Immunology 2016

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Immunology- Course Outline

- Course instructor Mohammad Altamimi, MD, PhD

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- Lecture: Time Sunday 11-12 pm
  Tuesday 11-12 pm

- Course outline and objective
- References and textbooks
- Course assessment: First 30 MARKS
  Second 30 MARKS
  Final 40 MARKS

Objectives

- Definition of Immunology
- Importance of Immunology
- Historical background of Immunology
- Modern Immunology
- Outline the major principles of the human immune response (innate immunity, humoral immunity, and adaptive immunity)

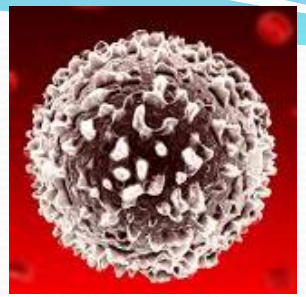
Introduction

- **Immunology** stems from
  - Latin - *immunis* = "exempt;"
  - English = protection from disease
- **Immunology is the study of our protection from foreign macromolecules or invading organisms and our responses to them.**

Functions of Immune System

1. Immune defense: Protection from harmful environmental antigens.
2. Immune homeostasis: Regulate and maintain the steady state of organisms.
3. Immune surveillance: Search and destroy neoplastic cells.

Haematology and blood transfusion



Immune deficiency

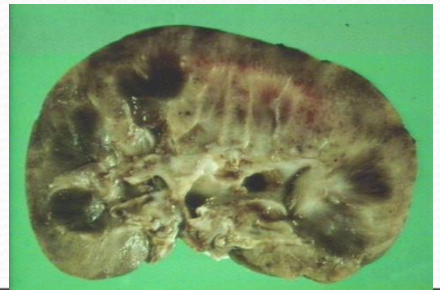
Allergy

Infections

Immunology

Autoimmunity

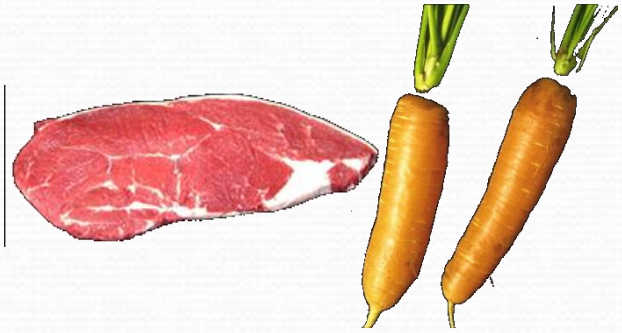
Transplantation



How Does the Immune System Work?

But……

What about the non-self proteins of commensals and symbionts?



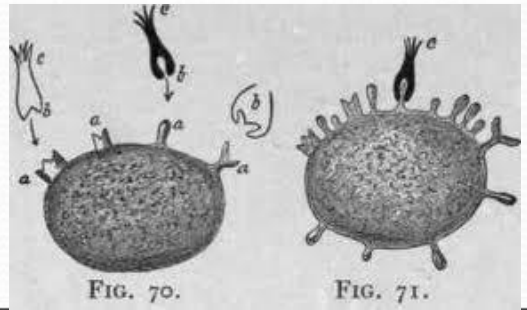
What about the non-self proteins in food?

What about the non-self proteins from microrganisms in food

History of Immunology

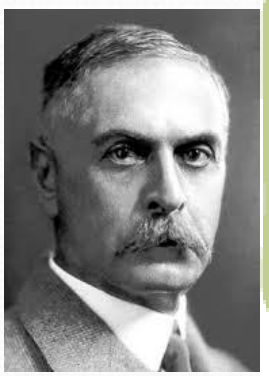
- 430 B.C.: Philosophers noted resistance to plague by those who recovered “Only those who had recovered from plague can nurse for sick people because they would not contract the disease a second time”
- 15th century: Chinese and Turks use dried crusts of smallpox by inhalation or introduction into small cut of skin in order to prevent the disease
- 1796: Edward Jennar discovered that cowpox vaccination protected against smallpox. He inoculated an 8 years boy with fluids from a cowpox pustule and then intentionally infected the boy with smallpox but the child did not develop the disease

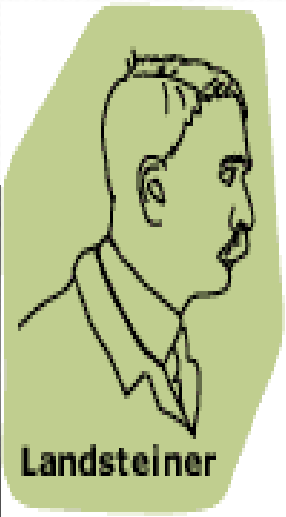
- In 1880: Pasteur discover Anti-cholera live-attenuated vaccine. He noticed that old cultures in his lab did not kill chicken after inoculation and that chicken become immune to cholera. He applies the same principle for anthrax and rabies vaccine
- In 1890: Von Behring and Kitasato discover diphtheriae antitoxin. They notice that serum from animals previously immunized to dipthteria could transfer the immune state to unimmunzed animals
- 1883 Ellie Metchinkoff that cells like phagocytes contribute to the immune state of animals

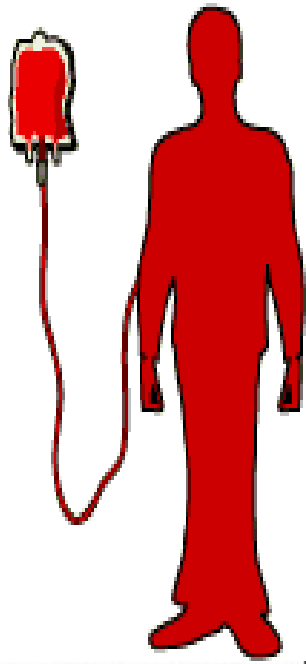


Blood Grouping and Immunology

- Experiments with blood transfusions have been carried out for hundreds of years with out any success.
- In 1901, Karl Landsteiner discovered human blood groups, and blood transfusions became safer.
- He found that mixing blood from two individuals can lead to blood clumping. The clumped RBCs can crack and cause toxic reactions. This can be fatal.
- Karl Landsteiner work on blood grouping has discover the fundamental principles of Immunology

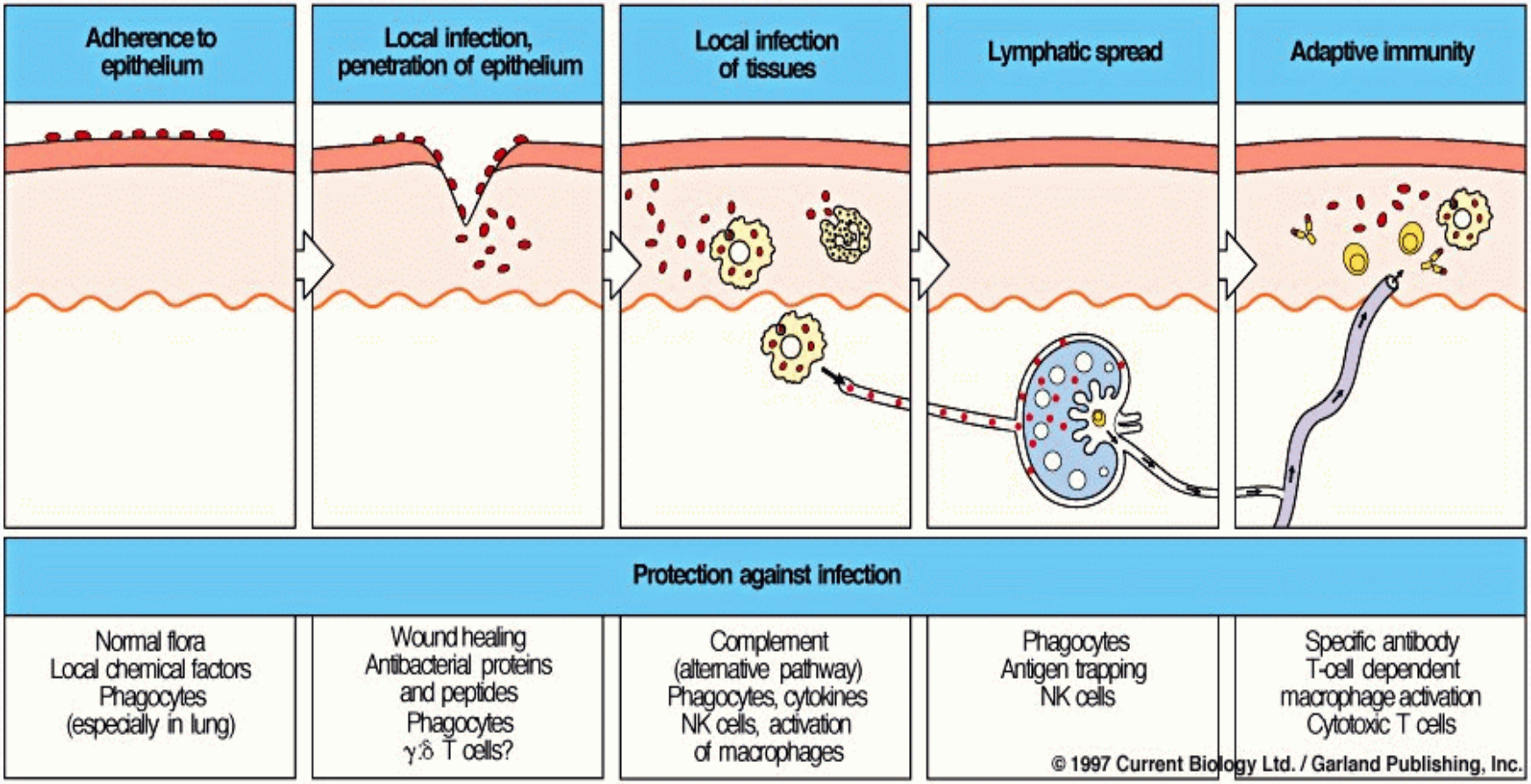






- Immunology act as an independent subject: (In 1971, International Conference of Immunology, in USA)

Stages of Response to Infection



Immune system

Innate (non-specific) immunity

- Anatomic barriers (Skin,mucous membranes)
- Physiological barriers (temperature, pH)
- Phagocytic Barriers (cells that eat invaders)
- Inflammatory barriers (redness, swelling, heat and pain)

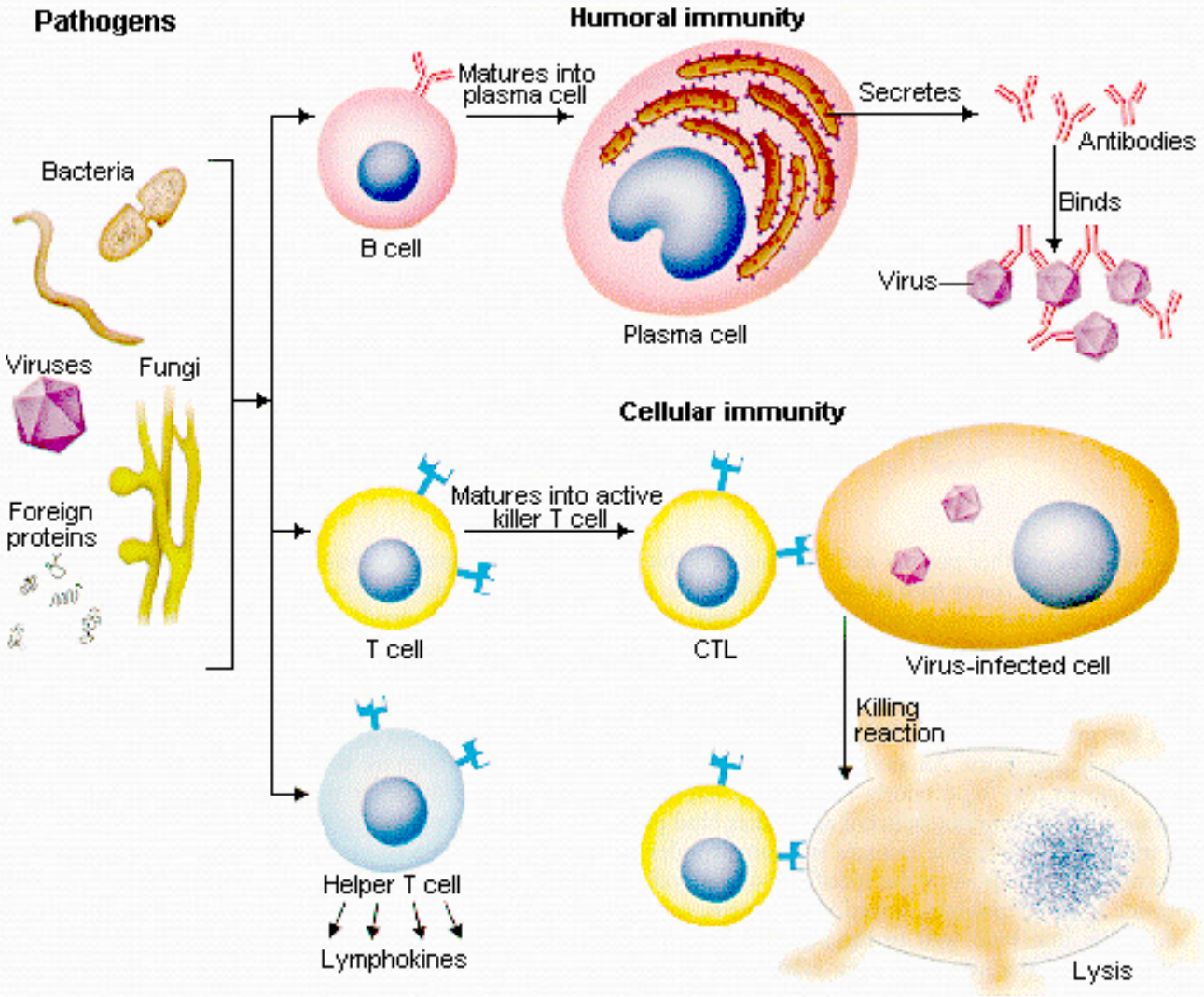
Adaptive (specific) immunity

- Antigen specificity
- Diversity
- Immunological memory
- Self/nonself recognition

Humoral

Cellular

Humoral and Cellular Immunity



Immunology- The Balance

Hyporeactive Immunodeficiency

Hyperreactive Immunopathology

Health

Neutrophil Disorders
Antibody Deficiency
Complement Deficiency
T & B Cells Dysfunction

Systemic Autoimmunity
Organ-Specific Autoimmunity
Allergies and Asthma

Organs and Cells of the Immune System

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Objectives

- The organs and tissues of the immune system
- Haematopoiesis and formation of blood cells
- Immune cells classes, functions and circulation
- Immune cells development and maturation

Anatomy of the Immune System

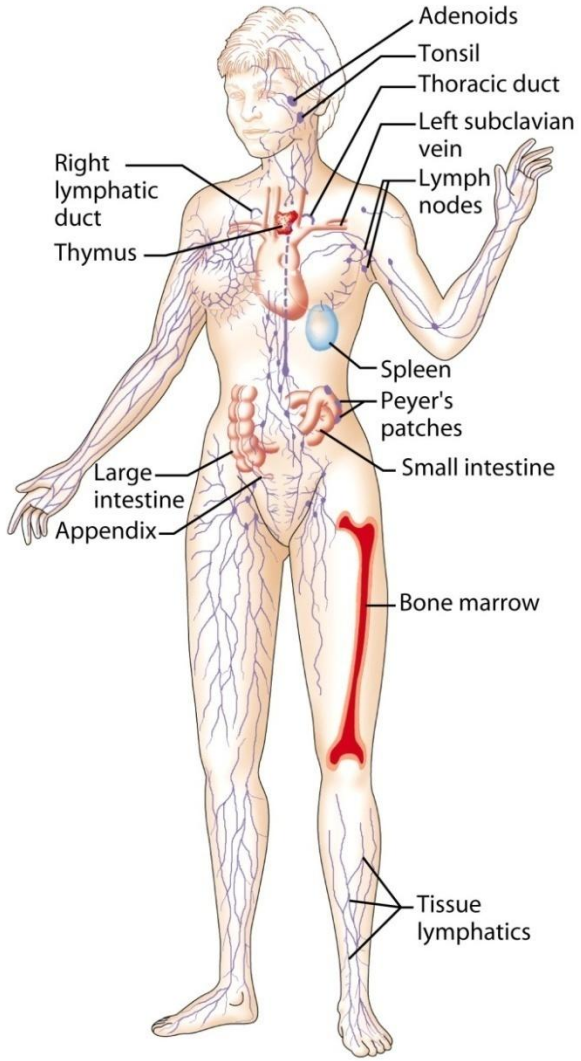
- **Lymphoid organs:**

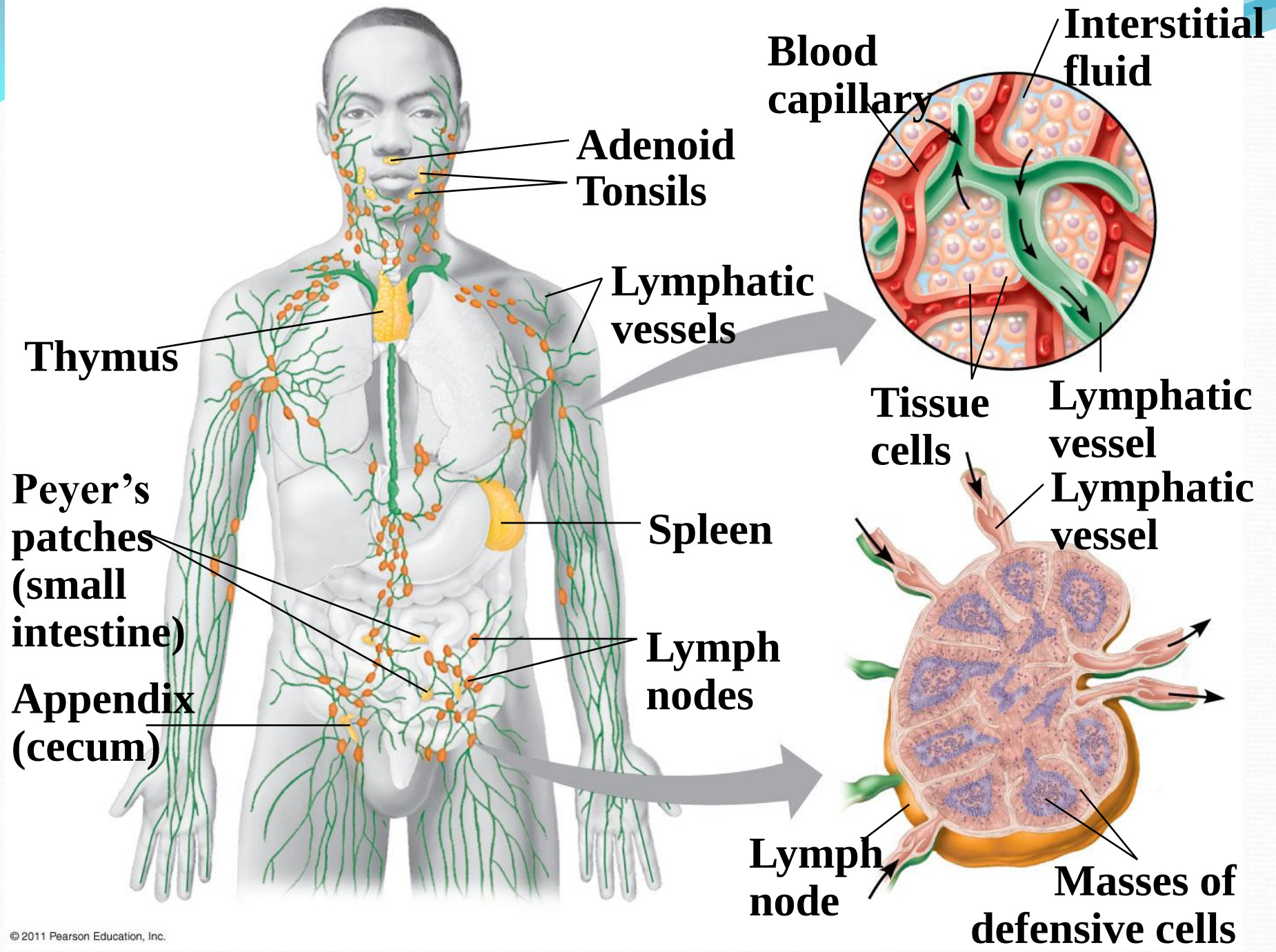
1. Primary or central lymphoid organs: bone marrow and thymus
2. Secondary or peripheral lymphoid organs: lymph nodes, spleen, and mucosal and cutanouse immune system

- **Blood cells in the immune sys:**

1. Innate immune cells: "phagocytes" macrophage, neutrophils, dendritic cells
2. Adaptive immune cells: "lymphocytes" T cells, B cells

- **Lymphatic and blood circulation**

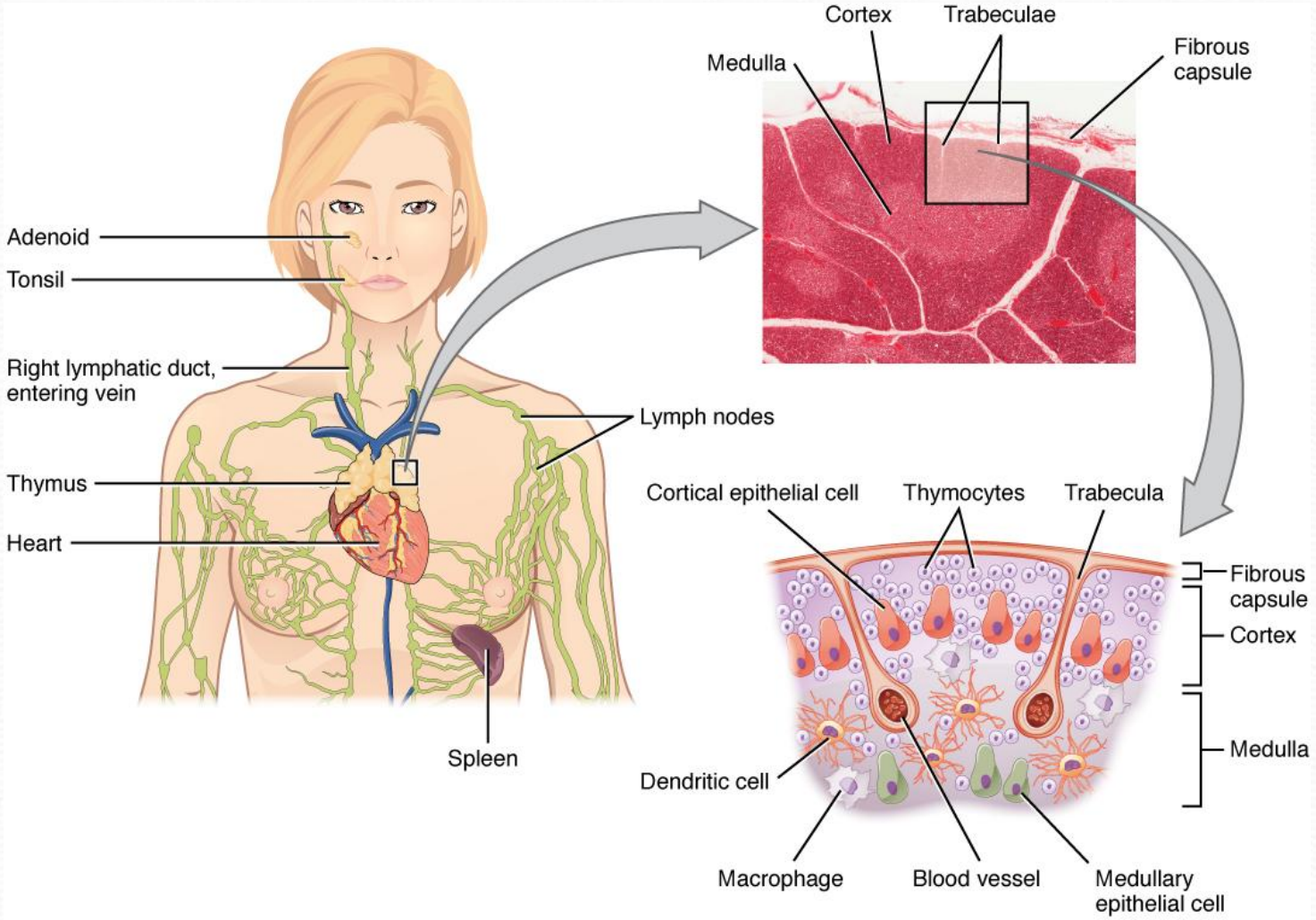




- The cells of the immune system spend much of their time in lymphoid organs. They develop (arise) in primary lymphoid organs, and they interact with antigens in secondary lymphoid organs.
  - Thymus: primary lymphoid organ for T cell development
  - Bone marrow: primary lymphoid organ for B cell development
  - Lymph nodes: collect antigens from tissues
  - Spleen: collects antigens from blood stream

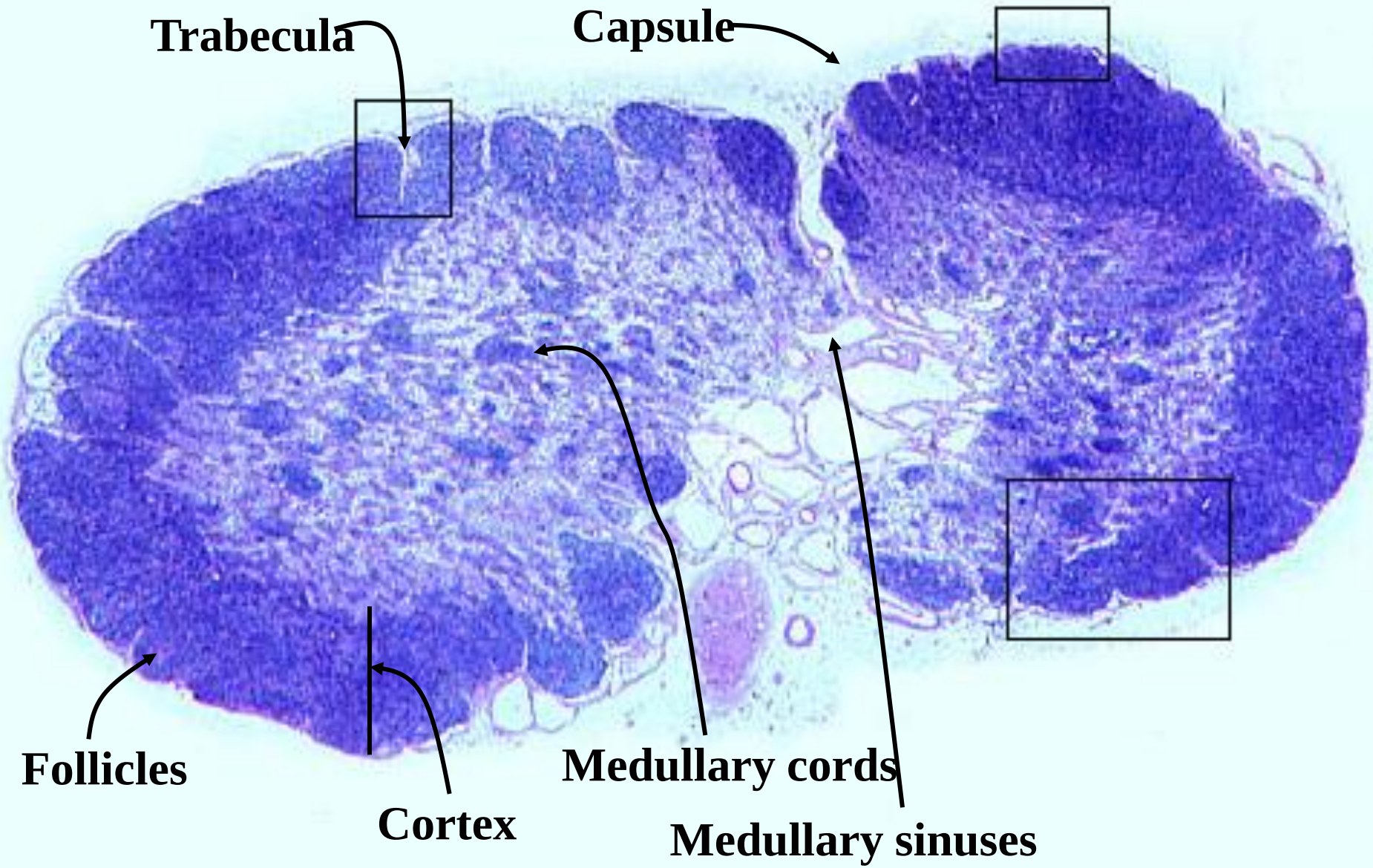
Lymphoid Organs
1. Thymus

- Flat bilobed organ situated above the heart
- Each lobe is surrounded by a capsule and divided into lobules separated by connective tissues called trabiculae
- The thymus reach its maximum size at puberty and then atrophies
- The thymus generation of T cells drop with time. By the age of 35 thymus generation of T cells drop to 20% and by the age of 65 it drop to 2% of newborn levels
- Play critical role in formation and maturation of T cells


Adenoid
Tonsil
Right lymphatic duct, entering vein
Thymus
Heart
Lymph nodes
Spleen
Cortex
Trabeculae
Medulla
Fibrous capsule
Cortical epithelial cell
Thymocytes
Trabecula
Fibrous capsule
Cortex
Medulla
Dendritic cell
Macrophage
Blood vessel
Medullary epithelial cell

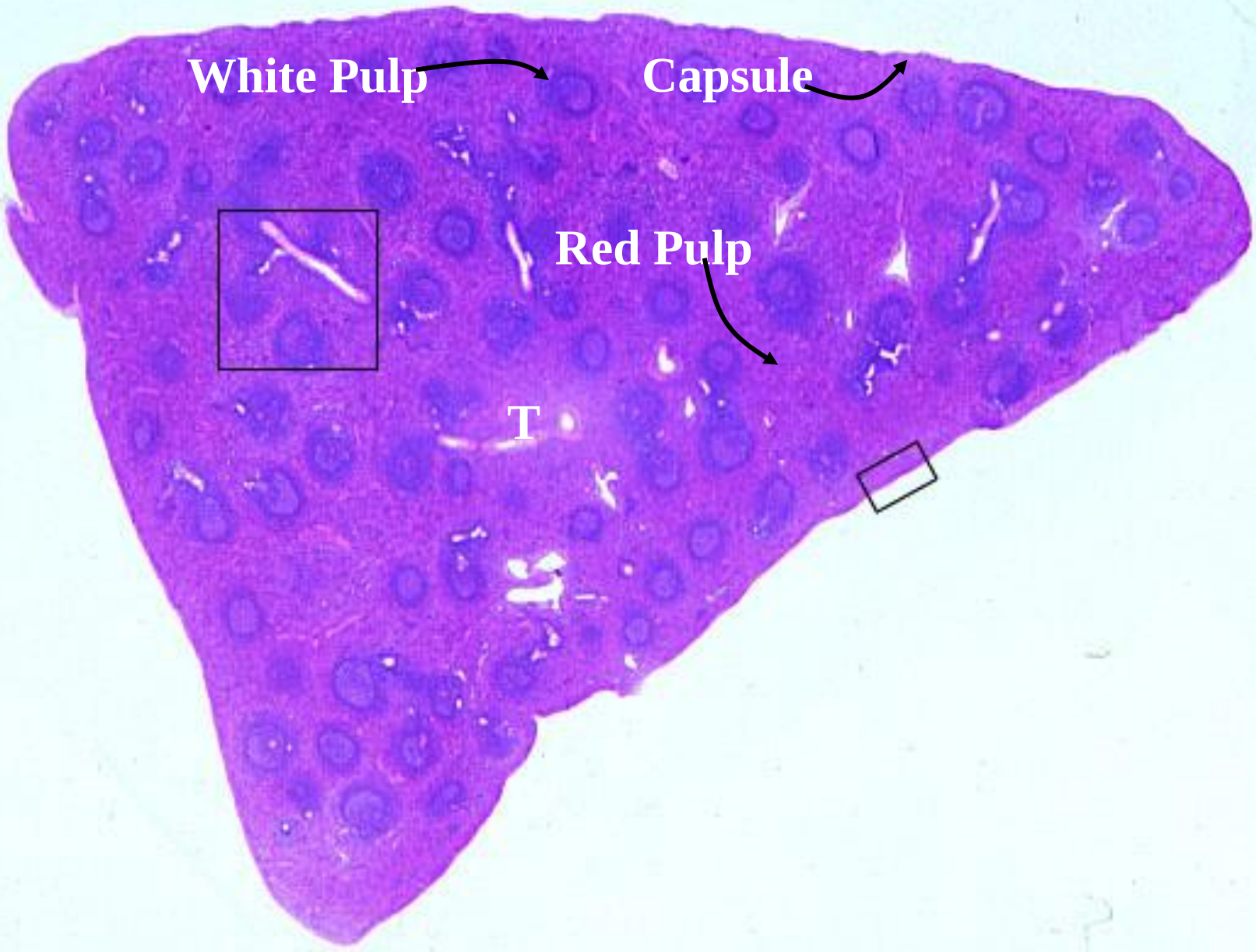
2. Bone Marrow

- Bone marrow is the flexible tissue in the interior of bones
- On average, bone marrow constitutes 4% of the total body mass of humans
- There are two types of bone marrow: red marrow (also known as myeloid tissue) and yellow marrow.
- Bone marrow is the site of haematopoiesis and the origin of B cells in human
- The hematopoietic component of bone marrow produces approximately 500 billion blood cells per day


Trabecula
Capsule
Follicles
Cortex
Medullary cords
Medullary sinuses

4. Spleen

- Abdominal organ that serve as a big lymph node
- Unlike the lymph nodes the spleen is not supplied by lymphatic vessels
- The spleen had two main compartment the red pulp and the white pulp separated by diffuse marginal zone
- Blood enter the spleen through a network of channels called sinusoids
- Blood-borne antigen are trapped and concentrated in the spleen
- Immune cells in the spleen identify, ingest and destroy microbes

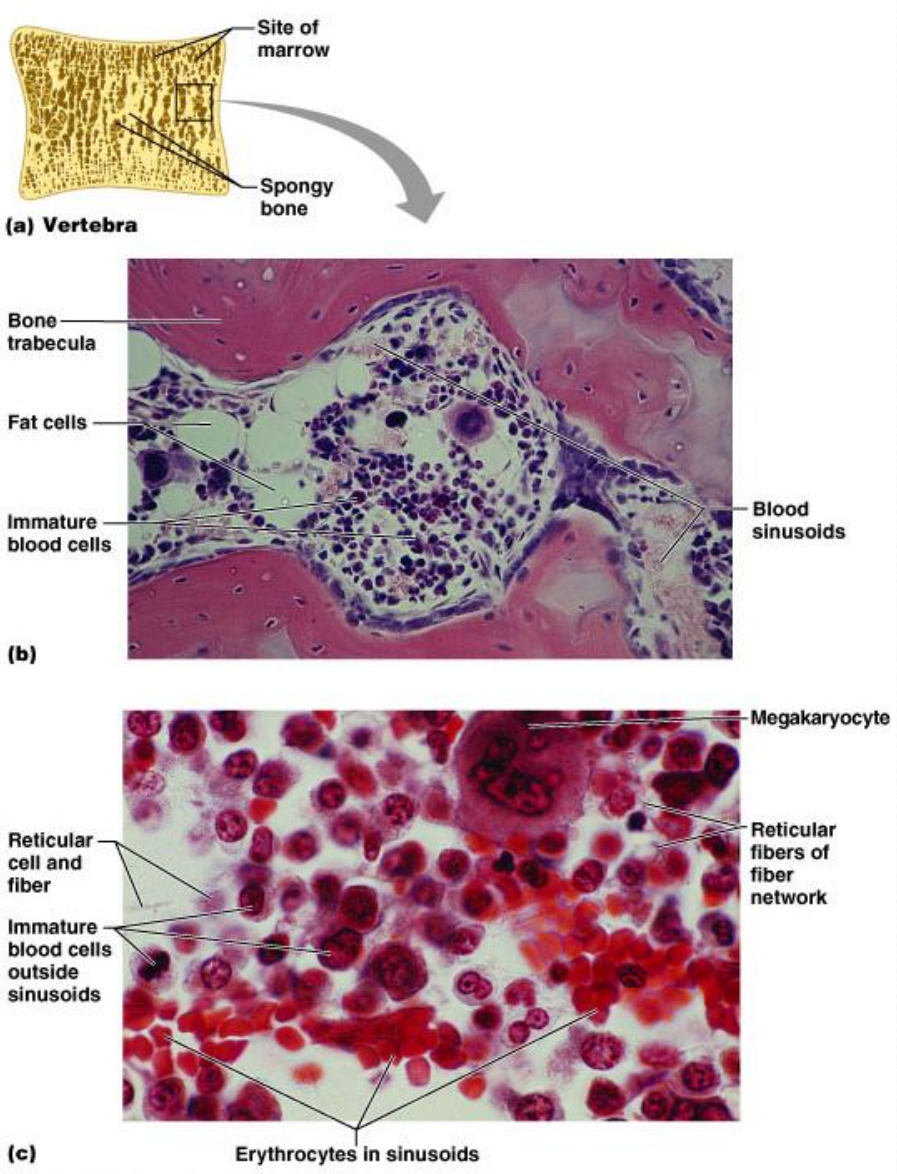

White Pulp
Capsule
Red Pulp
T

5. Cutaneouse and Mucosal Lymphoid Organs

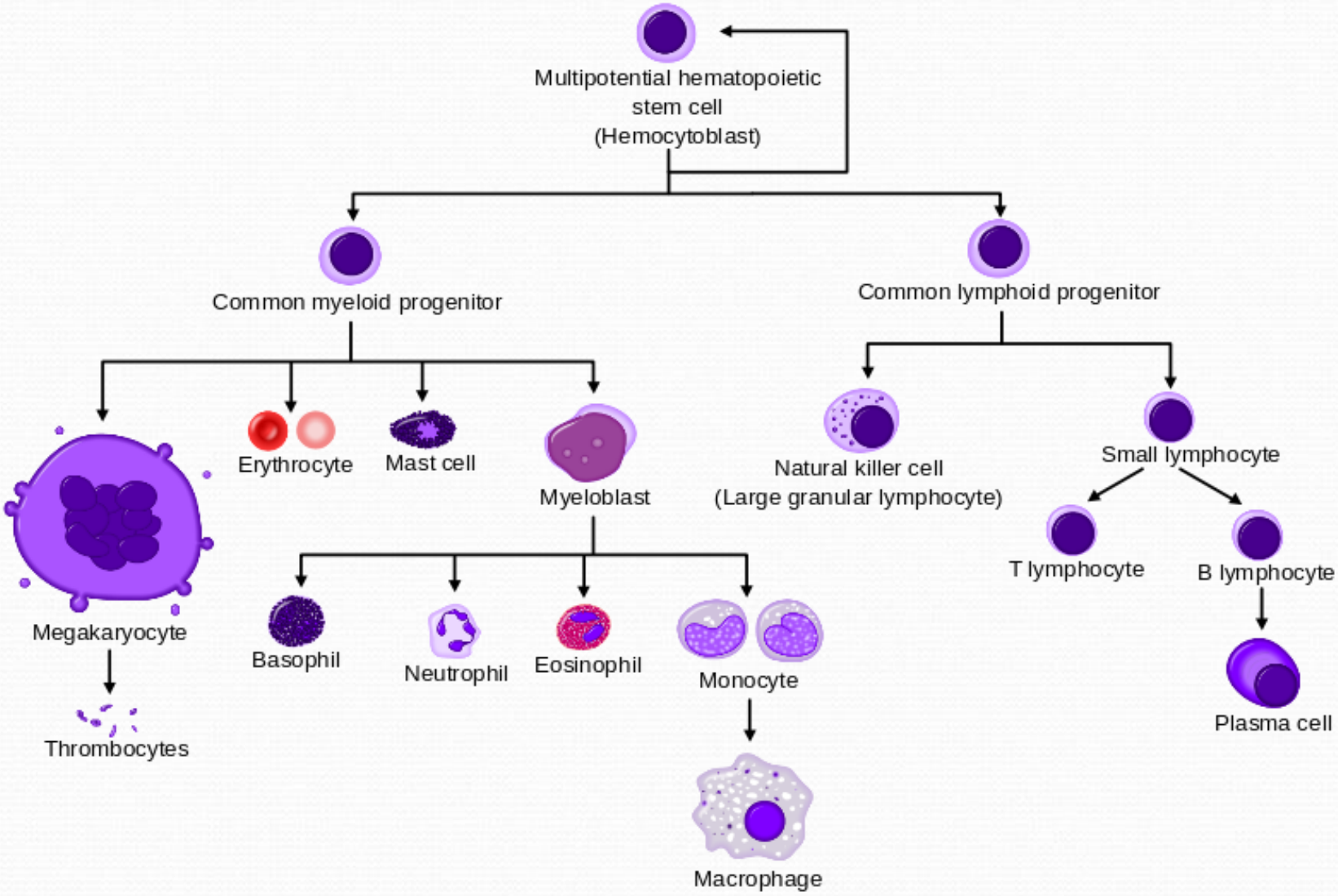
- Located under the epithelia of the skin, GIT and respiratory tracts. It includes: pharyngeal tonsils, adenoids, appendix and peyer's patch
- Sites of immune response to microorganisms that breach epithelia

Hematopoiesis

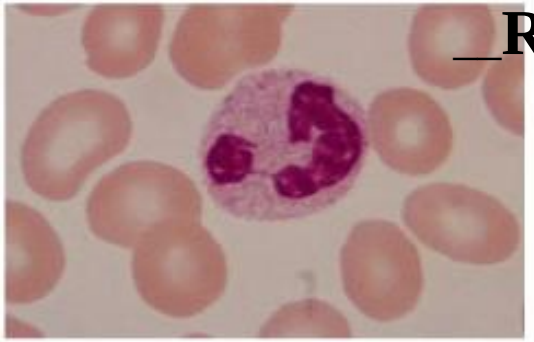
- Formation of blood cells
- Occurs mostly in red bone marrow
- All cells arise from same **blood stem cell** (pluripotent hematopoietic stem cells)



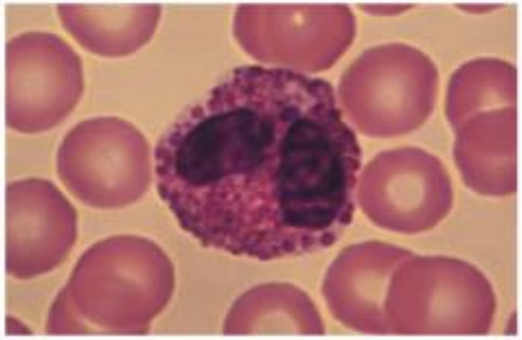
Formation of Blood Cells



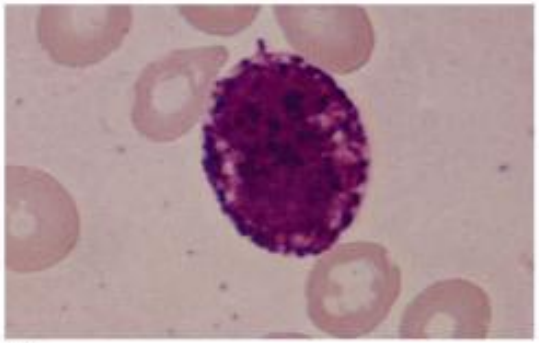
Leukocytes



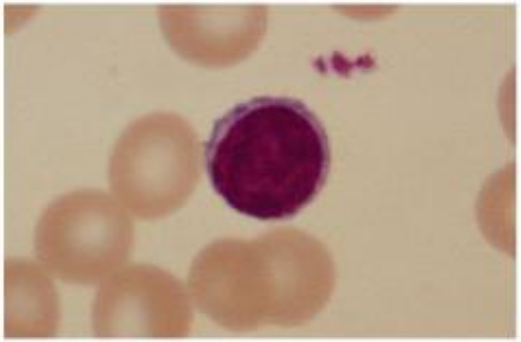
(a) neutrophil



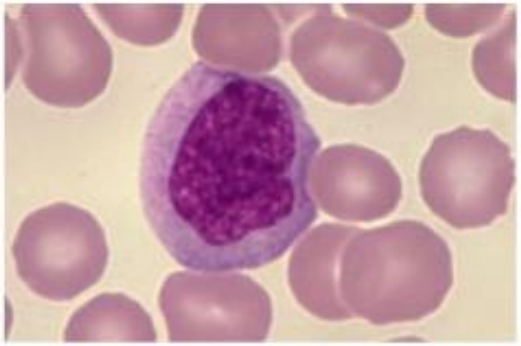
(b) eosinophil



(c) basophil

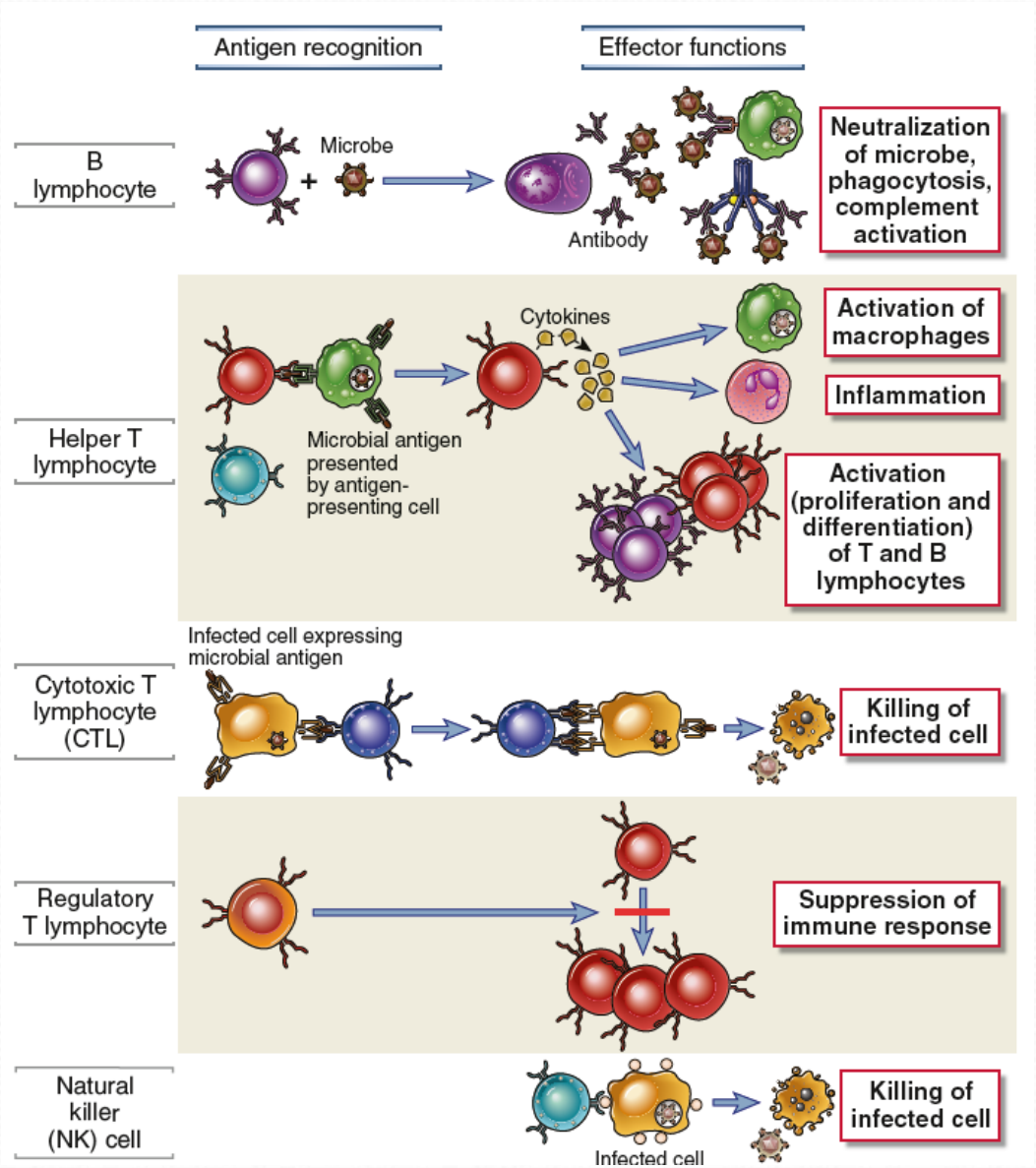


(d) small lymphocyte



(e) monocyte

Classes of Lymphocytes



Stages of Lymphocyte Activation

- Naïve lymphocytes
  - Mature lymphocytes that have not previously encountered antigen; function -- antigen recognition
  - Preferential migration to peripheral lymphoid organs (lymph nodes), the sites where antigens are concentrated and immune responses start
- Effector lymphocytes
  - Activated lymphocytes capable of performing the functions required to eliminate microbes (effector functions)
  - Effector T lymphocytes: cytokine secretion (helper cells), killing of infected cells (CTLs)
  - B lymphocytes: antibody-secreting cells (e.g. plasma cells)
- Memory lymphocytes
  - Long-lived, functionally silent cells; mount rapid responses to antigen challenge (secondary responses)

Function of Immune Cells

- Lymphocytes of the adaptive immune system
  1. T helper cells: regulate other immune cells
  2. T cytotoxic (killer) cells: kill infected cells
  3. B cells: produce antibodies (immunoglobulin)
- Dendritic cells and macrophage: directly kill microbes by phagocytosis and other mechanisms. They also help to activate T cells (connection between innate and adaptive immunity)
- Dendritic cells and other Antigen presenting cells (APCs) also play role in capturing microbes and then process and display antigens
- NK cells are lymphocytes: Recognizes and kill abnormal cells like tumour cells, and virus infected cells