Capillary exchange

Fluid movement in capillaries

Not all fluid is reclaimed at the venous end of the capillaries; that is the job of the lymphatic system.

Lymphatic system/body defenses

A reminder

The excess fluid that accumulates is **lymph**, and it must be reclaimed by the circulatory system.

Lymphatic vessels

**Lymphatic capillaries** permeate our tissues
Amazingly permeable
Contain **minivalves** that allow for only one-way flow
All lymph flows toward heart
Major collecting ducts (dump into subclavian veins):
- right lymphatic duct
- thoracic duct

Lymphatic capillaries

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Lymph nodes

Lymph is filtered through **lymph nodes** on its way back to the heart
Found in large clusters in **inguinal, axillary, and cervical regions** of the body
**Macrophages** are found in lymph nodes
Helps produce **lymphocytes** (a type of white blood cell) that also function in the immune response
Nonspecific body defenses

- Mechanical barriers that cover body surfaces/chemicals that initially act to protect the body from invading pathogens

**Surface membrane barriers**

- Acid pH of skin secretions inhibits bacterial growth
- Stomach secretes HCl and proteinases
- Saliva and lacrimal fluid contain lysozyme

**Mucus** traps bacteria that would enter respiratory tract

Nonspecific body defenses

**Cells and chemicals**

- **Phagocytes** (macrophages and neutrophils) engulf foreign particles

- **Natural killer cells** can recognize foreign pathogens, and inject a lytic enzyme into the cell, causing it to disintegrate

**Phagocytosis**
Nonspecific body defenses

**Fever**
White blood cells secrete pyrogens, which act on the hypothalamus to raise body temperature; causes liver to “take away” chemicals bacteria need and it increases metabolic rate, which speeds healing.

**Complement**: at least 20 plasma proteins that are inactivated until attached to foreign cells; can cause foreign cells to burst (membrane attack complexes), can release chemotactic chemicals for WBCs, or can assist macrophages.

**Interferon**: secreted by virus-infected cells to help protect neighboring cells from infection (“interferes” with viral infection).

Immune response

**Very specific body defenses**

**Antigen specific**

**Systemic**

Has memory--is able to prime itself for later attacks by the same antigen.

**Humoral immunity**: provided by antibodies circulating in body fluids

**Cellular immunity**: lymphocytes themselves defend the body against antigens.

What is an antigen?
Any substance capable of exciting a response from our immune system (what we recognize as “nonself”).

Pollen grains, bacteria illicit an immune response because they have foreign proteins.

Our cells often contain self-antigens, which our body recognizes, but other bodies may not.

**Haptens** = incomplete antigens
Small molecules are not antigenic, but can link with our own proteins.
Allergies result.

Lymphocytes
All blood cells originate from stem cells in the bone marrow.

**T cells** become immunocompetent in the thymus.

**B cells** become immunocompetent in the bone marrow.

Once immunocompetent, a lymphocyte can bind with only one antigen--our genes determine what lymphocytes we make.

Macrophages
Acts non-specifically to engulf pathogens.
Acts specifically by presenting antigens to T cells.

T cells then release chemicals that convert the macrophages to killer macrophages.
Localized to lymphoid organs.
(T cells mature in lymph tissue, but can go all over the body.)
Humoral immunity = antibody-mediated immunity

Antibodies = immunoglobulins
Capable of binding with a specific antigen
Inactivates antigens in a number of ways

Antibody structure

Humoral immunity = antibody-mediated immunity

Primary and secondary humoral responses

Active humoral immunity
Can be naturally acquired
Can be artificially acquired via vaccines
Vaccines "prime" the immune system (like jumping ahead to the secondary response)
We are spared the discomfort of the disease itself
Sometimes booster shots are necessary to re-intensify the immune system

Passive humoral immunity
Antibodies are obtained from another human or animal
"Borrowed" antibodies naturally degrade in the body with time
Conferred naturally mother–fetal exchange
Conferred artificially when one receives injections
Gamma globulin (hepatitis exposure)
Snake bites
Tetanus

Cell-mediated immunity
Immature T cells must be presented antigens by macrophages in order to bind them
Cytotoxic (killer) T cells specialize in killing virus-infected, cancer or foreign graft cells by injecting perforins under their cell membrane
Helper T cells recruit B cells and cytotoxic T cells by releasing lymphokines
Suppressor T cells suppress T and B cells, winding down the immune response
Immunodeficiencies

*Severe combined immunodeficiency disease:* a severe lack of B and T cells; sometimes bone marrow or umbilical cord stem cell transplants can help; victims must live in a bubble; congenital

*Acquired immune deficiency syndrome:* interferes with the activity of helper T cells

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Autoimmune diseases

The immune system loses its ability to recognize *self-antigens*

~5% of adults in North America suffer from an autoimmune disease

Several very common: multiple sclerosis, type I diabetes, rheumatoid arthritis, among others