

Immune Organs



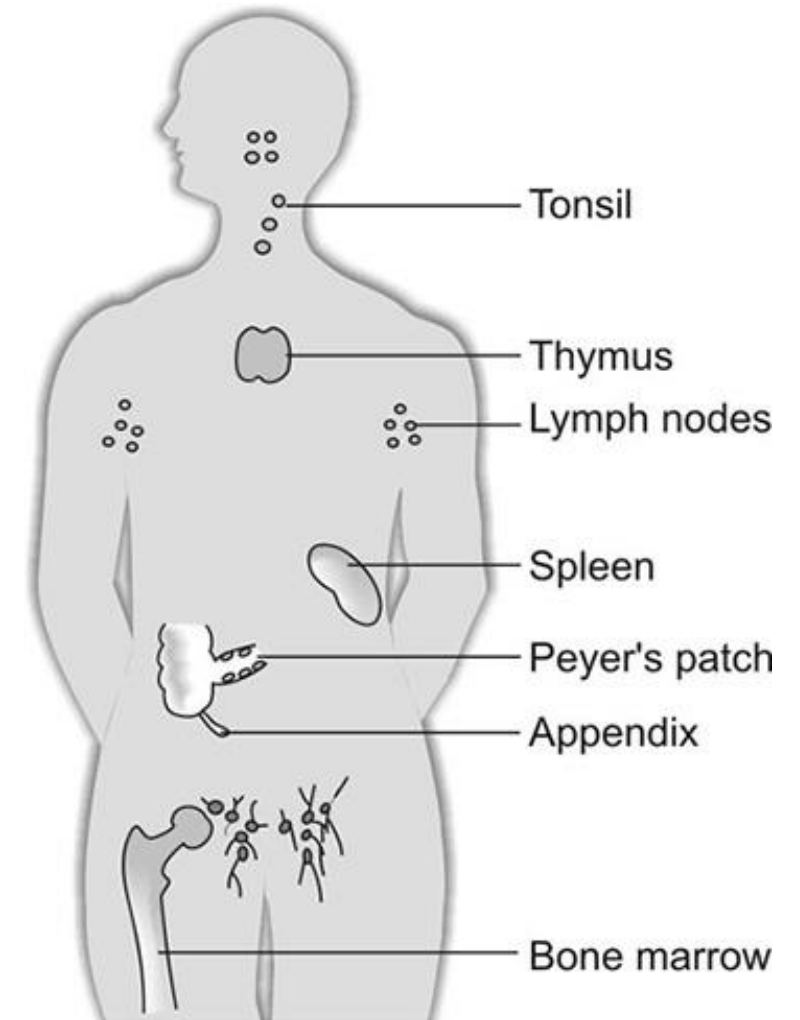
Organs of the Immune System

❖ Primary lymphoid organs

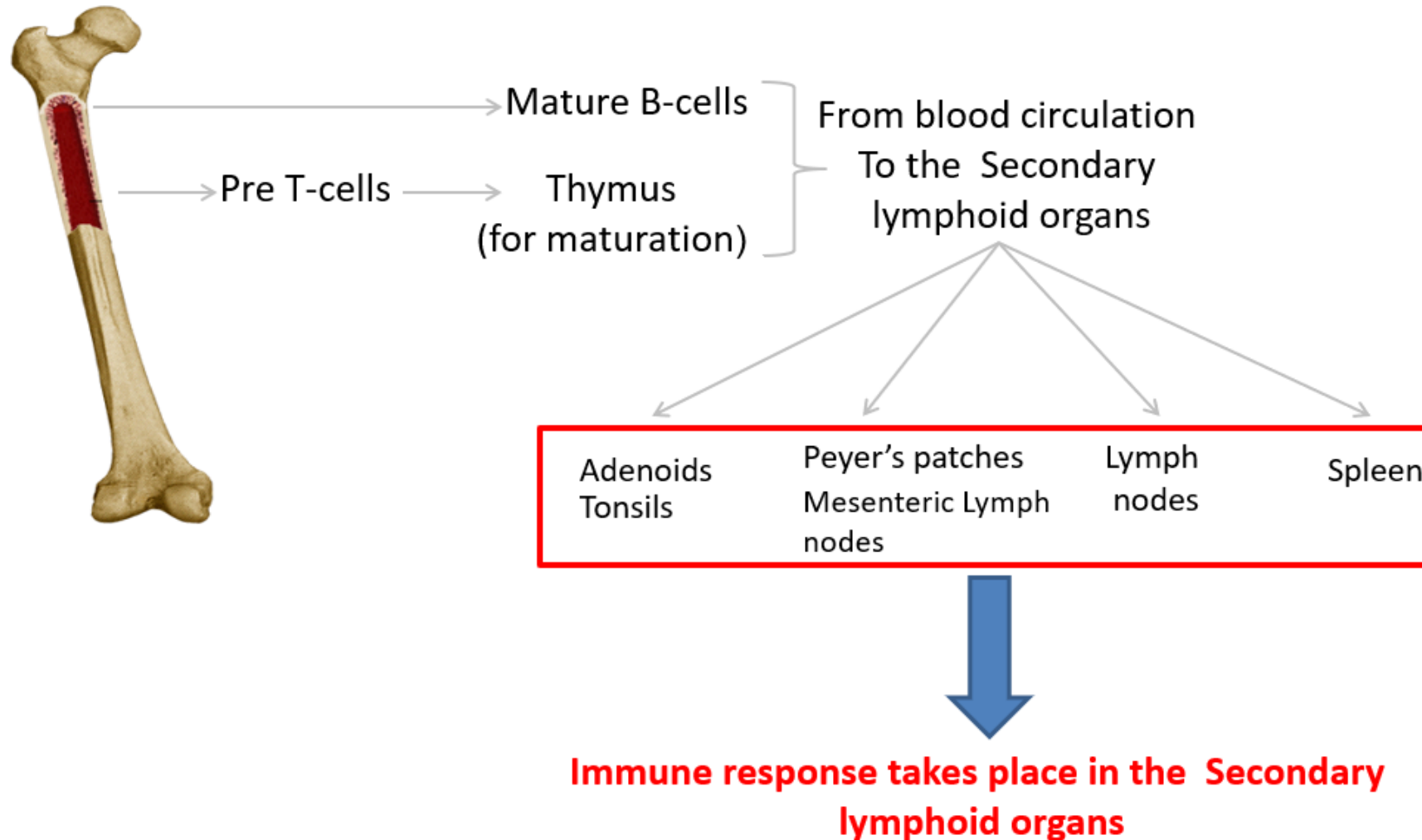
- Bone marrow (where the immune cells originate).
- Thymus (site of T cells differentiation to mature cells).

❖ Secondary lymphoid organs

- Maintain mature naive lymphocytes and initiate an adaptive immune response.
- The sites of lymphocyte activation by antigen, and where B and T cells proliferate.
- **Lymph nodes.**
- **Spleen**
- **Peyer's patches.**
- lymphoid follicles in **tonsils.**
- Adenoids.
- Mucosa-associated lymphoid tissue (MALT).



Organs of the Immune System



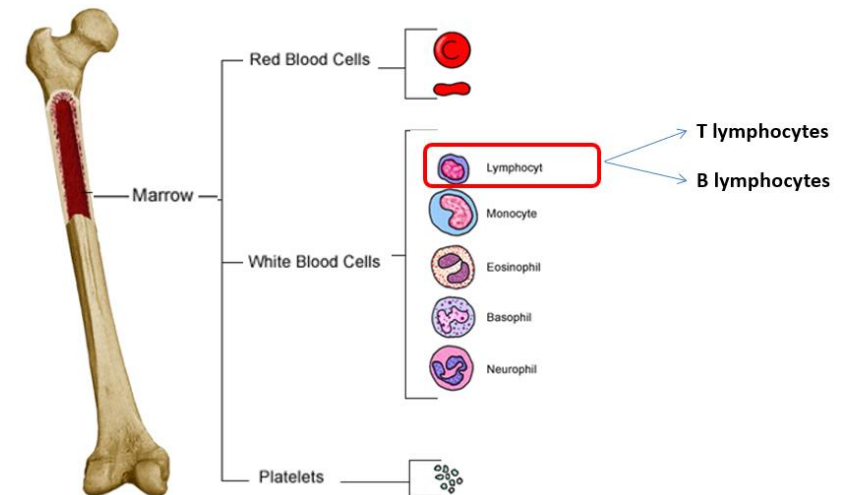
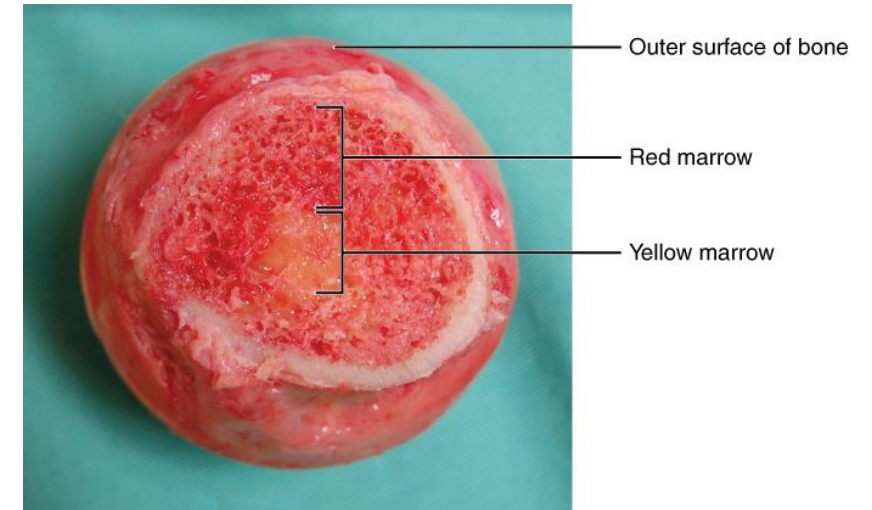
Primary Immune Organs (Bone Marrow)

❖ Functions

- Leukocytes production.
- B cells maturation.
- ❖ Hematopoiesis starts in the fetus in the yolk sac and mesenchyme, then liver and spleen and finally the bone marrow continuing so throughout (and get maximum in) adulthood.
 - most common sites of BM is sternum, vertebrae, iliac bones and ribs.
 - In cases of excess demand, liver and spleen help the BM (**extramedullary hematopoiesis**).

❖ Components

- Red marrow
- Yellow marrow
- Stroma



Primary Immune Organs (Bone Marrow) Cont.

❖ Red marrow:

- Consists mainly of hematopoietic tissue, RBCs, platelets, and most WBCs arise in red marrow .
- Found mainly in the flat bones, such as the pelvis, sternum, cranium, ribs, vertebrae and scapulae, and at the epiphyseal ends of long bones such as the femur and humerus.

❖ Yellow marrow:

- Mainly made up of fat cells.
- At birth, all bone marrow is red. With age, more and more of it is converted to the yellow type; only around **half of adult bone marrow is red.**
- In cases of severe blood loss, the body can convert yellow marrow back to red marrow to increase blood cell production.
- Yellow marrow is found in the hollow interior of the middle portion of long bones.

❖ Stroma:

- Any tissue not associated with blood production as fatty marrow, fibroblast, osteoclast and osteoblast.



Primary Immune Organs (Thymus)

- ❖ **Embryology:** The gland is derived from invaginations of the ectoderm in the developing neck and chest of the embryo, forming structures called branchial clefts.
- ❖ Thymus reaches its greatest size just prior to birth, then atrophies with age and the production of new T-cells in the adult thymus drops away
- ❖ **Anatomy:**
 - The gland is composed of two identical lobes and is
 - located anatomically in the thorax, in the anterior superior mediastinum, in front of the heart and behind the sternum
 - Has a rich vascular supply and efferent lymphatic vessels that drain into mediastinal lymph nodes.

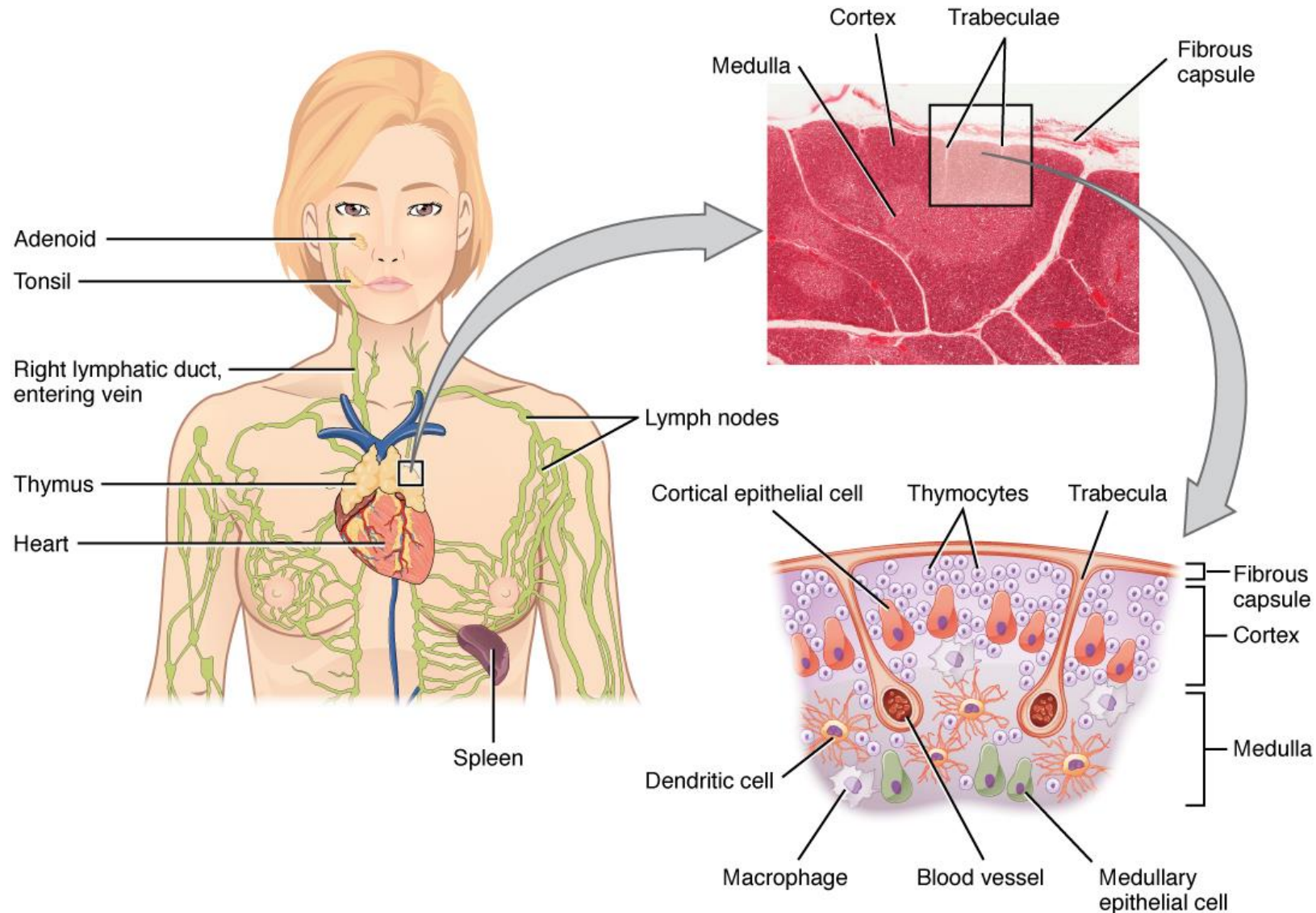


Primary Immune Organs (Thymus) Cont.

- ❖ **Histology:** The gland is surrounded by a fibrous capsule, and arranged into an outer, more cellular, cortex and an inner (**less cellular**) medulla. Cells involved:
 - The most immature T cells in the cortex. As thymocytes or T cells mature, they migrate toward the medulla, then to circulation.
 - Epithelial cells.
 - Macrophages and lymphoid dendritic cells.
- ❖ It gradually enlarges during childhood but after puberty it undergoes a process of involution resulting in a reduction in the functioning mass of the gland. It however, continues to function throughout life.
- ❖ **Function:** T cell maturation and formation of T cell antigen receptors.



Primary Immune Organs (Thymus) Cont.

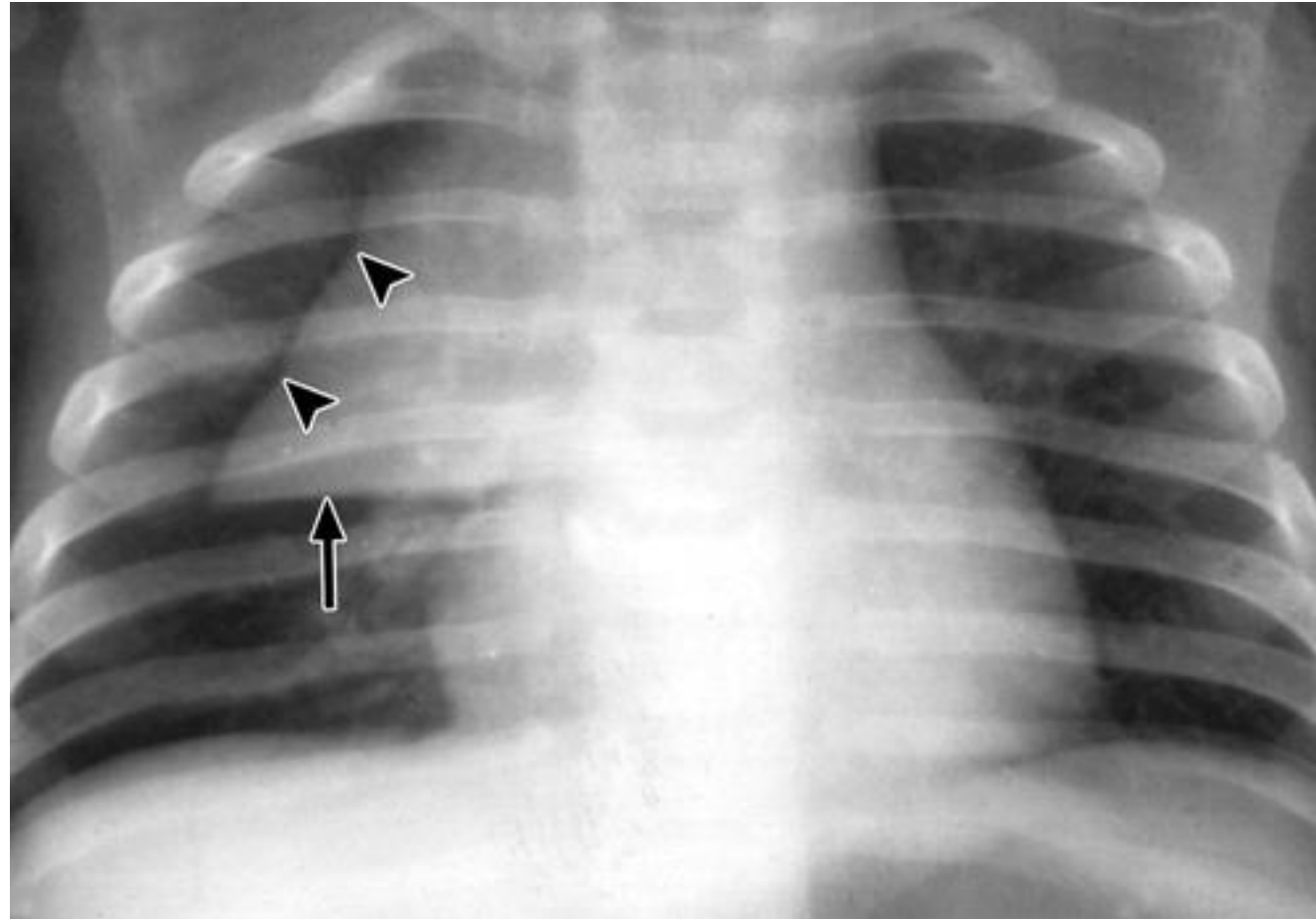


Digeorge Syndrome

- ❖ Genetic defect in development of 3rd pharyngeal pouch in embryo
- ❖ T cell deficiency as a result of impaired thymus development, plus parathyroid gland defect.
- ❖ Congenital immunodeficiency syndrome characterized by: (**CATCH-22**)
 - Cardiac defects
 - Abnormal facies
 - Thymic hypoplasia (in CXR may present with absence sail sign)
 - Cleft palate
 - Hypocalcaemia
 - Sub-microscopic deletion on chromosome arm **22q11**



Thymic Sail Sign



Lymph Nodes and Lymphatic System

- ❖ Peripheral or 2nd lymphatic system.
- ❖ Function to concentrate antigens that are introduced through the common portals of entry (**skin and gastrointestinal and respiratory tracts**), where the innate cells carry the antigen and present it to the adaptive immune system, to activate lymphocytes.
- ❖ Secondary lymphoid tissues consist of the
 - **Lymph nodes:** which are clustered at sites such as the groin, armpits and neck and along the small intestine, and collect antigen from the tissues.
 - **Spleen:** which collects antigen from the bloodstream.
 - **Mucosa-associated lymphoid tissues (MALT):** which collect antigen from the respiratory, gastrointestinal and urogenital tracts and are particularly well organized in the small intestine, in structures known as Peyer's patches.



Lymph Nodes and Lymphatic System Cont.

❖ The LN is made up of three components:

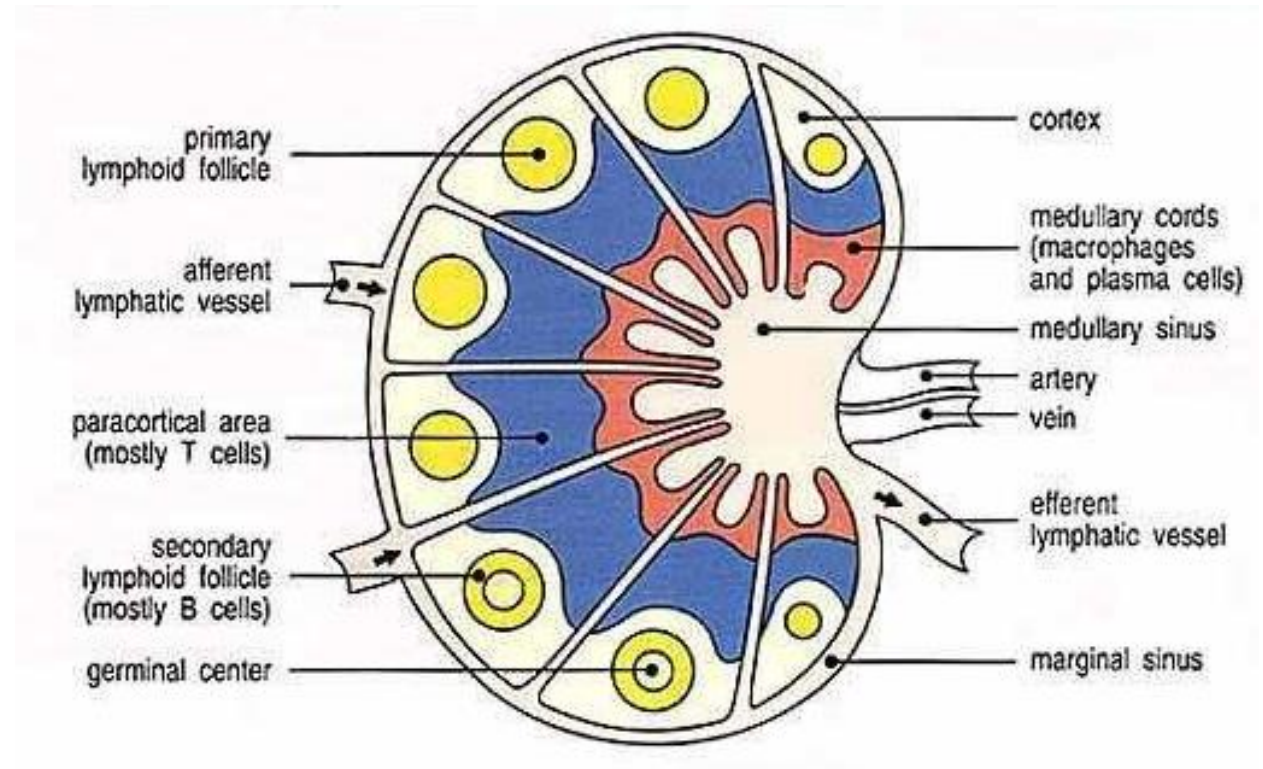
- **Lymphatic sinuses**

- the lymph flows from: afferent vessels cortical sinuses → medullary sinuses → efferent lymphatic vessels

- **Blood vessels**

- **Parenchyma**

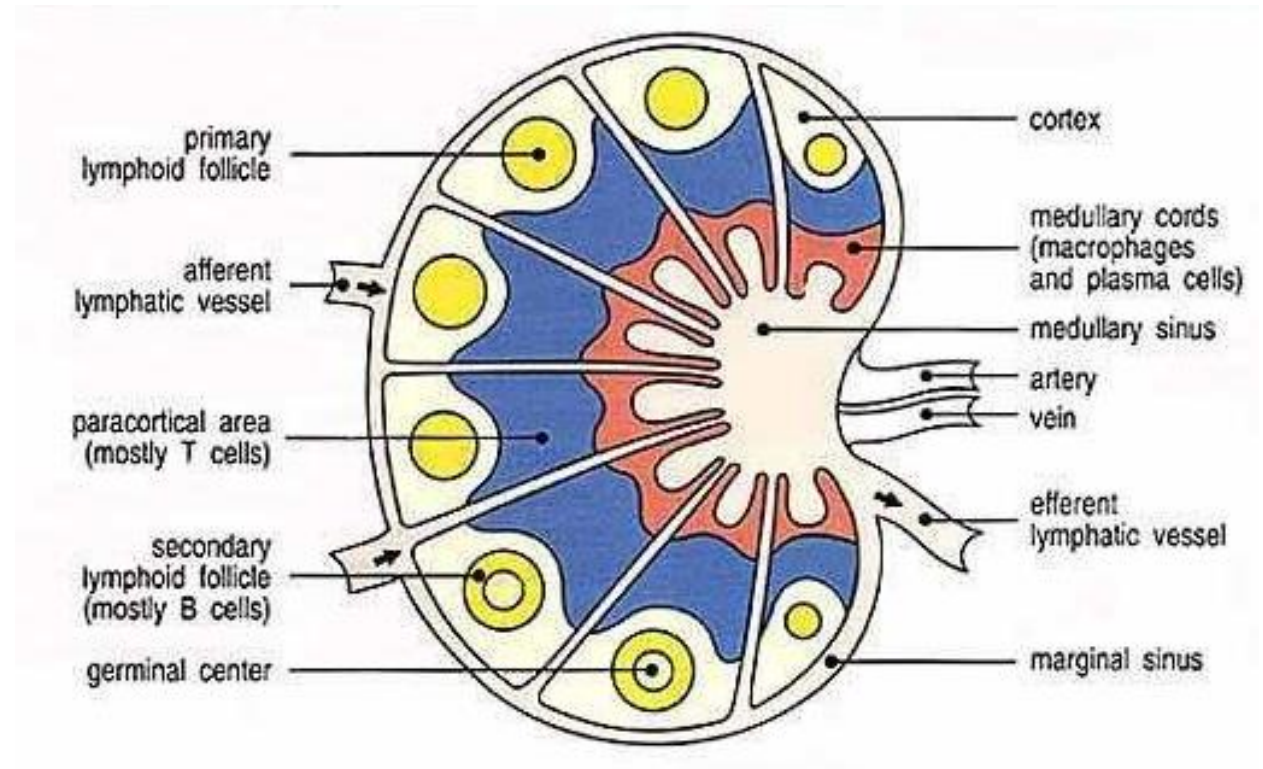
- Cortex
- Paracortex
- Medulla



Lymph Nodes and Lymphatic System Cont.

❖ Cortex

- Consists of **primary follicles** and **secondary follicles** (with **germinal center**).
- Germinal center formed from stimulated B cells and follicular dendritic cells. Whereas primary follicles have only mature but not activated B cells
- Stimulated mature B cells change into plasma cells or memory B cells which reside in medulla and antibodies that move to the circulation.



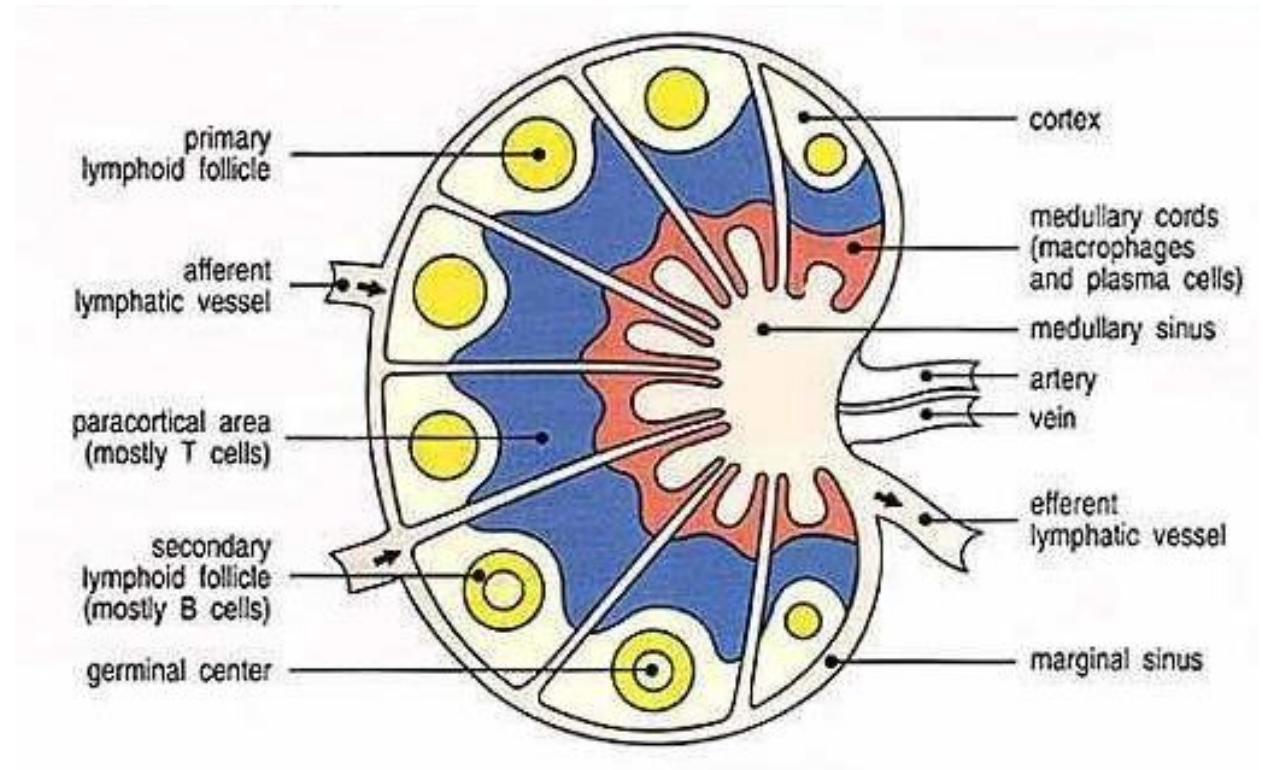
Lymph Nodes and Lymphatic System Cont.

❖ Paracortex

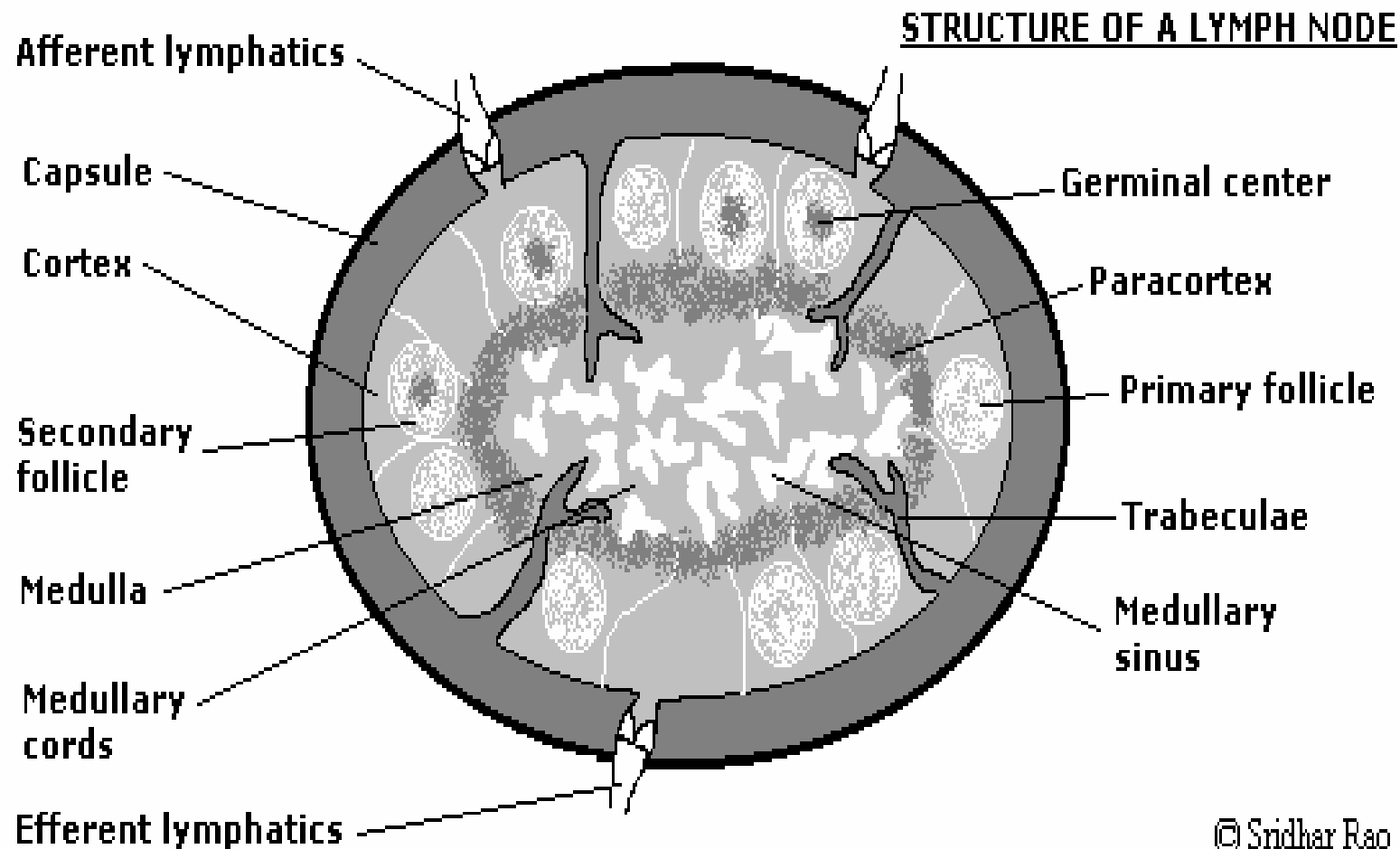
- Contains T lymphocytes and macrophages.
- The various types of T cell enter the node from the blood via the HEVs. When activated they form lymphoblasts which divide to produce a clone of T cells responding to a specific antigen. Activated T cells then pass into the circulation to reach peripheral sites.

❖ Medulla

- large blood vessels
- medullary cords and sinuses
- plasma cells



Lymph Nodes and Lymphatic System Cont.



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Spleen

- ❖ Weighs 150g, lies in the left upper quadrant of the abdomen.
- ❖ Filters blood rather than lymph.
- ❖ All blood elements can enter, where immune response against blood borne antigens happen.
 - No high endothelial venules
 - No selective entry T and B cells
- ❖ **White pulp (inner)**
 - Peri-arteriolar lymphoid sheath PALS (T cell zone).
 - Follicles (B cells zone).
 - Marginal zone (in between red and white pulp), have both B and T cells, macrophages that remove debris, and dendritic cells that process antigen.



Spleen Cont.

❖ Red pulp (outer)

- Lined by vascular "sinusoids"
- Open endothelium where all cells can pass in/out
 - Capillaries → cords (contain macrophages) → sinusoids
- Filters blood in sinusoids and removes aged RBCs by macrophages (hence the name, red pulp).
- Stores many platelets

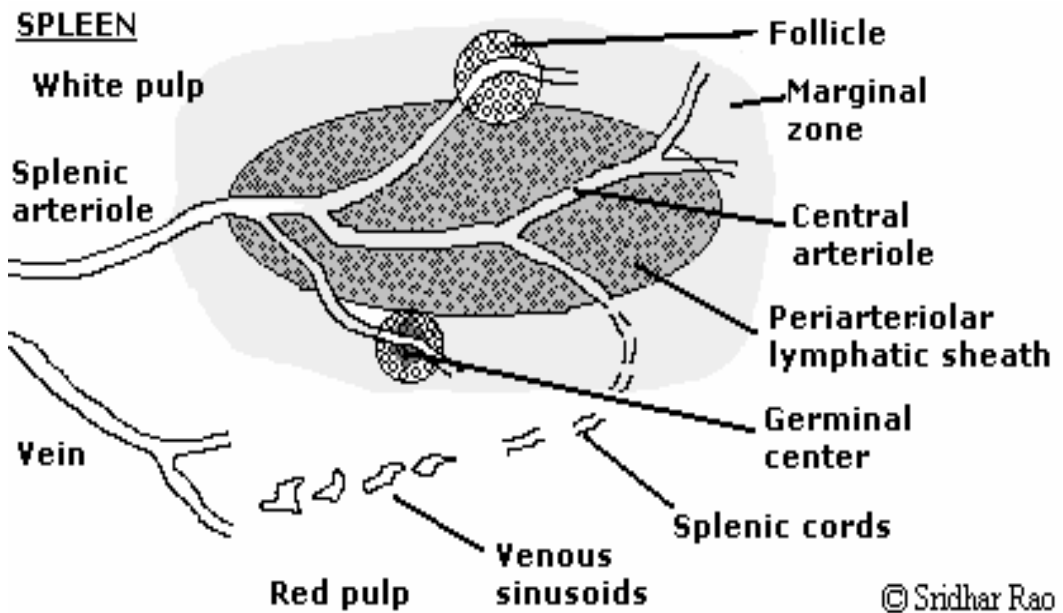
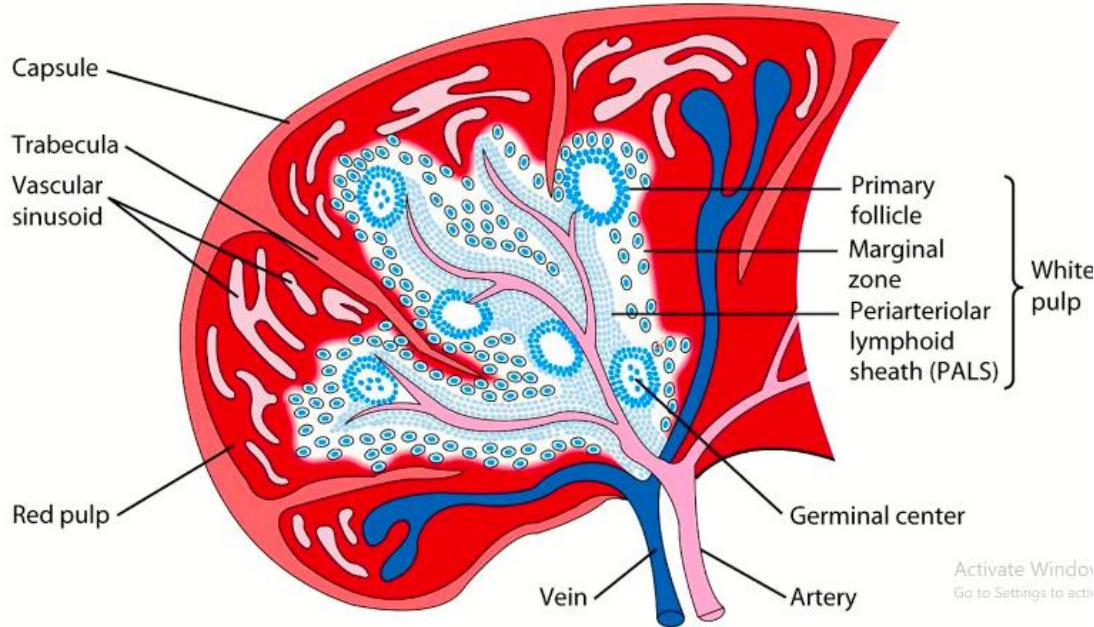
❖ Splenic artery, vascular sinusoids, splenic vein.

- The splenic artery enters the red pulp through a web of small blood vessels, and blood-borne microorganisms are trapped in this loose collection of cells until they are gradually washed out through the splenic vein.

❖ No afferent lymphatic vessel in spleen.



Spleen Cont.



Activate Windows
Go to Settings to activate Windows.

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Spleen Cont.

❖ Functions

- It is the major site for killing antibody coated microbes and destroying the damaged RBC.
- Storage of RBCs, lymphocytes and platelets.

❖ Splenic Dysfunction

- Individuals lacking a spleen are extremely susceptible to infections with encapsulated bacteria such as pneumococci and meningococci because such organisms are normally cleared by opsonization and phagocytosis, and this function is defective in the absence of the spleen.
- Causes:
 - Splenectomy (trauma, ITP, hereditary spherocytosis).
 - Functional asplenia (sickle cell anemia).



Mucosa associated lymphoid tissue (MALT)

- ❖ Approximately >50% of lymphoid tissue in the body is found associated with the mucosal system
- ❖ **Location:** found associated with the mucosal system
 - Gut-associated lymphoid tissues (GALT)
 - Bronchus-associated lymphoid tissue (BALT)
 - Lymphoid tissue lining the genitourinary tract
- ❖ **Function:** The major function of these organs is to provide local immunity by sIgA (secretory IgA) and IgE production
- ❖ **Mode of activation**
 - The intestinal epithelium overlying the Peyer's patches is specialized to allow the transport of antigens into the lymphoid tissue.
 - This function is carried out by specialized epithelial cells termed microfold (M) cells.
 - M cells endocytose, transport and present antigens to subepithelial lymphoid cells that start responding to foreign antigens



ileum, Peyer's patches



Esophagus MALT

