Chapter 6

INFECTIOUS DISEASES AND IMMUNITY

Set by: Mrs. Emebet Mohammed
Mr. Solomon Taddesse
Dr. Amir Alelign

Infectious diseases:-

- Are diseases caused by infectious agents like bacteria, viruses, fungi, protozoa, helminthes & prions
- It occurs as the result of interactions b/n pathogenic (disease-producing) microorganisms and the host.

- A pathogen must accomplish the following steps in order to cause **infectious disease** :-

- Pathogens must be able to enter the host body
- Adhere to specific host cells
- Invade and colonize host tissues
- It must metabolize and multiply on or in the host tissue.
- It must resist host defenses
- It must damage the host. (i.e. via production of toxins or destructive enzymes).

❑ Terminologies related to infection and disease

- **Incubation period:-** is the interval b/n initial infection & the first appearance of signs & symptoms
- **Symptom**: A change in body function that is felt by a patient as a result of disease
- **Sign**: A change in a body that can be measured or observed as a result of disease.
- **Syndrome**: A specific group of signs and symptoms that accompany a disease

- **Zoonoses :-** are a diseases that occur primarily in animals and can be transmitted to humans.
- **Pathogenicity:-** The ability of Mos to cause disease
- **Virulence:-** refers to a degree of pathogenicity
- **virulent Pathogens** causes significant disease, while **an a virulent** causes reduced or no disease

- **Pathogens are classified based on their pathogenicity:-**

1. **Primary pathogen** is microbe or virus that causes disease in healthy individual (i.e. Immunocompetent)

2. **Opportunistic pathogen** (opportunist) causes disease only when body's innate or adaptive defenses are compromised (i.e. Immunocompromized).

- **Patterns of infection------**In a host, 2 basic patterns of infection

a)Localized infection:- Pathogen replication remains localized near the site of entry - e.g. skin, respiratory or the GI tract

b) Systemic (disseminated) infection:- an infection throughout the body by blood and/or lymph

- Reach target organ or tissue & replicate
  - Neural & viremia spread

❑ **Systemic infection**: **Bacteremia**: bacteria in the blood

- **Sepsis**: toxic inflammatory condition arising from the spread of microbes, especially bacteria or their toxins
- **Septicemia**: growth of bacteria in the blood
- **Toxemia**: toxins in the blood

- **Persistent infection**

- The **majority of infections** are cleared but certain pathogens may cause persistent infections.

- **Types of persistent infection**

- **Chronic infections-**--are those in which replicating Phatogenes can be **continuously detected**

- **Latent infections-**---are those in which the pathogen persists in an occult (hidden) form most of the time.

- **Routes of entry/Exit of pathogens in humans**
  - Respiratory Tract
  - GI Tract
  - Skin
  - Urogenital Tract
  - Conjunctiva
  - blood borne: by: Needles, insect vectors, blood Transfusion
- **Transmission of Phatogens :-** The process of transfer of Pathogens between hosts is referred to as **transmission**
- Generally, there are **3 types** pathogen transmission in animals

A. Horizontal transmission-Person-to-person transmission

- Respiratory route: e.g. Tuberculosis, Influenza,
- Conjunctival route: Enterovirus, HSV
- Fecal route: e.g. Amoeba , Giardia, Rotaviruses
- Sexual route: e.g. Gonorrhea, Trichomonas, HIV

B. **Vertical transmission-**--is the transfer of Pathogen from mother to fetus/baby. Congenital, Transplacental & Transmammarian

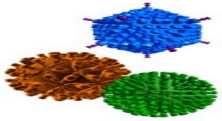
E.g -Toxoplasma, Cytomegalovirus; HBV

C. **Zoonoses-**-- infectious agent is transmitted from an animal other than a human, to a human.

- E.g Rabies virus (Rhabdovirus) --- Dog, fox

Causative agent of infectious disease

- Common pathogens known as causative agents for different types of infectious diseases are:-

Bacteria		
viruses		
Fungi		
protozoa		
worms		

- They vary in their size, shape, function, genetic content.

1. Bacteria

- Unicellular prokaryotic organisms, having circular genomes,
- ds DNA that is associated with much less protein.
- Reproduce by binary fission.
- The most common morphologies are bacillus (rod-shaped), coccus (spherical), or spirillum (helical rods).

❑ **2 classes** based on their cell wall structures(Gram stain rxn)

- **Gram-negative bacteria** appear pink after the staining procedure.
  - E.g. *Salmonella typhi*, which causes typhoid fever, and *Yersinia pestis*, which causes plague

- **Gram-positive bacteria** appear purple after the Gram staining procedure.
  - E.g. *Staphylococcus aureus*, which causes skin, respiratory, & wound infections,
  - *Clostridium tetani*, which produces a toxin that can be lethal for humans.

- Among trillions of strains of bacteria, & few of these cause diseases in humans. Examples: bacterial meningitis ,pneumonia, tuberculosis, upper respiratory tract infection, & STI .
- Bacterial infections can be treated with **antibiotics**

2. Viruses - Infect all types of organisms

- They are not organisms themselves b/c apart from a host cell, have no metabolism & cannot reproduce.
- Composed of a **viral** nucleic acid & surrounded by a protein coat called **a capsid**; in some additional outer lipid Layer called **envelope**
- viruses classified based on shape, size & type of genome.
- E.g. . Classifying based on genome (as DNA & RNA viruses)
- **DNA viruses -** herpes viruses that cause chicken pox, cold sores & poxvirus that causes

3. Fungi

- Eukaryotic, heterotrophic organisms that have rigid cellulose/ chitin-based cell walls
- Reproduce primarily by forming spores
- Most are multicellular, although some, such as yeasts, are unicellular.
- Examples of diseases caused by fungi are ringworm & histoplasmosis (a mild to severe lung infection transmitted by bat or bird droppings).

4. Protozoans

- Unicellular, heterotrophic eukaryotes
- Include amoeba and paramecium.
- Do not have cell walls, they are capable of a variety of rapid and flexible movements.
- Acquired through contaminated food or water or by the bite of an infected arthropod such as a mosquito.
- Diarrheal disease can be caused by two common protozoan parasites, *Giardia lamblia* and *Cryptosporidium parvum*.
- Malaria, a tropical illness that causes 300 million to 500 million cases of disease annually, is caused by different species of the protozoan *Plasmodium*.

5. **Helminths**

- They are simple, multicellular invertebrate animals
- some of which are infectious parasites.
- They are and have differentiated tissues
- have complex reproductive cycles
- The common helminthes are Ascaris, Tape worm, hook worm and *Schistosoma* etc…

Overview of the immune system

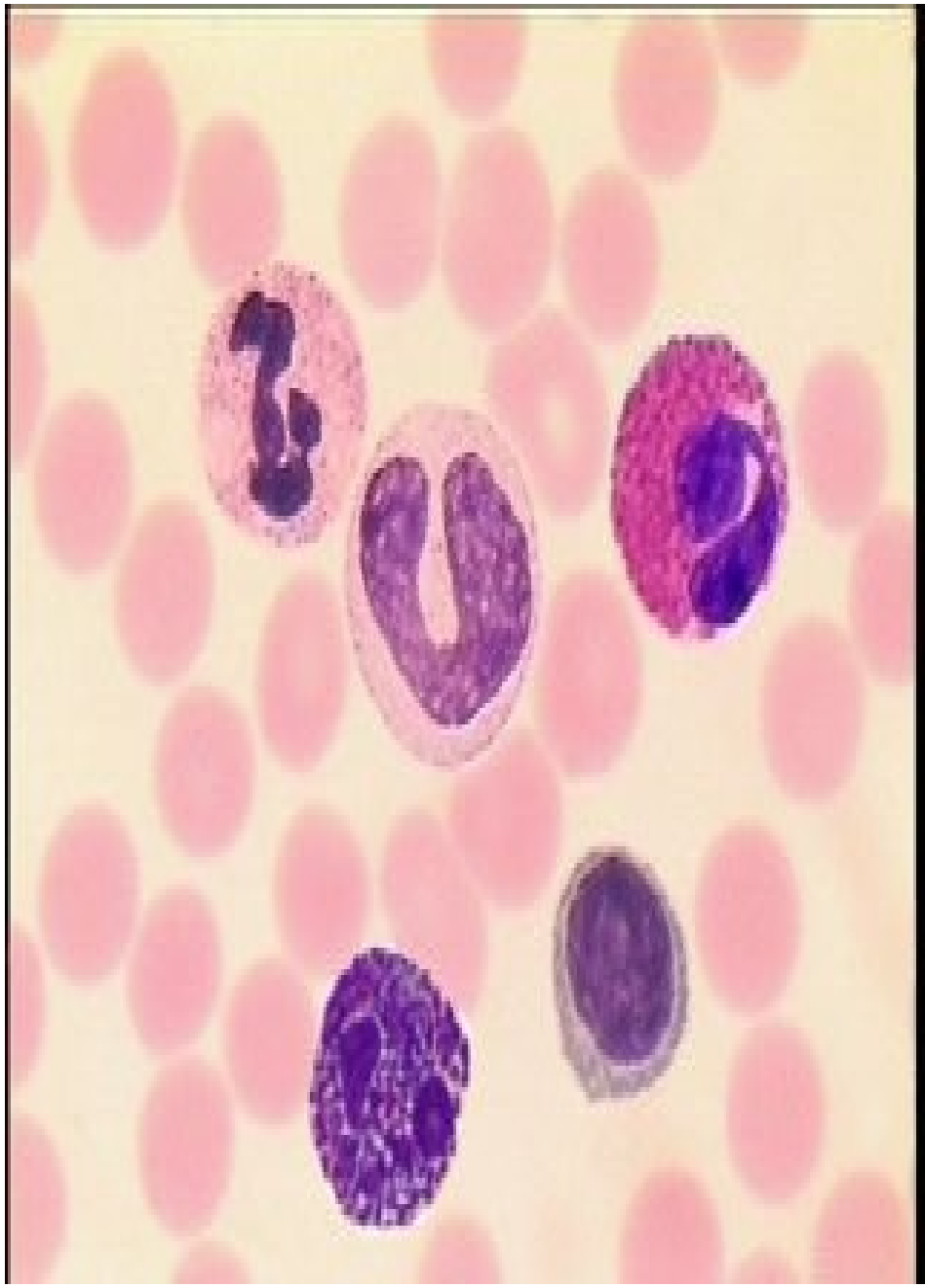
- Is the body's biological defense mechanism that protects against foreign invaders.
- The true roots of the study of the immune system date from 1796 by the work of an English physician, **Edward Jenner and**
- **Louis Pasteur (**established the cause of infectious diseases and the medical basis for immunization).

❑ Components of the Immune system

- It is composed of a number of different cell types, tissues and organs.
- Many of these cells are organized into separate lymphoid organs.
- It has a mobile force of cells in the bloodstream that are ready to attack the invading microbe wherever it enters the body.
- Cells maintain communication through cell contact and molecules called cytokines

Cells of the immune system

- **Myeloid cells**
  - Granulocytes (PMNC)
  - Monocytes/macrophages
  - Dendritic cells
- **Lymphoid cells**
  - Lymphocytes (B&T cells)



- **The human immune system has Two general mechanisms for preventing infectious diseases.**

1. Nonspecific (Innate) Defense Mechanisms :
defense that protect us from any (wide range) pathogen

2. Specific (Adaptive) Defense Mechanisms :
defense that the body offers against particular pathogen

1. **Innate Immunity** – There are **4 types** of defensive barriers (Protective actions) of **nonspecific (innate)**

1. **Physical/Anatomical barriers- the 1st line of defense**
   - Skin, Mucous membranes, Mucous, Cilia propel Mos out of the body & Normal flora-biological barriers
2. **Physiological barriers**
   - PH of our environment, HCL-Low PH
   - Temperature of our body
3. **Chemical barriers and biologically active substance**
   - tears, saliva, (enzymes lysozyme), vaginal secretions, sweat (lysozyme, toxic lipids)
   - These secretions act to wash away potential invaders
   - Contain antibacterial / antiviral substance

4. **Cellular defense (innate immune cells)- Non-specific leukocytes via phagocytosis and Inflammatory response**

2. ADAPTIVE/Acquired immune response

- Develops after birth – Acquired

    - Triggered when Innate response is not enough

    - Response is specific for individual microbe/epitope

    - Remembers – heightened response second time

- Two arms: Humoral Immunity (B cell mediated) &

1. **Humoral (antibody-mediated) immunity (HI):-** Involves the production of Antibodies by B cells (B- lymphocytes) defends mostly against bact., bact. toxin, and virus in body's fluids

2. **Cell-mediated immunit(CMI)** Involves the production of specialized lymphocytes called T cells; effective against bact. and viruses located within phagocytic or infected host cells and against fungi, protozoa

Adverse immune reactions /responses

- They can occur and cause adverse effects or severe tissue damaging reactions (immunopathology) due to several reasons such as:-
  - Exaggerated immune response
  - producing inappropriate immune response against self components.
  - Due to failure of appropriate recognition mechanism.
- The **three types** of immunological disorders:-

1. Hypersensitivity
2. Autoimmune diseases
3. Immunodeficiency

1. **Hypersensitivity**

- The word "*hypersensitivity*" Implies an increased response, the response is not always heightened but may, instead, be an inappropriate immune response to an antigen
- Develop in the course of either HI or CMI response
- **Immediate hypersensitivity if it occurs** within the humoral branch & initiated by Ab or Ag-Ab complexes
  - because the symptoms are manifested within minutes or hours after a sensitized recipient encounters antigen
- **Delayed-type hypersensitivity (DTH)** is so named in recognition of the delay of symptoms until days after exposure

Four (4) types of hypersensitivity reactions mediated b y immunological mechanisms that cause tissue damage

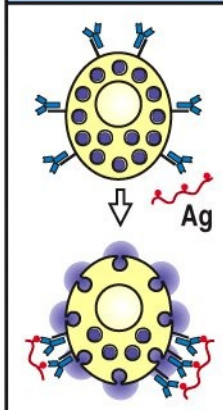
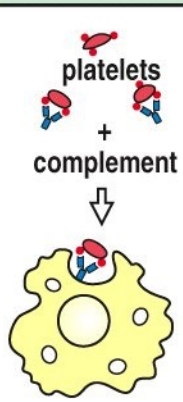
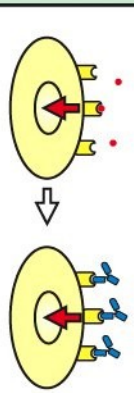
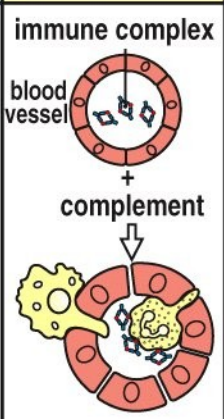
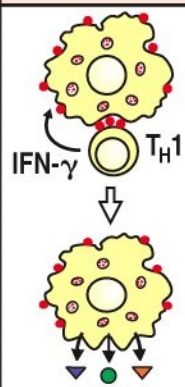
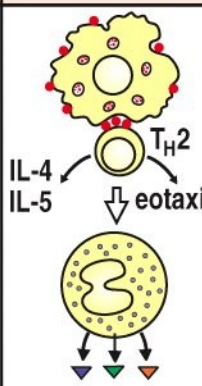
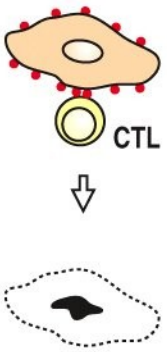
	Type I	Type II		Type III	Type IV		
Immune reactant	IgE	IgG		IgG	T_H1 cells	T_H2 cells	CTL
Antigen	Soluble antigen	Cell- or matrix-associated antigen	Cell-surface receptor	Soluble antigen	Soluble antigen	Soluble antigen	Cell-associated antigen
Effector mechanism	Mast-cell activation	Complement, FcR^+ cells (phagocytes, NK cells)	Antibody alters signaling	Complement, Phagocytes	Macrophage activation	IgE production, Eosinophil activation, Mastocytosis	Cytotoxicity
							
Example of hypersensitivity reaction	Allergic rhinitis, asthma, systemic anaphylaxis	Some drug allergies (eg, penicillin)	Chronic urticaria (antibody against FCεR1α)	Serum sickness, Arthus reaction	Contact dermatitis, tuberculin reaction	Chronic asthma, chronic allergic rhinitis	Contact dermatitis

Figure 12-2 Immunobiology, 6/e. (© Garland Science 2005)

2. **Autoimmunity**:- Results from a failure or breakdown of the mechanisms normally responsible for maintaining self-tolerance in B cells, T cells, or both.

- Autoimmune disease can be divided into:
- organ-specific & systemic

- Organ specific are target only one organ. E.g. Type 1 diabetes damages the pancreas.
- Systemic is therefore affects multiple organs& have a tendency to become chronic b/c the autoantigens can never be cleared E.g. systemic lupus erythematous (SLE), affect the whole body.

Disease	Self-antigen	Immune response
	ORGAN-SPECIFIC AUTOIMMUNE DISEASES	
Addison's disease	Adrenal cells	Auto-antibodies
Autoimmune hemolytic anemia	RBC membrane proteins	Auto-antibodies
Goodpasture's syndrome	Renal and lung basement membranes	Auto-antibodies
Graves' disease	Thyroid-stimulating hormone receptor	Auto-antibody (stimulating)
Hashimoto's thyroiditis	Thyroid proteins and cells	T_{DTH} cells, auto-antibodies
Idiopathic thrombocyopenia purpura	Platelet membrane proteins	Auto-antibodies
Insulin-dependent diabetes mellitus	Pancreatic beta cells	T_{DTH} cells, auto-antibodies
Myasthenia gravis	Acetylcholine receptors	Auto-antibody (blocking)
Myocardial infarction	Heart	Auto-antibodies
Pernicious anemia	Gastric parietal cells; intrinsic factor	Auto-antibody
Poststreptococcal glomerulonephritis	Kidney	Antigen-antibody complexes
Spontaneous infertility	Sperm	Auto-antibodies
	SYSTEMIC AUTOIMMUNE DISEASES	
Ankylosing sponkylitis	Vertebrae	Immune complexes
Multiple sclerosis	Brain or white matter	T_H1 cells and T_C cells, auto-antibodies
Rheumatoid arthritis	Connective tissue, IgG	Auto-antibodies, immune complexes
Scleroderma	Nuclei, heart, lungs, gastrointestinal tract, kidney	Auto-antibodies
Sjogren's syndrome	Salivary gland, liver, kidney, thyroid	Auto-antibodies
Systemic lupus erythematosus (SLE)	DNA, nuclear protein, RBC and platelet membranes	Auto-antibodies, immune complexes

3. Tumor Immunology

- In most organs and tissues of a mature animal, a balance is usually maintained between cell renewal and cell death.
- Under normal circumstances, the production of new cells is regulated so that the number of any particular type of cell remains constant.
- Some times, though, cells arise that no longer respond to normal growth-control mechanisms.
- These cells give rise to clones of cells that can expand to a considerable size, producing

- Tumor is

- **Two types of tumor**

- A tumor that is not capable of indefinite growth & does not invade the healthy surrounding tissue extensively is **benign.**
- A tumor that continues to grow and becomes progressively invasive is **malignant;** the term *cancer* refers specifically to a malignant tumor.

4. Immunodeficiency diseases

- Immunodeficiency (ID)- occur when one or more components of the immune system is defective

- Classified as primary or secondary

Primary: caused by mutations affecting any of a large number of genes that control the expression and activities of immune response.

Secondary: are acquired as a consequence of other diseases, or are secondary to environmental factors such as starvation, or are an adverse consequences of medical intervention

END of UNIT 6