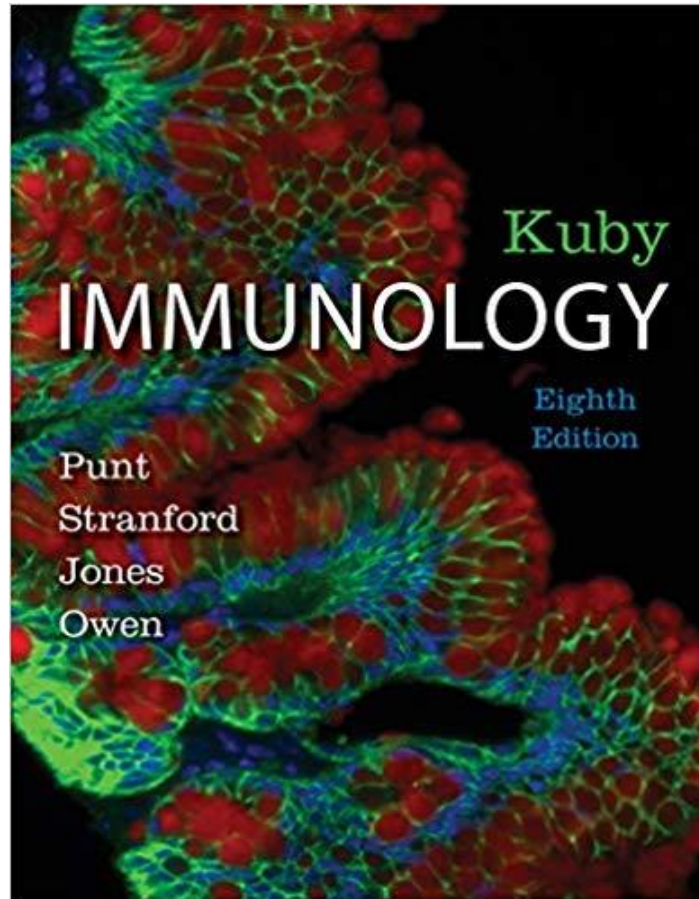
A microscopic view of tissue, likely a lymph node, showing various cellular structures. A large, prominent cell with a large nucleus and nucleolus is visible in the foreground. The background shows a dense network of cells and fibers, with some areas appearing more intensely stained (reddish) than others (purple/pink).

Introduction to Immunology & Lymphoid System

Immunopathology Unit
Department of Pathology
College of Medicine & Medical City
King Saud University



Reference

Kuby Immunology 8th Edition 2018

Chapter 1 & Chapter 2

Objectives

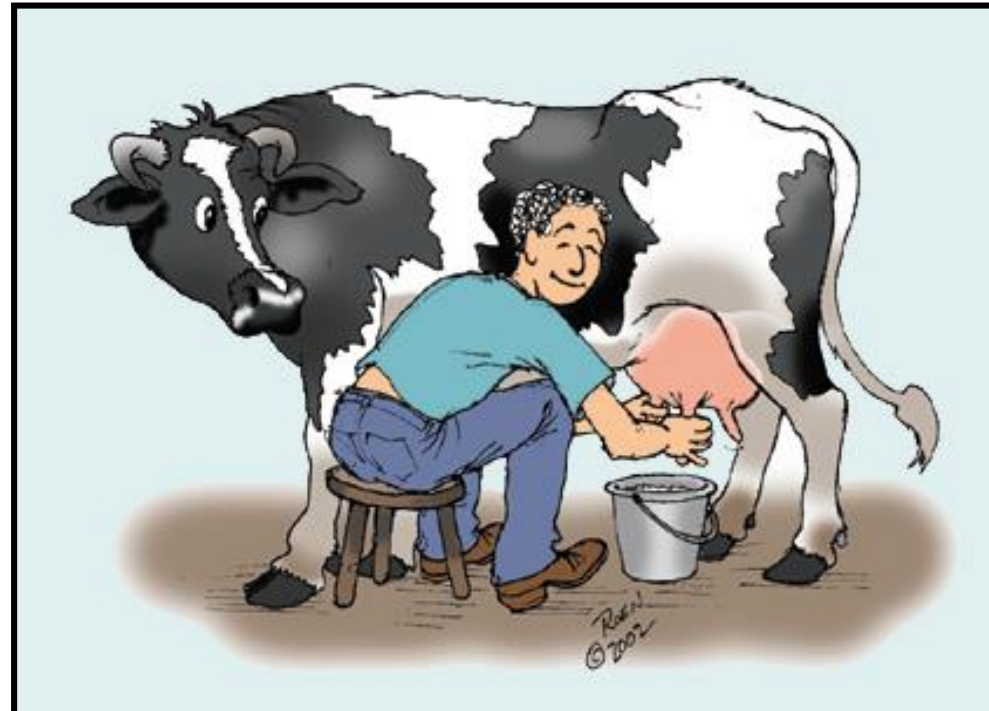
- To know the historical perspective of immunology
- To be familiar with the basic terminology and definitions of immunology
- To recognize immune response cells
- To understand types of immune responses
- To know about the lymphoid system
- To understand T and B cell functions



1798 Edward Jenner

Observation:

Milkmaids who contracted cowpox (a mild disease) were subsequently immune to small pox



Smallpox



SCARRING BUMPS, BLINDNESS,
LIMB DEFORMITIES

A child infected with smallpox in Bangladesh, 1973. Patients with ordinary-type smallpox usually had bumps filled with a thick and opaque fluid, often with a depression or dimple in the center. This is a major distinguishing characteristic of the disease.

1798 Edward Jenner

Profound results:

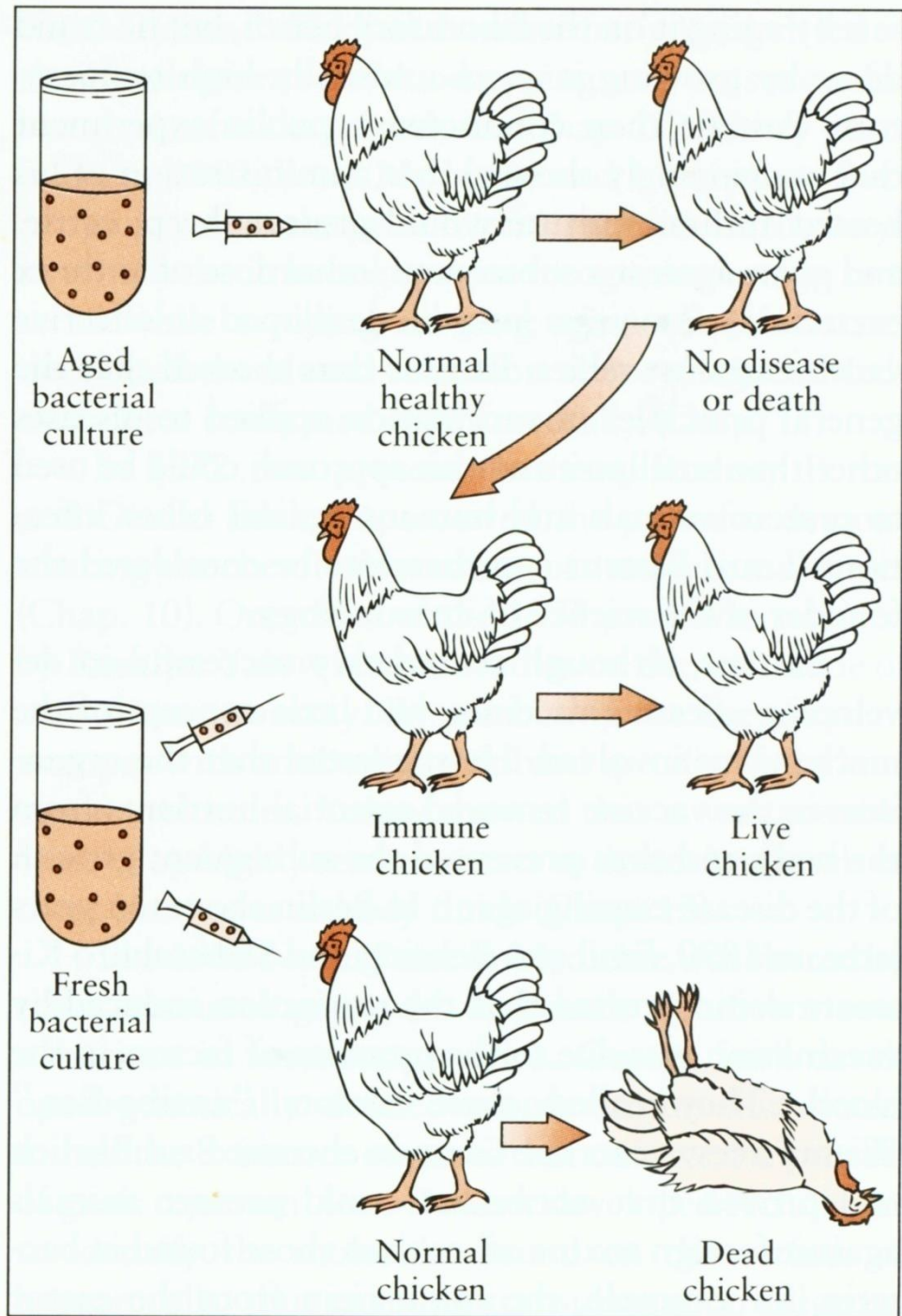
- (1) Jenner's technique of inoculating with cowpox to protect against small pox spread quickly throughout Europe.**
- (2) Began the science of Immunology, the study of the body's response to foreign substances.**

Louis Pasteur's Contributions

- Determined through studies of cholera in chickens that the virulence of a pathogen weakens with age (chickens inoculated with old strains not only survive but become resistant)
 - **Attenuated** – weakened, non-virulent strain whose exposure can confer resistance to disease
- **Classical experiment**
 - Heat attenuated anthrax bacillus and subsequent challenge with virulent *Bacillus anthracis* in sheep

Louis Pasteur

Observation: Cholera



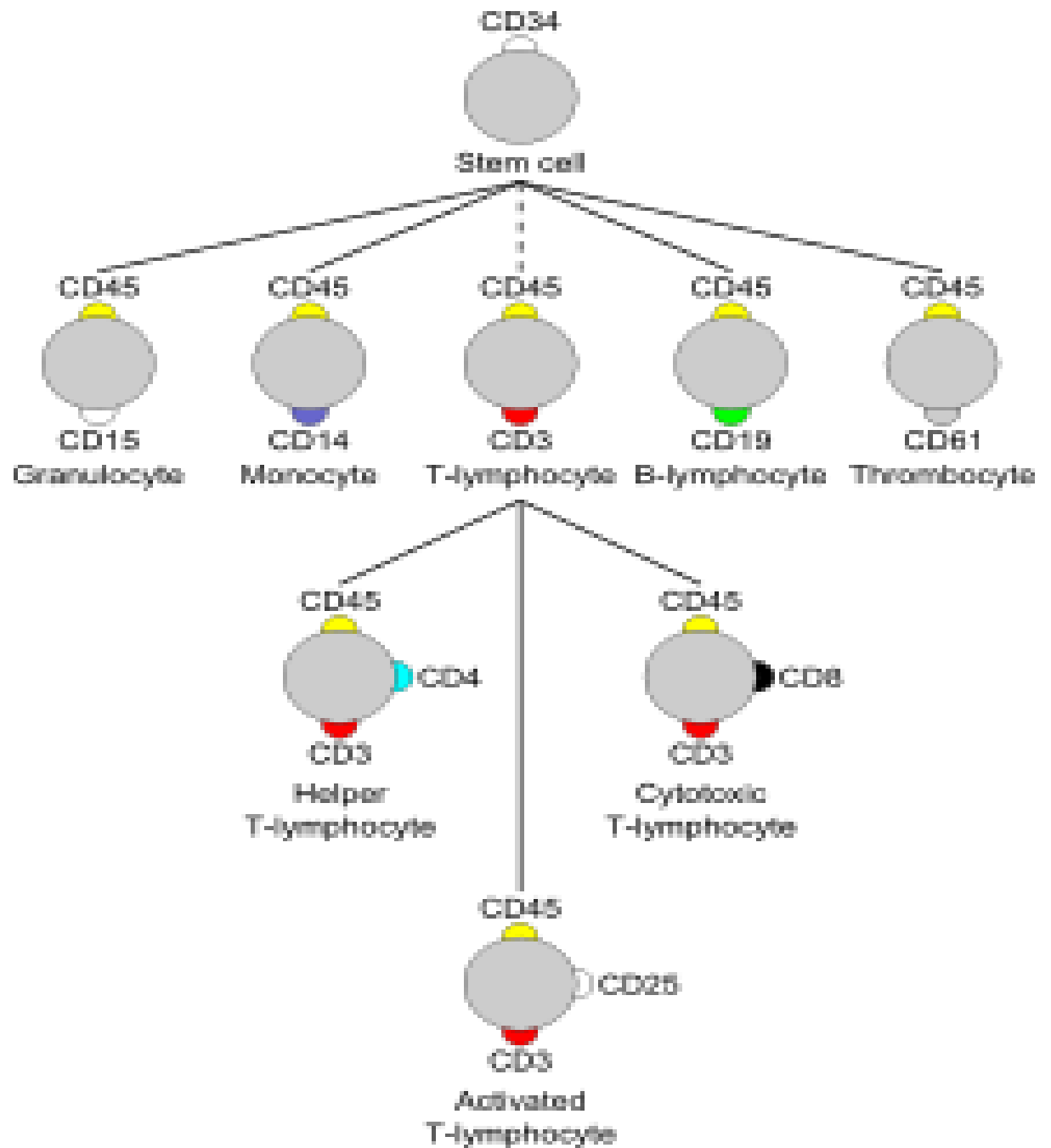
What is immunology?

- **Immune** (Latin- “immunus”)
 - To be free, exempt
 - People survived ravages of epidemic diseases when faced with the same disease again
 - **Immunity: The state of protection from infectious disease**
- The study of mechanisms that humans and other animals use to defend their bodies from invading organisms such as bacteria, viruses, fungi, parasites and toxins

Definitions

- **(CD) Cluster of Differentiation:** molecule with a CD designation has a characteristic cell surface protein are often associated with the cell's function.

Cellular Markers (CD)



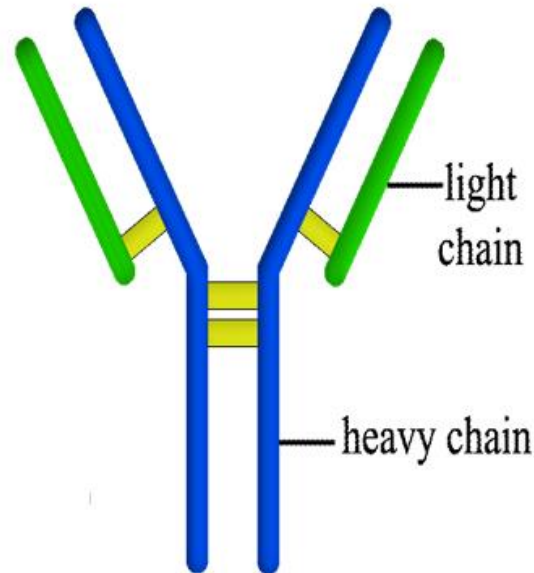
Definitions

Antigen (Ag): any substance (usually foreign) that binds specifically to a component of the adaptive immunity.

Allergen: noninfectious antigens that induce hypersensitivity reactions, most commonly IgE-mediated type I reactions.

Definitions

- **Immunoglobulin (Ig) or Antibodies:**
 - Secreted from plasma cell (B cell)
 - Consists of a heavy and light polypeptide chains linked to each other via disulfide bonds.

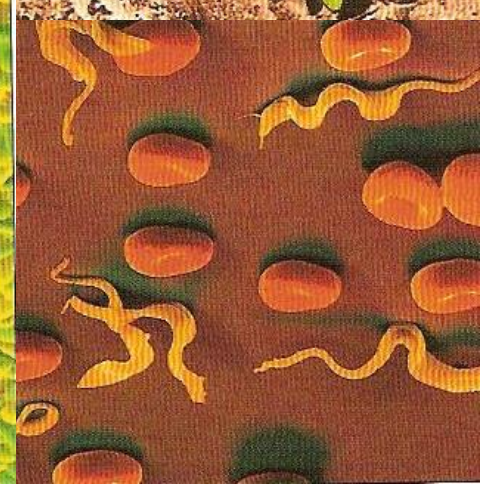
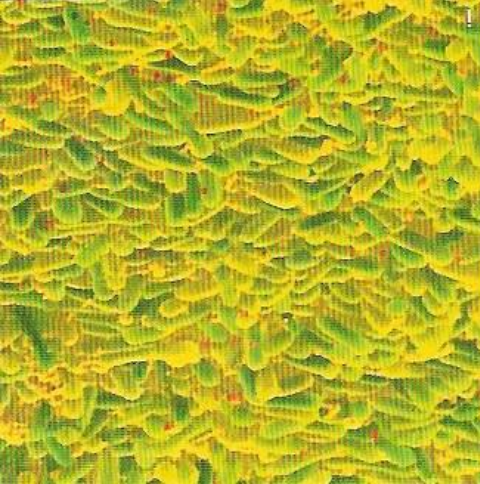
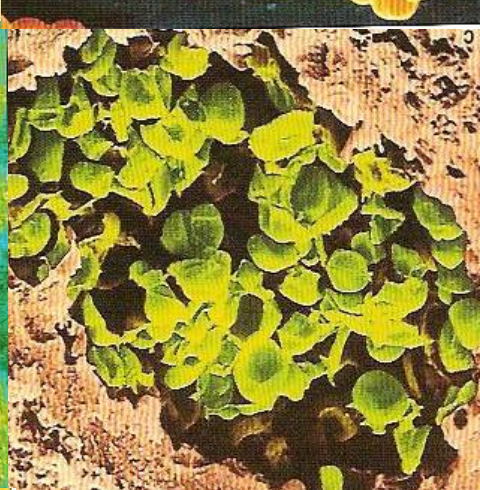
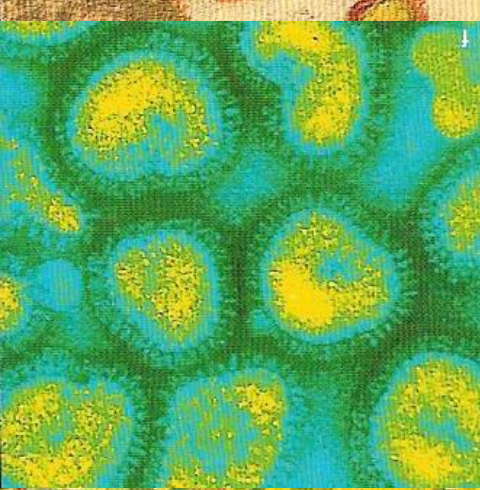
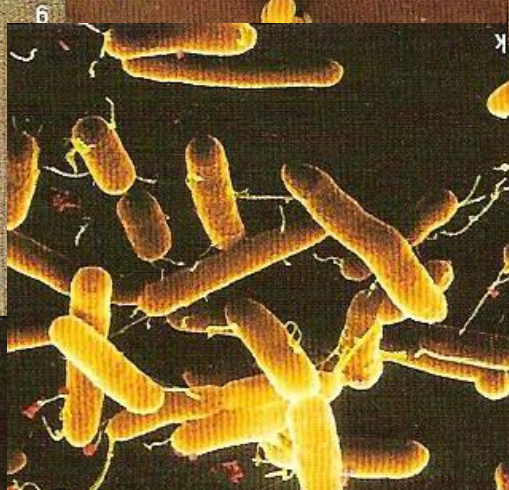
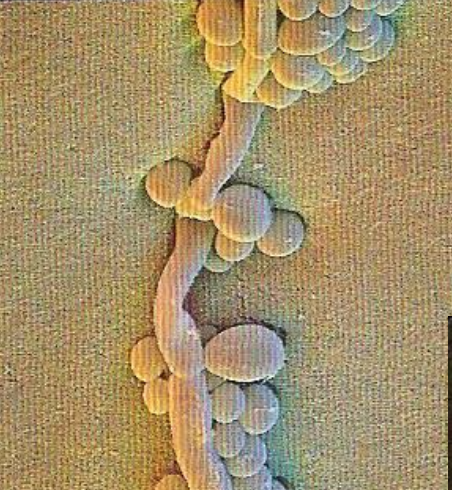
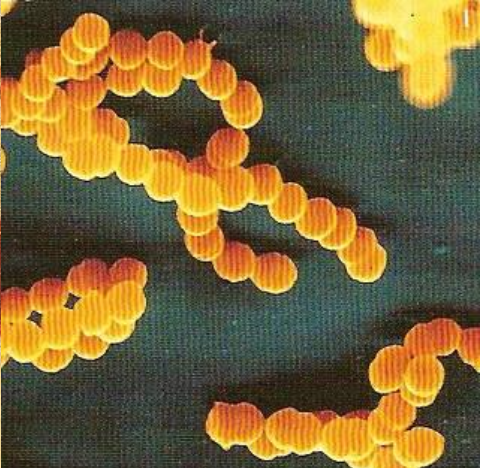
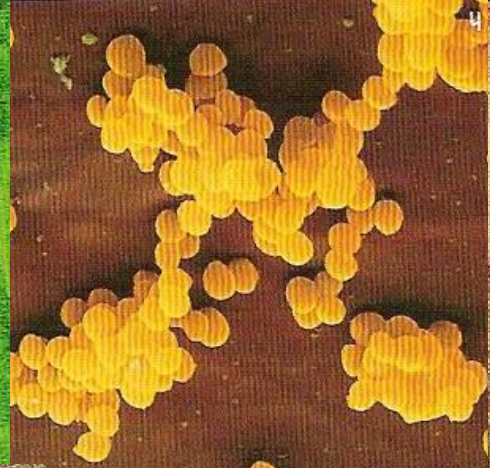


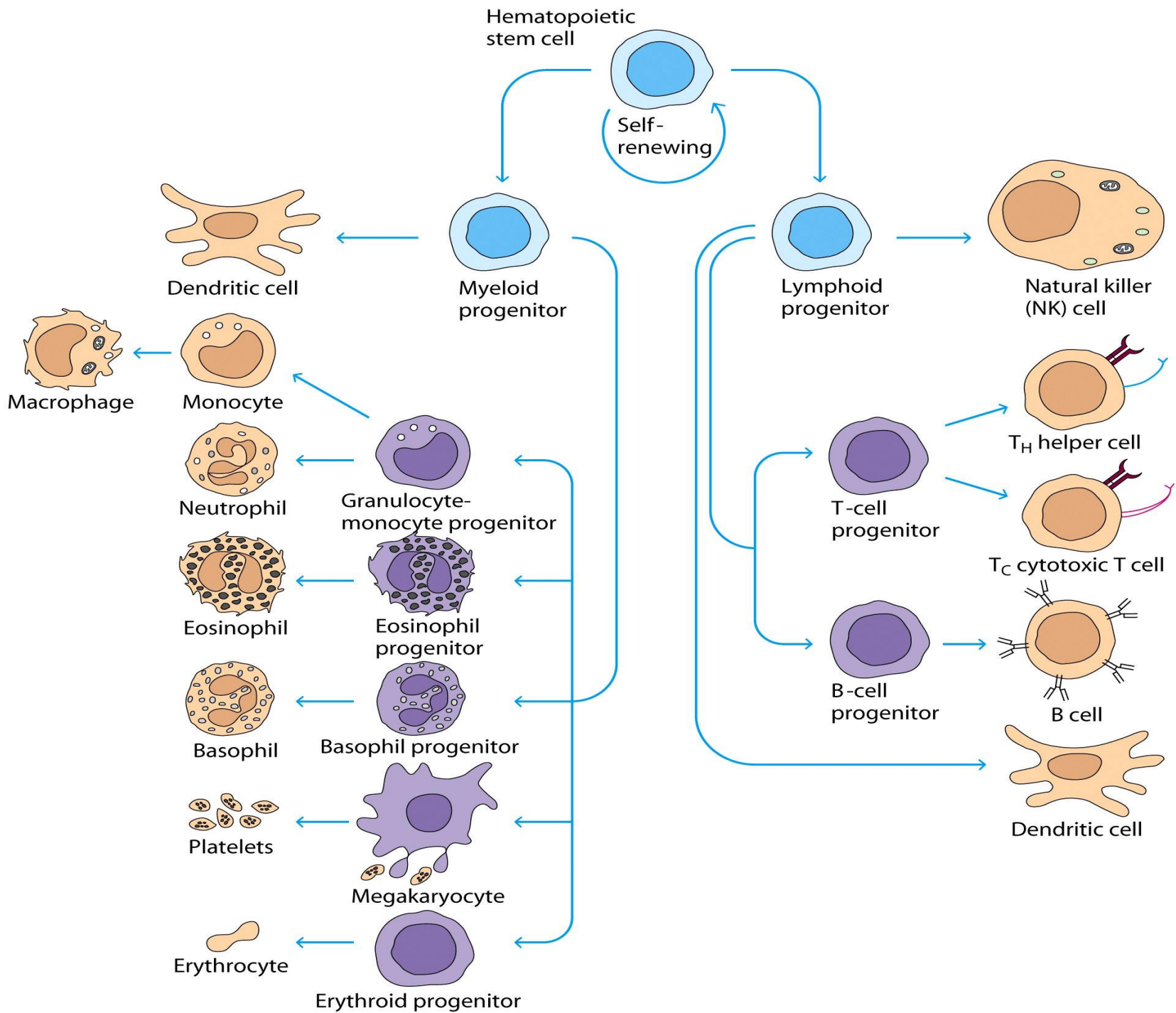
Definitions

- **Adaptive Immunity:** **Specific** host defenses that are mediated by T & B cells following exposure to Ag.
- **Innate immunity:** **Nonspecific** host defenses that exist prior to exposure to Ag.
- **Pathogen:** a disease causing organism
- **Vaccination:** deliberate induction of protective immunity to a pathogen

Where & what are antigens?

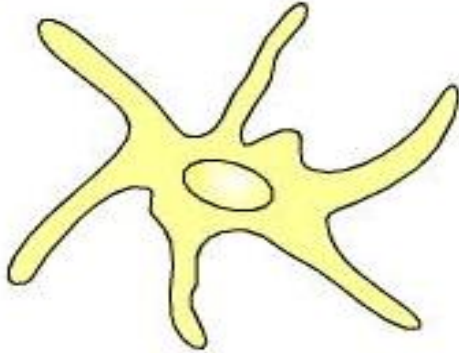
- Microorganisms & their related products (proteins, polysaccharides, lipids)
- Environmental substances
- Drugs
- Organs, tissues, cells



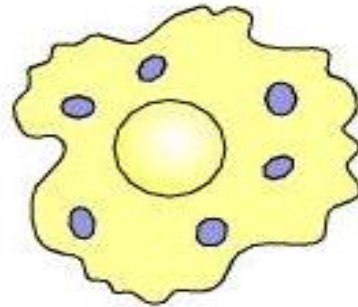


Antigen Presenting Cells

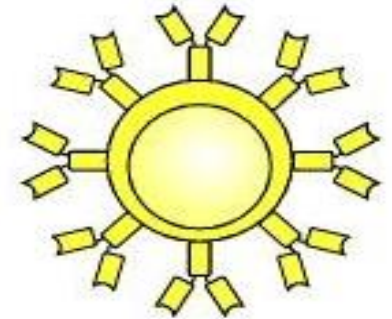
Dendritic cell



Macrophage



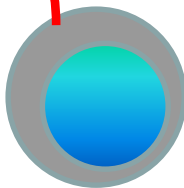
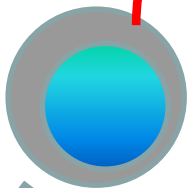
B lymphocyte



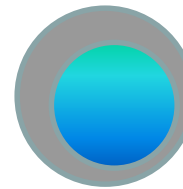
Responding Cells

CD3 Positive T Lymphocyte

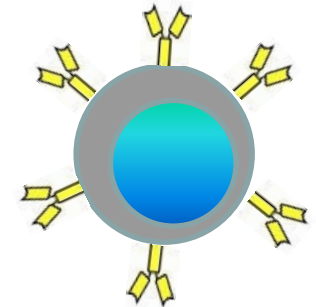
T helper lymphocyte (CD4)



T cytotoxic lymphocyte (CD8)



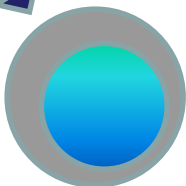
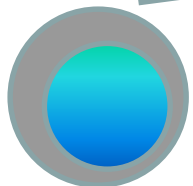
Natural Killer Cell



B lymphocyte

Th1 (CD4)

Th2 (CD4)



Types of Immunity

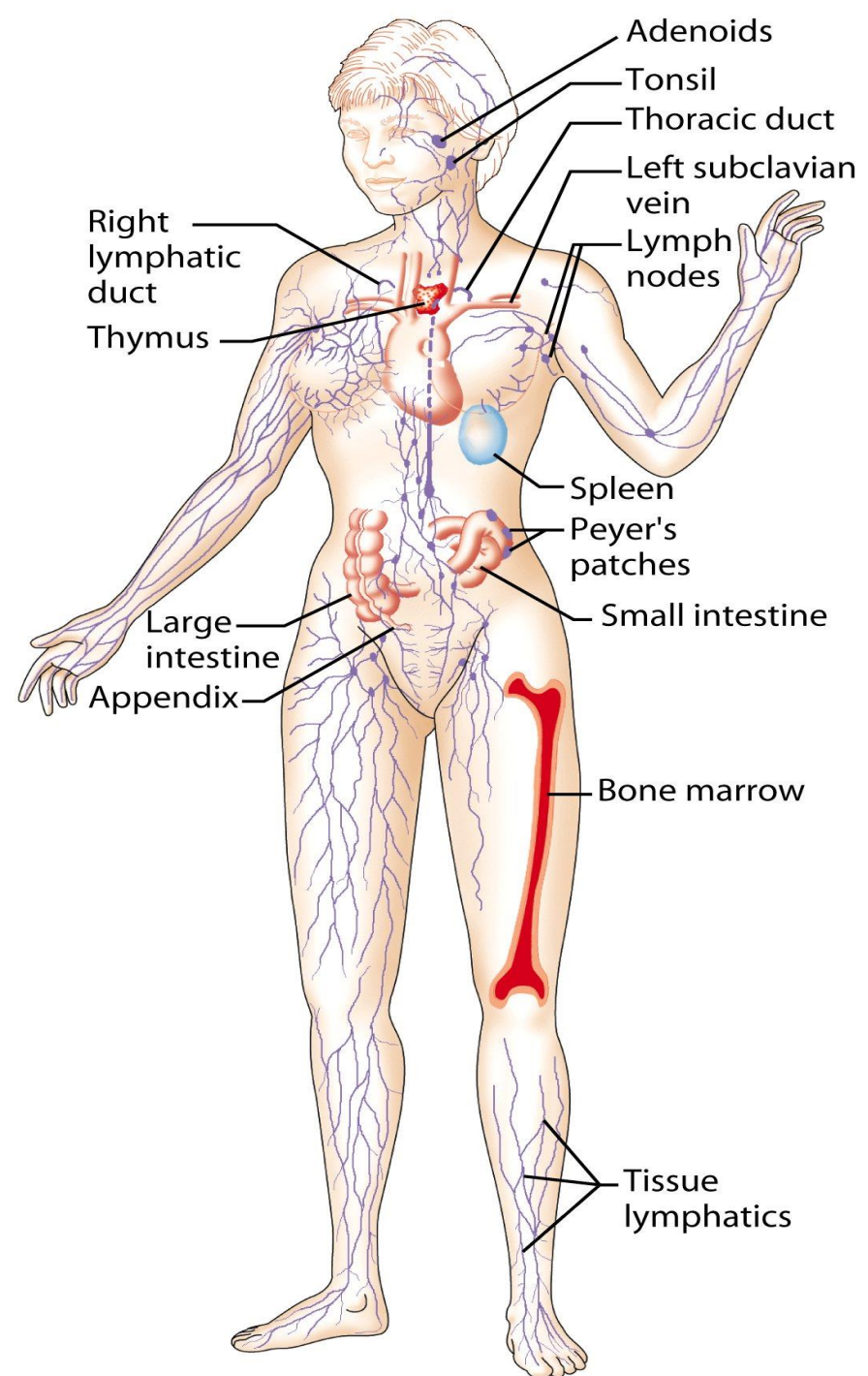
- **Innate (nonspecific) Immunity**
 - Shorter duration
 - No memory
- **Adaptive (specific) Immunity**
 - Response of a specific B and T lymphocytes to an antigen
 - Exhibit immunological memory
 - Specificity and
 - Self / non-self recognition

Adaptive Immunity

- **Humoral immunity**
 - Immunity that is mediated by antibodies (B cells)
- **Cell Mediated Immunity**
 - Immune response in which antigen specific T cells dominate

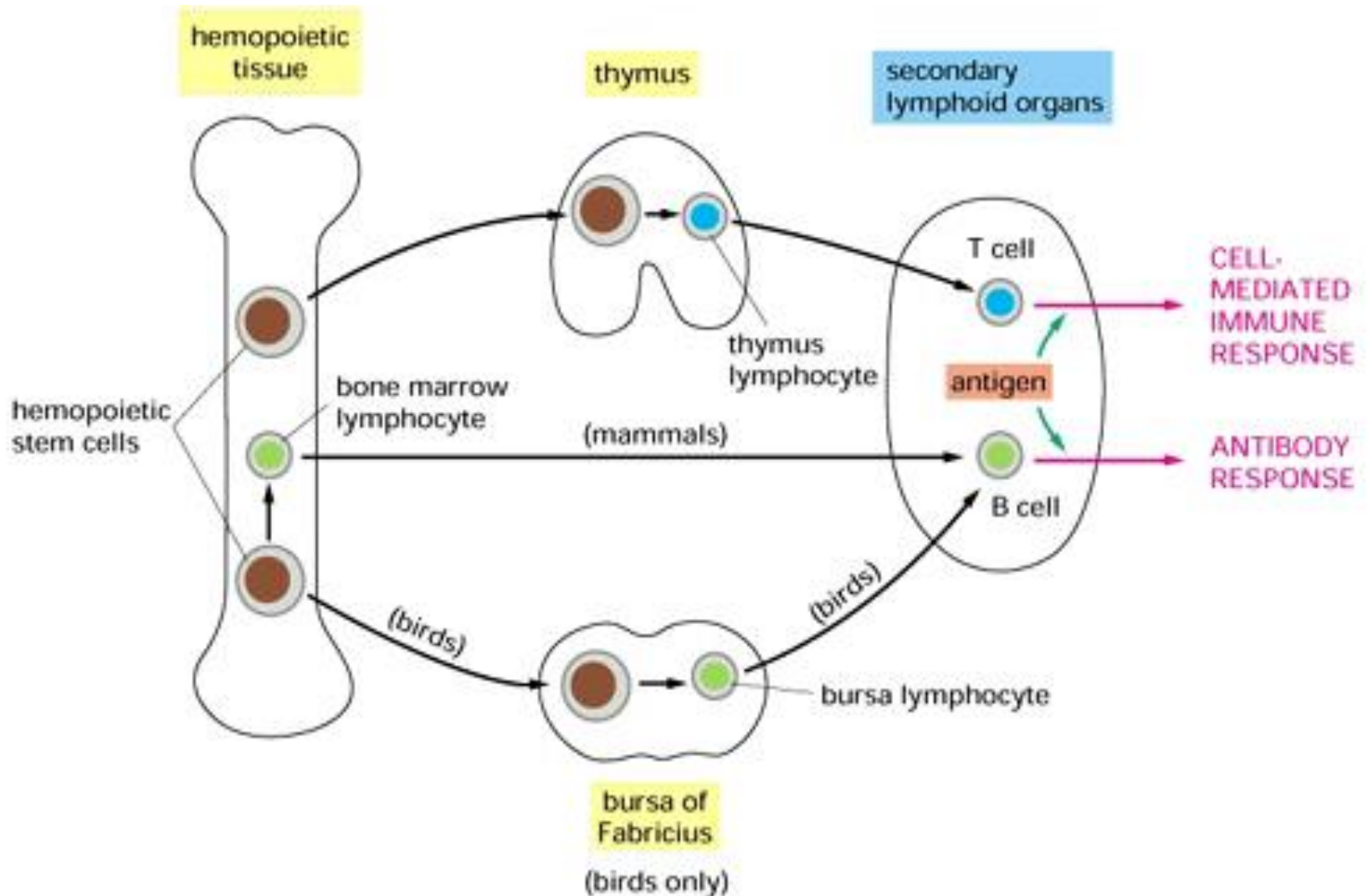
Lymphoid System

Lymphatic vessels and lymphoid organs



Primary Lymphoid Organs

(Development & Differentiation of immune cells)



Secondary Lymphoid Organs

(where the immune response occurs)

- Spleen
- Lymph nodes
- Tonsils
- MALT (Mucosa Associated Lymphoid Tissue)
- Peyer's patches
- Appendix

**Lymphoid series comprise of
two main lymphocyte populations**

T cells and B cells

T-Lymphocyte Differentiation

- T cells originate in Bone Marrow then migrate to Thymus for development.
- T cell precursors differentiate into mature T cells **in thymus**
- Stem cells lack antigen receptors and CD3, CD4, CD8 surface markers
- During their passage through thymus they differentiate into T cells expressing either markers (CD4 or CD8)

T-Lymphocytes

- All T cells have CD3 proteins on their cell surface
- Mature T cells have either CD4 or CD8 proteins but not both

Functions of T Helper Lymphocytes

- CD4 Lymphocytes (T helper 1 and 2: Th1 and Th2)
- Functions
 - Help B cells to develop into antibody producing plasma cells (Th2)
 - Help CD8 cells to become activated cytotoxic T cells (Th1)
 - Help macrophages in cell mediated immunity (Th1) during inflammatory response.

CD8 positive cells

Cytotoxic T Cells

- About 35% of peripheral blood T cells
- Perform cytotoxic functions
- They mediate the killing of:

Virus-infected cells

Tumors

Allograft cells (transplant)

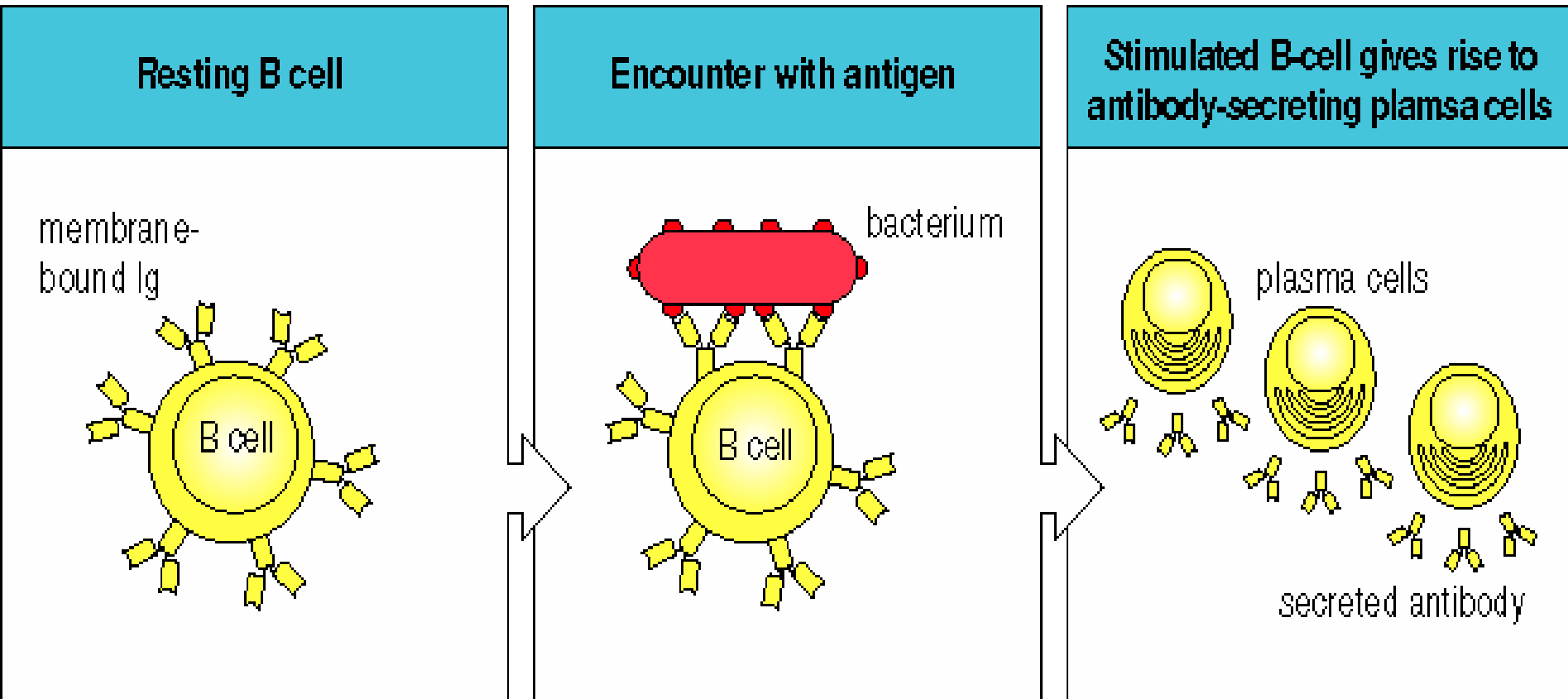
B cells

- **Origin**
 - During embryogenesis – fetal liver
 - Migrate to bone marrow – final destination
- They do not require thymus for maturation

B cells

- **B cell progenitors** like **Pro-B cells, Pre-B cells** and **immature B cells** are normally found **in bone marrow** and **Mature B cells** are found circulating in **body fluids and lymphoid organs.**
- **Mature B cells display surface IgM and IgD** which serves as antigen receptor

The Antibodies



Antibodies are also called Immunoglobulins

Immunoglobulins (Ig) are grouped into 5 classes:

IgG

IgM

IgA

IgD

IgE

Ig are glycoproteins

They differ in size, amount of CHO and biologic functions after binding to specific **antigens**

Take home message

- Normal healthy state is maintained by intact immune response either innate (natural immunity) and/or adaptive (acquired immunity after exposure to antigens)
- Cell mediated immunity and humoral immunity is mediated by T and B lymphocytes respectively
- Lymphoid system provides suitable environment for development, maturation and proper functioning of cells of immune system