Immune System

Cell Signaling and Innate Defense

Pattern recognition receptors (PRRs), such as the Toll-like receptors, on phagocytes and natural killer cells recognize nonself molecules.

Possible cellular responses:

- Production of defensins and cytokines
- Phagocytosis of invaders
- Activation of natural killer cells and complement system

Cytokines: signaling proteins produced in response of PRR activation

- Interferons (IF) - help increase resistance of neighboring cells to infection.
- Tumor necrosis factor (TNF) - kills target cells & activated immune cells.
    - The target cells are generally infected cells or tumor cells.
- Interleukins (IL) - regulate cell growth, differentiation, and motility.
    - Motility refers to cell movement.
    - These are molecules released by T cells.

Cytokine action is based on a large cytokine network, where different cells send signals to other cells. The moment the first line defense is broken through/defeated by a pathogen, the 2nd and 3rd line of defense are immediately activated. How fast a pathogen is stopped really depnds on how strong the host's immune system is.

Conditions Caused by Strong Inflammation Responses

The inflammation response can be too strong:

- **Allergic** reactions: a nonself molecule that is normally harmless binds to mast cells, causing the release of histamine and subsequent inflammation.
- **Autoimmune diseases**: the immune system fails to distinguish between self and nonself and attacks tissues in the organism's own body.
- **Sepsis**: inflammation due to a bacterial infection does not remain local (spreads to other parts of the body).
    - Dilation of blood vessels through the body can result in a dangerous drop in blood pressure.

Sites of the antigens recognized by the immune system are called antigenic determinants, or epitopes.

Binding of antibodies to antigens inactivates antigens by:

- Neutralization, which blocks viral binding sites; coats the bacteria
- Agglutination of microbes, which is the clumping up of bacteria.
- Precipitation of dissolved antigens
- Activation of complement system

The adaptive immune response can be summarized into three phases. The first phase is the recognition phase, then the activation phase, and then finally the effector phase.

Clonal Selection in B Cells

Purposes of clonal selection:

- Select B-cells producing antibodies bind to antigens effectively.
- Distinguishing self from nonself.
    - Any B and T cells show potential to mount an immune response to self antigens undergo apoptosis (clonal deletion).

This is all really based on chance, as only a specific B cells produced will have the right combination/form to actually bind to the antigen. Thus, no matter how many B cells are produced, only a few B cells will actually be able to bind to the antigen in play.

The Adaptive Humoral Response Involves Specific Antibodies

Antibodies, or immunoglobulins, are all tetramers of four polypeptides - two light chains and two heavy chains held together by disulfide bonds. each chain has a constant region and a variable region.

Remember: ig will usually refer to immunoglobulin.

Super Genes of B Cell Immunoglobulin

Every cell in the body has hundreds of immunoglobulin genes located in separate clusters. During B cell development, these genes are cut out, rearranged, and joined together in DNA recombination events to form a "supergene."

Each B cell precursor assembles two *unique* supergenes, one for a specific have chain and one for a specific light chain to form an irreversible cell differentiation. Not all B cell precursors of an individual have identical DNA.

T Cell Receptor (TCR)

T cells receptors are glycoproteins, with two polypeptide chains.

Regulatory T cells (Tregs) regulate the immune response.

Tregs recognize self antigens- when activated they release the cytokine interleukin-10. Interleukin-10 blocks T cell activation and leads to apoptosis of T_c and T_h cells bound to the same antigen-presenting cells.

Plants Have Constitutive and Induced Responses to Pathogens

Plant pathogens include fungi, bacteria, protists, and viruses.

Plant responses can be:

- Constitutive - always present; barriers such a cutin, wax and cell wall.
- Induced - produced in reaction to presence of a pathogen **elicitors**. Elicitors are molecules, such as peptides made by bacteria, fungal cell wall fragments, and derived from fragments of plant cell walls broke down by pathogens. Plants have receptors that recognize elicitors.

Signaling pathways are triggered by binding between elicitors and receptors.

Plant cellular responses to pathogens can include:

- Formation of NO and reactive oxygen species (H2O2) - toxic to some pathogens, and components of signaling pathways.
- Polymer deposition - lignin can block plasmodesmata, limiting ability of pathogens to spread from cell to cell.
- Hormone signaling - some pathways result in production of plant hormones.
- Changes in gene expression - upregulated genes include pathogenesis-related (PR) genes and genes encoding antimicrobial phytoalexins.