Unit 8 Microorganisms & The Immune System

CH 16-18

Host Defenses

- Host defenses that produce resistance can be either innate or adaptive:
- **Innate**: those that protect against any type of invading agent
- **Adaptive**: respond to antigens by producing antibodies
- **Antigen (Ag)**: a substance that the body recognizes as foreign and causes it to mount an immune response; also called an *immunogen*
- **Antibody (Ab)**: a protein made in response to an antigen and is capable of binding specifically to that antigen; also called an *immunoglobulin*

Innate immunity	Adaptive immunity
• general protection (not antigen-specific)	• highly specific for a particular pathogen (antigen-specific)
• early phase of host response to pathogens without requiring prior exposure	• late phase response of antigen-specific lymphocytes to antigens
• immediate maximal response	• lag time between exposure and maximal response
• does not alter on repeated exposure (no immunological memory)	• improves with each successive exposure (immunological memory)
* (rapid, non-specific, no memory)	* (slower, specific, diverse, memory)

Types of Innate Defenses

1. Physical barriers like **skin, mucous membranes, & the substances they secrete**
2. Chemical barriers like **antimicrobial agents in saliva, mucus, & gastric juices**
3. Cellular defenses like **defensive cells & phagocytes**
4. Inflammation
5. Fever
6. Molecular defenses like inteferon & complement

Defensive Cells—Leukocytes

Granulocytes—have granules in the cytoplasm - help the body fight bacterial infections - counted as part of a white blood cell differential test
Basophils—chiefly responsible for allergic and antigen response by releasing the chemical histamine
Dendritic cells—act as messengers between the innate and adaptive immune systems
Eosinophils—defend against parasitic infections; predominant inflammatory cells in allergic reactions
Neutrophils—phagocytes; defend against bacterial or fungal infection and other very small inflammatory processes

Defensive Cells—Leukocytes

Agranulocytes—no granules in the cytoplasm - contain lysosomes which are small vesicles containing digestive enzymes that break down any foreign matter that is endocytosed by the cell
Monocytes—phagocytes; present pieces of pathogens to T cells so that the pathogens may be recognized again and killed, or so that an antibody response may be mounted
Lymphocytes: 1. **B-lymphocytes (B cells)** which produce antibodies in the antibody-mediated immune response; differentiate in bone marrow 2. **T-lymphocytes (T cells)** which participate in the cell-mediated immune response; differentiate in thymus gland 3. **Cytotoxic cells** which participate in the innate immune response

Other Defensive Cells

- **Phagocytes**: cells that eat or engulf other materials that circulate through the body
  - aka neutrophils
  - Destroy cell debris & dead cells
  - Guard the skin & mucous membranes
- **Macrophages**: cells that engulf large particles
  - Originate as monocytes
  - Destroy microorganisms & cell debris left over from neutrophils

Brain Check

1. What are the 2 types of host defenses that we have?

a. Inherited & Adaptive
b. Innate & Adaptive
c. Inherited & Accepted
d. Innate & Accepted

2. What 2 defensive cells act as phagocytes?

a. Eosinophils & neutrophils
b. B cells & neutrophils
c. T cells & neutrophils
d. Moncytes & neutrophils

Inflammation

- **Inflammation**: the body's defensive response to tissue damage from
  - microbial infection
  - mechanical injury (cuts, etc.)
  - Heat & electricity (burns)
  - UV light (sunburn)
  - Chemicals (acids, etc.)
  - Allergies

Inflammation—Cardinal Signs

- **Increase in temperature**
- **Redness**
- **Swelling**
- **Pain at the infected or injured site**
- Usually prevents an infection from getting worse
- The duration of inflammation can be either acute or chronic; acute ends fairly quickly while chronic inflammation occurs when the agent producing inflammation persists in causing tissue damage & making pus

Stages of Acute Inflammation

- Battle between the microbes & host…host usually wins

1. Kill invading microbes
2. Clear away cell debris
3. Repair injured tissue

Effects of Inflammation

- Release of histamine: **acts as a vasodilator**; when cells are damaged, it's released from basophils & mast cells which causes vasodilation in nearby capillaries & venules…leads to redness, warmth, and swelling
- Clotting factors arrive along with macrophages and cytokines that attract more phagocytes
- **Leukocytosis** also occurs—an increase in leukocytes in the blood
- **Pus**—accumulation of dead phagocytes, cells, cell debris, and other tissue debris; only caused by bacteria

Brain Check

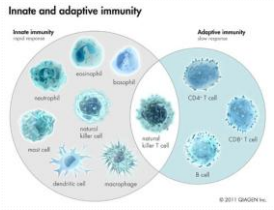
1. What are the 4 cardinal signs of inflammation?
2. What effect does histamine have on blood vessels?
3. What is leukocytosis?
4. What infectious organism causes pus to form?

Immunity

- **Immunity** is the ability of an organism to recognize and defend itself against infectious agents.
- In contrast, **susceptibility** is the vulnerability of the host to harm by infectious agents.
- 2 major types: innate & adaptive

Types of Immunity

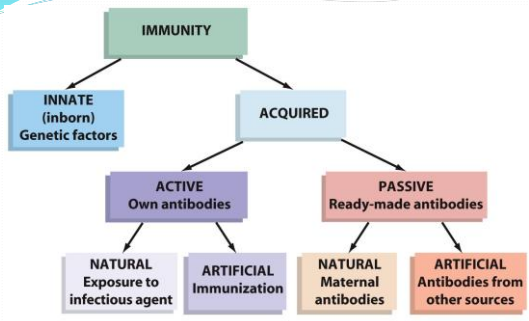
1. **Innate immunity** provides nonspecific, hereditary defense and protection against many pathogens without prior exposure.
   - **Species** immunity: common to all members of a species



Types of Immunity

2. **Adaptive or Acquired** immunity is immunity obtained in a manner other than hereditary.

- Either Active or Passive
- Active or passive is further classified as natural or artificial



Active vs. Passive Immunity

- Acquired immunity is active or passive
- **Active immunity**: when the person's own immune system activates T cells or produces antibodies or other defenses; can last weeks-lifetime as long as the Ab persists
  - Naturally acquired active: exposure to infectious agent
  - Artificially acquired active : exposure to a vaccine containing live, weakened, or dead organisms/their toxins (immunizations)
- Body usually retains a memory of the Ag

Active vs. Passive Immunity

- **Passive** immunity: when ready made Ab are introduced into the body
  - Naturally acquired passive: passed from mother to child
  - Artificially acquired passive: exposure to Ab made by other hosts (antivenins, plasma serums, antitoxins); *temporary*

Brain Check

1. When a mother breastfeeds and passes antibodies to her child, this is an example of

a. Artificially acquired active immunity
b. Artificially acquired passive immunity
c. Naturally acquired active immunity
d. Naturally acquired passive immunity

Dual Nature of the Immune System

- **Humoral immunity**: carried out by Ab circulating in the blood which stimulate B cells to release Ab BEFORE FOREIGN SUBSTANCES ENTER THE CELL
  - Clear out foreign substances like bacteria, bacterial toxins, and viruses
- **Cellular immunity**: carried out by T cells AFTER FOREIGN SUBSTANCES HAVE ENTERED THE CELL
  - Clear out virus infected-cells & defend against fungi, eukaryotic parasites, cancer, & foreign tissue (transplants)

General Properties of Immune Responses

1. Recognition of **self vs. nonself**

2. Specificity
   - reacts in different ways to each foreign substance

3. Heterogeneity
   - specific response to a variety of different foreign Ag

4. **Memory**
   - quick response to previous foreign substances years or decades later

Humoral Immunity—Types of Antibodies			
IgA	protects against pathogens; found in nasal discharge, saliva, breast milk and bowel fluid	**IgG**	protects the body; main antibody in blood; only one that can pass through the placenta; widely distributed to the blood and tissue
IgD	plays a role in the induction of antibody production; present on the surface of B cells	**IgM**	key role in the initial immune system
IgE	believed to be related to immunity reactions to parasites, and has recently become known as a key factor of allergies		

Cellular Immunity—Types of T cells

- After T cells are challenged by Ag, the cells differentiate into one of the following:

Killer (or cytotoxic) (T_C)	Destroy virus-infected and damaged cells
Memory	Allows the body to recognize previously encountered Ag
Helper (T_H)	Boost the immune response by stimulating B-cells to begin antibody production & activates more killer T cells
****Natural killer cells**	Not classified as B or T cells, but they nonspecifically kill cancer & virus-infected cells without a specific immune response

Types of Immunizations	
Active	Passive
Process of inducing active immunity by vaccines or toxoids; *long-term*	Process of introducing ready-made Ab into an unprotected individual by antisera or antitoxins; *temporary*
- **Vaccine**: a substance that contains an Ag to which the immune system responds -**Toxoid**: an inactivated toxin that is no longer harmful, but retains antigenic properties	-**Antisera**: blood serum from animals (horses, cows, pigs) -**Antitoxins**: Ab against specific toxins
Example: MMR, meningitis	Example: botulism, rabies, Hep A

Brain Check

1. What is the main antibody in the blood?

a. IgM b. IgG

c. IgE d. IgA

2. What do memory T cells do?

3. In regards to time, what is the difference between an active and a passive vaccine?

Immune Disorders

Overview of Immunological Disorders

Terms to know:

- **Immunological disorder**: condition that results from an inappropriate or inadequate immune response
- **Hypersensitivity or allergy**: an exaggerated or inappropriate reaction to a foreign substance
- Four types:

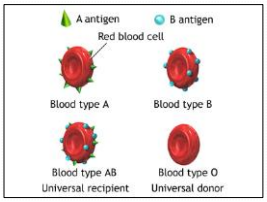
1. Type I: Immediate
2. Type II: Cytotoxic
3. Type III: Immune Complex
4. Type IV: Delayed

Type I: Immediate Hypersensitivity

- aka **anaphylaxis**
  - **Generalized** anaphylaxis: systemic reaction in which the airways are constricted
  - **Anaphylactic shock**: large decrease in BP
- Definition: when the **sensitizing dose** (initial contact) is followed by a latent period and then the next contact, or **shocking dose**, of the allergen (Ag) causes Ab to produce a hypersensitive response
- Examples: asthma, pollen, food, dander, insect stings

Type II: Cytotoxic Hypersensitivity

- Definition: when specific Ab react with cell surface Ag that are recognized as foreign leading to killer cell activity
- Examples: **receiving the wrong blood type in transfusions & hemolytic disease of newborns**



Type III: Immune Complex Hypersensitivity

- Definition: when large Ab-Ab complexes are formed and persist (these are usually destroyed by phagocytes), causing a hypersensitive response
- Can become chronic if the Ag persists
- Examples: **serum sickness** (horse serum in a vaccine)

Type IV: Delayed Hypersensitivity

- Definition: an exaggeration of the immune response caused by T cells and it takes more than 12 hours to happen
- Examples: **contact dermatitis from nickel, cosmetics, poison ivy/oak/sumac**

Autoimmune Disorders

- Occur when individuals become hypersensitive to specific Ag on cells or tissues of their own bodies, producing **autoantibodies**

Causes:

- Genetic factors
- Antigenic mimicry
- Thymus malfunction
- Mutations
- Sympathetic nervous system damage

Examples: myasthenia gravis, rheumatoid arthritis

Immunodeficiency Diseases

- **Primary**: caused by genetic defects that cause a failure of the thymus gland or Peyer's patches to develop normally so there is a lack of/defective B and T cells
  - Example: severe combined immunodeficency
- **Secondary**: nongenetic causes such as infectious agents, malignancies, immunosuppressants, some chemotherapeutic drugs, certain antibodies, & radiation
  - Examples: TB, leprosy, AIDS, leukemia

Inside Look at the Flu

https://www.youtube.com/watch?v=vmSVtqRz9QA