**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

( ), ( ), ( ), ( )

* 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 ( ).
  + ( ): ingestion and digestion of foreign invaders
  + ( ): attack microbes or impede their reproduction
  + ( ): recognize and eliminate diseased cells
  + ( ): 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.

Thymus:

Spleen:

Lymph nodes:

Bone marrow:

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

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

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

1. Humoral immune response defends against ( ) pathogens in blood and lymph by binding to antigens.
   * involves B cells (lymphocytes that mature in the **B**one marrow)
2. Cell-mediated immune response defends against ( ) 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)

* **Antigen**: any substance that elicits a response from immune cells
  + Epitopes:
* Humoral immune response involves ( ) and ( ).
  + 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 ( ) cells and ( ) 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 ( ) cells, recognized by

( ) cells

* + - Class II MHC molecules: found only in ( ) cells (dendritic cells, macrophages, B cells); recognized by both ( ) cells and ( ) cells
  + Cytotoxic T cells bind to class I MHC molecules of the infected cells and kill
* Helper T cells bind to ( ) 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 ( ) responses to certain antigens called ( ). The antibody (IgE) attaches to the mast cell, releasing histamines, causing allergic reactions.