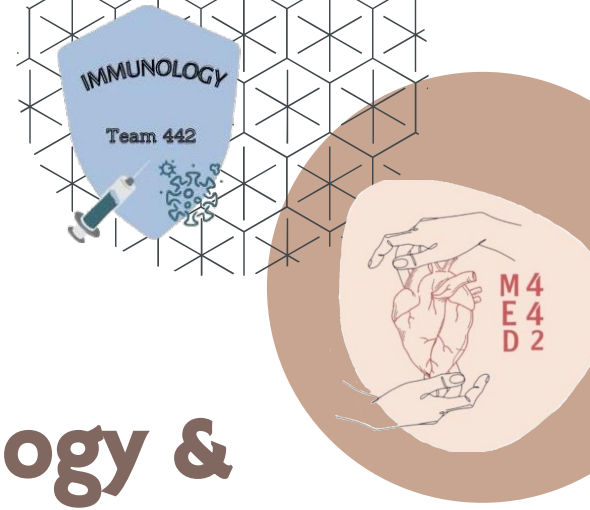
Foundation block

KSU




# Introduction to Immunology & Lymphoid System

W 5
L 1

**Color index :**

- Main text
- Important
- Dr notes
- Females slides
- Male slides
- Extra

Editing File

# 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

# Table of contents

# A Historical Perspective of Immunology

**What is immunity?**

**Immunity** is the state of protection (الحماية) against foreign pathogens or substances (antigens)

**Word origin:** Immunity (Latin: Immunis) which mean exempt or free

Observations of immunity go back over 2000 years

-Thucydides, an ancient historian, wrote in 430 BC of a plague in Athens where those who had recovered could safely nurse the currently ill

He meant they had resistance/immunity

# A Historical Perspective of Immunology

Can we generate Immunity without inducting disease?

Yes, through vaccination:

Prepares immune system to eradicate an infectious agent before it causes disease

Widespread vaccine use has saved many lives
-Examples:
- Rabies vaccine
- Eradication of smallpox (الجدري)

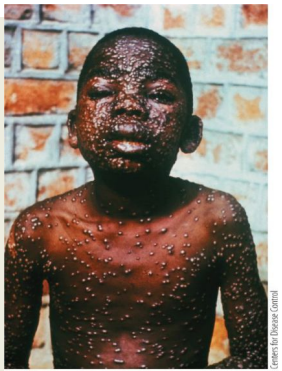


Figure 1-1
Kuby Immunology, Eighth Edition
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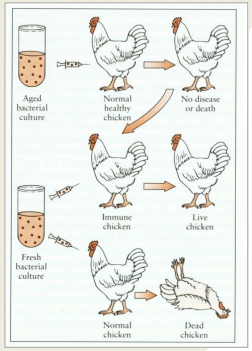
Explain:effective vaccine can measure by comparing number of annual cases for year with the cases we see now a day

| Disease | ANNUAL CASES/YR: Prevaccine | CASES IN 2016: Postvaccine | Reduction (%) |
|---|---|---|---|
| Smallpox | 48,164 | 0 | 100 |
| Diphtheria | 175,885 | 0 | 100 |
| Measles | 503,282 | 79^ | 99.98 |
| Mumps | 152,209 | 145* | 98.90 |
| Pertussis ("whooping cough") | 147,271 | 964* | 99.35 |
| Paralytic polio | 16,316 | 0 | 100 |
| Rubella (German measles) | 47,745 | 0* | 100 |
| Tetanus ("lockjaw") | 1,314 (deaths) | 1* (case) | 99.92 |
| Invasive *Haemophilus influenzae* | 20,000 | 356* | 98.22 |

**Dr Notes**
- **The effectiveness of a vaccine can be measured by comparing the number of annual cases per year before and after vaccination**
- **They tried vaccinations before even knowing the components of the immune system**




# Louis Pasteur's Contributions

## Cholera in Chickens

chickens inoculated (ملقح) with old strains not only survive but become resistant

## Attenuated:

weakened, non-virulent strain (سلالة) whose exposure can confer resistance to disease

## Determined

through studies of cholera that the virulence (خبث) of a pathogen weakens with age

## Classical Experiment:

Heat attenuated anthrax (الجمرة الخبيثة) bacillus and subsequent challenge with virulent Bacillus anthracis in sheep

# Definitions

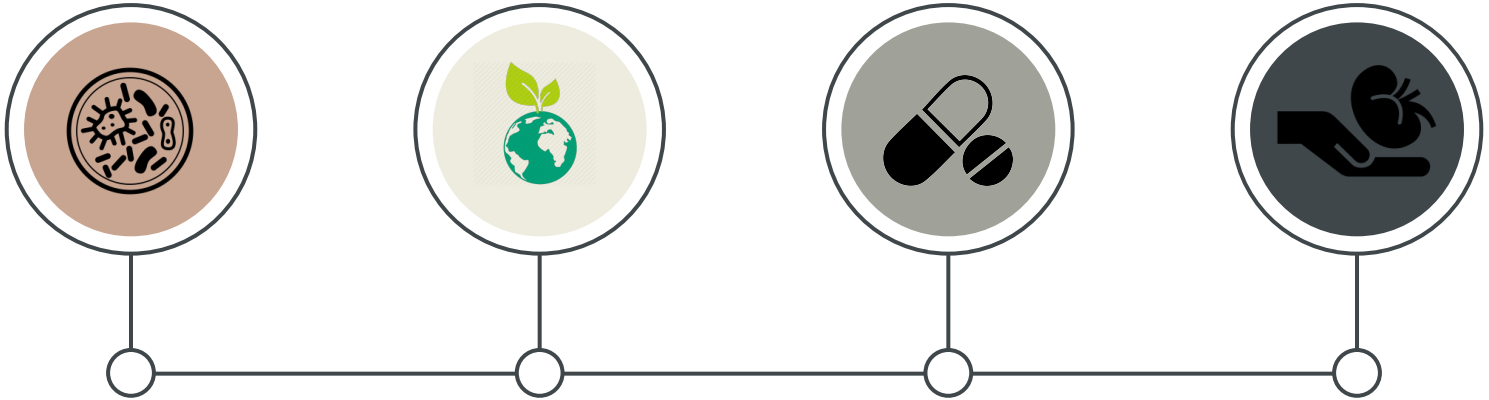
439: Under microscope we cannot distinguish between B and T lymphocytes, so we study the proteins on the surface to identify them.

| | |
|---|---|
| Antigen (Ag): | any substance (usually foreign) that binds specifically to a component of the adaptive immunity. |
| Allergen: | noninfectious antigens that induce Allergy. |
| Innate immunity: | **Nonspecific** host defenses that exist prior to exposure to Ag. |
| Adaptive Immunity: | **Specific** host defenses that are mediated by T & B cells following exposure to Ag. |
| Pathogen: | a disease causing organism |
| Vaccination: | deliberate induction of protective immunity to a pathogen |
| Immunoglobulin (Ig) or Antibodies: | Molecules secreted from plasma cell (B cell) as an adaptive immune response to extracellular Ag. |
| (CD) Cluster of Differentiation: | molecule with a CD designation has a characteristic cell surface protein which are often associated with the cell's function. |

441: Immediate response against pathogen

439: They are 2 heavy and 2 light polypeptide chains linked to each other via disulfide bonds

# Where and What are Antigens?



**Microorganisms & their related products**

Proteins - polysaccharides - lipids

**Environmental substances**

(Pollens, soil component)

**Drugs**

(Allergic reaction against certain drugs)

**Organ transplant**

tissues, cells

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

Important slide

# Lymphocyte Populations

441:
- Markers are used to distinguish lymphocytes.
- Lymphoid series comprise of main lymphocyte populations

## T Cell Markers

- CD3 — In all T cells
- CD4 — In T **helper** cells only
- CD8 — In T **cytotoxic** cells only

## B Cell Markers

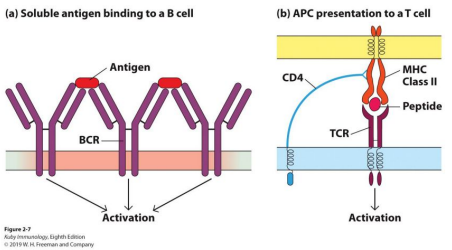
- CD19

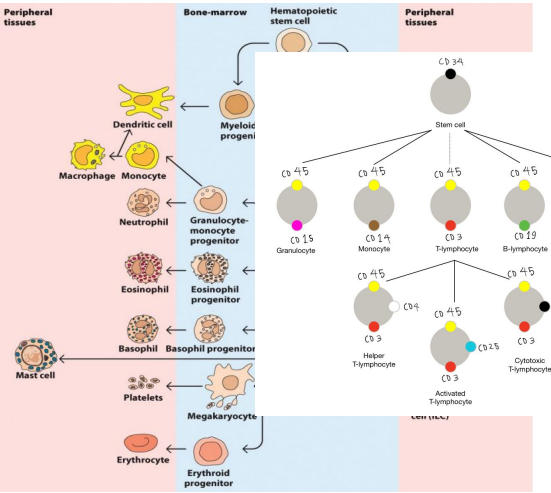
## Natural Killer Cell Markers (NK)

- CD16
- CD56

## Cells of the Immune system

- B cells — Also express the B cell receptor (BCR)
- T cells — Also express the T cell receptor (TCR)




They all have CD45 except Stem Cells

# Types of Immunity

## Innate (Natural) Immunity

**Nonspecific** host defenses that exist prior to exposure to Ag (Antigen)

- **First line** of defense
- **Fast, non-specific**
- Shorter duration
- Uses phagocytic cells
- **No memory**

## Adaptive (Acquired) Immunity

**Specific** host defenses that are mediated by T & B cells following exposure to Ag (Antigen)

- Response of a specific B and T lymphocytes to an antigen
- Exhibit Immunological **Memory**
- **Self / non-self recognition**
- Slower to develop (5–6 days or more)

### Humoral immunity (AbMI)

Immunity that is mediated by antibodies (**B cells**). Response takes place in blood and lymph

### Cell Mediated Immunity (CMI)

Immune response in which antigen specific **T cells** dominate. Response takes place inside the cell

AbMI: Antibody mediated immunity
Humoral means fluid (Latin)
439: Further explanation:
1-Antibodies are produced by (B-lymphocytes)
2- Antibodies are found in body
fluid (blood and lymph)

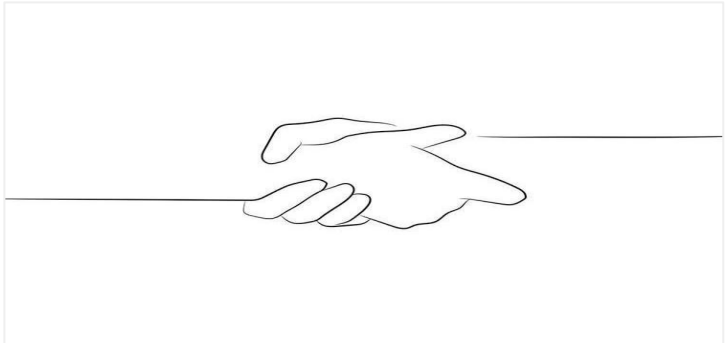
439: Recognize whether the body (antigen) is from inside or outside the body.
When Antigen is from inside the body it's called: Autoimmune disease

# Important concepts for understanding the immune response

**-Innate** and **Adaptive** immunity work **cooperatively**

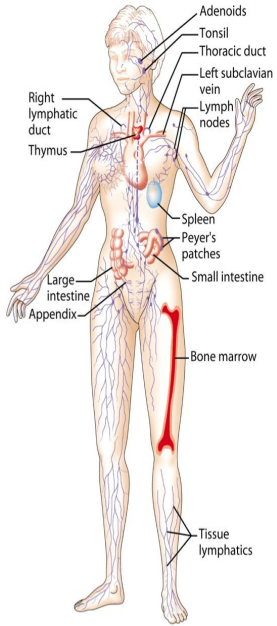
-Activation of innate immune responses produces signal molecules (cytokines).

-These signal molecules stimulate and direct adaptive immune responses.



# Lymphoid System

**Lymphoid vessels**

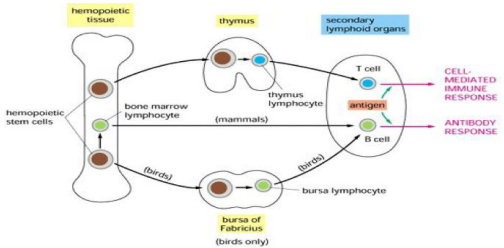



**Lymphoid organs**

## Primary Lymphoid Organs

(Development & Differentiation of immune cells)

- Bone Marrow
- Thymus




## Secondary Lymphoid Organs

(where the immune response occurs)

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

# Secondary Lymphoid Organs

- Differentiation into effector cells takes place in follicles of **secondary** lymphoid organs
- Both B and T lymphocytes will develop into **long-lived** memory cells in these areas, as well

| | |
|---|---|
| Lymph nodes **and** spleen | The most highly organized **secondary** lymphoid organs. |
| Spleen | **First** line of defense against **blood-borne** pathogens |
| Mucosa-associated lymphoid tissue (MALT) | Important layer of defense against **infection** at mucosal and epithelial layers. |

# Lymphoid series comprise of main lymphocyte populations

**B cells** | **T cells** | **Natural Killer**

## T-Lymphocyte Differentiation

Originate in Bone Marrow

Migrate to Thymus for development.

Differentiation

- T cell precursors differentiate into mature T cells in Thymus.
- **All** of them have **CD3** proteins on their cell surface.

During their passage through thymus they:
differentiate into:
T cells expressing either markers (CD4 T helper cell)
**or** CD8( T cytotoxic cell)
but not both!

# Two Major populations

## Of T lymphocyte

T helper lymphocytes (CD4+)

T cytotoxic lymphocyte (CD8+)

| Subtypes of T Helper (CD4+) | Function |
|---|---|
| **Th1** | ▪**(Inflammatory T helper cell)** mediates inflammation via helping macrophages in CMI during inflammatory response.<br><br>▪helps **CD8+** cells to become activated cytotoxic T cells. |
| **Th2** | provides **help** to **B** cell to produce antibody |
| **Th17** | ▪has a role in **innate Immunity** & the pathogenesis of autoimmune diseases. |
| **Treg** | ▪repress the growth and function of T cell helper and cytotoxic subsets.(regulatory T cells) |
| **Tfh** | ▪T follicular helper are critical to **prevent autoimmunity.** |

- About 35% of peripheral blood **T** cells
- Perform cytotoxic functions
- They mediate the killing of:
  - Virus-infected cells
  - Tumors
  - Allograft cells (transplant)

Th 17, Treg, Tfh we will take it after the block

# B cells

439:
★ B cells -> Bone marrow ( mature )
★ T cells -> Bone marrow (immature) -> Thymus (maturation)

**Origin:** During embryogenesis **– fetal liver** (before birth) **Important note**

**Migrate** to **bone marrow** – final destination

They **do not** require thymus for maturation

**B cell progenitors**

**Pro-B** cells, **Pre-B** cells and **immature B** cells are normally found in bone marrow

**Mature B**

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

Mature B cells display surface:
- IgM (immunoglobulin M)
- IgD (immunoglobulin D)

which serves as antigen receptor (Maturation Markers)

# The good, bad, and ugly of the immune system

**The Role of Immune system** → **PROTECT**

**Dysfunction of this role** → **Abnormal**

- Rejection of transplanted tissue or organ
- **Cancer**
- **Overly active:** Hypersensitivity / Autoimmunity
- **Defects in the immune response:** Immunodeficiency

# 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

# MCQs

| Q1:Humoral immunity is mediated by: | | | |
|---|---|---|---|
| A- TLymphocytes | B- Macrophages | C- B lymphocytes | D- Natural kiler cels |

| Q2:T cell precursors differentiate into mature T cells in? | | | |
|---|---|---|---|
| A- Thymus | B- Bone marrow | C-Lymph nodes | D-spleen |

| Q3: Which type of marker in T helper cells only? | | | |
|---|---|---|---|
| A-CD25 markers | B-CD4 markers | C-CD8 markers | D-CD56 markers |

| Q4: Which type of marker that All T cells have it | | | |
|---|---|---|---|
| A- CD8 markers | B- CD25 markers | C- CD4 markers | D- CD3 markers |

Q1-C
Q2-A
Q3-B
Q4-D

# Team leaders:

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