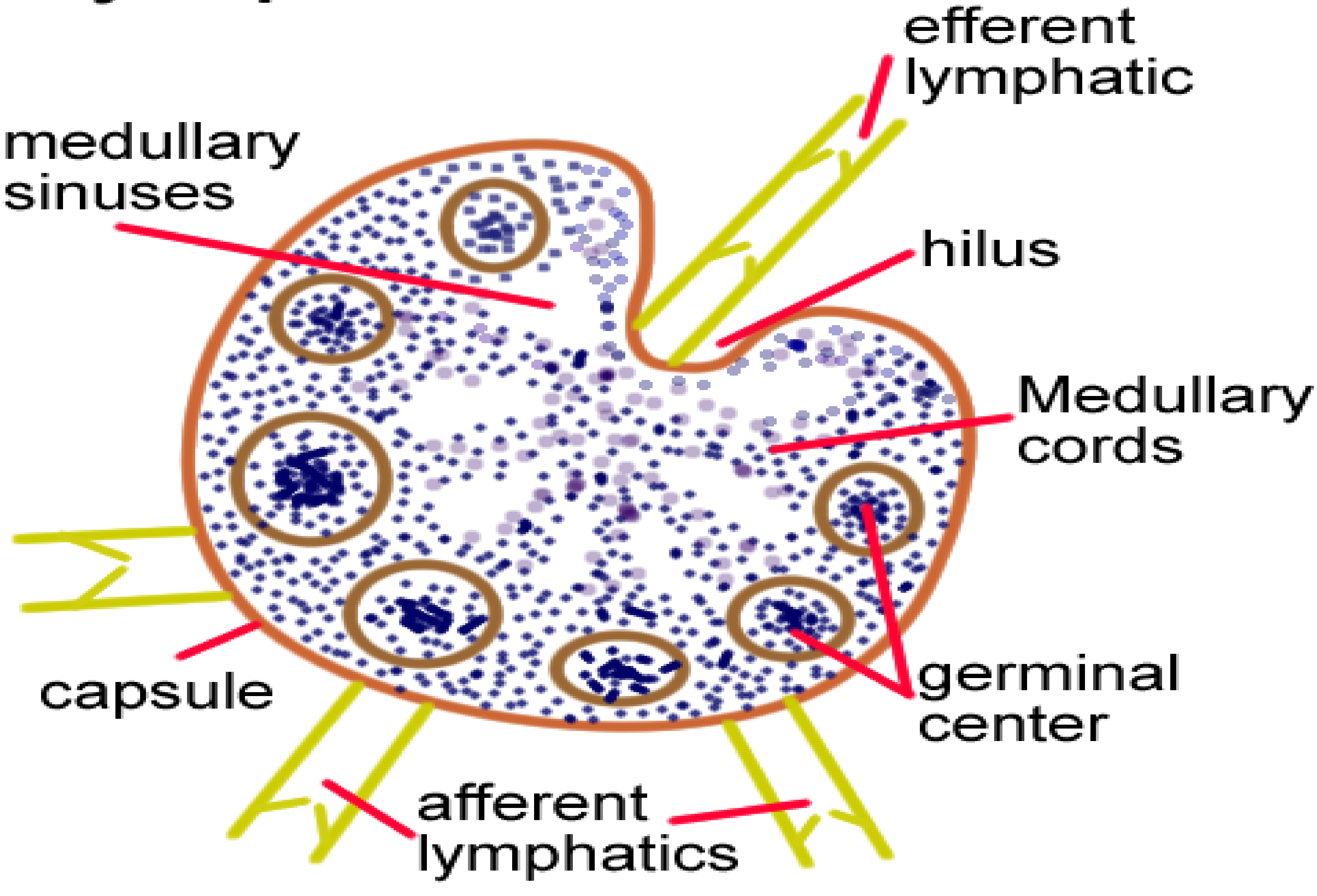

Epithelioid Cell Network
Blood Vessel
Trabecula
Thymic Nurse Cell
Medium Lymphocyte
Dense Aggregate of Small Lymphocytes
Small Lymphocyte
Macrophage
Thymic Dendritic Cell
Natural Killer Cell
Hassall's Corpuscle
B Cell
Reticular Fibroblast
Medulla
Cortex
Capsule

- **What are Secondary lymphatic organs?**
- **Secondary** lymphoid tissues are arranged as a series of filters monitoring the contents of the extracellular fluids, i.e. lymph, tissue fluid and blood. The lymphoid tissue filtering each of these fluids is arranged in different ways. Secondary lymphoid tissues are also where lymphocytes are **activated.**
- These include: **lymph nodes, tonsils, spleen**, **Peyer's patches** and **mucosa associated lymphoid tissue (MALT**).

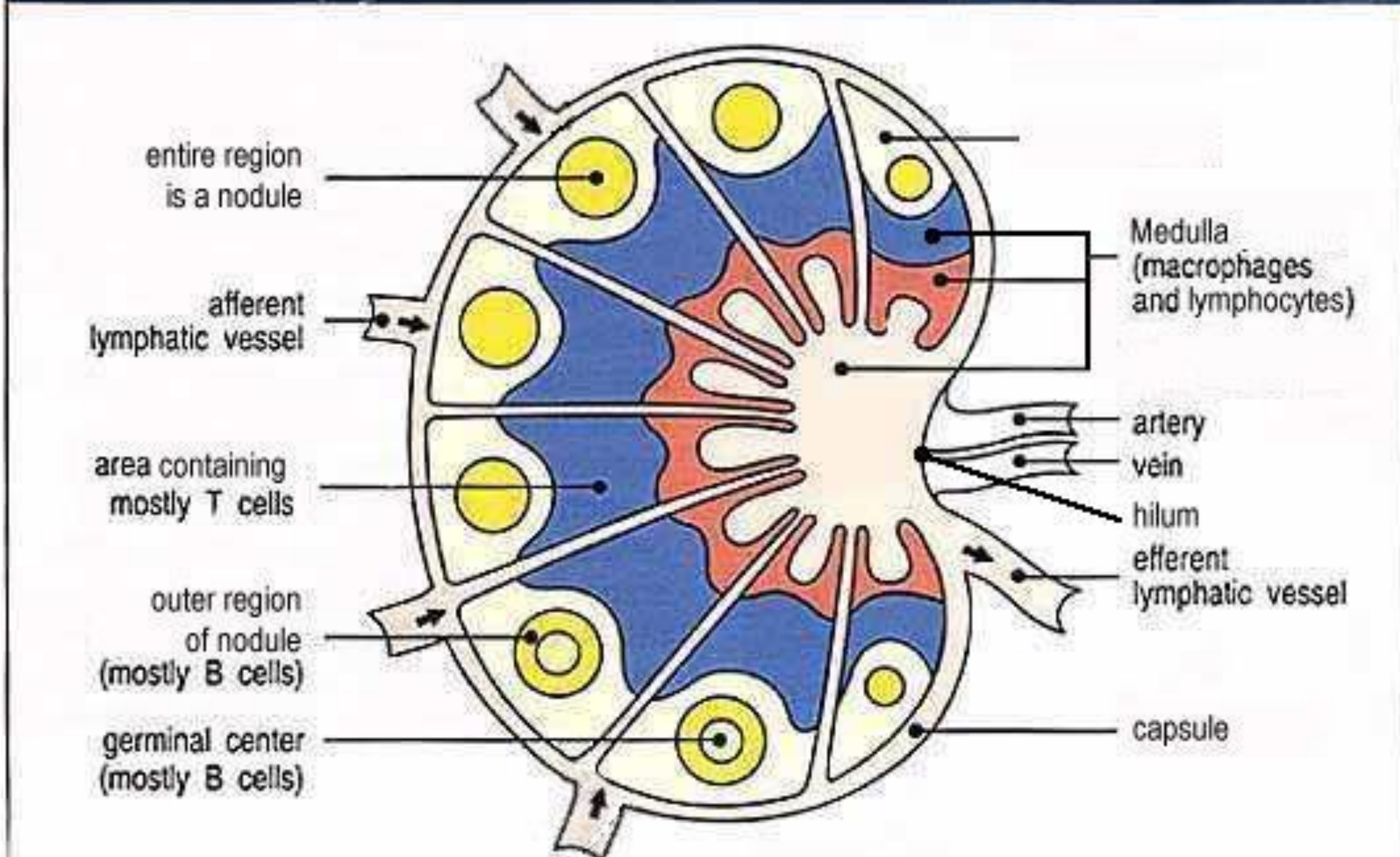
Lymph node

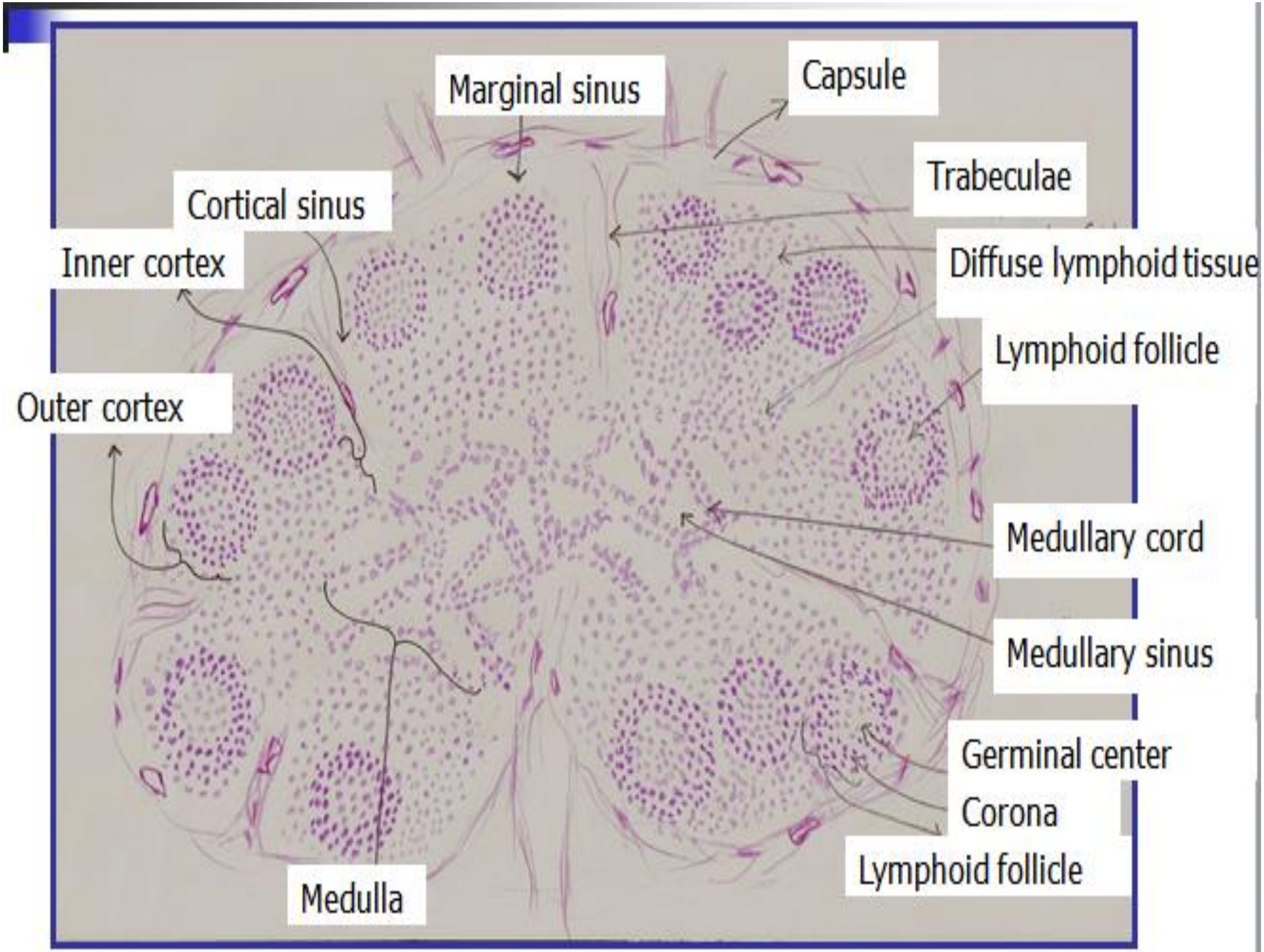

Cortex
Germinal center
(mostly B cells)
Paracortex
(mostly T cells)
Follicle
Medulla
(macrophages
and plasma cells)
Incoming
Lymph vessel
Outgoing
Lymph vessel
MOTIFOLIO

Lymph Node


efferent
lymphatic
medullary
sinuses
hilus
Medullary
cords
capsule
germinal
center
afferent
lymphatics

The lymph node

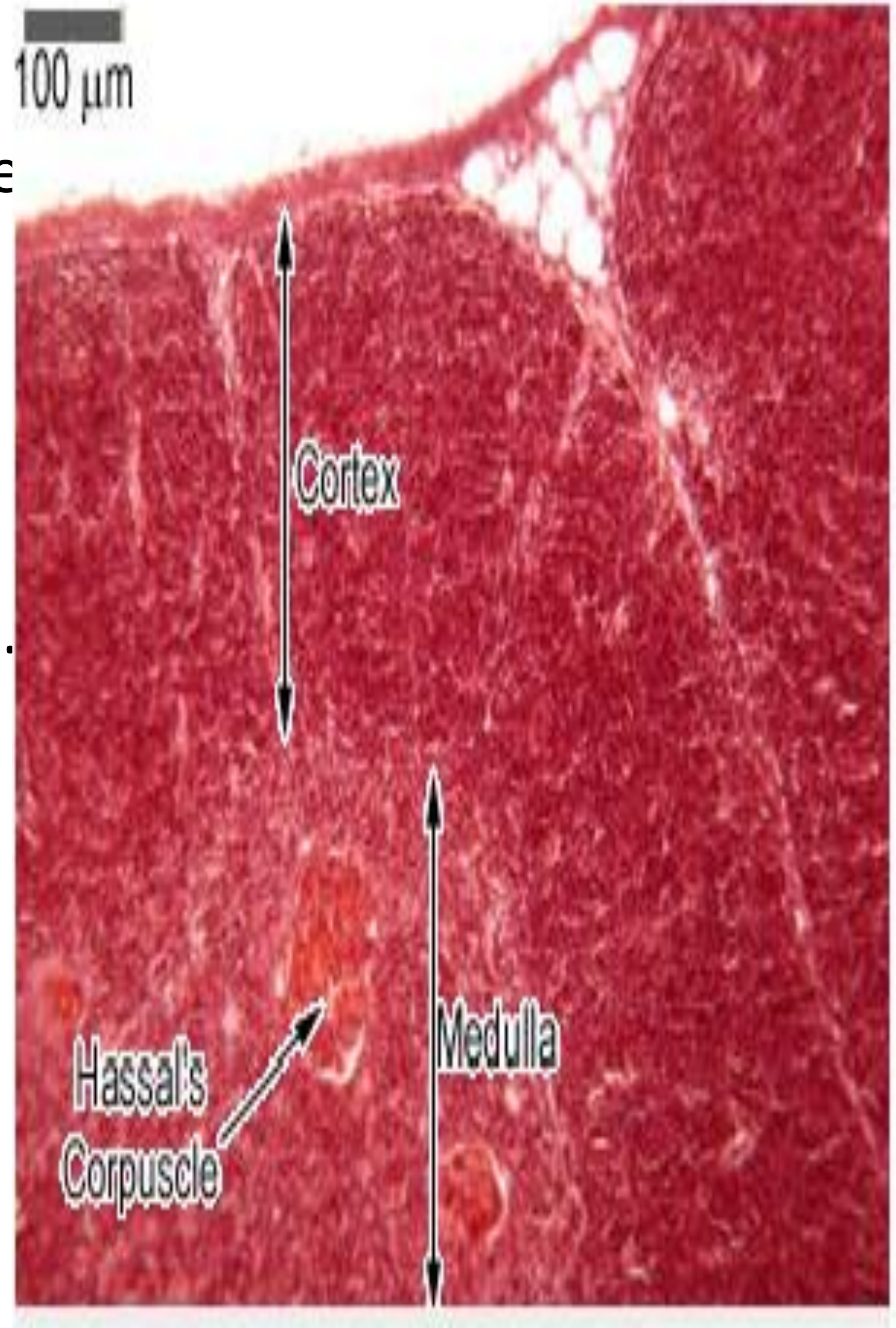


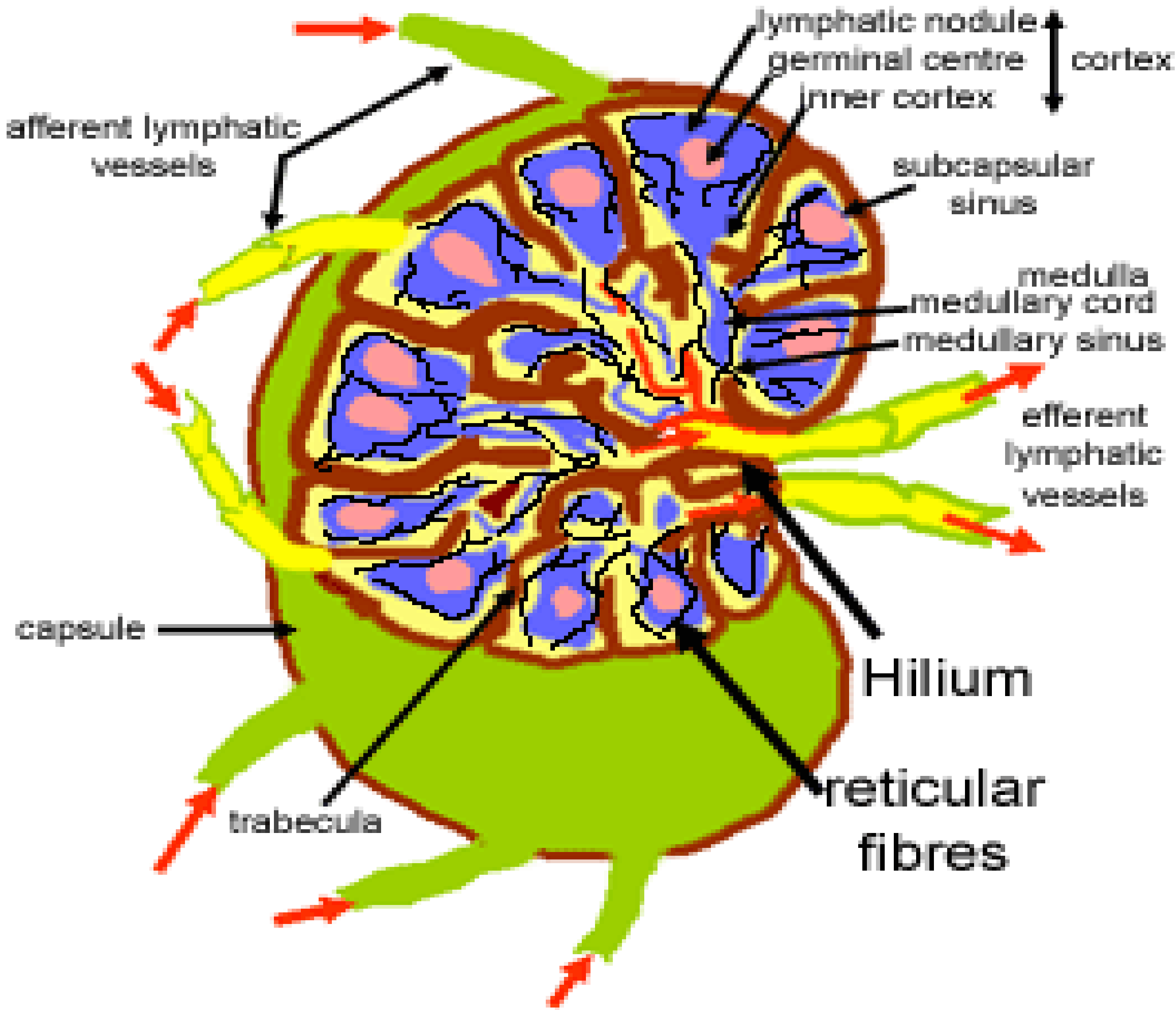

Marginal sinus
Capsule
Trabeculae
Cortical sinus
Inner cortex
Diffuse lymphoid tissue
Lymphoid follicle
Outer cortex
Medullary cord
Medullary sinus
Germinal center
Corona
Lymphoid follicle
Medulla

- The thymus is a primary lymphoid organ found within the superior mediatinum, behind the upper part of the sternum.
- This organ is active in children, but at the start of puberty, until old age, it starts to atrophy, producing fewer T-cells. The thymus also produces thymic hormones that support the growth and differentiation of T-cell progenitors.

- It has two lobes divided up into many lobules. The outer, more darkly staining region is the cortex, and this is highly cellular. The inner lighter staining region is the medullar, and this region is less cellular. It has an outer connective tissue capsule and septa.
- This organ is important for development of immunocompetent T-cells, proliferation of clones of of mature T-cells, developing immunological self-tolerance, and secretion of hormones for T-cell development. At least three hormones are made: thymosin, thymulin and thymopoietin. These hormones are produced by reticular epithelial cells in the cortex.

- At this magnification, you can't see individual lymphocytes, but you can see **Hassal's corpuscles** in the medulla. These are made up of flat non-secreting epithelial cells arranged in a concentric layers that have keratinised. These structures are only found in the thymus.
-
- This photograph shows part of the cortex and medulla at a higher magnification.
- Can you identify these two regions and the Hassal's corpuscle?




lymphatic nodule
germinal centre
inner cortex
cortex
afferent lymphatic vessels
subcapsular sinus
medulla
medullary cord
medullary sinus
efferent lymphatic vessels
capsule
Hilium
trabecula
reticular fibres

Lymph Node Structure

PD-INEL U-M Histology Collection

- Capsule & subcapsular sinus

- Trabeculae & trabecular sinuses

sinuses contain lymph, <u>macrophages</u>, and <u>reticular cells</u>

- Cortex:

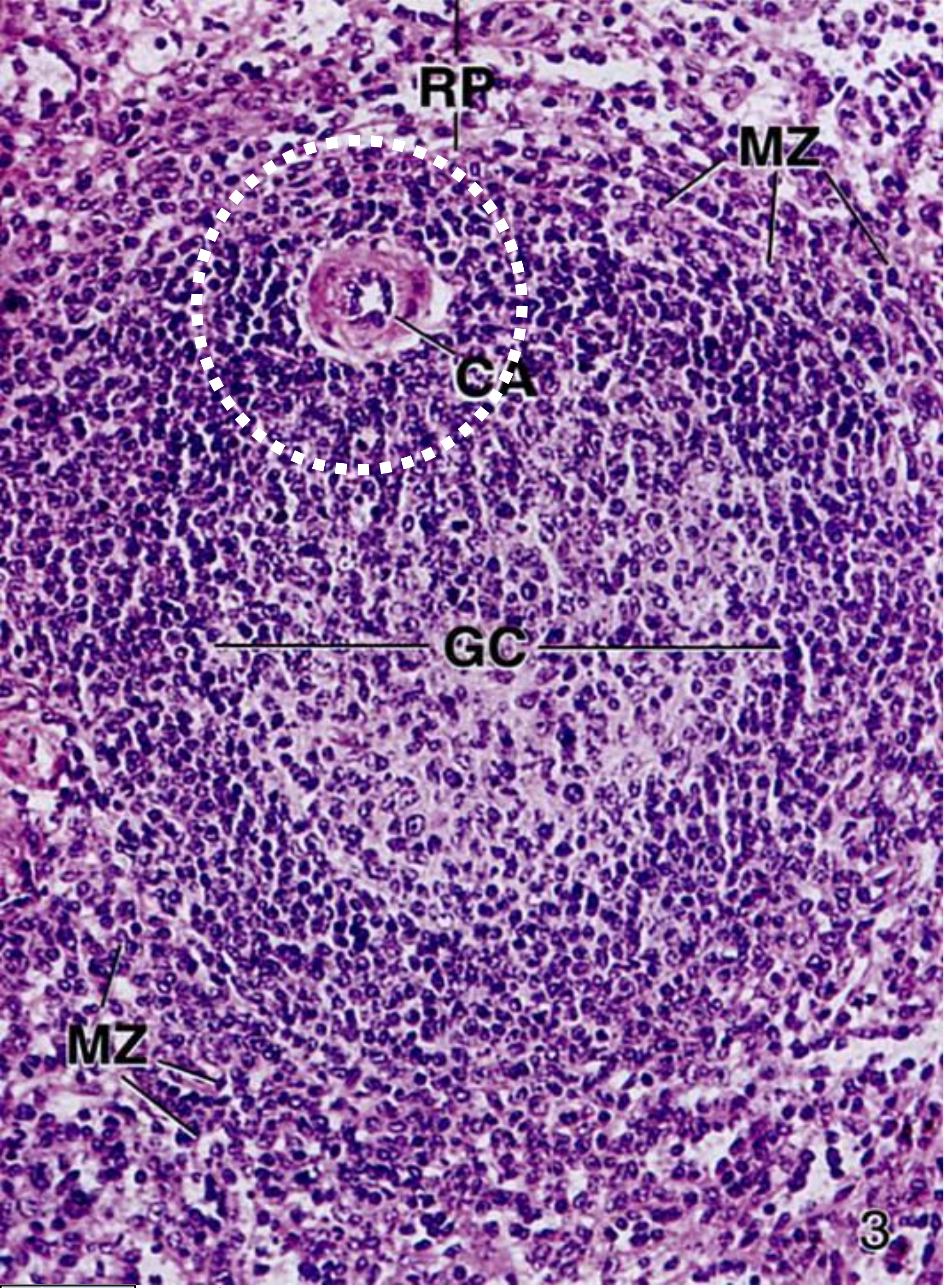
- superficial cortex (B-cells)
  - -primary follicles/nodules
  - -secondary follicles/nodules (i.e. with germinal centers)
- “deep” cortex (T-cells, dendritic cells)

- Medulla:

- medullary cords (B-cells, plasma cells)
- medullary sinuses (lymph, more macrophages, plasma cells, and reticular cells)

The Spleen

- Filters the blood.
- Destroys old red blood cells
- Serves as an immune organ
- Divided into **<u>Red Pulp</u>** (RBC/hemoglobin recycling)
- **<u>White Pulp</u>** (responsible for immune functions)



 Ross, plate 35-3

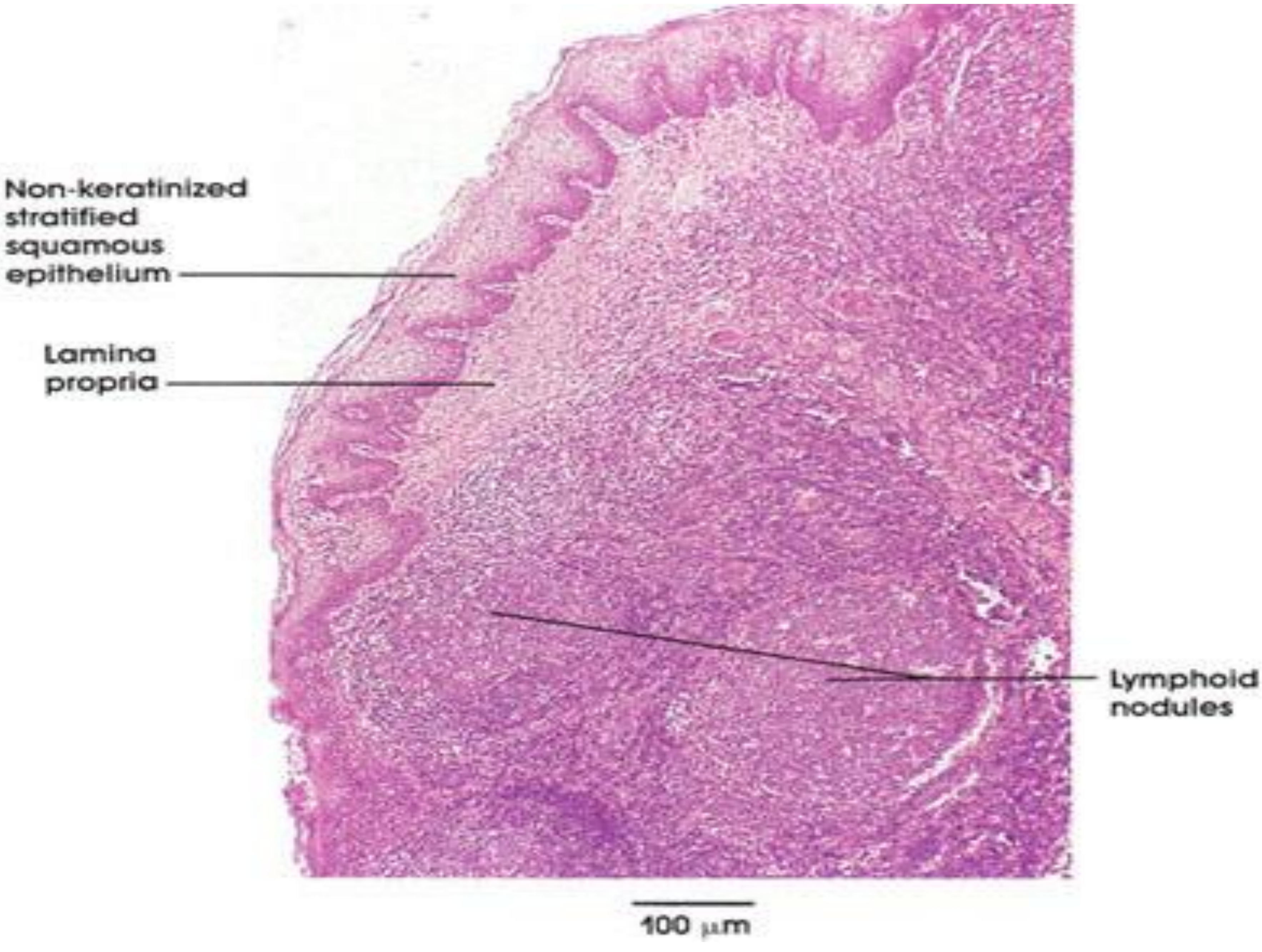
Spleen

Shown here with “central” artery cut in cross section – note that the CA has been pushed off to the side by the rapid expansion of cells in the germinal center (GC)

RP= red pulp

MZ= marginal zone (antigen presentation)

dashed circle = T-cell rich zone


Non-keratinized stratified squamous epithelium
Lamina propria
Lymphoid nodules
100 µm

THANKS

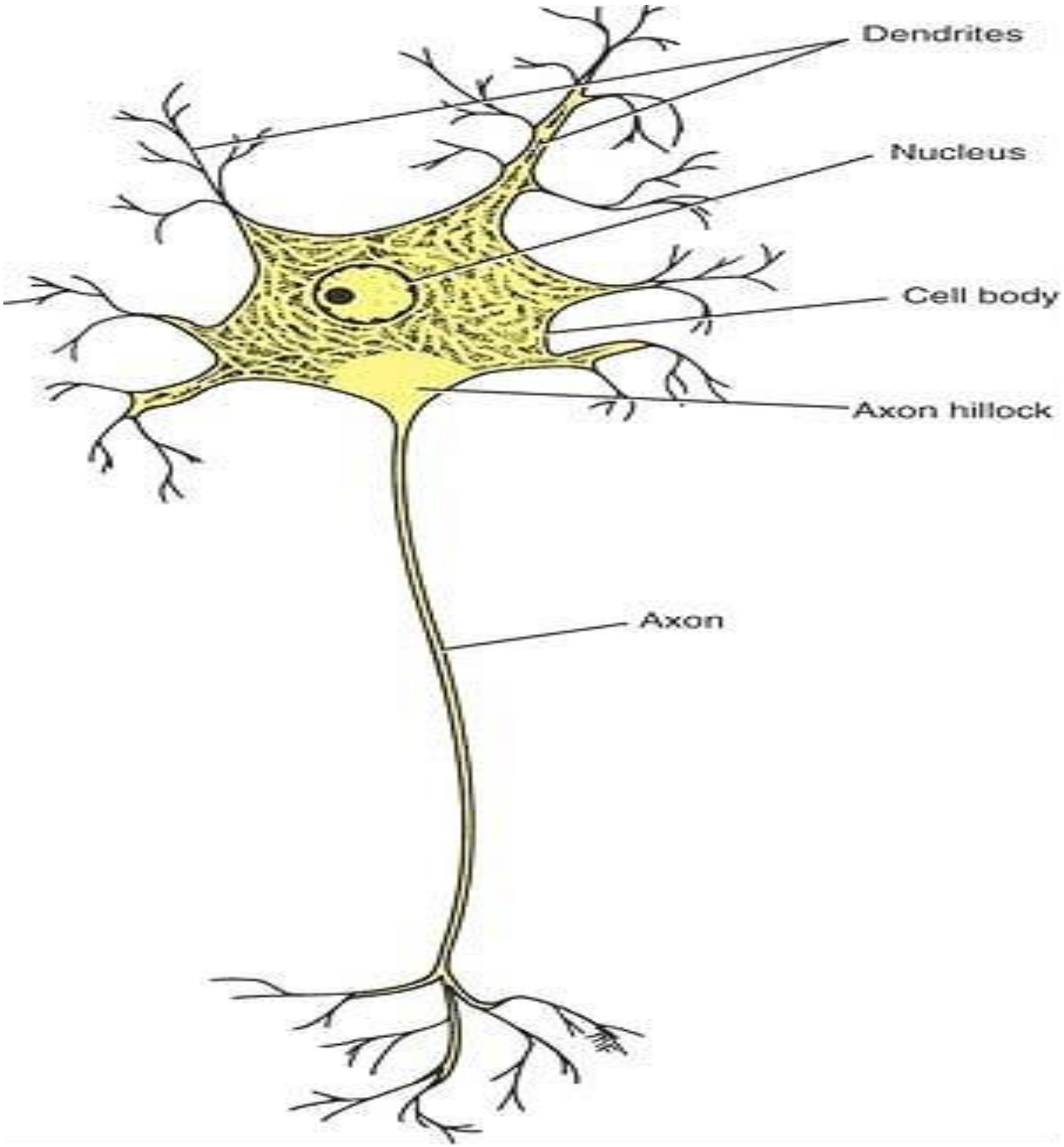
- A one-year old human has about 100 billion (10^{11}) neurons.
- No new neurons will be formed after that age.
- Neurons are lost at a rate of roughly 200,000 per day
- **A net loss of 2 to 5% by age 50.**
- Maximum brain weight is achieved at about **age 21**.
- A typical brain neuron will have connections with at least 1,000 other neurons.

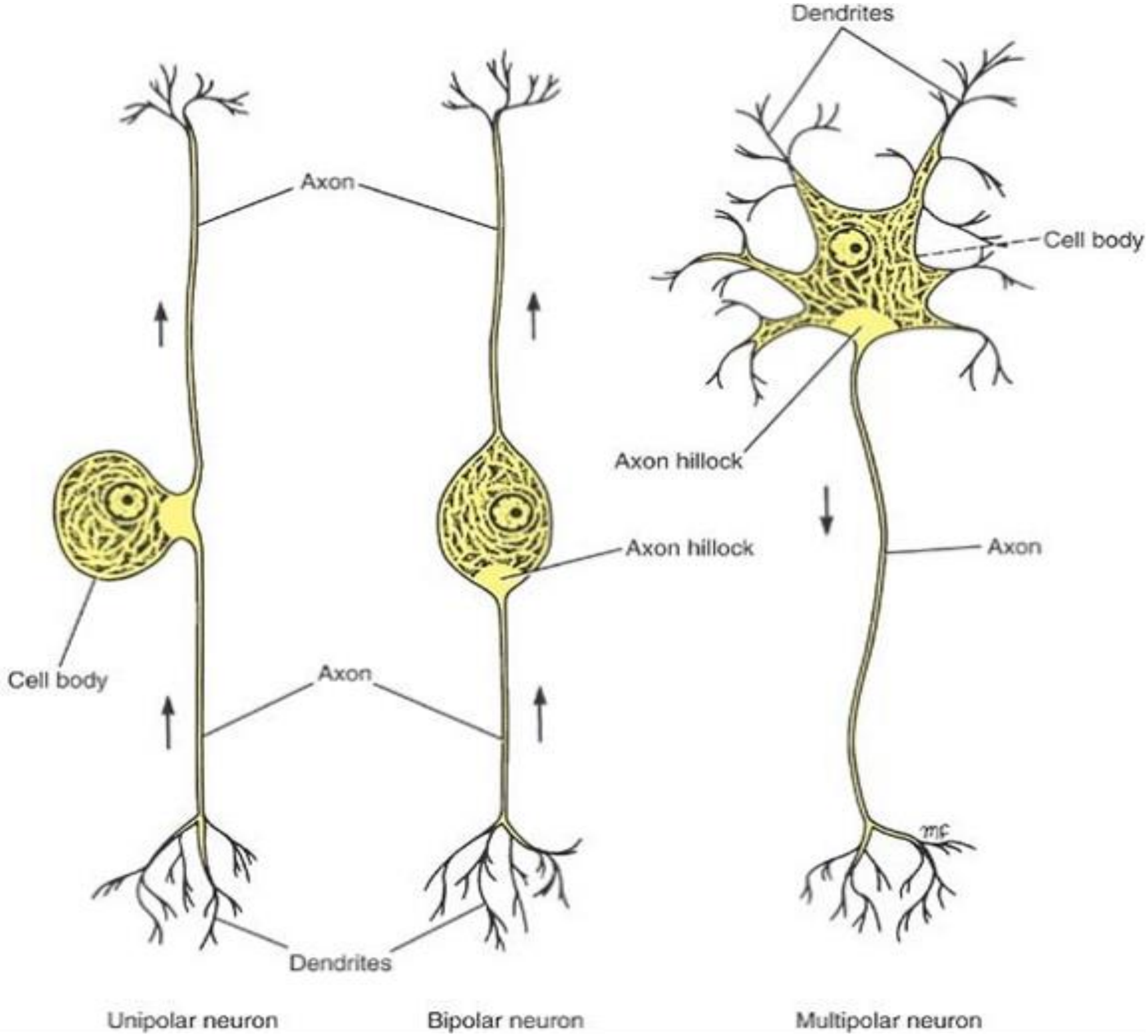
Proportion by Volume (%) in Human

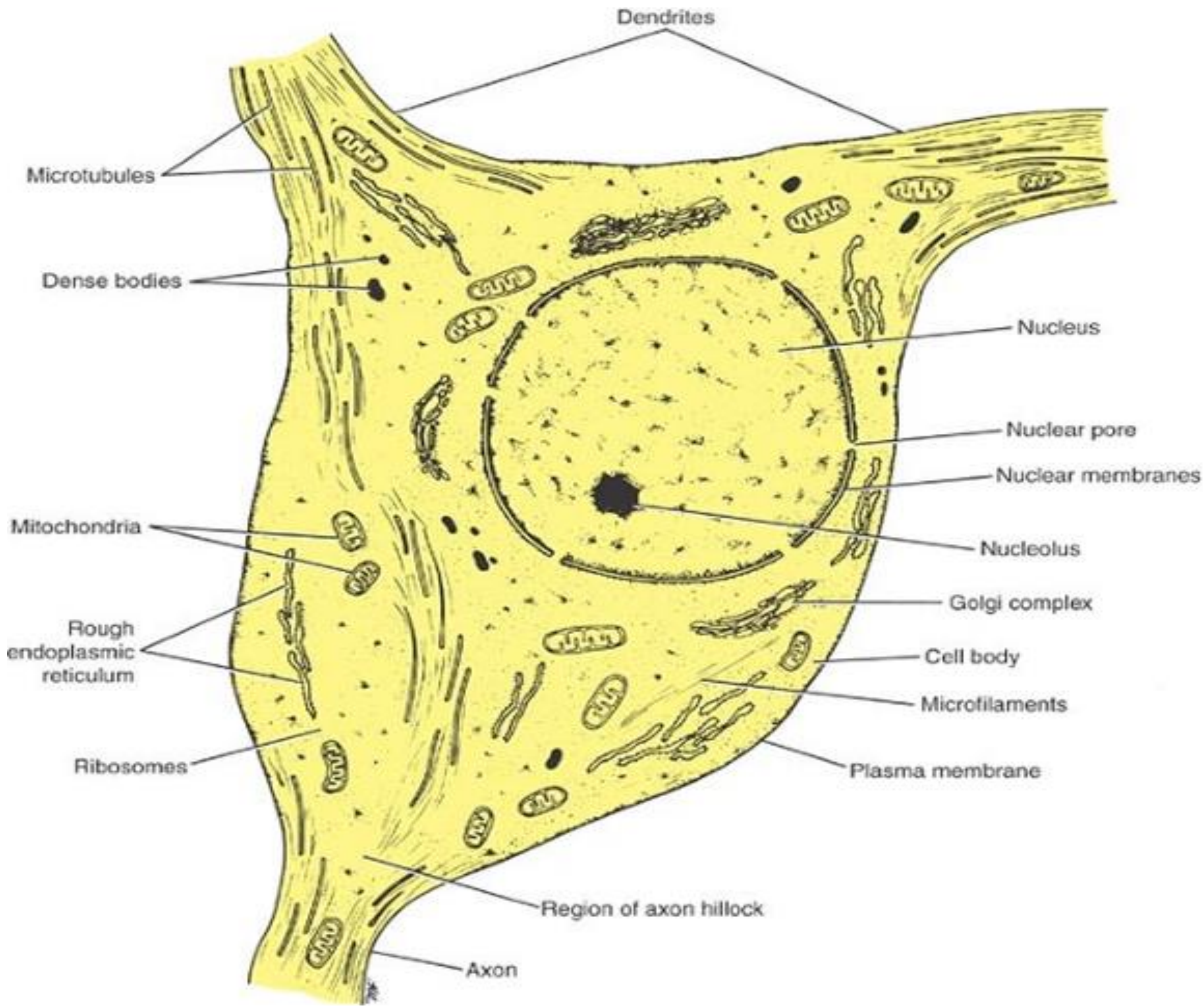
Cerebral Cortex	77
Diencephalon	04
Midbrain	04
Hindbrain	02
Cerebellum	10
Spinal Cord	02

Loss of neocortical neurons = 85,000 per day

Average number of neurons in the brain = 100 billion

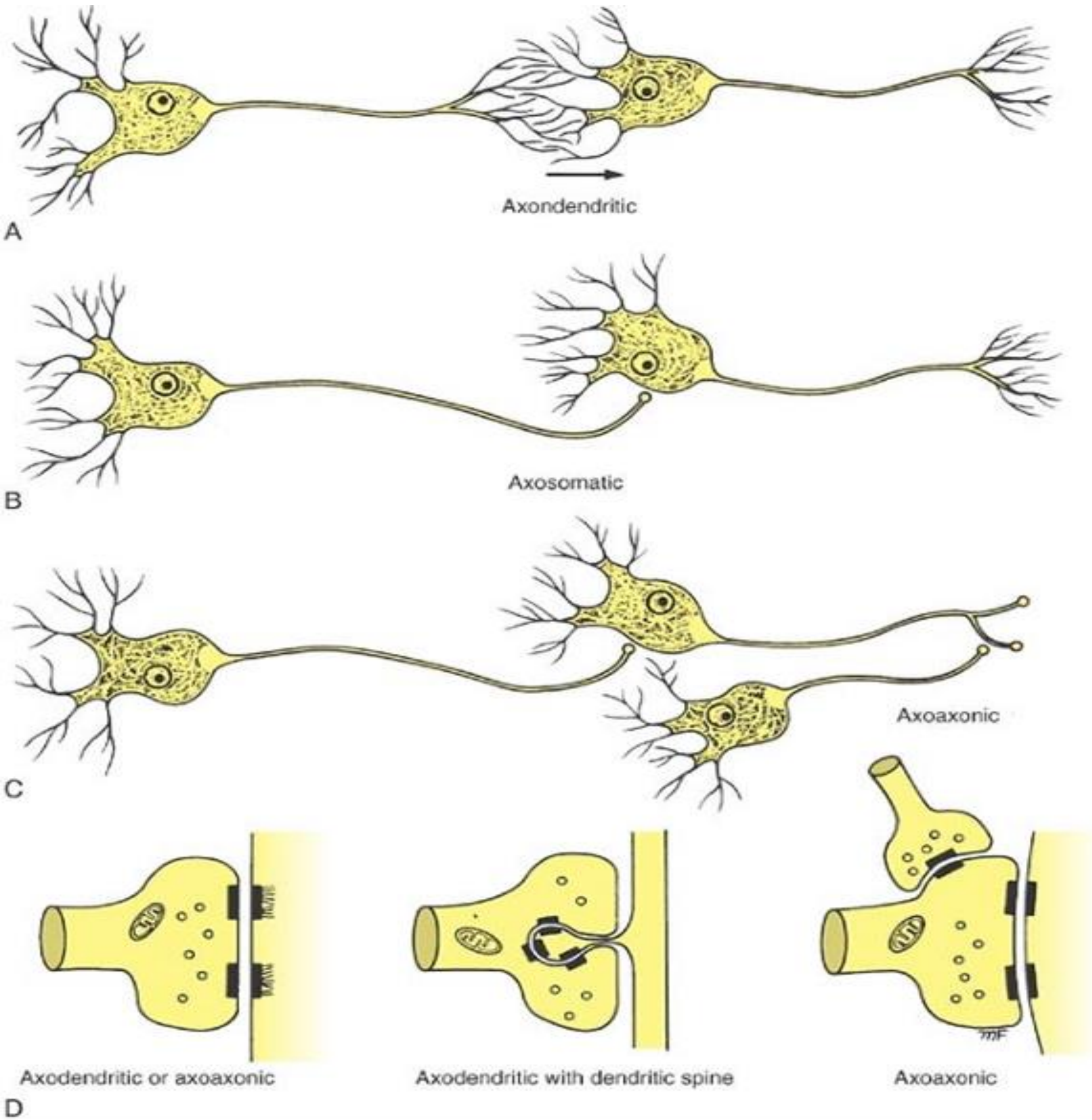



Dendrites
Axon
Cell body
Axon hillock
Axon hillock
Axon
Cell body
Axon
Dendrites
Unipolar neuron
Bipolar neuron
Multipolar neuron


Dendrites
Microtubules
Dense bodies
Nucleus
Nuclear pore
Nuclear membranes
Mitochondria
Nucleolus
Golgi complex
Rough
endoplasmic
reticulum
Cell body
Microfilaments
Ribosomes
Plasma membrane
Region of axon hillock
Axon

Synapses (Phy-Contact)

- Axodendritic
- Axosomatic
- Axo- axonal
- Somatodendritic
- Somatosomatic
- Dendro- dendretic


Axondendritic
A
Axosomatic
B
Axoaxonic
C
Axodendritic or axoaxonic
Axodendritic with dendritic spine
Axoaxonic
D

Neuroglia

Nonexcitable cells.

Smaller than neurons

Brain contain a trillion glial cells which is 90% of brain cells.

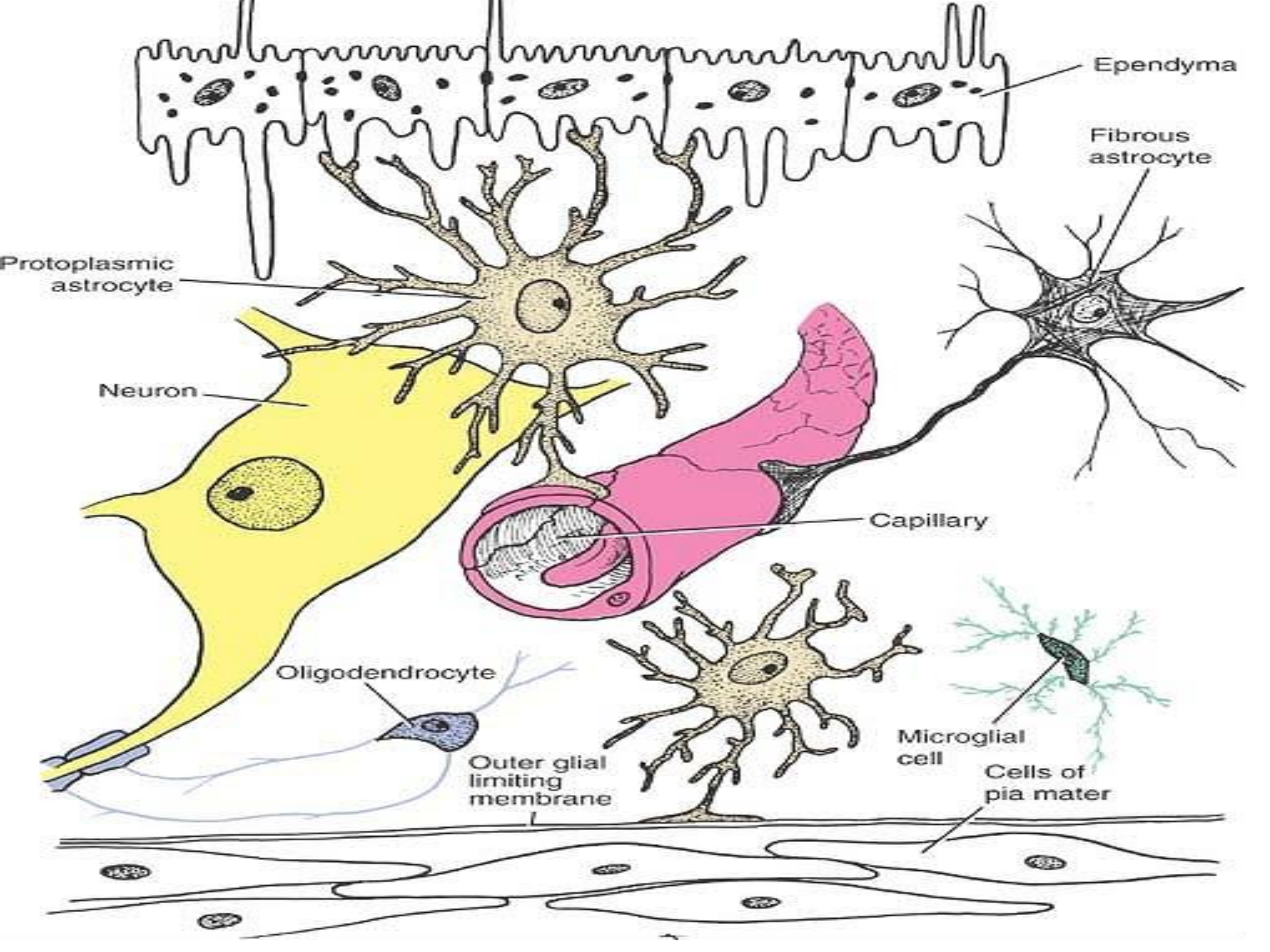
Types :

(1) Astrocytes,

(2) Oligodendrocyte,

(3) Microglia, and

(4) Ependymal Cells .



Ependyma
Fibrous astrocyte
Protoplasmic astrocyte
Neuron
Capillary
Oligodendrocyte
Microglial cell
Outer glial limiting membrane
Cells of pia mater

- **Astrocytes**
- Astrocytes have small cell bodies with branching processes that extend in all directions.
- Types of astrocytes: fibrous and protoplasmic.
- **Fibrous astrocytes present**
- In white matter
- Have long processes which is slender, smooth, and not much branched.
- The cytoplasm have more filaments

- **Protoplasmic astrocytes**
- In the gray matter .
- The processes are shorter, thicker, and more branched
- The cytoplasm have fewer filaments.
- Form perivascular feet on external surface of capillaries.
- Form the outer and inner glial limiting membranes

- Outer glial limiting membrane is found beneath the pia mater, and the inner glial limiting membrane is situated beneath the ependyma .
- Astrocytic processes separate axon terminals from other nerve cells .

Functions of Astrocytes

1. Supporting
2. Migration of immature neurons.
3. Act as phagocytes
4. Transfer of metabolites from blood to the neurons.
5. Store glycogen
6. Trophic substances.
7. Gliosis.
8. Secrete cytokines that regulate immunity .
9. Blood-brain barrier.
10. Have gap junctions. (Talk)
11. Electrical insulators and barriers for the spread of neurotransmitter substances limiting their influence.
12. It take up excess K^+ ions from the extracellular space.

- **Oligodendrocyte**

  Small cell bodies and a few delicate processes
- No filaments in their cytoplasm.
- Found in rows along myelinated nerve fibers and surround nerve cell bodies.

Functions of Oligodendrocyte

- Myelin sheath of nerve fibers in the central nervous system which start at 4 month of intrauterine life and complete by walking.
- Provides the axons with an insulating coat and greatly increases the speed of nerve conduction along these axons.
- A single Oligodendrocyte can form as many as 60 internodal segments.
- Also surround nerve cell bodies and influence the biochemical environment of neurons.

- **Microglia**
- **The microglial cells are derived from macrophages .**
- **They are the smallest of the neuroglial cells and are scattered in CNS.**
- **From their small cell bodies arise branching processes that give off numerous spinelike projections.**
- **Resemble connective tissue macrophages.**
- **Microglial cells increase in diseases**
- **Are monocytes that have migrated from the blood.**

Function of Microglial Cells

- Resting microglial cells.
- In inflammatory disease they become the immune effector cells.
- Retract their processes and migrate to the site of the lesion.
- Proliferate and become antigen presenting cells.
- Phagocytic
- Are joined by other monocytes .

Ependymal cells

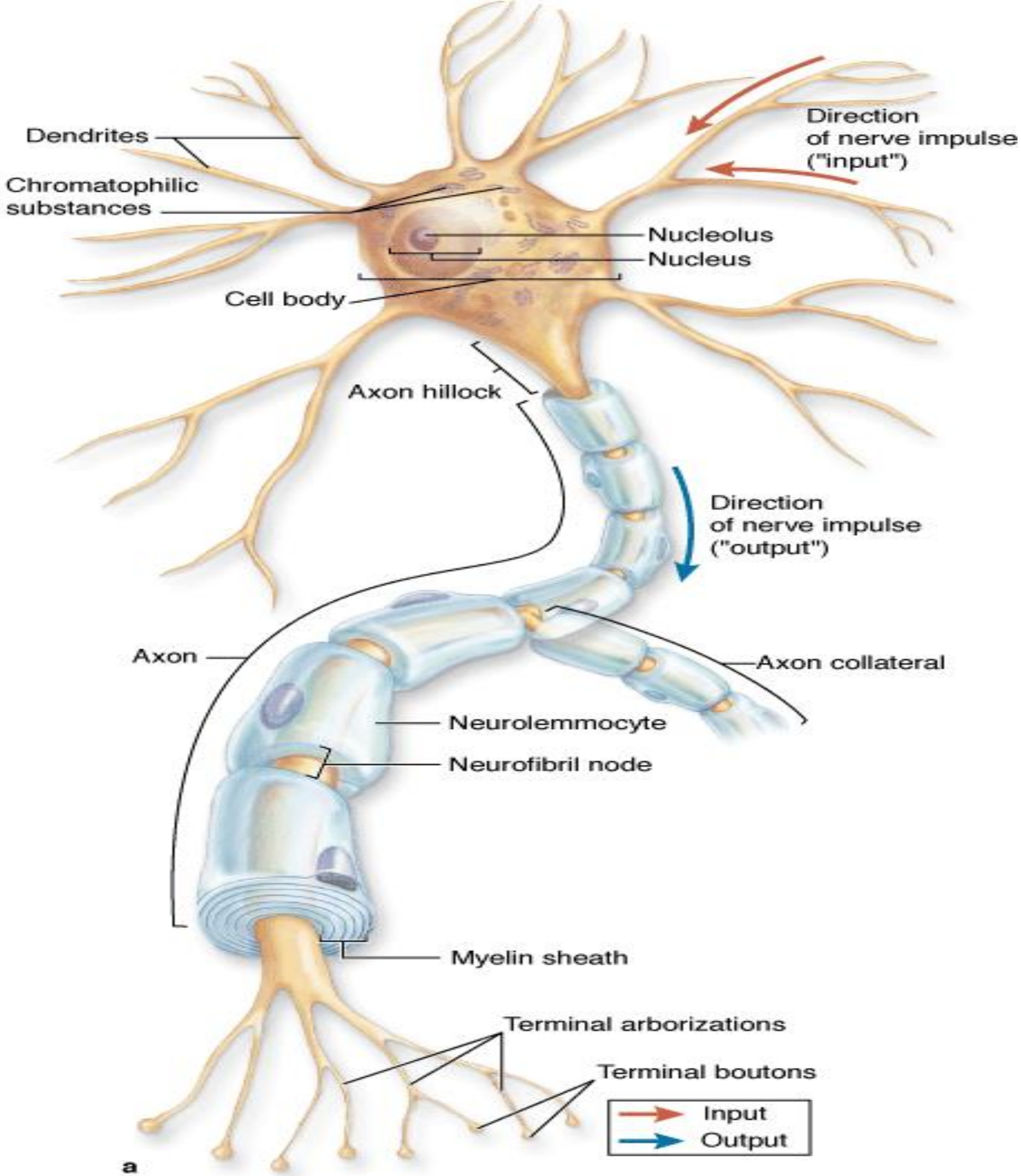
- Ependymal cells line the cavities of the brain and the central canal of the spinal cord.
- They form a single layer of cells that are cuboidal or columnar in shape and possess microvilli and cilia . The cilia are often motile, and their movements contribute to the flow of the cerebrospinal fluid. The bases of the ependymal cells lie on the internal glial limiting membrane.

- Ependymal cells may be divided into three groups:
- Ependymocytes, which line the ventricles of the brain and the central canal of the spinal cord and are in contact with the cerebrospinal fluid. Their adjacent surfaces have gap junctions, but the cerebrospinal fluid is in free communication with the intercellular spaces of the central nervous system.

- Tanycytes, which line the floor of the third ventricle .They place end feet on blood capillaries.
- Choroidal epithelial cells, which cover the surfaces of the choroid plexuses. The sides and bases of these cells are thrown into folds, and near their luminal surfaces, the cells are held together by tight junctions that encircle the cells. The presence of tight junctions prevents the leakage of cerebrospinal fluid into the underlying tissues

- **Functions of Ependymal Cells**

1. Ependymocytes assist in the circulation of the cerebrospinal fluid by the movements of the cilia.
2. Absorptive function.
3. Tanycytes are thought to transport chemical substances from the cerebrospinal fluid to the hypophyseal portal system
4. In this way control the hormone production by the anterior lobe of the pituitary.
5. Choroidal epithelial cells produce CSF

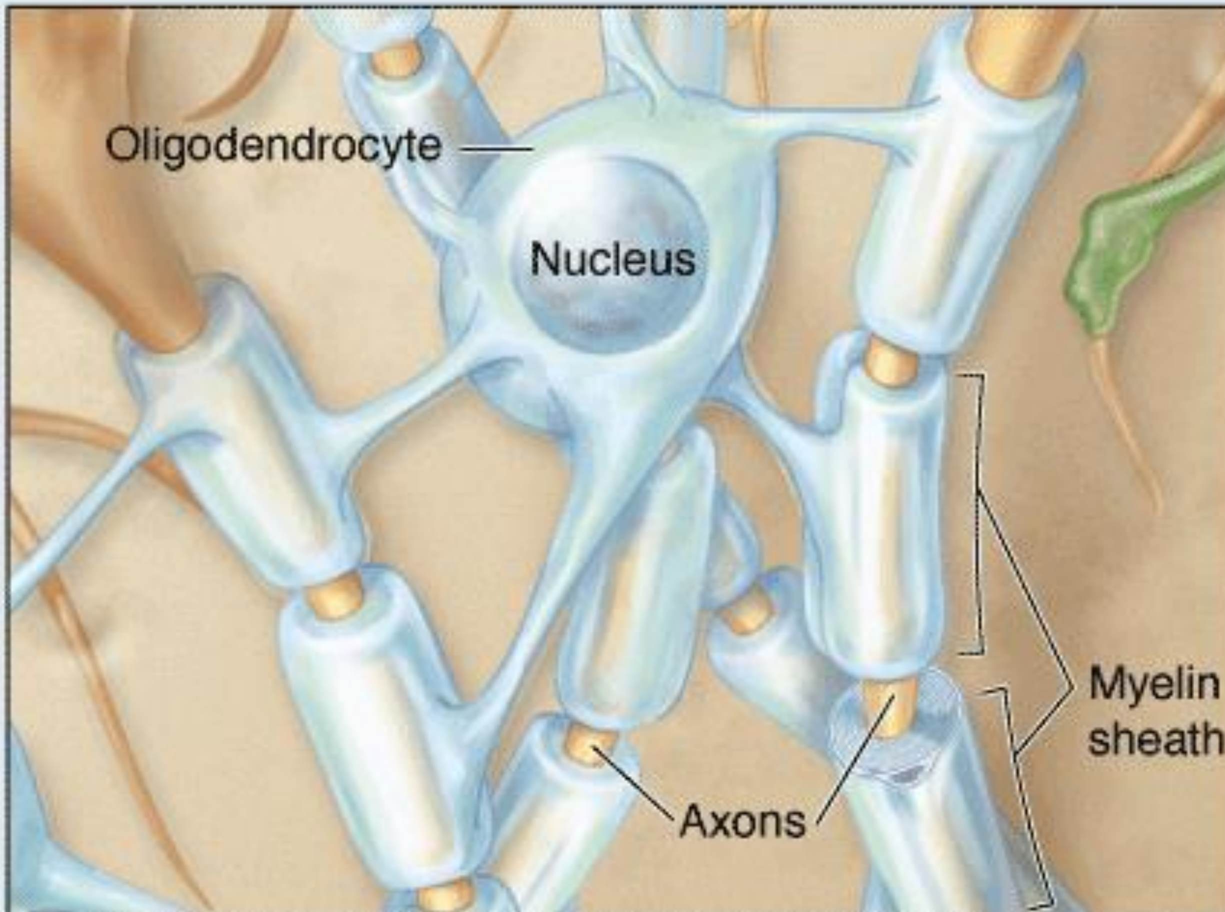


Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition*: http://www.accessmedicine.com

Table 9–2. Origin and principal functions of neuroglial cells.

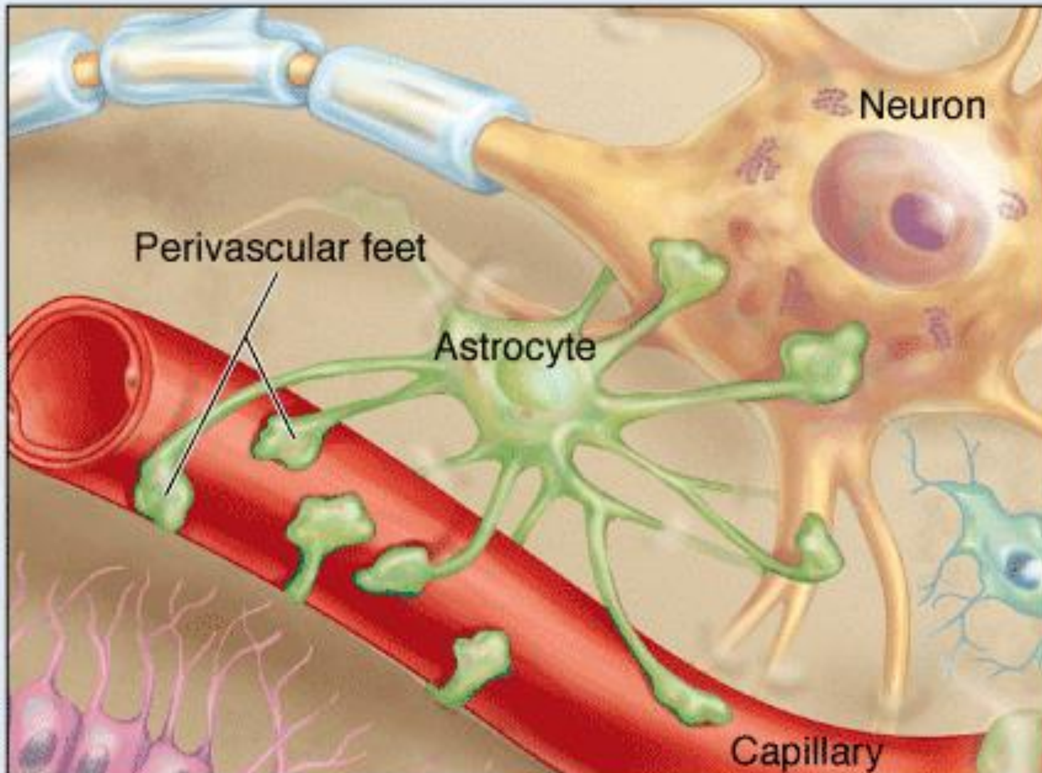
Glial Cell Type	Origin	Location	Main Functions
Oligodendrocyte	Neural tube	Central nervous system	Myelin production, electric insulation
Neurolemmocyte	Neural crest	Peripheral nerves	Myelin production, electric insulation
Astrocyte	Neural tube	Central nervous system	Structural support, repair processes
			Blood-brain barrier, metabolic exchange
Ependymal cell	Neural tube	Central nervous system	Lining cavities of central nervous system
Microglia	Bone marrow	Central nervous system	Immune-related activity

CNS Glial Cells



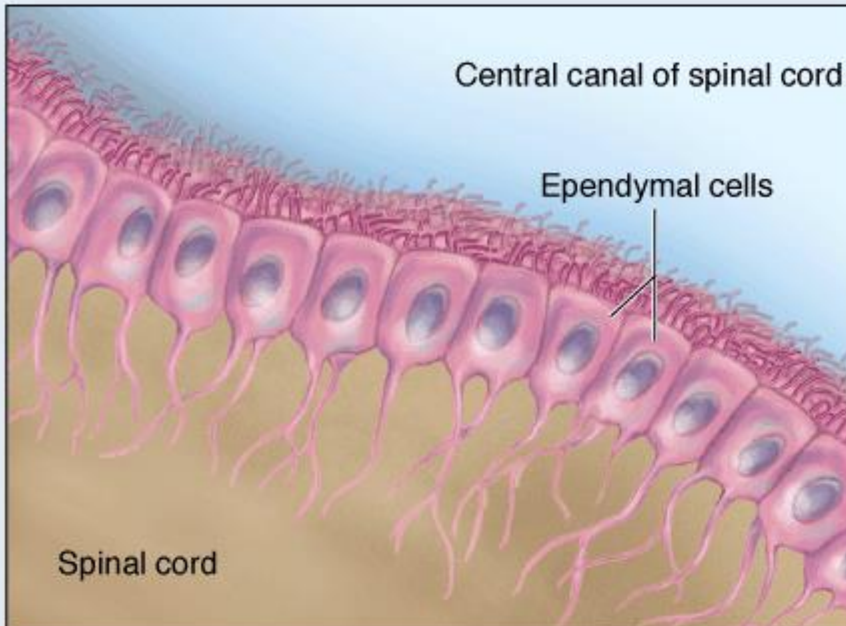
a Oligodendrocyte

Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition:* http://www.accessmedicine.com



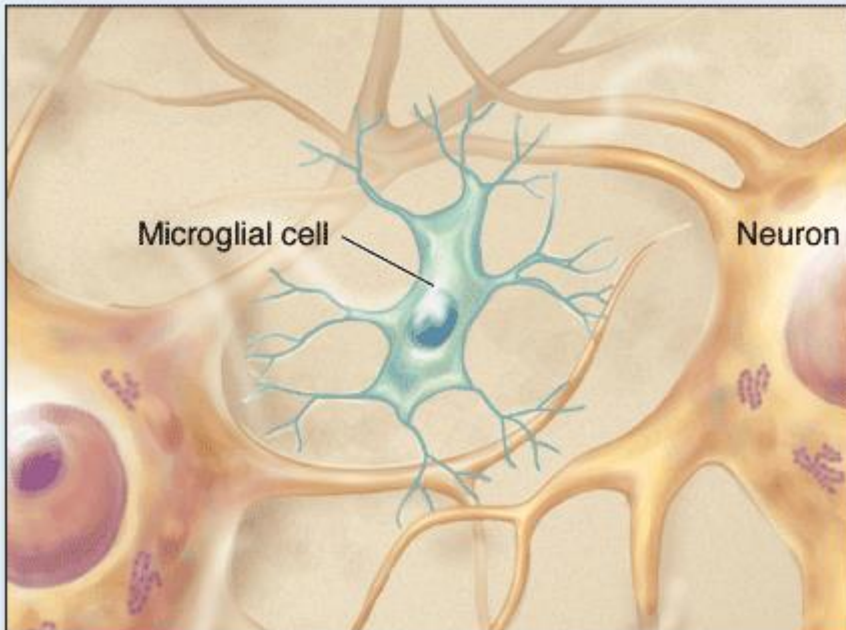
b Astrocyte

Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition:* http://www.accessmedicine.com



c Ependymal cells

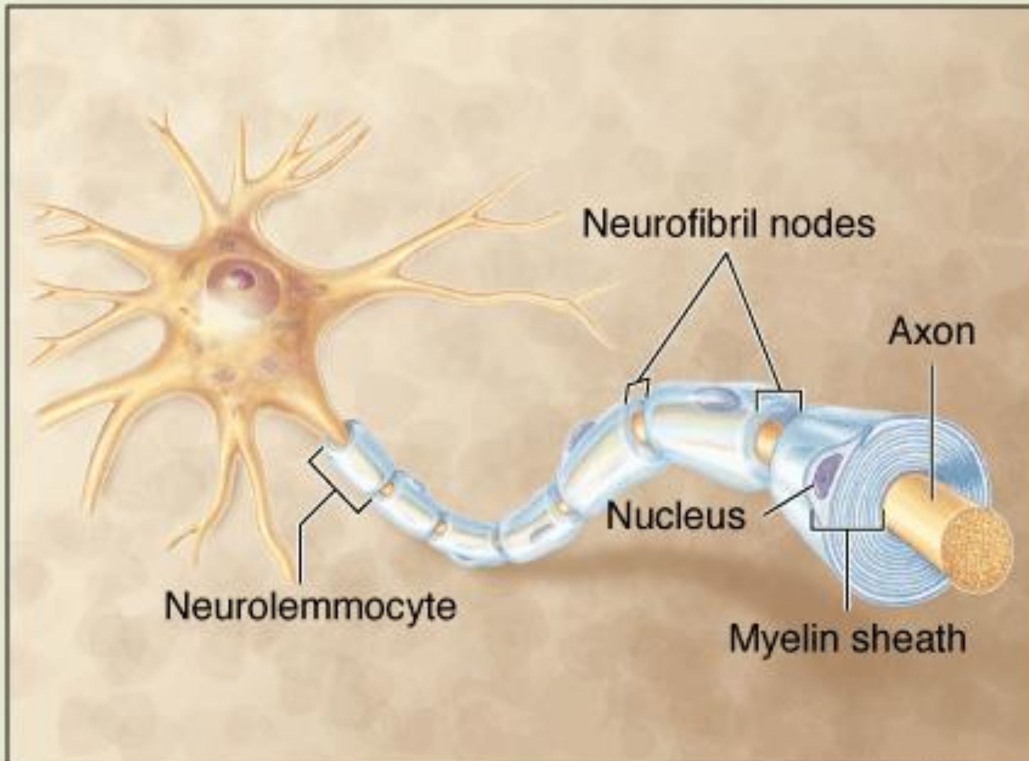
Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition:* http://www.accessmedicine.com



d Microglial cell

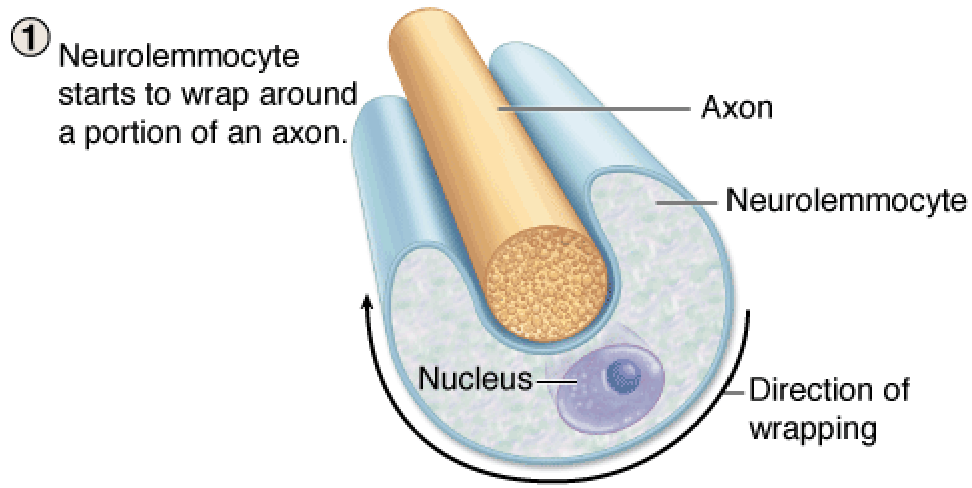
Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition*: http://www.accessmedicine.com

PNS Glial Cells

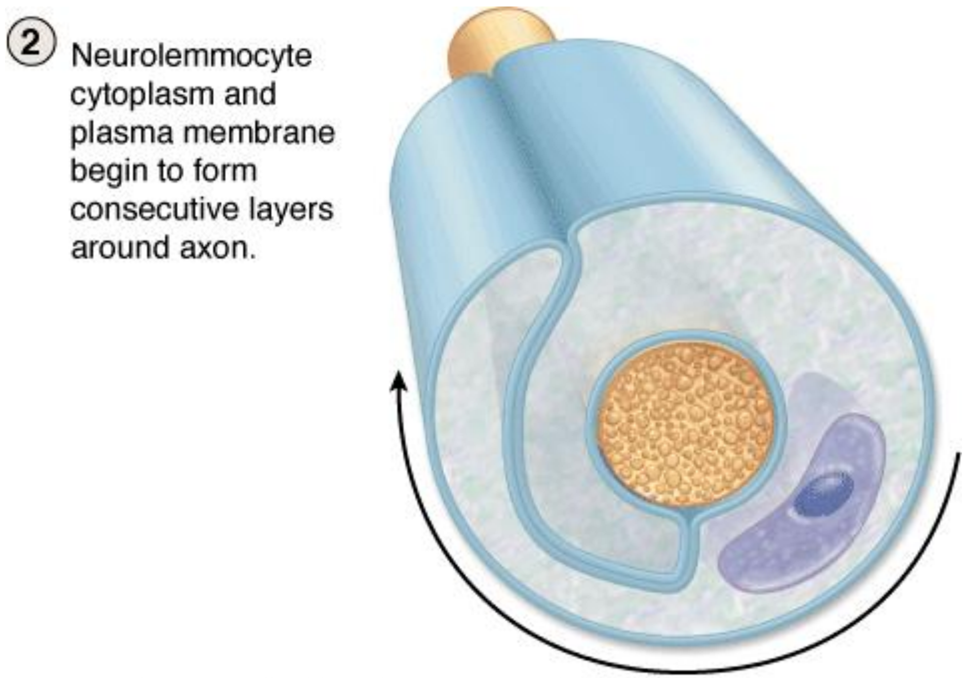


e Neurolemmocytes

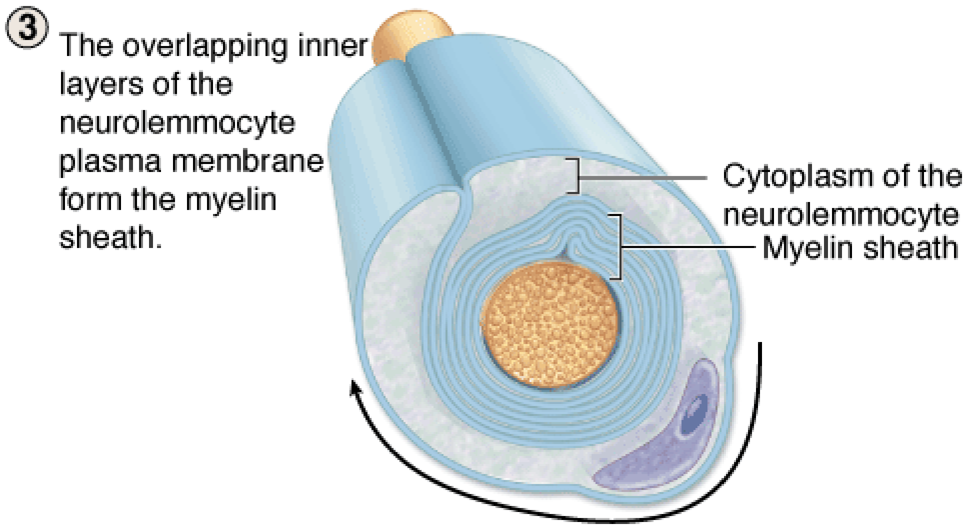
Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition:* http://www.accessmedicine.com



Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition:* http://www.accessmedicine.com

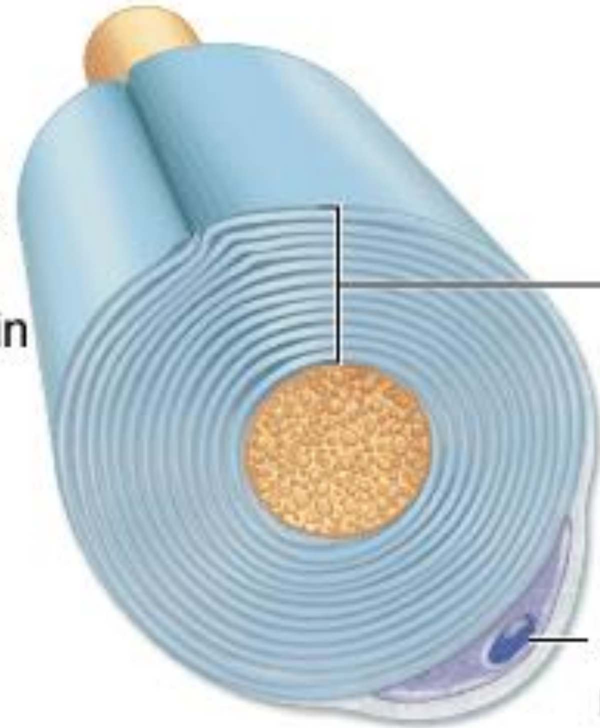


Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition:* http://www.accessmedicine.com



Source: Mescher AL: *Junqueira´s Basic Histology: Text and Atlas, 12th Edition:* http://www.accessmedicine.com

4 Eventually, the neurolemmocyte cytoplasm and nucleus are pushed to the periphery of the cell as the myelin sheath is formed.

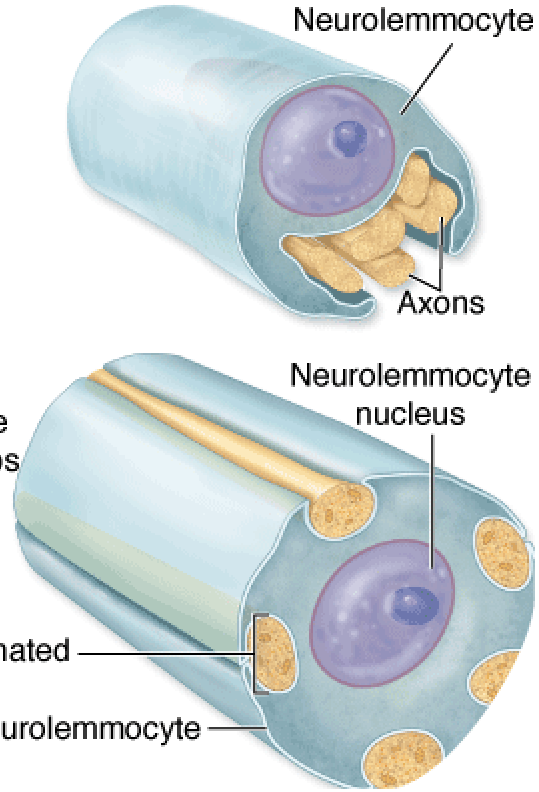


Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas, 12th Edition*: http://www.accessmedicine.com

Unmyelinated axons

① Neurolemmocyte starts to envelop multiple axons.

② The unmyelinated axons are enveloped by the neurolemmocyte, but there are *no* myelin sheath wraps around each axon.



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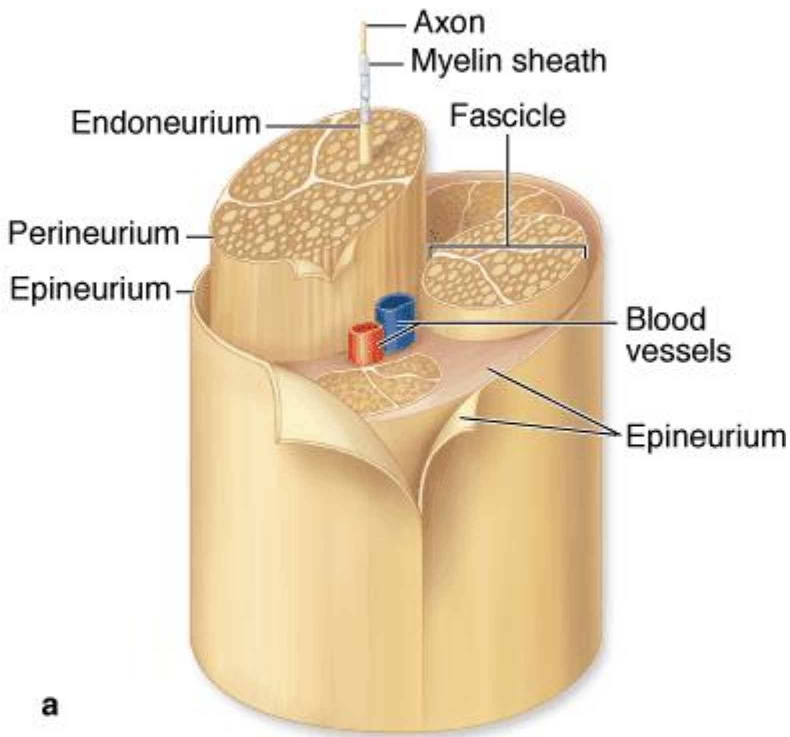

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THANKS