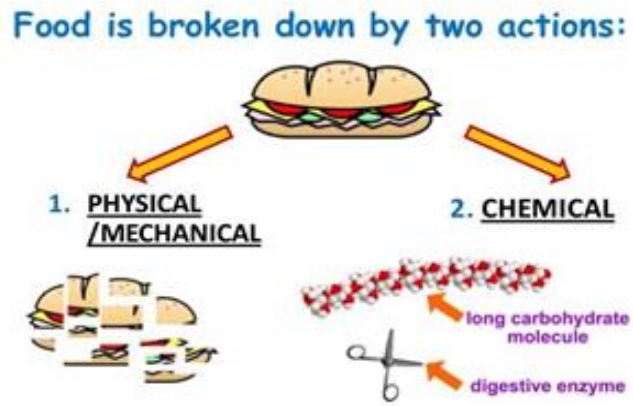
Unit 3 Part 4: The Digestive/Excretory Systems and Homeostasis

Name: _____

The Human Digestive System and Homeostasis

Launch Lab Technology Provides Tools to Learn More

Structure and Functions



_____ system into which food is taken and broken down

_____ breakdown of food through chewing or churning

_____ chemical breakdown of food by enzymes and other digestive juices

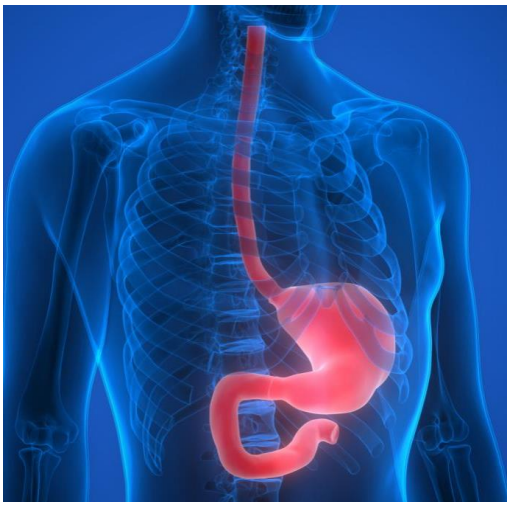
_____ part of the digestive system where ingestion occurs

_____ process of taking food into the body

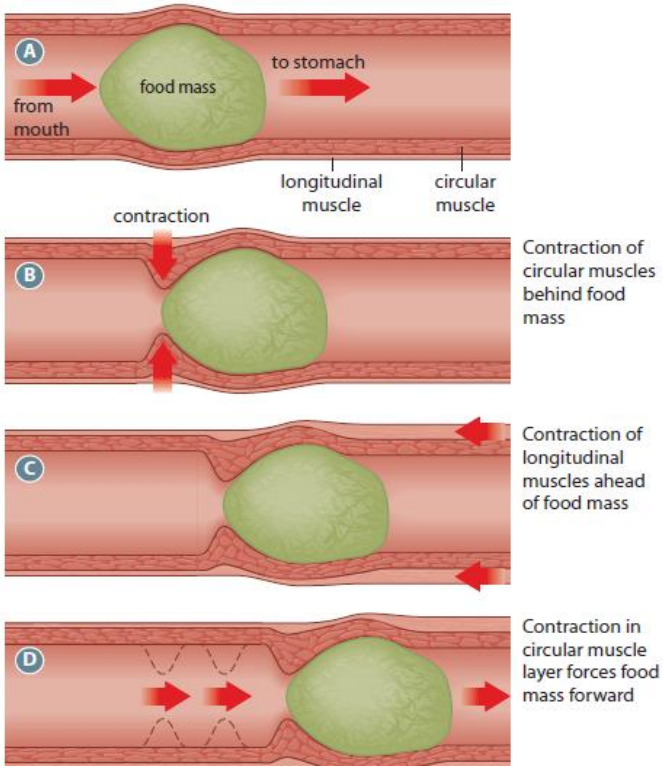
_____ secrete a watery fluid that contain starch digesting enzymes

_____ an enzyme in saliva that breaks down starch into simpler sugars (disaccharides).

_____ muscular portion of the digestive tract that directs food from the mouth to the stomach



peristalsis wavelike series of muscular contractions and relaxations that moves food through the digestive system

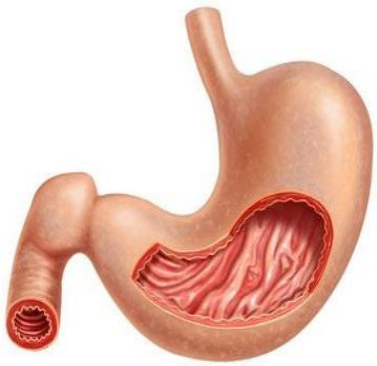


Peristalsis

_____ J-shaped sac whose muscles and secretions break down food and push it into the small intestine

_____

_____ occur in the stomach. Waves of peristalsis push food against the bottom of the stomach, churning it backward, breaking it into smaller pieces, and mixing it with gastric juice to produce a thick liquid called chyme.



Gastric juice is responsible for chemical digestion in the stomach. It is made up of water, mucus, salts, hydrochloric acid, and enzymes.

The strong _____ has a pH of 1 to 3. It provides a highly acidic environment that begins to soften and break down proteins in the chyme.

The low pH also serves to kill most bacteria that are ingested along with the food we eat. (Some disease-causing bacteria escape this fate, however, because they have an outer coating that resists stomach acid.)

_____ protein-digesting enzyme secreted in the stomach – is not activated until it comes into contact with hydrochloric acid.

Your stomach will not digest itself 😊

Activity 5.3 Scientific Inquiry in Action

_____ length of the digestive tract between the stomach and the large intestine (secretes enzymes that digest macromolecules; absorbs hydrolyzed molecules into bloodstream)

segmentation a process by which some mechanical digestion occurs in the small intestine. During this process, the chyme sloshes back and forth between segments of the small intestine that form when bands of circular muscle briefly contract. Meanwhile, peristalsis pushes the food along the intestine.

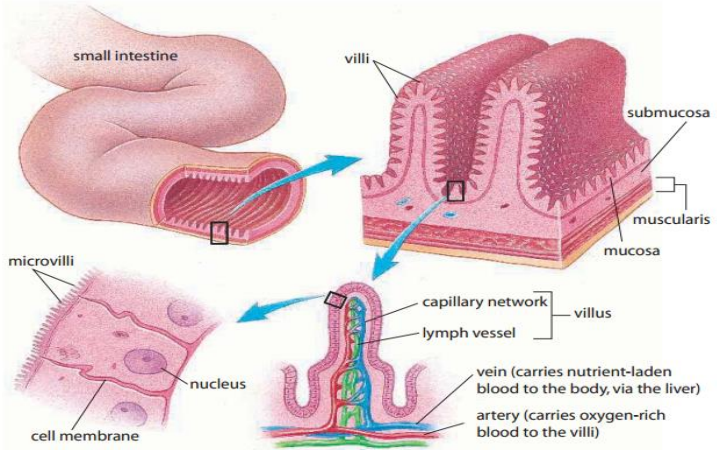
<u>Regions and Structures of the Small Intestine</u>

The first 25 cm of the small intestine is called the _____. The duodenum is generally U-shaped and is the shortest and widest of the three regions. Ducts (channels) from the liver and pancreas join to form one duct that enters the duodenum.

Thus, the duodenum is an important site for the chemical digestion of the chyme received from the stomach.

villus (villi) finger-like projection along the ridges of the small intestine; increases surface area to aid in the absorption of nutrients

microvillus (microvilli) microscopic projection found along exposed cell surfaces that greatly increases the surface area of the cell.

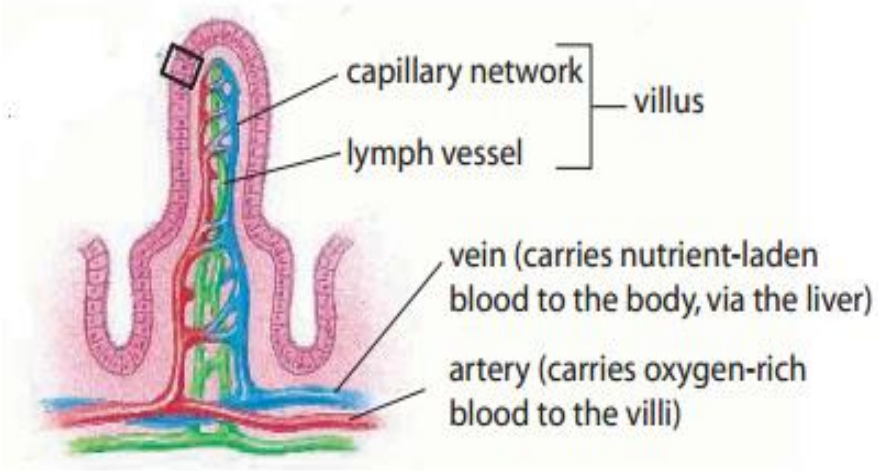


Each villus contains tiny structures called capillary networks and lymph vessels.

These structures are part of the circulatory system.

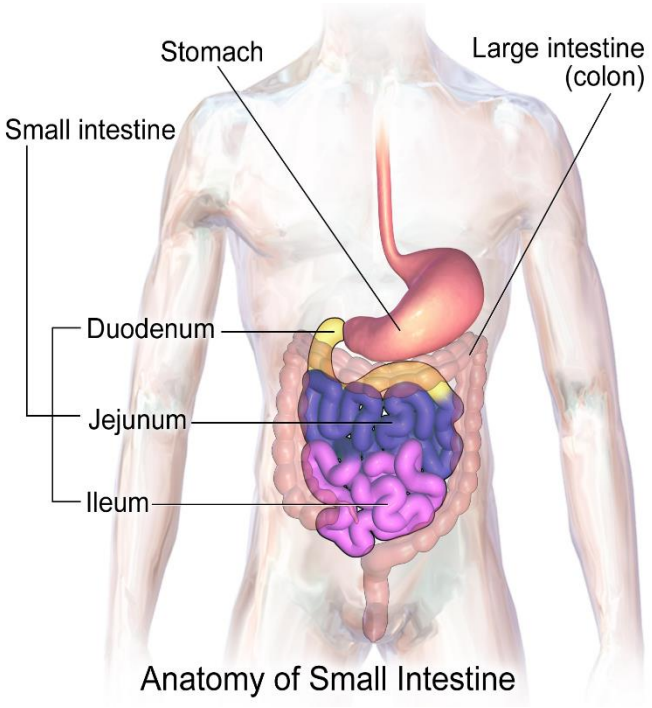
They conduct absorbed substances from the small intestine into the bloodstream and the lymphatic system.

The other regions of the small intestine are the jejunum and the ileum, and they are quite similar to the duodenum.



The _____, **which is about 2.5 m long**, contains more folds and secretory glands than the duodenum. It continues to break down food so that the end products can be absorbed.

The _____, **which is about 3 m long**, contains fewer and smaller villi. Its function is to absorb nutrients and to push the remaining undigested material into the large intestine.



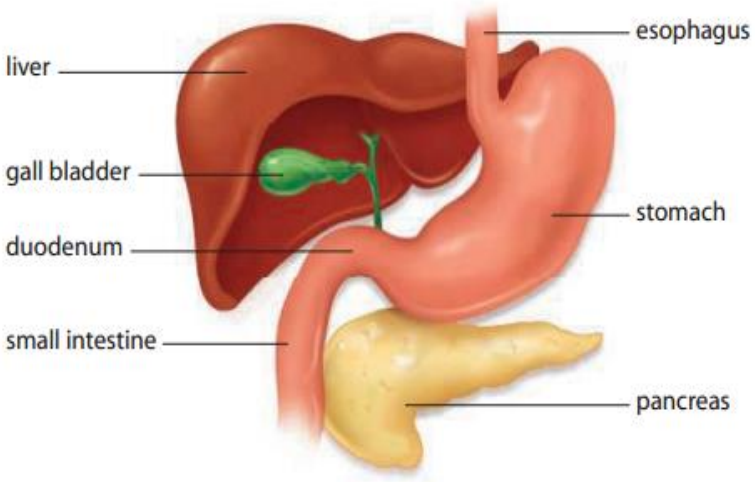
Anatomy of Small Intestine

Accessory organs

_____ organ found in the abdomen that performs hundreds of functions as an accessory organ of the digestive system, including _____

_____

_____



_____ organ that stores bile produced by the liver

Bile is a greenish-yellow fluid mixture that is made up of bile pigments and bile salts.

_____ breaks down fats into fatty acids that can be absorbed into the digestive tract.

After bile is produced in the liver, it is sent to the gall bladder, which stores the bile between meals. The arrival of fat-containing chyme in the duodenum stimulates the gall bladder to contract. This causes bile to be transported through a duct (shared by both the gall bladder and the liver) and injected into the duodenum.

_____ manufactures digestive enzymes to digest macromolecules; secretes _____ _____ that enters small intestine

The pancreas delivers about 1 L of pancreatic fluid to the duodenum each day. Pancreatic fluid contains a multitude of enzymes, including the following:

•trypsin and chymotrypsin, which are _____

•pancreatic amylase, which is a _____ in the small intestine

•_____

Bile salts assist lipases in accessing fats because they are partly soluble in water and partly soluble in fats.

Bile salts work like a detergent, dispersing large fat droplets into a fine suspension of smaller droplets in the chyme. This emulsification process produces a greater surface area of fats on which the lipases can act. As a result, the digestion of fats can occur more quickly.

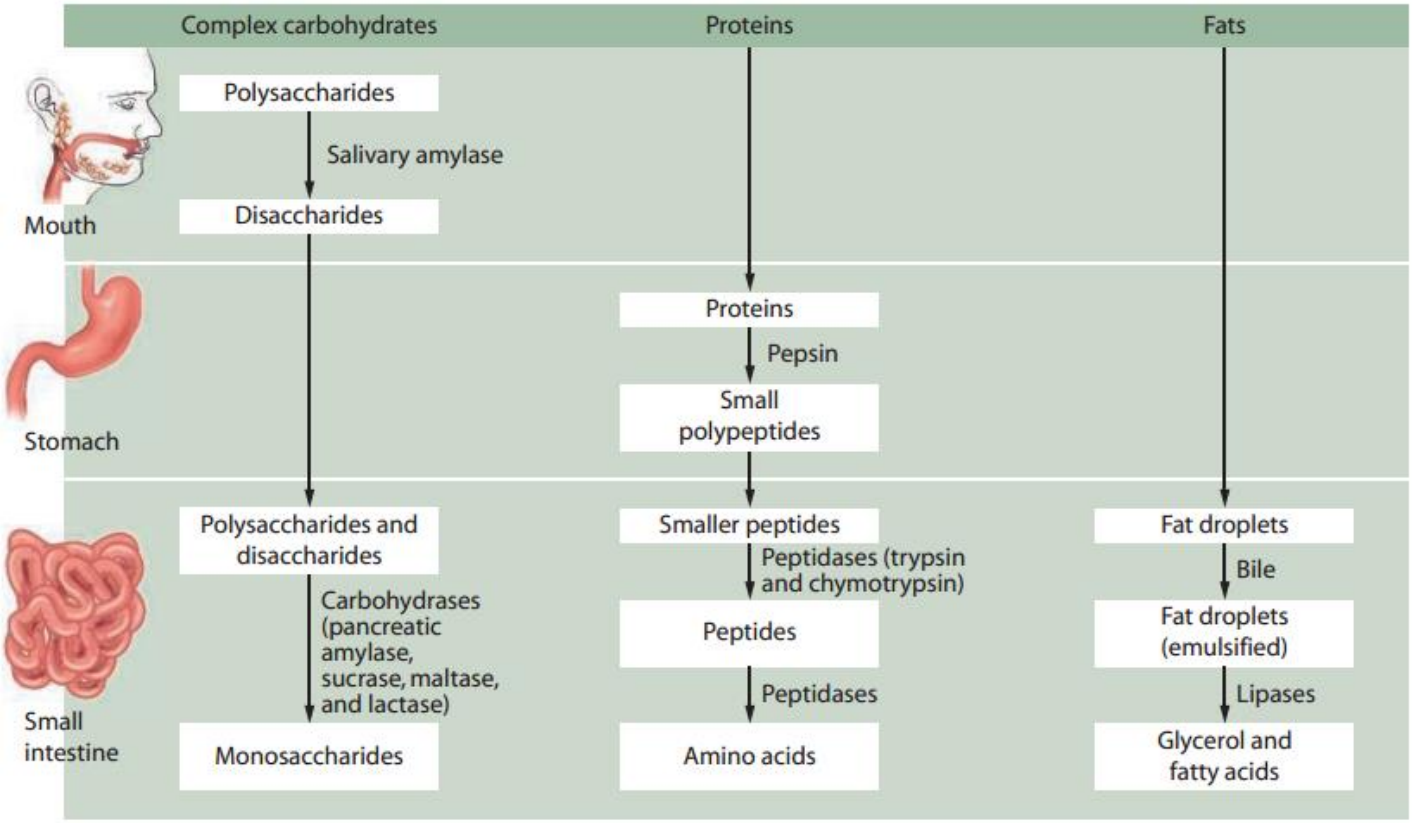


Figure 5.10 An overview of chemical digestion and absorption in the small intestine

Table 5.2 Selected Enzymes of the Digestive System

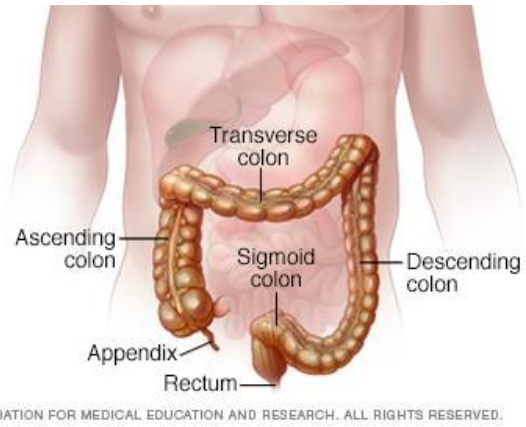
Enzyme	Where Enzyme Acts/pH	Substrate (food) Digested	Products of Digestion	Origin of Enzymes
salivary amylase	mouth/7	starch, glycogen	maltose (disaccharide)	salivary glands
pancreatic amylase	small intestine/8	starch, glycogen	maltose	pancreas
carbohydrases • sucrase • maltase • lactase	small intestine/8	 sucrose maltose lactose	 glucose + fructose glucose glucose + galactose	small intestine
pancreatic lipase	small intestine/8	lipids	fatty acids and glycerol	pancreas
peptidases • pepsin • trypsin • chymotrypsin	 stomach/1–2 small intestine/8 small intestine/8	 protein peptides peptides	 peptides smaller peptides smaller peptides	 stomach pancreas pancreas
peptidases	small intestine/8	peptides	amino acids	small intestine

_____ final portion of the digestive system; absorbs water and salts; passes remaining undigested material and some water out of body

_____ the process by which materials are reabsorbed into the bloodstream

Measuring only about 1.5 m long, it has a diameter of about 2.5 cm.

Digestion does not occur in the large intestine



Each day, the large intestine receives about 500 mL of indigestible food residue, reduces it to about 150 mL of feces by reabsorbing water and salts, and eliminates the **feces.**

In the colon, water and salts are reabsorbed from any undigested food, while billions of anaerobic intestinal bacteria break it down further.

These bacteria produce vitamins B12 and K, and some amino acids.

At the end of this process, any remaining indigestible materials, along with the colon bacteria, form the feces.

The feces pass into the rectum and anal canal, which comprise the last 20 cm of the large intestine.

From there, the feces pass out of the body through the anus.

_____ stores waste prior to elimination. The rectum has three folds that enable it to retain the feces while passing gas.

_____ holds rectum closed; opens to allow elimination

<u>Systems Work Together to Maintain Homeostasis in the Digestive Tract</u>

the activities of the digestive tract are coordinated by the nervous system and the endocrine system.

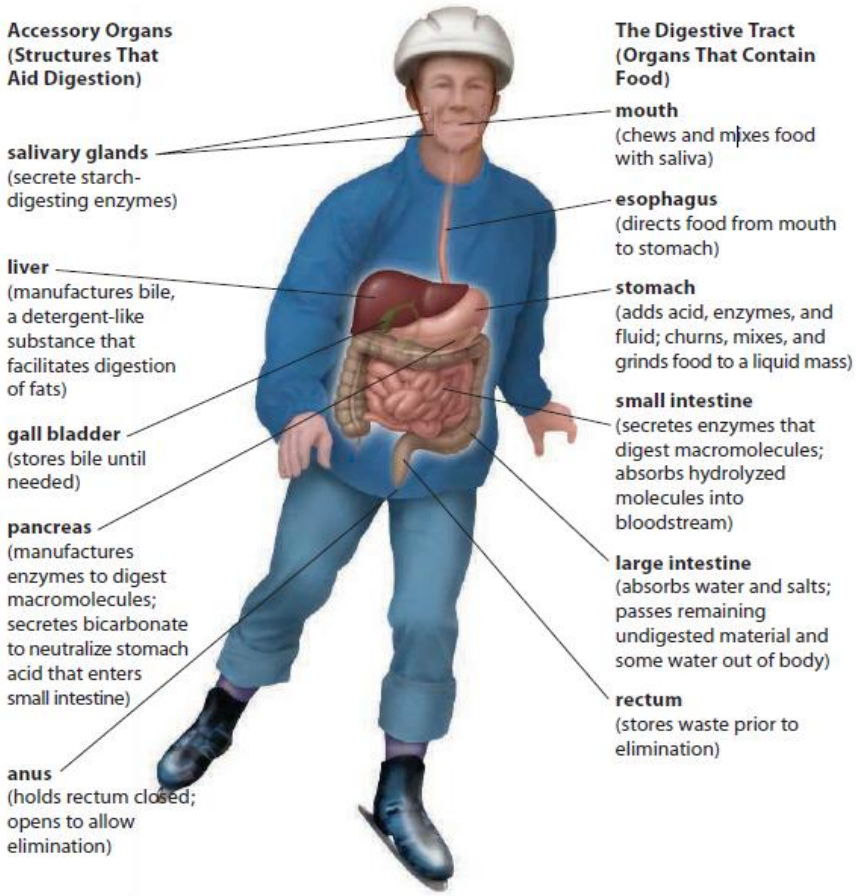
The nervous system stimulates salivary and gastric secretions in response to the sight, smell, and consumption of food.

When food arrives in the stomach, proteins in the food stimulate the secretion of a stomach hormone called gastrin.

Systems Work Together to Maintain Homeostasis in the Digestive Tract

_____ then stimulates the secretion of hydrochloric acid and the inactive precursor molecule of pepsin from glands in the stomach.

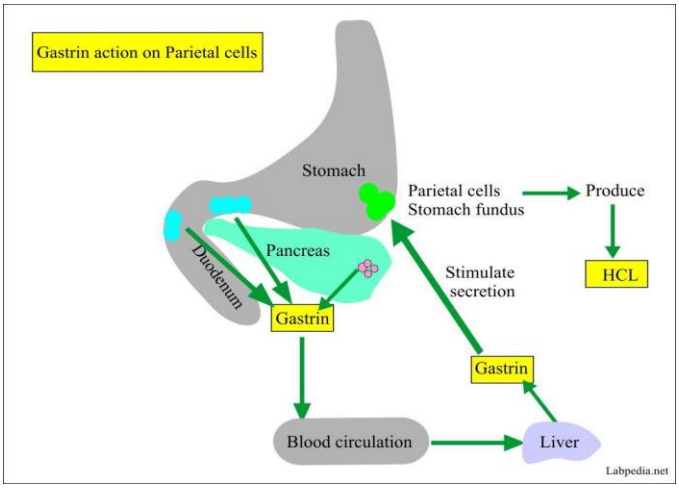
The secreted hydrochloric acid lowers the pH of the gastric juice, which acts to inhibit



further secretion of gastrin. Because the inhibition of gastrin secretion reduces the amount of hydrochloric acid that is released into the gastric juice, a negative feedback mechanism is completed.

In this way, homeostasis (the secretion and concentration) of gastric fluid is maintained.

The passage of chyme from the stomach into the duodenum inhibits the contractions of the stomach, so that no additional chyme can enter the duodenum until the previous amount has been processed.

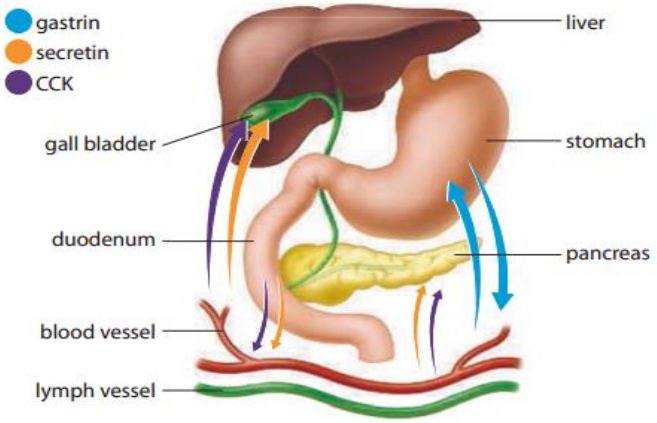


_____, and _____(cholecystokinin) two hormones secreted into the bloodstream by the duodenum cause inhibition of stomach contractions

CCK and secretin also have other regulatory functions in digestion.

CCK stimulates increased pancreatic secretions of digestive enzymes and gall bladder contractions. Gall bladder contractions inject more bile into the duodenum, which enhances the emulsifying and digestion of fats.

Secretin also stimulates the pancreas to release more bicarbonate to neutralize acidic chyme.



Gastrin, secretin, and CCK are hormones that must be transported by the bloodstream from their place of origin to the place where they act to stimulate the release of digestive secretions.

Lymph vessels carry absorbed fats.

Investigation 3.B Factors Affecting Enzyme Activity

<u>Health and the Digestive System</u>

The effects of poor dietary and lifestyle habits may take weeks, months, or even years to show up.

Good nutrition is the only way to provide the energy our bodies need to carry out their many activities, such as nerve transmission, muscle contraction, and cell repair and replacement.

Good nutrition provides the raw materials our bodies need as building blocks but are unable to manufacture themselves.

One part of eating a well-balanced diet includes consuming the proper amount of vitamins and minerals.

_____ are organic and inorganic substances that enable chemical reactions to occur and _____

_____

Vitamins and minerals are needed by a healthy, functional human body. They are needed in small amounts, but _____

_____

_____

Table 5.4 Functions and Possible Sources of Selected Vitamins and Minerals

	Key Functions in the Body	Possible Sources
Vitamin		
A (carotene)	• good vision • healthy skin and bones	vitamins A, C, and E: fruit 
B1 (thiamine)	• metabolizing carbohydrates • growth and muscle tone	vitamin B1: beans 
C (ascorbic acid)	• healthy bones, teeth, gums, and blood vessels • boosting immune system	see above
D	• absorbing calcium • forming bone	vitamin D: fish 
E	• strengthening red blood cell membranes	see above
K	• blood clotting	vitamin K: dark, leafy greens 
Mineral		
calcium	• forming bone • conducting nerve signals • contracting muscle • clotting blood	calcium: dairy products 
iron	• producing hemoglobin	iron: red meat 
magnesium	• supporting enzyme functions • producing protein	magnesium: dark, leafy greens 
potassium	• conducting nerve signals • contracting muscle	potassium: grains 
sodium	• conducting nerve signals • balancing body fluid	sodium: salt 
zinc	• supporting immune system • cell growth • wound healing	zinc: nuts 

Allergic Responses

Protein molecules are normally too large to pass through the cell membranes of the cells that make up the intestinal lining.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

This is why some people must avoid certain protein-rich foods, such as eggs, fish, and nuts

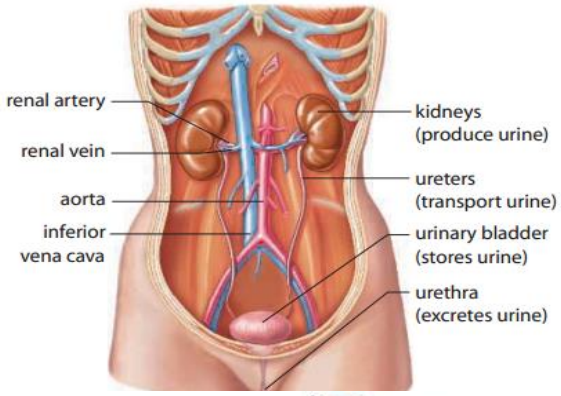
Diet Poster Assignment

The importance of scientific research to support claims made about diets should be discussed. Students should evaluate the reliability of each information source examined.

STSE Case Study Eating Well

The Human Excretory System and Homeostasis

_____ the system that regulates the volume and composition of body fluids by excreting metabolic wastes and recycling some substances for re-use



excretion process of separating wastes from body fluids and eliminating them from the body; performed by several body systems, **including respiratory, skin, digestive, and excretory systems**

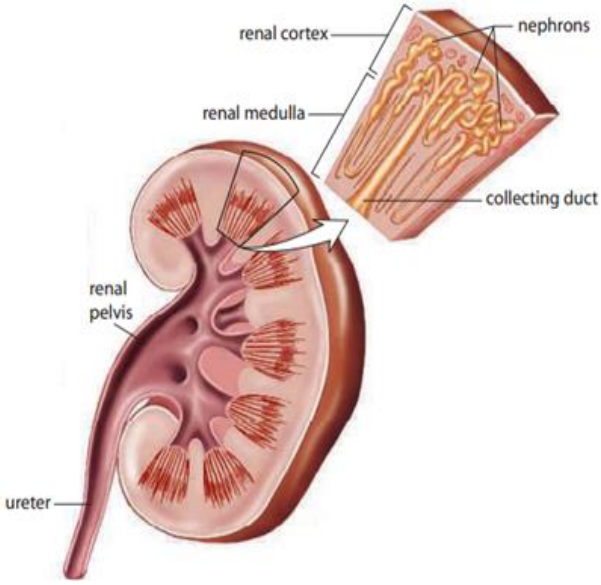
The respiratory system excretes carbon dioxide (Lungs)

The skin excretes water and salts in perspiration

The digestive system excretes water, salts, and lipids.

The urinary system filters blood and produces urine.

Ammonia is highly toxic but is quickly converted to the less toxic compound, urea, in the liver.



Excretory System Structures and Functions

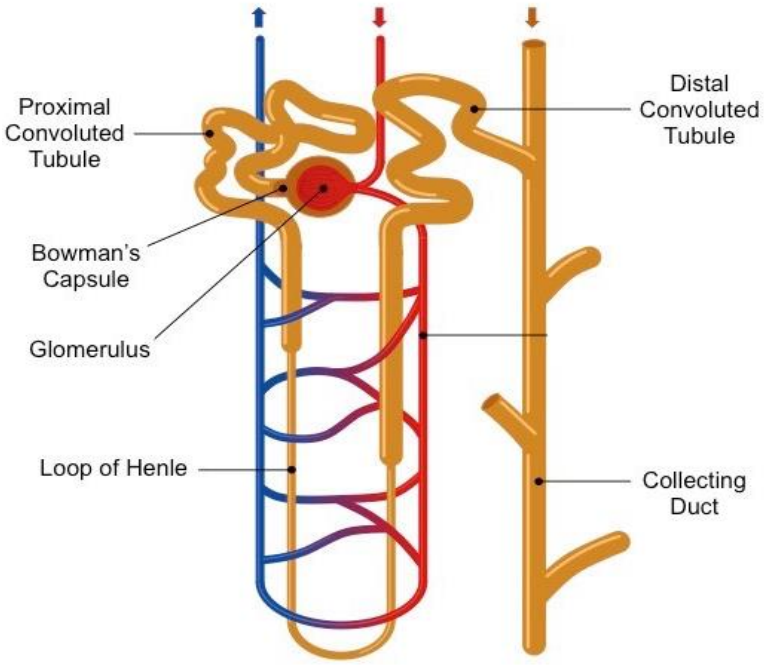
_____ a pair of muscular tubes that carry urine from the kidneys to the bladder

_____ organ where urine is stored before being discharged by way of the urethra

_____ the tube through which urine exits the bladder and the body

_____ one of a pair of organs that filters waste from the blood and adjusts the concentrations of salts in the blood

_____ microscopic tube-like filtration unit found in the kidneys that filters and reabsorbs various substances from the blood; produces urine



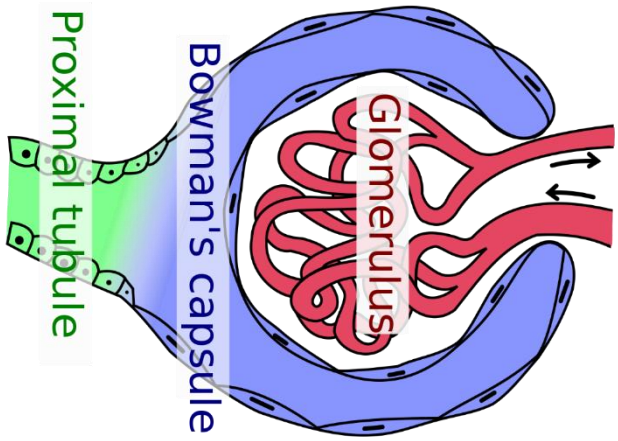
The Nephron

Each nephron is organized into three main regions:

- a filter
- a tubule
- a collecting duct.

The Nephron – A Filter

_____ the cap-like structure at the top of each nephron



Within each capsule, a renal artery enters and splits into a fine network of capillaries called a _____.

The walls of the glomerulus act as a _____ _____. They are impermeable to proteins, other large molecules, and red blood cells, so these remain within the blood.

Water, small molecules, ions, and urea—the main waste products of metabolism—pass through the walls and proceed farther into the nephron. The filtered fluid that proceeds from the glomerulus into the Bowman's capsule of the nephron is referred to as **filtrate.**

<u>The Nephron – A tubule</u>

The Bowman's capsule is connected to a small, long, narrow tubule that is twisted back on itself to form a loop.

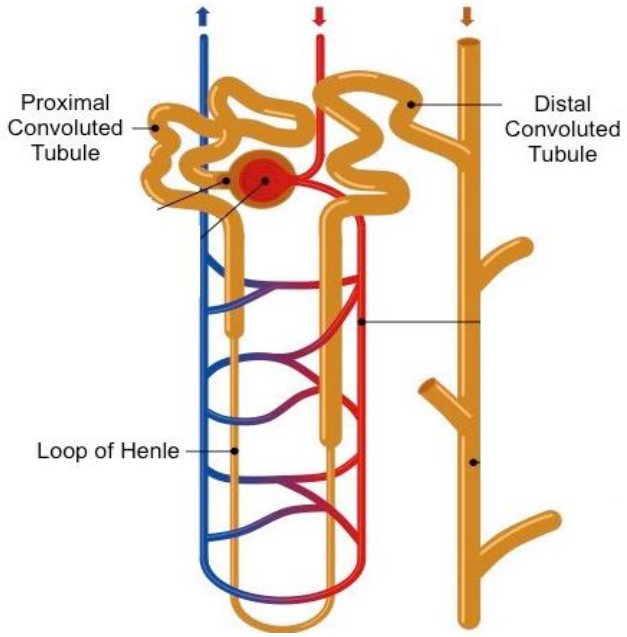
This long, hairpin loop is a **reabsorption device.**

The tubule has three sections:

the proximal tubule

the loop of Henle

and the distal tubule.



Like the small intestine, this tubule absorbs substances that are useful to the body, such as **glucose and a variety of ions,** from the filtrate passing through it. Unlike the small intestine, this tubule also secretes substances into the tissues surrounding it.

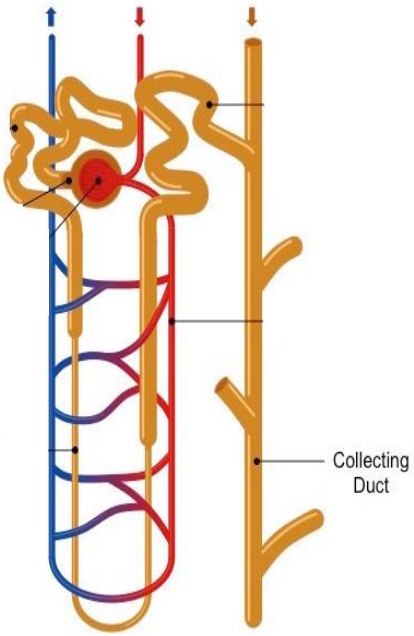
<u>The Nephron – The Collecting Duct</u>

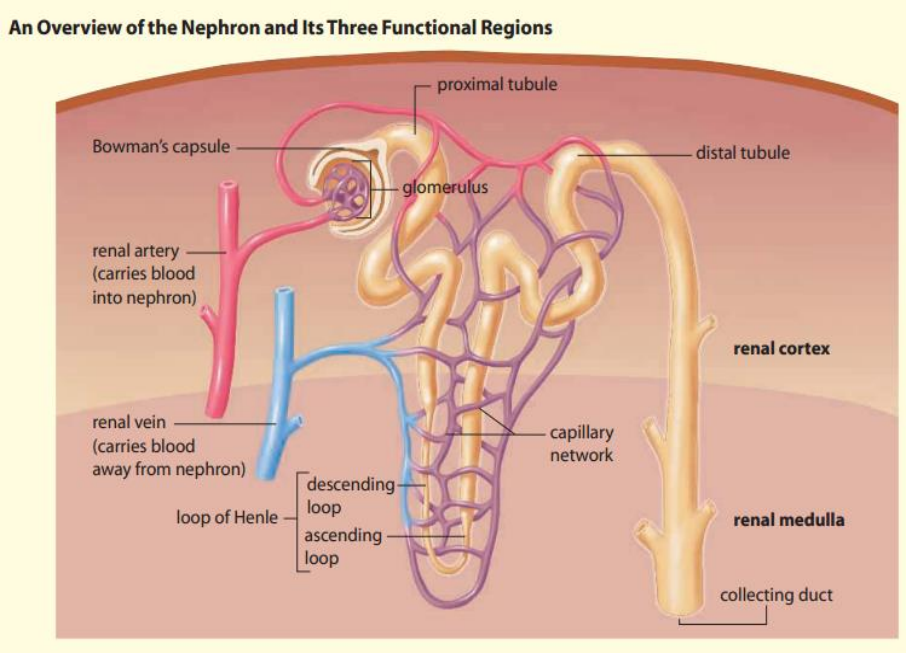
The tubule empties into a larger pipe-like channel called a collecting duct.

The collecting duct functions as a water-conservation device, reclaiming water from the filtrate passing through it so that very little precious water is lost from the body.

The filtrate that remains in the collecting duct is a suspension of water and various solutes and particles.

It is now called urine. Its composition is distinctly different from the fluid that entered the Bowman's capsule. The solutes and water reclaimed during reabsorption are returned to the body via the renal veins.





Urine Formation in the Nephron

_____

process that results in the movement of water and solutes, except proteins, from the blood plasma into the nephron down a pressure gradient

_____

process in which water and useful solutes are reabsorbed from the filtrate in the nephron and transported into capillaries for re-use by the body

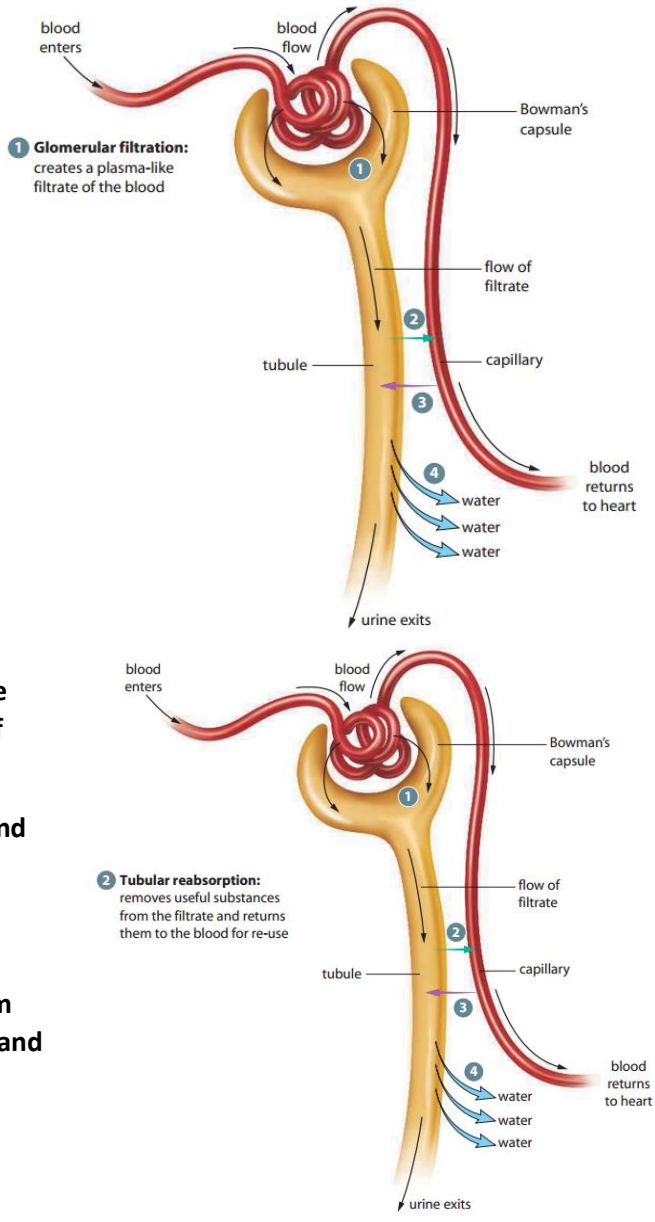
The cells of the descending limb are permeable to water and only slightly permeable to ions.

As a result of the salty environment of the medulla and permeability of the descending limb, water diffuses from the filtrate to the capillaries by osmosis.

As water moving through the descending limb leaves the filtrate, the concentration of sodium ions (Na+) inside the tubule increases, reaching its maximum concentration at the bottom of the loop.

As the filtrate continues around the bend of the loop of Henle and into the ascending limb, the permeability of the nephron tubule changes.

Near the bend, the thin portion of the ascending tubule is now impermeable to water and slightly permeable to solutes. Sodium ions diffuse from the filtrate along their concentration gradient and pass into nearby blood vessels



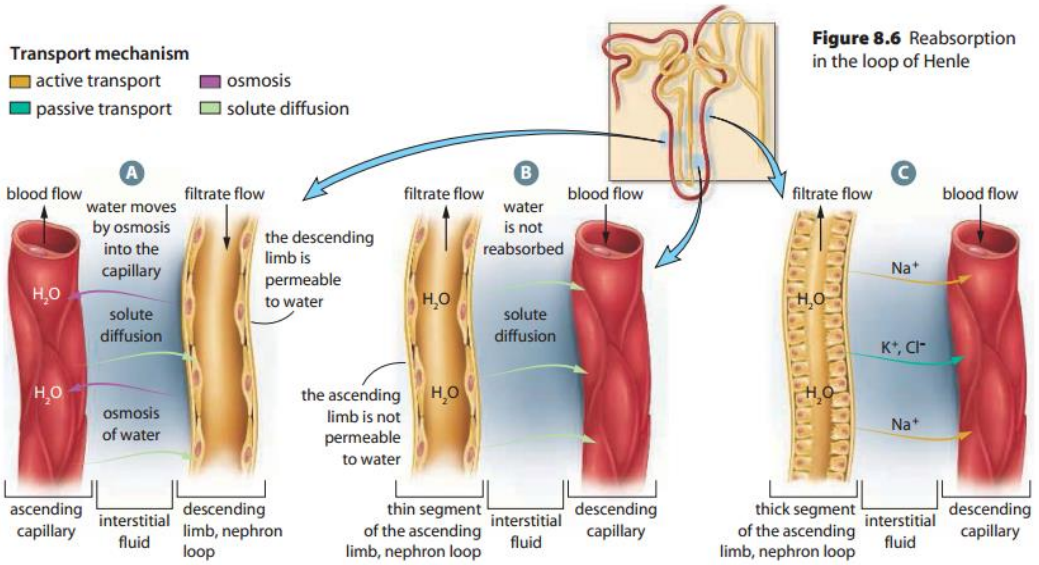


Figure 8.6 Reabsorption in the loop of Henle

A Water diffuses from the filtrate into surrounding capillaries. Solutes, to a much lesser extent, diffuse in the opposite direction.

B The ascending limb of the loop of Henle is not permeable to water. Solutes diffuse from the filtrate into the surrounding capillaries.

C Active transport of sodium and passive transport of other ions occurs in the thick segment of the ascending limb of the loop of Henle. There is no reabsorption of water in this part of the nephron.

_____

process that moves additional wastes and excess substances from the blood into the filtrate in the nephron; uses mainly active transport

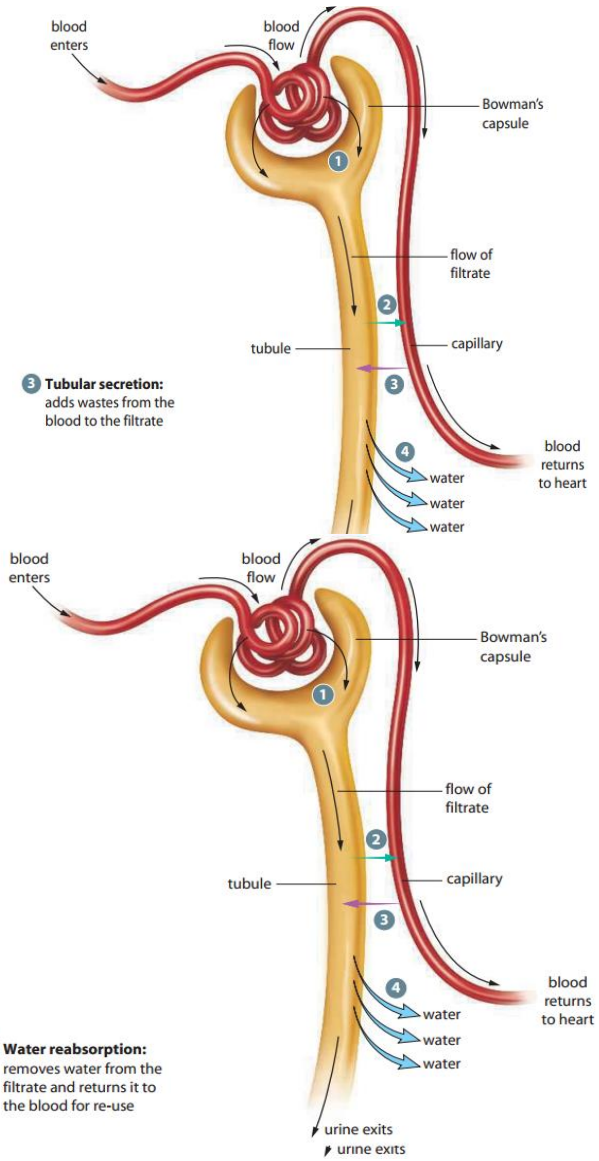
Potassium ions (K+) are actively secreted into the distal tubule from the bloodstream in the capillaries.

Hydrogen ions (H+) are also actively secreted as necessary in order to maintain the pH of the blood.

Other substances that are not normally part of the body, such as penicillin and other drugs, are secreted into the distal tubule.

_____

process that removes water from the filtrate in the nephron and returns it to the blood for re-use by body systems



The active reabsorption of sodium ions from the filtrate into the capillaries depends on the needs of the body

Passive reabsorption of negative ions such as chloride occurs by electrical attraction. The reabsorption of ions decreases the concentration of the filtrate, which causes water to be reabsorbed by osmosis into the blood stream as well from the collecting duct.

INVESTIGATION 8.B Urinalysis

Figure 8.7 Reabsorption in the distal tubule and collecting duct

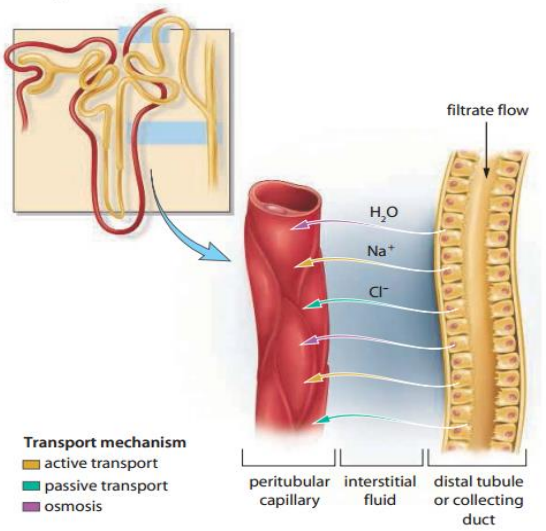


Table 8.2 A Summary of Nephron Functions

Part of the Nephron	Function
Glomerulus	**Filtration** • Glomerular blood pressure forces some of the water and dissolved substances from the blood plasma through the pores of the glomerular walls
Bowman's capsule	Receives filtrate from glomerulus
Proximal tubule	**Reabsorption** • Active reabsorption of all nutrients, including glucose and amino acids • Active reabsorption of positively charged ions such as sodium, potassium, calcium • Passive reabsorption of water by osmosis • Passive reabsorption of negatively charged ions such as chloride and bicarbonate by electrical attraction to positively charged ions **Secretion** • Active secretion of hydrogen ions
Descending loop of Henle	**Reabsorption** • Passive reabsorption of water by osmosis
Ascending loop of Henle	**Reabsorption** • Active reabsorption of sodium ions • Passive reabsorption of chloride and potassium ions
Distal tube	**Reabsorption** • Active reabsorption of sodium ions • Passive reabsorption of water by osmosis • Passive reabsorption of negatively charged ions such as chloride and bicarbonate **Secretion** • Active secretion of hydrogen ions • Passive secretion of potassium ions by electrical attraction to chloride ions
Collecting tube	**Reabsorption** • Passive reabsorption of water by osmosis

The Kidneys and Homeostasis

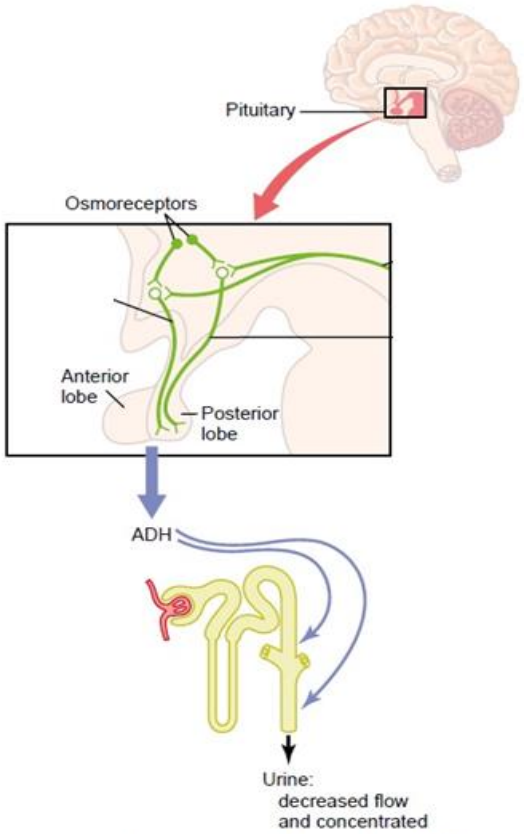
The amount of water reabsorbed from the filtrate influences two important characteristics of blood: its volume and the concentration of plasma solutes.

The force generated as water moves by osmosis is called osmotic pressure.

The greater the concentration gradient, the greater the osmotic pressure becomes.

Osmotic pressure affects many cellular activities, especially the exchange of materials between cells and blood.

Blood volume influences blood pressure and, thus, affects the health of the cardiovascular system.

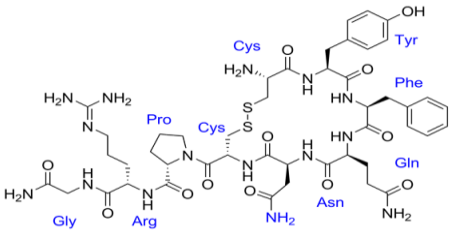


Homeostasis – Regulating Reabsorption of Water

The hypothalamus regulates mechanisms that enable the body to maintain homeostasis. When blood plasma becomes too concentrated (for example, if you are dehydrated), osmotic pressure increases. In response, osmoreceptors in the hypothalamus send impulses to the adjacent pituitary gland in the brain that causes the release of antidiuretic hormone(ADH).

_____

hormone regulated by the hyphothalamus and released by the pituitary gland that increases the permeability of the distal tubule and the collecting duct in the nephrons of the kidneys, allowing more water to be reabsorbed into the blood from the filtrate



Conversely, if blood plasma is too dilute (that is, if the osmotic pressure is too low), osmoreceptors stop or prevent the release of ADH.

As a result, the distal tubule and the collecting duct become less permeable to water.

This allows more water to be excreted in the urine, concentrating the solutes in the blood. The osmotic pressure of the plasma and tissue fluids rises to normal.

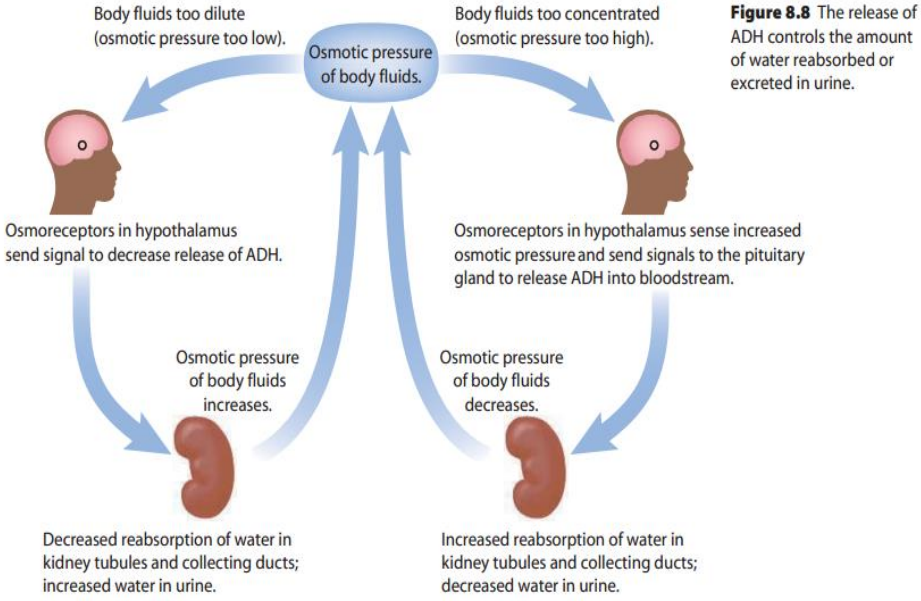
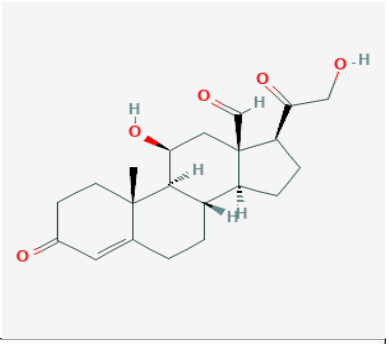


Figure 8.8 The release of ADH controls the amount of water reabsorbed or excreted in urine.

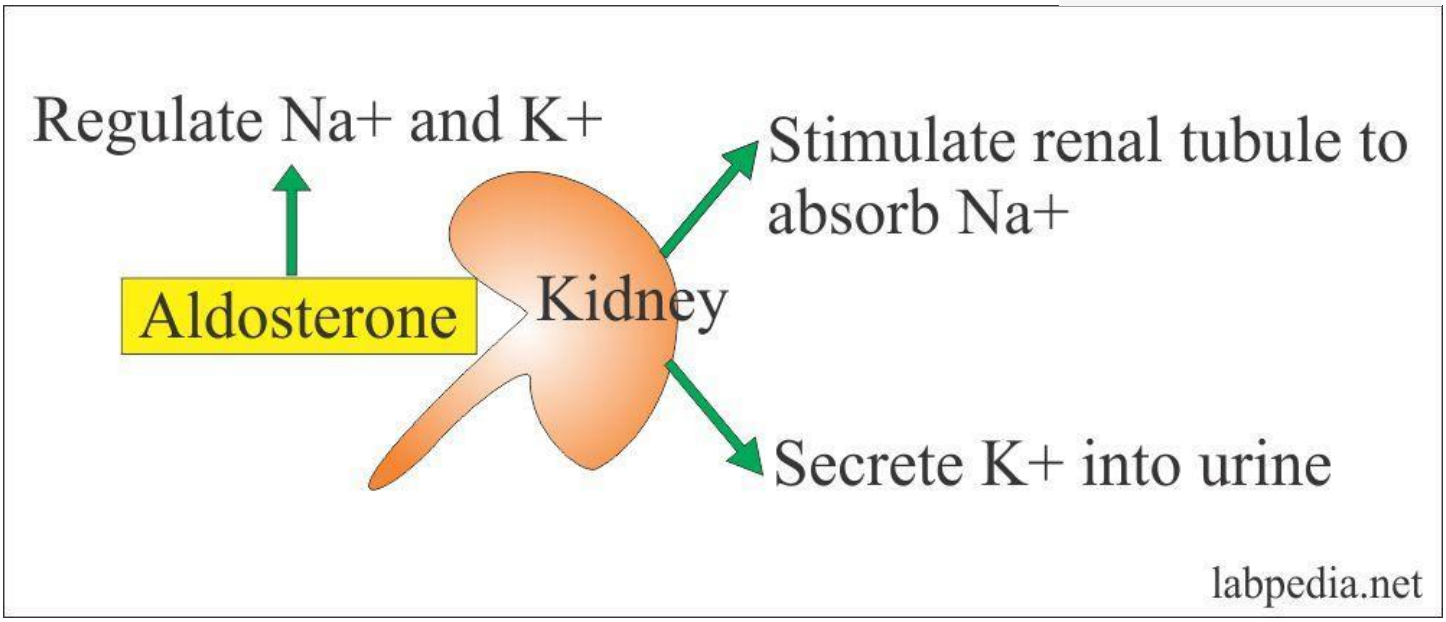
NEGATIVE FEEDBACK LOOP

Homeostasis - Reabsorption of Salts



_____ a type of mineralocorticoid hormone secreted by the adrenal cortex**; stimulates the distal tubule and collecting duct of the kidneys to increase the absorption of sodium into the bloodstream**, which is followed by the passive absorption of water and chloride

Aldosterone **also stimulates the secretion of potassium ions (K+) into the distal tubes and collecting ducts if K+concentration in the blood is too high.**



Disorder Poster Research Project

CASE STUDY Make a Decision

Investigation 8.A Identifying Structures of the Excretory System