Block HEM-210

Histology department

Second year 2020/2021

THE LYMPHTIC SYSTEM

Learning objectives:

After this lecture, students should be able to:

➢ A1- Describe the cytological characteristics of lymphocytes

➢ A2-Define & classify lymphatic tissue; diffuse and nodular

➢ A3- Describe the structure of lymphatic organs.

Lymphocytes (Fig. 1):

• Accounting for 20-35%, of the circulating W.B.Cs.

Structure:

By LM:

- They have deep stained nucleus and a thin rim of clear blue cytoplasm.
- They have no specific granules but they contain few small azurophilic granules.

By E.M. the cytoplasm contains;

- small Golgi,
- a pair of centrioles
- one or two mitochondria
- Many free ribosomes but no endoplasmic reticulum.

Types of lymphocytes:

• On the basis of cell diameter, they are divided into

- small (4-7 um),
- medium sized (7-11 um)
- Large lymphocytes (11-15 um).

• **According to** the presence of distinct surface markers determined by immunohistochemical methods small lymphocytes are divided into;

- B lymphocytes,
- T lymphocytes
- Null cells.

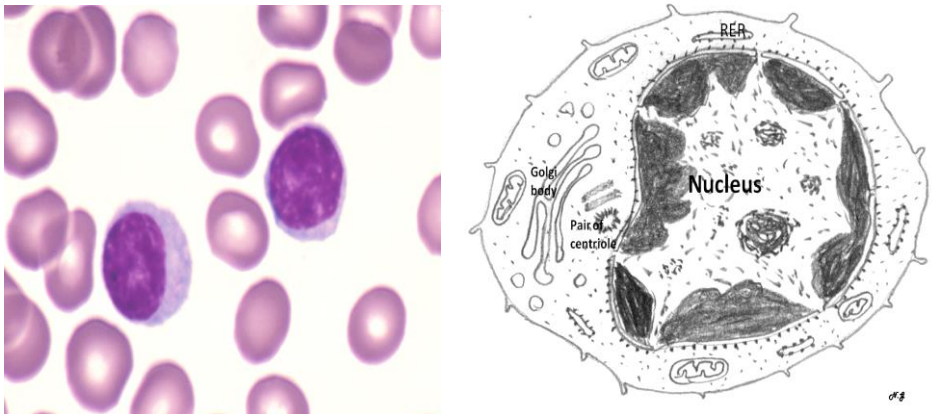

Fig. (1): **L.M & EM of lymphocyte**

B lymphocytes:

1- Origin: in mammals they arise from the stem cells in the bone marrow.

2- Life span: B lymphocytes have a short life span (few weeks) and during this time they circulate and recirculate through the blood, lymph nodes, spleen and lymph for many times.

During their extensive recirculation, they respond to any antigen that may have entered the body.

3- Activation: B lymphocytes when activated, they differentiate into large lymphocytes then to lymphoblasts to plasma cells that produce immunoglobulins. Some of activated lymphocytes remain as B memory cells. This type is called humeral response.

T lymphocytes:

1- Origin: Stem cells originate in the bone marrow that is carried through the blood to the thymus where they proliferate and differentiate to T lymphocytes.

At the cortico-medullary region they become mature T lymphocytes, then they leave the thymus through post capillary venules to the spleen then to the circulating pool of lymphocytes.

2- Life span: T lymphocytes have a long life span for several months.

3- Activation: T lymphocytes when activated by antigen, they soon differentiate into four types of cells producing cellular immune response. These cells are:

- T killer or rejection cells: Those reject transplanted organs or skin grafts.
- T memory cells: They are programmed to react with the same antigen on entering the body for another time.
- T helper cells: They help B lymphocytes producing humoral immunity.
- T suppressor cells: They inhibit the activity of both B and T lymphocytes triggering the end of the immune response.

THE LYMPHOID TISSUE

Lymphatic tissue is defined as reticular connective tissue that is infiltrated with lymphocytes. This includes discrete organs as well as more diffuse aggregations of lymphocytes.

- The lymphoid organs are either primary or secondary.
  - Primary organs are where lymphocytes are formed and mature as bone marrow and thymus.
  - Secondary organs are where lymphocytes are activated as lymph nodes, spleen and mucosa associated lymphoid tissue (MALT).
- **MALT** is numerous scattered non-capsulated lymphoid nodules distributed in the mucosa of the digestive, respiratory and urinary systems collectively.

The lymphoid nodule:

It is a spherical mass of lymphocytes.

Sites of the nodule:

1- Lymphatic organ as spleen, lymph node and tonsil.
2- In lamina propria of digestive and respiratory system.
3- Payer's patch of ilium
4- appendix

Types of the nodule:

1-Primary lymphoid nodules:

- They represent the unstimulated follicles. They are formed of closely packed small lymphocytes.

2-Secondary lymphoid nodules:

When the primary nodules are stimulated by antigen (any foreign protein), they become secondary nodule.

This **secondary nodule** consists of two zones.

- The **outer zone (mantle)**, also called peripheral zone contains small lymphocytes with less cytoplasm so it stains dense.
- The **inner zone**, also called **germinal center or central zone** contains large and medium lymphocytes, lymphoblast, plasma cells and macrophages. It stains pale due to these cells have more cytoplasm and euchromatic nuclei.

1- THYMUS

The thymus is a primary lymphoid organ situated in the superior mediastinum.

- Lymphoblast differentiates into T-lymphocytes within the special microenvironment of the thymus, independent of antigenic stimulation.
- After differentiation, the thymus populates T-lymphocytes to the peripheral lymphoid organs.
- The thymus is well developed at birth and during early childhood, then it begins to involute.

Histological Organization (Fig. 2):

The thymus is composed of stroma and parenchyma.

The Stroma: is formed of

- Thin capsule.

• Trabeculae of loose C.T divide the gland into incomplete **lobules** that remain in continuity with each other by slender connecting strands of lymphoid tissue.
• Supporting network of epithelial reticular cells.

The parenchyma: is formed of thymic lobules.

- Each lobule has a dark-staining peripheral zone, **the cortex** and a lighter-staining inner zone, **the medulla**.
- At the cortex, the lymphocytes (thymocytes) are numerous and densely packed, causing the intense basophilia of this region. Plasma and mast cells appear in the periphery of cortex.
- Macrophages appear at corticomedullary region.
- At the medulla, the lymphocytes are fewer and the epithelial reticular cells with their abundant eosinophilic cytoplasm are more prominent.

Thymocytes:

✓ Represent the main cellular population of the thymus.
✓ These include small, medium and large lymphocytes.

Epithelial Reticular Cells or cytoreticular cells:

✓ These are branched cells form a network that carry lymphocytes and is referred to as **cytoreticulum**.
✓ They share in characters of epithelial and C.T. cells.
✓ The cells have several processes that joined together by desmosomes.
✓ According to E.M. structure, location and histochemical characters they are of 6-types.

- **Hassall's corpuscles (Fig. 3):**

They are acidophilic with hyalinized centers. It is formed by type 6 reticular cells in the medulla. These cells are flattened and tend to wrap around one another and joined together by many desmosomes and contain abundant bundles of keratin filaments. The cells in the central portion of the corpuscle lose their nuclei and cytoplasm is full of keratin.

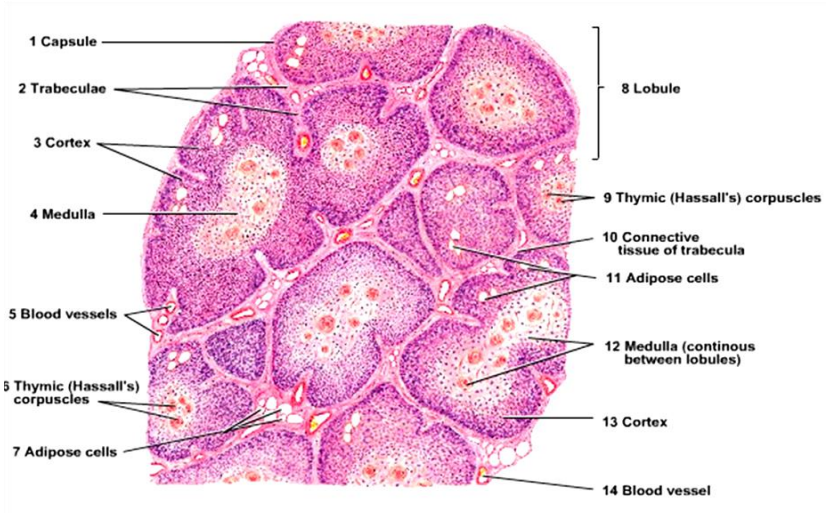

Fig.(2) A diagram showing the histological structure of thymus

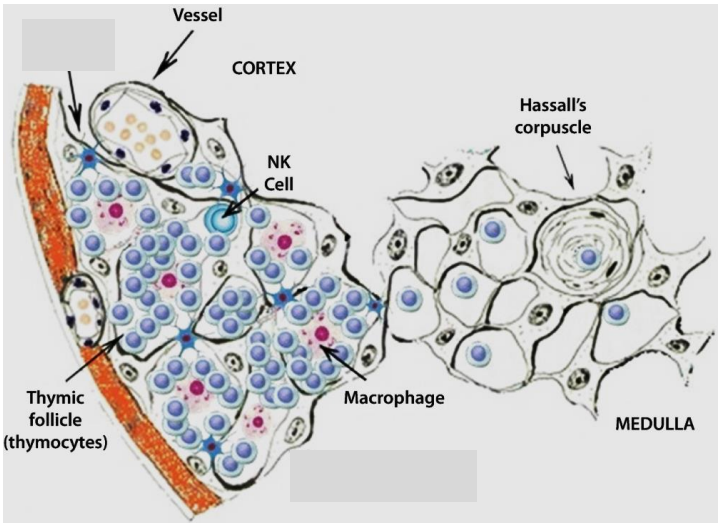

Fig (3): A diagram showing the cortex and medulla of the thymic lobule

The blood-thymus barrier (Fig. 4)

• It prevents antigenic macromolecules of the blood from reaching the thymus. This barrier makes the cortex as special micro-environment for differentiation of T-lymphocytes independent of antigenic stimulation.

• Layers of the barrier are:

- The continuous endothelial cells
- Perivascular CT contains macrophage
- The thick basement membrane of the capillary
- The layer of epithelial reticular cells joined by occluding junction.

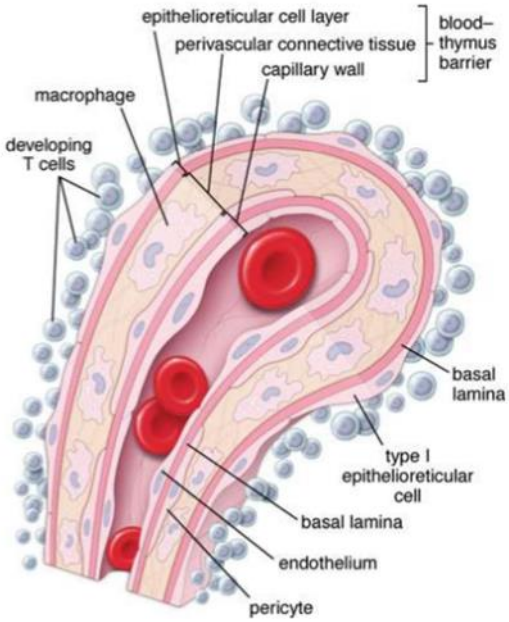

Fig (4): A diagram showing the blood thymic barrier

2- LYMPH NODES

There are 500-600 **lymph nodes** (lymph glands) in the body.

• A lymph node is capsulated round, ovoid, or bean-shaped and varies in size from less than 1 mm to 2-3 cm.

Structure (Fig. 5)

The lymph node is formed of stroma and parenchyma.

The stroma:

- C.T. capsule that greatly thickened at the hilum.
- Branching trabeculae extend from the deep surface of the capsule inwards to divide the organ into relatively regular compartments in the outer part (cortex) and more irregular compartments in the inner part (medulla) of the gland.
- Between the trabeculae, the lymphoid tissue is supported by a network of reticular fibers and reticular cells.

The parenchyma

1-The cortex

- It is formed of three zones; outer, mid and deep cortical region.
- The lymphoid nodules are of primary and secondary types. They form the great bulk of the outer cortex while the diffuse lymphoid tissue makes up the bulk of the mid and deep cortex.
- B-lymphocytes are the predominant cells in the outer cortex while T-lymphocytes are the predominant cells in the mid and deep cortical zones.
- The mid and deep zones are called **thymus dependent zones** of the lymph nodes. They contain an antigen presenting cells known as dendretic cells.

2-Medulla

- The medullary cords consist of aggregations of lymphoid tissue organized around small blood vessels. They are formed of small lymphocytes, plasma cells and macrophages.
- The lymph sinuses are channels lined with a layer of thin squamous cells without basal lamina and supported by a thin layer of reticular C.T.

Lymphatic circulation in lymph node. Lymph flow through a lymph node by the following course:

(1) Afferent lymph vessels.

(2) subcapsular sinus.

(3) peritrabecular sinus.

(4) Medullary sinus.

(5) Efferent lymph vessels.

- All the sinuses contain macrophages which remove particulate matter and degenerating cells from the lymph.

Functions of lymph nodes:

1- Production of lymphocytes.
2- Filtration of lymph from bacteria or malignant cells.

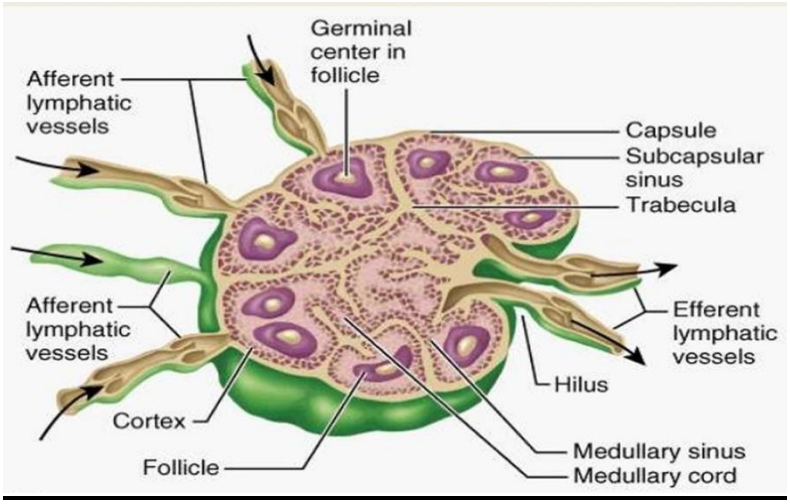

Fig. (5): A diagram showing the lymph circulation of the lymph node.

3-THE SPLEEN

The spleen is a large lymphoid organ present in the left upper quadrant of the abdominal cavity.

Histological Organization of the Spleen:

The spleen is formed of stroma and parenchyma.

The stroma: It is formed of ;

- Capsule
- Thick trabeculae.

  Both the capsule and the trabeculae consist of dense C.T. rich in elastic fibers. In human, they contain few smooth muscle cells.

- Delicate reticular fibers framework that occupies the interior of the organ and holds in its meshes the free cells of the parenchyma.

The Parenchyma (Fig.6):

A-The white pulp:

- **The periarterial lymphoid sheaths (PALS)**: It consists of a central artery (a branch of the splenic artery) that surrounded by a sheath of lymphoid tissue
- **Malpigian corpuscle (lymphoid follicle):** the central artery is located at the periphery of nodule.

B-The marginal zone:

It is the transitional zone between the white pulp and the red pulp of the spleen.

C-Red pulp:

1- Pulp cords (**cords of Billroth**) and the splenic venous sinuses.
2- The splenic sinuses are wide irregular channels which may be up to 40 um in diameter.

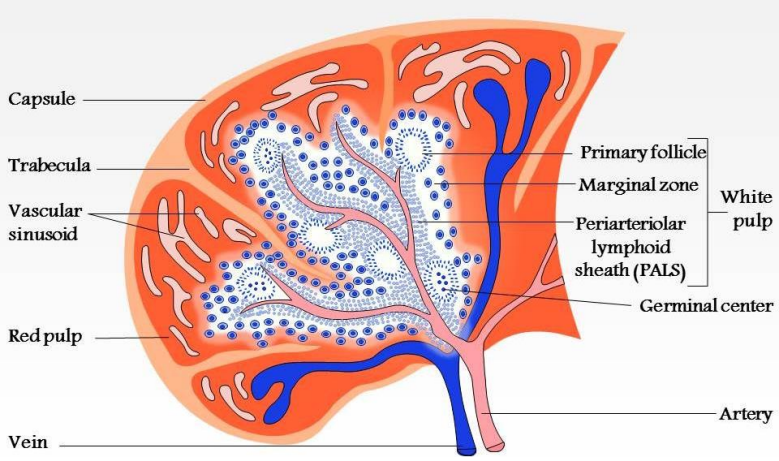

Fig. (6): A diagram showing the structure of the spleen

Function of the spleen

1-Immunological response

2-Filteration of blood by macrophage

3-Recycling of iron