

The Immune System

“For [my words] are life to those who find them, And health to all their flesh.” Proverbs 4:22

- most important part: white blood cells (leukocytes); specially programmed to search out and destroy unrecognizable organism or substance
- assisted by lymphatic system: complex network of fluid-filled vessels and chambers that help transport leukocytes throughout body
- also assisted by
 - skin - barrier against bacteria
 - respiratory passages - cilia trap airborne bacteria
 - brain - adjusts hormone levels, fever, signaling the body to rest

Antibodies

- antibodies: Y-shaped protein molecules; arms tipped with special receptors designed to bond tightly to a particular surface molecule of the pathogen
 - 1) inactivate pathogens until destruction
 - 2) marking pathogens for destruction by other defense mechanisms such as wbc
- antibodies especially effective against bacteria which live and reproduce outside of body cells, making them easily reached by antibodies; less effective against viruses already inside a cell

White blood cells

- immune system unique bc key components are individual cells - leukocytes
- several types of wbc designed to carry out specific function:
 - some engulf/dispose of bacteria, viruses, debris by acid secretion, H_2O_2 , free radicals, NO_3 , enzymes, other poisons
 - others warn body, kill infected cells
- new wbc produced in bone marrow
- wbc communicate over short distances by docking and exchanging info through receptor proteins on cell surface
- over longer distances wbc use chemical signals called cytokines
- histamine: neurotransmitter that causes blood vessels to dilate and become more permeable, allowing blood fluids to enter surrounding tissues causing inflammation
- interferon: produced by infected cells; chemical messenger which limits the spread of virus by telling nearby uninfected cells to produce antiviral compounds to protect themselves

Types of white blood cells

- phagocytes - cells that protect the body by ingesting (phagocytosing) harmful foreign particles, bacteria, and dead or dying cells
- lymphocytes - act to recognize antigens, produce antibodies, and destroy cells that could cause damage

- B cells - produce antibodies to target specific invaders
- T cells - originate in bone marrow and mature in thymus gland
 - helper T cells: recognize antigen or pathogen and activate B cells
 - killer T cells: work independently and destroy antigens or pathogens

→ T and B cells work together to determine the response that the immune system will take against foreign antigens in the body

- immunity: many activated wbc and antibodies remain in circulation to guard against particular pathogen for the rest of life; may take 3-5 days for immunity to develop

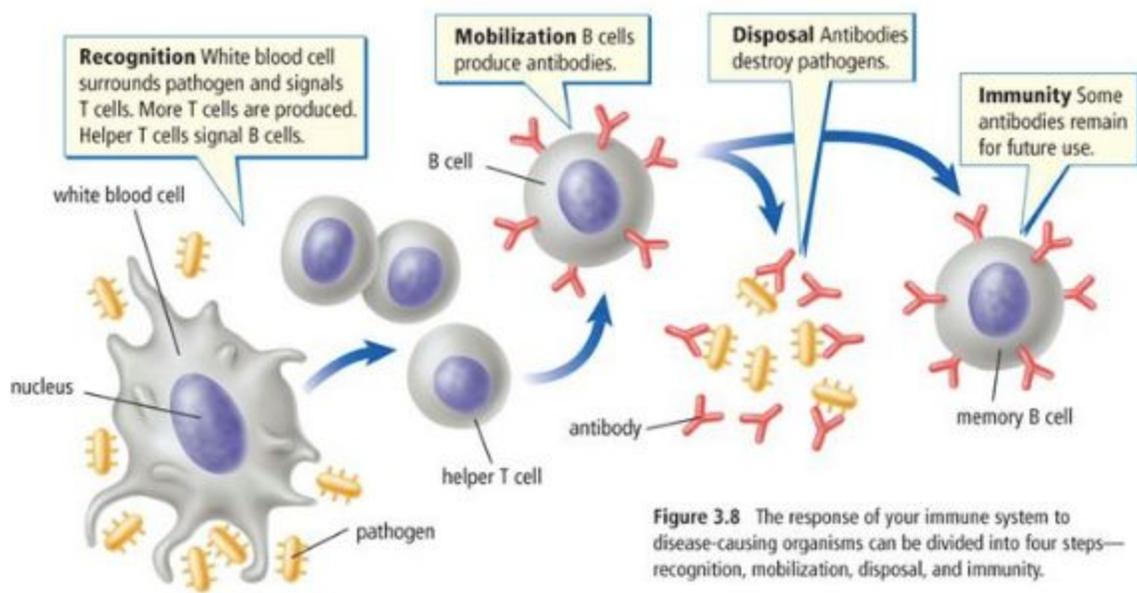
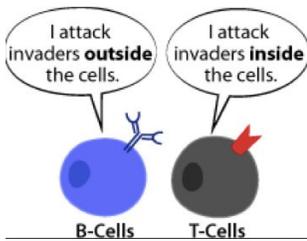
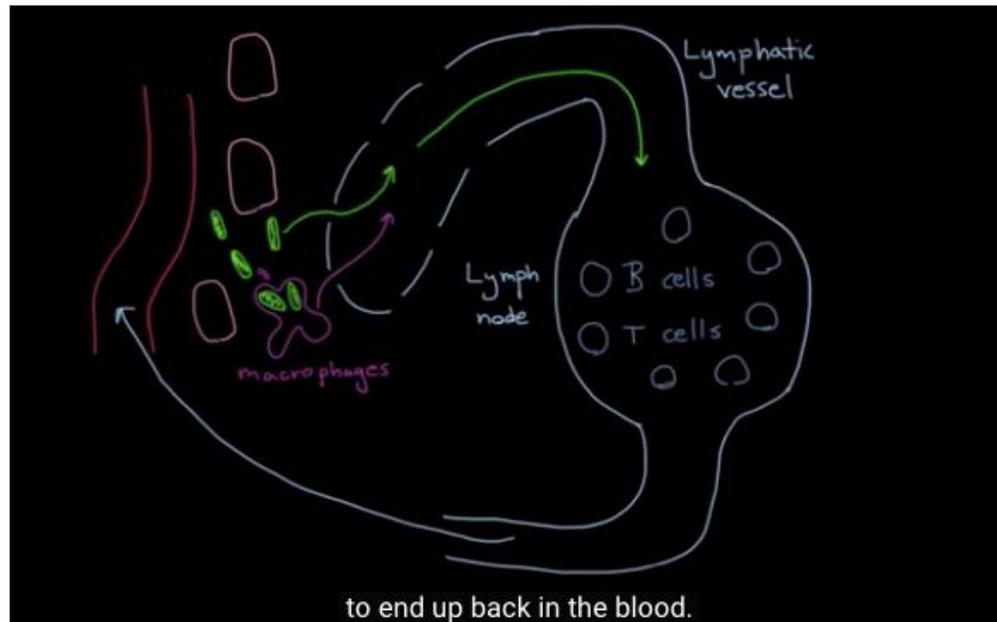
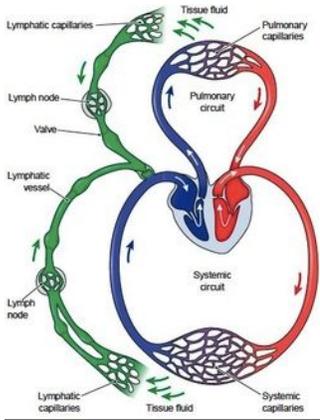


Figure 3.8 The response of your immune system to disease-causing organisms can be divided into four steps—recognition, mobilization, disposal, and immunity.

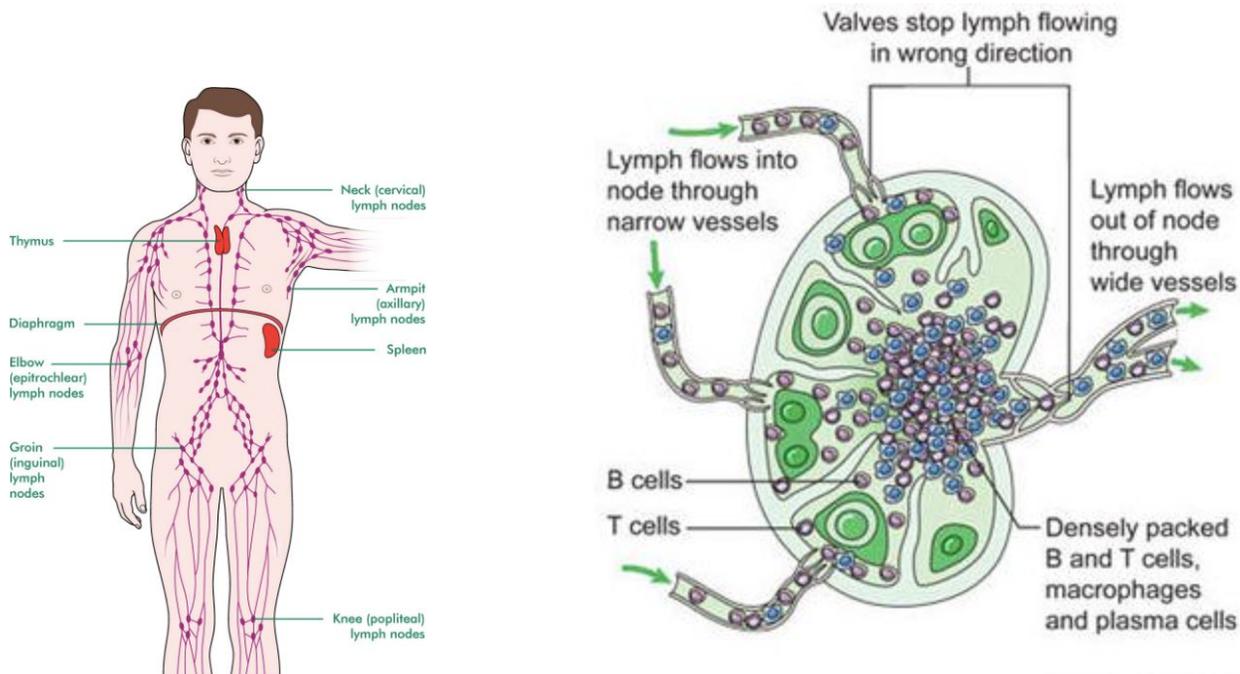
Lymphatic system



- purpose: collect fluid that is squeezed out of blood vessels and bring it back into the blood
- tissue fluid: originates in blood plasma; provides cells with environment that helps maintain proper balance of water and electrolytes
- lymphatic system works as drainage and sanitation system for tissue fluid
- tiny lymph capillaries in tissue collect excess fluid with debris and carry it through system of lymph vessels; one-way transportation system and does not circulate like blood; lymph vessels drain lymph into blood
- movement of skeletal muscle is major force that moves lymph; vessels designed with valves to prevent backward movement of fluid
- lymph vessels --> lymph duct --> subclavian vein --> vena cava --> R atrium

Lymph nodes

- lymph nodes: special enlargements of lymphatic tissue located all along lymph vessel network but especially numerous in armpit, groin, neck; wbc in nodes monitor tissue fluid



- compartments near rim used by resting B cells: produce target-specific antibodies
- compartments farther from rim used by resting T cells: activate B cells
- center of lymph node where macrophages (clean up cellular debris and also bring pathogen-destructive substances)
- core allows wbc to enter or exit bloodstream
- lymph nodes serve as staging areas for wbc; when macrophage or dendritic cell picks up pathogen --> nearest lymph node where fragments presented to B or T cells passing through; any cells that recognize fragment become activated and enter lymph node compartments where they reproduce; army of activated cells exit node
- pathogens can enter lymph node directly and battle wbc, causing node inflammation
- tonsils, adenoids - accumulation of lymph nodes in throat to protect that port of entry; exaggerated lymph nodes of baby give extra protection as baby's immunity develops; risk of tonsillitis
- spleen: located beneath diaphragm behind stomach; stationary macrophages clean blood of dead cells and microbes
- thymus: located between lungs above heart; location where immature T cells mature after production in bone marrow

Special defenses

- skin - bacteria and viruses cannot penetrate unbroken skin; harmless bacteria on skin surface hinders growth of harmful bacteria
- mucous membrane - nose and mouth have sticky coating lined with cilia that sweep pathogens to be expelled by cough or sneeze; most pathogens reaching stomach killed by HCl

- lysozymes: found in tears and perspiration; kill bacteria by destroying cell walls; tears wash pathogens from eyes into tear ducts which carry germs to nasal passages for disposal
- intestinal bacteria inhibit growth of most pathogens and crowd out harmful bacteria
- fever: speeds up body's cellular activities; hinders growth of some pathogens that reproduce more slowly at higher temps (not to reach above 103°F for more than a few hours); prolonged high fever can inactivate enzymes essential to normal brain function

Immunity

- circulating memory cells and antibodies
- acquired immunity - result of circulating antibodies or memory cells in bloodstream; acquired by infection, immunization, or serums (blood extracts that contain antibodies)
- can be active or passive [vaccine preventable diseases]
- inborn/innate - antibodies from mother's bloodstream (blood of mother and baby in utero do not mix)
- species immunity - only affect certain species (hoof-mouth disease, mad cow)
- immune deficiencies caused by chemical exposure, genetic defects
- immune therapy: vaccines, serums
- chemotherapy: chemical compounds used to treat disease
- antibiotic therapy: substances produced by bacteria, molds, other organisms effective in stopping bacterial growth (penicillin discovered by Alexander Fleming in 1928); antibiotics useless against viruses bc viruses manufactured by host's own cells
- prevention: nutrition, rest, exercise