The lymphatic organs

The secondary lymphoid

3- Spleen

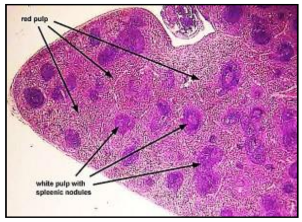
From where	Spleen
Def	Largest single hemo-lymphatic organ
Char	1- Important blood filter 2- Site of destruction of aged RBCs 3- recycling of iron 4- Immunological function through B & T cells (humoral & cell mediate immunity) 5- A site of hematopoiesis in the fetus 6- stores RBCs & platelets (blood reservoir in animals).
Structure of spleen	1- Stroma 2- Parenchyma

The structure of spleen

From where	Stroma	Parenchyma
Divide into	1- Capsule 2- Trabeculae 3- Reticular CT	1- White pulp 2- Red pulp
Explanation of the divisions	1-Capsule: 1- Thick 2- rich in collagenous, elastic fibers ,smooth ms cells. 2-Trabecula: are 1- short ones 2- extend from capsule. 3- divide the spleen into incomplete compartment, 4- rich in elastic fibers & smooth ms. cells 3-Reticular CT: 1- reticular cells and fibers 2- form background	1) White pulp: 1- lymphatic nodules (splenic Malpighian corpuscles): aggregations of lymphocytes forming 1ry or 2ry nodules distributed throughout the parenchyma of the spleen 2- Central arterioles (follicular arterioles): • Run at the periphery of the nodules (eccentric). They are branches of splenic artery • which give numerous branches before leaving the white pulp to enter the red pulp.
		2) Red pulp: (79%) 1-Splenic cords (Billroth cords): • Network of reticular fibers between blood sinusoids to support the free cells found e.g. blood cells, T & B lymphocytes , plasma cells , macrophages 2-Blood sinusoids (venous sinuses): • wide spaces lined e fenestrated endothelium called stave cells which filter the blood & surrounded e Macrophages called Littoral cells
Organization of Cells in white pulp of spleen:	• Periarteriolar lymphoid sheaths (PALS): mainly T lymphocytes encircle the central arteriole and called (Thymus dependent zone of spleen) • Germinal center: lightly stained, contain activated B cells, plasma cells & macrophages (located between PALS and marginal zone) • Marginal zone at the periphery of W. pulp close to red pulp has APCs & macrophages.	

B- parenchyma

- **White pulp**
  - **Lymphoid nodules**
  - **PALS** — Peri-arteriolar lymphatic sheath
- **Red pulp**
  - **Blood sinusoids**
  - **Splenic cords**



Prof Dr hala Elmazar 2022

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The lymphatic organs

The primary lymphoid

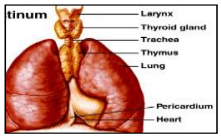
Thymus

From where	Thymus
Def	- is a 1ry lymphatic organ e an endocrine function - Single bi-lobed structure, highly lobulated organ
Location	behind the sternum in the mediastinum
Development	1) Infant – ↑ in size 2) Puberty – maximum size 3) Adult – ↓ in size
Function	Differentiation and maturation of T cells
Structure of thymus	1- Stroma 2- Parenchyma

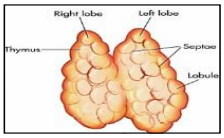
The structure of thymus

From where	Stroma	Parenchyma
Divide into	1- Capsule 2- Trabeculae	1- Lymphocytes 2- Epithelial R cells
Explanation of the divisions	1- Capsule: loose CT 2- Trabeculae (septa): Arise from capsule, penetrate its substance forming lobes, carry blood vessels. Each lobe is divided into incomplete lobules 3- Thymus has no reticular fibers . Reticulum is formed by the processes of epithelial reticular cells	1- Cortex: • Def: Peripheral dark-stained zone, where T cell maturation occur • Cortex contains thymocytes. The hematopoietic precursors which migrated from bone marrow → thymus. Thymocytes supported by a network of finely branched epithelial reticular cells • Thymocytes are completely surrounded epithelial reticular cells • The cortex is the site of earliest events in thymocyte development, where T cell receptor mature & positive selection take place • Mature T lymphocytes leave the cortex → the medulla.
		2-Medulla: - Contains fully differentiated T lymphocytes, which leave medulla through venules. - T cells travel to 2ry lymphatic organs (LN & spleen) where they settle in thymus dependent zones - Contains Hassall's corpuscles (diagnostic feature), which vary in size from 25 to 200 µm in diameter & are acidophilic in reaction.

Hassall's corpuscle consist mass of degenerated reticular cells surrounded e concentric layers of epithelial reticular cells



Thymus



A-Stroma
1-Capsule
2-Trabeculae

B-Parenchyma
1- Lymphocytes
2- Epithelial R cells

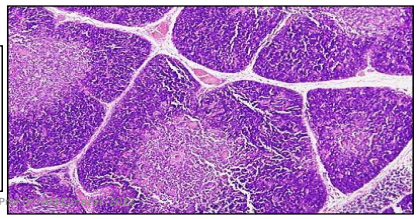
1. Cortex
2. Medulla

B-parenchyma

Cortex — Medulla

Outer & dark — Inner & pale

Both contain:
1- T. Lymphocytes.
2- Epithelial reticular cells.
3- Few macrophages.
4- Blood capillaries



T- lymphocytes

From where	**T- lymphocytes**
Fun	Responsible for cell mediated immunity & also assist B lymphocytes in initiating the humoral response (T- helper)
T- cells are several subtypes	1- Naïve 2- Memory 3- Effector (T- helper, T- cytotoxic , T- suppressor (T reg cells) & T- killer cells)
The progression of T- cell development	• The Stem cells from bone marrow travel to the thymus to reside in the outer part of cortex, once there they are called thymocytes • These thymocytes have neither CD4 nor CD8 surface markers (double –ve T cells) • Within outer cortex the thymocytes will proliferate & undergo genetic arrangement & express 2 cell markers: ✓ TCR (T cell receptor) ✓ Cluster differentiation: $CD4^+$ & $CD8^+$ (double positive T cells) • Double positive T cells that don't recognize self –MHC epitope offered to them by cortical ER cells are forced into apoptosis • (MHC: is a large section on vertebrates DNA contains all genes that code for cell surface proteins) • Still in cortex: double +ve cells that in contact e ER cells that carry MHC I will stop expressing $CD4^+$ marker & become single +ve T cells that express only $CD8^+$ maker • Double +ve T cells contact ER cells carry MHC-II stop expressing $CD8^+$ marker & become single +ve T cells that express only $CD4^+$ marker • By doing that the T cells acquired the Thymic education which was done under the influence of hormones secreted by epithelia R cells • Only 1- 3% of Double +ve T cells will survive the selection process and will allow to enter the medulla • The previous process is called positive selection and take place in the thymus cortex • The final step in maturation of T cells occurs in the medulla • The medullary ER cells will do another test & present self-epitopes of MHC-I & MHC-II to the single +ve T cells & those who bind strongly are forced to apoptosis • It has to be weak reaction to the MHC - epitopes complex to prevent autoimmune response. This called negative selection and takes place in the Thymic medulla • T cells re-enter blood stream & travel to 2ry lymphatic organs (LN & spleen) where they settle in thymus dependent zones • Epithelial Reticular cells secrete thymic hormones that stimulate: ✓ T cell differentiation ✓ Expression of surface markers • CD4+ cells called helper T cells: indirectly can kill cells indicated as foreign. • CD8+ cells called cytotoxic T cells are able directly to kill virus infected & tumor cells • MHC I molecule is expressed on all nucleated cells Except RBCs • MHC II molecule is expressed on antigen presenting cells: macrophages , dendritic cells …etc

Epithelial reticular cells (ERCs)

From where	Epithelial reticular cells (ERCs)
Char	1- Branched 2- acidophilic cells e oval nuclei 3- their long processes contain tonofilaments 4- Also called thymic nurse cells 5- They are connected together by desmosomes 6- Do not produce reticular fibers. 7- Found in both cortex & medulla (Cortical ERCs & medullary ERCs) 8- Contain secretory granules which contain the thymic hormones
Fun	1- nursing cells for T cells during their differentiation 2- Secrete the thymic hormones • Thymulin • Thymopoietin • Thymosins • Thymic humoral factor 3- Share in the blood-thymus barrier 4- Antigen presenting cells for developing T lymphocytes 5- in medulla form Hassall's corpuscles

Blood- thymes barrier

From where	Blood- thymus barrier
Located	Barrier exists in the cortex only
Fun	- to separate the developing T-lymphocytes from antigens in blood - The barrier allow immature T lymphocytes to multiply & differentiate free from foreign Ags before they migrate to medulla & leave thymus to blood
formed by	1-continuous capillary endothelium 2- pericytes 3-thick, continuous basal lamina around endothelium 4- perivacular space contains macrophages to deal e any antigen escape 5- complete layer of epithelial reticular cells around capillaries

Thymes gland of adult

From where	Thymus gland of adult
Formed by	* Fibrous & adipose tissue. * Few lymphocytes, ↓ ER cells. * ↑ Hassall's corpuscles

Malt – mucous associated lymphoid tissue

From where	**MALT- mucosa associated lymphoid tissue**
Def	**Collective name for the cells of the immune system in the mucosa of respiratory , alimentary , urogenital tracts**
Fun	**is to augment the mechanical & chemical barriers of surface mucosal epithelium**
Distribution	✓ **Tonsil** ✓ **Bronchus : BALT** ✓ **Gut: GALT**
MALT Examples are	**1 .Payer's patches of ileum .** **2. MALT of appendix.**