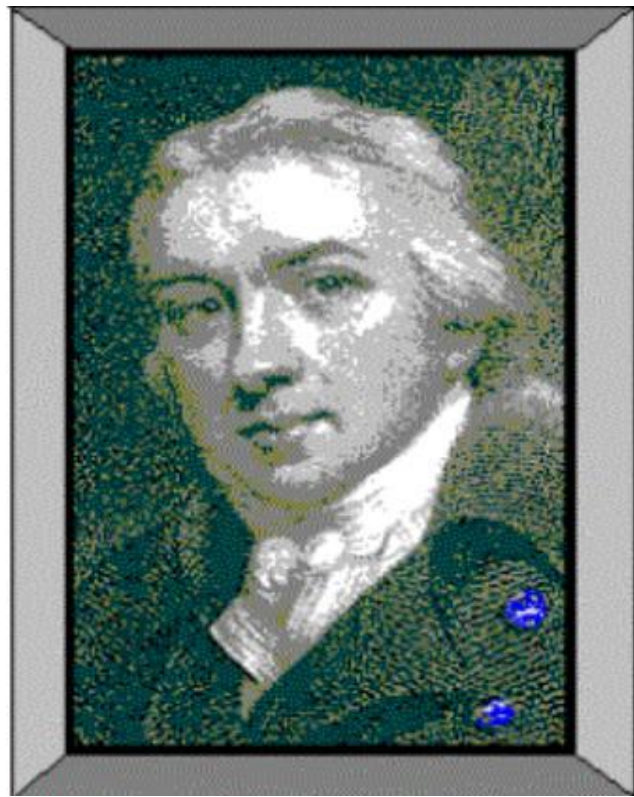


Introduction to Immunology & Lymphoid system

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Objectives

- To know the historical perspective of immunology
- To be familiar with the basic terminology and definitions of immunology
- Cells of immune response
- 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



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.

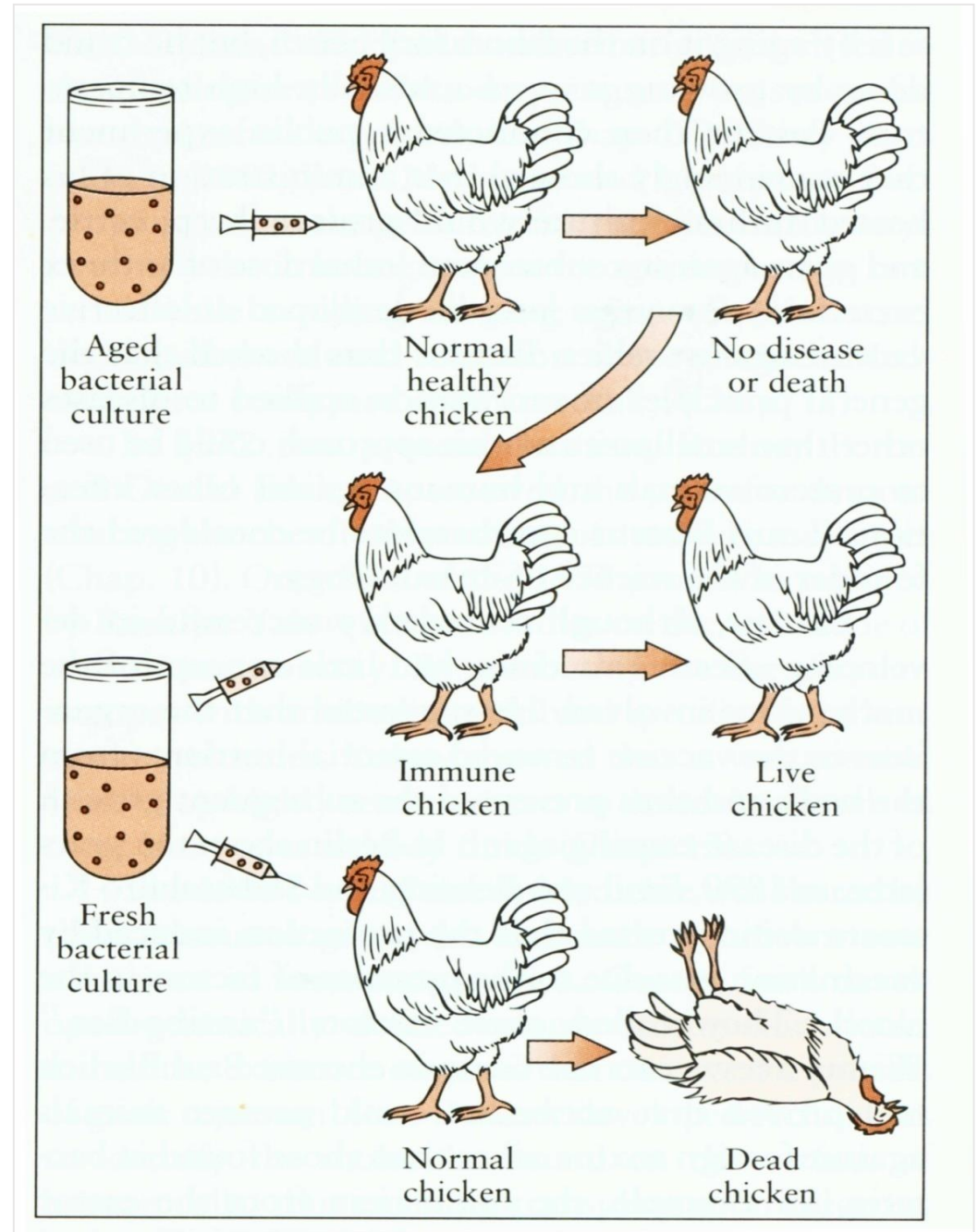
Louis Pasteur's Contributions

- Determined through studies of **cholera** in chickens that the virulence of a pathogen weakens with age
 - **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



Definitions

Antigen (Ag):

Any substance (usually foreign) that binds specifically to a component of adaptive immunity.

Allergen:

Noninfectious antigens that induce hypersensitivity reactions, most commonly IgE-mediated type I reactions.

Immunoglobulin (Ig) or Antibodies:

- Secreted from plasma cell.
- Consists of a heavy or light polypeptide chain.

Where & what are antigens?

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

Introduction to Immunology

Immune

(Latin- “immunus”)

To be free, exempt

People survived ravages of epidemic diseases when faced with the same disease again

Immunology

The study of mechanisms that humans and other animals use to defend their bodies from invading organisms such as bacteria, viruses, fungi, parasites toxins

Introduction to Immunology

Immunity

refers to protection against infection.

Immune system

is the collection of cells, tissues and molecules that functions to defend us against infectious microbes (bacteria, Virus , parasite Fungus).

Immune response

The reaction of the immune system against foreign substances.

Immune system abnormalities

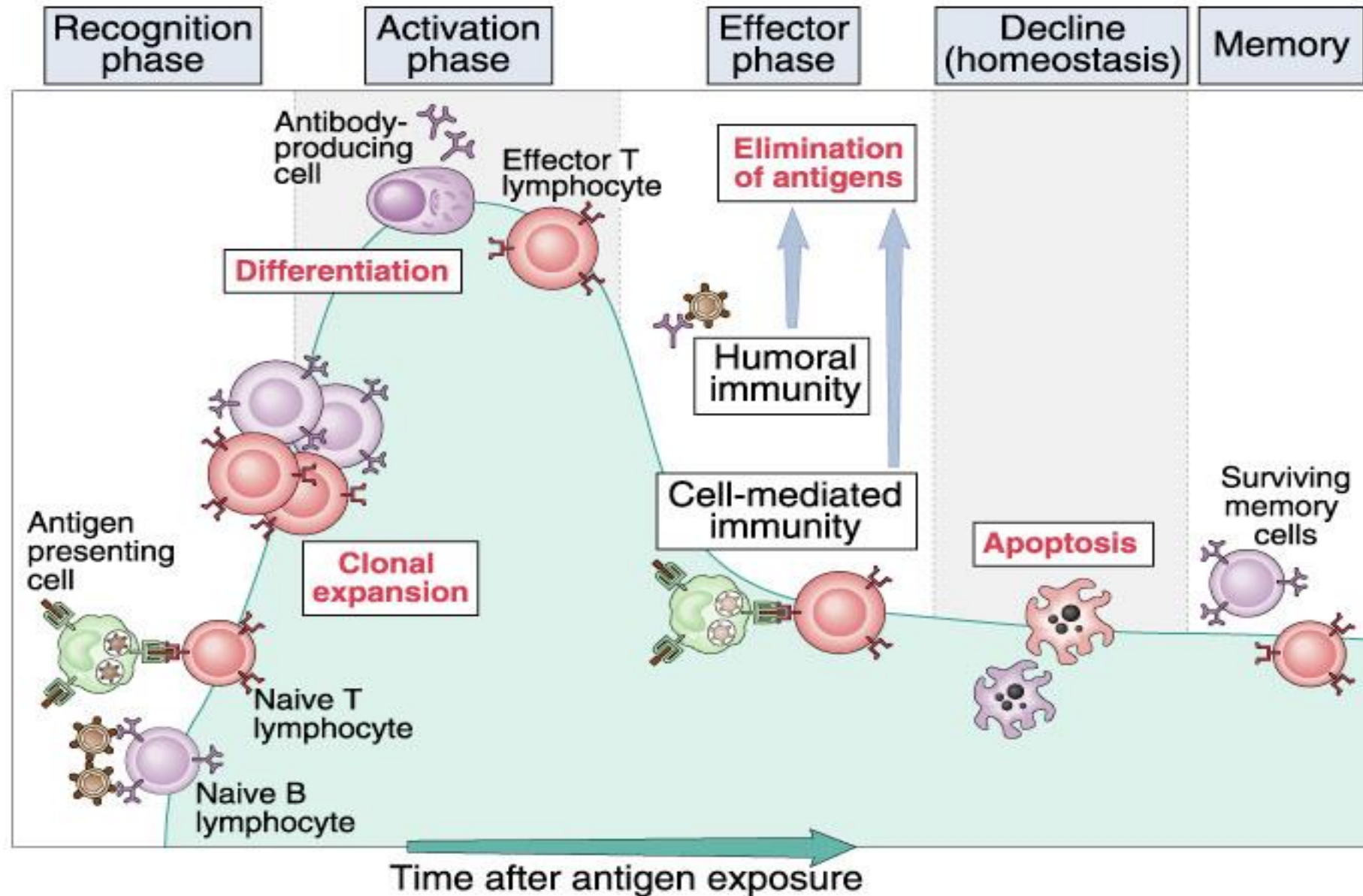
Defective in immune responses make individuals:

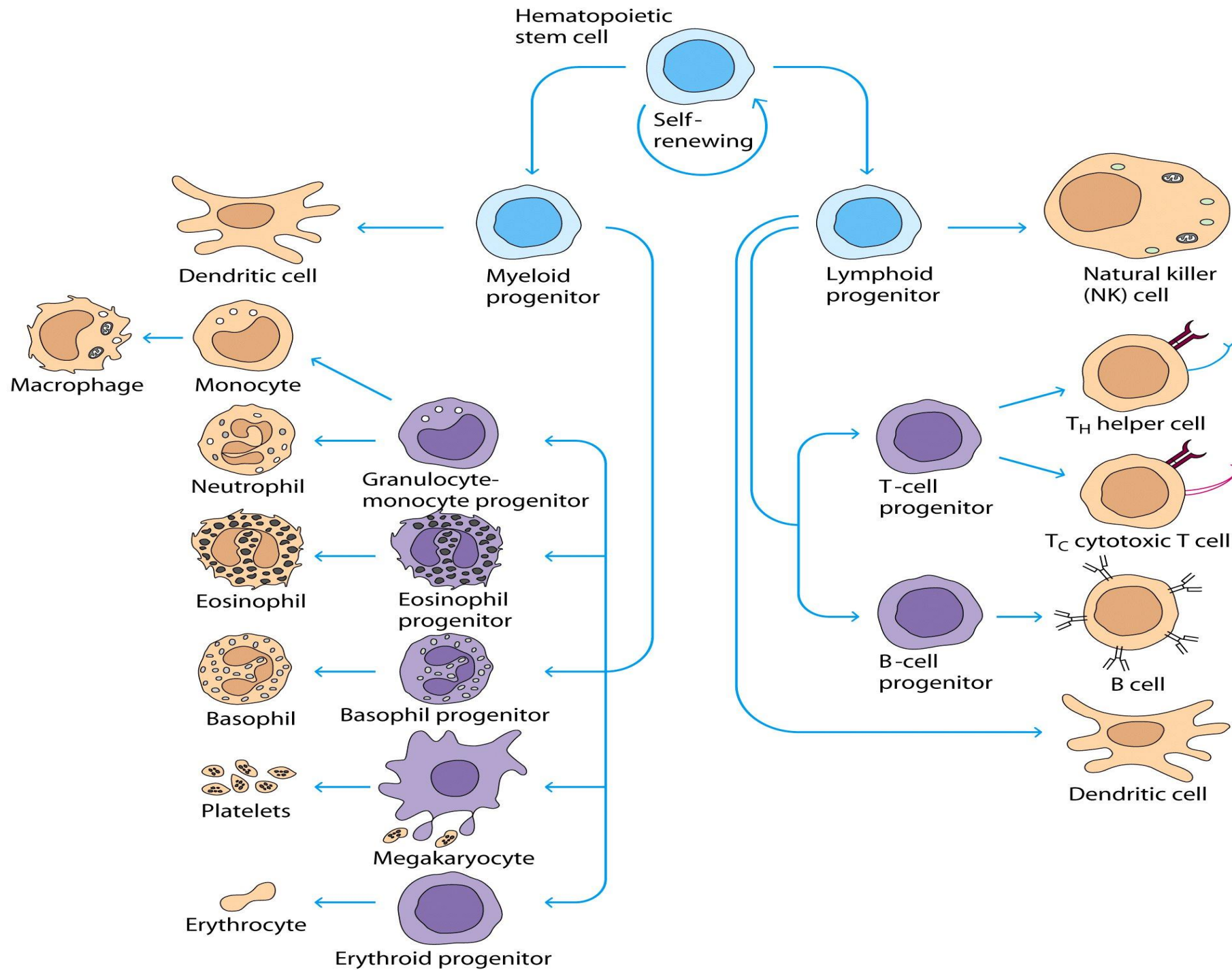
- susceptible to infections by Antigen like virus, bacteria, fungi and parasite.
- Hypersensitivity due to exposure to Allergen
Allergen :non-infectious antigens that induce hypersensitivity reactions,
most commonly IgE-mediated type I reactions
- Autoimmune disease
- Transplant rejection
- Immune deficiency

Types of Immune response

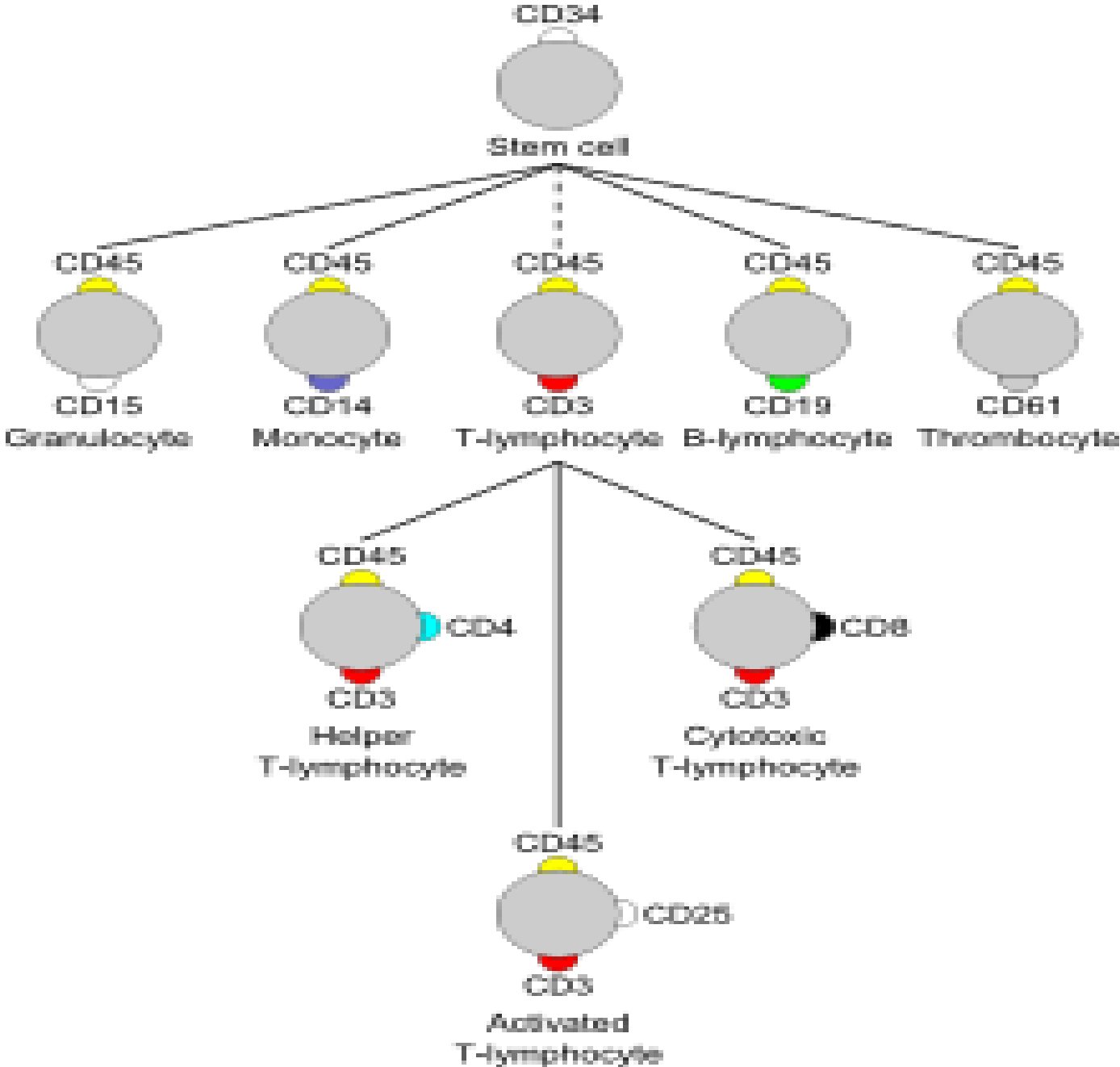
- Innate Immunity
- Adaptive Immunity
- The cells of innate and adaptive immunity are recruited to sites of infection and injury, and activated to get rid of the infectious agents and dead tissues. This process, called **inflammation**

Phases of adaptive immune responses.





Cellular Markers (CD)



(CD) Cluster of Differentiation

molecule with a CD designation has a characteristic cell surface protein are often associated with the cell's function.

Innate Immunity

- Mediated by cells and proteins that fight against microbes
- There are four major components of innate immunity:
 1. Epithelial barriers of the skin, GI tract and respiratory tract, which prevent microbe entry (and have to be breached for a microbe to establish infection, e.g. by cuts and burns)
 2. Phagocytic leukocytes (neutrophils and macrophages)
 3. Natural killer (NK) cell
 4. complement system

Phagocytic leukocytes (Neutrophils & Macrophages)

Neutrophils:

Neutrophils respond rapidly to foreign stimuli and to injury; their reaction is part of acute inflammation.

Macrophages:

When blood monocytes enter tissues, they mature, and are called macrophages. These cells are present under epithelia, connective tissues, and in all organs. this reaction is typical of chronic inflammation.

- Macrophages also help to repair damaged tissue

Natural killer cell

- Specialized in identifying cells that are infected by a Virus or that have become tumor cell.
- They do this by looking for changes in cell surfaces. If natural killer cells find cells with a changed surface, they dissolve them using cytotoxins.

Complement system

- The complement system consists of about 20 proteins in normal human serum.
- Synthesized mainly in the liver.
- Heat labile i.e. it is inactivated at 56°C for 30 minutes.

Complement function

Chemotaxis

Attract other immune cells from the blood such as macrophages and neutrophils .

Cell lysis

dissolve the cell walls of bacteria which lead to lose fluid, minerals and die.

- Fight viruses directly by destroying the virus envelopes, or indirectly by destroying cells infected by viruses

Opsonization

enhancing phagocytosis of antigens

Agglutination

clustering and binding of pathogens together

Adaptive Immunity

- Consist of highly specialized cells which has the ability to destroy invading pathogen and toxic molecule .
- Includes both humoral immunity and cell-mediated immunity.
- highly specific to a specific pathogen
- Mediated by T and B lymphocytes following exposure to specific antigen, and characterized by immunological memory
- Antigen is any substance that elicit the adaptive immune response.
- B- lymphocyte secretes antibodies
- T- Lymphocyte secretes cytokines

Adaptive Immunity

Two types:

- Humoral Immunity
- cellular Immunity

Humoral Immunity

- The humoral immune response begins with the recognition of antigens by naïve B cells.
- These cells then undergo a process of clonal expansion and differentiation.
- The B cell matures into antibody secreting plasma cells, which secrete antibodies.
- Antibodies are the effector products of humoral immunity.
- As this response declines, a pool of memory cells remains behind.
- If the body is re-exposed to the antigen, these memory B- cells will recognize the antigen and respond much more quickly and effectively.


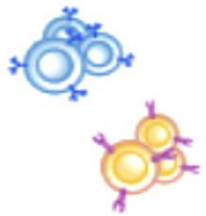

Antibodies

- 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

Cellular Immunity

Naïve T cells and their effector products make up the second branch of the adaptive immune system

- T cells types.
 - T-helper CD4
 - T-cytotoxic CD8
- is called into action against pathogens that overcome innate immune defenses.
- Components of the adaptive immune system are normally silent; however, when activated, these components “adapt” to the presence of infectious agents by activating, proliferating, and creating potent mechanisms for neutralizing or eliminating the microbes.

	Innate immunity	Adaptive Immunity
Components	 <ol style="list-style-type: none"> 1. Physical and chemical barriers 2. Phagocytic leukocytes 3. Dendritic cells 4. Natural Killer cells 5. Plasma proteins (complement) 	 <ol style="list-style-type: none"> 1. Humoral immunity (B cells, which mature into antibody secreting plasma cells) 2. Cell-mediated immunity (T cells, which mature into effector helper and cytotoxic T cells)
Activity	Always present	Normally silent
Response and potency	Immediate response, but has a limited and lower potency	Slower response (over 1-2 weeks, but is much more potent)
Specificity	General: can recognize general classes of pathogens (i.e. bacteria, viruses, fungi, parasites) but cannot make fine distinctions	Recognizes highly specific antigens
Course	Attempts to immediately destroy the pathogen, and if it can't, it contains the infection until the more powerful adaptive immune system acts.	Slower to respond; effector cells are generally produced in 1 week and the entire response occurs over 1-2 weeks. However, this course can vary somewhat during different responses in an individual.
Memory?	No--reacts with equal potency upon repeated exposure to the same pathogen.	 Yes--memory cells "remember" specific pathogens; upon re-exposure to a pathogen, these cells mount a much faster and more potent second response

Principle cells of the Immune response

- In a previous section, we organized various cell types as participating in innate or adaptive immunity.

Cells of Immune response are reorganized into three functional groups:

1. Lymphocytes

come from a distinct lineage of stem cells and are responsible for the adaptive response

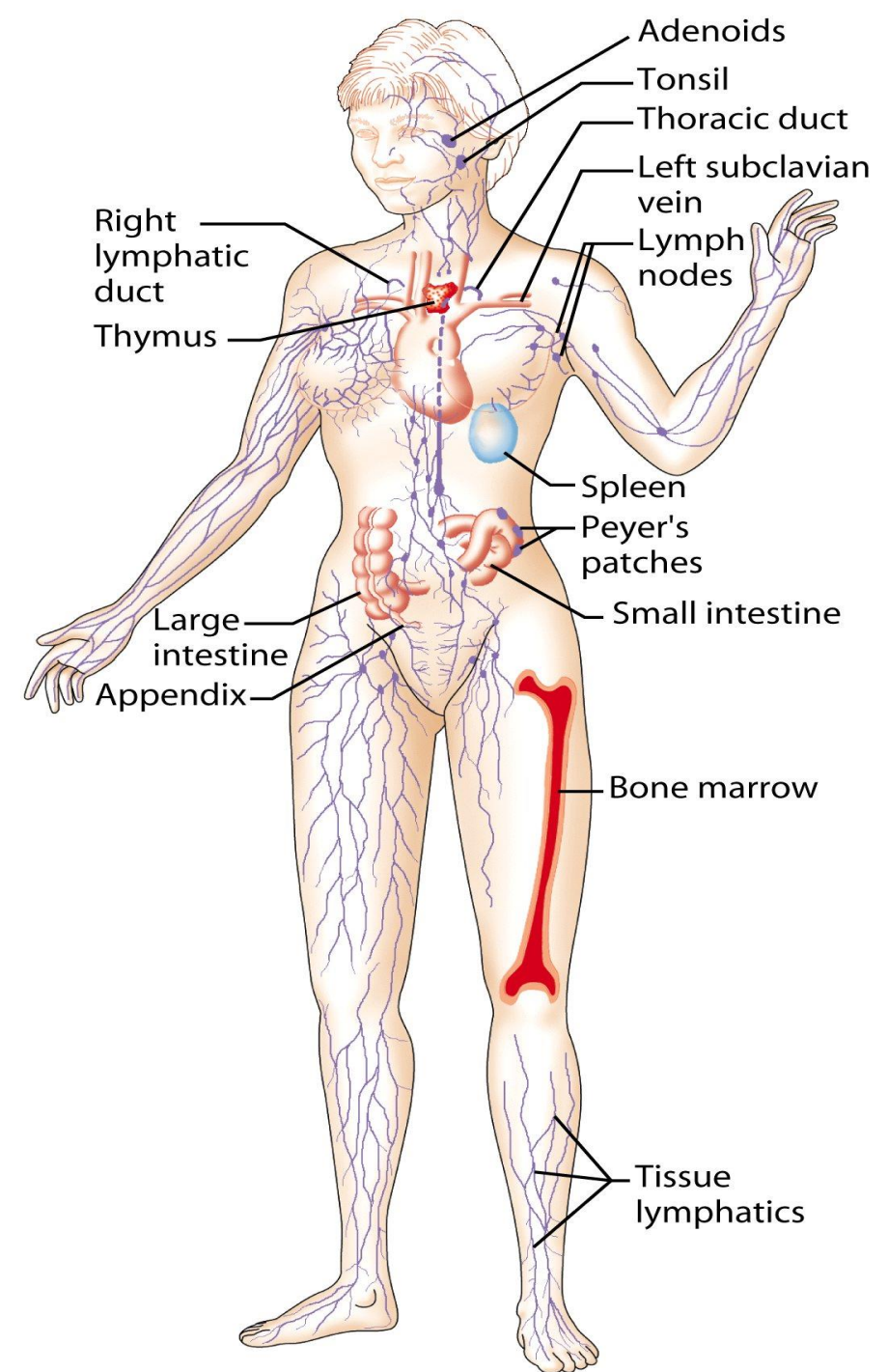
2. Antigen presenting cells

are capable of bringing antigens to lymphocytes to initiate the adaptive response

3. Effector cells

actually do the killing of microbes once an adaptive response is underway.

Lymphatic system & Immune system



Lymphatic System

Lymphatic system consists of :

lymphatic organs, lymphatic vessels, and the circulating lymph

- **Primary lymphoid organs**

 - Thymus

 - Bone marrow

- **Secondary lymphatic tissues**

 - Spleen

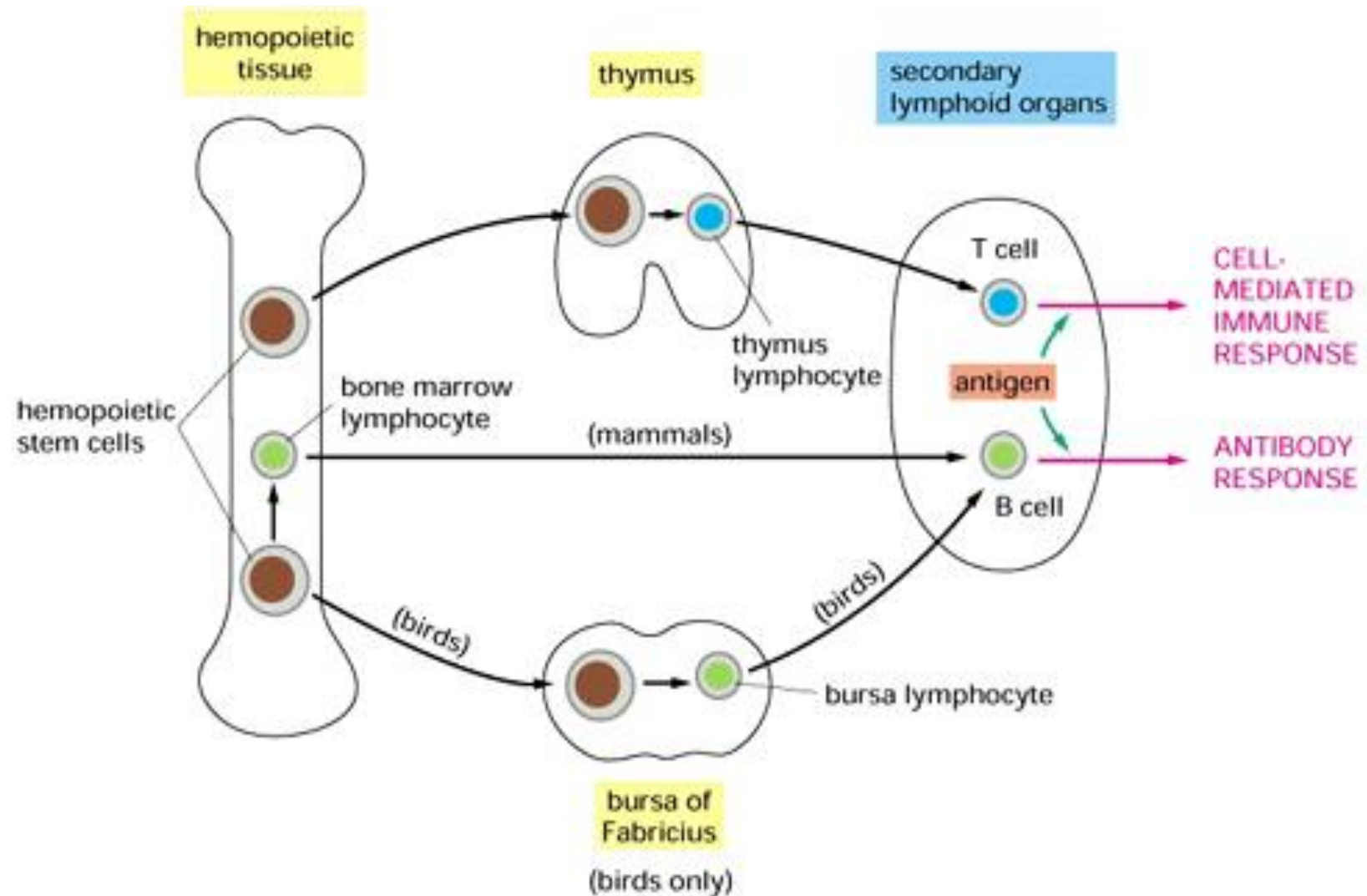
 - Tonsils

 - Lymph nodes

 - MALT (Mucosa Associated Lymphoid Tissue)

 - Peyer's patches

Primary Lymphoid Organs



Lymphoid cells

Lymphoid series comprise of two main lymphocyte populations

T cells & B cells

T-Lymphocyte Differentiation

- 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.
- All T- Cells have **CD3** as a cell marker.
- T cell passage take place in thymus and differentiate into T cells expressing either markers (**CD4 or CD8**).
- T-Helper cell **CD3/CD4**
- T-Cytotoxic Cell **CD3/CD8**

T-Helper cells CD3/CD4

- Two types:
 - T-Helper-1
 - T-Helper-2
- Functions:

T-helper-1

Help CD8 cells to become activated

Help macrophages in cell mediated immunity during inflammatory response.

T-helper-2

Help B cells (CD20) to develop into antibody producing plasma cells

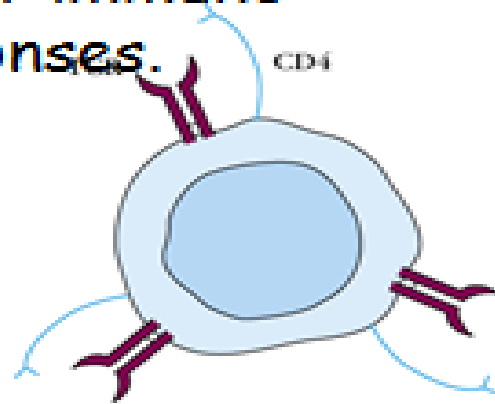
T-Cell Cytotoxic(CD3/CD8)

- About 35% of peripheral blood T cells
- Perform cytotoxic functions by killing:
 - virus-infected cells
 - Tumor
 - Allograft cells (transplant)

T cells:

- **Helper T cells (Th cells):**

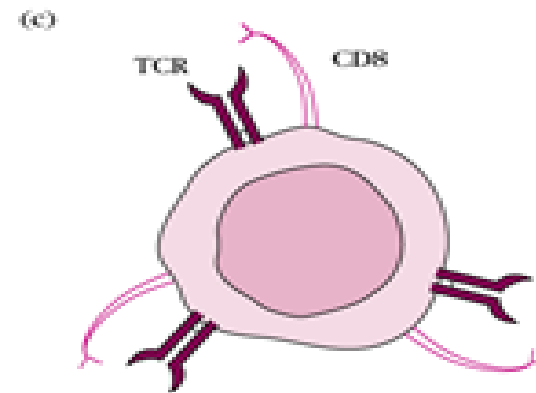
- T cell Receptor (TCR)
- CD4+
- Produce cytokines & direct immune responses.



Th cell

- **Cytotoxic T cells (Tc or CTL):**

- TCR+
- CD8+
- Cytotoxic



T_C cell

B Lymphocyte CD20 or CD19

- **Originate**

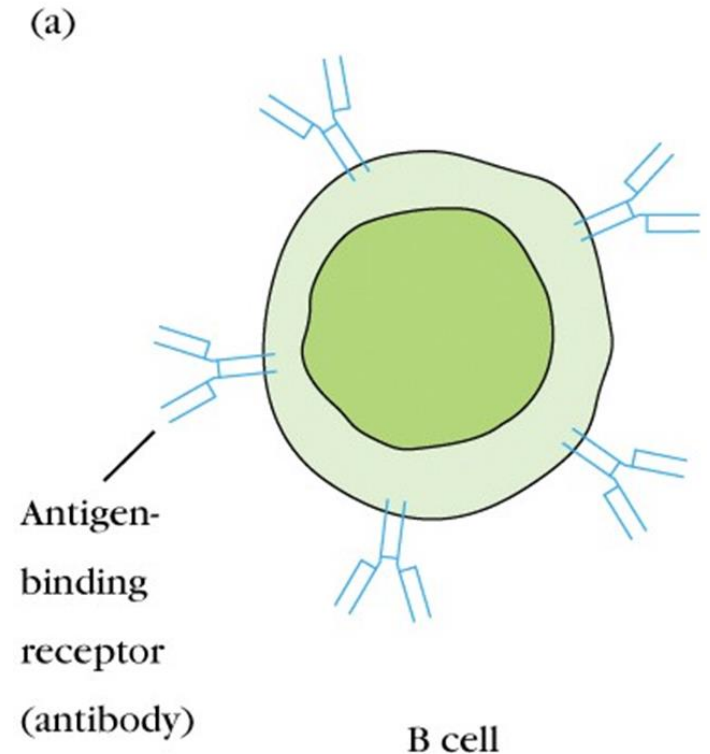
During embryogenesis – fetal liver

Migrate to Bone Marrow – final destination

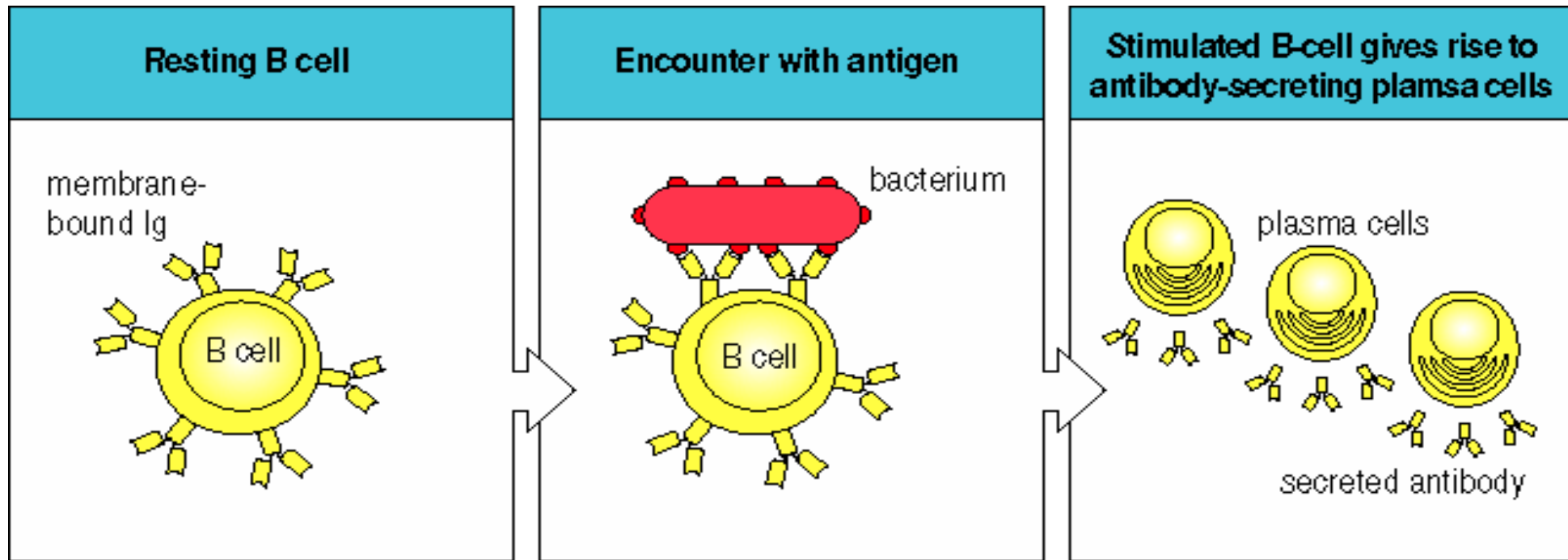
They do not require thymus for maturation

B-Lymphocyte CD20 or CD19

- B cells display surface IgM & IgD both serve as Ag receptor
- Pre B cells are found in Bone Marrow
- Mature B cells are found circulating bloodstream



Antibodies



Antibodies

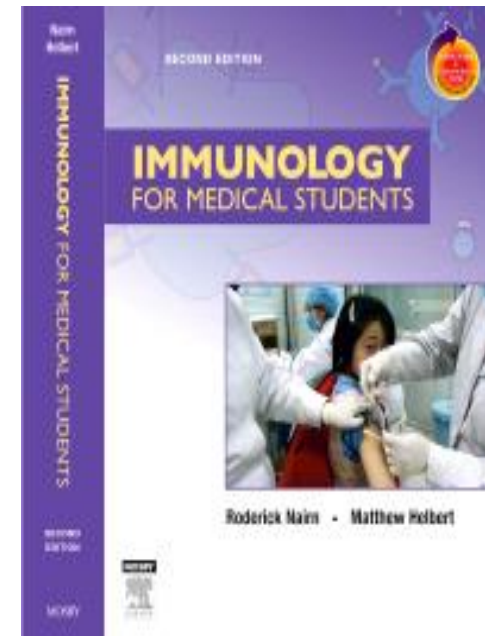
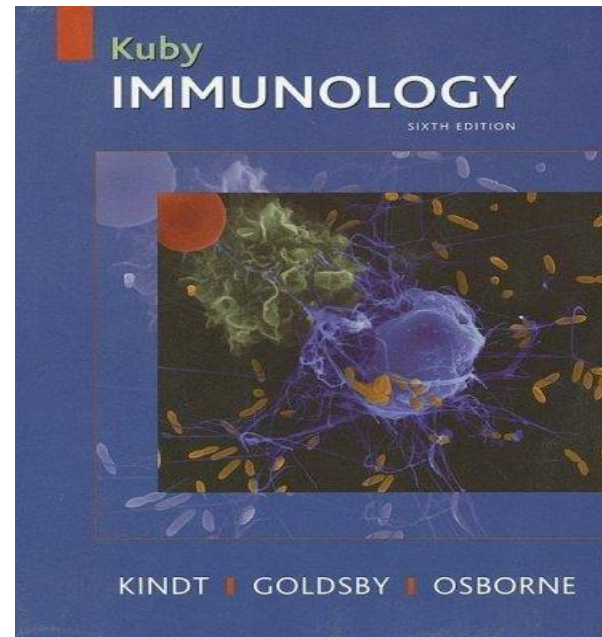
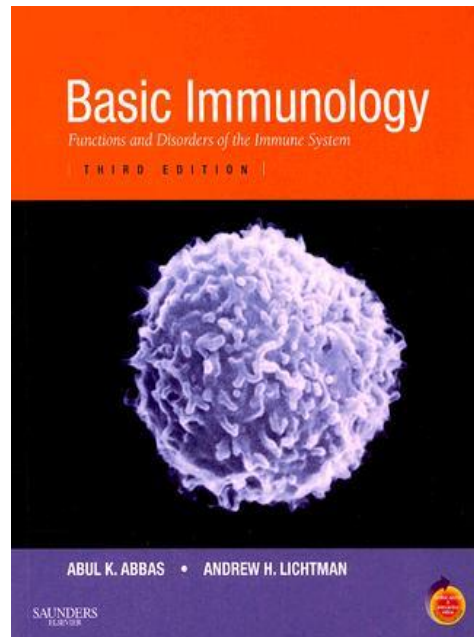
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- Ig are glycoproteins
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- They differ in size, amount of CHO and biologic functions after binding to specific antigens

Summary

- Normal healthy state is maintained by intact immune response either innate (natural immunity) 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

Suggested readings

- Immunology for medical students. Nairn & Helbert
- Immunology. Kuby
- Basic Immunology . Abul Abbas



Thanks