**Lecture 21 – Immune and Lymphatic System**

In this lecture, you will learn to distinguish between innate and adaptive immune responses, and specifically how human immunity works.

* Animals face constant danger from pathogens (bacteria, virus, fungus, nematodes, etc.)
* Immune system enables an animal to avoid or limit many infections

1. **Innate Immunity** (found in all animals and plants)

* Barrier defense is the first line of defense against pathogens

(**Exoskeleton (**arthropods**)** ), (**Skin (**non-arthropods**)** ), (**Mucus membrane**), (**Secretion** (lysozyme contained in saliva, mucus, tears) )

* Once a pathogen breaches barrier defenses, it faces the second line of defenses, called the internal defenses.
  + Animals recognize non-self (broad range of pathogens) using a small set of conserved receptors (**Toll receptor**).
  + (**Phagocytosis**): ingestion and digestion of foreign invaders
  + (**Antimicrobial peptides/proteins**): attack microbes or impede their reproduction
  + (**Natural killer(NK) cells (vertebrates only**): recognize and eliminate diseased cells
  + (**Inflammatory Responses (vertebrates only)**): changes brought about by signaling molecules released upon injury or infection (what molecules are involved?)

\*note which internal defenses are found in all animals and which are only found in vertebrates.

1. **Adaptive immunity** produces a vast arsenal of pathogen-specific receptors to recognize and response to pathogen attacks with tremendous specificity.

You need to know what organs are involved and what their functions are.

\*\* example: When you get a flu vaccine, your body responses to the flu virus and ‘remembers’ the flu so that when you actually catch the flu your body can quickly response to the flu and you don’t get that sick.

Thymus: **stores and matures T-cells**

Spleen: **removes old red blood cells; stores red blood cells; synthesizes antibodies; produces red blood cells and immune cells.**

Lymph nodes: **packed with immune cells (tonsils, adenoid are masses of immune tissues)**

Bone marrow:  **produces red blood cells, with blood cells, immune cells,**

\* These organs and lymph vessels are known as the lymphatic system.

- A precursor to immune cells and blood cells (stem cells) are produced in

(**bone marrow**), which differentiates into lymphoid stem cells, which give rise to ( ), which includes (**B**) cells and (**T**) cells, which are important for adaptive immunity.

1. Humoral immune response defends against (**extracellular**) pathogens in blood and lymph by binding to *antigens*.

* Antigens: any substance that elicits a response from immune cells.
* Antibody (immunoglobulin): secreted protein that binds to antigens.
  + involves B cells (lymphocytes that mature in the **B**one marrow)

1. Cell-mediated immune response defends against (**intracellular**) pathogens and cancer by binding to and lysing the infected cells or cancer cells.
   * Involves T cells (lymphocytes that migrate from bone marrow to **T**hymus and mature in the organ)
   * T cells do not produce antibodies
   * *T cells do not just go and attack antigens, they have a receptor that bind to the antigens when they are presented.*

* **Antigen**: any substance that elicits a response from immune cells
  + Epitopes:
* Humoral immune response involves (**B cells**) and (**antibodies**).
  + B cell antigen binding receptors are Y-shaped.
  + An antigen receptor of a B cell binds to an epitope.
  + This B cell gives rise to plasma cells that secrete antibodies.
  + Antibody, also known as the immunoglobulin, is a secreted protein that binds to antigens and can deactivate antigens.
  + An antibody is a multi-functional defensive weapon and it can deactivate pathogens by processes such as viral neutralization, opsonization, and activation of complement system and pore formation (see Fig. 43.19 [p.943] for further information).

\* Don’t confuse antigens with antibodies.

* Cell-mediated immune response involves (**Helper T**) cells and (**Cytotoxic T Cell**) cells.
  + Antigen receptors of T cells only bind to fragments of antigens that are presented on the surface of host cells.
  + T cells do not produce antibodies.
  + Antigen presentation is achieved through major histocompatibility complex (MHC).
    - Class I MHC molecules: found in (**almost all**) cells, recognized by

(**T**) cells

* + - Class II MHC molecules: found only in (**antigen-presenting**) cells (dendritic cells, macrophages, B cells); recognized by both (**T**) cells and (**Helper T**) cells
  + Cytotoxic T cells bind to class I MHC molecules of the infected cells and kill
* Helper T cells bind to (**Class II MHC**) molecule of the antigen-presenting cells and active B and T cells, thus they are at the intersection between humoral and cell-mediated immune responses.
  + Cytokines, produced by both antigen-presenting cells and helper T cells stimulate other immune cells
* Adaptive immunity relies on memory cells.
  + B and T cells give rise to memory cells that are long-live cells that can attack the antigens in the future encounter more readily.
  + 106 different B cells and 107 different T cells in each person
  + Self-reactivity tested in bone marrow or thymus
  + Lymphocyte amplification upon binding to antigen: clonal selection
  + You must understand Figure 43.20 (p. 944).
* Disruptions in immune system: allergies
  + Allergies are (**hypersensitive**) responses to certain antigens called (**allergens**). The antibody (IgE) attaches to the mast cell, releasing histamines, causing allergic reactions.