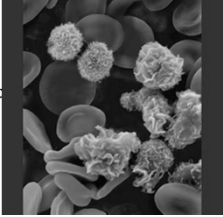


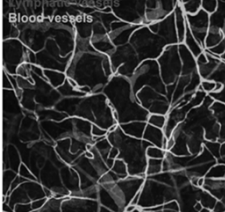
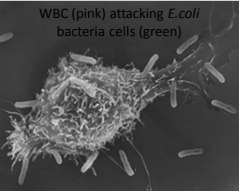
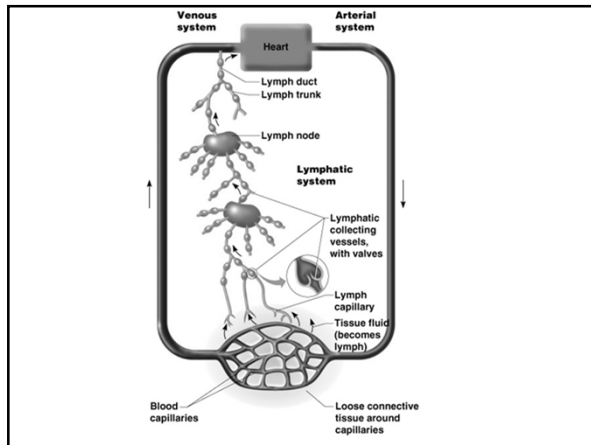
The Lymphatic System

Cardiovascular+ Immune = Lymphatic



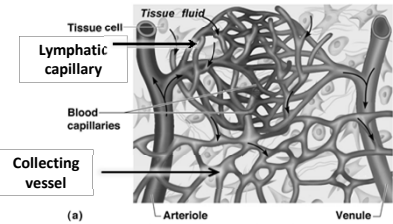
Functions of the Lymphatic System

- Returns leaked plasma to the blood stream
- Disposes of foreign matter or cancerous cells in the body
- Stores white blood cells for immunity

Structures of the Lymphatic System

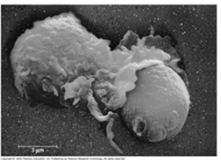
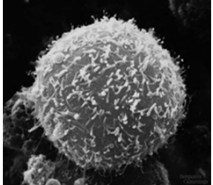
1. **Lymphatic Vessels** [more related to CV system]
 - **lymphatic capillaries** – absorb leaked plasma fluid from blood vessels (**lymph**)
 - **collecting vessels** – transports lymph toward heart



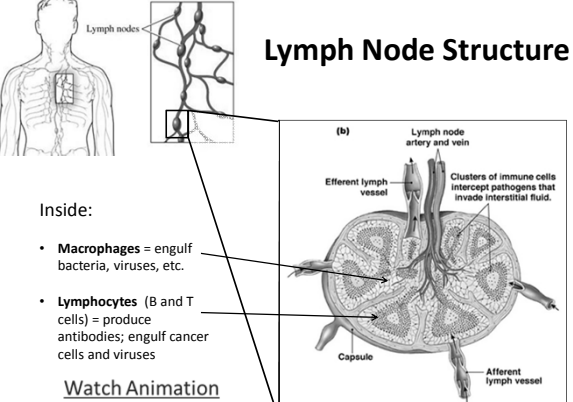
Lymph Nodes

– **Function:**

- **Filtration of lymph** (protect body) by **removing** foreign material (**bacteria**) before returning it to the blood
- Produce **lymphocytes** (**immunity**)
 - **Macrophages** – engulf and destroy foreign substances
 - **Lymphocytes** – provide immune response to antigens

Lymph Node Structure



Inside:

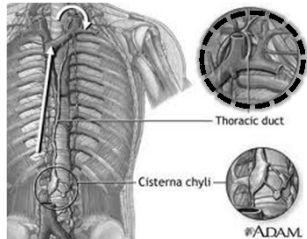
- **Macrophages** = engulf bacteria, viruses, etc.
- **Lymphocytes** (B and T cells) = produce antibodies; engulf cancer cells and viruses

[Watch Animation](#)

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Lymphatic Vessels (cont'd)

- **lymphatic ducts** – drain lymph from collecting vessels into subclavian veins (site where leaked plasma is returned to blood stream)



Structures of the Lymphatic System

2. Lymph Nodes [more related to immune system]

Mass of tissue that produce lymphocytes (WBCs) which “digest” foreign material (bacteria) and tumor cells

Act as filtering stations along lymphatic vessels as lymph is transported toward heart

Where are the largest clusters of lymph nodes found in the body?

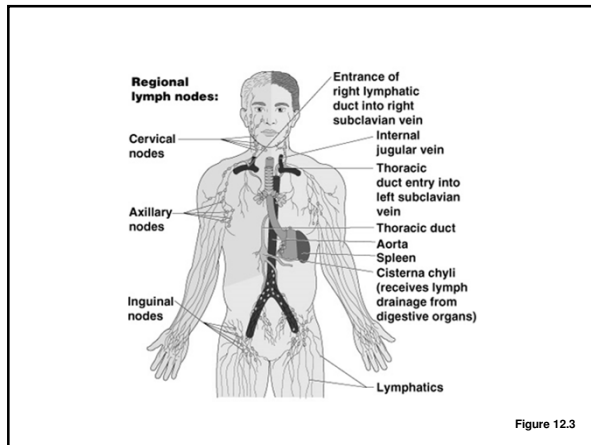
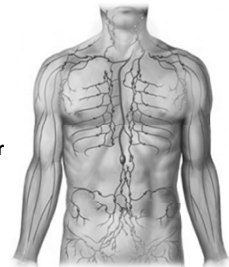
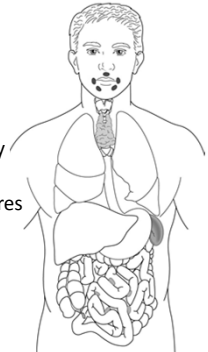


Figure 12.3

Structures of the Lymphatic System

Other Lymphoid Organs:

3. **Tonsils** – trap/destroy pathogens in throat
4. **Thymus** – produces hormones that “program” lymphocytes to destroy
5. **Spleen** – filters blood of pathogens and worn-out RBCs; produces/stores lymphocytes in adults
6. **Peyer’s patches** – trap/destroy pathogens in intestine



QUICK REVIEW

- What are the major structures that make up the lymphatic system?
Lymph, lymphatic vessels, lymph nodes, spleen, tonsils, thymus, Peyer’s patches
- What is **lymph** (where does it come from)?
Excess fluid that leaks out of blood vessels (mainly plasma)
- How is the lymphatic system functionally related to the cardiovascular and immune systems?
Cardiovascular = transports materials
Immune = fights “foreign bodies”

The Immune System

Innate (Non-specific) I.S.

involves:

1st line of defense:

Skin & Mucous Membranes

2nd line of defense:

Inflammatory Response & Fever

Adaptive (Specific) I.S.


involves:

3rd line of defense:

Lymphocytes, Macrophages & Antibodies

The Innate Immune System

- Responds immediately to protect the body of ANY foreign substance
- Involves:
 - **Skin** (1st line of defense)
 - Includes sweat, oil & keratin
 - **Mucous Membranes** (2nd line of defense)
 - Includes mucus linings, nasal hairs, respiratory cilia, gastric acid, tears & saliva



Inflammatory Response (Second Line of Defense)

- Triggered when body tissues are injured
- **Produces four cardinal signs**
 - Redness
 - Heat
 - Swelling
 - Pain
- Results in a chain of events leading to protection and healing

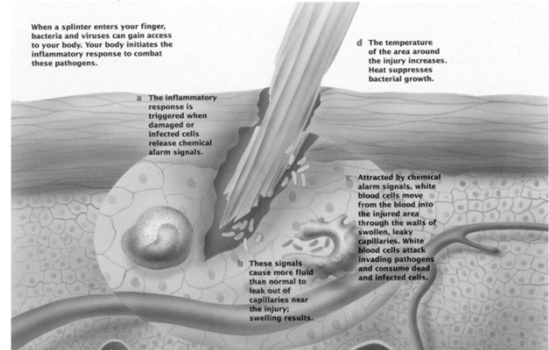
The Innate Immune System

– Inflammatory Response

- Injured cells release inflammatory chemicals (**histamine**) that:
 - (1) Dilate blood vessels, which leak lymph (causes redness, heat & swelling)
 - (2) Activate pain receptors
 - (3) Attract WBCs
- Goals:
 - (1) Prevent more damage
 - (2) Dispose of debris & pathogens
 - (3) Begin tissue repair

The Innate Immune System

– Inflammatory Response



When a splinter enters your finger, bacteria and viruses can gain access to your body. Your body initiates the inflammatory response to combat these pathogens.

a The inflammatory response is triggered when damaged or infected cells release chemical alarm signals.


b These signals cause more fluid than normal to leak out of capillaries near the injury. Swelling results.

c Attracted by chemical alarm signals, white blood cells move from the blood into the injured area through the walls of swollen, leaky capillaries. White blood cells attack invading pathogens and consume dead and infected cells.

d The temperature of the area around the injury increases. Heat suppresses bacterial growth.

The Innate Immune System

– Fever



Why?:

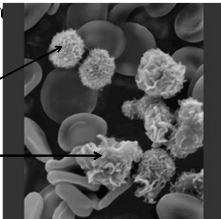
- Heat prevents bacteria from multiplying
- Speeds repair process

How?:

- When WBC's detect pathogens, they release chemicals that "tells" the brain to increase body temperature

The Adaptive Immune System

- Recognizes foreign "bodies" and acts to destroy them
- "Third line of defense"
- **Vaccines** help enable adaptive immune response
- Involves:
 - **Lymphocytes (WBCs)**
 - **Macrophages ("big eaters")**
 - **Antibodies (proteins)**



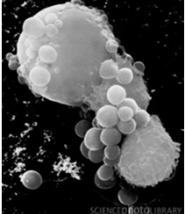
The Adaptive Immune System

- Defined by 3 landmark characteristics:
 - It is **antigen specific** → targets specific substances
 - It is **systemic** → not restricted to specific part of body
 - It has a **"memory"** → bigger attack after 1st infection

Lymphocytes

- Formed from stem cells in bone marrow (just like RBCs)
- Migrate to either lymph nodes or spleen
- Tend to circulate the body through blood stream
- 2 Types of lymphocytes:
 - B lymphocytes [B cells]**
 - T lymphocytes [T cells]**

T cells attacking cancer cells →



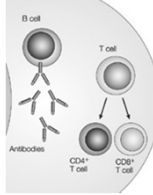
Lymphocytes

B lymphocytes

- "programmed" in the **bone marrow**
- Fighting method: Produce **antibodies** that target specific antigens on foreign materials



T lymphocytes

- "programmed" in the **thymus**
- Fighting method: No antibodies—the actual **cells attack** foreign materials



Macrophages

- Larger than lymphocytes
- Also formed in bone marrow
- Engulf any foreign object (innate)
- Act as antigen presenters for lymphocytes (adaptive)

2 Branches of Adaptive Immunity

Humoral Response

- Uses **ANTIBODIES** to fight

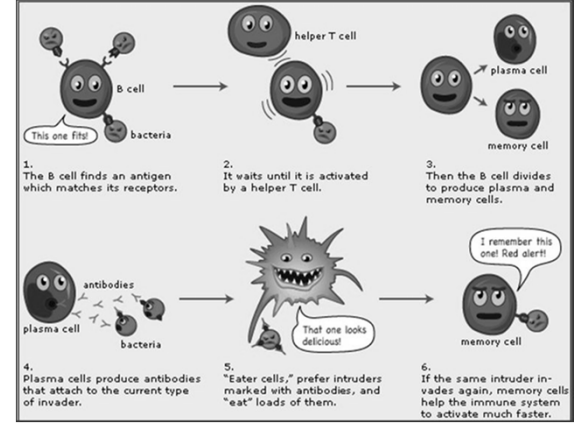
Ex: B lymphocytes are part of the humoral immune response

**** Vaccines** enable our body to activate the humoral immune response & produce the appropriate antibodies against common viruses

Cellular Response

- The **CELLS** themselves fight

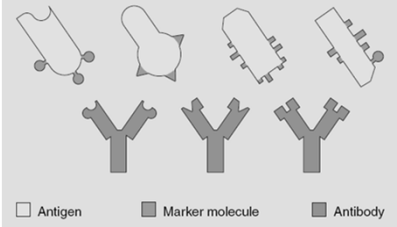
Ex: T lymphocytes and macrophages



Antibodies vs Antigens

- Recall: **Antibodies** are proteins that bind to specific antigens to “disarm” or destroy foreign substances

Which antibodies would bind to which antigens?



Antigen Marker molecule Antibody

Passive Immunity

- Antibodies are obtained from someone else
 - from a mother to her fetus (natural)
 - from immune serum or gamma globulin (artificial)
- No memory cells
- Protection provided by “**borrowed antibodies**”

Immune Disorders

- Autoimmune Diseases – a person’s immune system attacks his/her own tissues
 - **Multiple Sclerosis (MS)** – myelin sheath destroyed
 - **Grave’s disease** – antibodies attack thyroid gland
 - **Lupus** – attacks healthy tissues (usually skin, kidneys) throughout body (causes chronic inflammation)
 - **Rheumatoid arthritis** – attacks joint tissues

Immune Disorders

- Allergies – overactive immune response to harmless materials
 - AKA = hypersensitivity
 - Most common = **allergen** causes cells to release **histamine** (dilate blood vessels, leak fluid = runny & red nose/eyes)
 - **Anaphylactic shock** = when allergen gets into blood stream & circulates through body → air constriction, circulatory collapse → death?

ALLERGIC REACTIONS

Skin Contact	Injection	Ingestion	Inhalation
poison plants	bee sting	medication	pollen
animal scratches		nuts & shellfish	dust
pollen			mold & mildew
latex			animal dander

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Immune Disorders

- Immunodeficiencies – improper function of immune cells/proteins
 - **Severe combined immunodeficiency disease (SCID)** = both B and T cells are deficient → almost no protection against common pathogens
 - **Acquired immune deficiency syndrome (AIDS)** = HIVs destroy helper T cells

Quick Review

- What is the body's **1st line** of defense? **2nd? 3rd?**
- Which immune response is characterized by **swelling, redness, and pain**?
- How does a **fever** protect the body?
- Compare and contrast **B cells** and **T cells**.
- What is the difference between **humoral immunity** and **cellular immunity**?
- What is the difference between an **immunodeficiency** and **autoimmune disease**?