OVERVIEW OF IMMUNE SYSTEM

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Concept of Health and Disease

- Health can be defined as physical, mental, and social wellbeing, and as a resource for living a full life. It not only means the absence of pain and disease, but the ability to recover and bounce back from illness and other problems.
- A disease is a disorder that affects health by affecting an organism's body, organs, tissues or cells. A disease is a particular abnormal condition that negatively affects the structure or function of all or part of an organism, and that is not due to any immediate external injury. Diseases are often known to be medical conditions that are associated with specific symptoms and signs.

What is immunity?

The concept of immunity grew from the observation that people who had recovered from certain infectious diseases were thereafter protected from the disease.

The term ‘immunity’ comes from the Latin word ‘immunis’ meaning “exempt”, meaning the state of protection from infectious disease.

Immunity can thus be defined as ‘ All those physiological mechanisms that endow the animal with the capacity to recognize materials as foreign to itself and to neutralize, eliminate or metabolize them with or without injury to its own tissues.

Functions of immunity

- Defense against micro-organisms
- Homeostasis ; removal of damaged or affected cells
- Surveillance; recognition and destruction of mutant cells

Innate and adaptive immunity

- Innate immunity is present in all multicellular organisms.
- It is the non-specific component of immunity composed of a set of disease-resistance mechanisms that are not specific to a particular pathogen. It comprises four types of defensive barriers: anatomic, physiologic, phagocytic and inflammatory.

- Adaptive immunity is found only in the vertebrates.
- It is the specific component of immunity which displays a high degree of specificity as well as the remarkable property of "memory". It displays four characteristic attributes:
  - ❑ Antigenic specificity
  - ❑ Diversity
  - ❑ Immunologic memory
  - ❑ Self/nonself recognition

Cells of the immune system

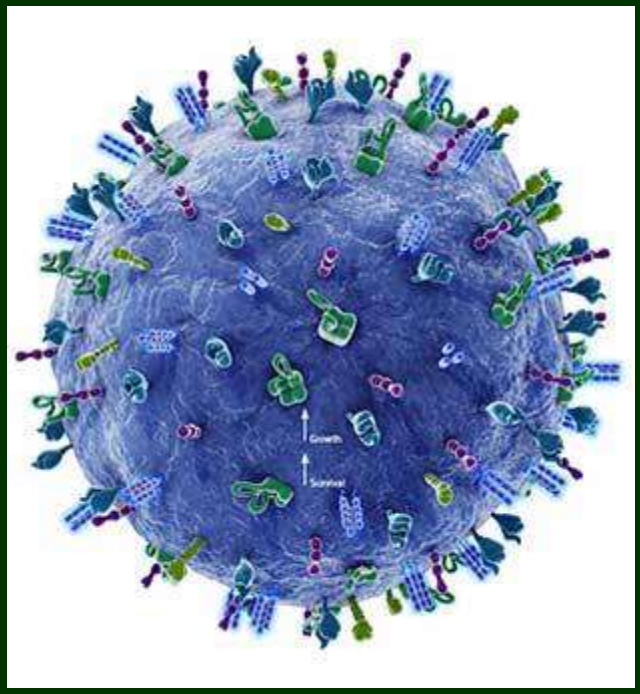
The central cells of the immune system are the lymphocytes. They are responsible for acquired immunity and the immunologic attributes of diversity, specificity, memory and self/nonself recognition. The other types of WBCs play important but often ancillary roles, engulfing and destroying microorganisms, presenting antigens and secreting cytokines.

Lymphoid cells

- A class of white blood cells --- are the principal active components of the adaptive immune system.
- Constitute 20-40% of the body's WBCs and 99% of the cells in the lymph.
- When an antigen invades the body, normally only those lymphocytes with receptors that fit the contours of that particular antigen take part in the immune response. When they do, so-called daughter cells are generated that have receptors identical to those found on the original lymphocytes. The result is a family of lymphocytes, called a lymphocyte clone with identical antigen-specific receptors.
- They can be broadly subdivided into three populations:
  - B cells
  - T cells
  - Null cells

B lymphocytes

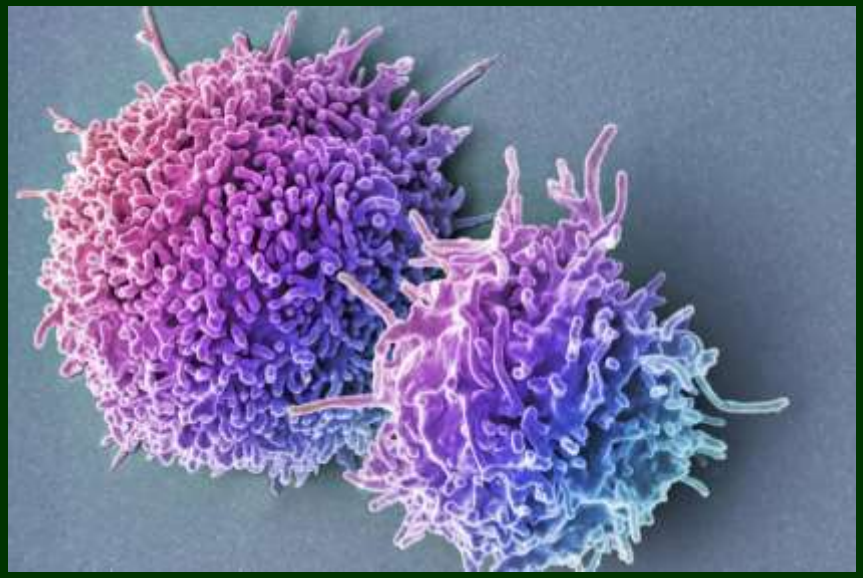
- Derives its letter designation from its site of maturation , which is the bursa of Fabricius in birds. In mammals including humans and mice it maturates in the bone marrow.
- Synthesizes and displays membrane-bound immunoglobulin (antibody) molecules.
- Surface of a single B-cellhas about 1.5×10^5 molecules of antibody.
- Interaction between antigen and the membrane-bound antibody on a mature naiveB cell activates and differentiates B cell clones of corresponding specificity.



•Surface of mature B-cells express molecules like B220, Class II MHC molecules, CR 1 & CR2, FcγRII, B7-1, B7-2, CD40

T lymphocytes

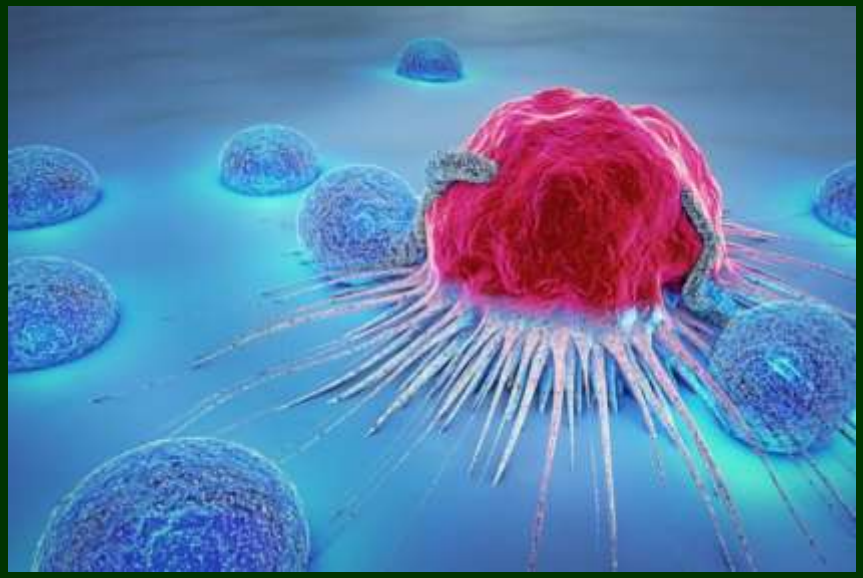
- Derive their name from their site of maturation in the thymus.
- Possess membrane receptors known as T-cell receptor which recognize antigens displayed together with MHC (Major histocompatibility complex) molecules on the surface of antigen-presenting cells or on virus-infected cells, cancer cells and grafts.
- Most mature T-cells express membrane molecules such as CD4, CD8, CD28 and CD45.



- Based on the expression of CD4 and CD8 molecules, T –cells can be
  - ➢ $CD4^+$ T cells , called T helper (T_H) cells, which are Class II MHC restricted.
  - ➢ $CD8^+$ T cells, called T cytotoxic (T_C) cells, which are Class I MHC restricted.

Null cells

- A small group of lymphocytes.
- Do not express membrane molecules and receptors, so lack precise immunologic specificity and memory.
- Most members are large, granular lymphocytes called natural killer (NK) cells. They play a major role in the host-rejection of both tumors and virally infected cells.



Mononuclear cells

- The mononuclear phagocytic system consists of
  - Monocytes circulating in the blood
  - Macrophages in the tissues

  Monocytes circulate in the bloodstream for about 8 hours during which time they enlarge, they then migrate into the tissues and differentiate into specific tissue macrophages. Macrophage-like cells serve different functions in different tissues and are named according to their tissue location:

  ✓Alveolar macrophages in the lung.

  ✓Histiocytes in connective tissues

  ✓Kupffer cells in the liver

  ✓Mesangial cells in the kidney

  ✓Microglial cells in the brain

  ✓Osteoclasts in bone

Granulocytic cells

On the basis of cellular morphology and cytoplasmic staining characteristics, granulocytes are classified as

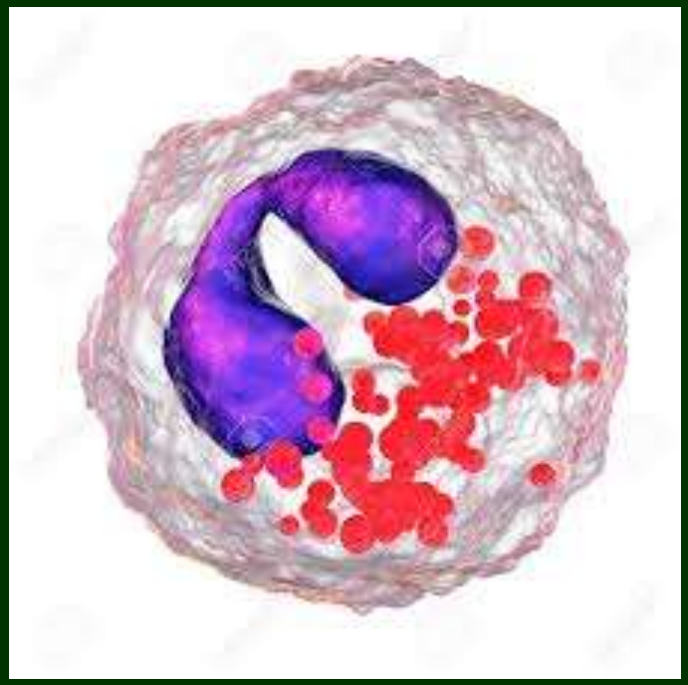
- Neutrophils
- Eosinophils
- Basophils

Neutrophils

- Produced by hematopoiesis in the bone marrow.
- Has a bilobed nucleus and a granulated cytoplasmthat stains with both acid and basic dyes.
- Often called a polymorphonuclear leukocyte (PMN)for its multilobed nucleus.

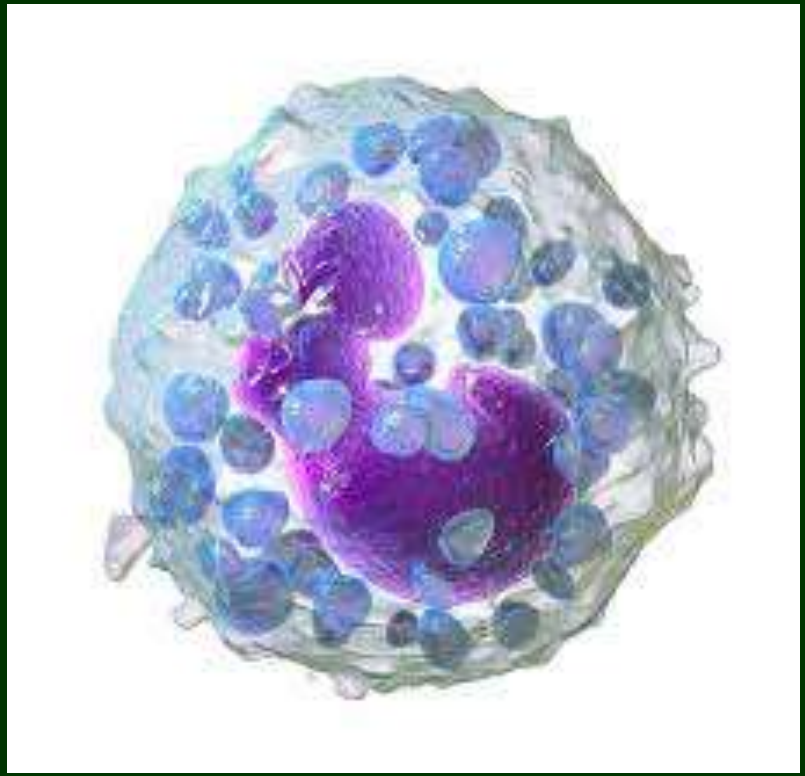
Eosinophils

- Motile phagocytic cells that can migrate from the blood into the tissue spaces.
- Has bilobed nucleus and a granulated cytoplasm that stains red with acid dye eosin.
- Phagocytic role is significantly less than important than that of neutrophils.
- They play a role in the defense against parasitic organisms.
- Secreted contents of eosinophilic granules may damage the parasitic membrane.



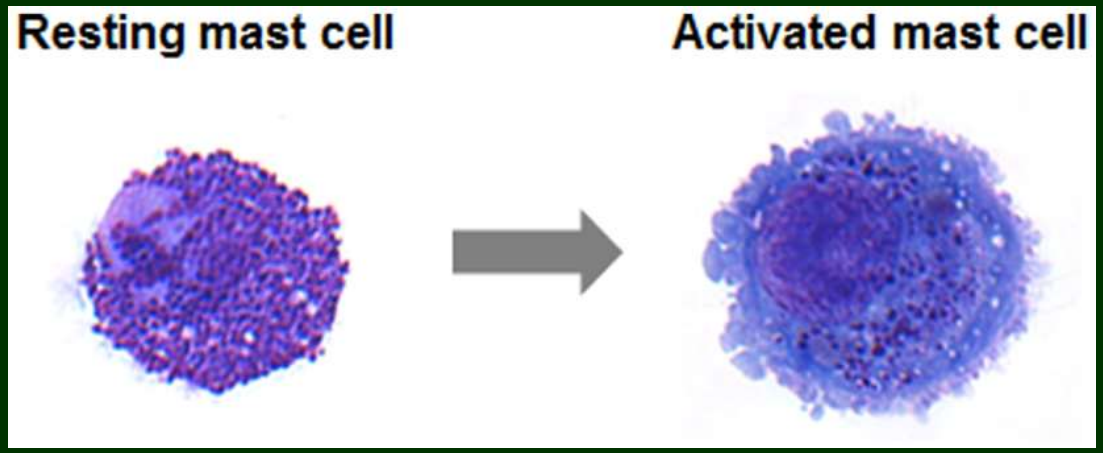
Basophils

- Nonphagocytic granulocytes.
- Has a lobed nucleus and heavily granulated cytoplasmthat stains with the basic dye methylene blue.
- Release pharmacologically active substances from their cytoplasmic granules, which play amajor role in certain allergic responses.



Mast cells

- Precursors of these cells are formed in the bone marrow, released into the blood as undifferentiated cells.
- They only differentiate when they leave the blood and enter the tissues.
- Mast cells are found in a variety of tissues , such as the skin, connective tissues of various organs, and mucosal epithelial tissue of the respiratory, genitourinary and digestive tracts.
- They have large numbers of cytoplasmic granules that contain histamine and other pharmacologically active substances.
- Together with blood basophils, they play an important role in allergy development.



Dendritic cells

- So named because it is covered with a maze of long membrane extensions that resembles dendrites of nerve cells.
- Mostly process and present antigen to T helper (T_H) cells.
- According to location, classified as:
  - Langerhans cells
  - Interstitial dendritic cells
  - Interdigitating dendritic cells
  - Circulating dendritic cells
- Another type, follicular dendritic cells, are located in lymph follicles, which are rich in B cells. They express high levels of membrane receptors for antibody and complement.

Organs of the immune system

- Functionally can be distinguished as
  - ❖ Primary lymphoid organs
    - * Thymus
    - * Bone marrow
  - ❖ Secondary lymphoid organs
    - * Lymph nodes
    - * Spleen
    - * Mucosa-Associated lymphoid tissue

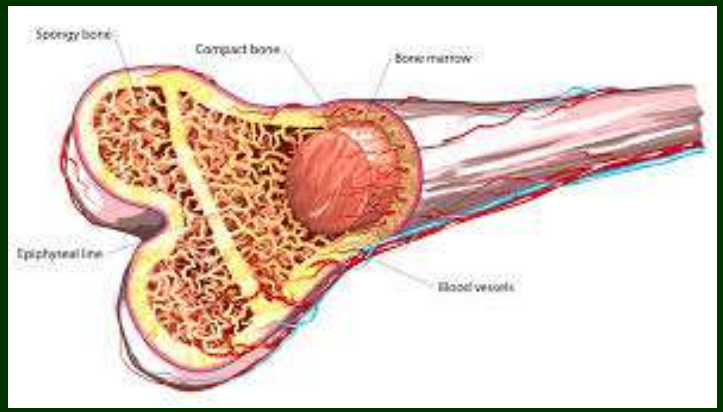
Primary lymphoid organ- Thymus

- Is a flat, bilobed organ situated above the heart.
- Is a lymphoepithelial organ with key adaptive immune functions.
- T cells mature here.
- Is responsible for the development of T-dependent lymphocytes.
- Plays an important role in immunogenesisi n the young and the T cells derived from orchestrate the immune response throughout life.

•It represents a system of homeostasis.

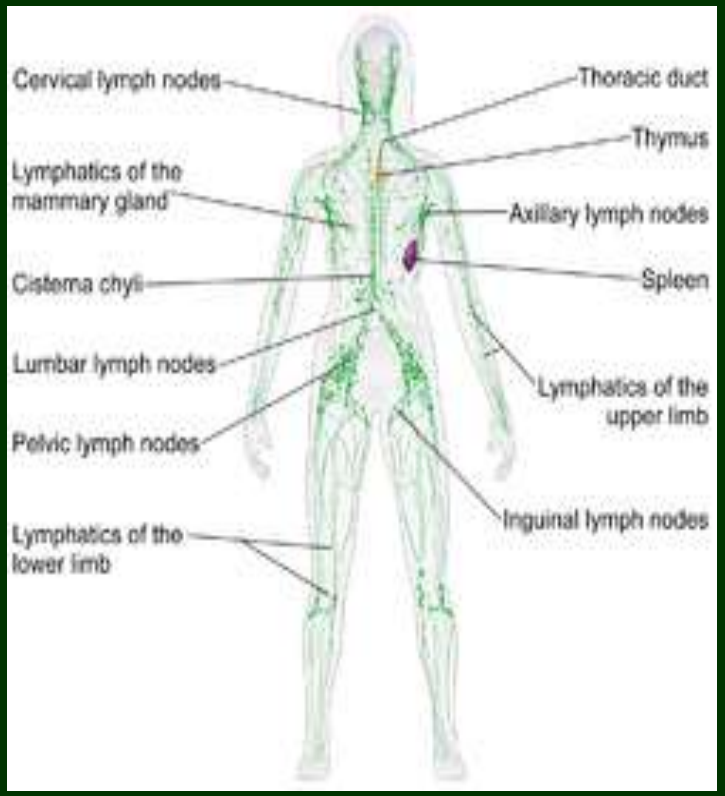
Primary lymphoid organ- Bone marrow

- In birds, B-cell maturation occurs in a lymphoid organ called the Bursa of Fabricius.
- In mammals, B-cell maturation occurs in the bone marrow and some other lymphoid tissues.
- In those animals whose immature B cells proliferate and differentiate within the bone marrow, stromal cells within the bone marrow interact directly with the B cells and secrete various cytokines.
- A selection process within the bone marrow eliminates B cells with self-reactive antibody receptors.



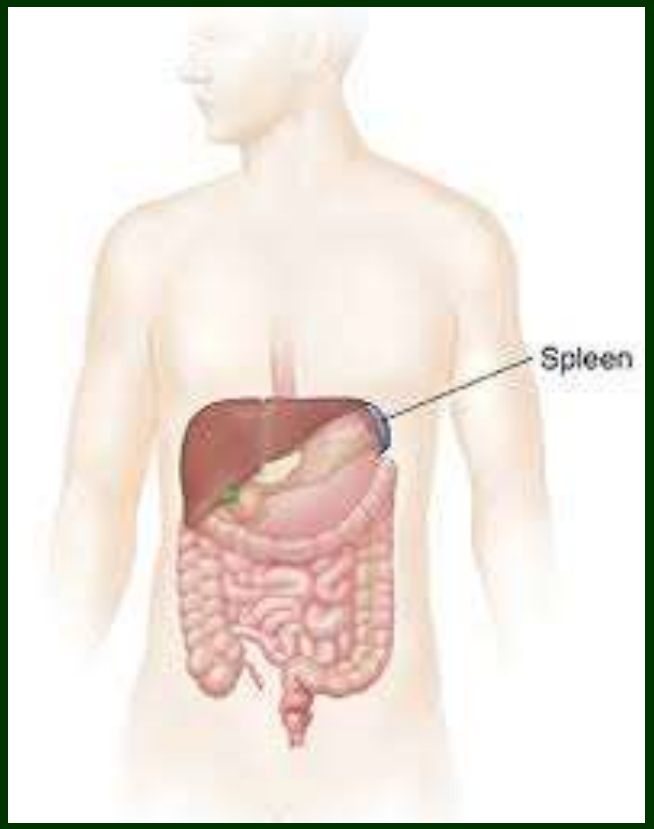
Secondary lymphoid organ- lymph nodes

- They are encapsulated bean-shaped structures containing a reticular network packed with lymphocytes, macrophages and dendritic cells.
- They are the first organized lymphoid structure to encounter antigens that enter the tissue spaces.
- The structure of lymph nodes support an ideal microenvironment for lymphocytes to effectively encounter and respond to trapped antigens.



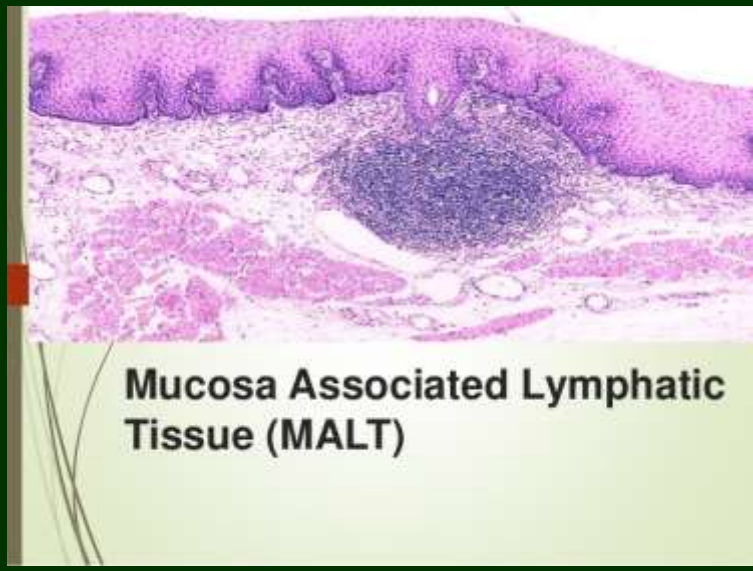
Secondary lymphoid organ-Spleen

- Is a large, ovoid secondary lymphoid organ situated high in the left abdominal cavity.
- It responds to systemic infections by filtering blood and trapping blood-borne antigens.
- Blood-borne antigens and lymphocytes are carried into the spleen through the splenic artery.



Secondary lymphoid organ- Mucosa-associated lymphoid tissue

- Abbreviated as MALT.
- They are a group of organized lymphoid tissues that defend the mucous membranes lining the digestive, respiratory and urogenital systems.
- These tissues range from loose, barely organised clusters of lymphoid cells in the lamina propria of intestinal villi to well-organized structures .Such organized structures may be tonsils and appendix, as well as Peyer's patches, which are found within the submucosal layer of the intestinal lining.



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