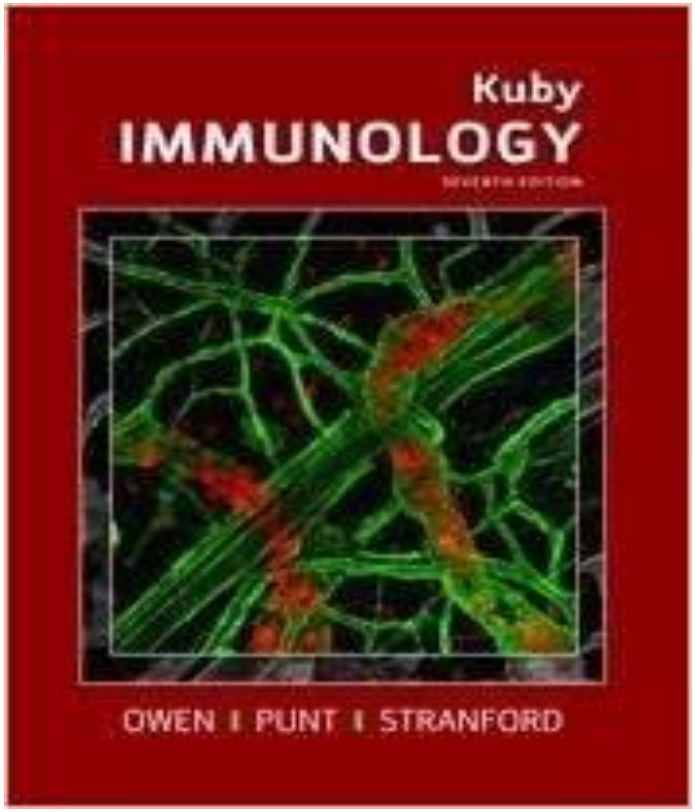
Introduction to Immunology
&
Lymphoid System

Immunology Unit
Department of Pathology
College of Medicine
KSU



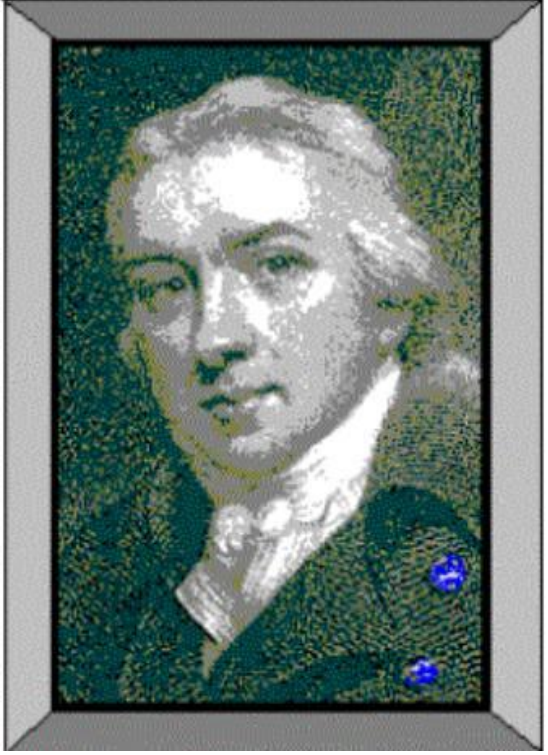
Reference

Kuby Immunology 7th Edition 2013

Chapter 1 Pages 1-22 & Chapter 2 Pages 27-57

Objectives

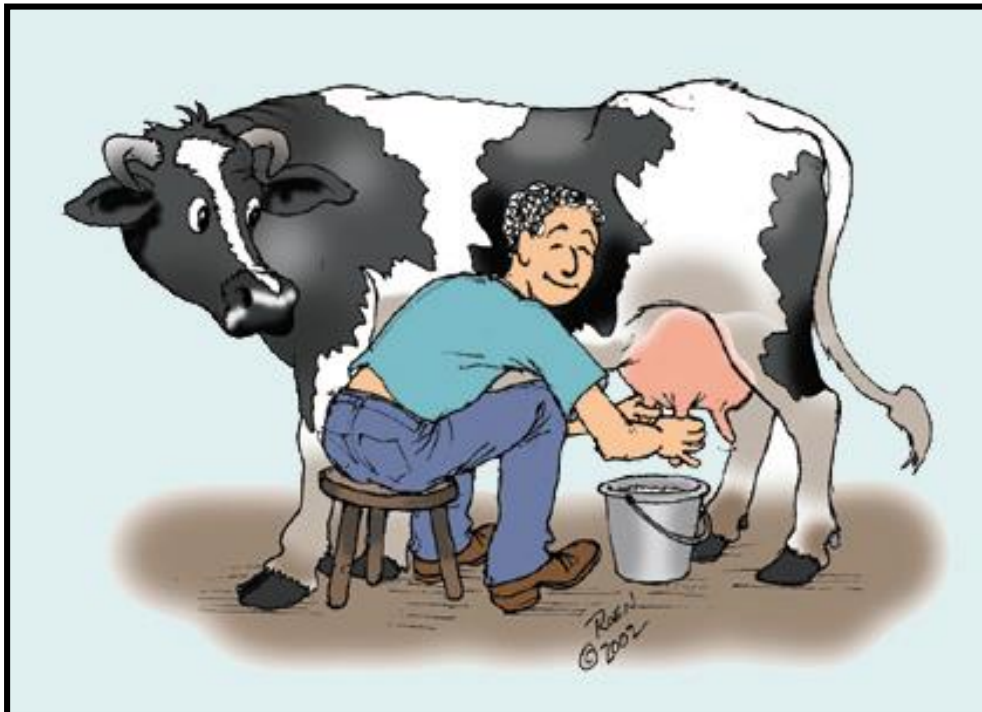
- To know the historical perspective of immunology
- To be familiar with the basic terminology and definitions of immunology
- To recognize immune response cells
- To understand types of immune responses
- To know about the lymphoid system
- To understand T and B cell functions



1798 Edward Jenner

Observation:

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



Smallpox

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.

SCARRING BUMPS, BLINDNESS, LIMB DEFORMITIES

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

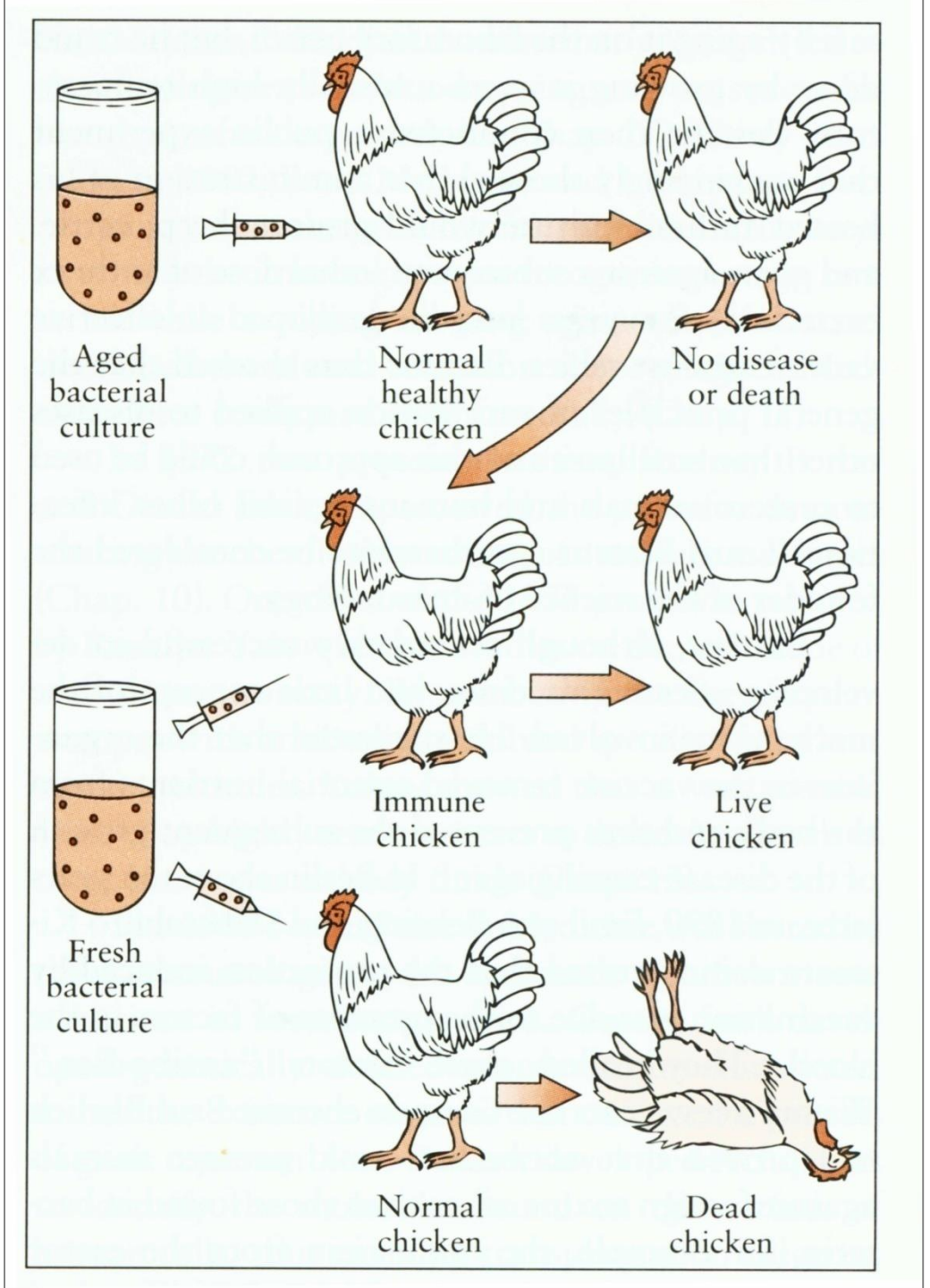
- Determined through studies of cholera in chickens that the virulence of a pathogen weakens with age (chickens inoculated with old strains not only survive but become resistant)
  - Attenuated – weakened, non-virulent strain whose exposure can confer resistance to disease

- **Classical experiment**
  - Heat attenuated anthrax bacillus and subsequent challenge with virulent *Bacillus anthracis* in sheep

Louis Pasteur

Observation:

Cholera



What is immunology?

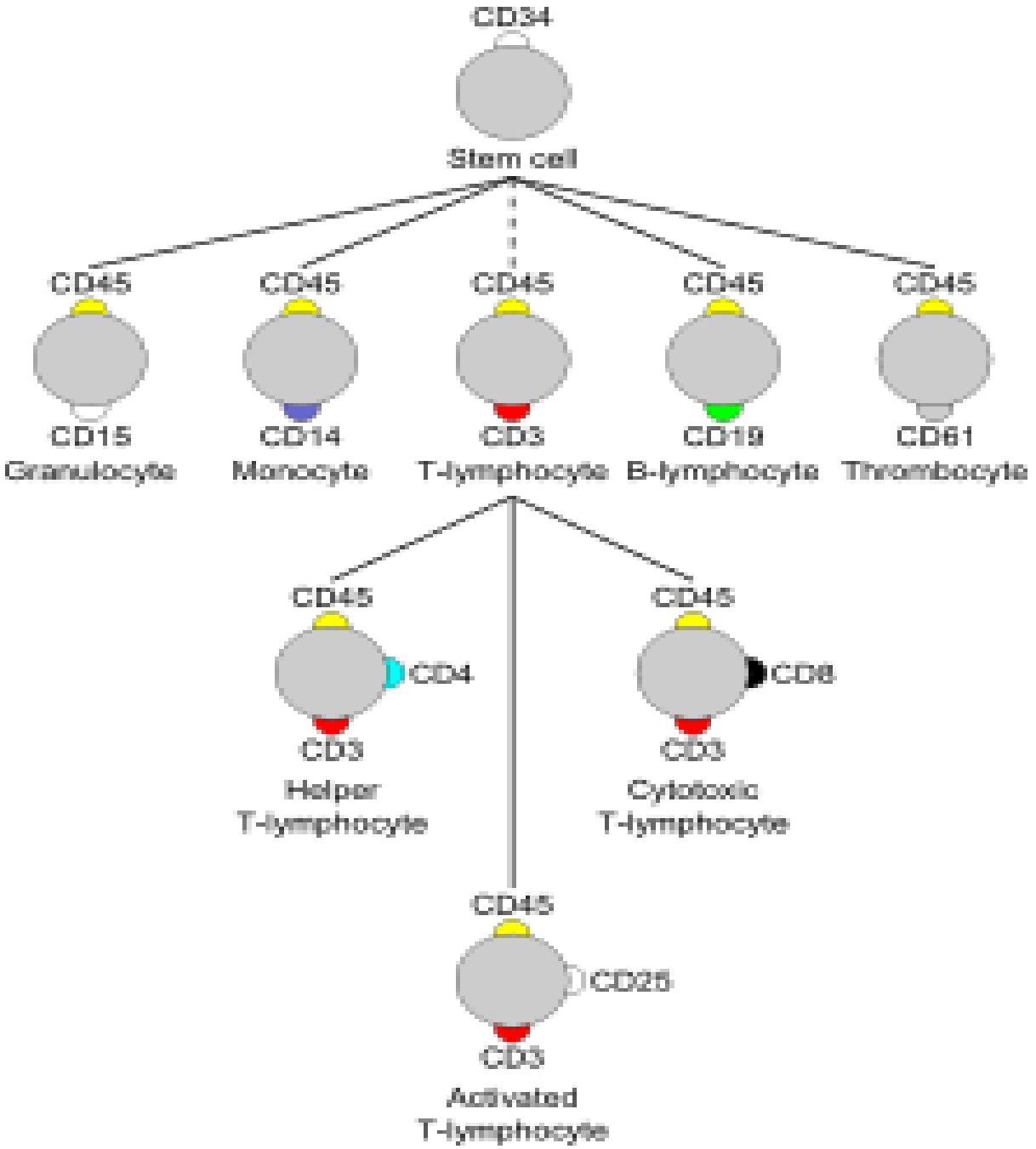
- **Immune** (Latin- “immunus”)
  - To be free, exempt
  - People survived ravages of epidemic diseases when faced with the same disease again
  - **Immunity: The state of protection from infectious disease**

- 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.

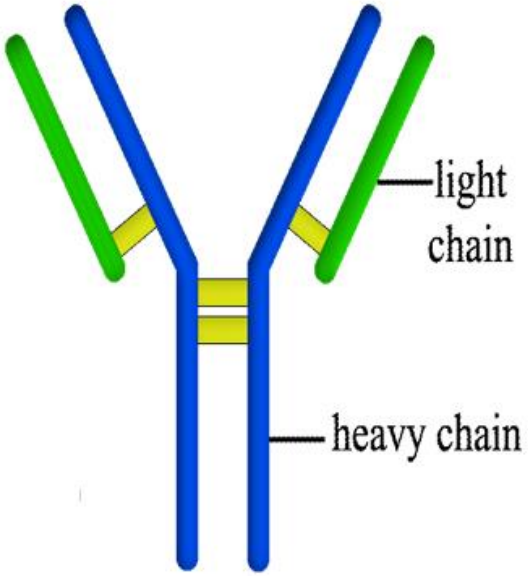
Allergen: noninfectious antigens that induce hypersensitivity reactions, most commonly IgE-mediated type I reactions.

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.

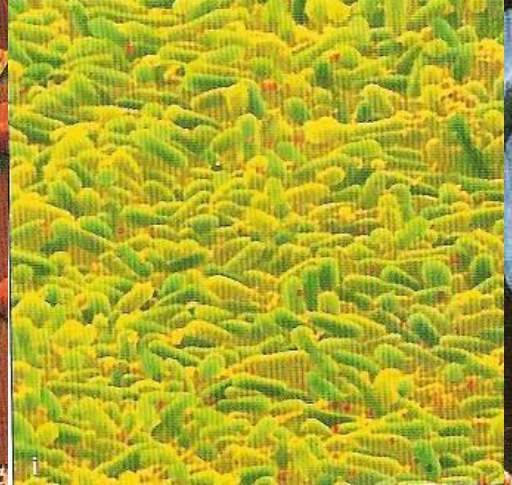


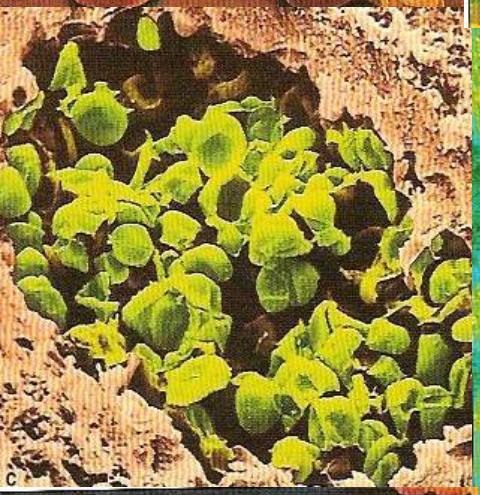
Definitions

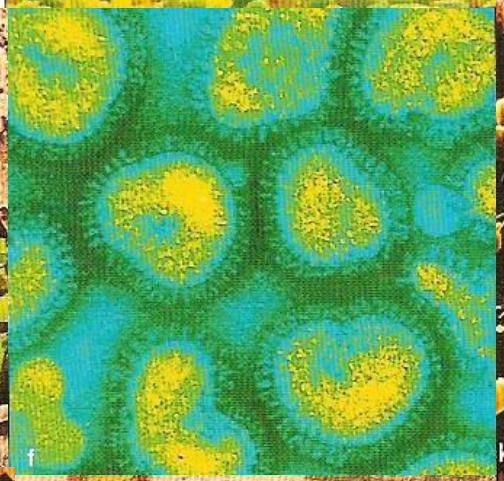
- **Adaptive Immunity**: Specific host defenses that are mediated by T & B cells following exposure to Ag.
- **Innate immunity**: Nonspecific host defenses that exist prior to exposure to Ag.
- **Pathogen**: a disease causing organism
- **Vaccination:** deliberate induction of protective immunity to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

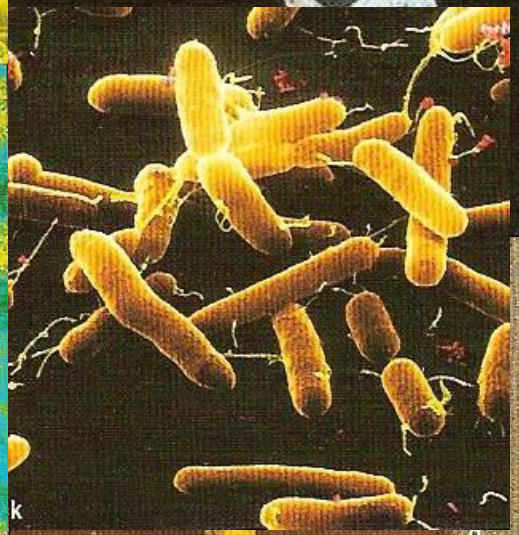
Where & what are antigens?

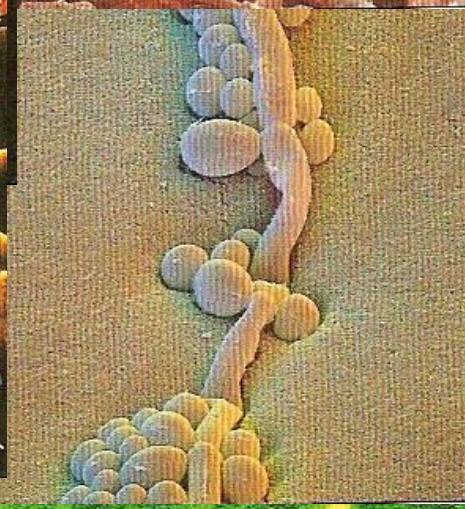
- Microorganisms & their related products (proteins, polysaccharides, lipids)
- Environmental substances
- Drugs
- Organs, tissues, cells

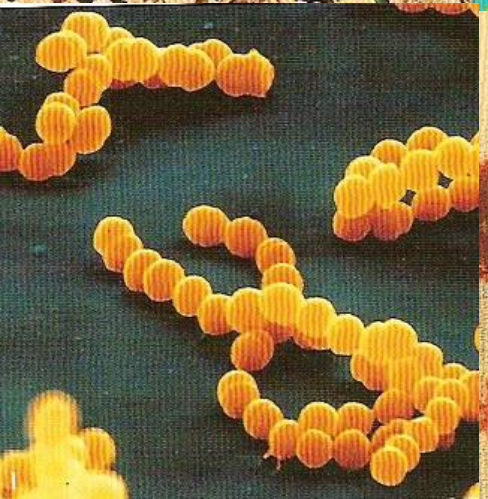


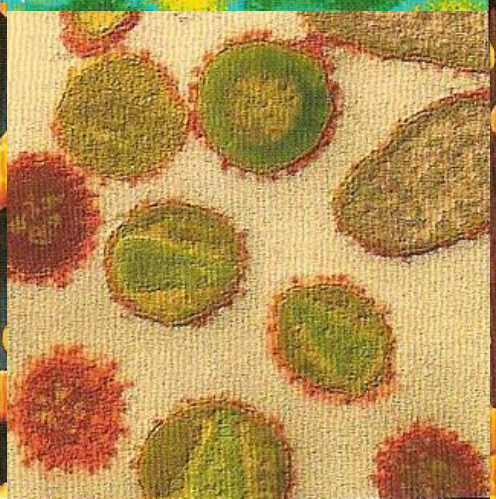


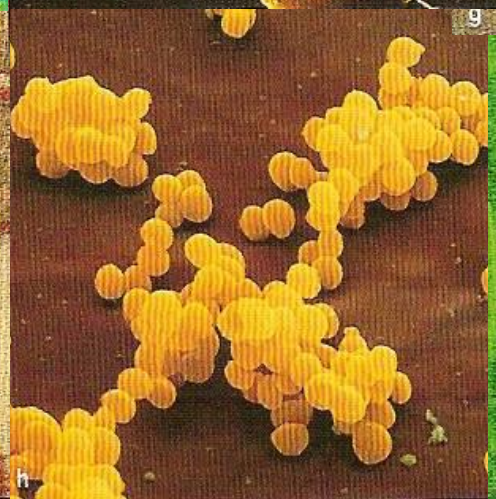


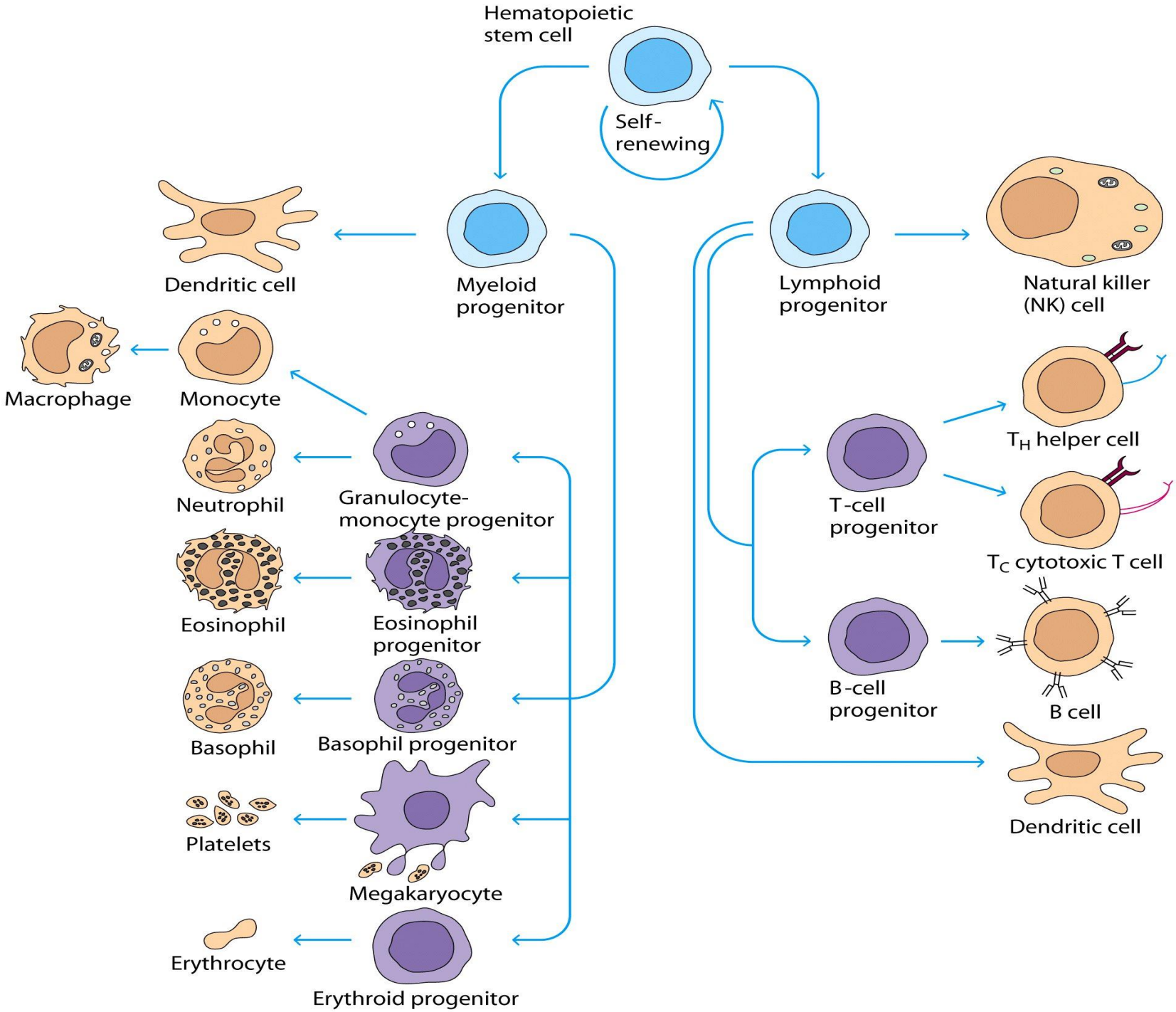




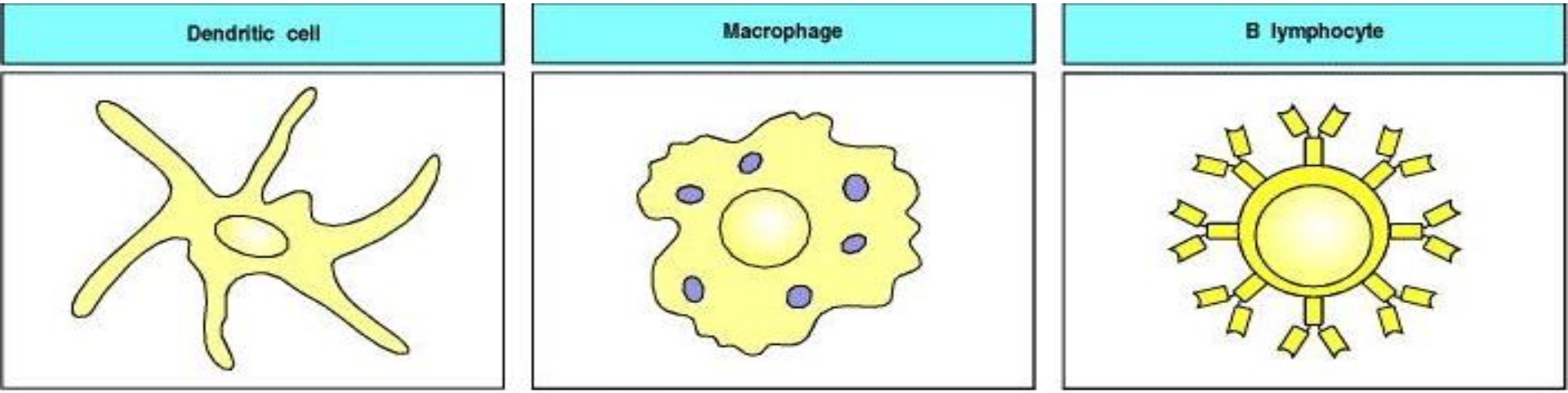




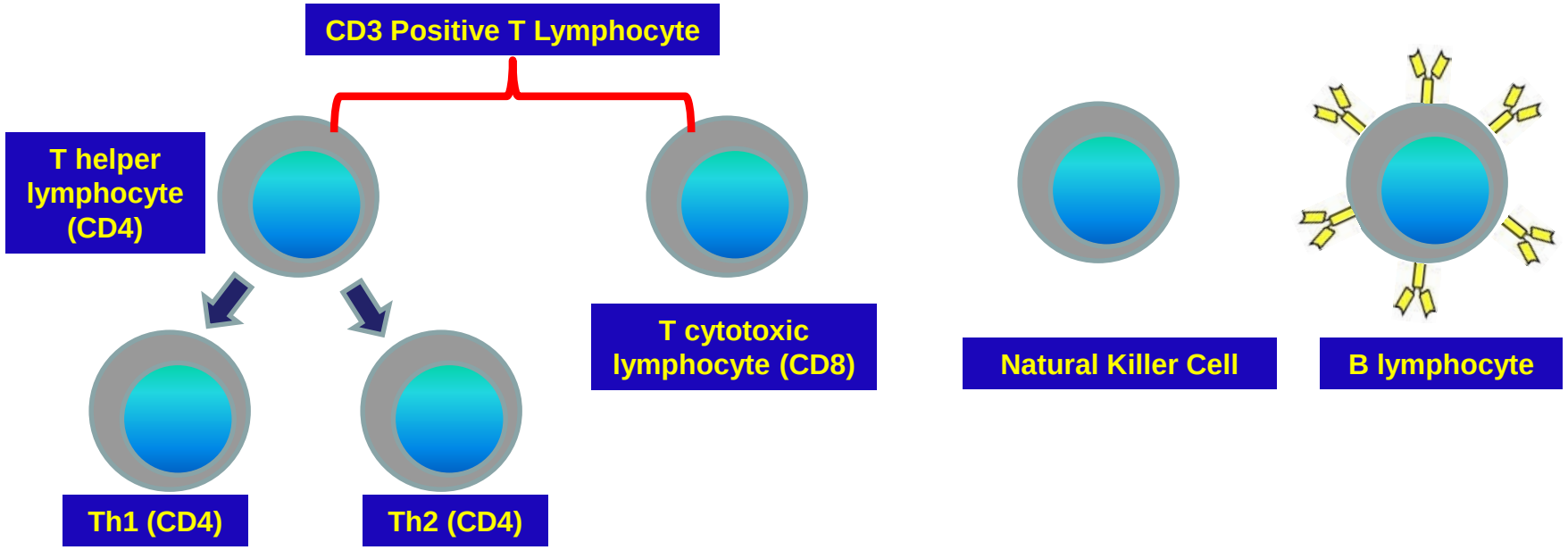



Hematopoietic stem cell
Self-renewing
Dendritic cell
Myeloid progenitor
Lymphoid progenitor
Natural killer (NK) cell
Macrophage
Monocyte
Neutrophil
Granulocyte-monocyte progenitor
T_H helper cell
T-cell progenitor
T_C cytotoxic T cell
Eosinophil
Eosinophil progenitor
B-cell progenitor
B cell
Basophil
Basophil progenitor
Dendritic cell
Platelets
Megakaryocyte
Erythrocyte
Erythroid progenitor

Antigen Presenting Cells



Responding Cells



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/nonself recognition

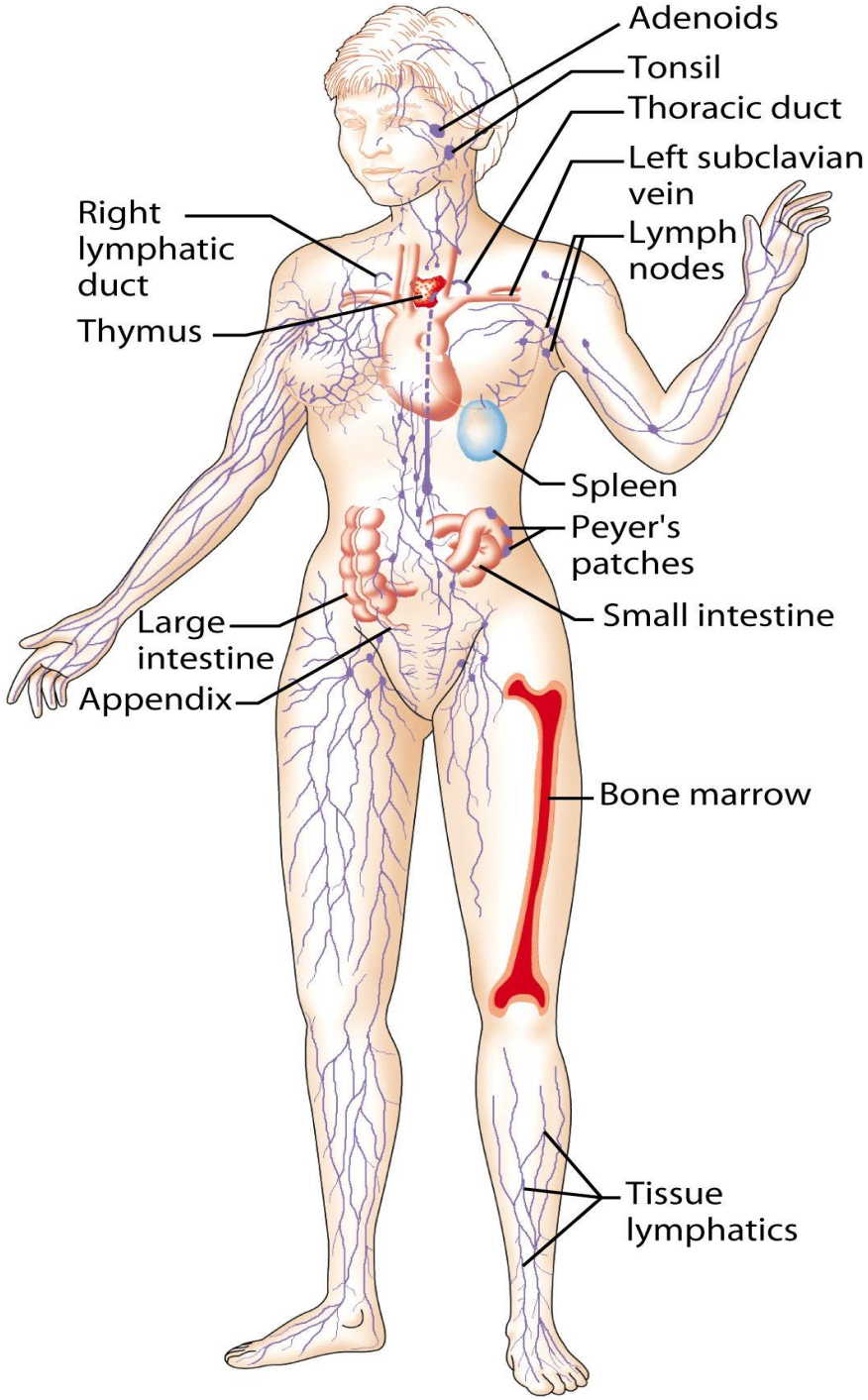
Adaptive Immunity

- **Humoral immunity**
  - Immunity that is mediated by antibodies (B cells)

- **Cell Mediated Immunity**
  - Immune response in which antigen specific T cells dominate

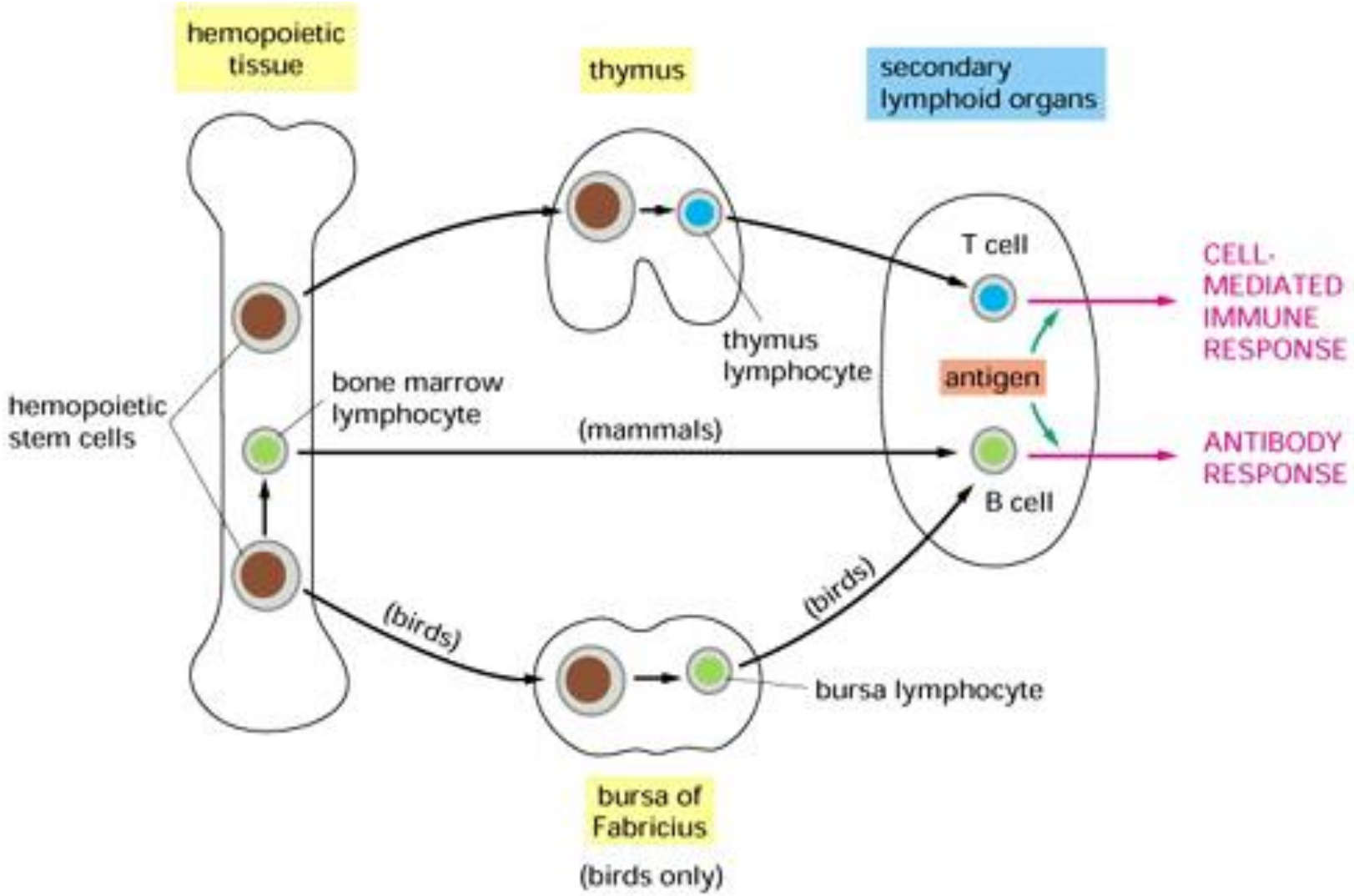
Lymphoid System

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 kill virus-infected cells, tumors and allograft cells (transplant)

B cells

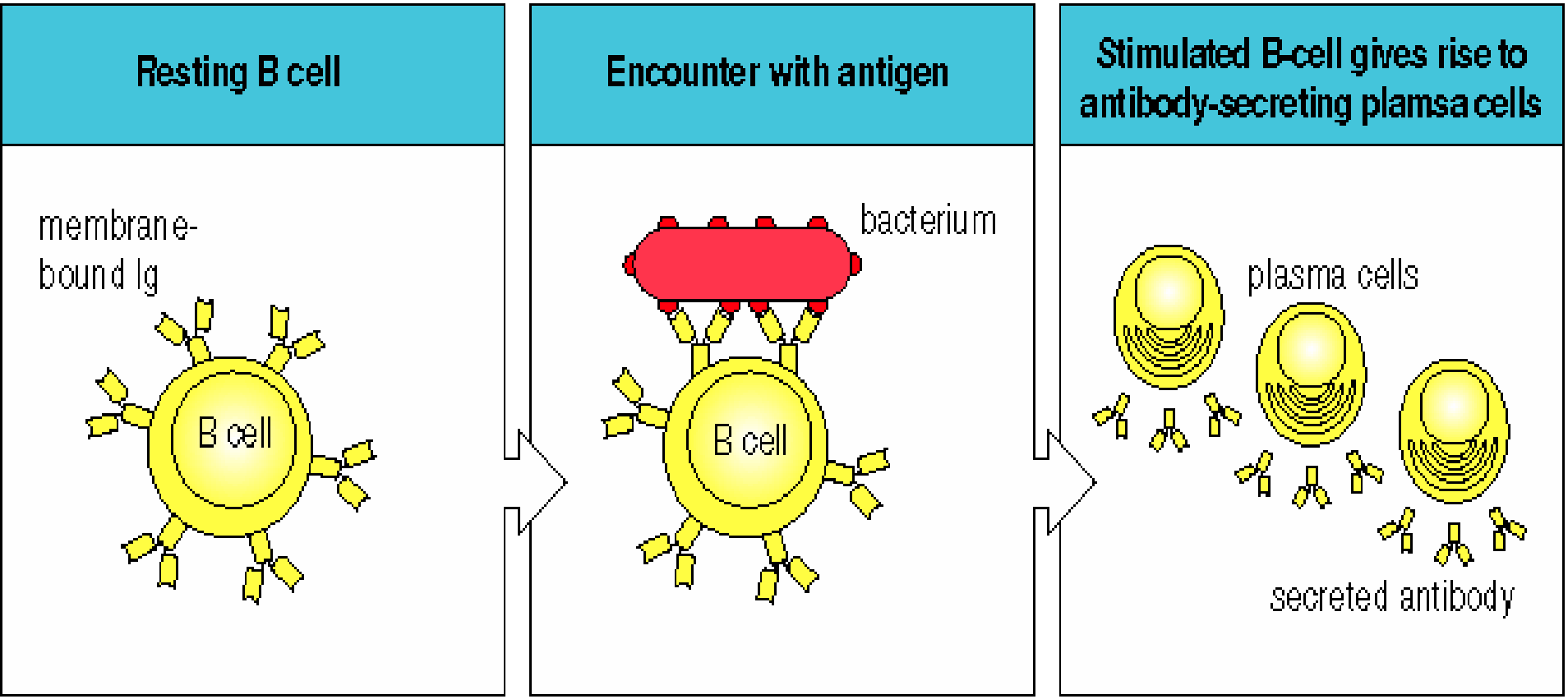
- **Origin**
  - During embryogenesis – fetal liver
  - Migrate to bone marrow – final destination
- They do not require thymus for maturation

B cells

- **B cell progenitors** like Pro B cells, Pre B cells and immature B cells are found in bone marrow and mature B cells are found circulating in body fluids (blood, lymphatic fluid….etc.)

- **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