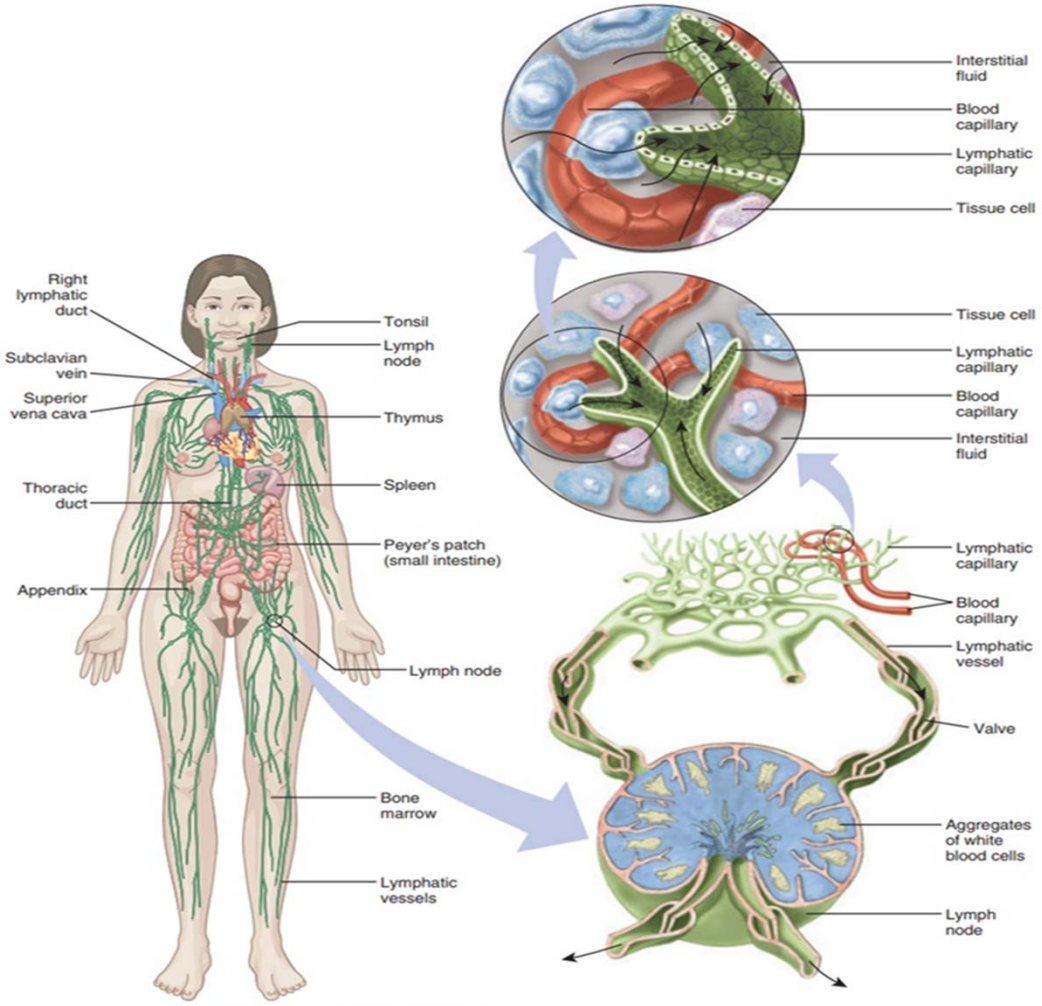


FIGURE 20-2 Lymphatic capillaries.

Assist. Lec.: Safa Jalil AL-Yassiri
Lymphatic system, body fluid and Homeostasis

The Lymphatic System:

Although the lymphatic system may be considered part of the circulatory system, we will consider it separately because its functions are so different from those of the heart and blood vessels.

Functions of the Lymphatic System:

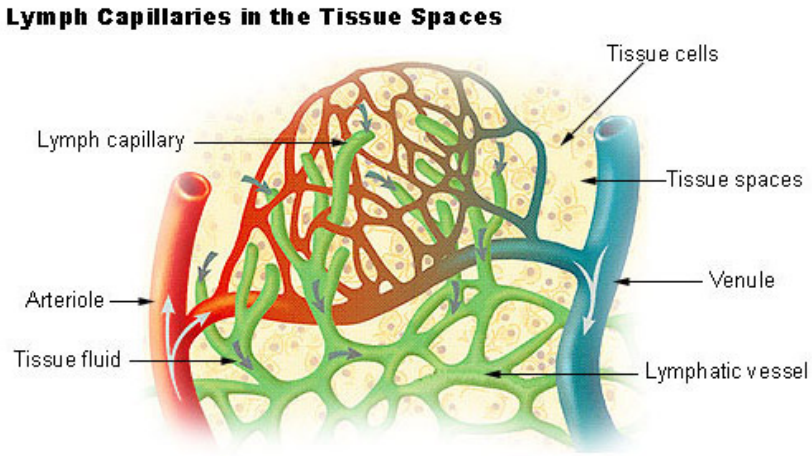
1. A major function of the lymphatic system is to return the fluid and proteins filtered from the capillaries into the interstitial to the circulation. Without this, the plasma volume would be rapidly depleted, and interstitial edema would occur.
2. Removal of bacteria, toxins and other foreign bodies from tissues
3. Maintain structural and functional integrity of tissue.
4. plays an important role in the absorption of fats from the intestine. (Lacteals are specialized lymph capillaries in the villi of the small intestine; they absorb the fat-soluble end products of digestion, such as fatty acids and vitamins A, D, E, and K.
5. Transport lymphocytes.

➢ **The parts of the lymphatic system are**:

- The lymph.
- Lymphatic vessels.
- lymphatic tissue includes lymph nodes and nodules, the spleen, and the thymus gland.

Lymph

Lymph is a fluid similar in composition to blood plasma. It is derived from blood plasma as fluids pass through capillary walls at the arterial end. As the interstitial fluid begins to accumulate, it is picked up and removed by tiny lymphatic vessels and returned to the blood.



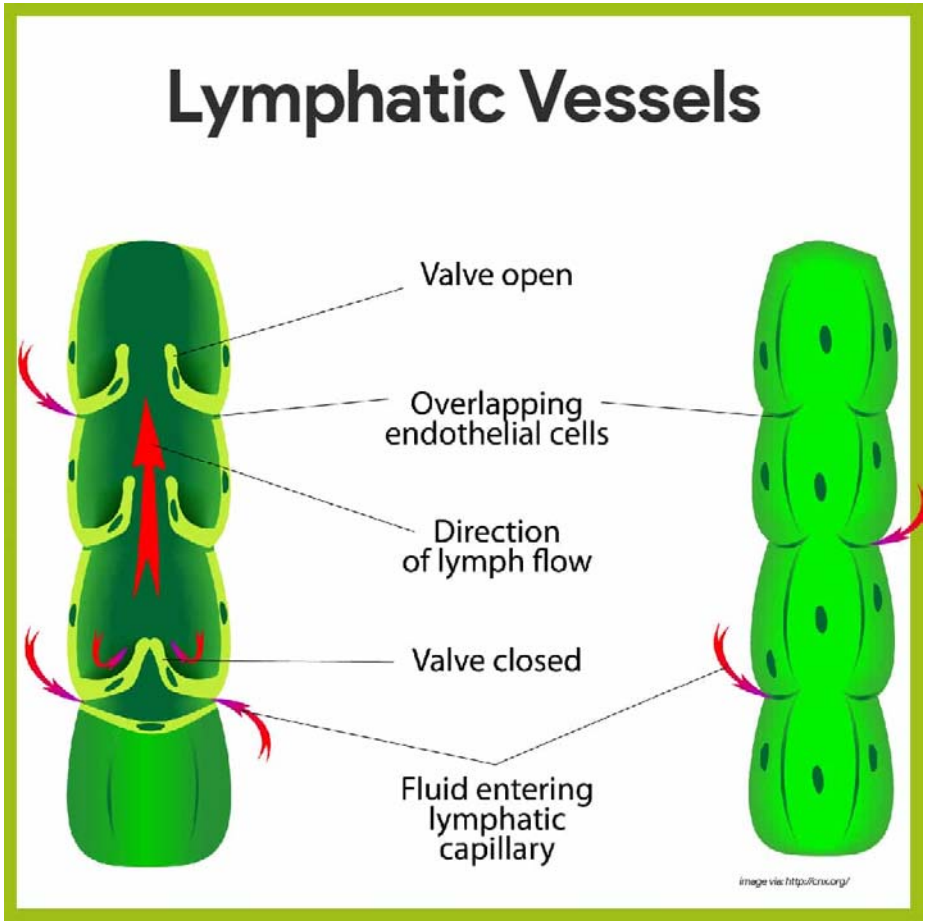
Lymph is the tissue fluid that enters lymph capillaries:

- Similar to plasma, but more WBCs especially lymphocytes (the cells that attack bacteria in the blood and body tissues) and has less protein.

- Must be returned to the blood to maintain blood volume and blood pressure.

Lymphatic Vessels:

- Lymphatic vessels, unlike blood vessels, only carry fluid away from the tissues.
- lymph vessels begins as dead-end lymph capillaries found in most tissue spaces. Lymph capillaries are very permeable and collect tissue fluid and protein.
- Lymph capillaries are found in all regions of the body except the bone marrow, central nervous system, and tissues, such as the epidermis, that lack blood vessels.
- The wall of the lymph capillary is composed of endothelium in which the simple squamous cells overlap to form a simple one-way valve. This arrangement permits fluid to enter the capillary but prevents lymph from leaving the vessel.



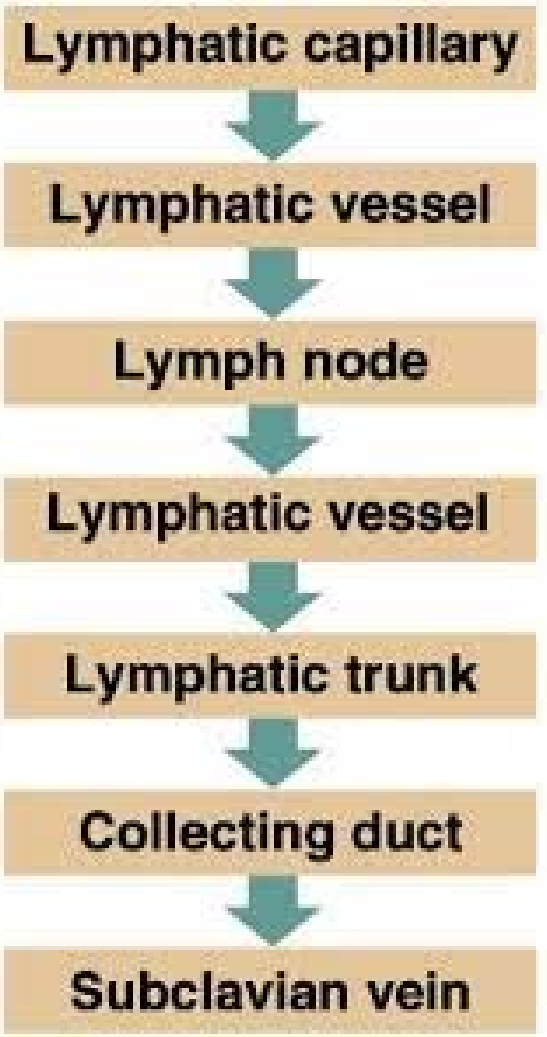
- The microscopic lymph capillaries merge to form lymphatic vessels. Small lymphatic vessels join to form larger tributaries, called lymphatic trunks, which drain large regions.

- Lymphatic trunks merge until the lymph enters the two lymphatic ducts.

1. Right lymphatic duct

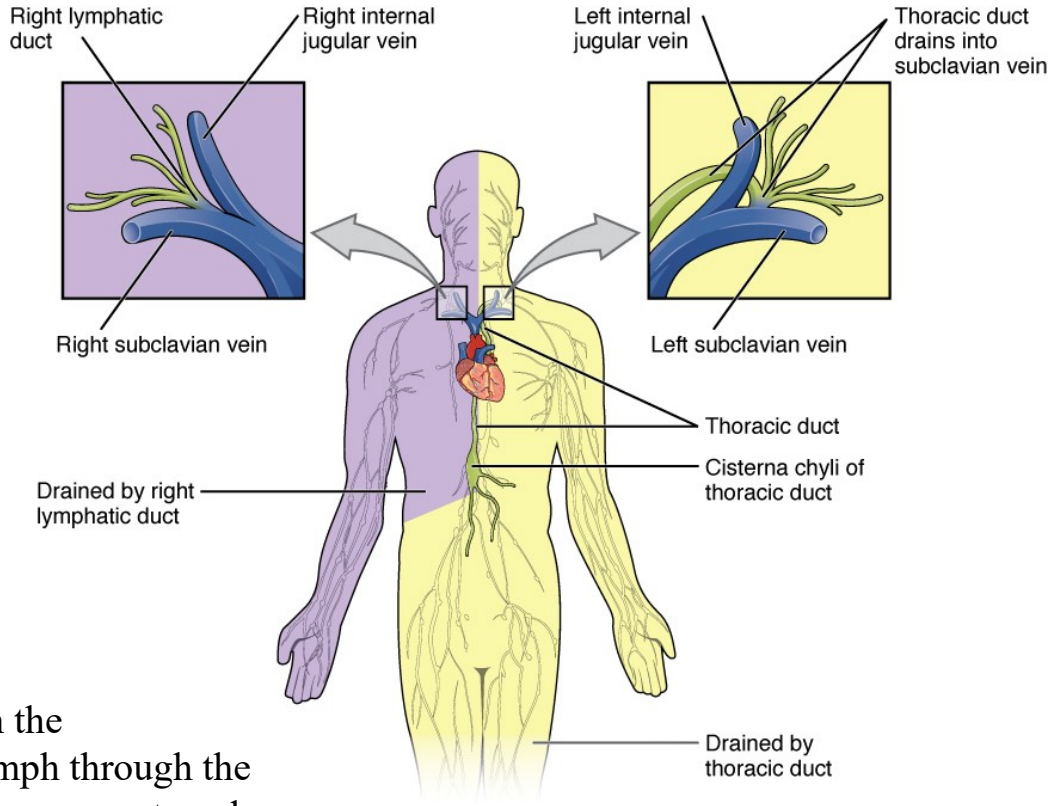
- This is a dilated lymph vessel a bout 1 cm long.
- It lies in the root of the neck and opens into the right subclavian vein.
- It drains lymph from the right half of the thorax , head and neck and the right arm.

- the subclavian vein is a paired large vein, one on either side of the body, and runs under the clavicle and anterior to the artery of the same name.



2. Thoracic Duct

- It is a largest duct and it begins at the cisterna chyli.
- The cisterna chyli is a dilated lymph channel situated in front of the bodies of the first two lumber vertebrae. It extends from abdomen through diaphragm and runs next to the aorta.
- The duct is about 40 cm long and opens into the left subclavian vein in the root of the neck.
- It drains lymph from both legs, the pelvic and abdominal cavities, the left thorax, head and neck, and the left arm



- There is no pump in the lymphatic system like the heart in the cardiovascular system. The pressure gradients to move lymph through the vessels come from the skeletal muscle action, respiratory movement, and contraction of smooth muscle in vessel walls.

Lymphatic tissue: consists mainly of lymphocytes in a mesh-like framework of connective tissue. Most lymphocytes are produced from stem cells in the red bone marrow, then migrate to the lymph nodes and nodules, to the spleen, and to the thymus. In these structures, lymphocytes become activated and proliferate in response to infection (this is a function of all lymphatic tissue).

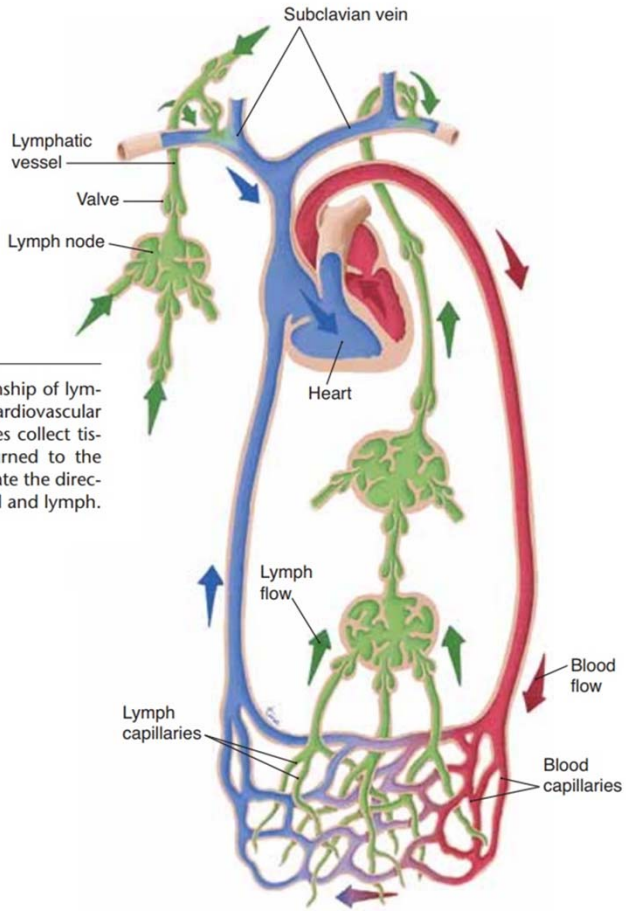


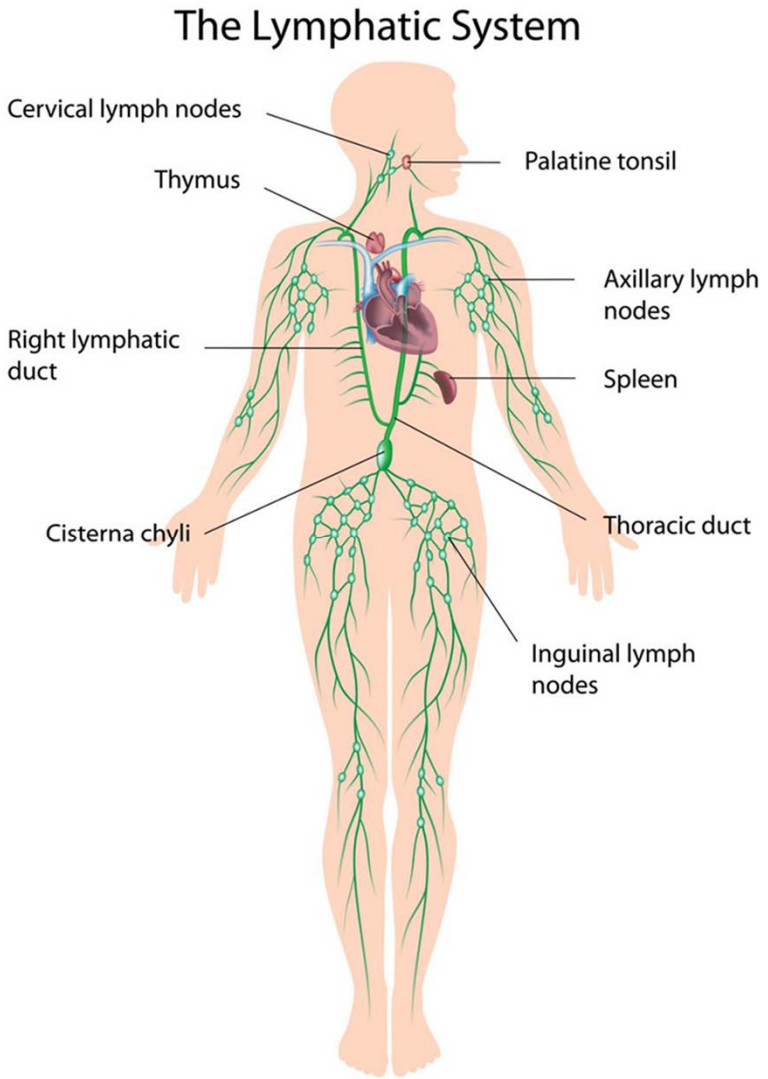
Figure 14–1. Relationship of lymphatic vessels to the cardiovascular system. Lymph capillaries collect tissue fluid, which is returned to the blood. The arrows indicate the direction of flow of the blood and lymph.

Lymph nodes and nodules: are masses of lymphatic tissue.

- Nodes and nodules differ with respect to size and location.
- Nodes are usually larger, 10 to 20 mm in length, and are encapsulated.
- Nodules range from a fraction of a millimeter to several millimeters in length and do not have capsules.

Lymph nodes:

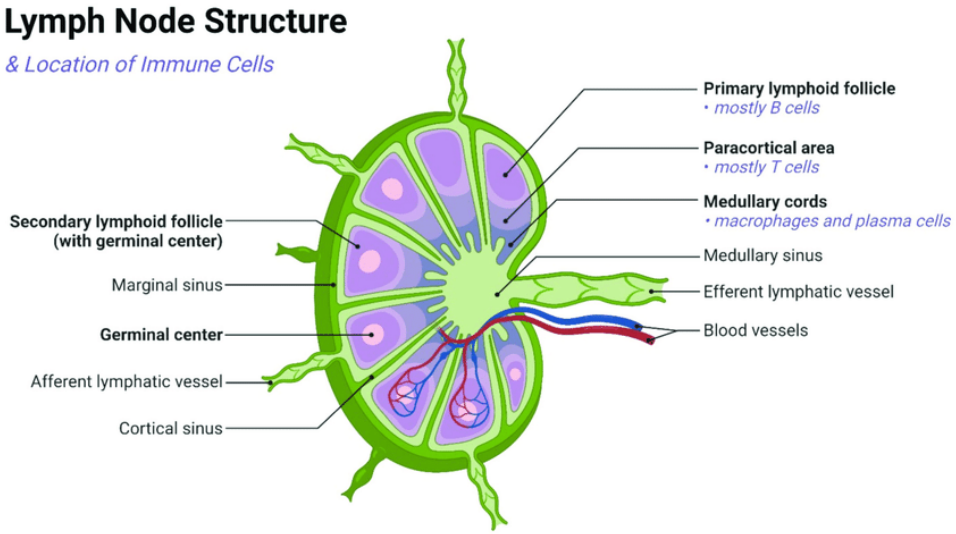
- Found in groups along the pathways of lymph vessels, and lymph flows through these nodes on its way to the subclavian veins.
- Lymph enters a node through several afferent lymph vessels and leaves through one or two efferent vessels. As lymph passes through a lymph node, bacteria and other foreign materials are phagocytized by fixed macrophages.
- Plasma cells develop from lymphocytes exposed to pathogens in the lymph and produce antibodies.
- These antibodies will eventually reach the blood and circulate throughout the body.



- There are many groups of lymph nodes along all the lymph vessels throughout the body, but three paired groups deserve mention because of their strategic locations. These are the cervical, axillary, and inguinal lymph nodes. Notice that these are at the junctions of the head and extremities with the trunk of the body. Breaks in the skin, with entry of pathogens, are much more likely to occur in the arms or legs or head rather than in the trunk. If these pathogens get to the lymph, they will be destroyed by the lymph nodes before they get to the trunk, before the lymph is returned to the blood in the subclavian veins.

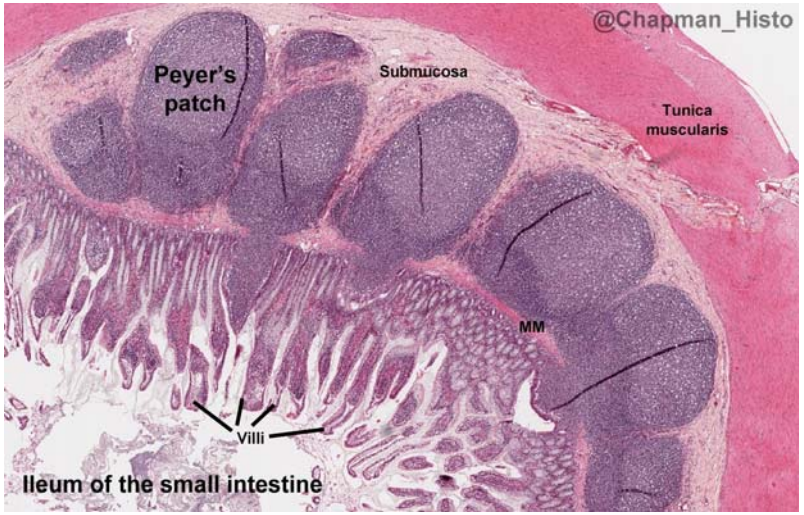
Main groups of lymph Nodes:

1. In the neck there are superficial and deep Cervical lymph nodes.
2. In each axilla there are Axillary lymph nodes.
3. In the thorax there are Mediastinal lymph nodes.
4. In the abdomen there are Mesenteric lymph nodes.
5. In the groin there are Inguinal lymph nodes.



Lymph nodules:

- Are small masses of lymphatic tissue found just beneath the epithelium of all mucous membranes.
- The body systems lined with mucous membranes are those that have openings to the environment: the respiratory, digestive, urinary, and reproductive tracts.
- Because any natural body opening is a possible portal of entry for pathogens. For example, if bacteria in inhaled air get through the epithelium of the trachea, lymph nodules with their macrophages are in position to destroy these bacteria before they get to the blood.

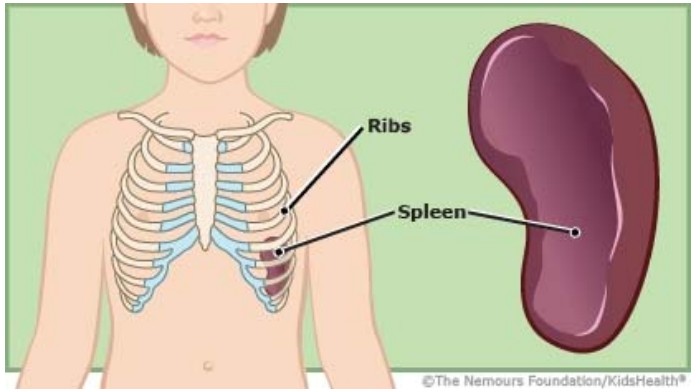


Some of the lymph nodules have specific names:

1. The small intestine are called Peyer's patches.
2. pharynx are called tonsils

- Pharyngeal tonsils (present in the posterior wall of the pharynx). Hypertrophy of this tonsils in children is called adenoids.
- palatine tonsils are on the lateral walls of the pharynx
- the lingual tonsils are on the base of the tongue

Spleen:



- Is located in the upper left quadrant of the abdominal cavity, just below the diaphragm, behind the stomach. The lower rib cage protects the spleen from physical trauma.
- In the fetus, the spleen produces red blood cells, a function assumed by the red bone marrow after birth.
- After birth the spleen is very much like a large lymph node, except that its functions affect the blood that flows through it rather than lymph.

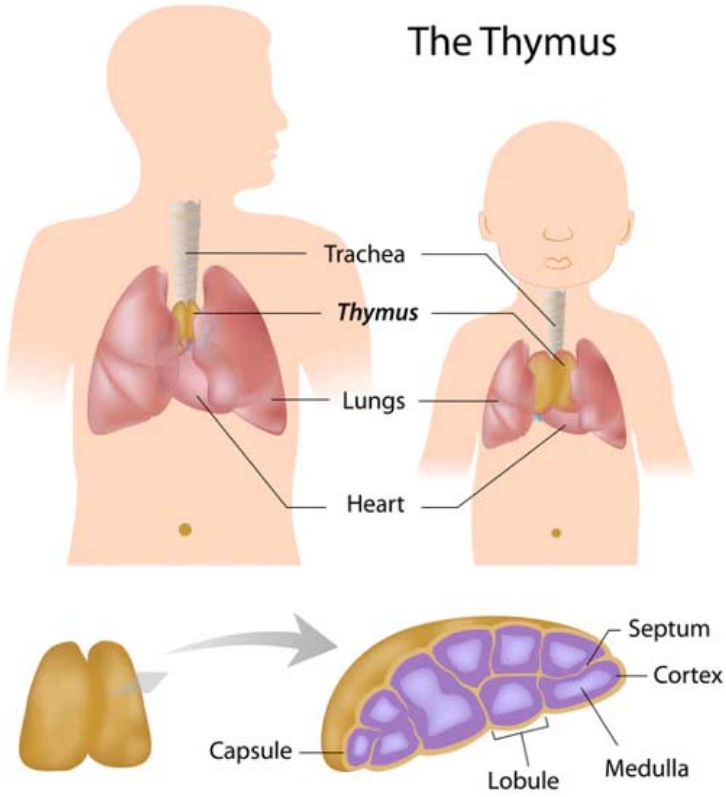
- **The functions of the spleen after birth are:**

✓ Contains plasma cells that produce antibodies to foreign antigens.
✓ Contains fixed macrophages that phagocytize pathogens or other foreign material in the blood and old red blood cells and form bilirubin.
✓ Stores platelets and destroys them when they are no longer useful.

- **The spleen is not considered a vital organ, because other organs compensate for its functions if the spleen must be removed. The liver and red bone marrow will remove old red blood cells and platelets from circulation. The many lymph nodes and nodules will phagocytize pathogens (as will the liver) and have lymphocytes to be activated and plasma cells to produce antibodies**.

Thymus:

- The thymus is part of both the lymphatic system and the endocrine system. Located inferior to the thyroid gland.
- In the fetus and infant, the thymus is large and extends under the sternum. With increasing age, the thymus shrinks, and relatively little thymus tissue is found in adults, though it is still active.
- The primary function of the thymus gland is to produce special white blood cells called T-lymphocytes or T-cells. White blood cells (lymphocytes) travel from bone marrow to thymus. The lymphocytes mature and become specialized T-cells in thymus.
- After the T-cells have matured, they enter your bloodstream. They travel to lymph nodes and other organs in lymphatic system, where they help your immune system fight disease and infection.
- Produces thymic hormones that make T cells immunologically competent, that is, able to recognize foreign antigens and provide immunity.



PROTECTION OF THE BODY

Immune System. The immune system includes white blood cells, tissue cells derived from white blood cells, the thymus, lymph nodes, and lymph vessels that protect the body from pathogens such as bacteria, viruses, parasites, and fungi. The immune system provides a mechanism for
the body to carry out the following:

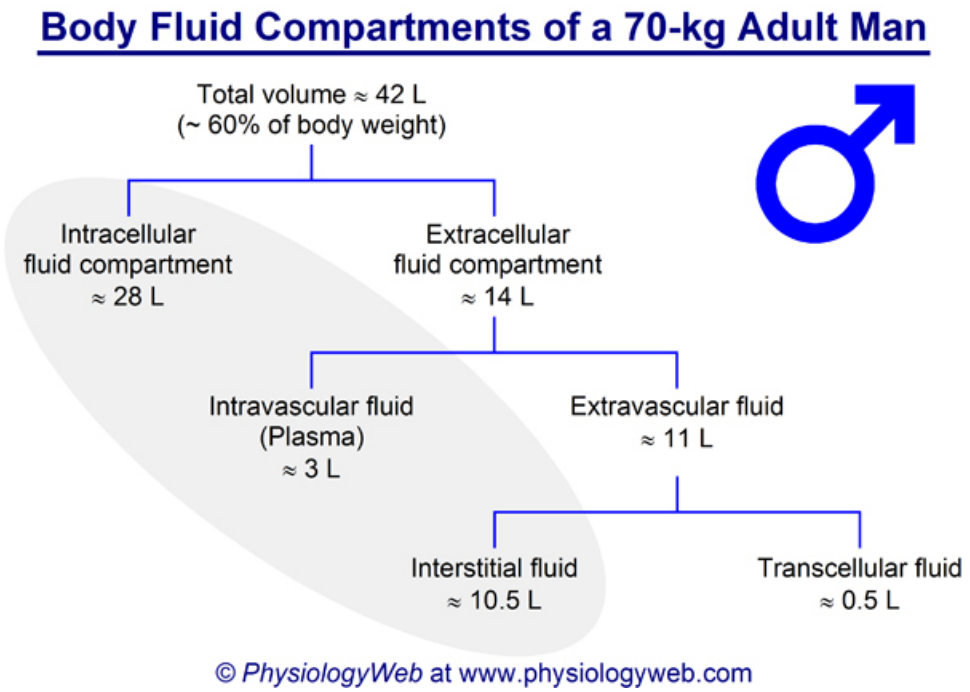
1. distinguish its own cells from harmful foreign cells and substances.
2. destroy the invader by phagocytosis or by producing sensitized lymphocytes or specialized proteins (e.g., antibodies) that destroy or neutralize the invader.

Body fluid compartments:

The total body fluid is distributed mainly between two compartments:

- The intracellular fluid within the cell
- The extracellular fluid: out the cell is divided into:

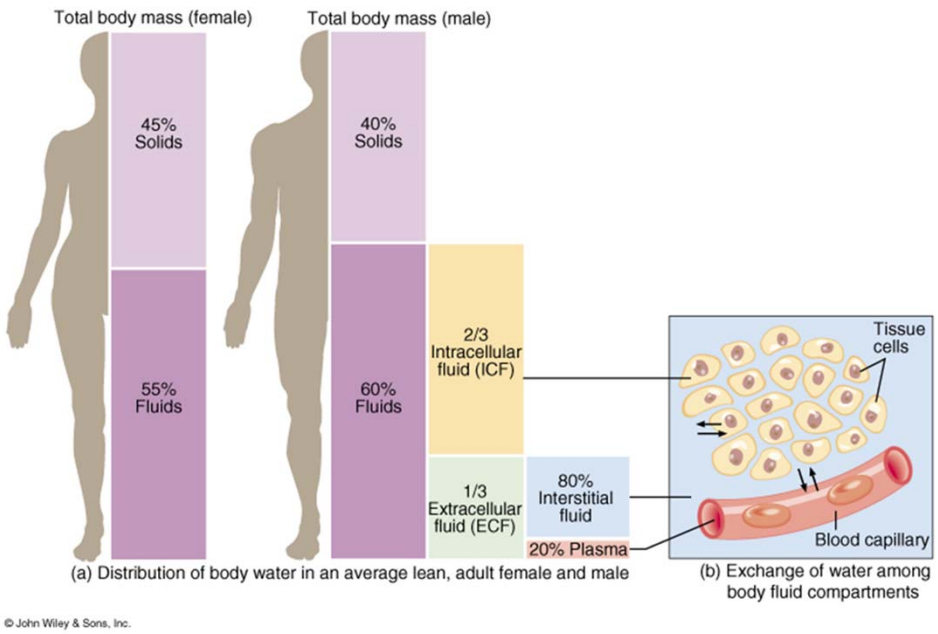
- The interstitial fluid
- The blood plasma
- transcellular fluid. This compartment includes fluid in the synovial, peritoneal, pericardial, and intraocular spaces, as well as the cerebrospinal fluid.



- In a 70-kg adult man, the total body water is about 60% of the body weight, or about 42 liters. This percentage depends on age, sex, and degree of obesity.

- As a person grows older, the percentage of total body weight that is fluid gradually decreases. This decrease is due in part to the fact that aging is usually associated with an increased percentage of the body weight being fat, which decreases the percentage of water in the body.

- Because women normally have a greater percentage of body fat compared with men, their total body water averages about 50% of the body weight. In premature and newborn babies, the total body water ranges from 70% to 75% of body weight. Therefore, when discussing average body fluid compartments, we should realize that variations exist, depending on age, sex, and percentage of body fat.



Composition of body fluids

- Organic substances
  - Glucose
  - Amino acids
  - Fatty acids
  - Hormones
  - Enzymes
- Inorganic substances
  - Sodium
  - Potassium
  - Calcium
  - Magnesium
  - Chloride
  - Phophate
  - Sulphate

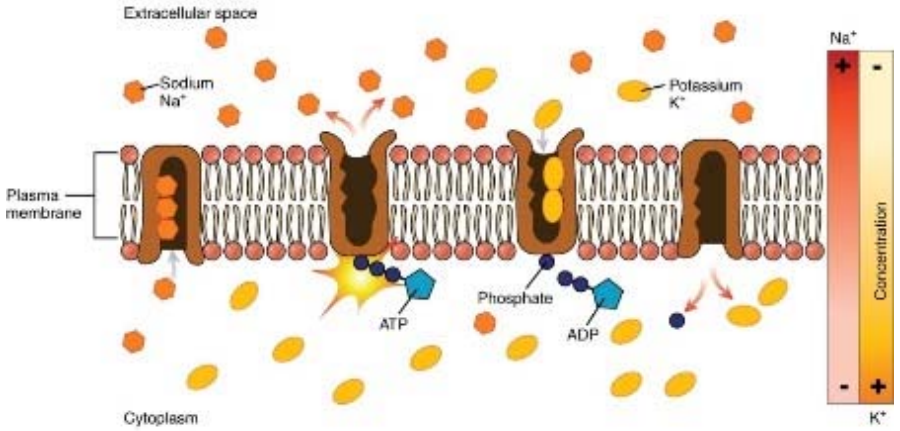
Differences in Extracellular and Intracellular Fluids:

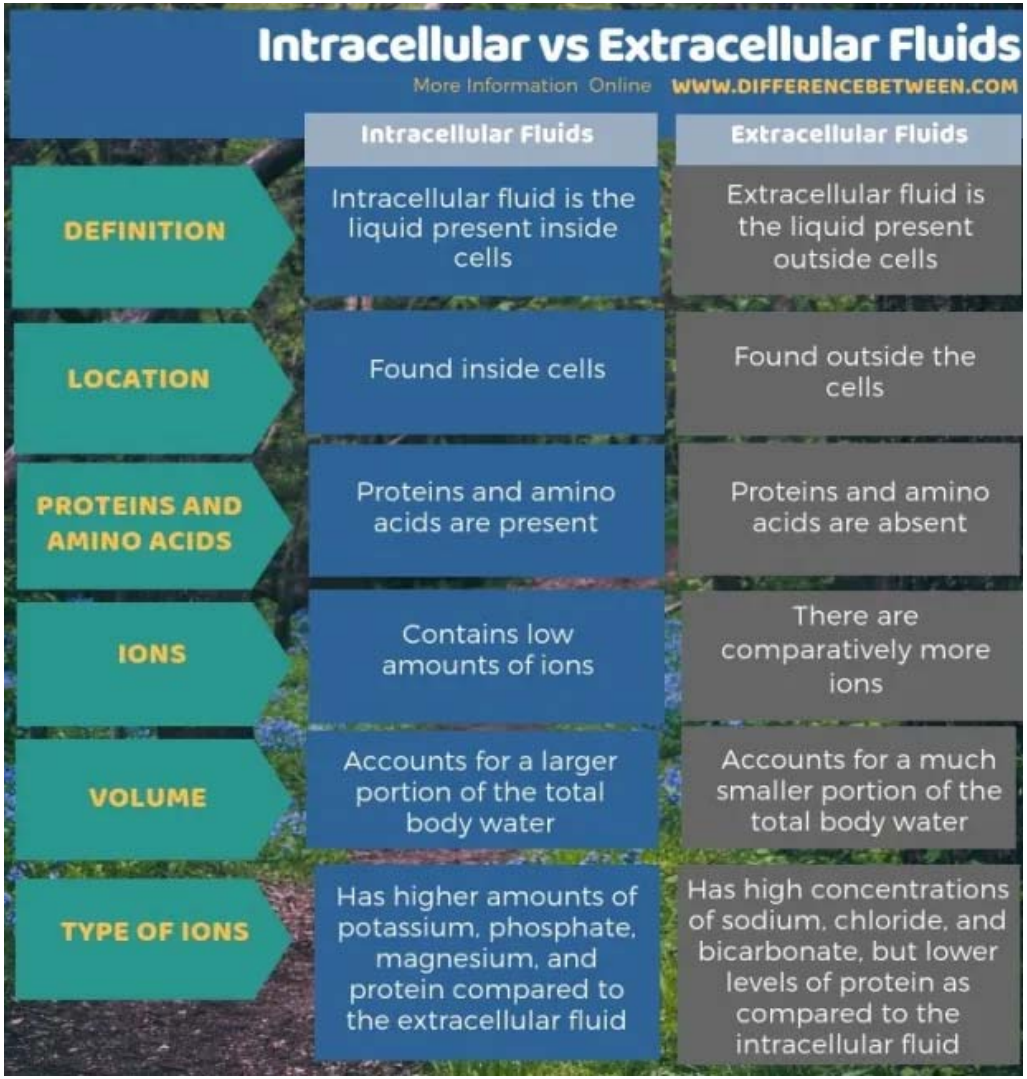
- ❑ **The extracellular fluid contains large amounts of:**

✓ Sodium, chloride, and bicarbonate ions.
✓ Nutrients for the cells, such as oxygen, glucose and fatty acids.
✓ Also contains carbon dioxide that is being transported from the cells to the lungs to be excreted, plus other cellular waste products that are being transported to the kidneys for excretion.

- ❑ **The intracellular fluid contains large amounts of:**

✓ potassium, magnesium, and phosphate ions instead of the sodium and chloride ions found in the extracellular fluid.





Electrolytes & Body Fluids

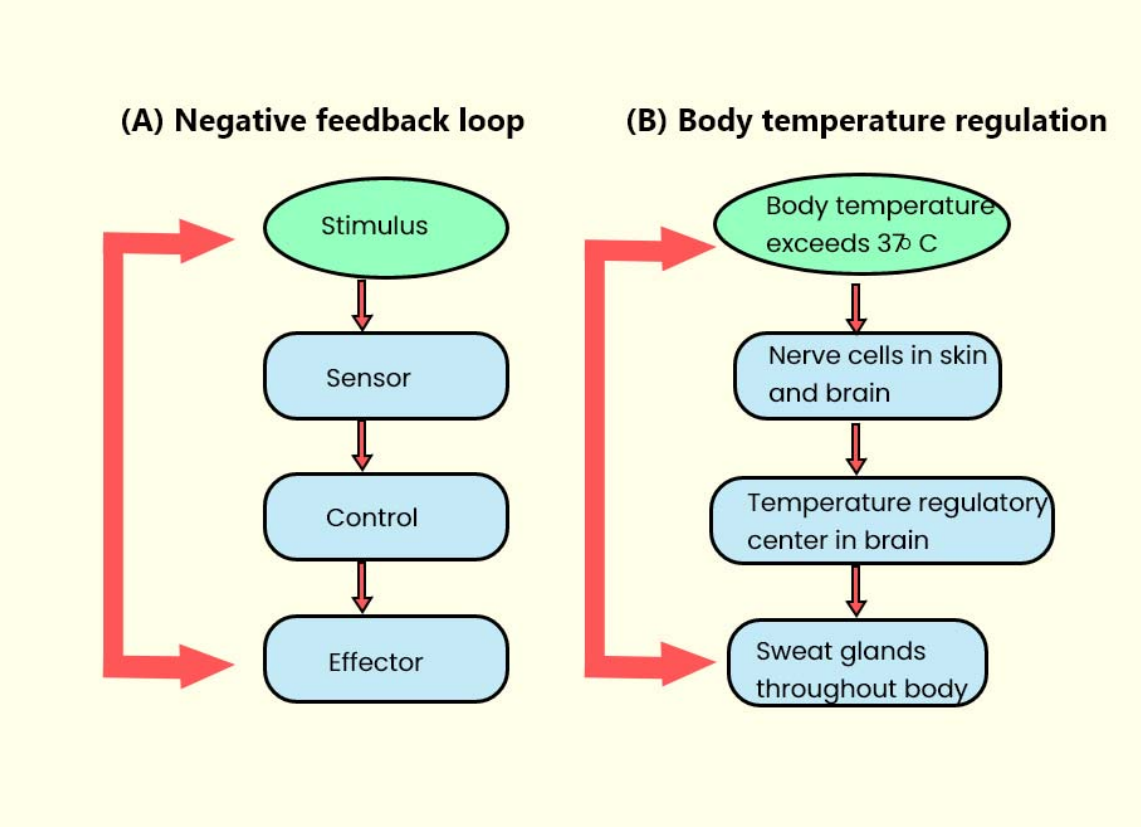
- **Major Cations:** Sodium, Potassium, Calcium, Magnesium.
- **Major Anions:** Chloride, Bicarbonate, Phosphate.
- **Intracellular Fluid:** K^+ is the most abundant cation, while HPO_4^{-2} is the most abundant anion.
- **Extracellular Fluid:** Na^+ is the most abundant cation, while Cl^- is the most abundant anion.

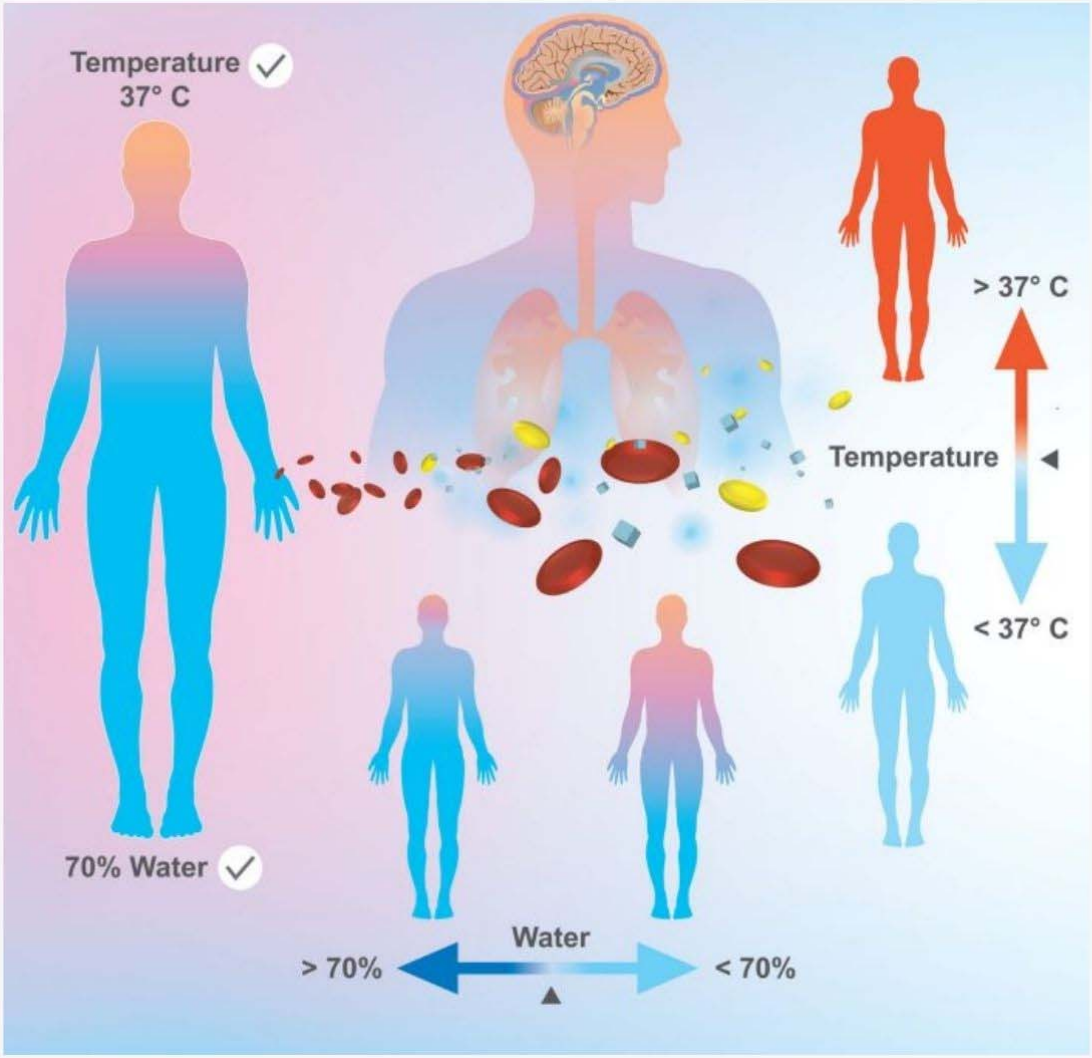
Homeostasis :

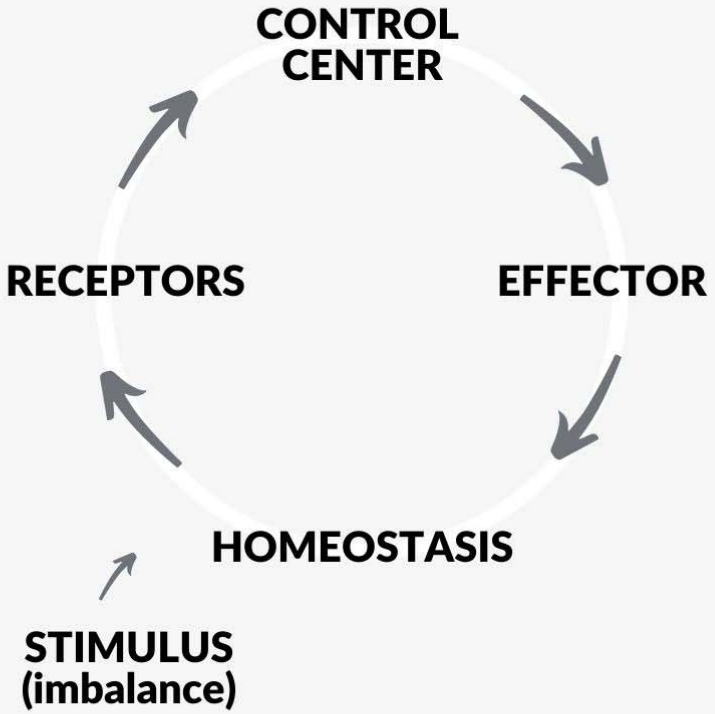
- **Homeostasis:** reflects the ability of the body to maintain a relatively stable metabolism and to function normally despite many constant changes. The changes that are part of normal metabolism may be internal or external, and the body must respond appropriately.

- Homeostasis is maintained through regulatory mechanisms, each comprised of three general components: a receptor, a control center, and an effector.

- The homeostatic mechanism may be in the form of a loop, which can either be positive or negative.




Temperature
37° C
70% Water
> 37° C
Temperature
< 37° C
Water
> 70%
< 70%


CONTROL CENTER
EFFECTOR
HOMEOSTASIS
STIMULUS (imbalance)
RECEPTORS

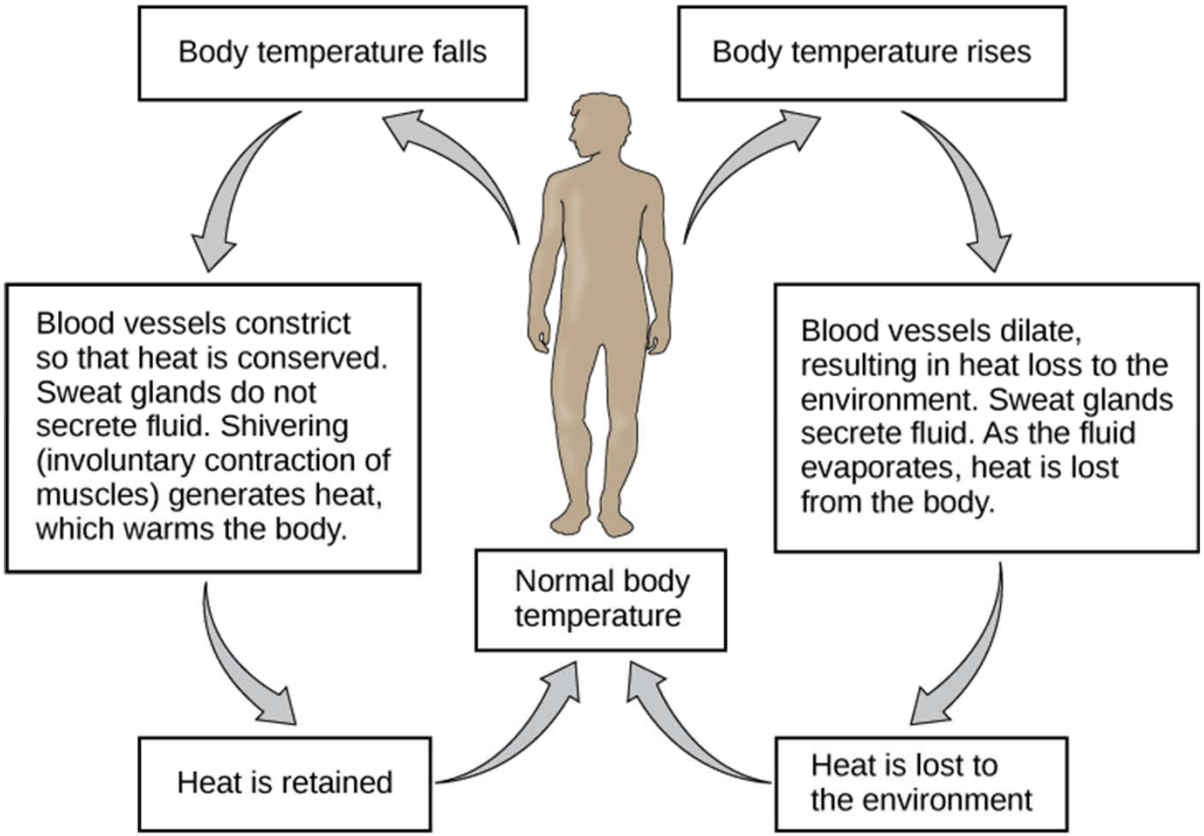
Feedback mechanisms: physiological regulation system in a living body that works to return the body to its normal internal state, or commonly known as homeostasis. triggered when the system undergoes a change that causes an output.

1. **Negative feedback mechanism:** is in which the body's response reverses the stimulus (in effect, turning it off for a while) and keeps some aspect of the body metabolism within its normal range.

An example of an external change is a rise in environmental temperature. On a hot day, the body temperature would also tend to rise. However, body temperature must be kept within its normal range of about (36 to 38C) in order to support normal functioning. What happens?

One of the body's responses to the external temperature rise is to increase sweating so that excess body heat can be lost by the evaporation of sweat on the surface of the skin.

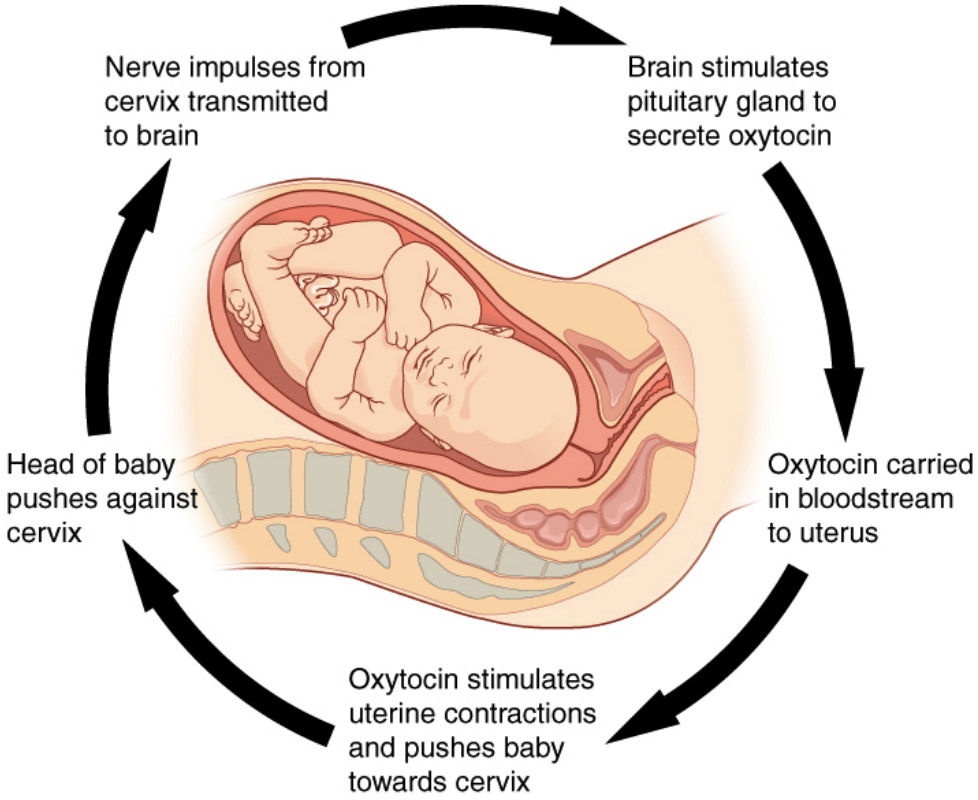
This response, however, may bring about an undesirable internal change, dehydration. What happens? As body water decreases, we feel the sensation of thirst and drink fluids to replace the water lost in sweating. Notice that when certain body responses occur, they reverse the event that triggered them. In the preceding example a rising body temperature stimulates increased sweating, which lowers body temperature, which in turn decreases sweating. Unnecessary sweating that would be wasteful of water is prevented.


Body temperature falls
Body temperature rises
Blood vessels constrict so that heat is conserved. Sweat glands do not secrete fluid. Shivering (involuntary contraction of muscles) generates heat, which warms the body.
Blood vessels dilate, resulting in heat loss to the environment. Sweat glands secrete fluid. As the fluid evaporates, heat is lost from the body.
Normal body temperature
Heat is retained
Heat is lost to the environment

2. Positive feedback mechanism:

- The response to the stimulus does not stop or reverse the stimulus, but instead keeps the sequence of events going. A good example is childbirth, in which the sequence of events, simply stated, is as follows:

- Stretching of the uterine cervix stimulates secretion of the hormone oxytocin by the posterior pituitary gland. Oxytocin stimulates contraction of the uterine muscle, which causes more stretching, which stimulates more oxytocin and, hence, more contractions. The mechanism stops with the delivery of the baby and the placenta. This is the "brake," the interrupting event.



- because positive feedback mechanisms have the potential to be self-perpetuating and cause harm, that they are rare in the body.