Lecture 8: The Immune System

Important Concepts

- what is *innate* and adaptive *immunity*?
- what are the types of immune system cells?
- what are *antibodies* and *antigens*?
- how do antibodies work?
- what are *allergies* and *autoimmune diseases*?

The Immune System

Innate Immunity

- *non-specific* defence against foreign objects (eg viruses, bacteria)
- occurs rapidly upon infection (minutes/hours)
- chemicals (*cytokines*) released by immune cells into blood cause inflammation at site of infection
- cells include *white blood cells* (WBC) produced in bone marrow (eg *macrophages* and *neutrophils*)
- WBC digest and clean up invading cells
- *Mast cells* produce *histamines* that increase blood flow to area (redness at infection site)

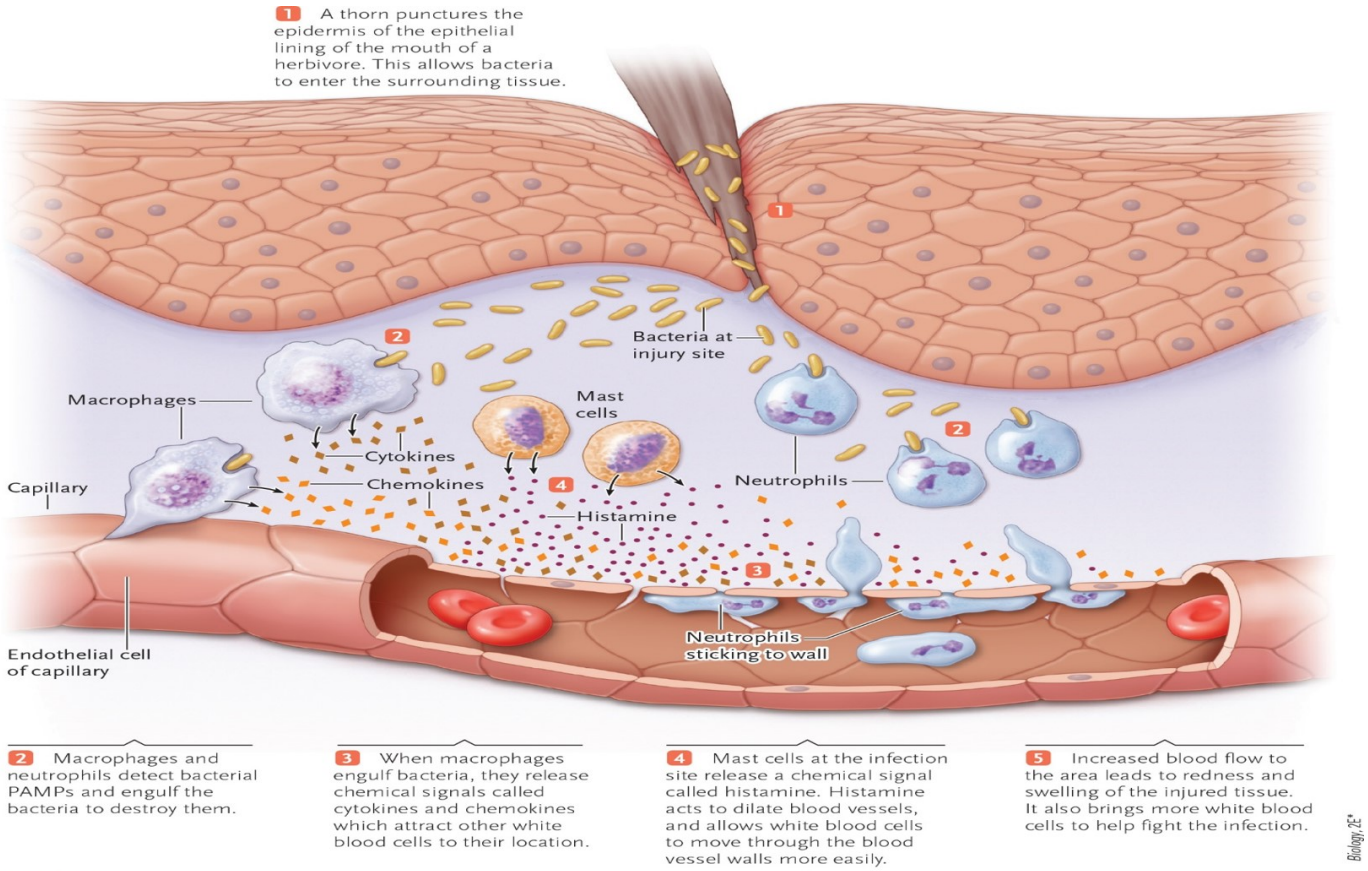
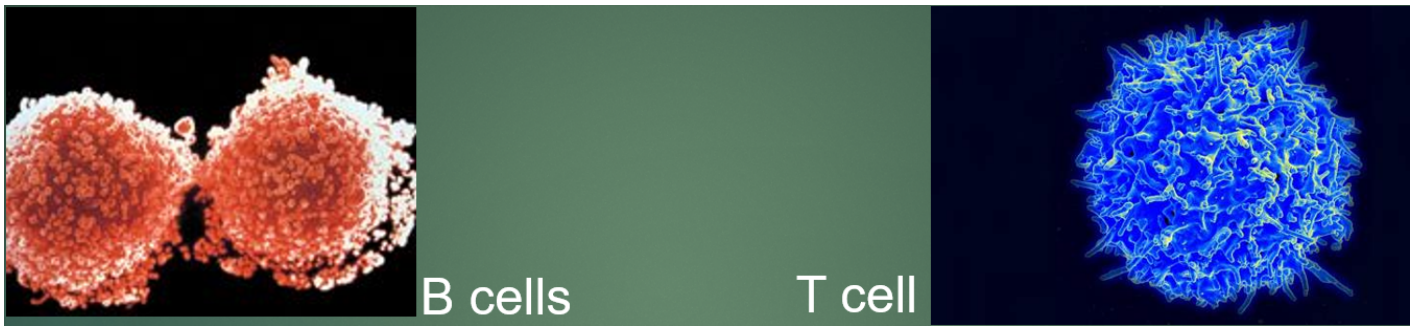


FIGURE 27.10 Thorns on plants can cause physical damage to herbivores, and as mentioned in Section 27.1, the presence of bacteria on the thorns can lead to an infection in the mouth of the herbivore. When the outer defensive layer of a vertebrate is compromised, bacteria can enter and begin to reproduce. The damaged skin and presence of bacteria trigger the inflammation response, which recruits cells of the immune system through programmed cellular signalling. In this way, the innate immune response is turned on as it is needed.

Adaptive Immunity

- specific and long lasting defense against pathogens
- requires recognition of the pathogen and production of *antibodies*
- all pathogens have proteins (*antigens*) on their surface that are recognized by the antibody (lock and key binding)
- once an antibody is produced against an antigen, it forms a "memory" so that the same antigen is always recognized

Main principle behind vaccines: inject an antigen (eg smallpox virus epitope) and body becomes immune to smallopx infection - sometimes need "booster"

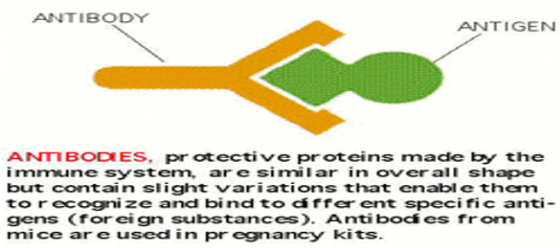


Cells include:

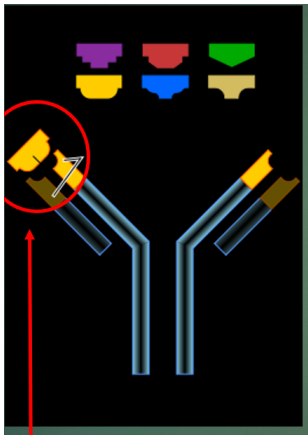
- **B cells**: produce *antibodies*
- **T cells**: search for pathogens and assist in killing forein cells/viruses (several types of T cells)
  - **Helper T cells**: can bind to viruses uses T cell receptors and produce cytokines which can kill virus
  - HIV infects helper T cells leading to immune system impairment

Antibodies

- all antibodies are produced by B cells in reponse to infection
- antibodies are proteins that bind to specific proteins on surfaces of viruses/bacteria/cells called antigens
- one antibody binds to and recognizes one antigen
- once antibody/antigen is bound together, the cell or virus that is bound is destroyed



ANTIBODIES, protective proteins made by the immune system, are similar in overall shape but contain slight variations that enable them to recognize and bind to different specific antigens (foreign substances). Antibodies from mice are used in pregnancy kits.



Antigens (e.g. cells, viruses, toxins)

Antibody (only one antigen binds to one antibody)

Antigen (key) binds to Antibody (lock)

How many different antibodies can the body make? >1 trillion!

5 Types of Antibodies (immunoglobulins-lg) are made:

- **lgG**: most common antibody
- **lgE**: produced in allergic reactions, binds to parasitic worms
- **lgA**: found in gut and lungs - prevents bacterial colonization (also in breast milk)
- **lgM**: produced by cells prior to lgG
- **lgD**: least expressed

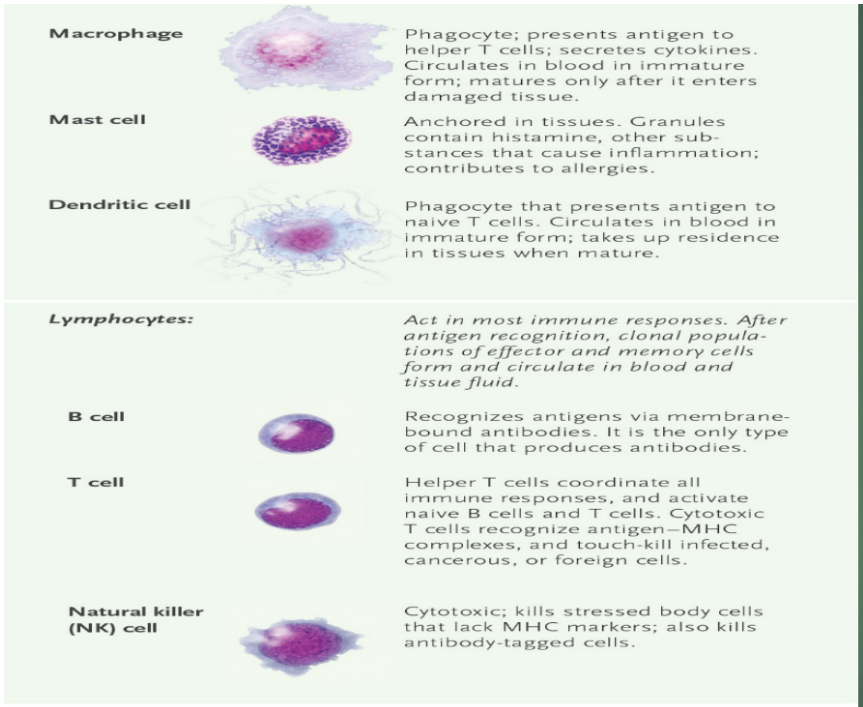


FIGURE 27.11 The white blood cells (leukocytes) of the immune system. Each cell type plays an important role in defending the body from pathogens, parasites, and environmental toxins.

Innate immunity

Innate and Adaptive immunity

Antibodies Used in Testing Kits

- pregant women produce *hCG hormone* in urine which is detected by *anti-hCG* antibody
- bacterial/viral testing using antibodies against specific bactera/viruses

Immune System Malfunction

- **Allergies**: results from overactive immune system
- **Allergens**: are antigens that activate immune system but are not dangerous to individual (e.g. pollen, foods, penicilin, bee stings)
  - cause antibodies to attach to mast cells (release histamines) and cause inflammation of airways/lungs
  - patients take anti-histamines to reduce inflammation
- **Autoimmune diseases**:
  - your immune system recognizes your cells (self) from invading cells (non-self)
  - sometimes immune system attacks "self" which causes destruction of own cells/tissue (autoimmune disorders)
  - e.g. type 1 diabetes, crohn's/colitis, lupus, rheumatoid arthritis, multiple sclerosis, psoriasis
- **Treatments**:
  - steroids: reduce inflammation (cannot be used long term)
  - biologics: *recombinant DNA anditbodies* against inflammatory/immune molecules (given as infusion)