Chapter 19 - The Immune Response: Specific Host Resistance

Specific Immunity & The Immune Response - Immunization occurs when an individual is naturally or artificially exposed to an antigen, and the immune system is activated to produce humoral immunity and cellular immunity.

Characteristics of the Specific Immune Response

1. It discriminates between "Self" (not foreign) and "NonSelf" (foreign) and responds only to materials that are foreign to the host.
2. Its highly specific
3. Immunologic memory - the specific immune response is able to produce a greater response more quickly when there is a second exposure to the same foreign antigen.
4. Immunity is transferable only from one inbred animal to another and only by means of living immune lymphocytes and not by antiserum (serum containing antibodies

The Lymphocytes - (WBC) capable of responding to antigens. Divided into:

1. T-Cells - Thymus derived lymphocytes
   - Help fight Viral and Cancer cells
2. B-Cells - Bone marrow derived lymphocytes
   - Help fight bacteria, Exotoxins viruses outside the cell
3. Null Cells - Natural killer cells,Killer cells (ADCC)
   - Non specific responses, usually fight cancer cells and virus infected cells

Clonal-Selection theory of immunity - A theory of antibody formation. Selected lymphocytes, whose receptors interact with a specific antigen, respond by undergoing mitosis and producing a clone of cells expressing the same receptor specificity and secreting the same type of antibodies. Occur during the formation of B cells

- 1st encounter = Effector cells produce B, T, & Memory Cells
- 2nd encounter = Memory cells produce B, T, & Memory Cells

Terms Associated with the Bodies Response to Antigens

Macrophage - digests microbe and presents antigens to Helper T cells
Virgin B Cell - has different types of antibodies
Helper T Cell - links activated B cells or T cells to Macrophages that are antigen presenting cells
Clonal Selection - process by which T or B cell with appropriate receptor for Ag is activated
Activated B Cell - differentiates into Memory Cells and Plasma cells (Ab secreting cells)
Cytotoxic T Cell - kill infected cells (virus,fungal or intracellular bacteria)
Suppresser T Cell - stops the immune response when no longer needed
Plasma Cell - B cells that secrete antibodies
Natural Killer Cells and Killer cells- nonspecific killing of tumor and virus infected cells
- Bind to & lysis tumor cells
- Secrete perforin (punches holes in cells)

Humoral Immunity - (blood, lymph, & mucus) Makes antibodies or B cells production that are directed at foreign microbes before they enter the actual cell. Aid in Extracellular bacteria, toxins, and viral infections

1. Macrophage - engulfs bacteria & digest it. The macrophage then displays bacterial antigens and is referred to as "Antigen presenting cell".
2. Virgin B Cell - with an antibody binds to the antigen thereby activating the B Cell to begin producing:
   Effector Cells - fight the antigen right away by tagging it for macrophages
   Memory Cells - B cells that may be used at a later date
3. Helper T Cells - act to link the "antigen presenting cell" and the "activated B cell" together by recognizing the combination of the foreign antigens and their self antigens presented.
   1. An Antigen-presenting cell presents antigen to helper T cell
   2. Helper T cell produces hormonelike factors called "interleukins" to promote B cell growth.
   3. B cells are activated by antigen & interleukins.

Acquired Immunity Types

Naturally Acquired Active - (common cold) getting the actual infection
Artificially Acquired Active - immunization or vaccine due to memory cells
Naturally Acquired Passive - Antibodies cross the placenta to the fetus
Artificially Acquired Passive - animal sources = temporary protection.

Antibody

- Y shaped (antigen binding site)
- lock & key fit for antigen
- 1 end = regions to bind to antigen (different for all antibodies)
- other end = constant region because the same for all antibodies of one class

Classes: Ig - Immunoglobulin

IgM: 1st antibody made - in response to antigen. Early response. Not as much produced during a second exposure to the same antigen.
IgG: produced after IgM in greater amounts (most prevalent) than IgM & can cross placenta & secondary response (possible memory involvement). More production than the IgM during a response to a previously exposed antigen.
IgD: helps initiate production of antibody response
IgA : dimer (secretory antibody) found in mucous, breast milk
IgE: Allergies, and associated with parasite infections

Second response is called "Amnestic response"

Antigen

- almost any large foreign substance. Ex. Protein, Nucleoprotein, Lipoprotein. Could also be pili, capsule, toxin, pollen, serum, or small molecules if sitting on a big molecule. Antibodies & T Lymphocytes recognize specific regions on an antigen surface called an "antigen determinant" or an "epitope". These regions are "foreign" or "nonself"

Self Antigens - one of your own, naturally found within your body. Your cells have specific regions on surface which are recognized by your immune cells "self" or MHC

- Used for ABO blood typing, tissue typing
- Body designates self-antigens during fetal development.
- Specific Immune Tolerance - before birth, proteins secreted from your own body cells inactivate the cells of your own immune system so later your own cells will not react with them.

MHC - Major Histocompatability Complex - "self" antigens found on your cells:

- MHC Class I - body cells
- MHC Class II - T cells, B cells, & Macrophages

Non-Self Antigen - foreign, not an antigen normally found in your body

A good antigen must be able to:

- stimulate the immune system
- react with antibody or immune cells

Cell-Mediated - Lymphocytes in blood & lymph tissues →T-Cells (refined in thymus) react with antigen to fight infected cells directly as well as cancer cells.

Infections: Intracellular viral, bacteria, fungal, protozoan, and helminth (worm)

Also, play an important role in rejection of grafts, transplants, & defense against cancer cells

1. Antigen Presenting Cell - develops the same as in humoral response. "Interleukin-1" Is produced which helps to aid the Helper T Cell in stimulating cloning of the B cells or Cytotoxic cells depending on the antigen present.
2. Helper T Cell - Acts the same as in the humoral response. "Interleukin-2" enhances the production of Cytotoxic T cell or B cell production depending on the antigen present.
3. Cytotoxic T Cell - secretes perforin which punches holes in target cells causing lysis and their destruction.
4. Suppresser T Cells - act as a negative feedback for the production of B cells &/or Cytotoxic T Cells.

Antibodies

Neutralization - antibodies bind to antigen preventing them from entering the cell.
Agglutination - antibodies cause the clumping together of antigens making them easier for phagocytosis
Precipitation - antibodies cause the dissolving together of antigens allowing them to precipitate as a solid for phagocytosis
Activation of the complement - an activated complement can punch holes in the plasma membrane of the antigen causing cell lysis or rupture

Complement - Interacts with antibody

Non Specific Response

Alternative Pathway - binds directly to a cell. Its presence enhances phagocytosis and the inflammation processes.

Specific Response

Classical Pathway - combines with antibody on a cell causing an attach complex which punches holes in the cell membrane resulting in lysis and destruction.
- Attracts phagocytes
- help to cause lysis of microbes

HIV - Impairs the immune response by infecting a Helper T Cell

Monoclonal Antibodies - more pure antibodies due to no cross activity.

1. First you obtain Myeloma cells that have the immortality characteristic and the ability to reproduce antibodies rapidly.
2. In order to obtain Specificity, you immunize a species with the antigen and allow it to produce antibodies. You then remove the spleen with the lymphocytes and B cells.
3. Fuse the Myeloma cells with the antibodies cells from #2 to form a hybridoma cell.
4. Grow and purify

Hopefully this will be a form of cancer treatment one day.

Transplantation

- Bone marrow, heart, liver
- Cornea transplants - no problem
- Largest advance = in bone marrow

Autograph - transplant own tissue
Allograph - same species/different genes
Heterograph - different species
Isograph - same species/genetic identical

Cyclosporin - immunosuppressive drug inhibits production of cytotoxic T cells.