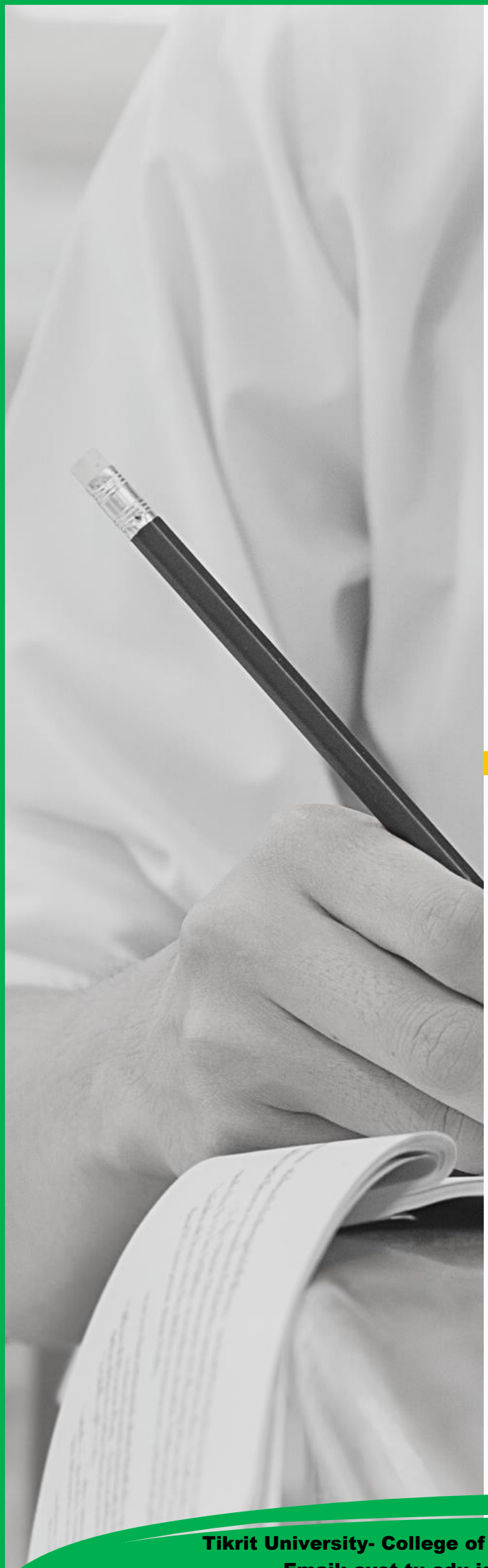

Tikrit University
College of Veterinary Medicine

Lecture5: Anatomy and Function of the Lymphoid Organs

Subject name: Immunology (Theoretical)

Subject year: Third Stage / 3rd Year

Lecturer name:

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SCAN ME

Lecturers link

2026-2025

Anatomy and Function of the Lymphoid Organs

1. Primary (Central) Lymphoid Organs

Primary organs generate and educate lymphocytes prior to antigen encounter. Bone marrow supports hematopoiesis and early B-cell development. The thymus educates T cells via positive selection in the cortex and negative selection in the medulla to enforce self-tolerance.

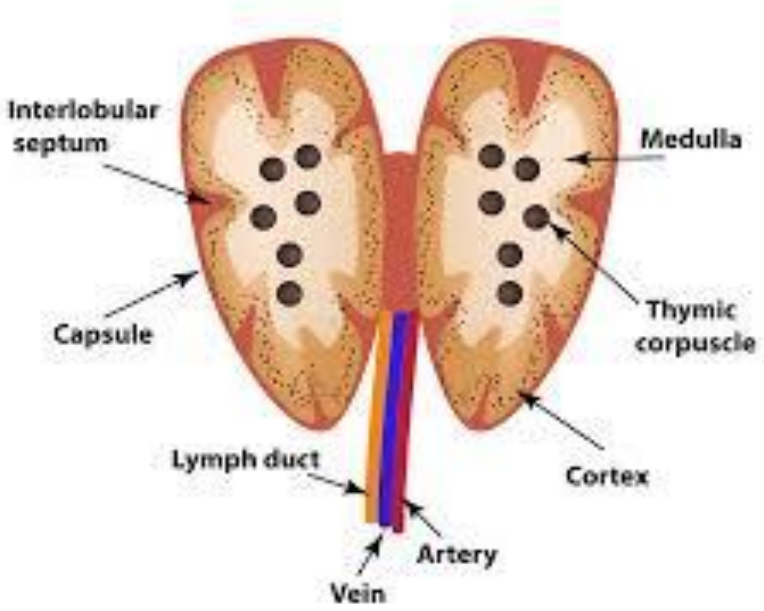

Figure 2 Thymus cortex→medulla

Bone marrow

Bone Marrow – Concise Summary

Bone marrow is a primary lymphoid organ and the central site of hematopoiesis, where all blood and immune cells originate from hematopoietic stem cells (HSCs).

Types

- **Red marrow: Active; produces immune cells and blood cells.**
- **Yellow marrow: Fat-rich; can revert to red marrow during stress or infection.**

Functions

1. Hematopoiesis

HSCs differentiate into:

- **Myeloid lineage: neutrophils, eosinophils, basophils, monocytes → macrophages, dendritic cells, erythrocytes, platelets**
- **Lymphoid lineage: B cells, T-cell precursors, NK cells, ILCs**

2. Microenvironment (Niches)

- **Endosteal niche: Maintains HSC quiescence (self-renewal).**
- **Vascular niche: Supports proliferation and release of mature cells into the bloodstream.**

3. B-Cell Development

Bone marrow is the primary site of B-cell maturation, involving:

- **Heavy and light chain gene rearrangement**
- **Negative selection to eliminate self-reactive cells**
- **Production of mature naïve B cells (IgM/IgD)**

4. Immune Support Role

- **Houses long-lived plasma cells that maintain antibody levels**
- **Contains memory T cells**
- **Produces key cytokines (IL-7, GM-CSF, G-CSF, CXCL12) that regulate immune cell development**

2. Secondary (Peripheral) Lymphoid Organs

Lymph Nodes

Encapsulated organs along lymphatic vessels that filter lymph and optimize encounters between antigen-bearing dendritic cells and naïve lymphocytes. Architecture: cortex with B-cell follicles (± germinal centers), paracortex with T cells and DCs (and HEVs), and medulla with plasma cells and macrophages.

Germinal centers are specialized structures in lymph node follicles where B lymphocytes proliferate and undergo processes like affinity maturation and isotype switching to generate long-lived plasma cells and memory B cells.

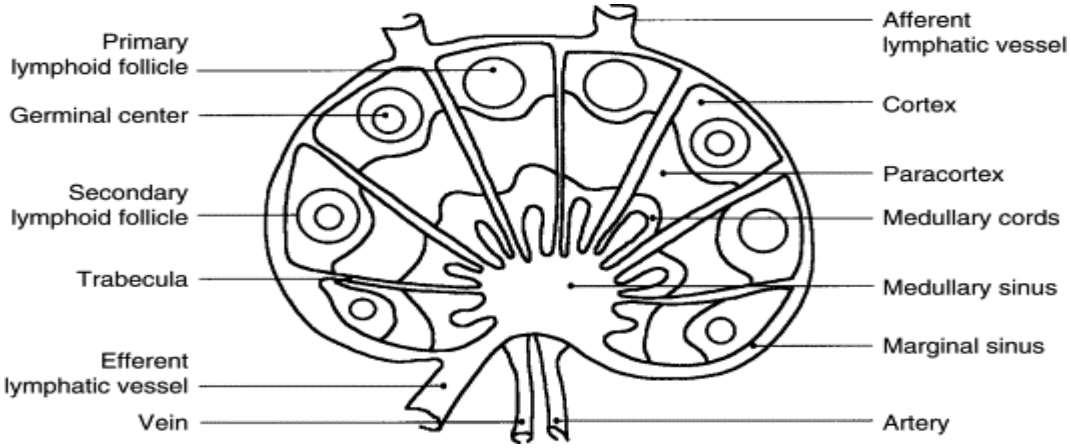

Figure 2 Lymph node architecture

Spleen

The spleen surveys blood for antigens and removes aged erythrocytes. White pulp (PALS and follicles) organizes adaptive responses to blood-borne microbes; red pulp filters and recycles red cells. The marginal zone bridges innate sampling with adaptive activation

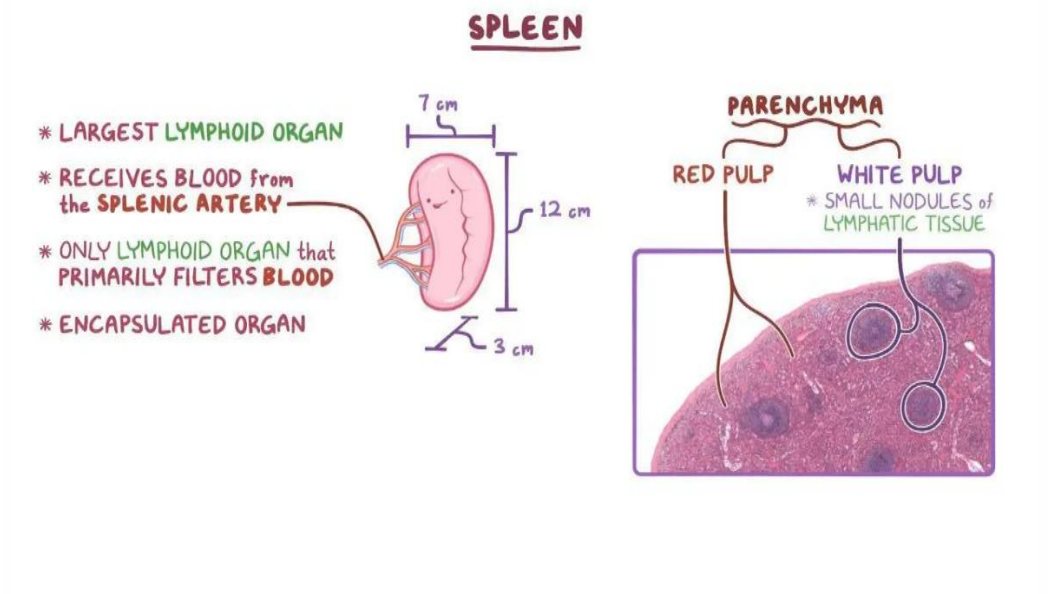

Figure :Spleen: white pulp vs red pulp; marginal zone schematics.

MALT (Mucosa-Associated Lymphoid Tissue)

Includes Peyer's patches, tonsils, and bronchus-associated lymphoid tissue. Specialized M cells sample lumenal antigens to deliver them to immune cells. MALT promotes IgA-mediated, relatively non-inflammatory defenses suited to constant environmental exposure.

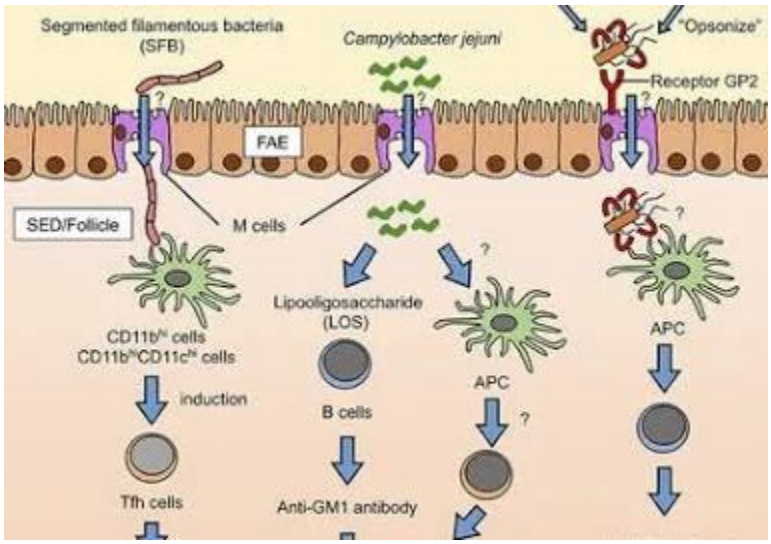

Figure 8 — Peyer's patch with M cells and underlying lymphoid tissue.

Cutaneous (Skin-Associated) Immune System

Skin hosts Langerhans cells, dermal DCs, macrophages, ILCs, and resident memory T cells. It provides a physical barrier and a rapid immunologic response to breaches.

3. The Lymphatic System

A one-way vascular network that returns interstitial fluid to blood, transports antigens and APCs to nodes, and maintains tissue fluid homeostasis. Lymph flows from capillaries to collecting vessels and nodes, then to the thoracic duct/right lymphatic duct and into the bloodstream. Flow depends on skeletal muscle movement and vessel valves.

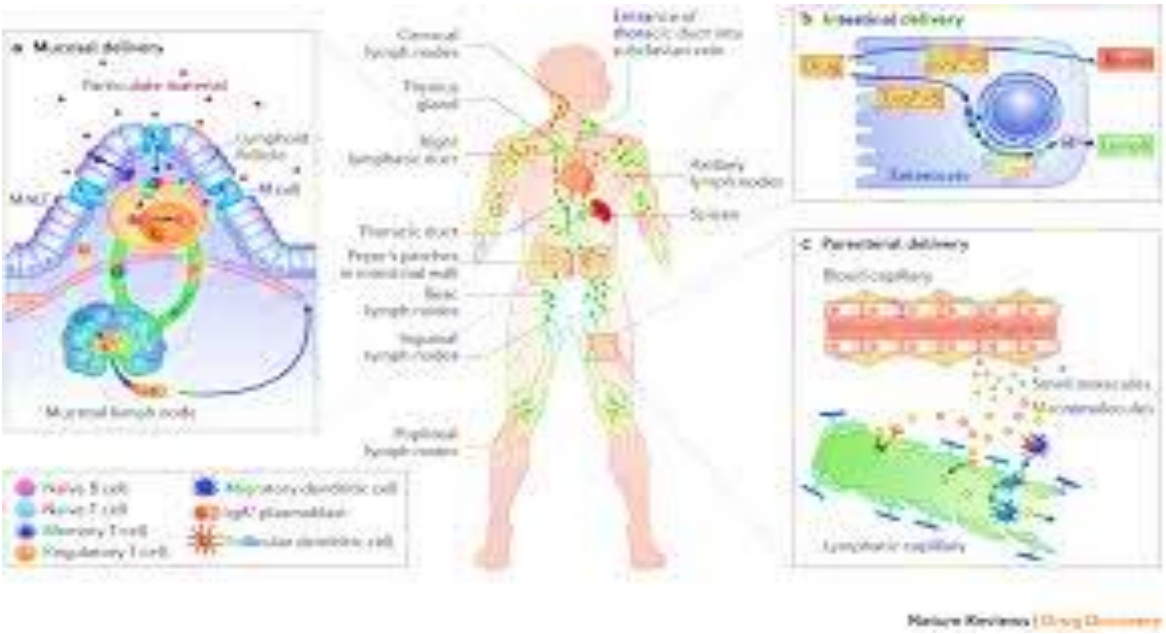

Figure 9 — Body-wide lymphatic drainage pathways and ducts.

4. From Naïve to Effector

Naïve lymphocytes enter nodes via high endothelial venules, scan DCs for cognate antigen, receive co-stimulation and cytokines, and undergo clonal expansion. B cells form germinal centers for affinity maturation and class switching; T cells polarize into effector subsets. Outputs exit via efferent lymphatics (nodes) or splenic sinusoids (spleen) to reach sites of need.

5 Reference Tables

Category	Primary (Central)	Secondary (Peripheral)
Core function	Lymphocyte generation & education (B in marrow, T in thymus)	Antigen encounter, activation, proliferation, differentiation
Main structures	Bone marrow, Thymus	Lymph nodes, Spleen, MALT, Skin-associated system
Key processes	Positive/negative selection (T); early B maturation	Germinal centers, DC–T priming, plasma cell generation

Cell Type	Primary Functions	Notes
Neutrophil	Phagocytosis; ROS; NETs	First responder; short-lived
Macrophage	Phagocytosis; cytokines; APC	M1 vs M2 polarization
Dendritic Cell	Antigen capture & T-cell priming	Conventional vs plasmacytoid refers to a type of immune cell, the plasmacytoid dendritic cell (pDC), which has a physical appearance similar to plasma cells but functions like a dendritic cel
B Cell	Antibody production; memory	Germinal centers(GC) affinity maturation
T Cell	Helper/CTL/regulatory functions	Th subsets; cytotoxicity
NK Cell	Cytotoxic killing of abnormal cells	No antigen-specific receptor