

Department Of Biotechnology

ORGANS OF IMMUNE SYSTEM

By

Dr. Sapna Baghel

ORGANS OF IMMUNE SYSTEM

Two main types of organs present in immune system of humans:

1. Primary Lymphoid Organs

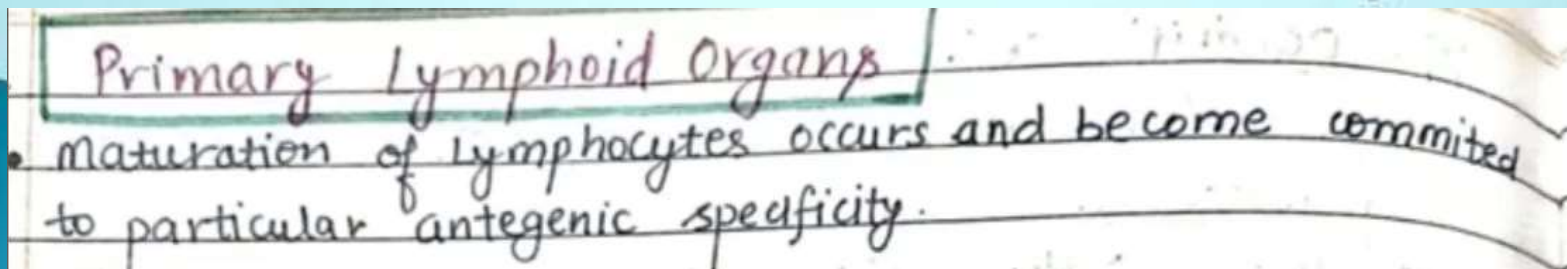
1. Bone marrow
2. Bursa of fabricius (in birds)
3. Thymus

2. Secondary Lymphoid Organs.

1. Lymph nodes
2. Spleen
3. Mucosa associated lymphoid tissue (MALT)

A. Primary lymphoid organs

- ❖ **Primary lymphoid organs (PLO) are the major sites of lymphocyte development i.e. *lymphopoiesis*.**
- ❖ **Lymphocytes differentiate from lymphoid stem cells, proliferate and mature into functional cells called immuno-competent cells.**
- ❖ **In mammals, B-cell maturation occurs in the bone marrow**
- ❖ **and T-cell maturation occurs in the thymus.**



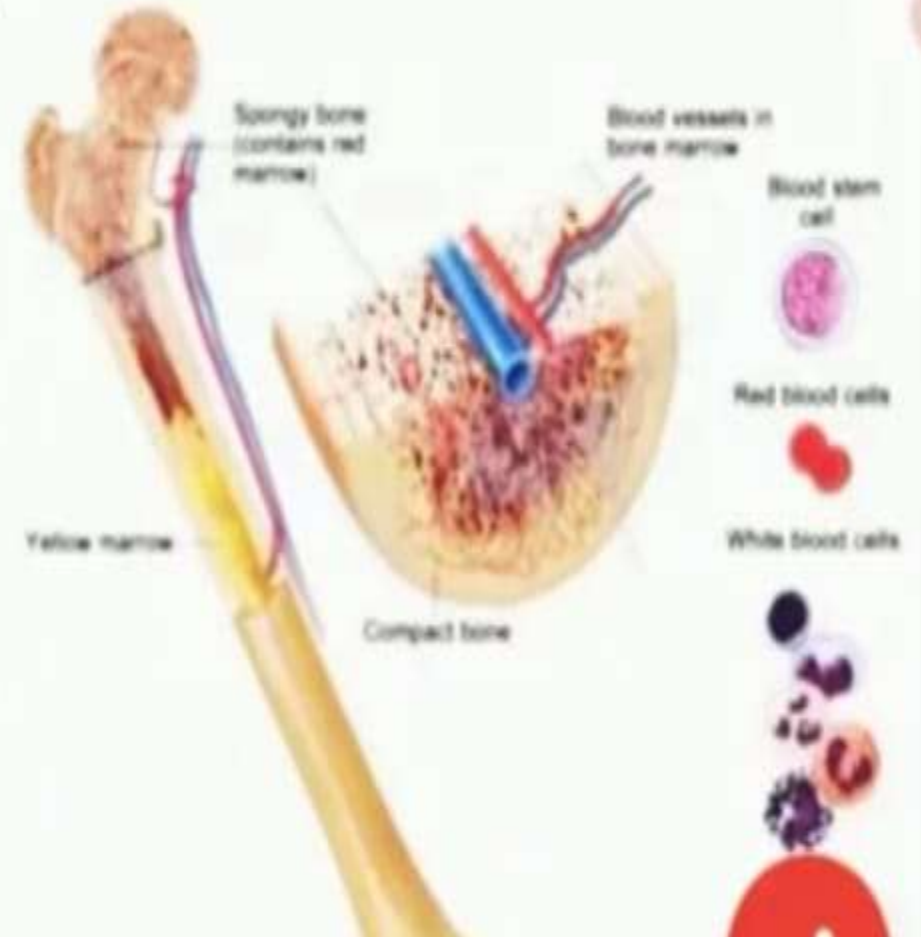
1. Bone marrow:

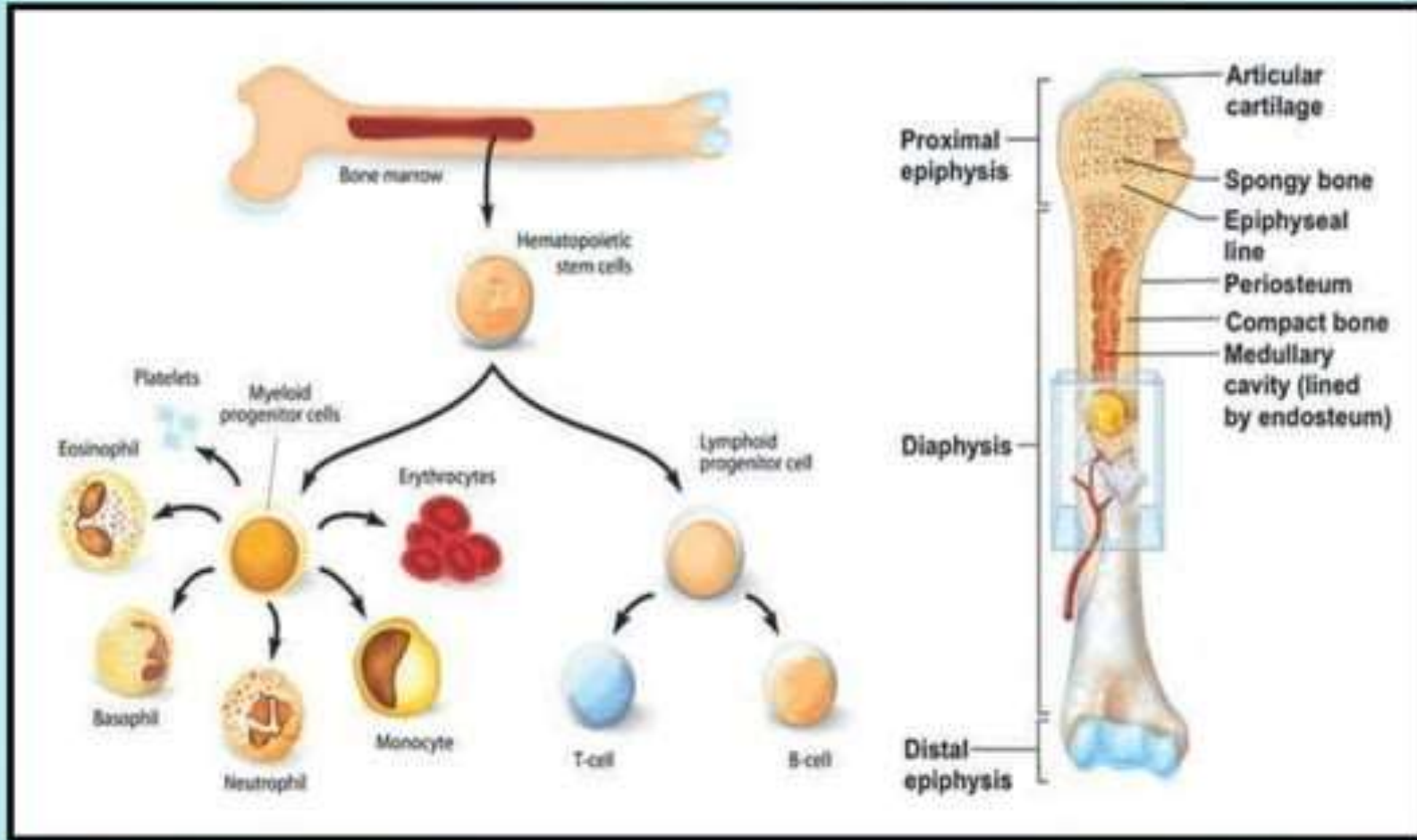
A. location:

- ❖ It is found in the cavities of most bones in the body including the *skull, ribs, sternum, femur and spine*.
- ❖ In birds, no bone marrow is found to be present, instead a lymphoid organ named Bursa identified by Fabricius called *Bursa of Fabricius*, is present and performs the same duty of bone marrow of mammals.

Bone marrow:

- Bone marrow is a semi-solid tissue which may be found within the spongy or cancellous portions of bones.
- Bone marrow is the primary site of new blood cell production or **Hematopoiesis**.
- It is composed of hematopoietic cells, marrow adipose tissue, and supportive stromal cells.
- In adult humans, bone marrow is primarily located in the ribs, vertebrae, sternum, and bones of the pelvis.





- The site of B-cell origin and development.
- Immature B cells proliferate and differentiate within the bone marrow, and stromal cells within the bone marrow interact directly with the B cells and secrete various cytokines that are required for development.
- Selection process within the bone marrow eliminates B cells with self-reactive antibody receptors.



3. Functions:

- ▶ The bone marrow is the main site of generation of all types of circulating blood cells in adult and is the principal site of B-cell maturation and proliferation.
- ▶ During foetal development, the generation of all blood cells, called haematopoiesis, occurs initially in blood island of yolk sac and para-aortic mesenchyme and later in the liver and spleen.
- ▶ Gradually, these functions are shifted to bone marrow.
- ▶ All blood cells originate from haematopoietic stem cell and become committed to differentiate along particular lineages (erythroid, megakaryocyte granulocytic, monocyte and lymphocytic).

Contd...

- ▶ Bone marrow is not only the source of all blood cells but also provides the microenvironment for the antigen independent differentiation of B-cell.
- ▶ Besides this, bone marrow serves as a secondary lymphoid organ where mature, virgin, antigen reactive lymphocytes (T & B cell) may respond to antigen, trapped by antigen presenting cells, such as macrophages.
- ▶ Thus, like spleen, bone marrow may provide an antigen processing environment.

2. Thymus

I. location

- ▶ Thymus is located in the thoracic cavity (in the mediastinum), just above the heart and beneath the breast bone.
- ▶ Location of the Thymus in the Chest of Child.

II. Origin:

- ▶ In mammals thymus develops from the endoderm of the third and fourth pharyngeal pouch.

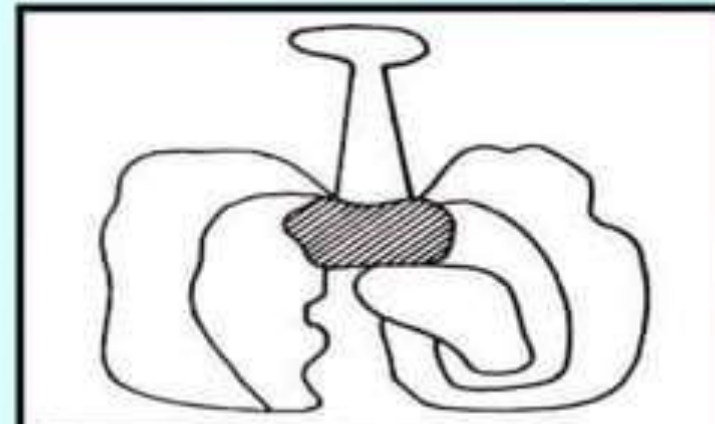


Fig. 3.2.1: Thymus

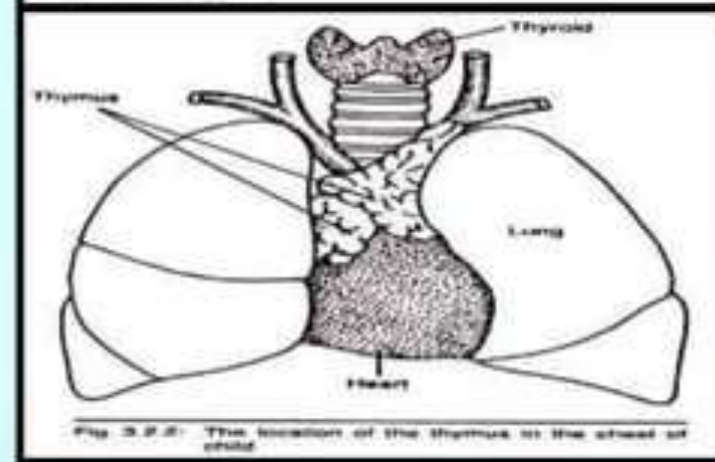
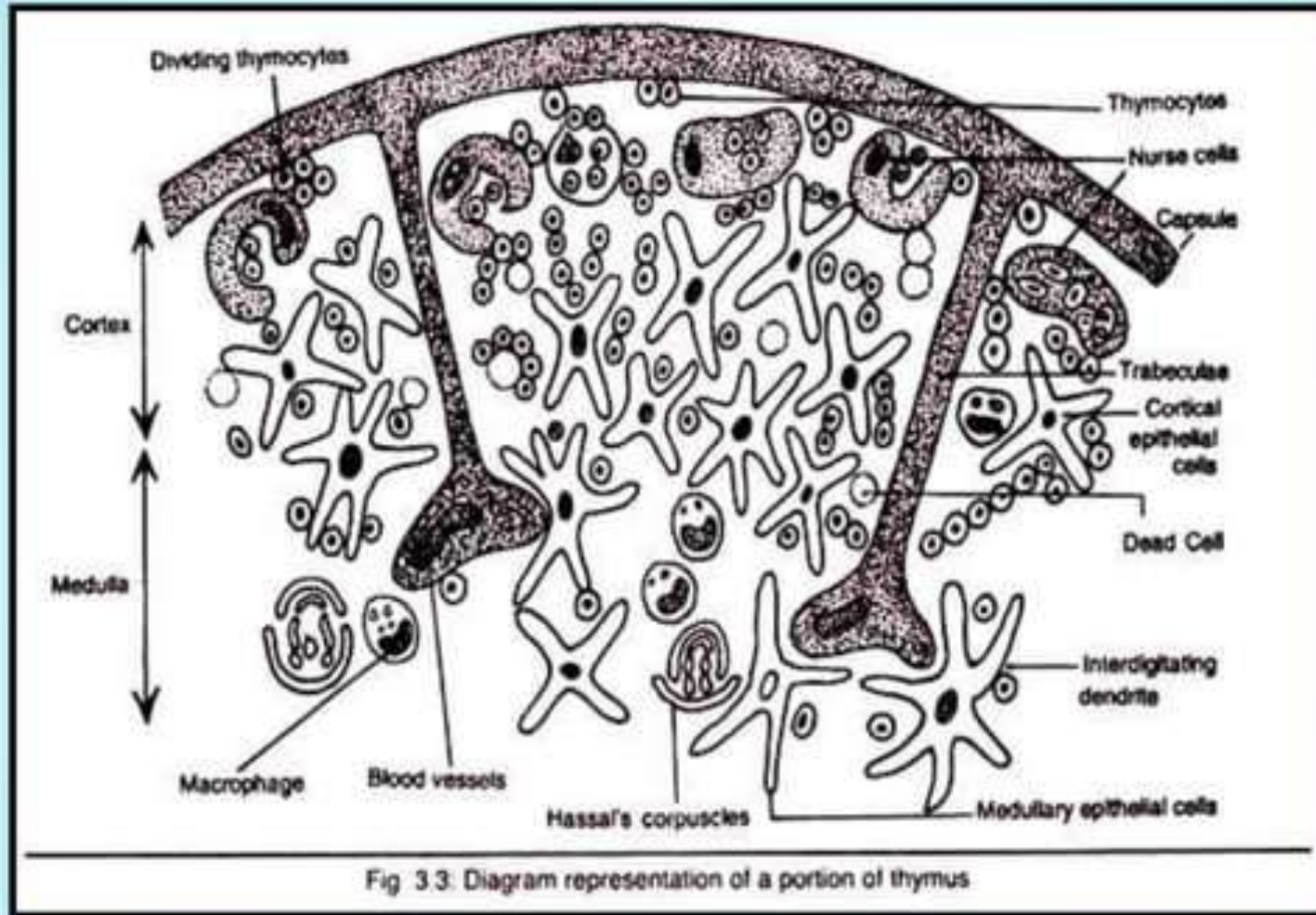


Fig. 3.2.2: The location of the thymus in the chest of child

Contd..

III. Structure

- ▶ The thymus is flat, bilobed, greyish lympho-epithelial organ.
- ▶ Each lobe is made of lobules separated from each other by strands of connective-tissue trabeculae and covered by a capsule.
- ▶ Each lobule consists of two compartments the outer compartment (cortex) is densely packed with immature T-cells (thymocytes)
- ▶ And, the inner compartment (medulla) is sparsely populated with mature thymocytes which express CD44 (not found in the cortical thymocytes).



Cell types of thymus

- ▶ There are basically four types of cells found in thymus—
 - Thymocytes
 - dendritic cells
 - epithelial cells
 - Macrophages
- ▶ Both the cortex and medulla of the thymus are criss-crossed by a three dimensional stromal-cell network.

Both cortex & medulla are criss crossed by 3D stromal cell network composed of Epithelial, dendritic cells, Macrophages which makeup framework of organ & help in growth & mat of Thymocytes.

Functions of thymus

- ▶ Out of four cell types, dendritic cells, epithelial cells and macrophages act in a combine manner, as a framework to assist in thymocyte maturation.
- ▶ Some thymic epithelial cells in the outer cortex, called nurse cells, have long membrane processes which surround as many as 50 thymocytes forming large multicellular complexes.
- ▶ Other cortical epithelial cells have long inter-connecting cytoplasmic processes that form a network.
- ▶ The thymocytes are differentiated and matured into different types of T-cells under hormonal influence.
- ▶ Lymphoid progenitor cells formed in the bone marrow migrate to the thymus under the influence of specialized thymic environment.

... (surrounding 50 thymocytes)

Along this T cell receptors also produced.

more than 95% of all Thymocytes die by Apoptosis without use.
function

help in immune system by maturing T cells.

By Aging T cells decline.

Thymus reaches max. size at puberty and then ↓ cortical & medulla cells ∴ fat content ↑.

Infants → 70g

elder → 3g



B. Secondary lymphoid organs:

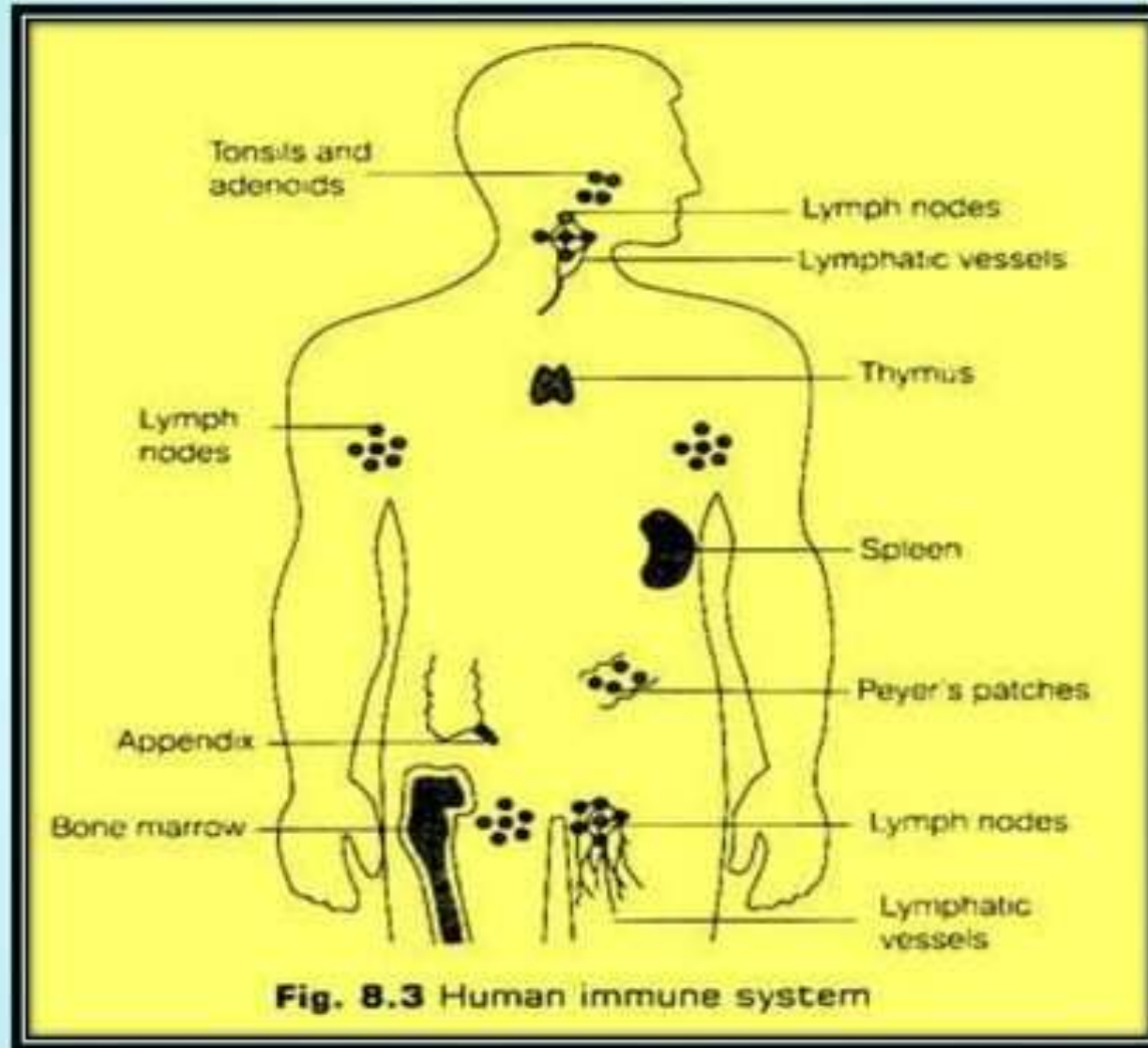
- Besides the primary lymphoid organs, there are some other lymphoid organs which are referred to as secondary lymphoid organs.
- **Lymph nodes** and **spleen** are the most important and highly organized secondary lymphoid organs.
- Besides these, less organized lymphoid tissue collectively called mucosal-associated lymphoid tissue (MALT) which includes Peyer's patches in the small intestine, the tonsils, the appendix, as well as numerous lymphoid follicles within the lamina propria of the intestines and in the mucous membranes lining the upper airways, bronchi and genital tract.

Secondary Lymphoid Organs

- ⇒ Which Trap antigen and provide site for mature lymphocytes to interact with that antigen.
- ⇒ Region where Immune Response is initiated.

(1) Lymph Nodes

- They are encapsulated bean shaped structures containing a reticular network packed with lymphocytes, Macrophages



lymphocytes to interact with that antigen.

⇒ Region where Immune Response is initiated.

(1) Lymph Nodes

- They are encapsulated bean shaped structures containing a reticular network packed with lymphocytes, Macrophages and dendritic cells.
- present in Neck area, Axilla, Thorax, abdomen & groin.
Where group of nodes are found.
- distributed along various lymphatic vessel.



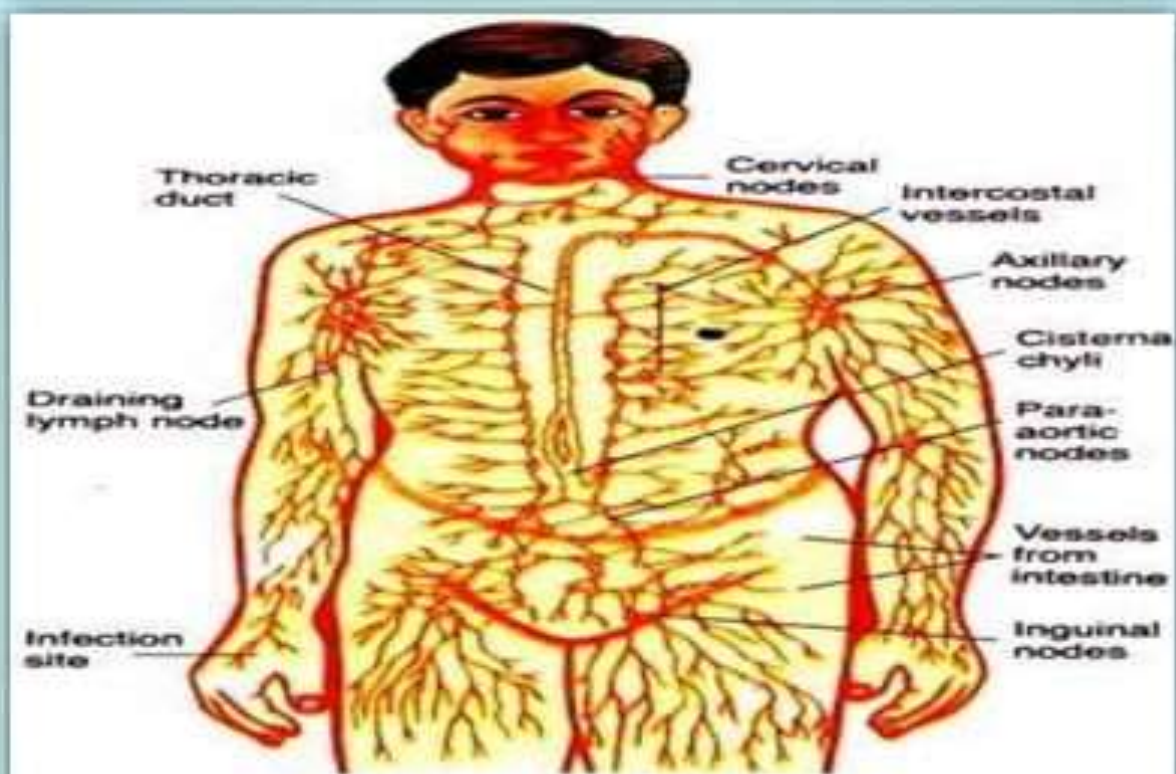


Fig. 3.6: The lymphatic system. The major lymphatic vessels and collections of lymph nodes are illustrated. Antigens are captured from a site of infection, and the draining lymph node to which these antigens are transported and where the immune response is initiated

CORTEX :-

Outer most layer

Contains lymphocytes, macrophage, follicular dendritic cells arranged in primary follicle

⇒ Lymphoid tissues organized into structures - lymphoid follicle.

⇒ Lymphoid follicle activated by antigen – primary follicle
[Follicular Dendritic Cell, Resting B Cell]

⇒ Primary follicle develop into secondary follicle.

⇒ In children with B cell deficiency cortex lack primary follicles and germinal centers.

PARACORTEX :-

[T lymphocytes, interdigitating dendritic cells].

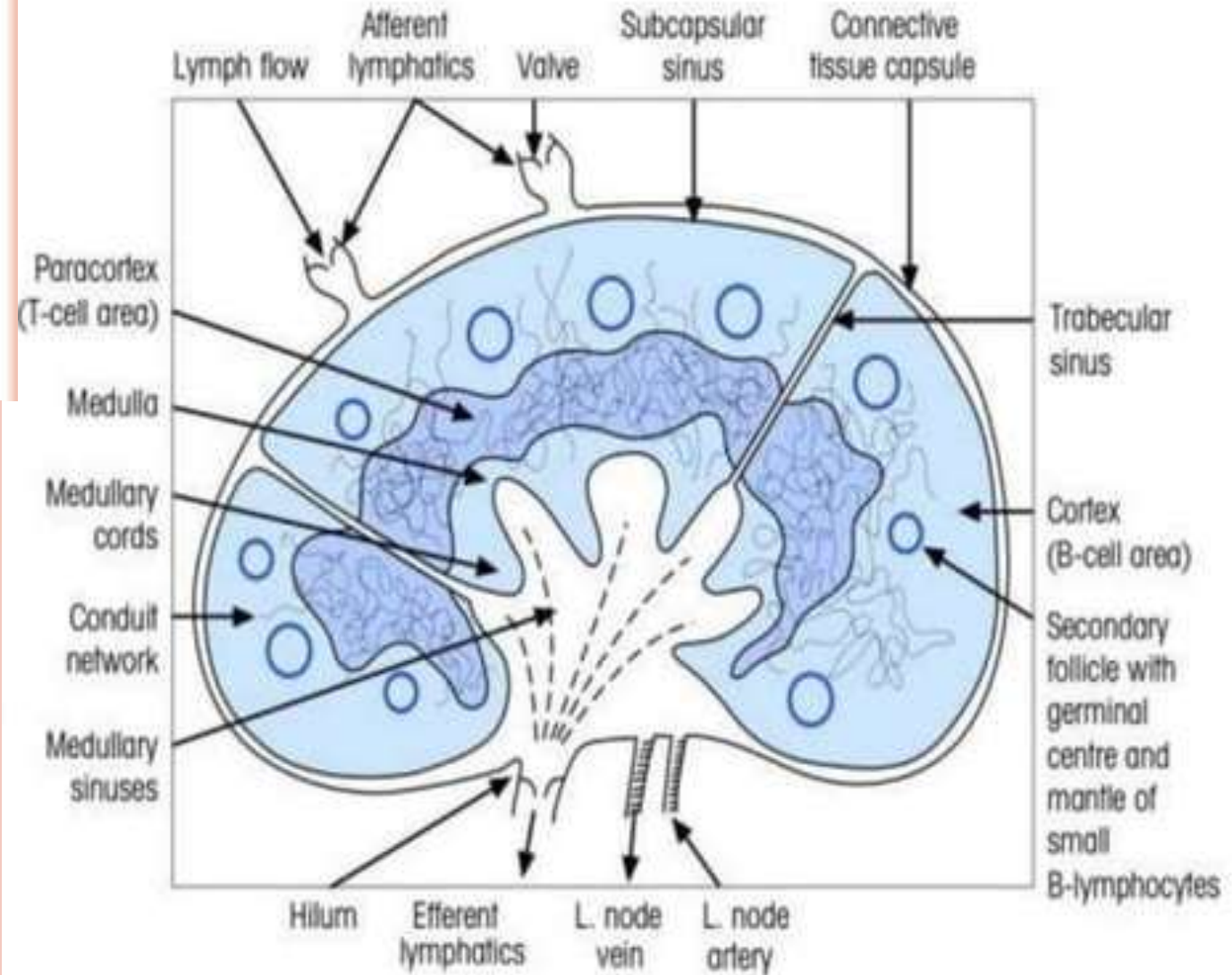
Thymus dependent area – Para cortex

Thymus independent area – Cortex

Class II MHC present.

MEDULLA :-

Inner most layer



- & - that in
- Spleen** → specialized for trapping blood born Ags
- Encapsulated organ found under the liver
 - highly vascular organ that filterate blood
 - It is responsible for eliminating blood borne pathogens
 - RBCs carrying immune complexes are processed here to remove Ag.

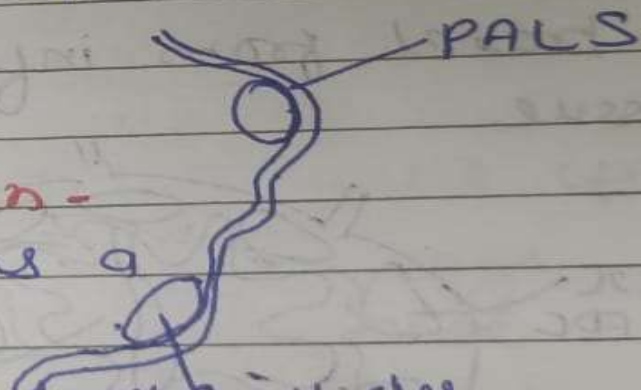
Two main region is spleen

- 1) White pulp region
- 2) Red pulp region

The white pulp region -

The white pulp forms a sleeve ↓

The periarteriolar lymphoid follicle sheath (PALS) around the arterioles this sheath contains numerous T cells



Page No.
 Date: / /

closely associated with PALS are the B cell rich lymphoid follicles that can develop into 2° follicles containing germinal centers

→ In the red pulp area, the old red blood cells & defective red blood cells are destroyed

→ In white pulp area - many T cells, B cells & DC present in this area.

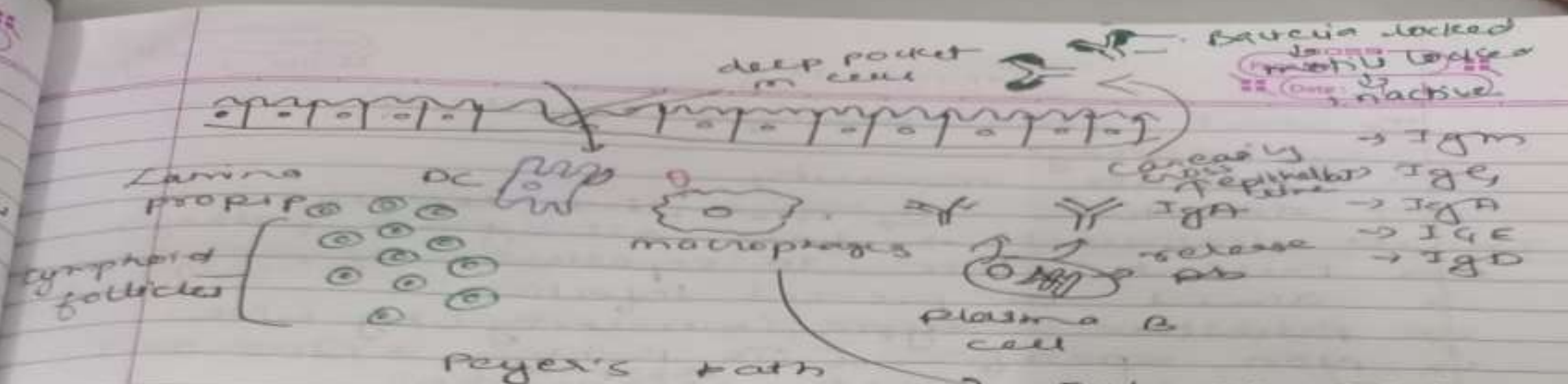
→ The B cells are organized into 1° lymphoid follicles.

→ Upon antigenic challenge, the 1° follicles develop into 2° lymphoid follicles

→ The dendritic cell trap the Ags in blood & present them to T helper cells, leading to the activation of helper T cells. Activated helper T cells help in the activation of B cells.

- Mucosal - associated Lymphoid Tissues (MALT)
- +nt in respiratory tract, gastrointestinal tract & genitourinary tract covered with mucous membrane:
 - prone to entering of many microbes
 - Therefore defense forces are needed
 - The lymphoid tissue defending this vast area are called MALT
- 2 types of lymphoid tissue in mucosal areas

- lymphoid cells are arranged as loose clusters
- lymphoid tissue are not organized structure (such as tonsil, appendix & Peyer's patches)



- Ad as APC
- engulf processed & present
- TH TC & B start proliferate
- TH → activate → release cytokine → stimulate B cells to form
- plasma B cell
- memory B cell
- Tc lymphocyte form
- plasma Tc cell
- ~~memory~~ Tc cell

TH memory

TH plasma

TH also get stimulate by own cytokine

THANK YOU

