

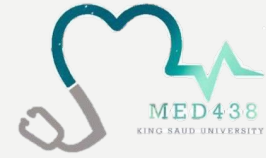


Color code:
Important in red
Extra in blue



Immunology
MED438

Introduction to Immunology & the Lymphoid System



Objectives

- To know the history behind immunology
- To be familiar with the basic terminologies and definitions
- To recognize immune responses
- To understand the types of immune responses
- To know about the lymphoid system
- To understand T and B cells functions

During 1798, Edward Jenner

Observation:

He found out that milkmaids (girls who milked cows) who contracted cowpox (a mild disease) were subsequently immune to smallpox.

What is smallpox?

A very deadly infectious disease جدري

Symptoms: scarring bumps, blindness, limb deformities.

Results:

- He created a technique of vaccination with cowpox to protect against smallpox.
- This started the science of immunology.



During 1849, Louis Pasteur

- He studied **Cholera in chickens**.

Observation:

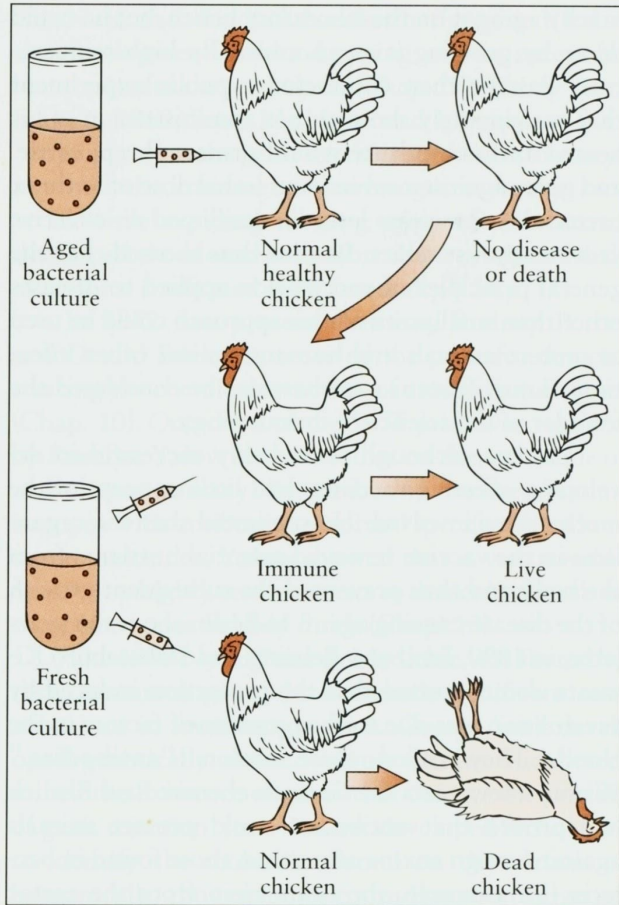
He found out that the virulence of a pathogen **weakens** with age. Chickens **inoculated** (vaccinated) with an attenuated strain not only survived the pathogen but **became resistant**.

Attenuated: weakened, non-virulent strain.

- This is **vaccination**.

Side Note:

The Classical Experiment of this concept was Anthrax Bacillus in sheep



What is immunology?

- **Word origin:** Immune (Latin “immunus”) which means to be free or exempt.
- **Immunity:** Is the state of protection from infectious diseases.
- **Immunology:** Is 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**.

What is Cluster of Differentiation (CD)?

Definition:

is a **characteristic** cell surface protein often associated with the cell's function.

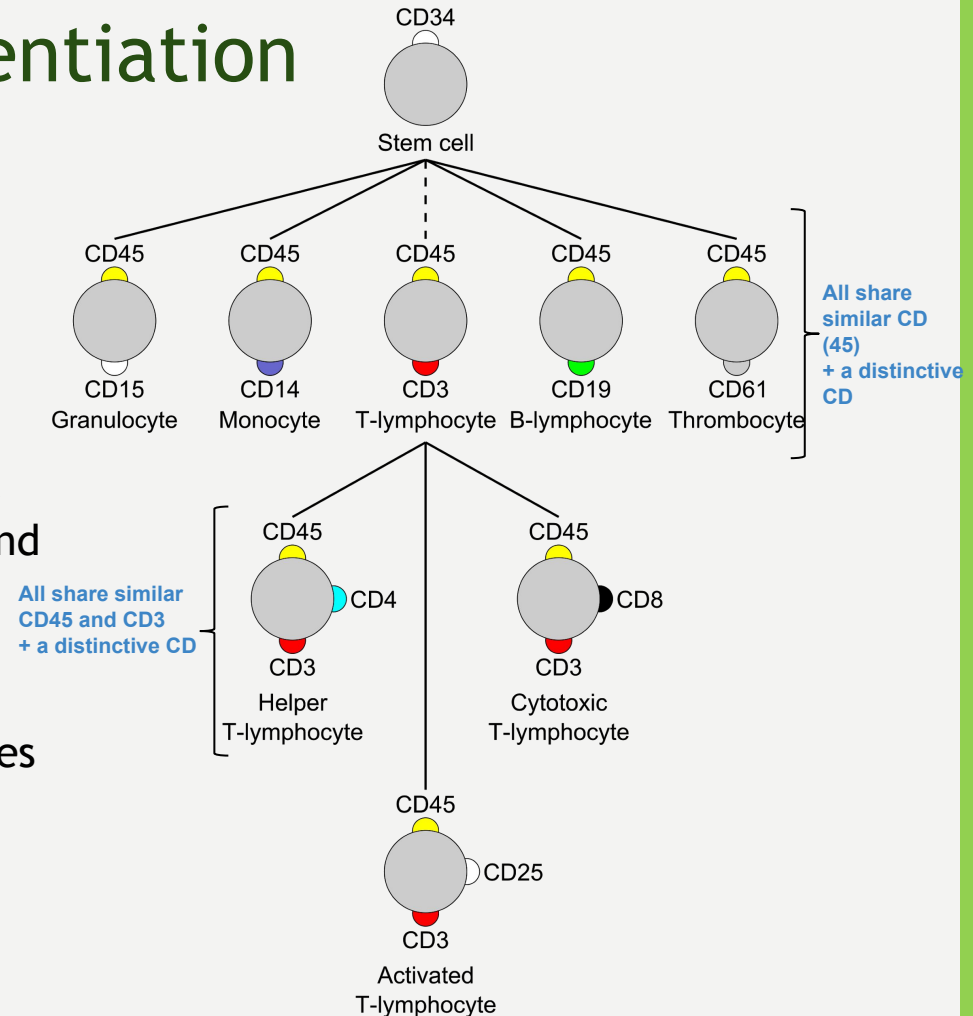
In other words, they are **markers for the cells**.

They are surface molecules such as proteins and receptors that are **used to identify** the cell.

For example:

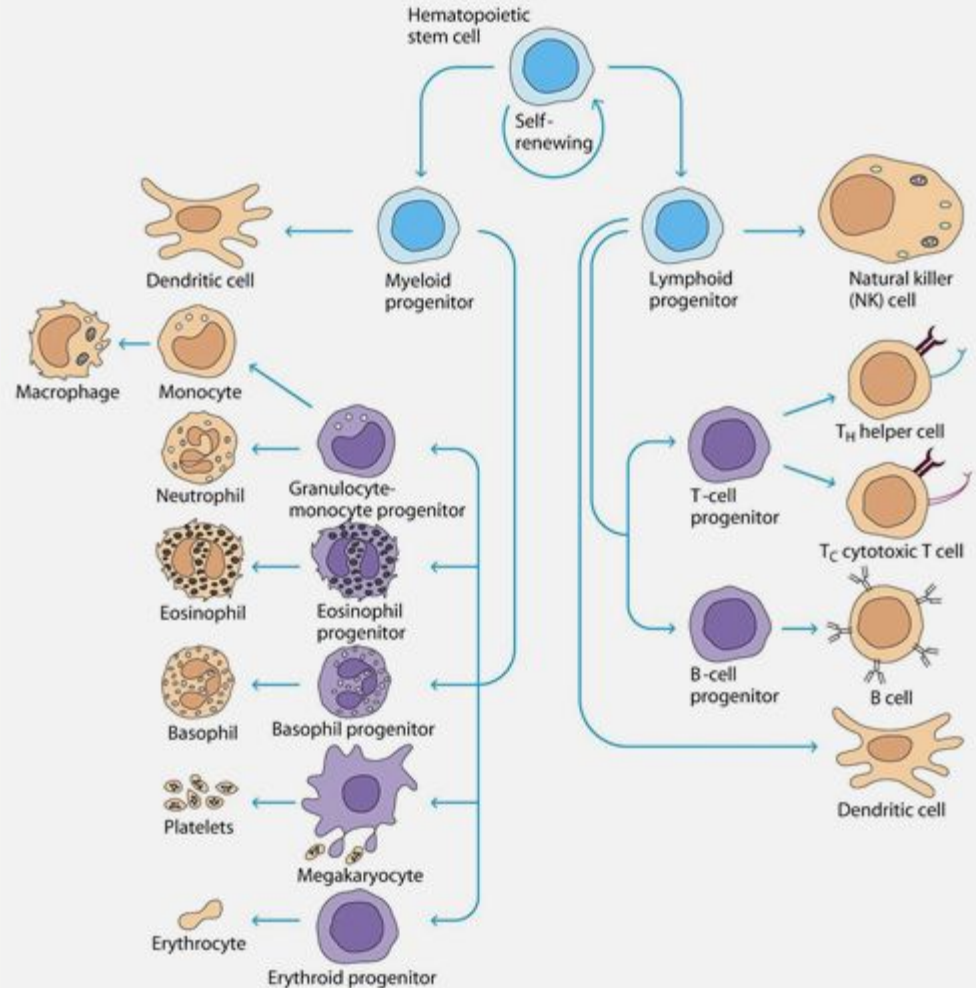
CD3 markers are used to identify T-lymphocytes

CD25 markers are used to identify **activated** T-lymphocytes.



Cells of the Immune System

- ▶ All blood cells emerge from **hematopoietic** stem cells (hematopoiesis).
- ▶ **Myeloid** lineage includes macrophages, neutrophils, basophils, platelets and erythrocytes.
- ▶ **Lymphoid** lineage include NK cells, T cells and B Cells. However, the two main populations are T and B lymphocytes.
- ▶ Both lineages form dendritic cells.



What are Antigens (Ag)?

Definition:

Antigens: are substances (usually foreign) that binds to the cells of the adaptive immunity and **may** trigger an immune response.

Immunogens: are **antigens** that **induce** an immune response.

Examples:

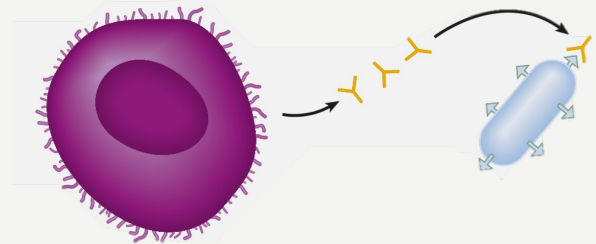
Microorganisms (bacteria, viruses...etc.) and their related products (proteins, polysaccharide, lipids)

Environmental substances (pollens, soil component...etc.)

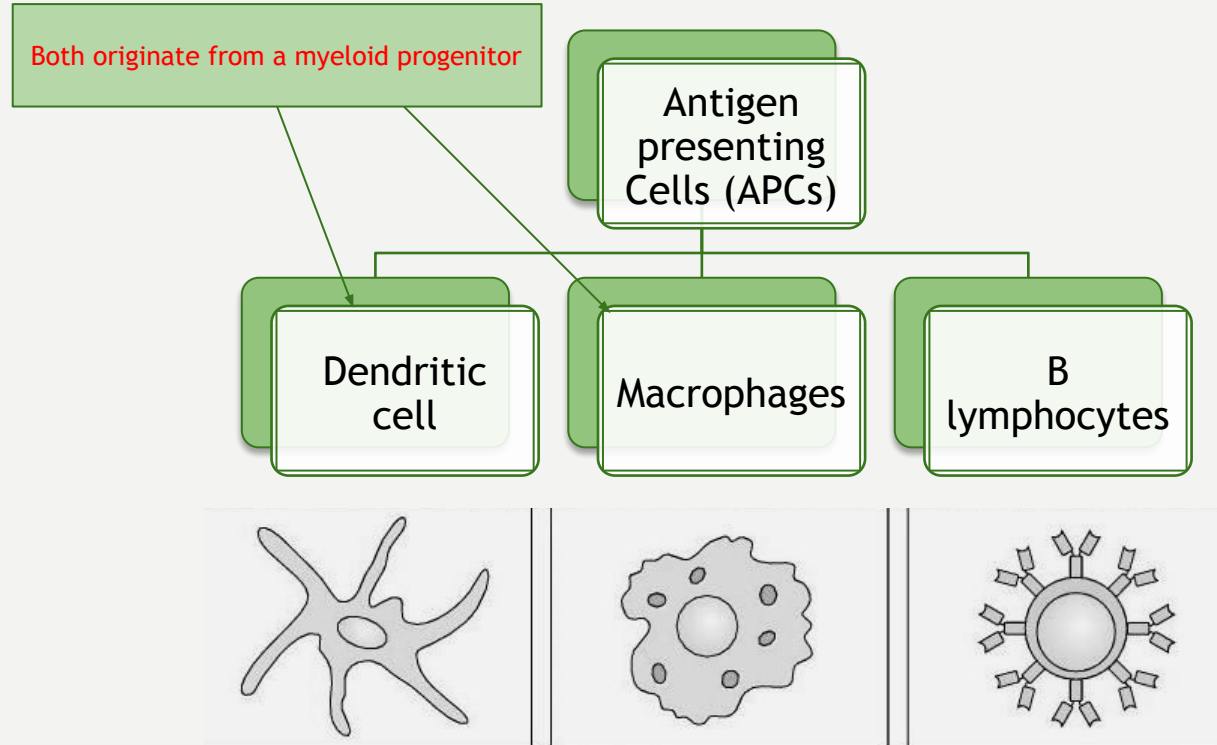
Drugs (allergic reactions against certain drugs)

Organs (kidney transplant), tissues and cells

Note: There's a difference between antigens and immunogens. Not all antigens induces an immune response. Antigens that induce an immune response are called immunogens. So all immunogens are antigens but not all antigens are immunogens.

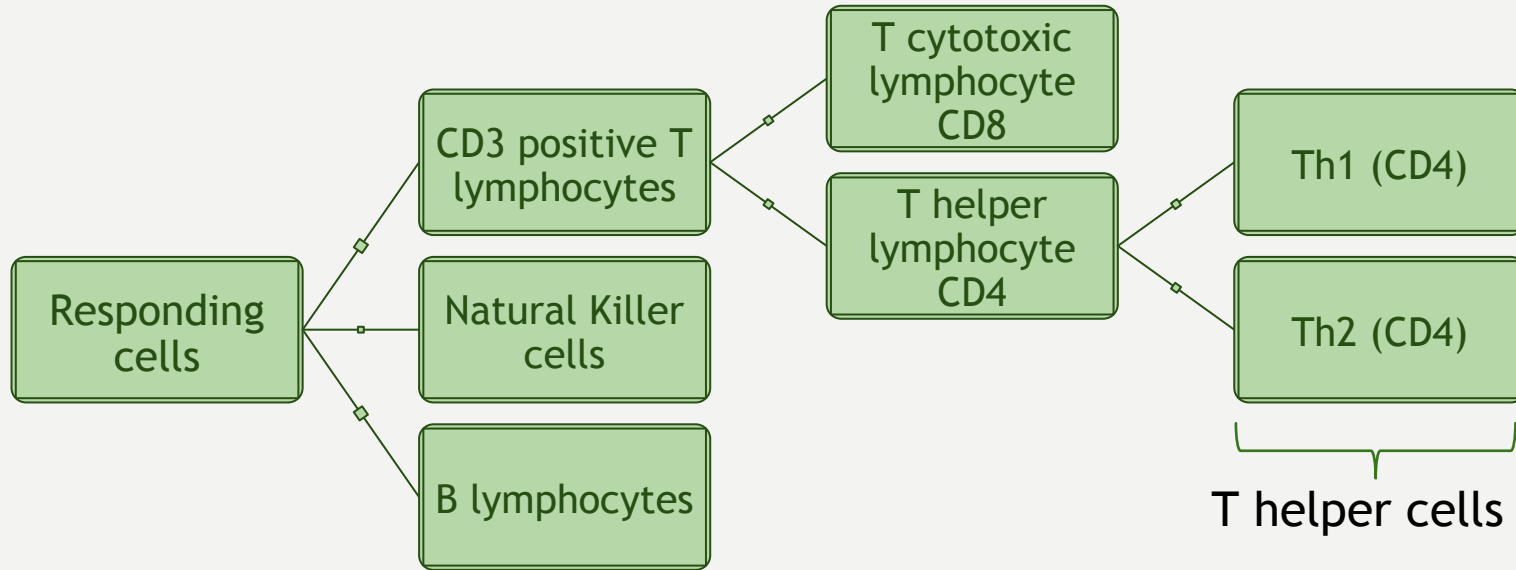


Lymphocytes can't recognize antigens on their own. They need to be represented by **Antigen Presenting Cells (APCs)**



APCs: Cells that process the antigen by “**breaking it down**” into amino acids and then **presenting** it to T and B lymphocytes. (Phagocytic cells)

After being presented by APCs, responding cells will take action.



Note: Cyto=cell

Cytotoxic: it contains chemicals that are toxic to cells, preventing their replication.

Types of Immunity

▶ Innate Immunity: (1st line of defense):

Short duration.

No immunological memory.

Non-specific.

▶ Adaptive Immunity: (2nd line of defense):

Response of T or B lymphocytes to an antigen or pathogen.

Develop an immunological memory.

Specific and self/nonsel self recognition (differentiate between self and foreign bodies)

Of two types:

Humoral immunity: Immunity that is mediated by anti**b**odies, **B** cells.

Cell-mediated immunity: Response in which antigen specific **T** cells dominate.

Note: Adaptive immunity is the reason why we get vaccinated. The Adaptive immune system requires that it recognizes its enemies before it attacks. Vaccination is simply presenting an early introduction of a weakened enemy so that the immune system “adapts” to it and can easily fight it in the future even when it’s not weakened.

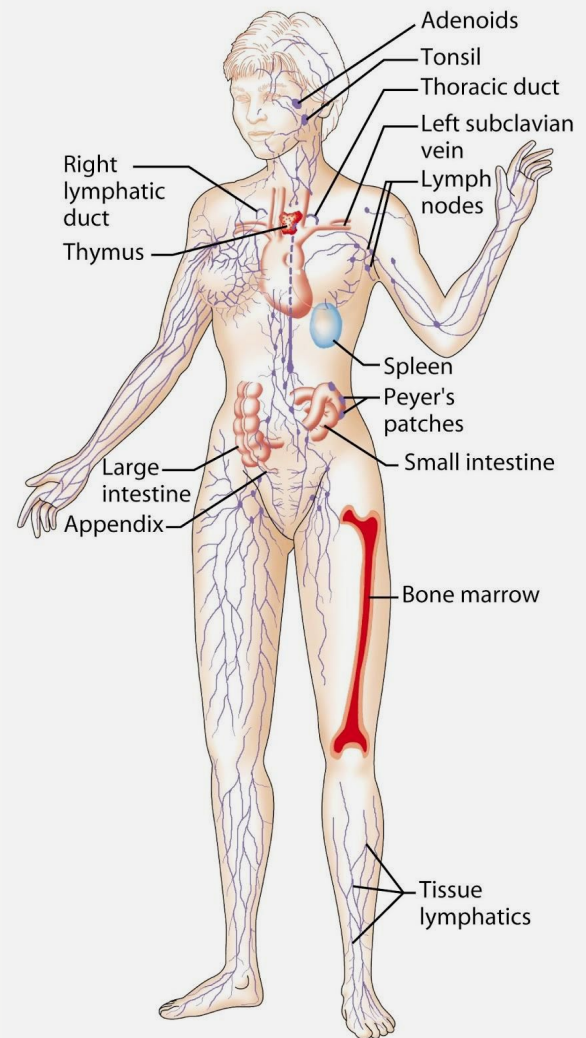
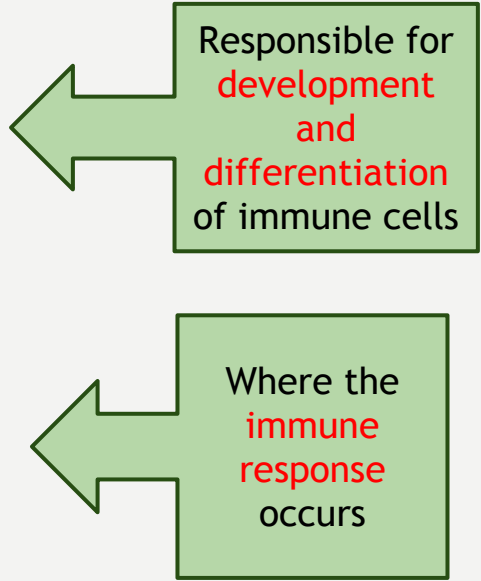
Lymphoid System

- ▶ Lymphatic vessels
- ▶ Lymphoid organs

Primary organs: bone marrow and thymus.

Secondary organs: spleen, lymph nodes, tonsils, **MALT**, Peyer's patches and appendix.

(Mucosa Associated Lymphoid Tissue)



T-Lymphocyte Differentiation

1 T Cells Move to the Thymus Gland

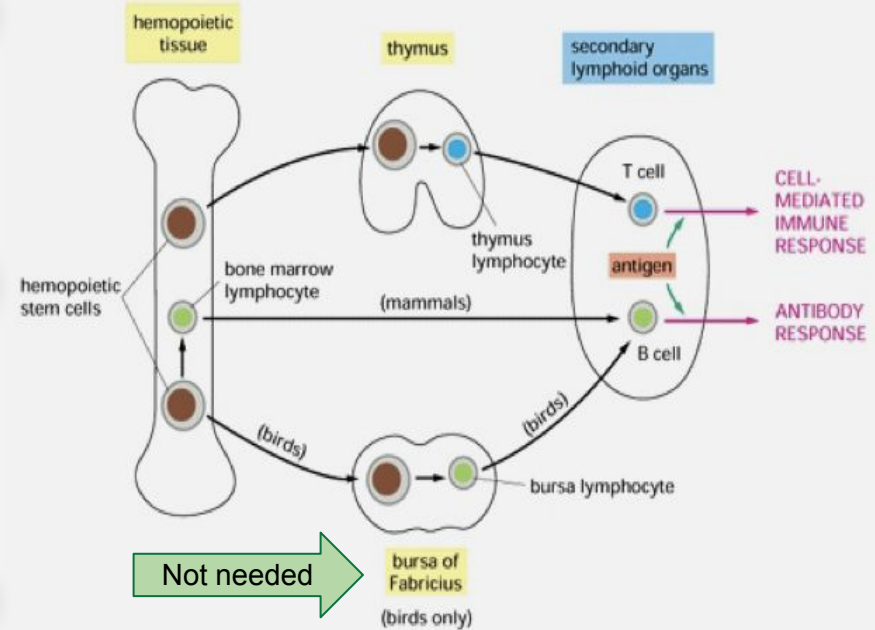
T cells **originated** in the Bone marrow migrate to the **T**hymus gland for further development.

2 Differentiation

T cell precursors **differentiate** into mature T cells in the Thymus. However, stem cells **lack** antigen receptors and CD markers.

3 Further Differentiation

During their passage through the 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.

1) T Helper Lymphocytes (CD4):

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 become activated cytotoxic T cells (Th1).
- Help macrophages in cell mediated immunity during inflammatory response (Th1).

2) Cytotoxic T cells (CD8):

- About 35% (approximately one third) of peripheral blood T cells are CD8 positive cells.
- They mediate the killing of (cytotoxic functions):
 - Virus-infected cells.
 - Tumors.
 - Allograft cells (transplant).

B cells

Origin:

- Before birth: during **embryogenesis** - fetal liver.
- After birth: migrate to **bone marrow** - final destination.

They **do not require** thymus for maturation (refer back to the bone image).

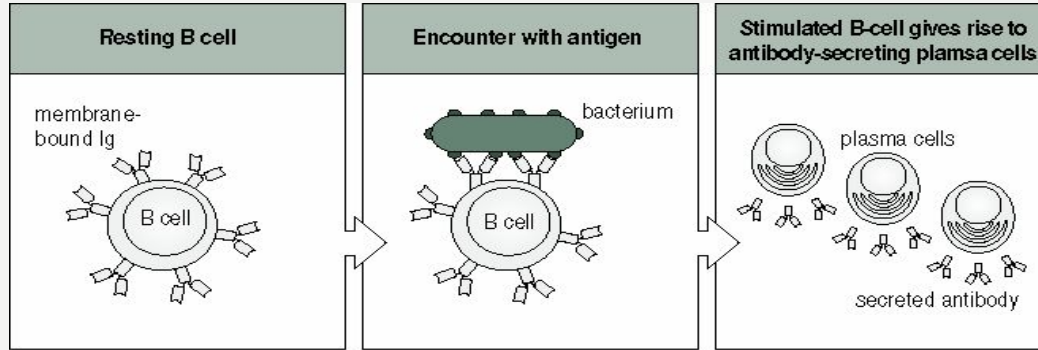
They mature in the bone marrow (B-cells) and leave to secondary organs.

B cell progenitors like Pro-B cells, Pre-B cells and immature B cells are normally found in **bone marrow**.

Mature B cells are found **circulating** in body fluids and lymphoid organs.

They display surface **IgM** and **IgD** which serve as antigen receptors.

Antibodies formation:



Immunoglobulins (Ig) or antibodies are grouped into **5** classes:

IgG (**gamma**)

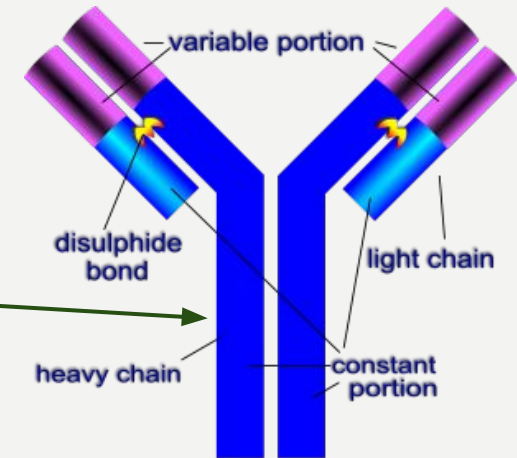
IgM (**miu**)

IgA (**alpha**)

IgD (**delta**)

IgE (**epsilon**)

The groups are based on the antibody's heavy chain



Ig are **glycoprotein**. They differ in size, amount of carbohydrates (CHO) and biologic functions after binding to specific antigens.

Immune system

Adaptive Immunity
(SPECIFIC)

Humoral

B cells

Origin: Liver (before birth)
Bone marrow (after birth)

Cell mediated
(CMI)

T cells

Originated in bone marrow
and matured in the thymus

CD4: T helper cells
(Th1 & Th2)

CD8: Cytotoxic T cells

Innate Immunity
(NONSPECIFIC)

Physical and Chemical
barriers (skin and mucous)

Nonspecific resistance
(inflammatory response)

Referenced from
team 437
(slightly edited)

Basic definitions:

- ▶ Pathogen: a disease causing organism.
- ▶ Vaccination (inoculation): is the induction of protective immunity against a pathogen.
- ▶ Antigen (Ag): any substance (usually foreign) that binds specifically to a component of the adaptive immunity.
- ▶ Allergen: is a noninfectious antigen that induces hypersensitivity reactions, most commonly IgE-mediated type I reactions.

Basic definitions:

- ▶ **Immunoglobulin (Ig) or Antibodies:** a heavy and light polypeptide linked by **disulfide bonds** secreted from **plasma cells (B cells)**.
- ▶ **Adaptive immunity:** **Specific** host defenses that are **mediated by T & B cells** **following** exposure to antigen. المكتسبة
- ▶ **Innate immunity:** **Nonspecific** host defenses that exist **prior** to exposure to antigen. الطبيعية

Take home messages:

- 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

Quiz:

1. Which of these can induce an immune response?

- a) Pathogen
- b) Immunogen
- c) Antigen
- d) NK cells

2. All T cells have:

- a) CD8 markers
- b) CD4 markers
- c) CD25 markers
- d) CD3 markers

3. Which of these can produce memory cells:

- a) Cytotoxic T cells
- b) Macrophages
- c) Lymphoid progenitor
- d) NK cells

4. The light and heavy chain of the antibody is linked by:

- a) Hydrogen bond
- b) Covalent bond
- c) Dipole bond
- d) Disulfide bond

5. Dendritic cells originate from:

- a) Myeloid progenitor
- b) Lymphoid progenitor
- c) Hematopoietic stem cell
- d) All of the above

6. Allergens are mediated by which of these antibodies:

- a) Immunoglobulin class alpha
- b) Immunoglobulin class gamma
- c) Immunoglobulin class epsilon
- d) Immunoglobulin class beta

Team Leaders:

Sedra Elsirawani

Ibrahim Aldakhil

Team Members:

- | | | | |
|----|--------------------|----|---------------------|
| 1. | Noura Alturki | 1. | Alwaleed Alsaleh |
| 2. | Lama Alzamil | 2. | Muhannad Makkawi |
| 3. | Shahad Althaqeb | 3. | Abdullah Basamh |
| 4. | Leena Alnassar | 4. | Hashem Halabi |
| 5. | Joud Aljebreen | 5. | Amjad Albaroudi |
| 6. | Renad Alkanaa | 6. | Abdulrahman Alhawas |
| 7. | Shahad Bin Selayem | 7. | Mohammed Alhuqbani |
| 8. | Sara Alflaj | | |



Immunology

MED438