Immune System

Rita Carey- Nita

Immune System

- The immune system protects the body from foreign agents such as pathogens, pollens, toxins & cancer cells
- It includes all structures & processes that mount a defense against foreign agents

Immune System

- The defense mechanisms are classified as nonspecific & specific immunity
  - Nonspecific immunity protects the body against many different types of foreign agents
  - Specific immunity focuses on a particular foreign substance & provides protection for that particular substance

Nonspecific Immunity

- Nonspecific Immunity can be divided into lines of defense:
  - First line of defense includes:
    - Mechanical barriers
    - Chemical barriers
    - Certain reflexes
  - Second line of defense includes:
    - Phagocytosis
    - Inflammation
    - Fever
    - Protective proteins
    - Natural killers

Nonspecific Immunity

- First line of defense:
  - Mechanical barriers include intact skin & mucous membranes; pathogens cannot cross these structures & enter the body
  - Chemical barriers include:
    - Tears, saliva & perspiration; they wash away microorganism
    - Digestive enzymes kill microorganisms
    - Mucus in resp. tract is sticky so it traps foreign material then the cilia sweeps it toward the throat where it is coughed or swallowed
  - Reflexes also protect the body
    - Sneezing—coughing—blinking—vomiting—diarrhea

Nonspecific Immunity

- Second line of defense
  - Phagocytosis:
    - By WBC's such as neutrophils & monocytes
    - Some travel in blood & tissue fluid & some are fixed
    - Enter endothelial cells of capillary walls & enter tissue space at site of infection (diapedesis)
    - The phagocytes are attracted to chemotaxis which are chemicals released by injured cells
    - They travels to the area & surround the pathogen
    - The pathogen then meets with the lysosome & lysosomal enzymes are secreted killing the pathogen

Nonspecific Immunity

- Second line of defense:
- Phagocytosis:
- Liver—Spleen—Lungs—Lymph nodes have many fixed phagocytes
  - Macrophages arise from monocytes & are fixed in organs; they divide & produce more; big eaters
  - Kupffer cells are in the liver fixed to the walls of large capillaries called sinusoids; as blood flows through the sinusoids pathogens & foreign substances are removed & phagocytosed

Nonspecific Immunity

- Second line of defense:
- Inflammation:
  - Is the response of the body to an irritant
  - An irritant can include:
    - Pathogens—friction—excessive heat or cold—radiation injury—chemicals
  - If an irritant is caused by a pathogen, the inflammation is called an infection
- Signs of Inflammation:
  - Redness—heat—swelling—pain

Nonspecific Immunity

- Second line of defense
- Inflammation:
  - Causes:
    - Injured cells release histamine & other substances that cause blood vessels to dilate increasing blood flow to the area
    - Increased blood flow causes redness & heat
    - Histamine causes blood vessel walls to leak out fluid & dissolved substances into tissue space causing swelling
    - The accumulation at the site of injury stimulates pain receptors hence pain

Nonspecific Immunity

- Second line of Defense
  - Increase in blood flow brings increase number of phagocytic cell to injury site
  - As the phaocytes do their job the area becomes filled with leukocytes, pathogens, injured cells & tissue fluid composing **PUS**
  - The cells then build a wall around the debris to protect the rest of the body from the infection; the walled off area is called an abscess
  - Pus indicates that phagocytes have done their job

Nonspecific Immunity

- Inflammation:
- Because of leaky vessels, fluid collects in the tissue spaces
- This tissue contains blood clotting factors such as fibrogen
- Fibrogen creates fibrin threads within the tissue spaces
- Fibroblasts then enter the area & restrict the injured area keeping the inflammation from spreading to the rest of the body.
- Fibroblastic activity also assist with tissue repair

Nonspecific Immunity

- Fever:
  - As phagocytes perform their job, they release pyrogens (fever producing substances) that stimulate the hypothalamus in the brain to raise the body's temperature which produces fever
  - Two benefits to fever:
    - Stimulates phagocytosis
    - Decreases the ability to some pathogens to multiply

Nonspecific Immunity

- Two groups of Protective Proteins:
  - Interferons:
    - group of proteins secreted by cells infected by a virus
    - Prevent further replication of the virus protecting the cells
    - Boost immune system
  - Complement:
    - Circulate in blood in an inactive form
    - When activated against bacterium, they sworm in
    - Attach to bacterium's membrane & punch holes in it allowing the fluid & electrolytes to flow into the bacterium causing it to burst & die
    - They also activate phagocytosis & inflammatory response

Nonspecific Immunity

- Natural Killer Cells:
  - Special type of lymphocyte that act nonspecifically to kill certain cells
  - Effective against many microbes & certain cancer cells
  - Cooperate with the specific defense mechanism to mount the most effective defense possible

Specific Immunity

- Third line of defense:
  - Defense mechanisms with very specific actions
  - Protect against a specific foreign agent; example measles or pollen
  - Two cell play key role:
    - Lymphocytes: B lymphocytes & T lymphocytes
    - Macrophages

Specific Immunity

- Antigens:
  - Large & complex molecules; most are proteins but a few are polysaccharides & lipids
  - Found an the surface of pathogens, RBC's, pollens, foods, toxins & cancer cells
  - Substances with antigens are said to be antigenic
  - Lymphocytes attack antigenic substances

Specific Immunity

- T & B lymphocytes:
  - Both come from the stem cells in bone marrow but mature & differentiate in different areas
  - Differ in development & function
- T lymphocytes:
  - Have matured & differentiated in the thymus gland
  - Then carried away from thymus & where deposited in various lymphoid tissue; spleen & lymph nodes
  - Some live & work in lymphoid tissue & others circulate in the blood
  - They constitute 70% - 80% of all lymphocytes
  - AKA: T cells

Specific Immunity

- B Lymphocytes:
  - Originate from stem cells in the bone marrow
  - Differentiate in the fetal liver & bone marrow
  - Reside in the lymphoid tissue
  - B lymphocytes account for 20% - 30% of all lymphocytes
  - AKA: B cells

Specific Immunity

- Both T cells & B cells attack antigens but in different ways
- T cells attack directly through cell to cell contact called cell-mediated immunity
- B cells interact with the antigen indirectly through the secretion of antibodies called antibody-mediated immunity
- Antibody-mediated immunity is also called humoral immunity

Cell-Mediated Immunity

- The steps are:
  1. The antigen on the surface of the pathogen is engulfed & phagocytosed by a macrophage. The macrophage digest the antigen & pushes the antigen to its surface called antigen presentation
  2. T cells that have receptor sites bind to the antigen & become activated: T-cell activation
  3. Activation of the T cell requires an antigen-presenting cell; such as a macrophage
  4. The activated T-cells divide repeatedly increasing their #; called clone
  5. 4 subgroups within the clone:

     Killer T cells—Helper T cells—Suppressor T cells—Memory T cells

Cell-Mediated Immunity

- Killer T-Cells:
  - Destroy the antigen by punching holes in it's cell membrane & secreting lymphokines (increase phagocytic activity)
  - Engage in cell to cell combat
- Helper T cells:
  - Secrete lymphokines that stimulate both T cells & B cells enhancing immunity
- Suppressor T cells:
  - Inhibit or stop immune response when the antigen has been destroyed
  - Controls the activity of T & B cell activity
- Memory T cells:
  - Remember initial encounter with the antigen & quickly reproduce causing faster immune response

Antibody-Mediated Immunity

- B cells engage in antibody-mediated immunity
- Activated B cells produce clone cells that secrete antibodies
- The antibodies are carried by the blood & bodily fluids to antigen bearing pathogens
- An individual B cell can produce over 10 million different antibodies which allows the body to develop immunity against several disease

Antibody-Mediated Immunity

- Steps of antibody-mediated immunity:

1. A macrophage engulfs & processes antigen.
2. Antigen is pushed to the surface of macrophage & presented with both the B cell & T helper cell
3. The presented antigens bind to both the B cell & the T helper cell, activating both cells that contain the proper receptors
4. The activated helper T cells secrete a lymphokin that stimulates the B cell to reproduce, producing a clone

Antibody-Mediated Immunity

- Steps:

5. The clone subgroups are:
    - plasma cells that produce large quantities of antibodies that travel through the blood to the antigens
    - Memory B cells that remember the specific antigen & during future encounters have a quicker response to the invading antigen

Antibodies

- Antibodies:
  - Secreted by B cells
  - Are proteins called immunoglobins
  - Primarily found in plasma in the gamma globulin part of plasma proteins
  - 5 major types & 3 most abundant:
    - Immunoglobulin G (IgG)
    - Immunoglobulin A (IgA)
    - Immunoglobulin M (IgM)

Antibodies

- Immunoglobulin G: antibody found in plasma & body fluids; effective against certain bacteria, viruses & toxins
- Immunoglobulin A: antibody found primarily in the secretions of exocrine glands; breast milk, tears & gastric juices help protect against infection
- Immunoglobulin M: antibody found in plasma; anti-A and anti-B antibodies are associated with RBC

Antibodies

- What they do:
  - Destroy antigens by directly attacking the membrane & indirectly by activating complement proteins that facilitate on the antigens
- Antigen-Antibody reactions occur when antibodies act directly with antigens by binding with them
  - The antigen-antibody components clump or agglutinate making them easier to phagocytose
  - Not the most effective means of protecting the body

Antibodies

- Activation of complement proteins is more effective way of attacking antigens
  - Promote agglutination making them more susceptible to phagocytosis
  - Encourage lysis of pathogens cell membrane

Immune Response

- Primary response is the initial response to an antigen
  - Slow development & low plasma levels of antibodies
- Secondary response is the subsequent exposure to the same antigen
  - Quick response & large number of antibodies
- Secondary response is quicker due to the memory cells that were produced in the initial inducing the formation of antibody-secreting plasma cells
- Second response means we become immune to a certain disease; won't get the disease a second time
- Antibody titer tells the level of an antibody in body

Types of Immunity

- Genetic Immunity:
  - Immunity we are born with
  - We are protected from certain disease
- Acquired Immunity:
  - Is as the name states; acquired during one’s lifetime
  - Either naturally or artifically

Naturally Acquired Immunity

- Two ways to acquire natural immunity:
  1. Getting the disease triggers your body to develop antibodies
     - After first exposure your immune system has the antibodies & memory cells to prevent a second invasion
     - Because your body produces the antibodies it is called acitve immunity
     - Active immunity is long lasting

Naturally Acquired Immunity

2. Second way to acquire immunity naturally is by receiving antibodies from your mother
   - Some antibodies (IgG) cross the placenta from mother to fetus
   - Antibodies are also transferred through breast milk (IgA)
   - Because your immune system did not produce this immunity, it is called passive immunity
   - Passive immunity only last about 6 months

Artificially Acquired Immunity

- Two ways to receive artificial immunity:

1. Vaccination: an antigen-bearing substance injected into a person in an attempt to stimulate antibody production
   - The antigen is altered or attenuated called a vaccine
   - When a toxoid is attenuated its called toxoid
- Purpose of the vaccine is to provide initial exposure & stimulate the formation of memory cells
- Booster shot is to stimulate the secondary response

Artificially Acquired Immunity

- Immune globulin:
  - Differs from vaccine
  - Obtained from a donor & contains antibodies
  - The antibodies are formed in the donor in response to a specific antigen
  - The antibodies are taken from the injected into the recipent creating passive immunity
  - Given to people in an attempt to protect from recent exposure to a virus
  - Short lived protection

Artificially Acquired Immunity

- Anti-toxins contain antibodies that neutralize the toxins secreted by pathogens but do not affect the pathogen themselves
- Antivenoms contain antibodies that combat the effects of poisonous venom of snakes

Allergic Reactions

- Allergic reaction occurs when the immune system forms antibodies to substances not usually recognized as foreign
- Two types:
  - Delayed-reaction allergy
  - Immediate-reaction allergy

Delayed-reaction allergy

- Reaction usually takes about 48 hours
- Can occur in anyone
- Usually occurs as a result of repeated exposure of the skin to chemicals
- Repeated exposure to chemicals activates T cells which accumulate in skin causing eruptions & inflammation
- Skin response is called contact dermatitis

Immediate-reaction allergy

- Occurs rapidly in response to stimulus
- AKA immediate hypersensitivity reaction
- Involves immunoglobulin E antibodies
- Allergens trigger the reaction

Immediate-reaction Immunity

- Steps in immediate-reaction:

1. Allergen activates a B cell
2. The activated B cell forms a clone of antibody-secreting plasma cells
3. The plasma cells secrete large amounts of IgE antibodies against a specific allergen
4. The IgE antibodies bind to the mast cells in body tissues
5. When the allergen invades the body again it binds with the IgE antibodies of the mast cell which release large amounts of histamine & other chemicals causing a systemic reaction

Immediate-reaction Immunity

- Anaphylaxis Reaction is a severe systemic effect causing:
  - Massive vasodilation
  - Sharp drop in BP
  - Brochoconstriction impairing breathing

Autoimmune Disease

- Person's own T cell attack self causing extensive tissue damage or organ dysfunction
- Called autoimmunity
- Disease itself is referred to as autoimmune
- Some diseases include:
  - Thyroiditis—lupus—myasthenia gravis—rheumatic fever—rheumatoid arthritis—some forms of diabetes

Organ Rejection

- Organ transplants recipient's are faced with the chance of organ rejection
- Immune system recognizes the organ as foreign & mounts an immune attack against it
- When an immune attack is successful, the organ is destroyed & is said to be rejected
- To prevent the physician will:
  - Match the recipient with a immunologically similar donor
  - Administer immunosuppresant that inhibit immune attack