



# hystology



## LEC.1

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## Lymphatic System

The lymphatic system collects excess interstitial fluid into lymphatic capillaries. It includes all cells, tissues, and organs in the body that contain aggregates of immune cells called **lymphocytes**. lymphatic organs, lymphatic vessels, lymph & small masses of lymphoid tissue called lymph nodes. The major lymphatic organs are the lymph nodes, tonsils, thymus & spleen.

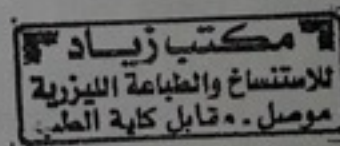
### Function:

- 1- Drain the protein containing fluids from the tissue spaces, such proteins can not be directly reabsorbed by the capillaries of the blood.
- 2- Transport absorbed lipids from the digestive tract after digestion of food to the blood.
- 3- Produce lymphocytes and respond immunologically to invading foreign substances.
- 4- Protect the organism against invading antigens like (bacteria, viruses, and parasites).

### Lymph:

Is an exudates from the tissue space to the capillaries, it is a clear colorless fluid similar to the blood (formed of plasma + cells) but some differences are:

- ❖ The lymph circulates in one direction.
- ❖ No granular leukocytes.
- ❖ No R.B.C"s.
- ❖ Platelets are absent .
- ❖ Albumin and globulin proteins are higher than that of the blood.
- ❖ Fibrinogen is less.
- ❖ Coagulation is slower than blood.
- ❖ Oxygen level is less than blood.
- ❖ Carbonic acid is higher than blood.
- ❖ Fats are seen in the lymphatics of the intestine & appear milky (chyle) due to the presence of fat globules.



### Lymphatic vessels:

1-They begin first as a network of lymphatic capillaries which are similar to blood capillaries but with some differences:

- Irregular in shape and diameter but wider than blood capillaries.



- Thinner than blood capillaries.
- Lined by fenestrated endothelial cells with discontinuous basement membrane.
- Have no pericytes & perithelial tissue.
- Lie deeper than the blood capillaries in skin & muscularis mucosa.
- More permeable than blood capillaries, permeating the entry of large molecules like proteins, triglycerides, and immune cells

2-The lymphatic capillaries unite to form lymphatic vessels which have thinner wall and wider diameter than veins & they have more valves, the small lymphatic vessels measuring less than 0.2 mm in diameter are lined by endothelial cells while the larger lymphatic vessels measuring more than 0.2 mm in diameter are lined by thicker wall formed of 3 layers:

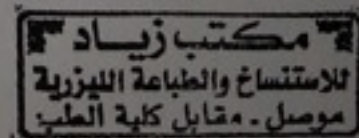
- **Tunica intima:** formed of endothelial cells + thin layer of connective tissue.
- **Tunica media:** formed of circularly arranged smooth muscle fibers.
- **Tunica adventitia:** thickest layer formed of bundles of smooth muscle fibers with elastic & collagen fibers in between.

3-All lymphatic vessels end in 2 main ducts: right lymphatic duct & thoracic duct.

4- The lymphatics are absent in the sclera & lens of the eye, avascular tissue, uncalcified cartilage, in the C.N.S, splenic pulp, fetal part of the placenta, internal ear and in the bone marrow

### **Lymphocytes:**

are the cells that carry out the immune response, 2 main types of lymphocytes are present found in the blood, lymph & lymphatic organs: **T-lymphocytes & B- lymphocytes** they appear similar morphologically but very different functionally, they are distinguished according to the **receptors** present on their cell membrane, both cell types originate from precursor hemopoietic stem cells in the bone marrow then enter the blood stream.



### **Types of lymphocytes:**

1-**T-lymphocytes:** responsible for cell-mediated immune response. They arise from lymphocytes that are carried from the bone marrow to the thymus gland where they become mature, differentiated and acquire surface receptors and immunocompetence before migrating to peripheral lymphatic



tissues and organs. The cells destroy the antigen either by cytotoxic action or by activating B cells. They are circulating in the blood.

- 2- **B- lymphocytes:** They mature and become immunocompetent in bone marrow then carried to lymph nodes, spleen. They responsible for humeral immunity (i.e. they produce antibodies & these antibodies attack the invading antigen) they are the fixed type.

### **Function of T-lymphocyte:**

Four groups of T- lymphocytes can be recognized:

#### **1-Helper T-lymphocytes:**

They present the antigen to the B cells and secreting some immune chemicals (interleukin 2) that stimulate proliferation & differentiation & maturation of B-lymphocytes into plasma cells which then produce large amount of antibodies specific to the antigen which triggered the plasma cell formation .

#### **2-Cytotoxic T- cells (T- killer):**

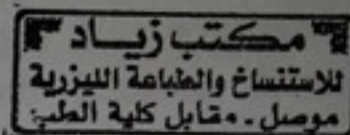
- They can recognize foreign cells, malignant cells & virally-infected cell, on activation & binding to the target cells they secrete **cytotoxic substances** that perforate the target cell membrane causing cell death.
- Secreting a substance called ( MAF ) macrophage activating factor that attract the macrophage to the site of invasion of the micro-organism.
- It is effective in slowly developing diseases in T.B., cancer.

**3-Suppressor T- lymphocyte:** they inhibit the function of helper T-lymphocyte & cytotoxic T-lymphocytes & inhibit the development of B-lymphocyte into plasma cells.

**4-Memmmory cell:** are long-lived progeny of T-lymphocytes, when sensitized by foreign antigen, they will print that antigen on its surface & respond rapidly to the same antigen when second invasion occur by stimulating immediate production of cytotoxic T cells.

### **Function of B- Lymphocyte:**

B-lymphocytes become mature in the bone marrow then carried by the blood to the lymph node, spleen & connective tissue, specific B-lymphocytes are present for each specific antigen they become activated when:





- The invading antigen binds to specific Ag- receptors present on the surface of their cell membrane.
- The response of B cells is more intense when Ag- presenting cells such as T- Helper present that Ag to the B-lymphocytes.

Activates B - lymphocyte enlarges, divide, proliferate, & differentiate into:

- **Plasma cells:** which produce **antibodies** specific for the invading Ag then Ag-Ab reactions will occur forming immune complexes.
- **Memory cell:** some activated B-lymphocytes not become plasma cells instead they persist as memory B-lymphocytes which produce a more rapid immune response when exposed to the same antigen.

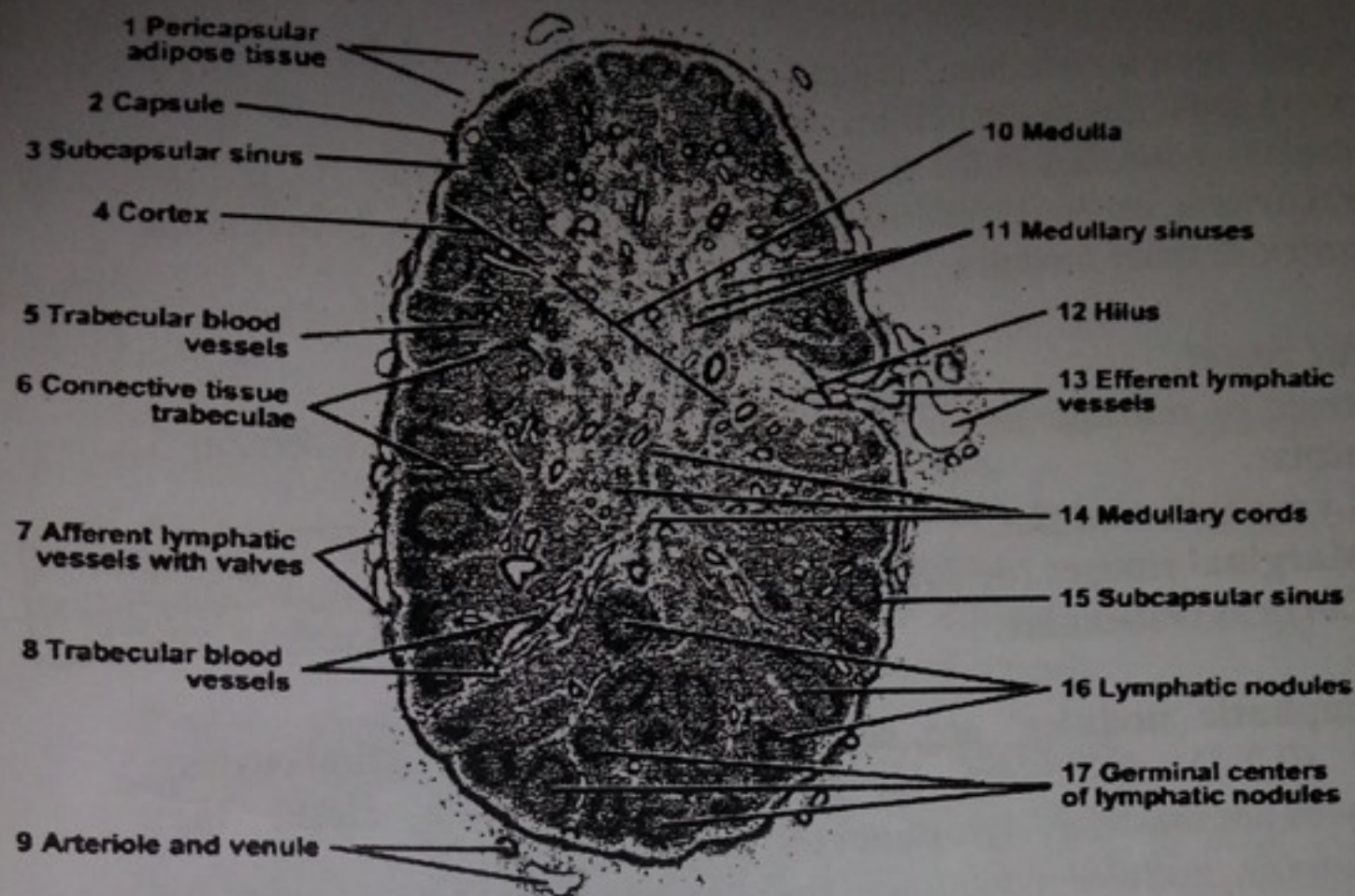
### Lymph node:

The L.N are encapsulated bean or kidney shaped organs composed of lymphoid tissue, inactive nodes are only few millimeter long but may increase greatly in size after stimulation & active immunological response, distributed throughout the body along the course of the lymphatic vessels, they are found in the axilla, groin, around the aorta ( paraaortic lymph nodes), along the great vessels of the neck, in the thorax, abdomen especially in the mesentery, each L.N characterized by a convex & concave side, the **afferent** lymphatic vessels enter through the convex side while on the concave side called "**hilum**" through which the arteries & nerves penetrate & the veins with the **efferent** lymphatic vessels leave.

### Characters of the lymph node which differentiate it from other lymphatic organs:

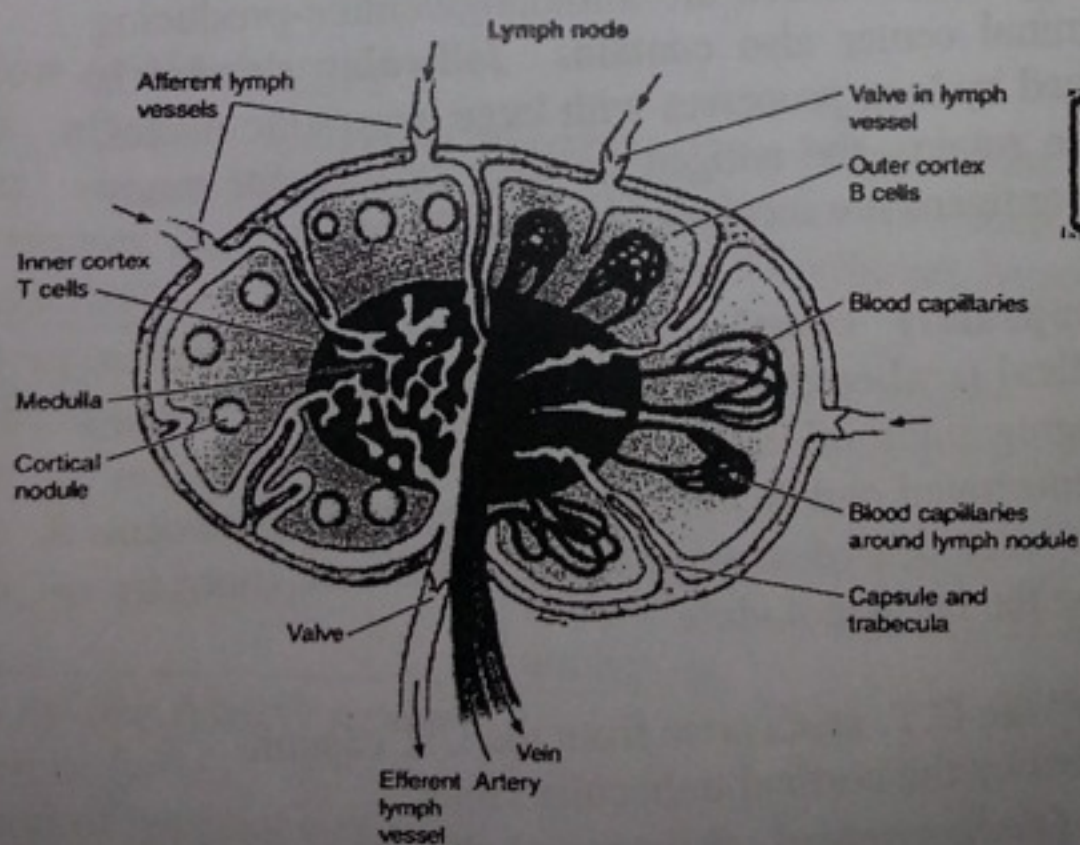
- The only lymph organ that lies along the course of lymphatic vessels.
- The only organ that contain **lymph** in the lymphatic sinuses.
- The only lymphatic organ that have afferent & efferent lymphatic vessels.
- The only organ deal with filtration of lymph.
- Usually present in groups or chains ( paraaortic L.N ).





### ***Histological structure:***

- It is surrounded with a C.T capsule formed of collagen, elastic fibers, & smooth muscle cells present only at the point entrance & exit of lymphatic vessels, the C.T. capsule send C.T trabeculae that divide the lymph nodes into compartments called **cortical trabeculae** which extend to the medulla & called **medullary trabeculae**, they carry the trabecular vessels that deliver the nutrition & oxygen supply to the cortex & medulla.



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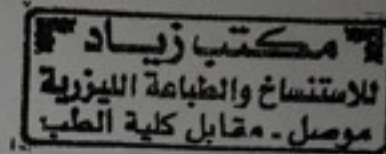
- Each lymph node has 3 regions:

- 1- **cortical zone**: lies at the periphery below the capsule.
- 2- **medullary zone**: lies in the central part of the lymph node.
- 3- **paracortical or juxtamedullary or deep cortex**: lies between the outer cortex & inner medulla.

### **Cortical zone:**

It is formed of reticular tissue infiltrated with lymphocytes, it contain 3 components:

- 1- **Lymphatic nodules.**
- 2- **Marginal sinuses (or subcapsular sinuses).**
- 3- **Cortical trabeculae.**



The "**lymphatic nodules**" are spherical aggregation of lymphocytes, diameter (0.2-1) millimeter in sections stained with H&E, the lymphocytes are mostly **B- lymphocytes**, they could be:

- **Primary nodules** containing **inactive or naïve B-lymphocytes** distributed uniformly throughout the nodule.
- **secondary nodules** containing a peripheral dark-stained area crowded with small B-lymphocytes with a central light area called **germinal centre** containing **lymphoblasts** which are large activated B-lymphocytes with large light nucleus contain uncoiled chromatin (heterochromatin ), it give rise to the 2<sup>nd</sup> type of cells called **plasmoblasts (immunoblasts)** this cells divide to give rise to **plasma cells** which are immunoglobuline-producing cells. The germinal center also contains **follicular dendritic cells** characterized by long processes with large basophilic nuclei, its function is to retain the antigen on their surface for many months then the antigens are recognized by the B-cell.

The "**marginal (subcapsular) sinus**" lies below the capsule is continuous with the **cortical (trabecular) sinuses** which extend between the trabeculae & the aggregations of the cortical nodules, the cortical sinuses are lined with fenestrated endothelial cells (with gaps in between them) associated with reticular cells & macrophages which are more in the side of the sinus facing the cortical nodule.

The "**cortical trabeculae**" are C.T. septa arise from the C.T capsule & run in the cortex surrounded by the cortical trabecular sinus.

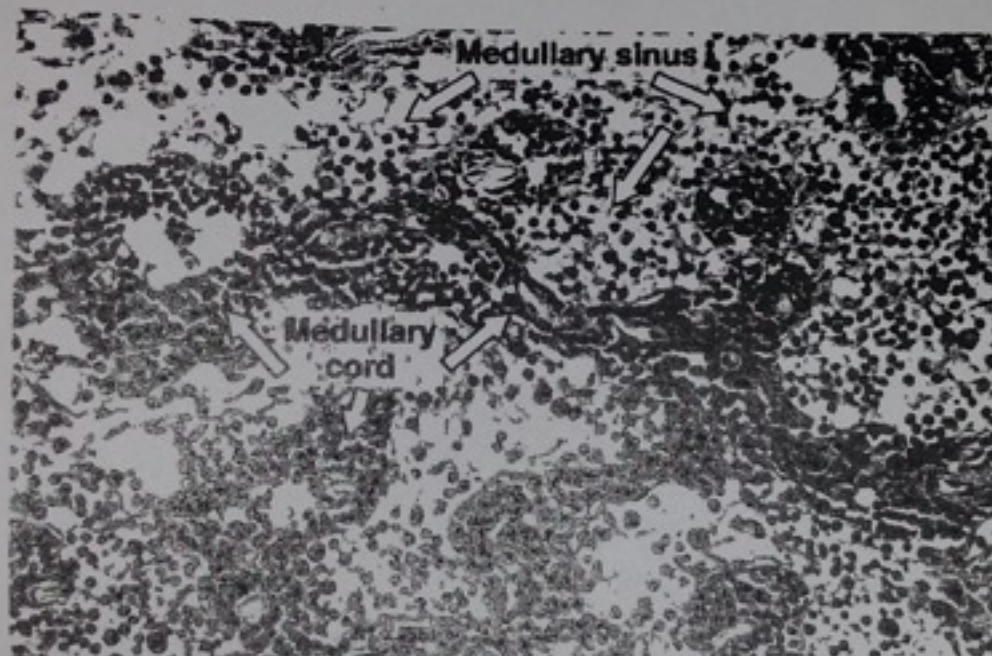
(**Paracortical region**), (**deep cortex**), (**juxtamedullary zone**):



consist of dense lymphoid tissue, it contain **T-lymphocytes** & **endothelial venules** which are lined with cuboidal endothelium having receptors on their surface which can be recognized by the circulating T-lymphocyte to enter the lymph node.

**Medulla:** consist of

- **Medullary cords:** contains numerous **B-lymphocytes**, plasma cells that migrate from the cortex & macrophages.
- **Medullary sinuses:** continuous with the cortical lymphatic sinuses drain the lymph into the efferent lymphatic vessels.
- **Medullary trabeculae:** are C.T trabeculae continuous with the cortical trabeculae carrying the medullary blood vessels.



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### ***Circulation of the lymph:***

From the afferent lymphatic vessels the lymph pass to the subcapsular sinuses then to the cortical sinuses then to the medullary sinuses then it will be collected by the efferent lymphatics & leave through the hilus.

Afferent lymph vessels	Efferent lymph vessels
1- enter the lymph node at the convex side	1- leave the lymph at the hilus
2- contains few lymphocytes, no plasma cells, no antibodies	2- contains large number of lymphocytes, plasma cells & antibodies

### ***Functions of the lymph node:***

- 1- filtration of lymph.
- 2- production of lymphocytes.
- 3- production of antibodies.
- 4- phagocytosis of foreign bodies.