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DEPARTMENT OF BIOTECHNOLOGY
FACULTY OFENGINEERING & TECHNOLOGY

LT.2 : Cells & organs of the immune system.

Content Outline

1. Immune System Organ
2. Primary Lymphoid Organ
3. Secondary Lymphoid Organ
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Immune system organs

•The key primary lymphoid organs of the immune system include the thymus and bone marrow, as well as secondary lymphatic tissues including spleen, tonsils, lymph vessels, lymph nodes, adenoids, skin, and liver.

•The thymus “educates” T cells and provides an inductive environment for the development of T cells from hematopoietic progenitor cells. The thymus is largest and most active during the neonatal and pre-adolescent periods of development. By the early teens, the thymus begins to atrophy and thymic stroma is replaced by adipose tissue. Nevertheless, residual T-lymphopoiesis continues throughout adult life.

•Bone marrow is the flexible tissue found in the interior of bones. In humans, red blood cells are produced in the heads of long bones. The red bone marrow is a key element of the lymphatic system, being one of the primary lymphoid organs that generate lymphocytes from immature hematopoietic progenitor cells. Bone marrow and thymus constitute the primary lymphoid tissues involved in the production and early selection of lymphocytes.

•The lymphatic system is a part of the circulatory system, comprising a network of conduits called lymphatic vessels that carry a clear fluid, called lymph, unidirectionally towards the heart. The lymphatic system has multiple interrelated functions including the transportation of white blood cells to and from the lymph nodes into the bones, and the transportation of antigen -presenting cells (such as dendritic cells) to the lymph nodes where an immune response is stimulated. Lymphoid tissue is found in many organs, particularly the lymph nodes.

•**Primary Lymphoid Organs**

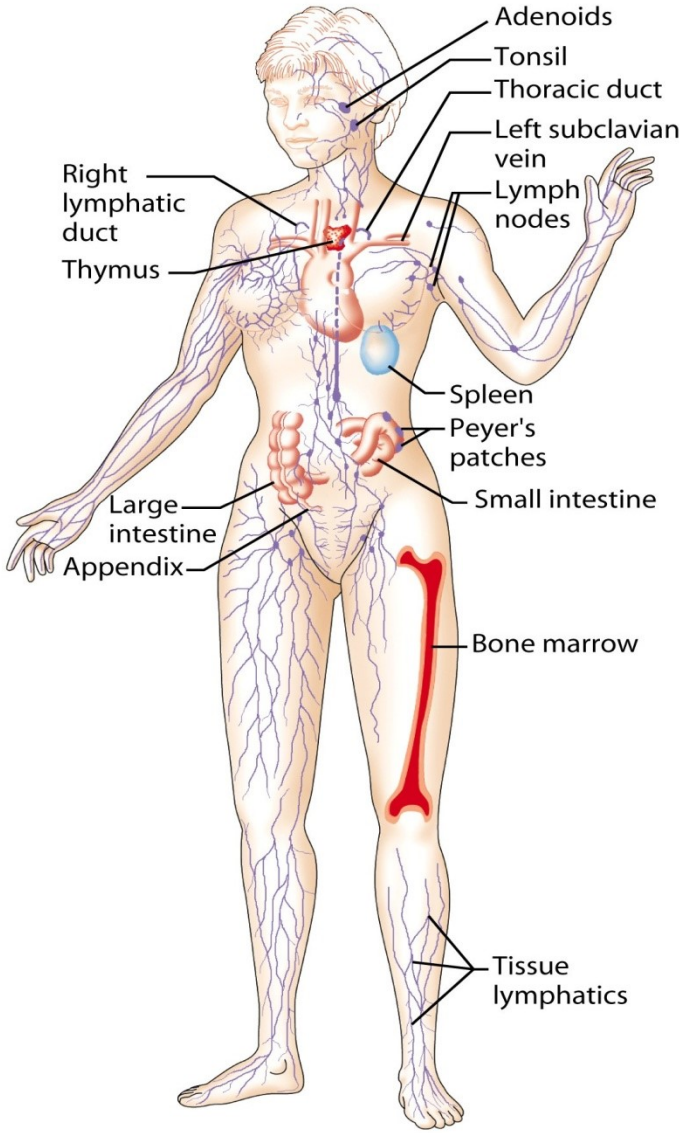
- •Bone Marrow and Thymus
- •Maturation Site

➢Immature lymphocytes generated in hematopoiesis mature and become committed to a particular antigenic specificity within the primary lymphoid organs.

➢Only after a lymphocyte has matured within a primary lymphoid organ is the cell **immunocompetent** (capable of mounting an immune response). T cells arise in the **thymus,** and in many mammals—humans and mice for example—B cells originate in **bone marrow**

➢ **Secondary Lymphoid Organs**

- •Spleen, lymph nodes,
- •MALT (mucosal associated lymph tissue)
- •GALT (gut associated lymph tissue)
- •Trap antigen, APC, Lymphocyte Proliferation

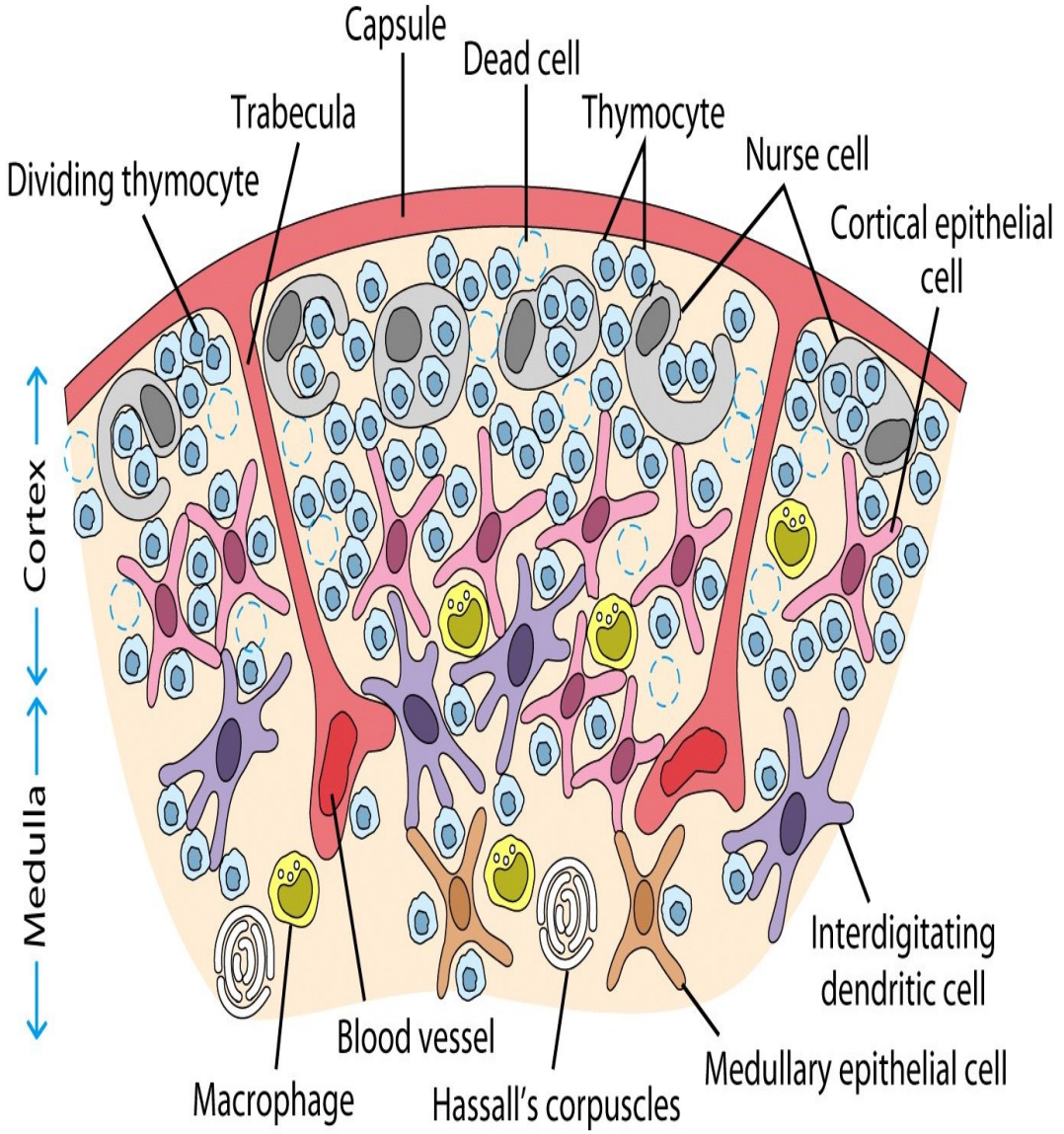


Primary lymphoid organs: Thymus

•Bilobed Organ on Top of Heart; Each lobule is organized into two compartments: the outer compartment, or *cortex,* is densely packed with immature T cells, called thymocytes, whereas the inner compartment, or *medulla,* is sparsely populated .

•The function of the thymus is to generate and select a repertoire of T cells that will protect the body from infection.

•As thymocytes develop, an enormous diversity of T-cell receptors is generated by a random process (see Chapter 9) that produces some T cells with receptors capable of recognizing antigen-MHC complexes.



•Importance of the thymus comes from studies of a congenital birth defect in humans **(DiGeorge's syndrome)** and in certain mice **(nude mice)** in which the thymus fails to develop.

•In both cases, there is an absence of circulating T cells and of cell-mediated immunity and an increase in infectious disease.

•Aging is accompanied by a decline in thymic function. This decline may play some role in the decline in immune function during aging in humans and mice.

Primary lymphoid organs: Bone marrow

•In humans and mice, bone marrow is the site of B-cell origin and development.

• Arising from lymphoid progenitors, 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 .

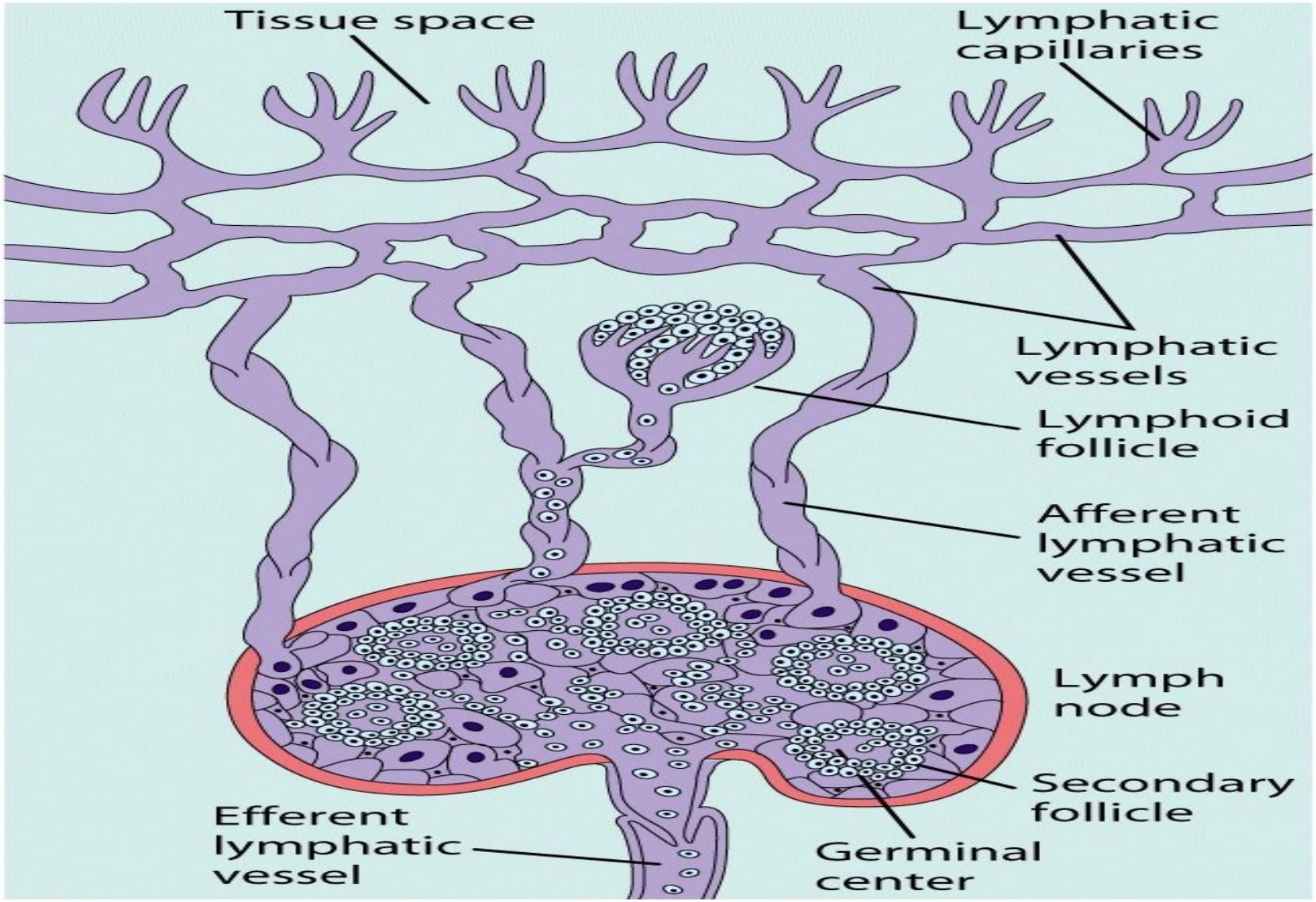
•Bone marrow is not the site of B-cell development in all species. In birds, a lymphoid organ called the bursa of Fabricius, a lymphoid.

•tissue associated with the gut, is the primary site of B-cell maturation.

Lymphatic system

The *lymphatic system* is a network of tissues and organs that help rid the body of toxins, waste and other unwanted materials. The primary function of the *lymphatic system* is to transport *lymph*, a fluid containing infection-fighting white blood cells, throughout the body.

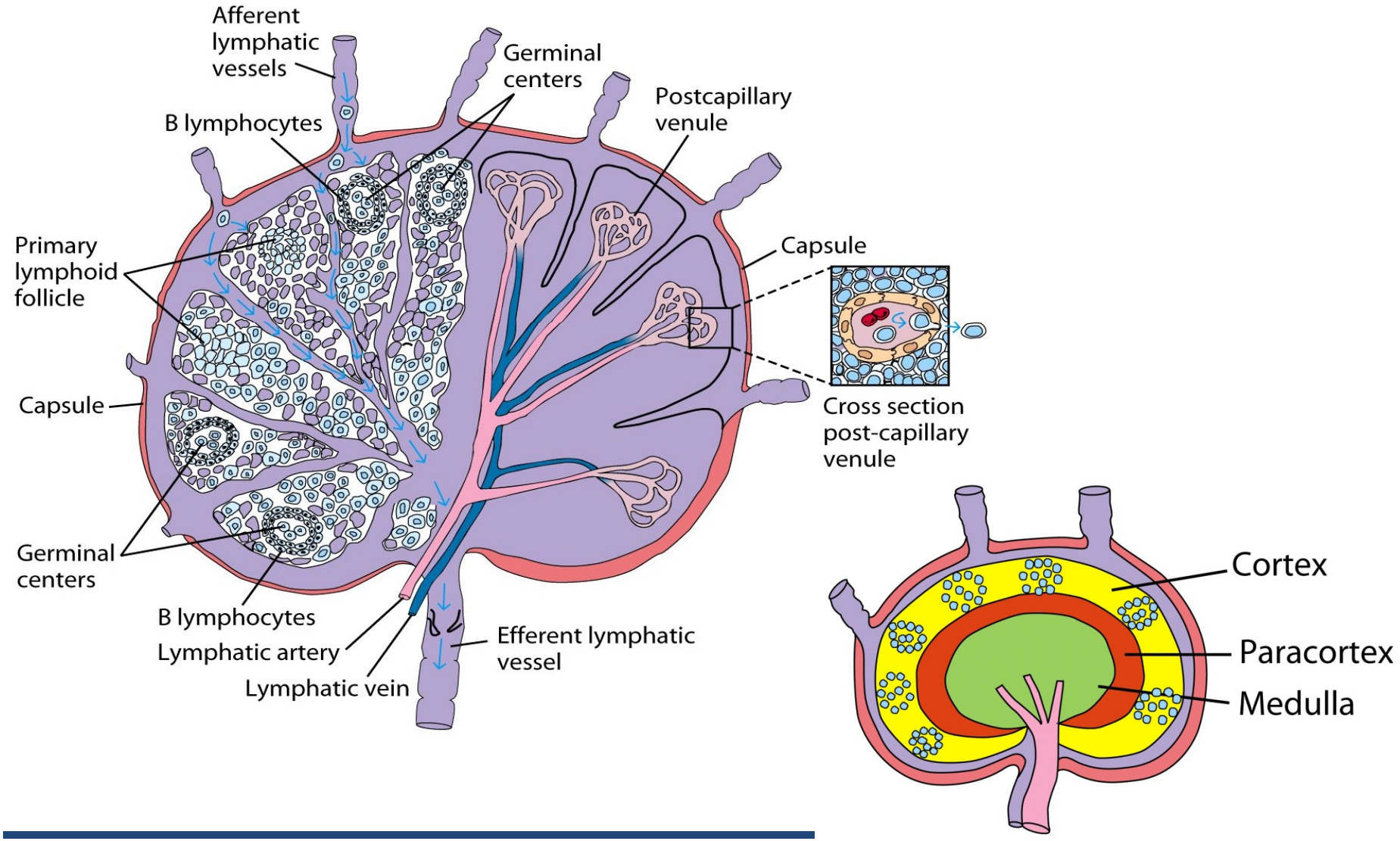
- Plasma From Blood Seeps Into Tissue
- Interstitial Fluid Either Goes Back or Becomes Lymph
- Lymph Enters Lymphatic Vessels
- Thoracic Duct Is Largest Lymphatic Vessel Empties Into Left Subclavian Vein
- Lymphatic Vessel Depends On Muscle Contractions For Movement
- One Way Valves Ensure One Direction
- Lymph Nodes Act As Filters For Antigens


Tissue space
Lymphatic capillaries
Lymphatic vessels
Lymphoid follicle
Afferent lymphatic vessel
Lymph node
Secondary follicle
Germinal center
Efferent lymphatic vessel

•**Lymph nodes** and the **spleen** are the most highly organized of the secondary lymphoid organs; they comprise not only lymphoid follicles, but additional distinct regions of Tcell and B-cell activity, and they are surrounded by a fibrous capsule.

•Less-organized lymphoid tissue, collectively called mucosal-associated lymphoid tissue (MALT), is found in various body sites. MALT includes Peyer's patches (in the small intestine), the tonsils, and 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.

Lymph node


Afferent lymphatic vessels
Germinal centers
B lymphocytes
Postcapillary venule
Primary lymphoid follicle
Capsule
Capsule
Cross section post-capillary venule
Germinal centers
B lymphocytes
Lymphatic artery
Lymphatic vein
Efferent lymphatic vessel
Cortex
Paracortex
Medulla

•Lymph nodes are the sites where immune responses are mounted to antigens in lymph. They are encapsulated beanshaped structures containing a reticular network packed with lymphocytes, macrophages, and dendritic cells.

•Multiple Afferent Lymphatics

•Cortex

- •B-cells, Follicular DCs, MΦ, GCs, Primary Follicles

•Paracortex

- •T_H, MΦ, DCs

•Medulla

- •Plasma Cells

•Post Capillary Venule

- •Allow Lymphocyte Migration From Circuilation Into Lymph Node

•One Efferent Lymphatic

- •Rich In Abs and Lymphocytes

•Until it is activated by antigen, a lymphoid follicle—called a **primary follicle**—comprises a network of follicular dendritic cells and small restingB cells.

• After an antigenic challenge, a primary follicle becomes a larger **secondary follicle**—a ring of concentrically packed B lymphocytes surrounding a center (the **germinal center**) in which one finds a focus of proliferating B lymphocytes and an area that contains nondividing B cells, and some helper T cells interspersed with macrophages and follicular dendritic cells .

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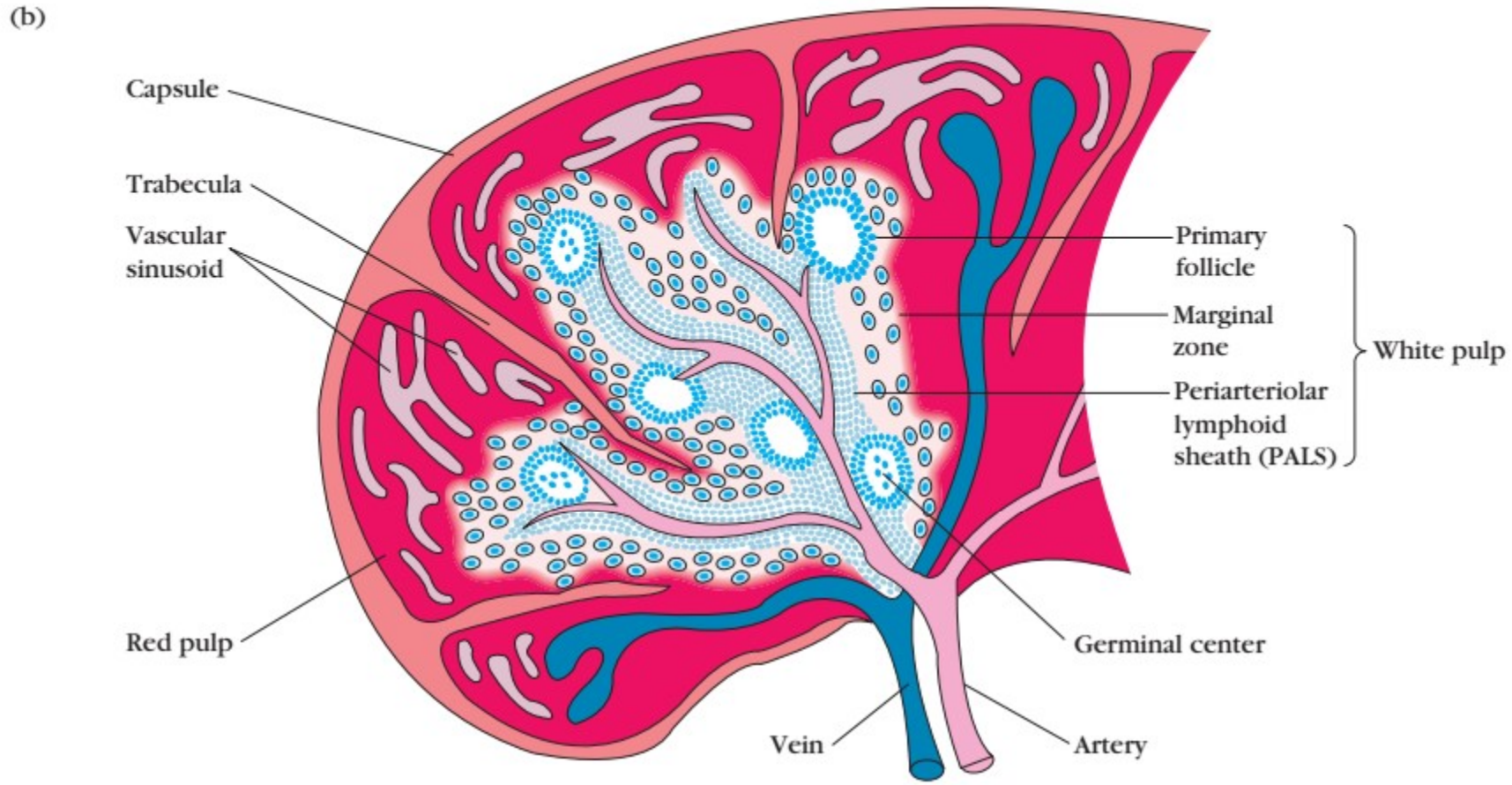
Spleen

•The spleen, which is about 5 inches long in adults, is the largest secondary lymphoid organ. It is specialized for trapping blood-borne antigens and plays a major role in mounting immune responses to antigens in the blood stream. It is a large, ovoid secondary lymphoid organ situated high in the left abdominal cavity. While lymph nodes are specialized for trapping antigen from local tissues, the spleen specializes in filtering blood and trapping blood-borne antigens; thus, it can respond to systemic infections. The blood borne antigens and lymphocytes are carried into the spleen through the splenic artery.

•The splenic **white pulp** surrounds the branches of the splenic artery, forming a **periarteriolar lymphoid sheath (PALS)** populated mainly by T lymphocytes. The white pulp is surrounded by the marginal zone — a region that contains discrete subsets of macrophages and B cells. Whereas blood flows freely through the marginal zone, the white pulp is excluded from the bloodstream, and specific signals are required for entry.

•The effects of splenectomy on the immune response depend on the age at which the spleen is removed. In children, splenectomy often leads to an increased incidence of bacterial sepsis caused primarily by *Streptococcus pneumoniae, Neisseria meningitidis,* and *Haemophilus influenzae.* Splenectomy in adults has less adverse effects, although it leads to some increase in blood-borne bacterial infections **(bacteremia).**



Diagrammatic cross section of the **spleen**. The splenic artery pierces thecapsule and divides into progressively smaller arterioles, ending in vascular sinusoids that drain back into the splenic vein. The erythro cyte-filled red pulp surrounds the sinusoids. The white pulp forms asleeve, the periarteriolar lymphoid sheath (PALS), around the arterioles; this sheath contains numerous T cells. Closely associated with the PALS is the marginal zone, an area rich in B cells that containslymphoid follicles that can develop into secondary follicles containing germinal centers

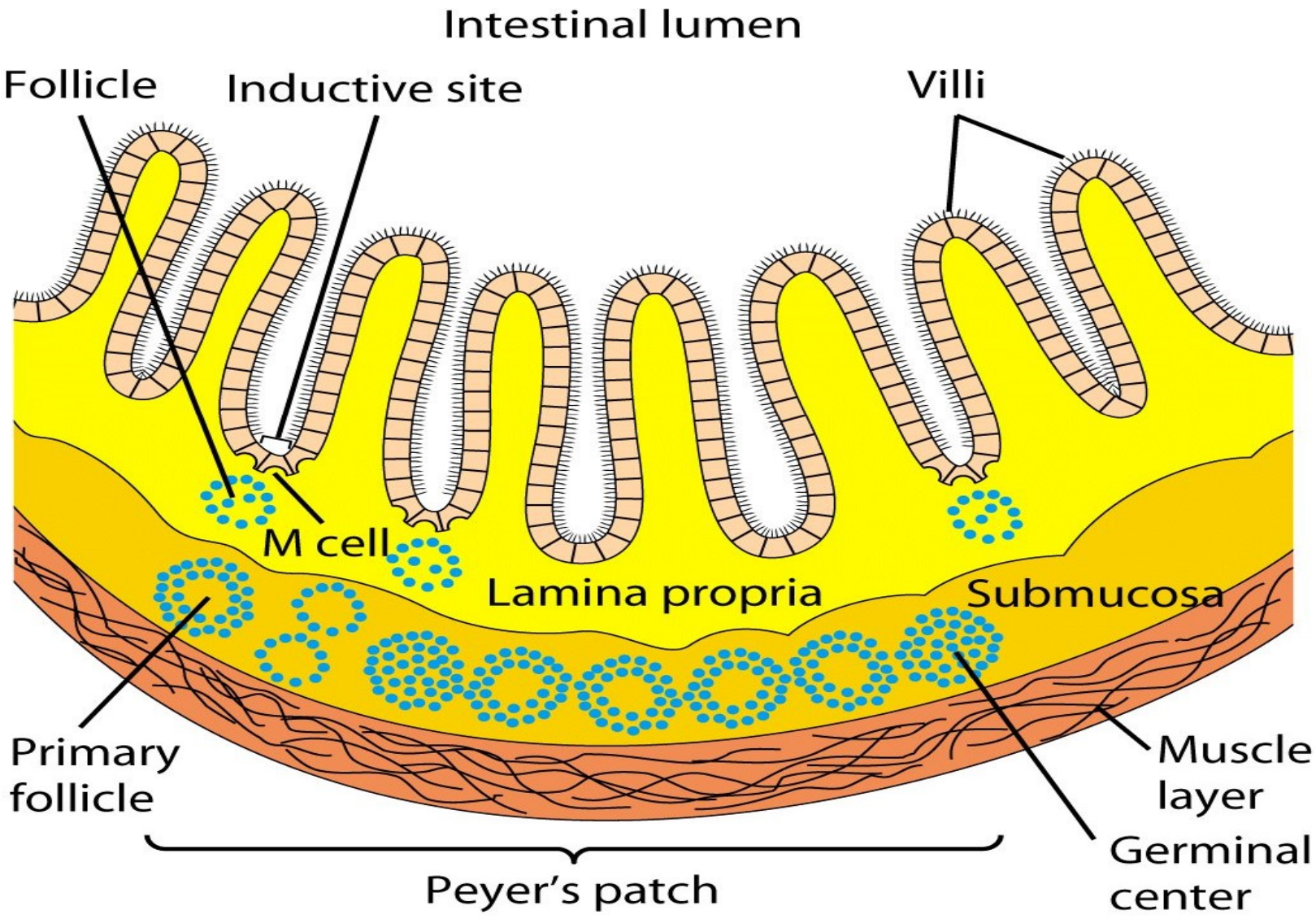
MUCOSAL-ASSOCIATED LYMPHOID TISSUE

•The mucous membranes lining the digestive, respiratory, and urogenital systems have a combined surface area of about 400 m2 (nearly the size of a basketball court) and are the major sites of entry for most pathogens. These vulnerable membrane surfaces are defended by a group of organized lymphoid tissues mentioned earlier and known collectively as **mucosal-associated lymphoid tissue (MALT).**

•Structurally, these tissues range from loose, barely organized clusters of lymphoid cells in the lamina propria of intestinal villi to well-organized structures such as the familiar tonsils and appendix, as well as Peyer's patches, which are found within the submucosal layer of the intestinal lining.

•The functional importance of MALT in the body's defense is attested to by its large population of antibody-producing plasma cells, whose number far exceeds that of plasma cells in the spleen, lymph nodes, and bone marrow combined

- Mucous Membranes S.A=400m^2
- Mucous Membr. Most Common Pathogen Entry Site
- M.M Protected by MALT
- Organization Varies (most organized P.P, Tonsils, appendix
- GI Tract, IEL Unique $\gamma\delta$ TCRs
- Lamina Propia (below epithelium) MΦ, B cells, T_H
- M Cell Allows Ag Entry, Unique Architecture


Intestinal lumen
Follicle
Inductive site
Villi
M cell
Lamina propria
Submucosa
Primary follicle
Muscle layer
Germinal center
Peyer's patch

•The best studied of the mucous membranes is the one that lines the gastrointestinal tract. This tissue, like that of the respiratory and urogenital tracts, has the capacity to endocytose antigen from the lumen.

•The outer mucosal epithe lial layer contains so-called **intraepithelial lymphocytes (IELs).**

•The epithelial cells of mucous membranes play an important role in promoting the immune response by delivering small samples of foreign antigen from the lumina of the respiratory, digestive, and urogenital tracts to the underlying mucosal-associated lymphoid tissue. This antigen transport is carried out by specialized **M cells.**

•Mucous membranes are an effective barrier to the entrance of most pathogens, which thereby contributes to nonspecific immunity. One reason for this is that the mucosal epithelial cells are cemented to one another by tight junctions that make it difficult for pathogens to penetrate.

Cells of Immune system

lymphocytes: A lymphocyte is a type of white blood cell in the vertebrate immune system. The three major types of lymphocyte are T cells, B cells and natural killer (NK) cells. T cells (thymus cells) and B cells (bursa-derived cells) are the major cellular components of the adaptive immune response.

Leukocytes: Cells of the immune system involved in defending the body against both infectious disease and foreign materials. Five different and diverse types of leukocytes exist.

•Lymphocytes are the central cells of the immune system, responsible for adaptive immunity and the immunologic attributes of diversity, specificity, memory, and self/nonself recognition.

Lymphoid cells

•The lymphocytes can be broadly subdivided into three populations—B cells, T cells, and natural killer cells—on the basis of function and cell-membrane components. **Natural killer cells (NK cells)** are large, granular lymphocytes that do not express the set of surface markers typical of B or T cells

•Resting B and T lymphocytes are small, motile, nonphagocytic cells, which cannot be distinguished morphologically. B and T lymphocytes that have not interacted with antigen— referred to as **naive,** or unprimed—are resting cells in the G0 phase of the cell cycle.

•Interaction of small lymphocytes with antigen, in the presence of certain cytokines induces these cells to enter the cell cycle by progressing from G0 into G1 and subsequently into S, G2, and M .

•As they progress through the cell cycle, lymphocytes enlarge into 15 μm-diameter blast cells, called **lymphoblasts;** these cells have a higher cytoplasm:nucleus ratio and more organellar complexity than small lymphocytes .

•Lymphoblasts proliferate and eventually differentiate into **effector cells** or into **memory cells.** Effector cells function in various ways to eliminate antigen.

B-lymphocytes

•The B lymphocyte derived its letter designation from its site of maturation, in the *b*ursa of Fabricius in birds; the name turned out to be apt, for *b*one marrow is its major site of maturation in a number of mammalian species, including humans and mice. Mature B cells are definitively distinguished from other lymphocytes by their synthesis and display of membrane-bound immunoglobulin (antibody) molecules, which serve as receptors for antigen. Each of the approximately 1.5 ×10^5 molecules of antibody on the membrane of a single B cell has an identical binding site for antigen.

•Among the other molecules expressed on the membrane of mature B cells are the following:

■ **B220** (a form of CD45) is frequently used as a marker for B cells and their precursors. However, unlike antibody, it is not expressed uniquely by B-lineage cells.

■ **Class II MHC molecules** permit the B cell to function as an antigen-presenting cell (APC).

■ **CR1** (CD35) and **CR2** (CD21) are receptors for certain complement products.

■ **Fc RII** (CD32) is a receptor for IgG, a type of antibody.

■ **B7-1** (CD80) and **B7-2** (CD86) are molecules that interact with CD28 and CTLA-4, important regulatory molecules on the surface of different types of T cells, including TH cells.

■ **CD40** is a molecule that interacts with CD40 ligand on the surface of helper T cells. In most cases this interaction is critical for the survival of antigen stimulated B cells and for their development into antibody-secreting plasma cells or memory B cells.

•Interaction between antigen and the membrane-bound antibody on a mature naive B cell, as well as interactions with T cells and macrophages, selectively induces the activation and differentiation of B-cell clones of corresponding specificity.

•In this process, the B cell divides repeatedly and differentiates over a 4- to 5-day period, generating a population of plasma cells and memory cells. Plasma cells, which have lower levels of membrane-bound antibody than B cells, synthesize and secrete antibody.

T-lymphocytes

•T lymphocytes derive their name from their site of maturation in the *t*hymus. Like B lymphocytes, these cells have membrane receptors for antigen.

•Unlike the membrane-bound antibody on B cells, though, the T-cell receptor (TCR) does not recognize free antigen. Instead the TCR recognizes only antigen that is bound to particular classes of self-molecules. Most T cells recognize antigen only when it is bound to a self-molecule encoded by genes within the major histocompatibility complex (MHC) .

•Like B cells, T cells express distinctive membrane molecules. All T-cell subpopulations express the T-cell receptor, a complex of polypeptides that includes CD3; and most can be distinguished by the presence of one or the other of two membrane molecules, CD4 and CD8 .

•T cells that express the membrane glycoprotein molecule CD4 are restricted to recognizing antigen bound to class II MHC molecules, whereas T cells expressing CD8, a dimeric membrane glycoprotein, are restricted to recognition of antigen bound to class I MHC molecules. Thus the expression of CD4 versus CD8 corresponds to the MHC restriction of the T cell.

Classes of T-cells

T cells can be categorized into three distinct classes: **helper T cells**, regulatory T cells, and **cytotoxic T cells**. These classes are differentiated based on their expression of certain surface molecules, their mode of activation, and their functional roles in adaptive immunity

Class	Surface CD Molecules	Activation	Functions
Helper T cells	CD4	APCs presenting antigens associated with MHC II	Orchestrate humoral and cellular immunity
			Involved in the activation of macrophages and NK cells
Regulatory T cells	CD4	APCs presenting antigens associated with MHC II	Involved in peripheral tolerance and prevention of autoimmune responses
Cytotoxic T cells	CD8	APCs or infected nucleated cells presenting antigens associated with MHC I	Destroy cells infected with intracellular pathogens

The different classes of T cells also play different functional roles in the immune system. **Helper T cells** serve as the central orchestrators that help activate and direct functions of humoral and cellular immunity. In addition, helper T cells enhance the pathogen-killing functions of **macrophages** and **NK cells** of innate immunity. In contrast, the primary role of regulatory T cells is to prevent undesirable and potentially damaging immune responses. Their role in **peripheral tolerance**, for example, protects against **autoimmune disorders**, as discussed earlier. Finally, **cytotoxic T cells** are the primary effector cells for cellular immunity. They recognize and target cells that have been infected by **intracellular pathogens**, destroying infected cells along with the pathogens inside.

Cytotoxic T Cells (CD8 T Cells)

Cytotoxic T cells kill their target cells, primarily by releasing cytotoxic granules into the cell to be killed. These cells recognise their specific antigen (such as fragments of viruses) when presented by **MHC Class I** molecules that are present on the surface of all nucleated cells.

MHC Class I molecules interact with a protein called CD8 on the cytotoxic T cells, which helps to identify this cell type. **Cytotoxic** T cells require several signals from other cells to be activated, such as from dendritic cells and T helper cells.

Their main function is to kill virally infected cells, but they also kill cells with intracellular bacteria or tumorous cells.

T-Helper Cells (Th) (CD4 T Cells)

T helper cells have a wider range of effector functions than CD8 T cells and can differentiate into many different subtypes, such as **Th1, Th2, Th17** and regulatory T cells.

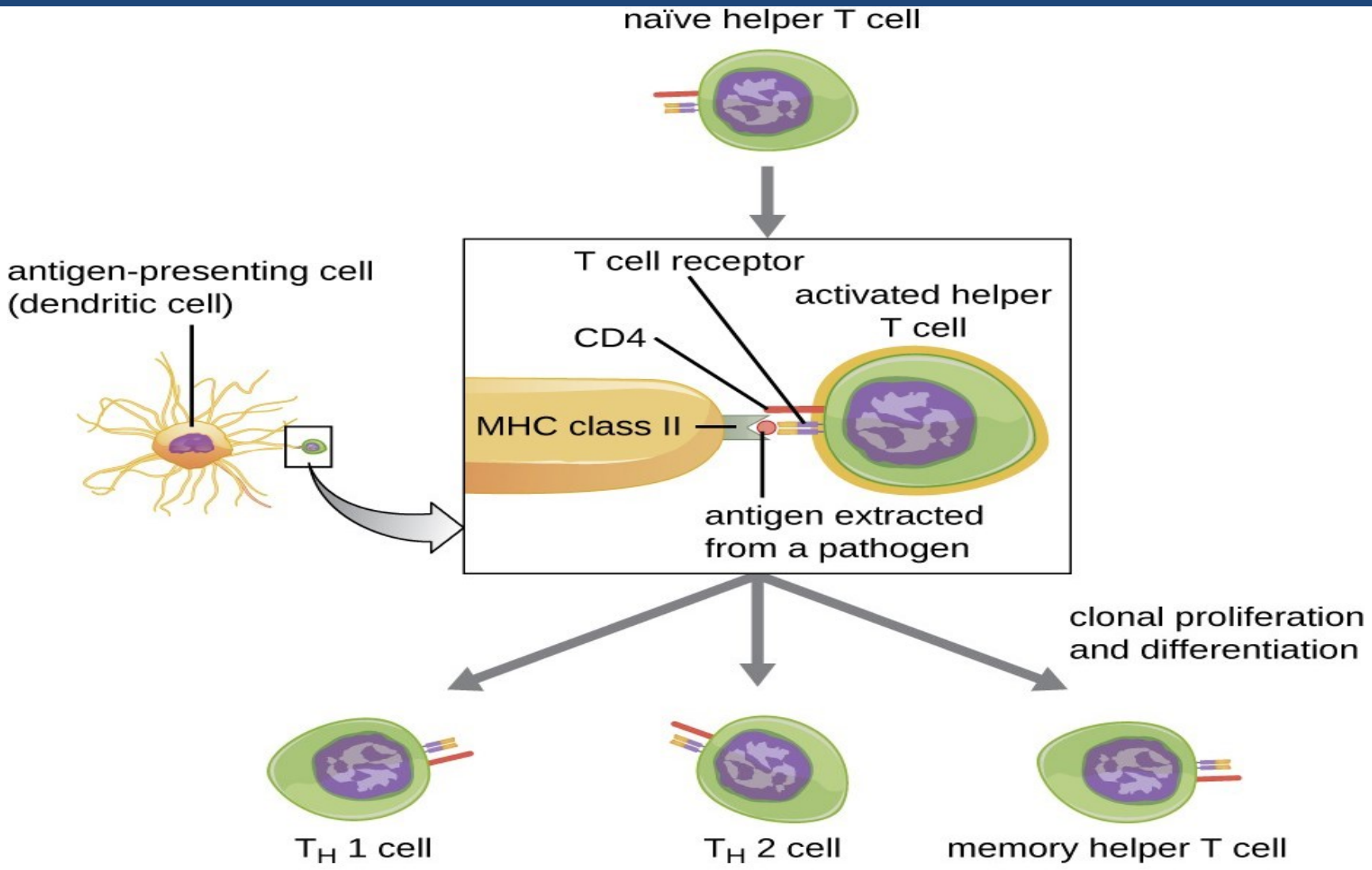
They become activated when they are presented with peptide antigens by MHC Class II molecules, which are expressed on the surface of APCs. **MHC Class II** molecules interact with a protein called CD4 on the T helper cells, which helps to identify this cell type.

The roles of a CD4 T cell may include activating other immune cells, releasing **cytokines,** and helping B cells to produce antibodies. They help to shape, activate and regulate the adaptive immune response.

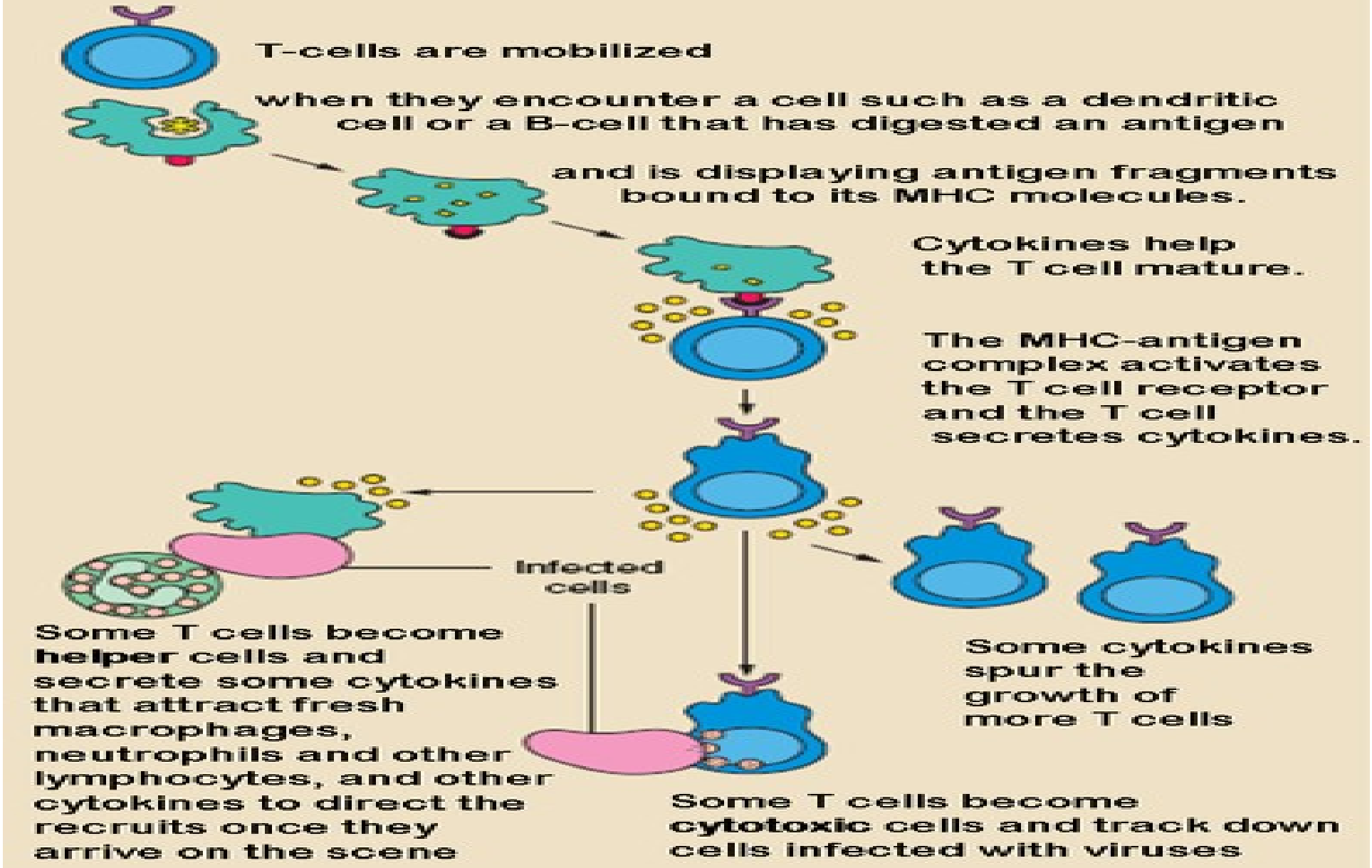
Memory T Cells

Following an infection, antigen-specific, long-lived memory T cells are formed. **Memory T cells** are important because they can quickly expand to large numbers of effector T cells upon re-exposure to the antigen and have a low threshold for activation.

They provide the immune system with memory against previously encountered antigens. Memory T cells may either be CD4+ or CD8+.



This illustration depicts the activation of a naïve (unactivated) helper T cell by an antigen-presenting cell and the subsequent proliferation and differentiation of the activated T cell into different subtypes.


T-cells are mobilized
when they encounter a cell such as a dendritic cell or a B-cell that has digested an antigen
and is displaying antigen fragments bound to its MHC molecules.
Cytokines help the T cell mature.
The MHC-antigen complex activates the T cell receptor and the T cell secretes cytokines.
Infected cells
Some T cells become helper cells and secrete some cytokines that attract fresh macrophages, neutrophils and other lymphocytes, and other cytokines to direct the recruits once they arrive on the scene
Some cytokines spur the growth of more T cells
Some T cells become cytotoxic cells and track down cells infected with viruses

•**Null cell/ NK cells:** They are large, granulated lymphocytes and constitute 5 to 10 % of the peripheral blood lymphocytes in humans. These cells are involved in immune defenses against viruses and tumor and are stimulated by IFN-α, IFN-β, and IL-12. They also display membrane marker such as CD2, the 75-kDa subunit of the IL-2 receptor, and, on almost all NK cells, CD16 (or FcRIII), a receptor for the Fc region of IgG. NK cells are constitutively cytotoxic, and contain numerous granules such as perforin and granzymes in their cytoplasm for killing tumour cells and virus infected cells. Their killing mechanism is similar to CTLs (Cytotoxic T lymphocytes) mediated response. The Chediak-Higashi syndrome illustrates the disastrous consequences of a lack of NK cells (The identfying features of this disease is progressive neurological dysfunction, an increased tendency to develop leukemia and lymphoma, and depigmentation of hair, skin and eyes).

•Because NK cells express CD16, a membrane receptor for the carboxyl-terminal end of the IgG molecule, called the Fc region, they can attach to these antibodies and subsequently destroy the targeted cells. This is an example of a process known as **antibody-dependent cellmediated cytotoxicity (ADCC).**

Several observations suggest that NK cells play an important role in host defense against tumors. For example, in humans the **Chediak-Higashi syndrome**—an autosomal recessive disorder—is associated with impairment in neutrophils, macrophages, and NK cells and an increased incidence of lymphoma .

Mononuclear Phagocytes

The mononuclear phagocytic system consists of **monocytes** circulating in the blood and **macrophages** in the tissues.

Macrophages are specialized cells involved in the detection, phagocytosis and destruction of bacteria and other harmful organisms. In addition, they can also present antigens to T cells and initiate inflammation by releasing molecules (known as **cytokines**) that activate other cells. Macrophages originate from blood **monocytes** that leave the circulation to differentiate in different tissues. There is a substantial heterogeneity among each macrophage population, which most probably reflects the required level of specialisation within the environment of any given tissue.

•This heterogeneity is reflected in their morphology, the type of pathogens they can recognise, as well as the levels of inflammatory cytokines they produce (i.e. **IL-1**, **IL-6**, **tumour necrosis factor alpha, Interferon-α**). In addition, macrophages produce reactive oxygen species, such as **nitric oxide**, that can kill phagocytosed bacteria. Activated macrophages also synthesize **lysozyme** and various hydrolytic enzymes whose degradative activities do not require oxygen.

•In addition, activated macrophages produce a group of antimicrobial and cytotoxic peptides commonly known as **defensins.** These molecules are cysteine-rich cationic peptides containing 29–35 amino-acid residues. Defensins can kill a variety of bacteria, including *Staphylococcus aureus, Streptococcus pneumoniae, Escherichia coli* , *Pseudomonas aeruginosa,* and *Haemophilus influenzae.*

•Activated macrophages also secrete **tumor necrosis factor (TNF-),** a cytokine that has a variety of effects and is cytotoxic for some tumor cells . Macrophages are able to detect products of bacteria and other microorganisms using a system of recognition receptors such as **Toll-like receptors** (**TLRs**). These receptors can bind specifically to different pathogen components like sugars (**LPS**), RNA, DNA or extracellular proteins (for example, **flagellin** from bacterial flagella).

•Macrophages migrate to and circulate within almost every tissue, patrolling for pathogens or eliminating dead cells.

Types of macrophage

Type of macrophage	Location	Function
Alveolar macrophage	Lung alveoli	Phagocytosis of small particles, dead cells or bacteria. Initiation and control of immunity to respiratory pathogen
Kupffer cells	Liver	Initiate immune responses and hepatic tissue remodelling.
Microglia	Central nervous system	Elimination of old or dead neurons and control of immunity in the brain.
Splenic macrophages (marginal zone, metallophilic and red pulp macrophages)	Spleen marginal zone, red and white pulp	Elimination of dysfunctional or old red blood cells

•**Neutrophils:**

•Neutrophils, also known as polymorphonuclear (PMN) leukocytes, are the most abundant cell type in human blood (50-75 %). The **neutrophil** has a multilobed nucleus and a granulated cytoplasm that stains with both acid and basic dyes. Neutrophils form an essential part of the innate immune system and belong to a class of innate immune cells called **granulocytes**.

•Movement of circulating neutrophils into tissues, called **extravasation,** takes several steps: the cell first adheres to the vascular endothelium, then penetrates the gap between adjacent endothelial cells lining the vessel wall, and finally penetrates the vascular basement membrane, moving out into the tissue spaces.

•Neutrophils are active phagocytic cells containing lytic and bactericidal substances enclosed within primary and secondary granules. The larger, denser primary granules are a type of lysosome containing peroxidase, lysozyme, and various hydrolytic enzymes. The smaller secondary granules contain collagenase, lactoferrin, and lysozyme.

•Three main antimicrobial functions are recognized for neutrophils: phagocytosis, degranulation, and the release of nuclear material in the form of neutrophil extracellular traps (NETs). These functions were considered, until recently, the only purpose of neutrophils. Neutrophils respond to multiple signals and respond by producing several cytokines and other inflammatory factors that influence and regulate inflammation and also the immune system.

Eosinophils: The **eosinophil** has a bilobed nucleus and a granulated cytoplasm that stains with the acid dye eosin red (hence its name). They are also motile phagocytic cells like neutrophils and can migrate from the blood into tissue spaces. They secrete basic proteins, sulfotransferase and sulfatase which damages parasitic membrane. They also have Fc receptor for IgE and show antibody dependent cell-mediated cytotoxicity.

Basophils: The **basophil** has a lobed nucleus and heavily granulated cytoplasm that stains with the basic dye methylene blue. Basophils are nonphagocytic granulocytes that function by releasing pharmacologically active substances from their cytoplasmic granules. These substances play a major role in certain allergic responses.

Mast cells: Mast cells circulating immune cells having hematopoietic lineage. They are formed in bone marrow and remains undifferentaited until they enters the tissues. Mast cells can be found in a wide variety of tissues, including the skin, connective tissues of various organs, and mucosal epithelial tissue of the respiratory, genitourinary, and digestive tracts. They contain large number of cytoplasmic granules that contain histamine and other pharmacologically active substances. Mast cells, together with blood basophils, play an important role in the development of allergies. They plays important role in innate immunity by initiating site-specific inflammation through the recruitment of neutrophils, resulting in killing of bacteria.

Dendritic cells: Dendritic cells (DCs) are professional antigen-presenting cells located in the skin, mucosa and lymphoid tissues.There are four main types cells: Langerhans cells, interstitial dendritic cells, myeloid cells, and lymphoid dendritic cells. Each of these cells arises from hematopoietic stem cells. Dendritic cells constitutively express high levels of both class II MHC molecules and members of the co-stimulatory B7 family.

•There major function is to present antigen to T_H cells. They also secrete cytokines to regulate immune responses. Under resting conditions, DCs are considered “immature” and have been shown to induce peripheral tolerance by causing T-cell anergy, directing T-cell deletion or by inducing the generation of regulatory T cells.

•There is another type of dendritic cells, known as follucular dendritic cells. It does not expresses class II MHC molecules and therefore do not function as antigen presenting cells for T_H-cell activation. However, they express high levels of membrane receptors for antibody, which allows the binding of antigen-antibody complexes. The interaction of B cells with this bound antigen can have important effects on B cell responses.

Test your understandng

Which one of the following is a primary lymphoid organ:

a. Lymph nodes
b. Spleen
c. T hymus
d. Peyer's patch

The specialized cell type involved in the entry of lymphocytes into lymph nodes are called:

a. M-cells
b. Mesangial cells
c. HEV endothelial cells
d. PALS

On entering a germinal center, the primary B-blasts grow exponentially to form which cell type in the dark zone:

a. Secondary B-blasts
b. Centrocytes
c. Centroblasts
d. Memory B-cells

The paracortical area of a lymph node comprises mainly:

a. Plasma cells
b. Macrophages
c. B-cells
d. T-cells

Which of the following lymphoid tissues is unencapsulated:

a. Lymph node
b. Spleen
c. Tonsil
d. MALT

References & Further reading

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