Acquired Immunity

Acquired Immunity is a very specific immunity that you pick up as you are exposed to various antigens. These usually take days to develop, but once formed remain throughout one's life. They involve the following:

Lymphoid System—is the mechanism the body uses to bring lymphocytes in contact with antigens. It is responsible for the initiation of the acquired immune response. There are 3 parts: the primary lymphoid organs, the lymphatic vessels and secondary lymphoid organs.

Primary Lymphoid Organs—bone marrow and thymus. B- & T-lymphocytes are produced in the bone marrow and mature in the bone marrow and the thymus respectively.

Lymphatic Vessels—move lymph around the body. The portion of the blood plasma lost at the arteriole *not* recaptured at the venule enters the lymph system (15%). The lymph flows to lymph nodes and any invaders are removed before the lymph is returned to circulation.

Secondary Lymphoid Organs—the lymph nodes and spleen and other lymph tissue found in the body. It is here that the antigen presenting cells detect antigens.

Humoral immunity—involves the production of antibody molecules in response to antigen and is mediated by B-lymphocytes.

B-lymphocytes (B-cells)—lymphocytes produced in the bone marrow and require interactions with marrow cells for their development. During development, the B-cells become genetically programmed through a series of gene rearrangement reactions (via recombinase) producing up to 10^9 unique antibodies enabling the immune system to recognize any antigen encountered. B-lymphocytes have the ability to acquire antigens from the surface of dendritic cells. B-lymphocytes become activated when they bind antigens, and when they receive signals from the complement system (a part of innate immunity). Once bound, the antigen is engulfed, degraded, and presented on the surface via the MHC-II molecules. B-lymphocytes also produce immunoglobulins.

Antibodies—are also called immunoglobulins. They are produced by the humoral system in response to an antigen. They circulate in the blood and enter tissue as a part of the inflammatory response. There are 5 main classes of antibodies: IgG, IgM, IgA, IgD, and IgE.

IgE—most common antibody (80% of total). Activates complement. Binds to macrophages and neutrophils for enhanced phagocytosis. Enhances NK cell activity. Can cross placenta and cause problems with Rh-factor.

IgM—(13% of total). First antibody produced during immune response. Activates complement.

IgA—(6% of total). Found in body secretions. Blocks attachment of viruses and bacteria to mucous membranes.

IgD—(0.2% of total). Plays a role in B-cell activation.

IgE—(0.002% of total). Initiates allergic reactions. Promotes inflammation and subsequent entry of complement proteins and leukocytes into tissues.

Clonal selection—when antigens bind to the surface of a B-lymphocyte, they become activated. Cytokines released from T-cells enable the B-cells to proliferate rapidly. T-lymphocytes are also involved. When a helper T-cell encounters an antigen presenting cell and binds to its MHC molecule there is often a release of cytokines that activates B-cells and cytotoxic T-cells inducing them to proliferate and carry out their jobs of destroying invaders.

Disposal Mechanisms—there are ways the body uses to get rid of the foreign invaders that come in from the environment. Once they are tagged with antibodies, a variety of mechanisms are in place to remove the invader.

Agglutination—the clumping of microorganisms bound to antibodies enhancing phagocytosis.

Opsonization—the enhanced attachment of antigens to phagocytes enhancing phagocytosis.

Neutralization—the process by which antibodies attach to foreign invaders and prevent infection.

Precipitation—binds antigens that become immobile and get removed by phagocytosis.

Membrane Attack Complex—is the process by which complement is activated and chemicals are released that put holes in the membranes of foreign invaders.

Passive immunity—serum antibodies made by another person or animal enter the body. Immunity is short lived. An example would be RhoGAM.

Active immunity—antigens enter the body and stimulate it to make its own antibodies and memory B-cells. Here, the immunity is usually longer lived due to the production of memory B-cells. Active immunity is often obtained from attenuated microbes—active, non-virulent bacteria and viruses—which stimulate the body to produce and immune response without the effects of illness (tetanus, measles, mumps, rubella, polio). Also, killed and fragmented microorganisms may also be administered in the form of a vaccine which will give rise to a long-lived immunity (influenza vaccine). Lastly, toxoids can also be given in vaccines to stimulate the immune system. An example would be a tetanus shot.

Cell mediated immunity—involves the production of cytotoxic T-lymphocytes, activated macrophages, and activated NK cells. These cells release a variety of cytokines in response to antigen and are mediated by T-lymphocytes. It does not involve antibodies, but it does involve the production of a large number of different combinations of T-lymphocytes (via recombinase) in a manner very similar to that of the B-lymphocytes.

Major Histocompatibility Complex (MHC)—produce molecules which enable T-lymphocytes to recognize foreign invaders. There are two classes of MHC molecules, MHC-I and MHC-II. MHC I molecules are made by all nucleated cells of the body. They present antigens to cytotoxic T-cells. MHC-II molecules are made by antigen presenting cells, and they present antigens to helper T-cells. There are a variety of helper T-cells that function by releasing factors which activate macrophages, stimulate B-lymphocytes to produce immunoglobulins, and produce substances which stimulate immune responses such as inflammation and attraction of neutrophils.

Antigen Presenting Cells—cells that engulf foreign invaders and present pieces of them to the rest of the immune system. These include macrophages, dendritic cells, and B-lymphocytes. They express MHC-I and MHC-II molecules and enable recognition of the antigen by the T-lymphocytes. Additionally, these cells produce signals for the proliferation and differentiation of lymphocytes.

Macrophages (which also function with innate immunity)

Dendritic cells—these cells produce both MHC-I and MHC-II molecules and present the antigens to undifferentiated T-lymphocytes (both helper T-cells (via MHC-II) and cytotoxic T-cells (via MHC-I)).

B-cells—circulate through the blood and lymph. They capture and present antigens to helper T-cells. The MHC-II molecules within the B-cell capture and present these antigens to helper T-cells stimulating the production of cytokines (by the helper T-cell) which, in turn, stimulate the B-cell to proliferate and differentiate into an antibody-secreting cell.

Eosinophils—were mentioned in class as being phagocytic. They have a low phagocytic activity but remove invaders by binding to them and releasing substances that damage them beyond repair.

T-lymphocytes—these are a part of the cell mediated immune system and can only bind epitopes after they are bound to MHC molecules; these mature in the thymus.

Effector T-lymphocytes (Effector T-cells)—Bind to presented antigens on the surface of B-lymphocytes (and other antigen presenting cells) and release substances which result in the destruction of the invader.

Helper T-lymphocytes—cells with surface receptors that bind antigens bound to MHC-II molecules on the surface of antigen presenting cells. These become genetically programmed by gene rearrangement reactions (via recombinase) and serve to recognize many different antigens. The overall roles of the helper T-lymphocytes are to activate macrophages and NK cells, to produce cytokines to enable activated B-lymphocytes to rapidly proliferate, and produce cytokines that enable activated T-lymphocytes to rapidly proliferate and differentiate into effector cells.

Cytotoxic T-cells—comprise one of the body's major defenses against viruses, intracellular bacteria and cancers. These are the effector cells that remove these infected cells. These cells respond to signals from antigen presenting cells and helper T-cells which cause them to become the effectors of the immune system. They destroy foreign invaders via apoptosis.

Natural Killer cells (which also function with innate immunity)—there are two types of NK cells: NK T-cells and NK cells. The NK T-cells function to bridge the gap between the acquired and innate immune system. They recognize the invaders as presented by antigen presenting cells and produce large amounts of cytokines and perforins to induce apoptosis. These cytokines also promote acquired and innate immunity and regulate immune responses (macrophage activation, promotion of dendritic maturation so as to stimulate acquired immunity). NK cells participate in both innate and acquired immunity. NK cells lack B-cell and T-cell receptors and are designed to kill mutant (cancer) cells and virus-infected cells by recognizing cells that have antibodies attached to them as being foreign, or via apoptosis.

