Immune system

The parts of the body that guard against pathogens (disease-causing organisms, such as bacteria and viruses)

- Infection = An invasion of the body by a pathogen

- The body's defenses against pathogens also defend against certain cancers

- The immune system distinguishes pathogens from normal body cells by the antigens present on each cell type

  √ Antigens = Molecules (usually proteins, carbohydrates and fats on the surface of a cell) that the immune system interacts with, to determine which cells are the body's own cells and which are not.

  - Self antigens = Antigens that are made naturally as part of the body

    - The immune system does not attack cells displaying only self antigens

  - Foreign antigens = Antigens that are not a natural part of the body (such as antigens of viruses and bacteria)

    - The immune system attacks cells displaying foreign antigens

White blood cells (WBC) (leukocytes)

The blood cells that are part of the immune system

- There are five major types of WBCs, each with its own role in the defending the body

WBC cell type	Function
Neutrophils	Phagocytosis
Eosinophils	Phagocytosis
Basophils	Release histamine
Monocytes √ (become macrophages)	Phagocytosis
Lymphocytes √ (There are two types: B cells and T cells)	Roles in specific immune system

Figs 3.34, 18.5, 18.10, 18.11, 18.13, 21.5, and 21.14; Table 21.3

Phagocytosis

One cell engulfing (eating) another cell

- Neutrophils and monocytes (macrophages) are the two most active phagocytes

Fig 18.10 (part 3)

The "battlefields" where the body defenses fight most pathogens are usually the blood and the lymphatic system

Lymphatic system

A network of vessels, ducts, and nodes throughout the body that (a) return lymph (excess tissue fluid) back to the circulatory system, and (b) filter the lymph to cleanse it of pathogens

• Lymphatic vessels/ducts = The tubes that drain lymph from tissues

• Lymph nodes = Hollow structures located at the points where lymphatic vessels converge

√ The lymph is filtered at the lymph nodes

√ Many WBCs are stationed at the lymph nodes to destroy pathogens in the lymph

• All lymph vessels eventually converge into two large ducts that return the lymph to the blood in the subclavean veins of the thorax

Figs 21.2 and 21.4

The body has two defensive systems:

- The innate immune system (the non-specific immune system)
- The adaptive immune system (the specific immune system)

Fig 21.12

The innate immune system (the non-specific immune system)

The defense system that makes the body less accessible and less hospitable to all pathogens. The innate immune system's parts do **not** specialize in fighting specific pathogen types. Instead, the innate immune system defends against pathogens in general.

- Skin = Physically blocks pathogens from entering the body

- Phagocytes = WBCs that engulf pathogens
  - √ The three phagocytic WBCs: Neutrophils, Eosinophils, and Monocytes/Macrophages

- Inflammation = The redness, swelling, and pain in injured tissues
  - √ The redness and swelling are caused by basophil WBCs releasing histamine, a molecule that dilates the capillaries (so that more nutrients reach the injured site) and that makes the capillaries leaky (so WBCs can exit the blood vessel to attack pathogens in the injured tissue)

- Complement = Blood proteins that lyse (tear open) pathogen cells

Figs 18.10, 21.12, and 21.14; Tables 21.2 and 21.3

The adaptive immune system (the specific immune system)

The defense system consisting of the lymphocyte WBCs. Each individual lymphocyte cell specializes in attacking one (and only one) specific pathogen type.

• There are two lymphocyte types: B cells and T cells

• B cells attack pathogens by making antibodies (Y-shaped proteins that bind to the pathogen's antigens)

√ B cells release antibodies which then circulate in the lymph and the blood

√ All the B cells and their antibodies are together called the "humoral immune system"

• T cells attack pathogens by injecting the pathogen cells with toxins

√ All the T cells together are called the "cell mediated immune system"

• The adaptive immune system has "memory": It attacks a pathogen more quickly and more effectively if it has encountered that specific pathogen before

√ This is why person is "immune" to a disease if they have previously been exposed to it

√ This is also the basis for vaccinations against diseases. The vaccination is a weak or non-living version of the pathogen.

Figs 21.21, 21.23, and 21.24; Table 21.1

The humoral immune system (B cells and their antibodies)

- Each B cell makes and coats its surface with antibodies that can bind to the foreign antigens of one specific pathogen
  - √ B cells differ from each other in regards to which pathogen type their antibodies bind to. There are thousands of different B cells types, each specializing in fighting a different pathogen from all the other B cells. Therefore, no matter which pathogen infects the body, there will be B cells with antibodies that can bind to that pathogen's antigens.

- When a B cell encounters the pathogen whose foreign antigens fit into the B cell's antibodies, that B cell divides repeatedly
  - √ This produces millions of identical clones of the original B cell. All the clones have antibodies against the foreign antigens of the same pathogen

- In about two weeks, the cloning is completed. The B cells release their antibodies, which circulate in the blood and the lymph to attack the pathogen

- The circulating antibodies bind to the foreign antigens on the pathogen cells
  - √ The antibodies agluttinate (link together) the pathogen cells, which helps the body eliminate them by reducing their mobility

  - √ Complement proteins lyse (tear open) the antibody-coated pathogen cells

- Memory B cells = B cell clones that retain their antibodies
  - √ Memory cells remain ready to divide in future encounters with the pathogen

  - √ Memory B cells provide a rapid and strong defense if the same pathogen is encountered again. The person is "immune" to that pathogen

Figs 21.13, 21.21, 21.23, and 21.24; Table 21.1

The cell mediated immune system (T cells)

- When a macrophage engulfs and digests a pathogen, the pathogen's foreign antigens become displayed on the surface of the macrophage

- Each T cell is programmed to attack one (and only one) foreign pathogen

  √ T cells differ from each other in regards to which pathogen they attack. There are thousands of different T cells types, each specializing in fighting a different pathogen from all the other T cells. Therefore, no matter which pathogen infects the body, there will be T cells that can attack it

- A T cell becomes activated only when it encounters a macrophage displaying the specific foreign antigen for that T cell

- When a T cell becomes activated, the T cell divides repeatedly
  √ In about a week, the cloning is completed. This produces millions of identical clones of the original T cell. All the clones are programmed to attack the same pathogen

- T cells come in three types:
  √ Cytotoxic T cells = They attack the pathogen directly by injecting it with toxic substances

  √ Memory T cells = They remain ready to divide in future encounters with the pathogen

Figs 21.17, 21.19, 20.20, and 21.25; Table 21.5