Lecture Exam 4

STUDY GUIDE

TOPICS COVERED:

The Renal/Urinary System

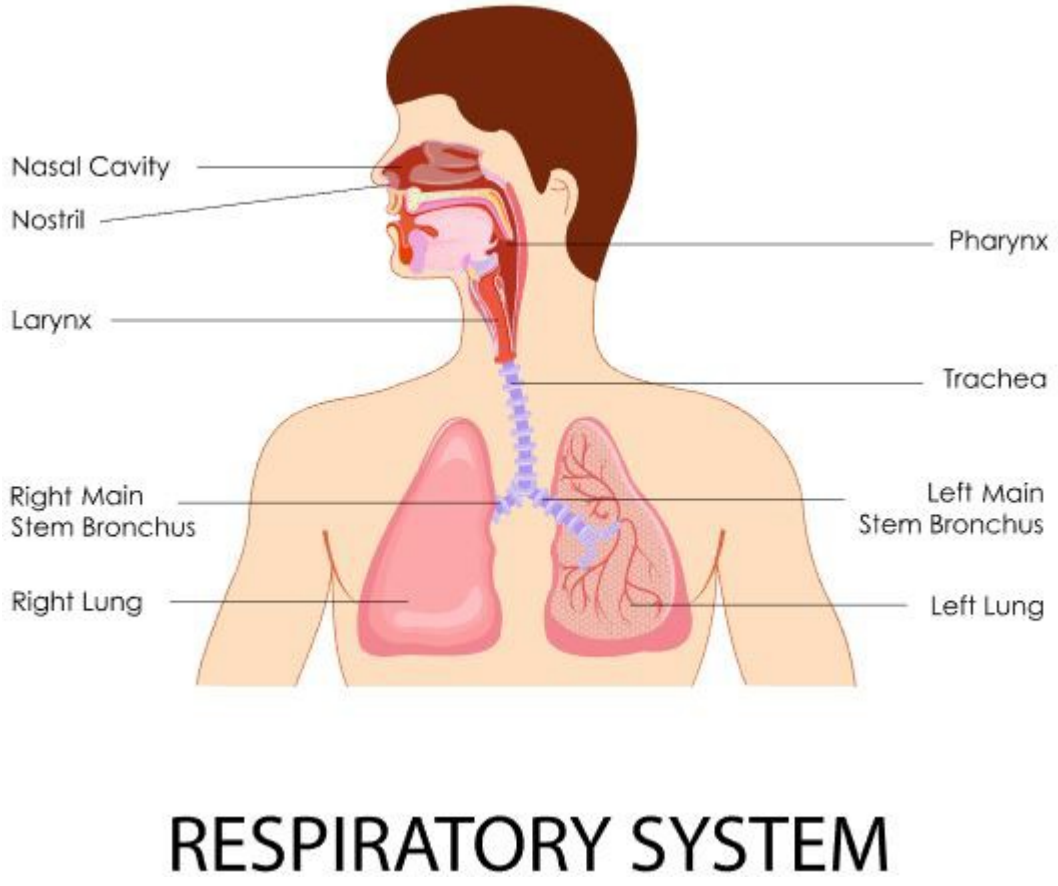
The Respiratory System

The Respiratory System

BY SCIENTIST CINDY

Divisions of the Respiratory Tract

- The respiratory tract is the path of air from the nose to the lungs. It is divided into two sections: **Upper Respiratory Tract** and the **Lower Respiratory Tract**.
  - The upper respiratory tract consists of the **Nostrils**, **Nasal Cavities**, **Pharynx**, **Epiglottis**, and the **Larynx**.
  - The lower respiratory tract consists of the **Trachea**, **Bronchi**, **Bronchioles**, and the **Lungs**.



The four primary processes of respiration are:

BREATHING or ventilation

EXTERNAL RESPIRATION, which is the exchange of gases (oxygen and carbon dioxide) between inhaled air and the blood.

INTERNAL RESPIRATION, which is the exchange of gases between the blood and tissue fluids.

CELLULAR RESPIRATION

The secondary processes of respiration include:

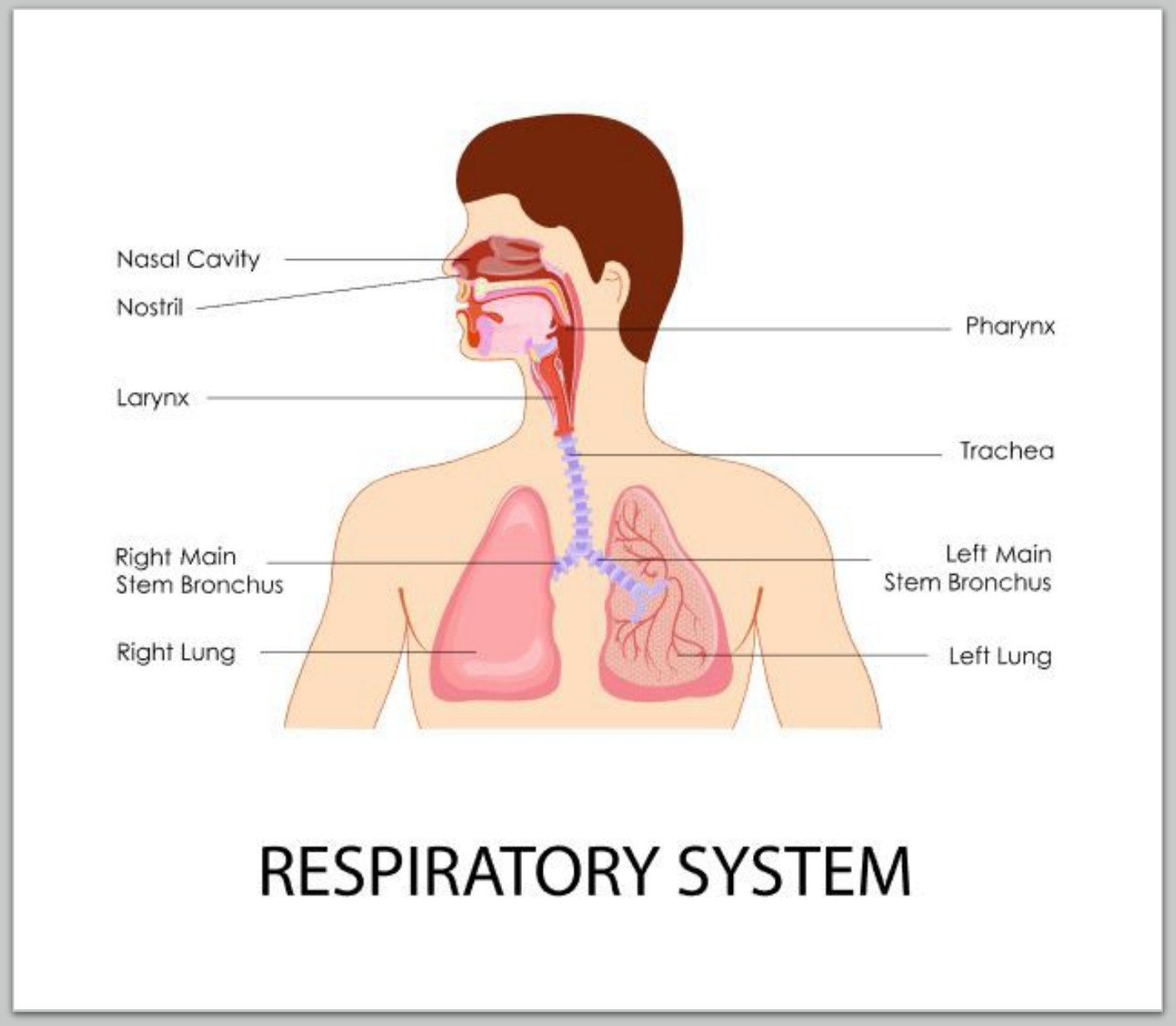
REGULATION OF BLOOD pH, which occurs in coordination with the kidneys

DEFENSE AGAINST MICROBES

CONTROL OF BODY TEMPERATURE due to loss of evaporate during expiration

The Pathway of Air

1. **nasal cavities**
2. **pharynx *(nasopharynx, oropharynx, and laryngopharynx)***
3. **larynx**
4. **trachea**
5. **bronchi *(right bronchus and left bronchus)***

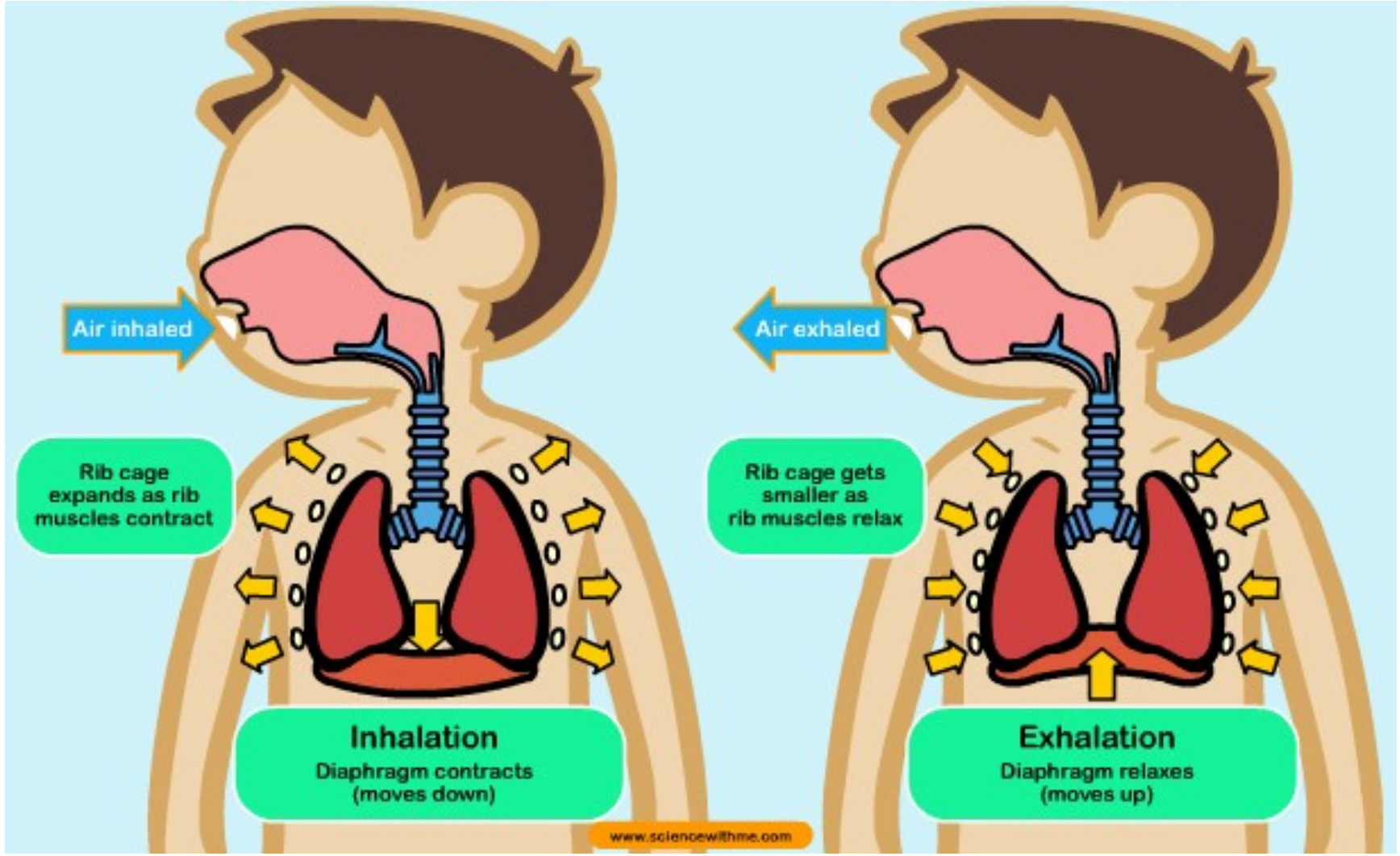


Breathing and Lung Mechanics

Ventilation

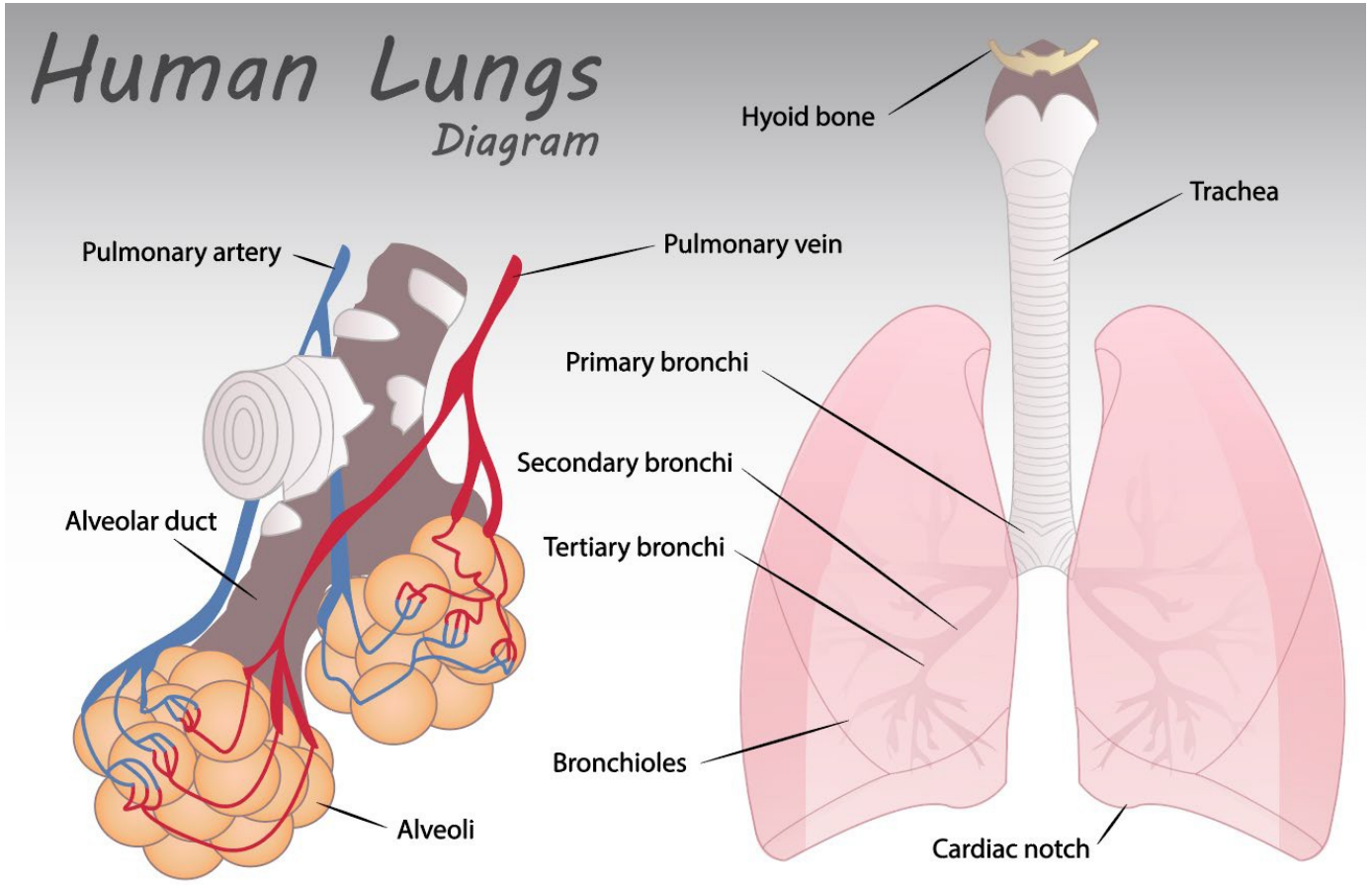
•There are two phases of ventilation;

- Inspiration
- Expiration



Breathing and Lung Mechanics – Ventilation

Ventilation is the exchange of air between the external environment and the alveoli.



Breathing and Lung Mechanics – Ventilation

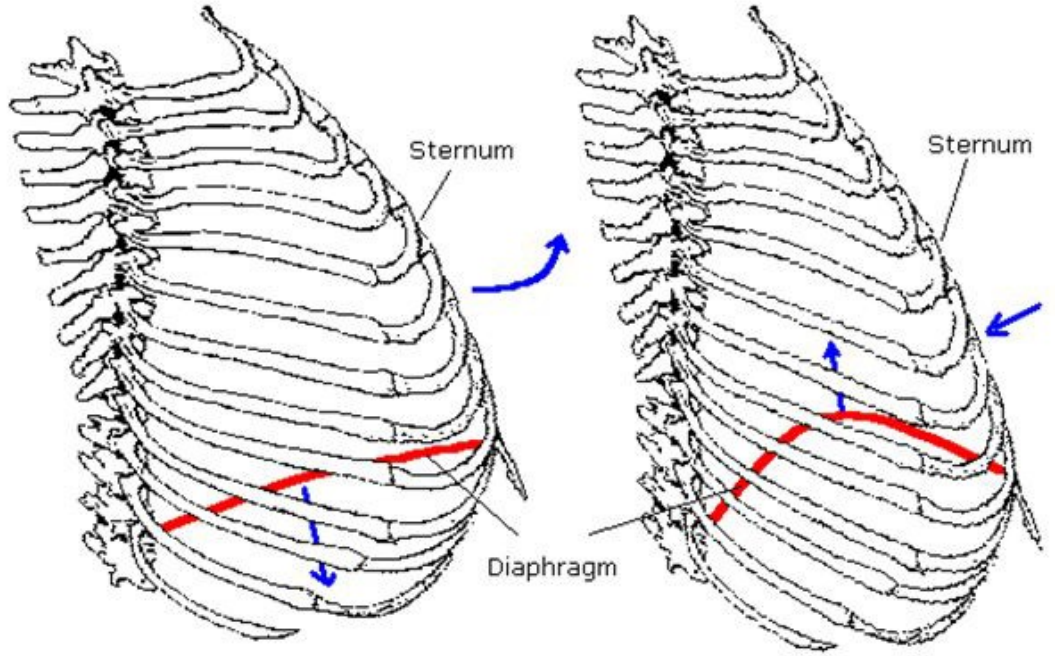
Air moves by bulk flow from an area of high pressure to low pressure.

Air outside → Air inside

PRESSURE CHANGES

High pressure → Low pressure

Breathing in and out



Breathing in:

Sternum rotated upwards as intercostals contract. Diaphragm descends

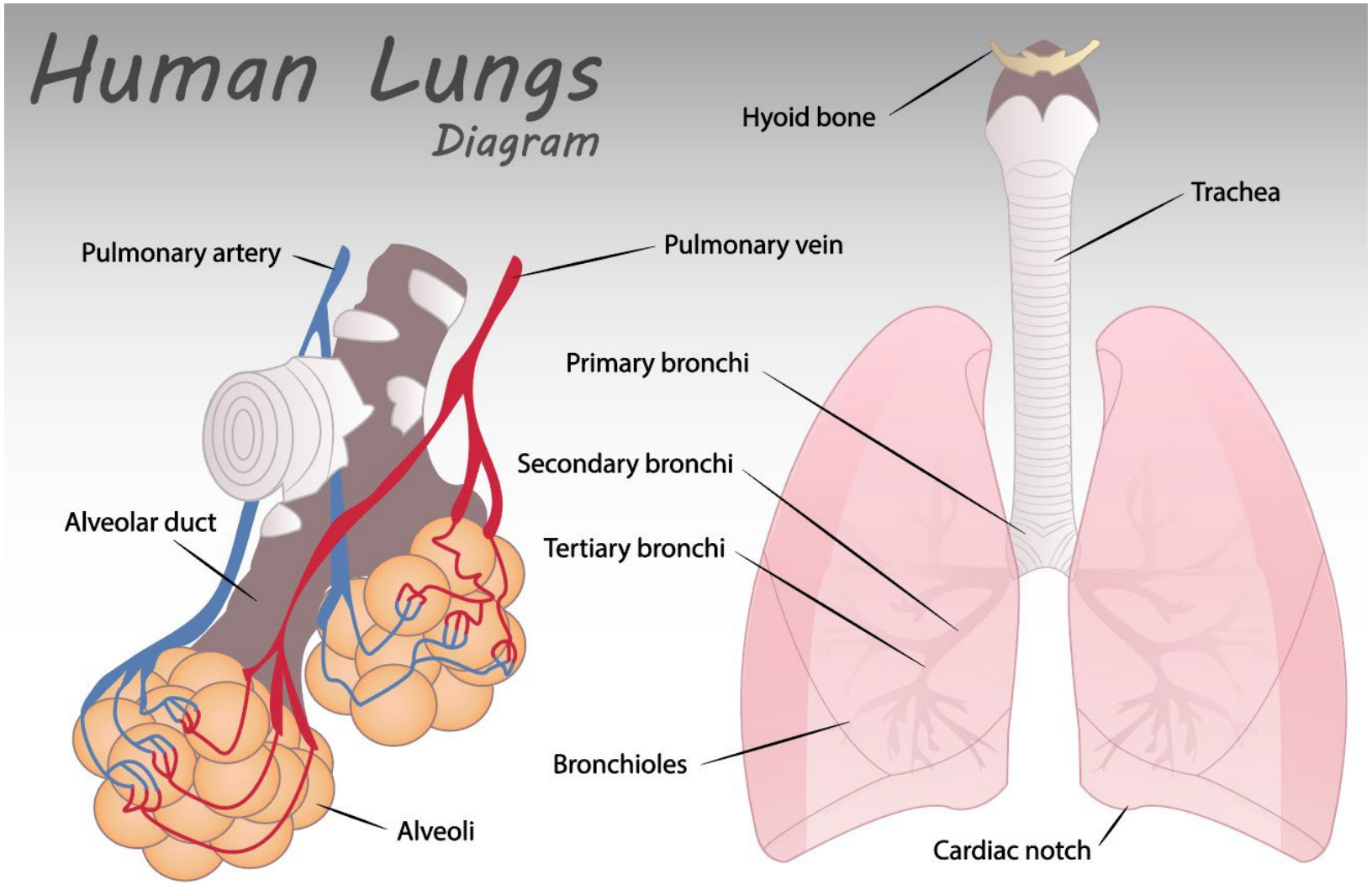
Breathing out:

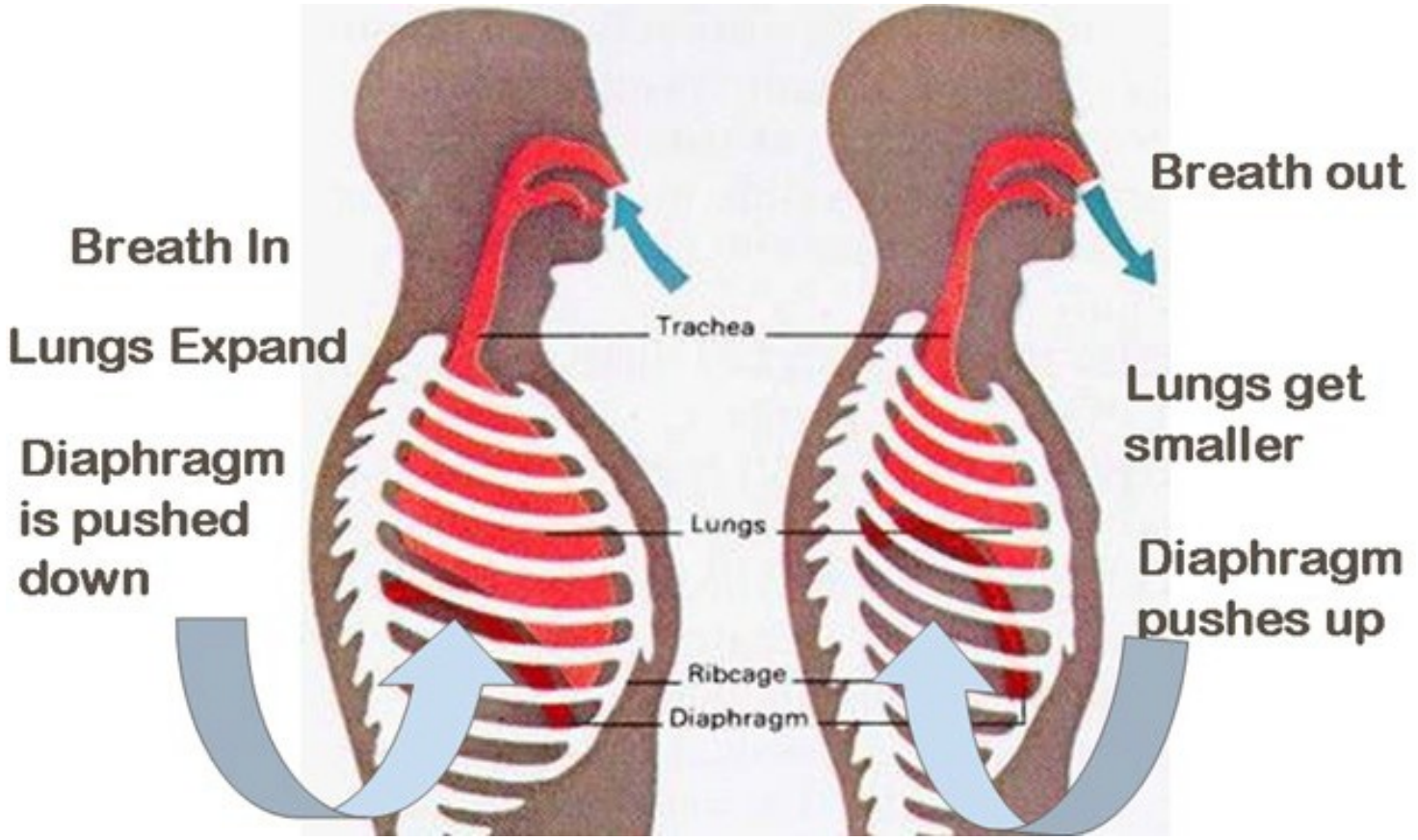
Sternum rotates downwards as intercostals relax. Diaphragm ascends.

Pleural membrane covers lungs and allows smoother movement

Breathing and Lung Mechanics – Ventilation

- Air will move in or out of the lungs depending on the pressure in the alveoli.
- The body changes the pressure in the alveoli by changing the volume of the lungs.
- As volume increases pressure decreases and as volume decreases pressure increases.

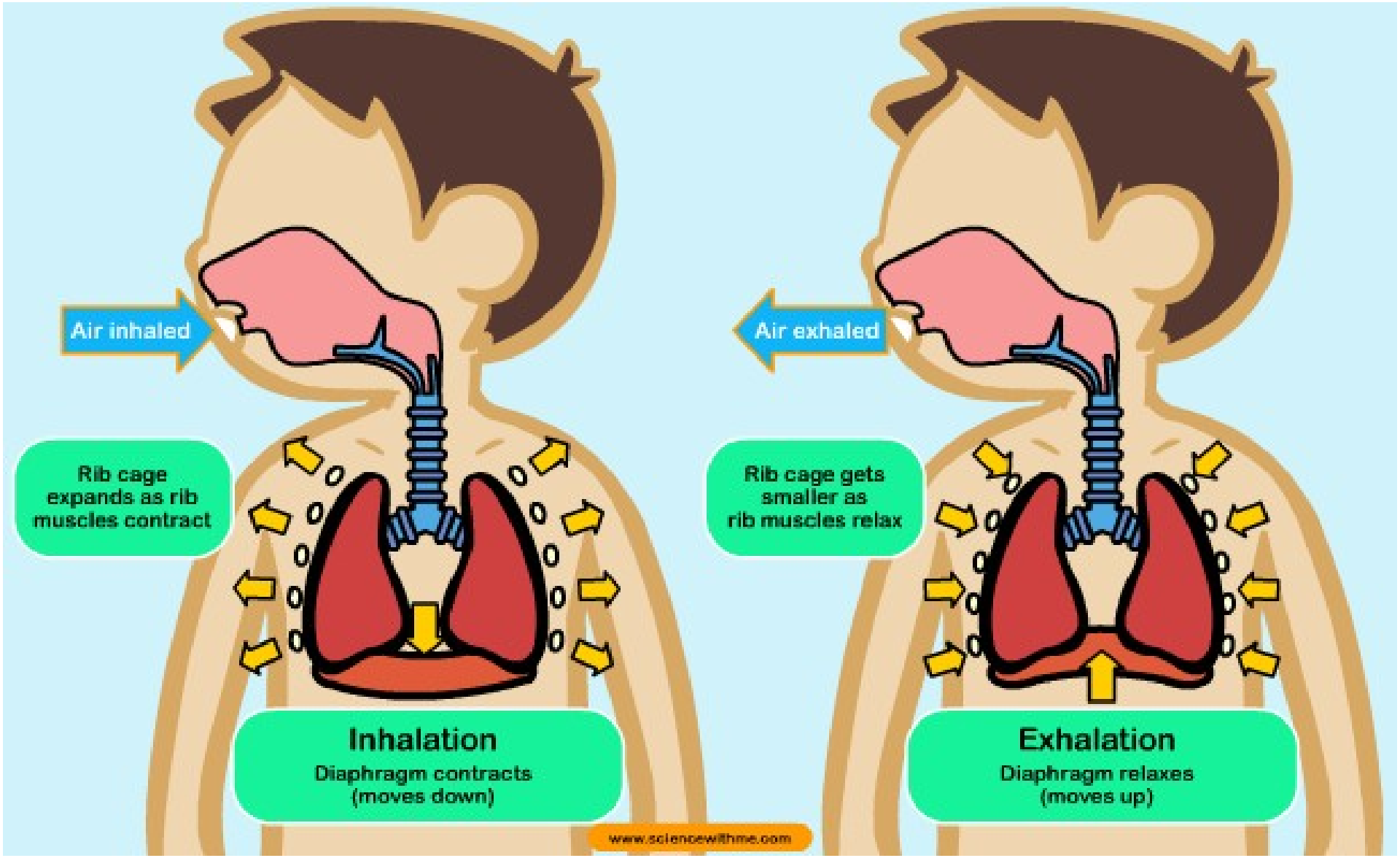




Changes in Intrapulmonary Pressure

Changes in pressure are driven by changing the volume of the lungs.

- Gas pressure DECREASES when lung volume INCREASES
- Gas pressure INCREASES when lung volume DECREASES


Air inhaled
Rib cage expands as rib muscles contract
Inhalation
Diaphragm contracts (moves down)
Air exhaled
Rib cage gets smaller as rib muscles relax
Exhalation
Diaphragm relaxes (moves up)
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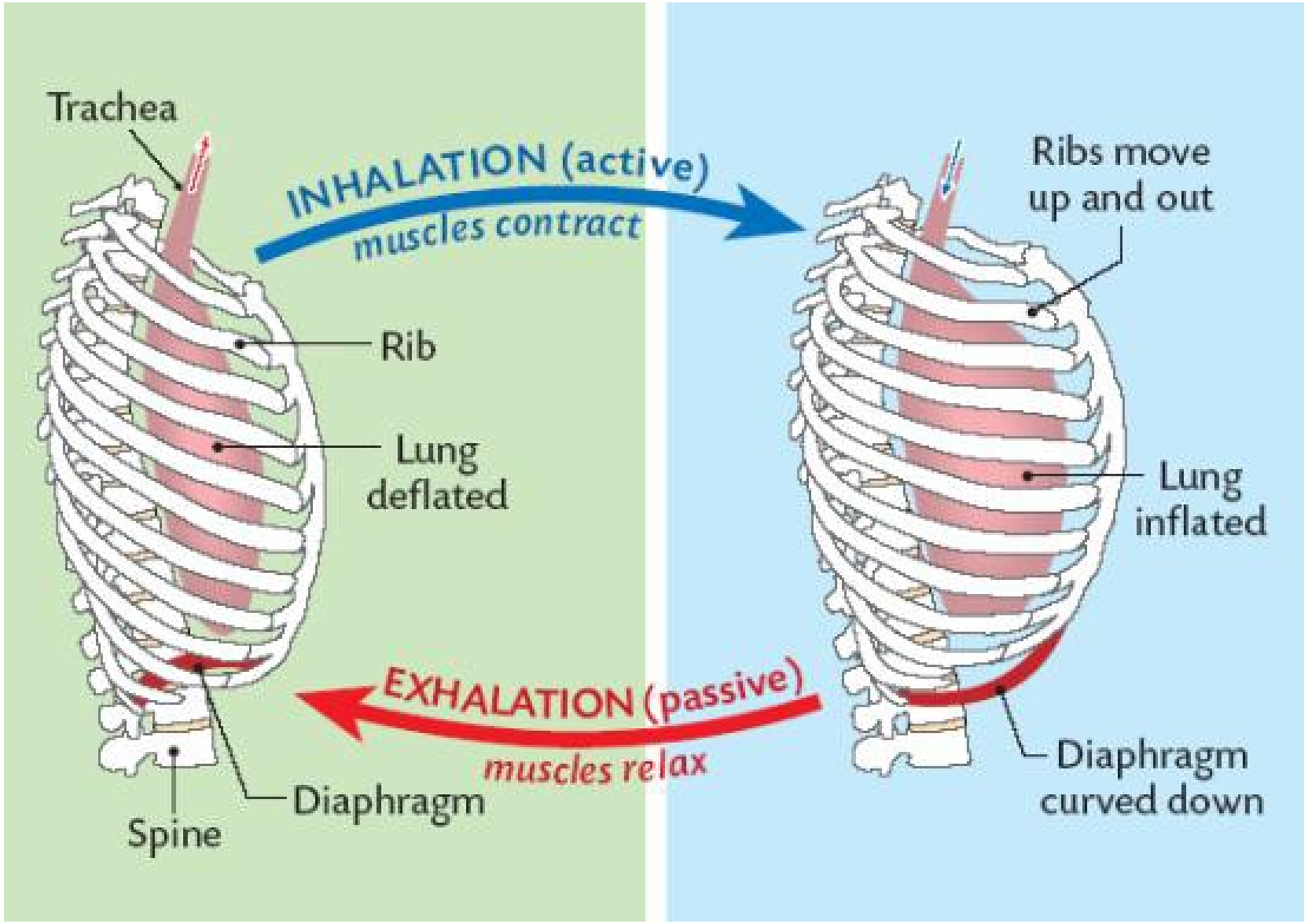
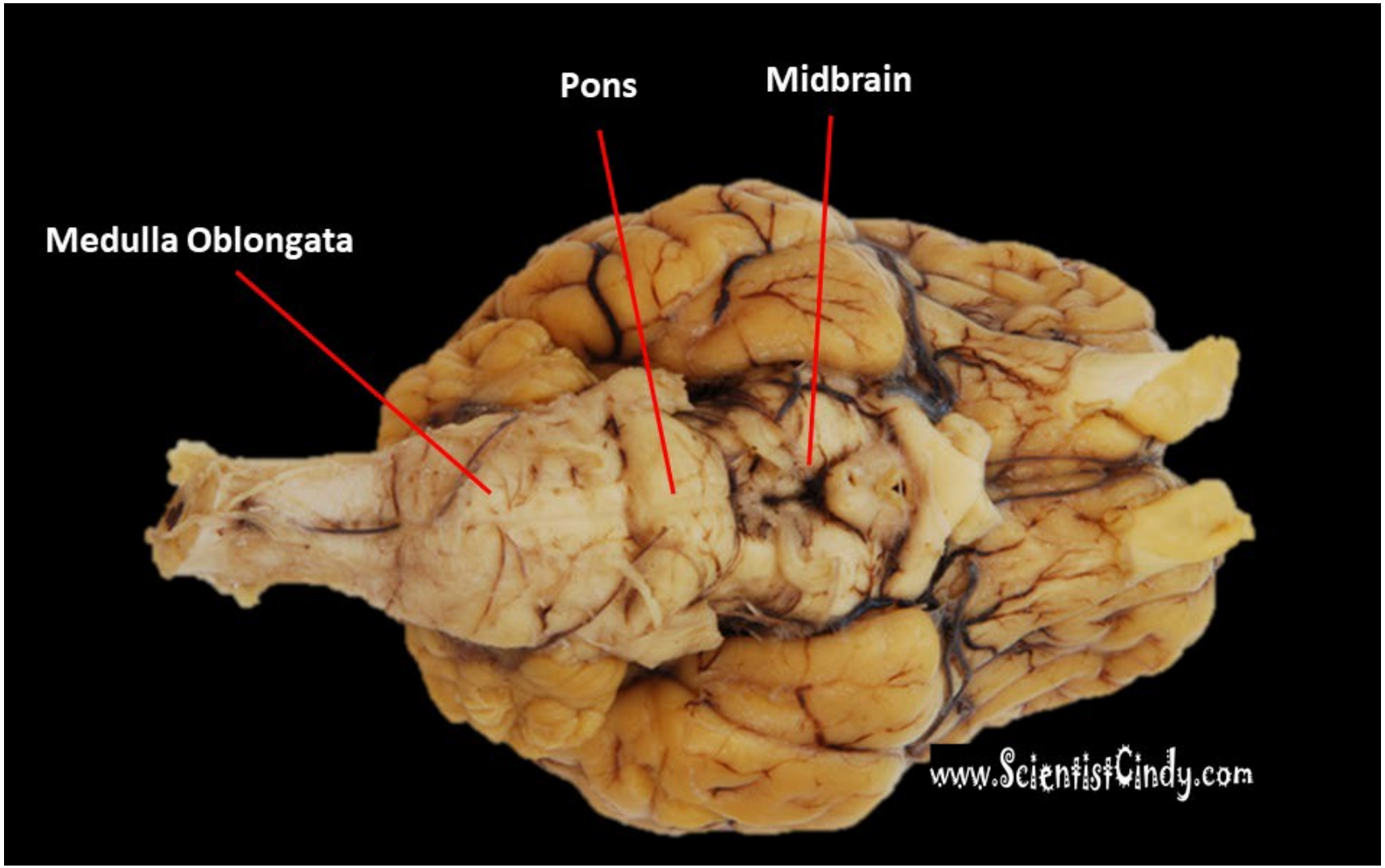

Trachea
INHALATION (active)
muscles contract
Rib
Lung
deflated
Ribs move
up and out
Lung
inflated
EXHALATION (passive)
muscles relax
Diaphragm
Spine
Diaphragm
curved down

Control of Ventilation

- The rhythm of ventilation is also controlled by the "Respiratory Center" which is located largely in the medulla oblongata of the brain stem.
- This is part of the autonomic nervous system and is involuntarily.

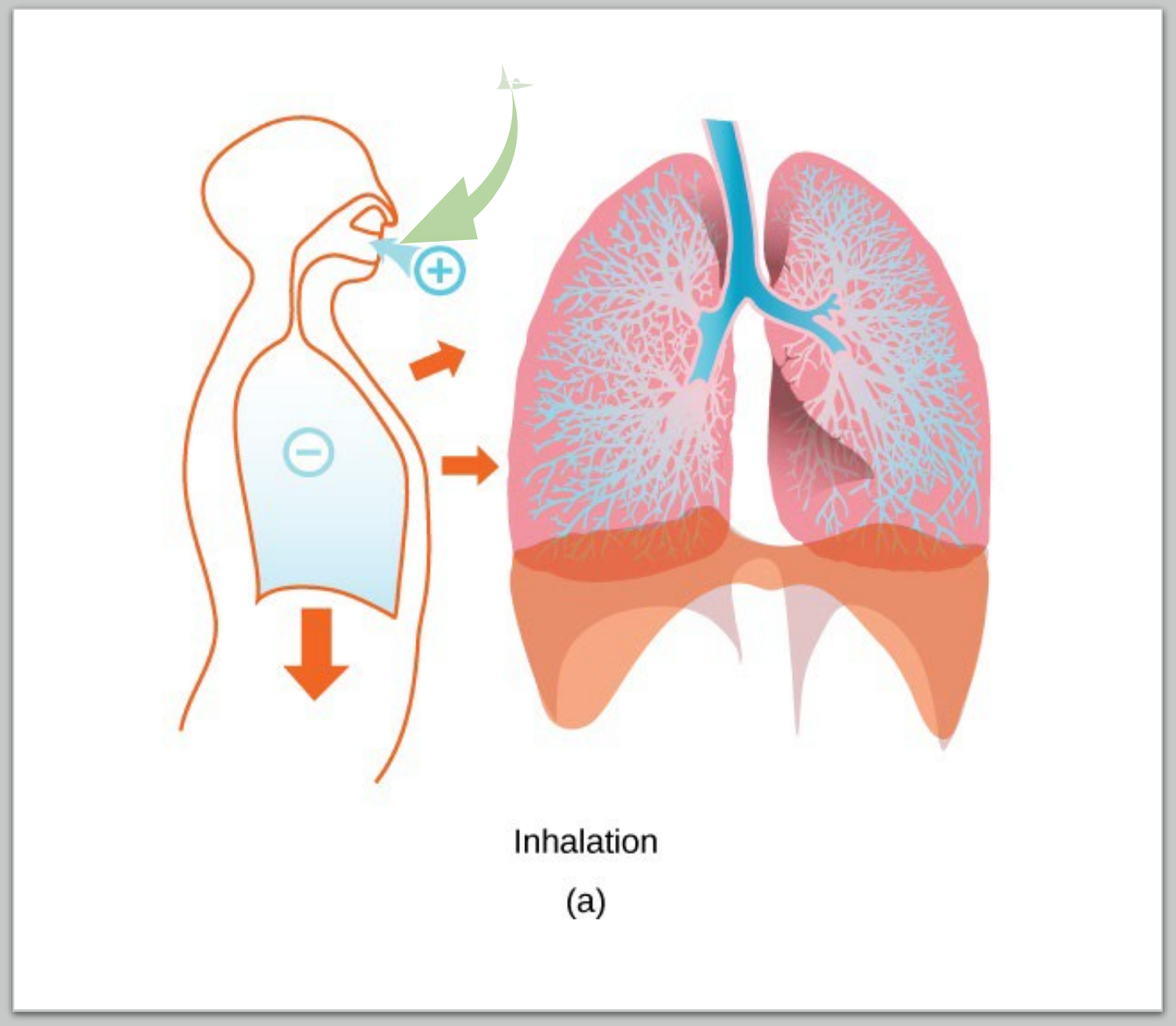


Inspiration (Inhalation)

During normal quiet breathing,

•**Inspiration is initiated by contraction of the diaphragm -**

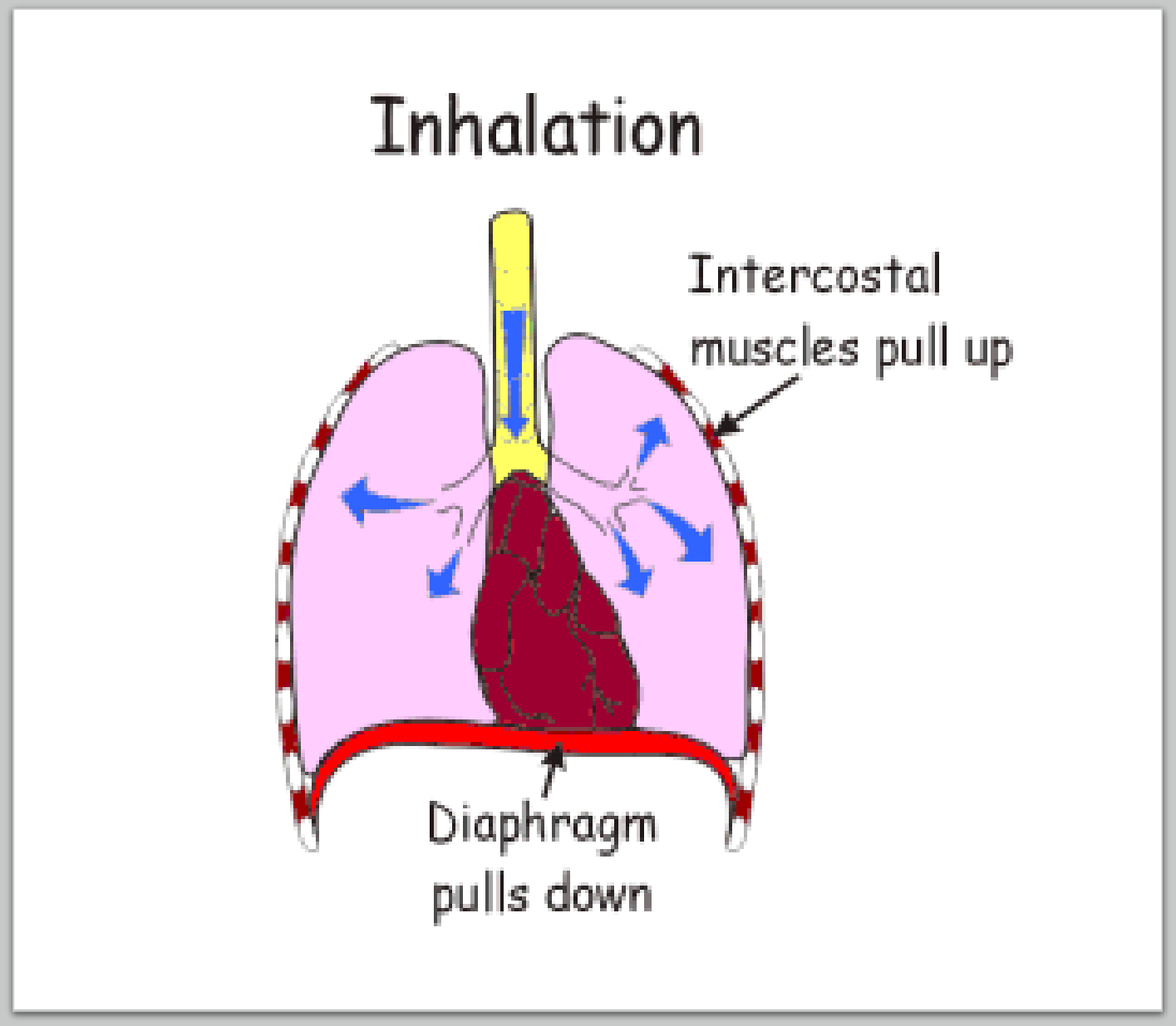
- **When the diaphragm contracts it moves downward toward the abdomen**.
- This downward movement of the diaphragm
  - Enlarges lung volume
  - Decreases lung pressure
  - Air moves from low pressure to high pressure, so air flows INTO the lungs.



Inspiration (Inhalation)

During forceful breathing,

- **Inspiration is assisted by the intercostal muscles**
- **initiated by contraction of the intercostal muscles -**
  - **When the intercostal muscles contract, the rib cage moves…**
    - **Upward and Outward**
  - This upward and outward movement of the rib cage
    - Enlarges lung volume
    - Decreases lung pressure
    - Air moves from low pressure to high pressure, so air flows INTO the lu

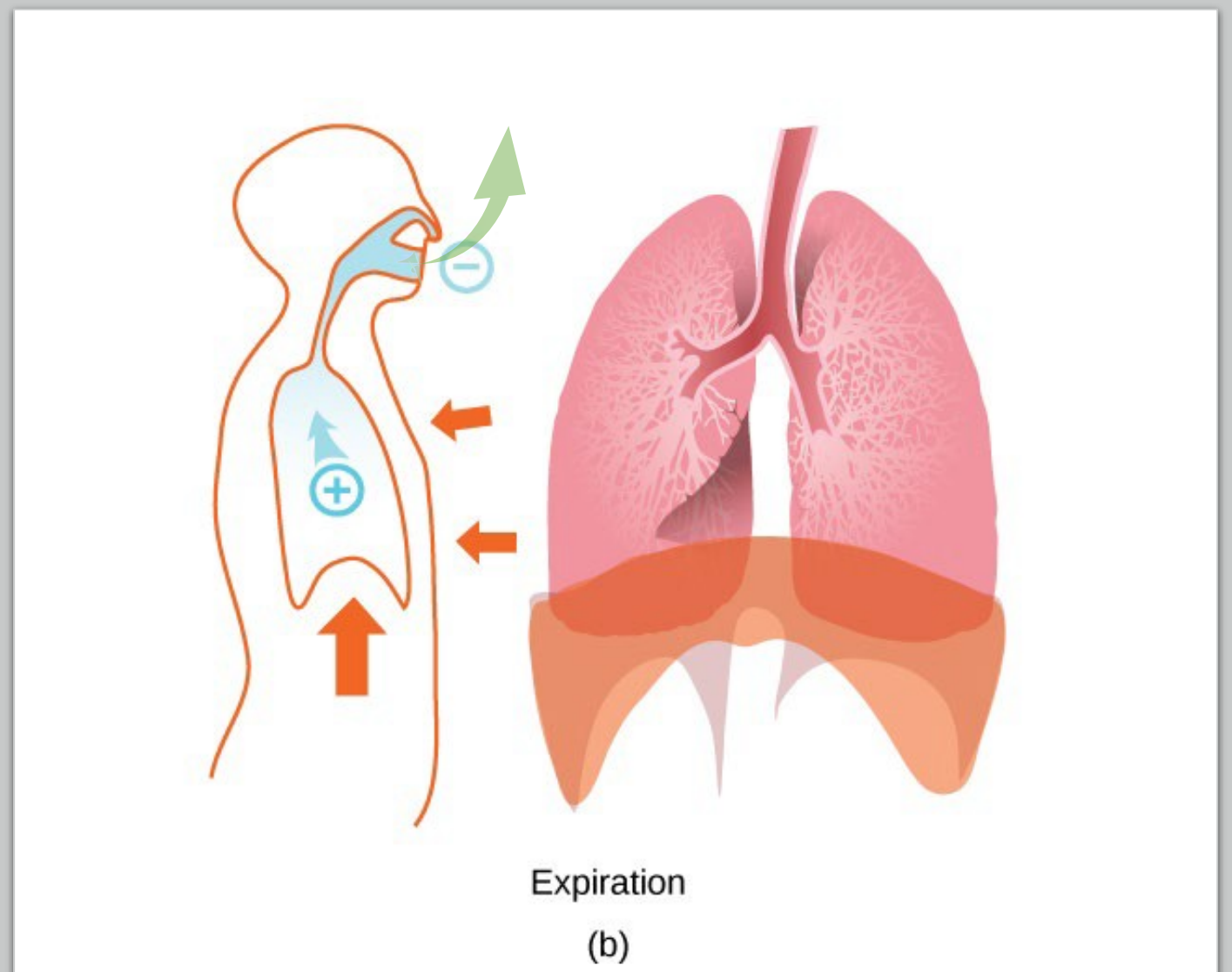


Expiration (Exhalation)

During normal quiet breathing,

•Expiration is initiated by RELAXATION of the diaphragm -

- **When the diaphragm RELAXES it moves UPWARD toward the thorax (chest).**
- This upward movement of the diaphragm
  - Decreases lung volume
  - Increases lung pressure
  - Air moves from low pressure to high pressure, so air flows **OUT OF** the lungs.



During quiet breathing, expiration is normally a passive process and does not require muscles to work (rather it is the result of the muscles relaxing).

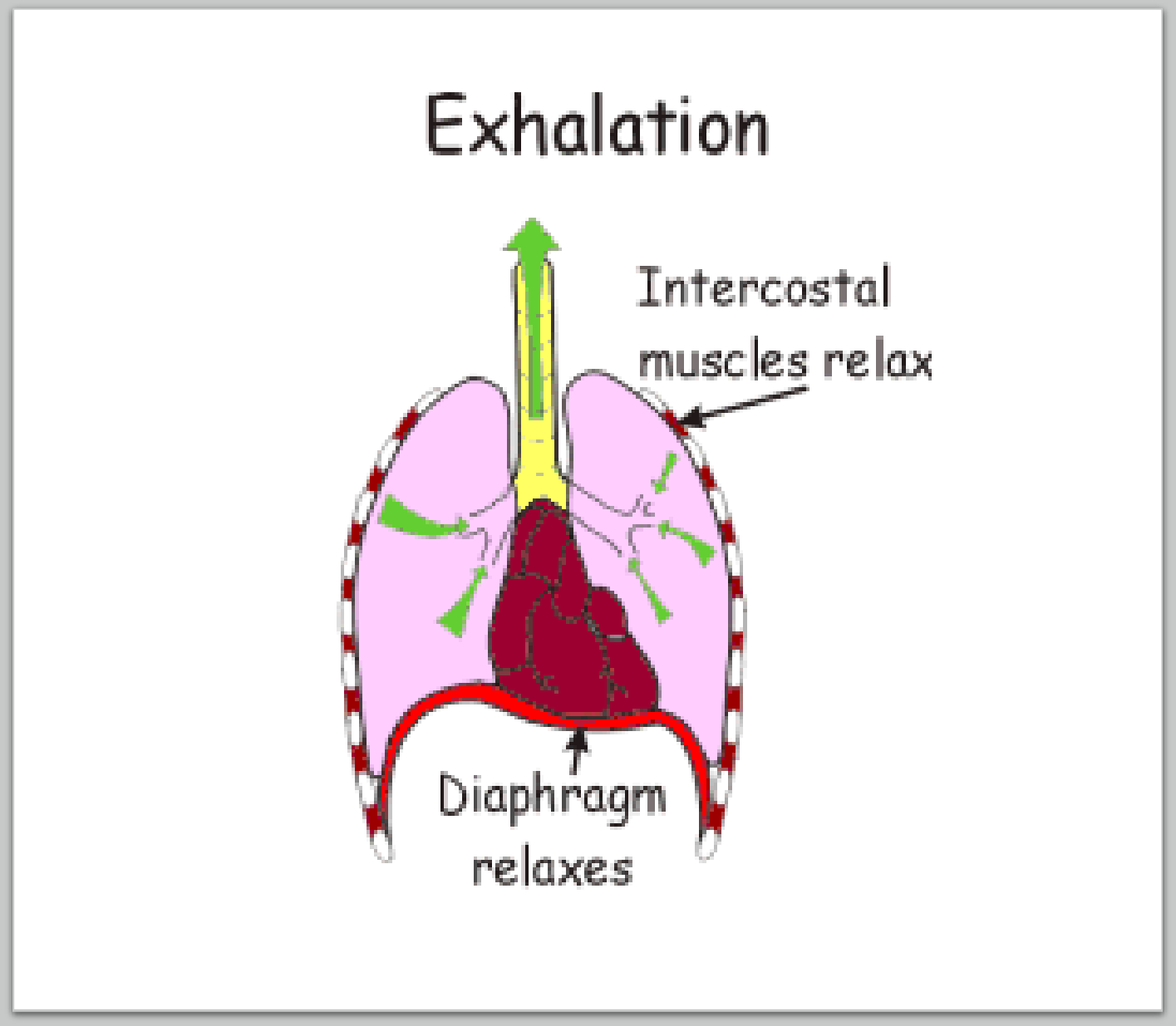
Expiration (Exhalation)

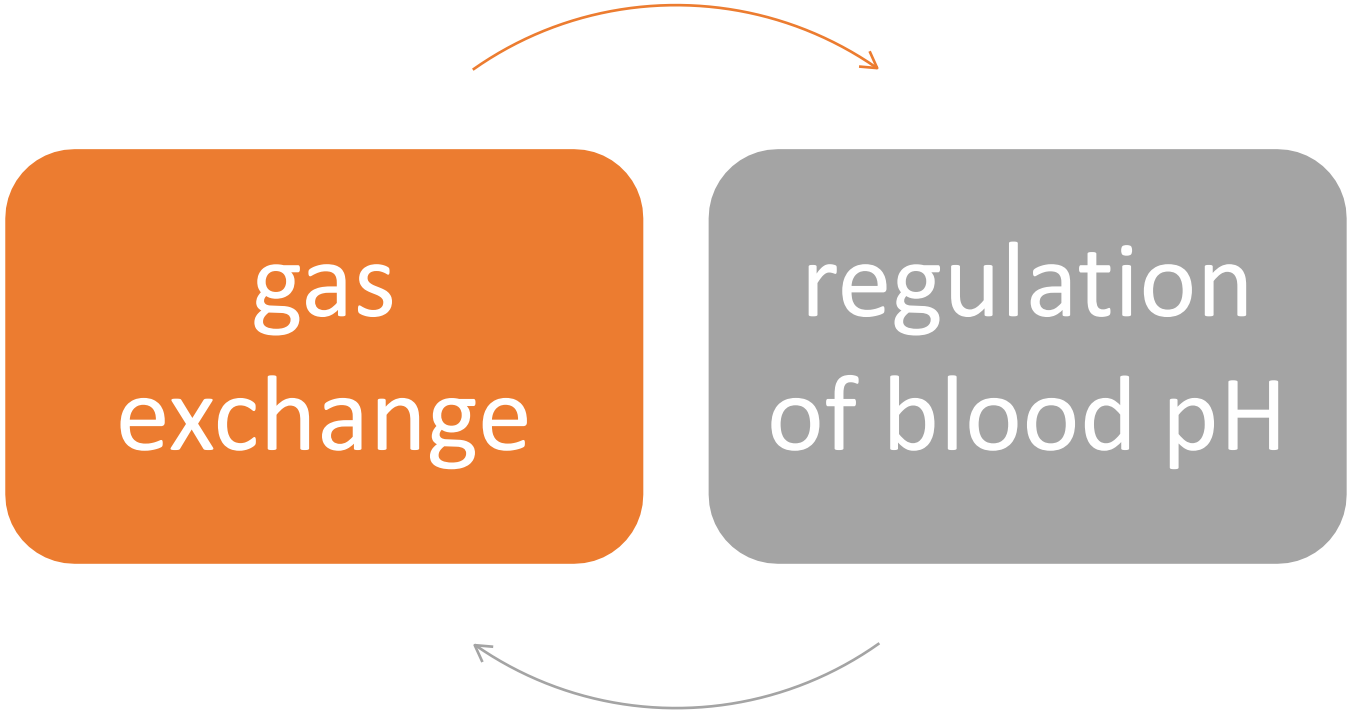
During forceful breathing,

•**Expiration is initiated by the RELAXATION of the intercostal muscles**

•**RELAXATION of the intercostal muscles causes the rib cage to move downward and Inward**

- This **Downward and Inward** movement of the rib cage
  - Decreases lung volume
  - Increases lung pressure
  - Air moves from low pressure to high pressure, so air flows **OUT OF** the lungs.





Homeostasis is maintained by the respiratory system in two ways:

Gas exchange

Gas exchange is performed by the lungs

- supplying oxygen
- eliminating carbon dioxide

Fig 2. **Gas exchange in the lungs**

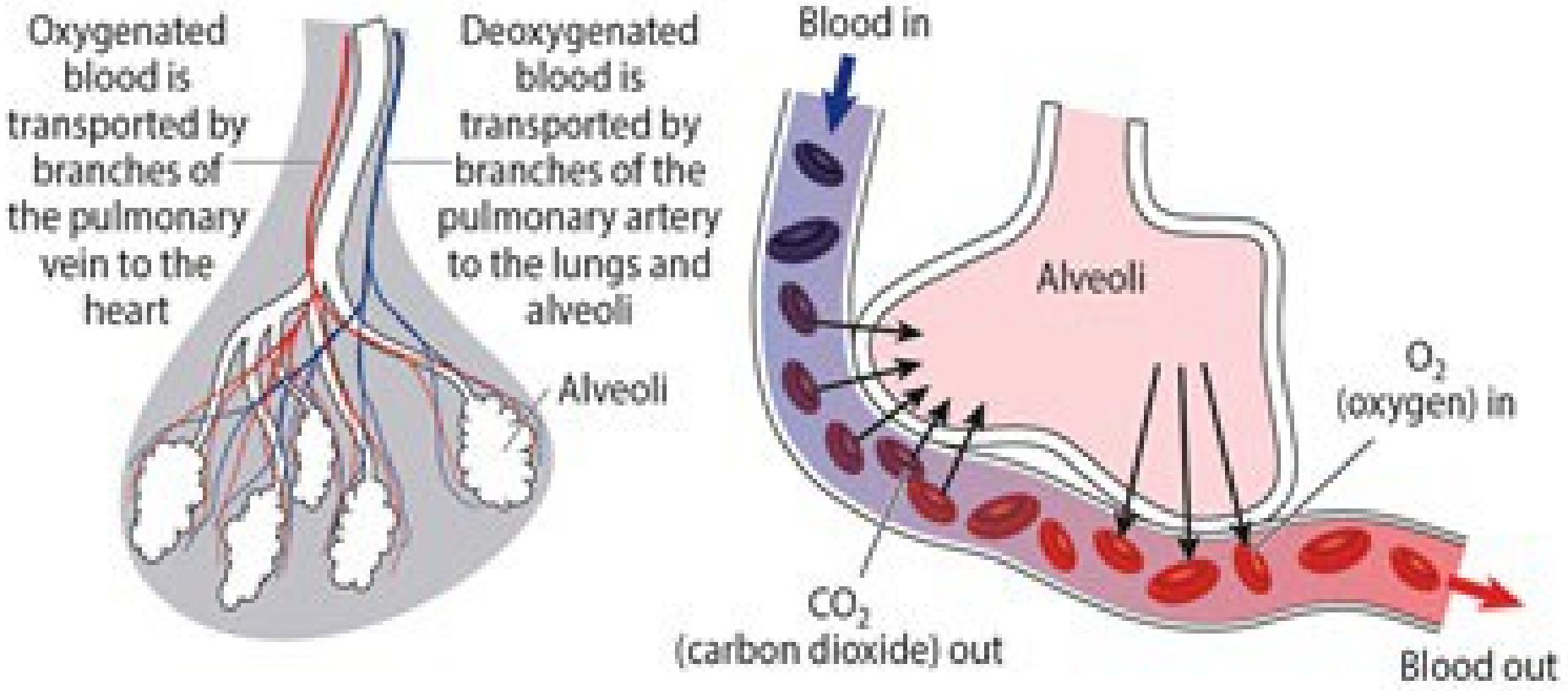
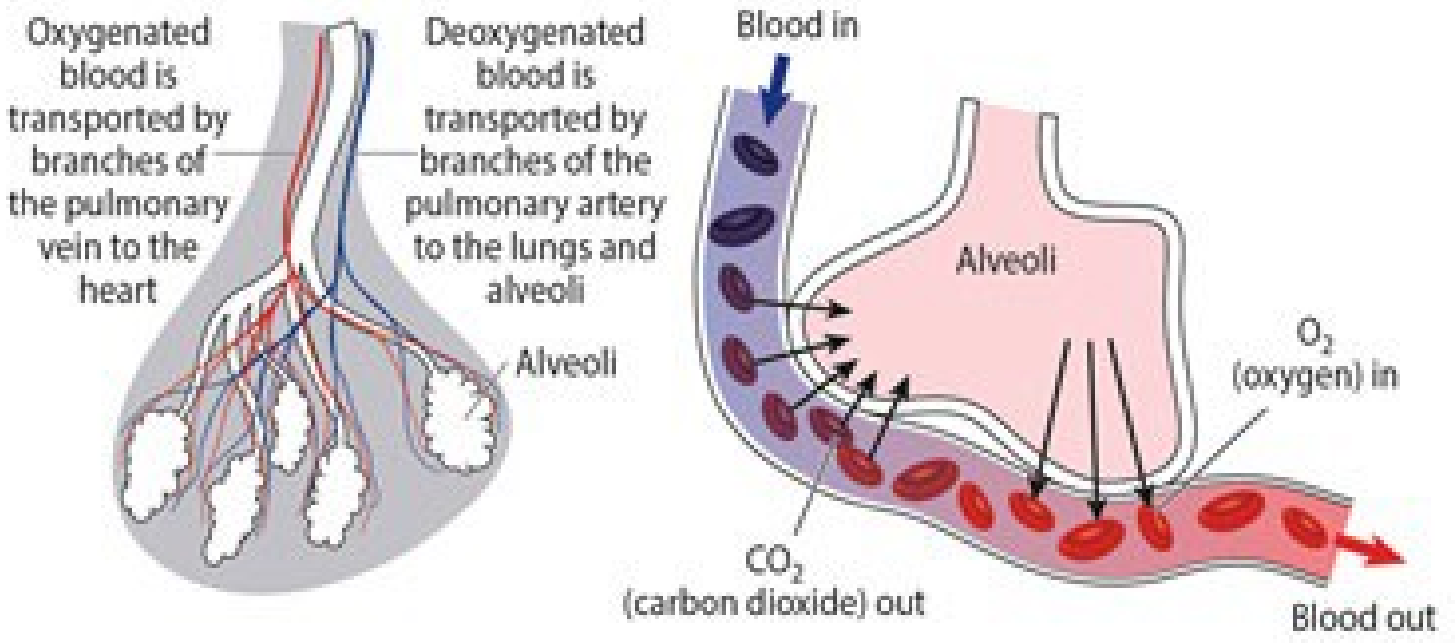


Fig 2. **Gas exchange in the lungs**



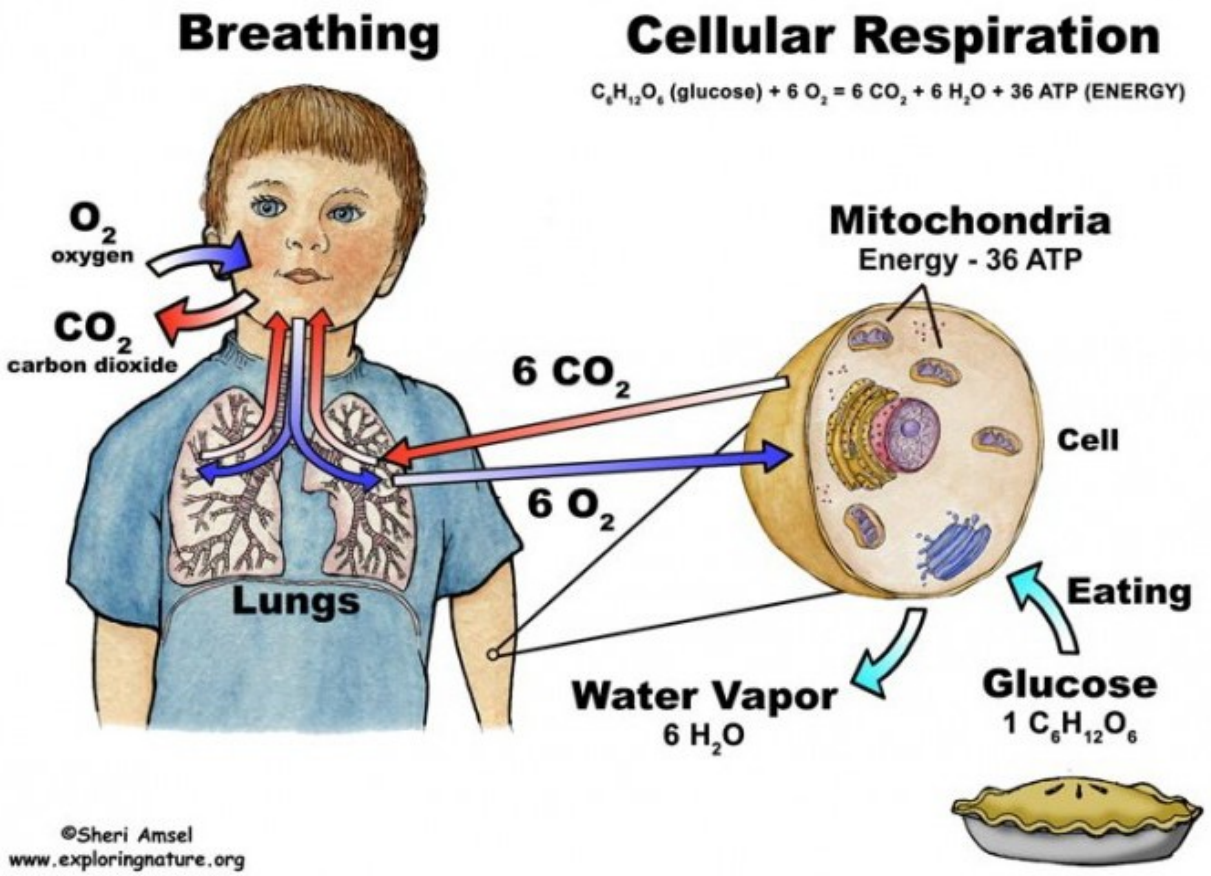
Gas exchange

- Gas exchange takes place between the air in the alveoli of the lungs, and the blood in the pulmonary capillaries.
  - •Gas exchange is the result of a pressure gradient or concentration gradient that exists between the alveoli and the blood.
  - •This process of gas exchange is done through diffusion.

Gas exchange

Carbon dioxide is a waste product given off by cellular respiration.

- As carbon dioxide exits the body, oxygen needed for cellular respiration enters the body through the lungs.
- ATP, produced by cellular respiration, provides the energy for the cells of the body.



carbon dioxide (CO_2)

- Most of the carbon dioxide is carried to the lungs **in plasma** as bicarbonate ions (HCO_3^-).
  - When blood enters the pulmonary capillaries, the bicarbonate ions and hydrogen ions are converted first into carbonic acid (H_2CO_3) and then converted into carbon dioxide (CO_2) and water.
- This chemical reaction removes hydrogen ions.
- This neutralizes acidity (low pH).

De-oxygenated blood

- ***Deoxygenated*** blood coming ***from the pulmonary arteries*** has…
  - An O_2 partial pressure (pp) of ~40 mmHg
  - A CO_2 partial pressure (pp) of ~45 mmHg
- ***Oxygenated*** blood leaving the lungs ***through the pulmonary veins*** has…
  - An O_2 partial pressure (pp) of ~100 mmHg
  - A CO_2 partial pressure (pp) of ~40 mmHg
- The partial pressure (pp) of O_2 in the alveoli is ~105 mmHg

Internal Respiration

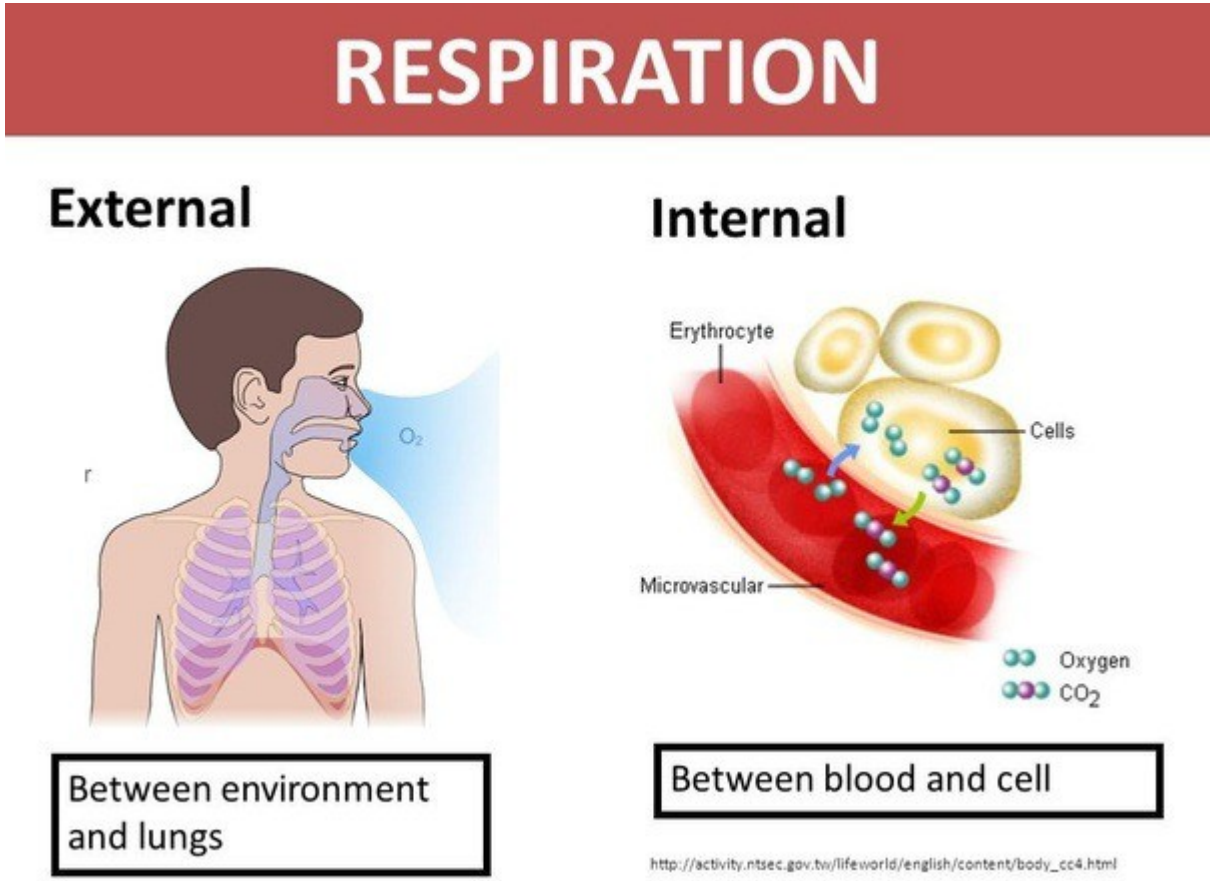
Internal respiration is the exchanging of gases at the cellular level.

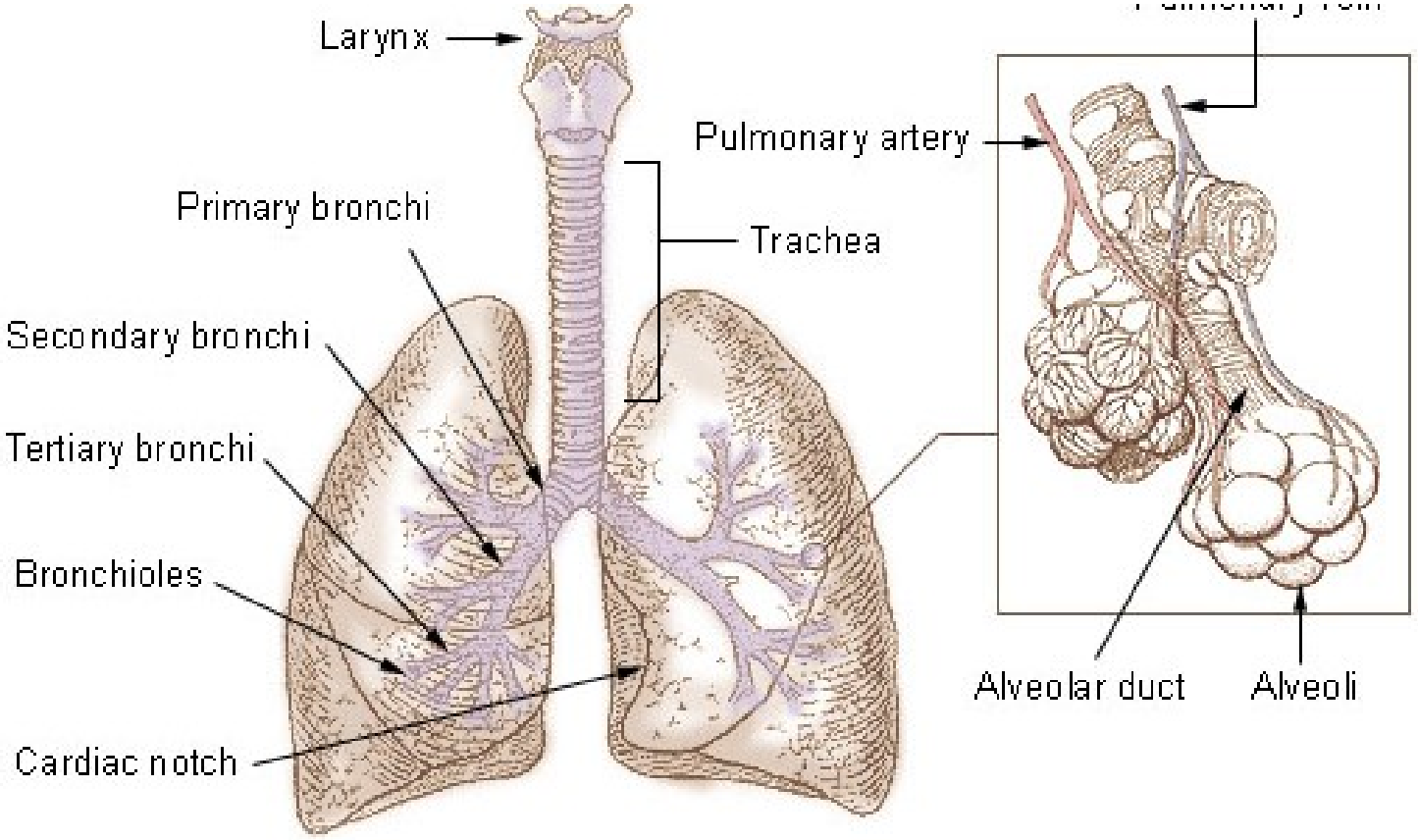
The Passage Way From the Trachea to the Bronchioles

•The inferior portion of the trachea to form the right primary bronchus and left primary bronchus.

- The point at which the trachea branches to form these bronchi is called the **Carina.**

- The **Bronchial Tree** is a series of respiratory tubes that branch off into smaller and smaller tubes as they run throughout the lungs.



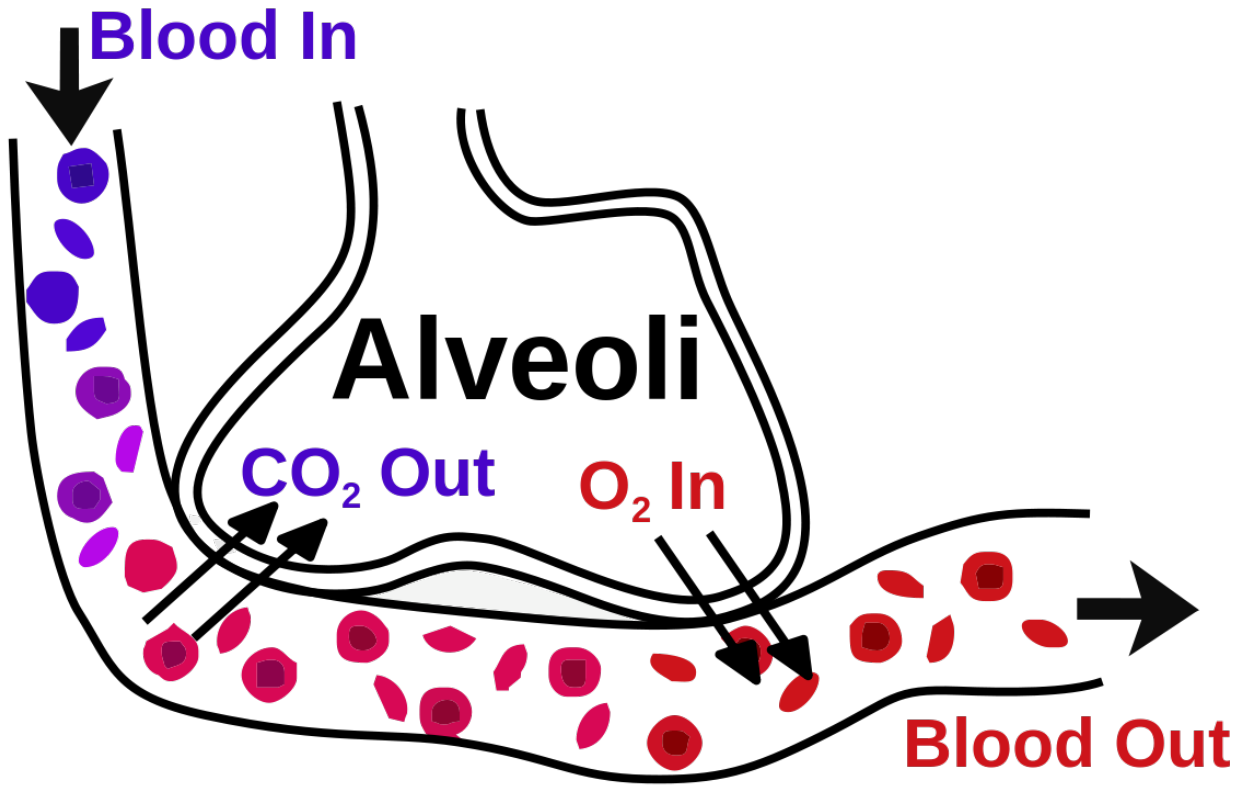


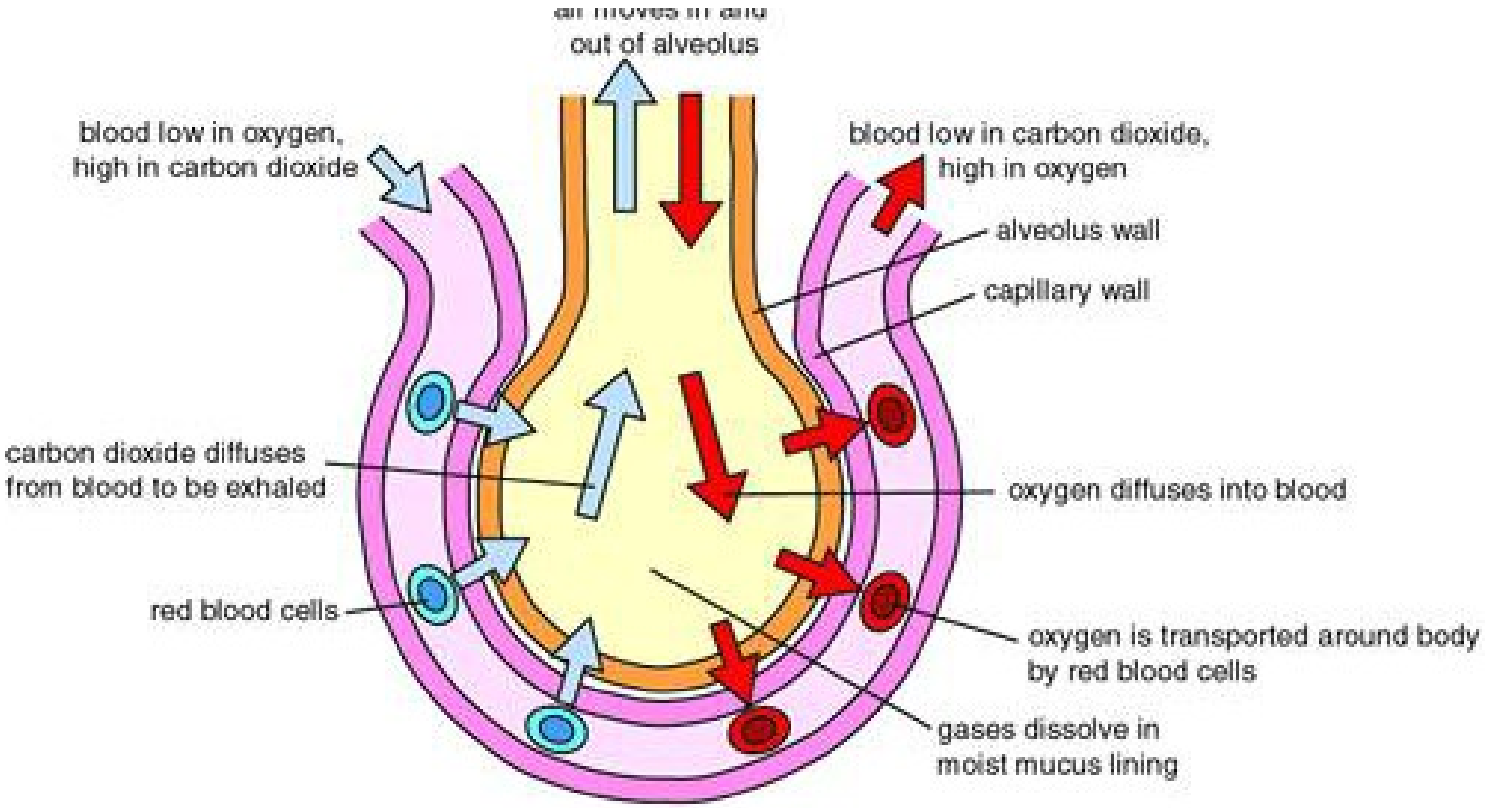
Bronchial Tree

- The lungs are attached to the heart and trachea through structures that are called the **roots of the lungs**.
  - The roots of the lungs are the bronchi, pulmonary vessels, bronchial vessels, lymphatic vessels, and nerves.
  - These structures enter and leave at the **hilus** of the lung
- There are a number of **terminal bronchioles** connected to **respiratory bronchioles** which then advance into the **alveolar ducts** that then become **alveolar sacs**.
- Each bronchiole terminates in an elongated space enclosed by many air sacs called **alveoli** which are surrounded by blood capillaries.

Alveoli

- The **Pulmonary Alveoli** are membranous air sacs within the lungs.
- Alveoli are units of respiration and the site of gas exchange between the respiratory and circulatory systems.



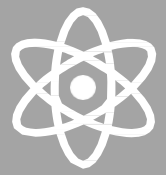


Oxygen Diffusion

- Oxygen diffuses alveolus into the capillaries
  - Capillaries are permeable to oxygen.
  - Once in the capillary
    - ~ 5% of the oxygen will be dissolved in the blood plasma.
    - ~ 95% of the oxygen will bind to hemoglobin in red blood cells.

Cellular Respiration

It is in the mitochondria of the cells where oxygen is actually consumed and carbon dioxide produced.



Oxygen is produced as it combines with hydrogen ions to form water at the end of the electron transport chain.

As cells take apart the carbon molecules from glucose, these get released as carbon dioxide.

Each body cell releases carbon dioxide into nearby capillaries by diffusion.

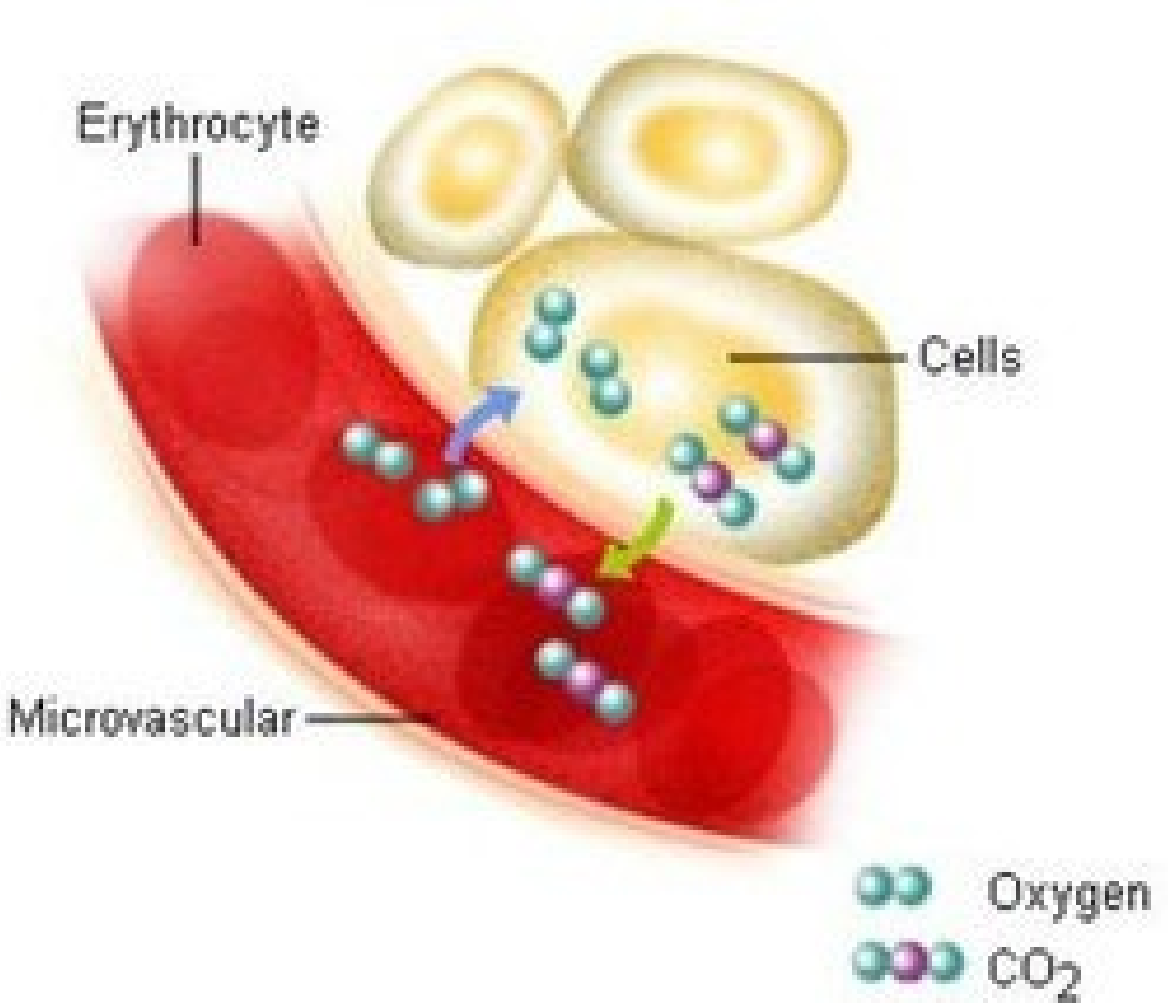
•The concentration of carbon dioxide is higher in the body cells than in the blood.

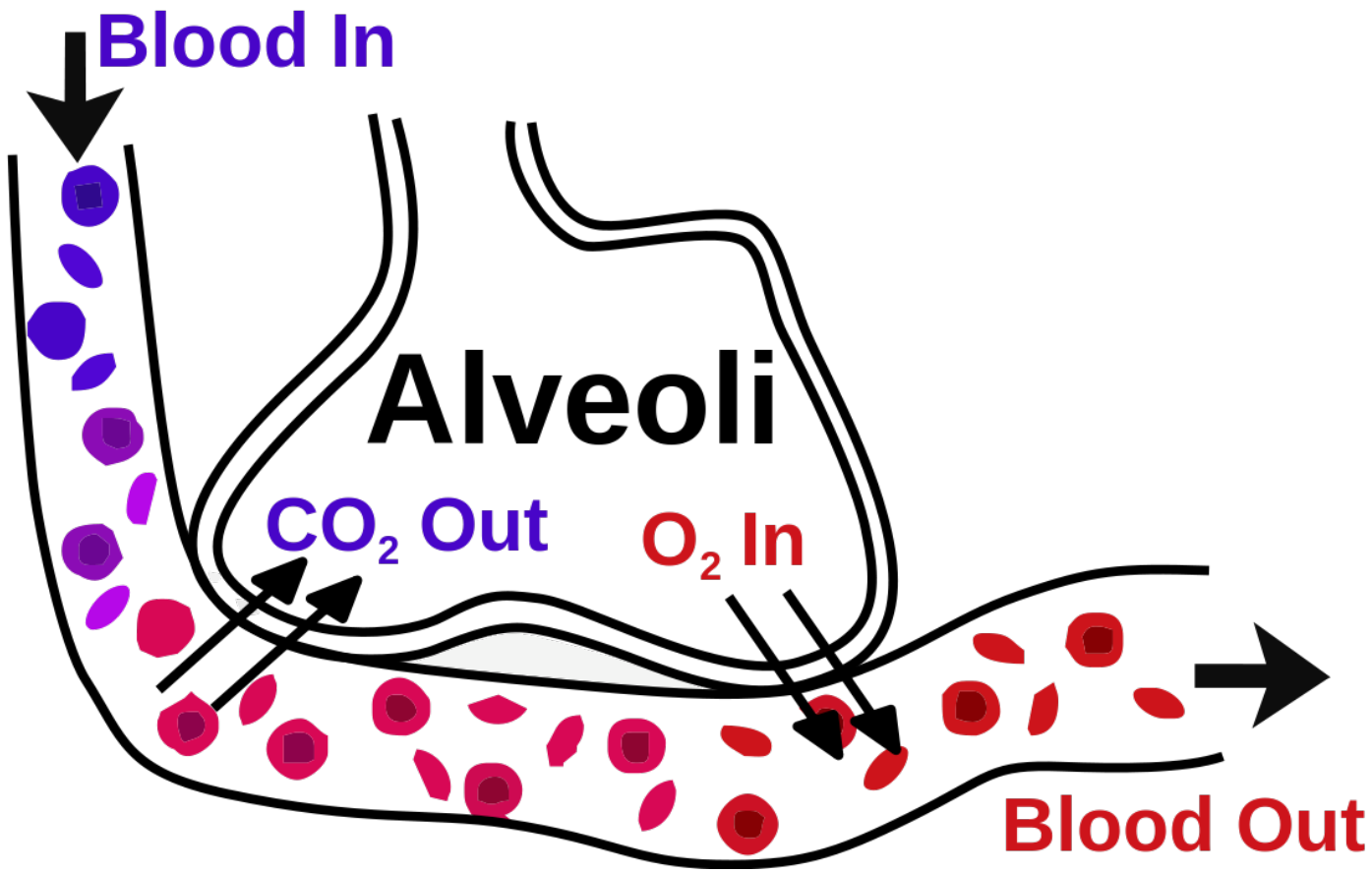
•In the capillaries…

- some of the carbon dioxide is dissolved in plasma
- some of the carbon dioxide is taken up by red blood cells and bound to hemoglobin
- most carbon dioxide enters the red blood cells where it binds with water to form carbonic acid.
- carbon dioxide then travels to the capillaries surrounding the lung

•water molecule leaves, causing it to turn back into carbon dioxide.

•It then enters the lungs where it is exhaled into the atmosphere.





Carbon Dioxide

1. Carbon Dioxide enters the red blood cells at capillary beds.
2. Carbon Dioxide binds with water to form carbonic acid.
3. Carbonic Acid then travels to the capillaries surrounding the lung.
4. Carbonic Acid is transformed into water and carbon dioxide.
5. Carbon Dioxide diffuses from the red blood cells in the capillaries to the alveoli of the lungs.
6. The Carbon Dioxide is exhaled out of the body through the lungs.

Stimulation of Breathing

- There are two pathways of motor neuron stimulation of the respiratory muscles.
  1. The first is the control of voluntary breathing by the cerebral cortex.
  2. The second is involuntary breathing controlled by the medulla oblongata.

Stimulation of Breathing

chemoreceptors that since pH levels are located in the…

- The aorta
- The carotid arteries
- The medulla oblongata

Stimulation of Breathing

As carbon dioxide levels increase, there is a buildup of carbonic acid, which releases hydrogen ions and lowers pH, making the blood more ACIDIC.

Chemoreceptors **do not** respond to changes in oxygen levels

Chemoreceptors **do** respond to changes pH

pH levels are dependent upon plasma carbon dioxide levels.

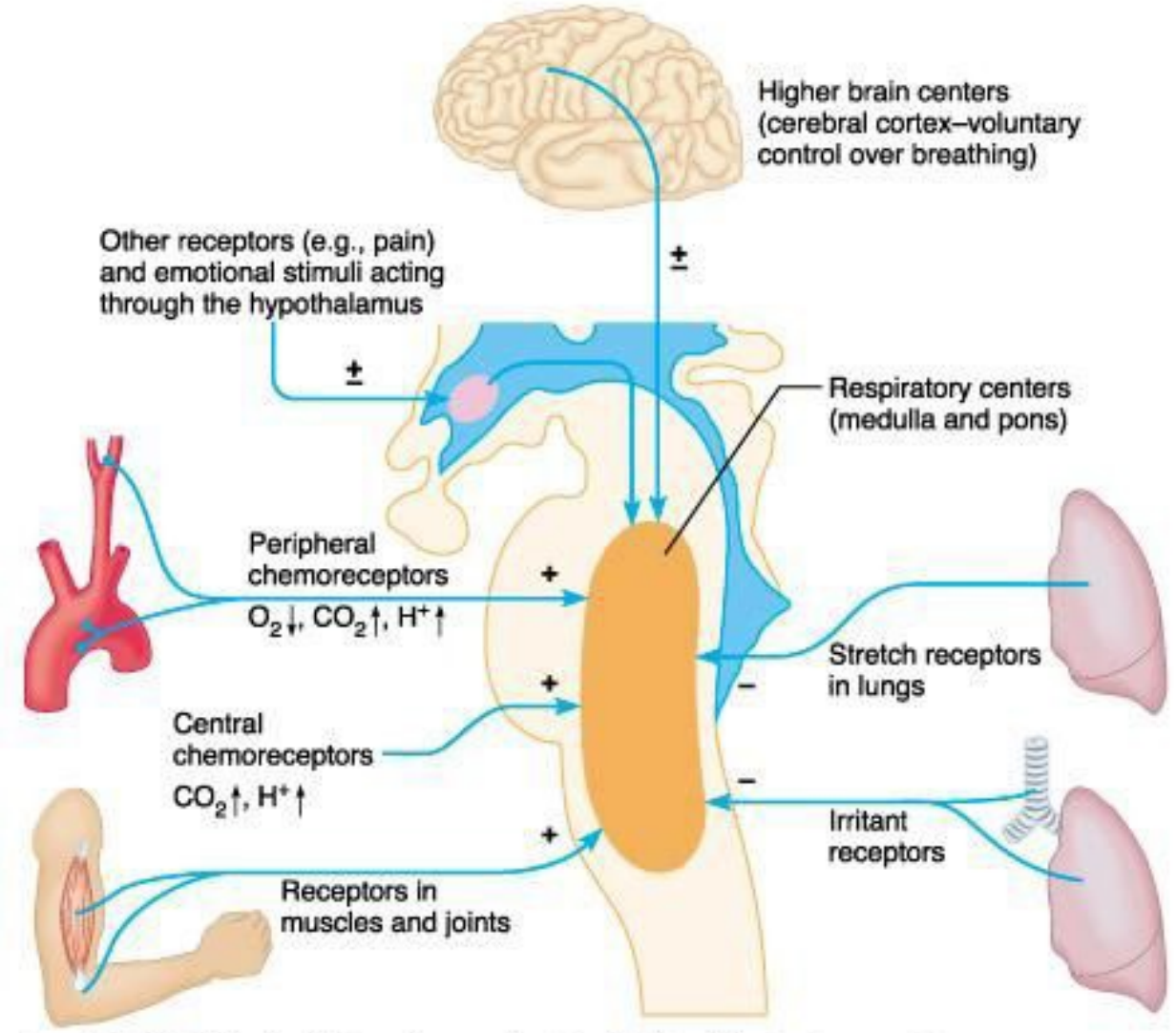
In other words, the level of CO_2 is the driving force for breathing.

Regulation of Breathing

- The receptors in the aorta and the carotid sinus initiate a reflex that immediately stimulates breathing rate.
- Receptors in the medulla stimulate a sustained increase in breathing until blood pH returns to normal.

Example

- During exercise, muscle cells metabolize ATP at a much faster rate than usual.
- This increase in ATP production produces much higher quantities of CO2.
- When CO2 levels increase, blood pH drops.
- The body responds (compensates) by involuntarily increasing breathing rate.
- The increased breathing rate expels more carbon dioxide
- The increased breathing rate continues until pH has returned to normal.
- Metabolic acidosis therefore can be corrected by respiratory compensation (hyperventilation).

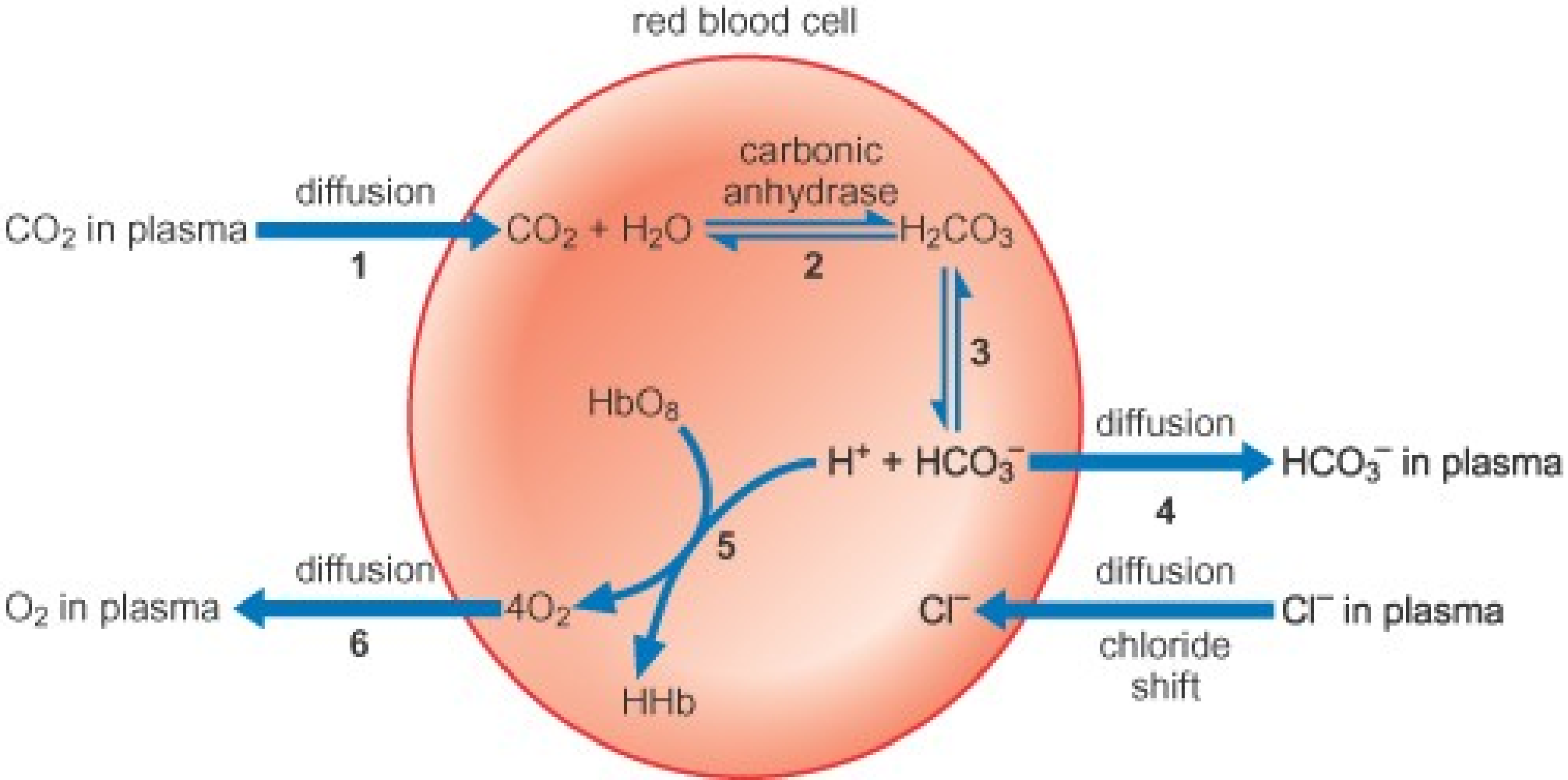


pH is the concentration of hydrogen ions (H+).

Buffers are molecules which take in or release ions in order to maintain the H+ ion concentration at a certain level.

Buffers

- When blood pH is too low and the blood becomes too acidic (acidosis), there are too many H+ ions is to blame.
- Buffers help to soak up those extra H+ ions.
- The lack of H+ ions causes the blood to be too basic (alkalosis).
- In this situation, buffers release H+ ions.
- Buffers function to maintain the pH of our blood by either donating or grabbing H+ ions as necessary to keep the number of H+ ions floating around the blood at just the right amount.



Bicarbonate Buffer System

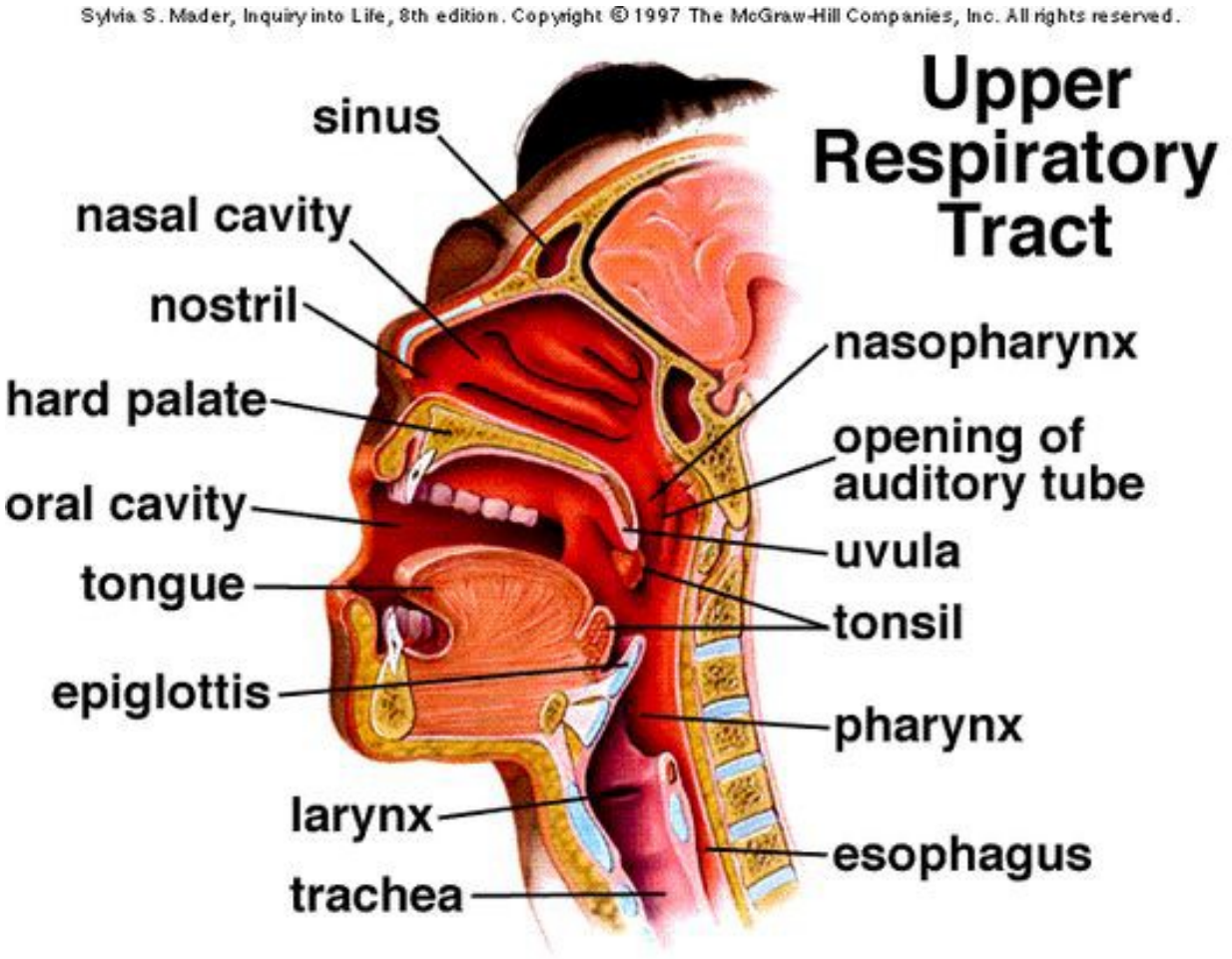
The most important buffer we have in our bodies is a mixture of carbon dioxide (CO_2) and bicarbonate ion (HCO_3).

CO_2 forms carbonic acid (H_2CO_3) when it dissolves in water and **acts as an acid** giving up hydrogen ions (H^+) when needed.

HCO_3 is a base and soaks up hydrogen ions (H^+) when there are too many of them. In a nutshell, blood pH is determined by a balance between bicarbonate and carbon dioxide.

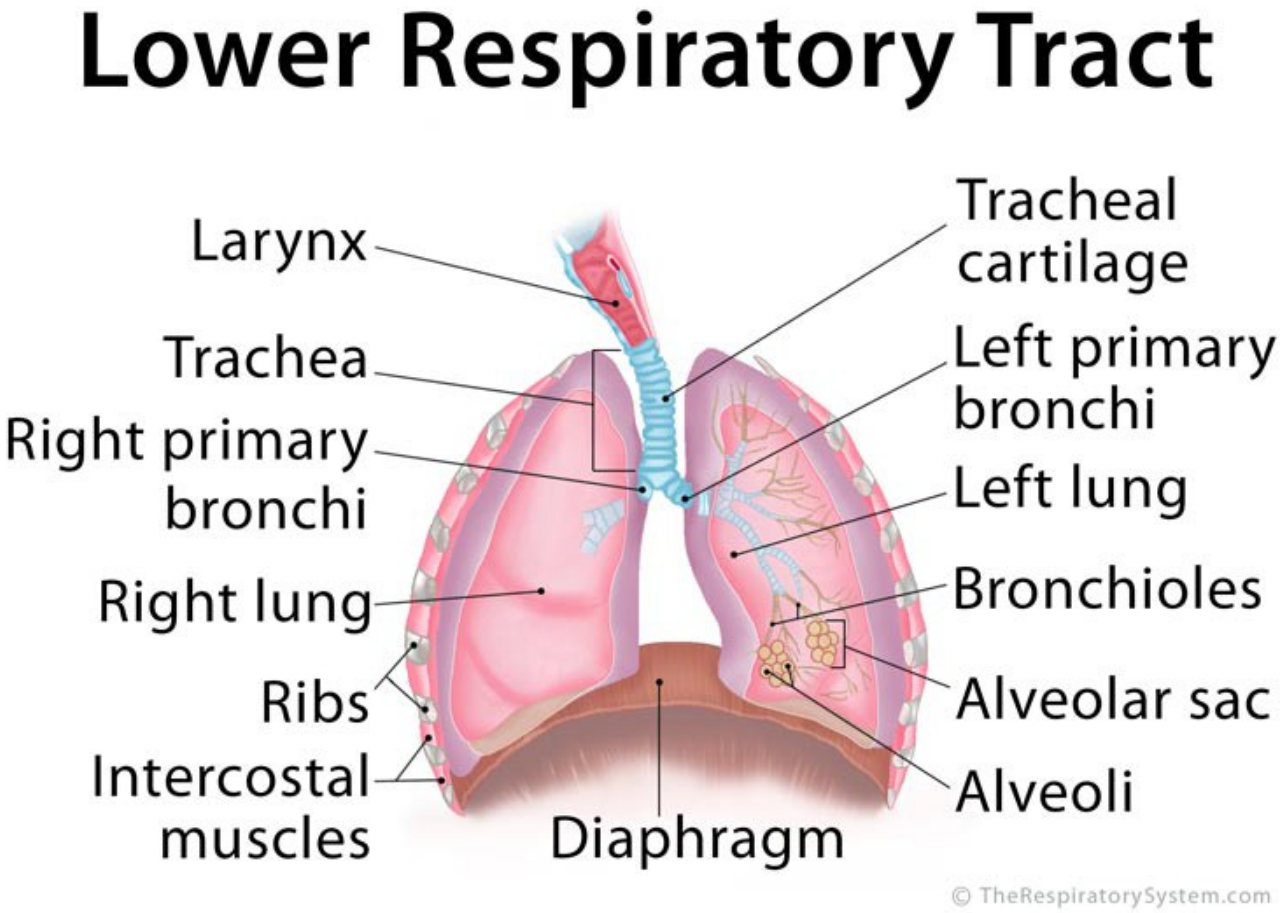
the nose and the pharynx

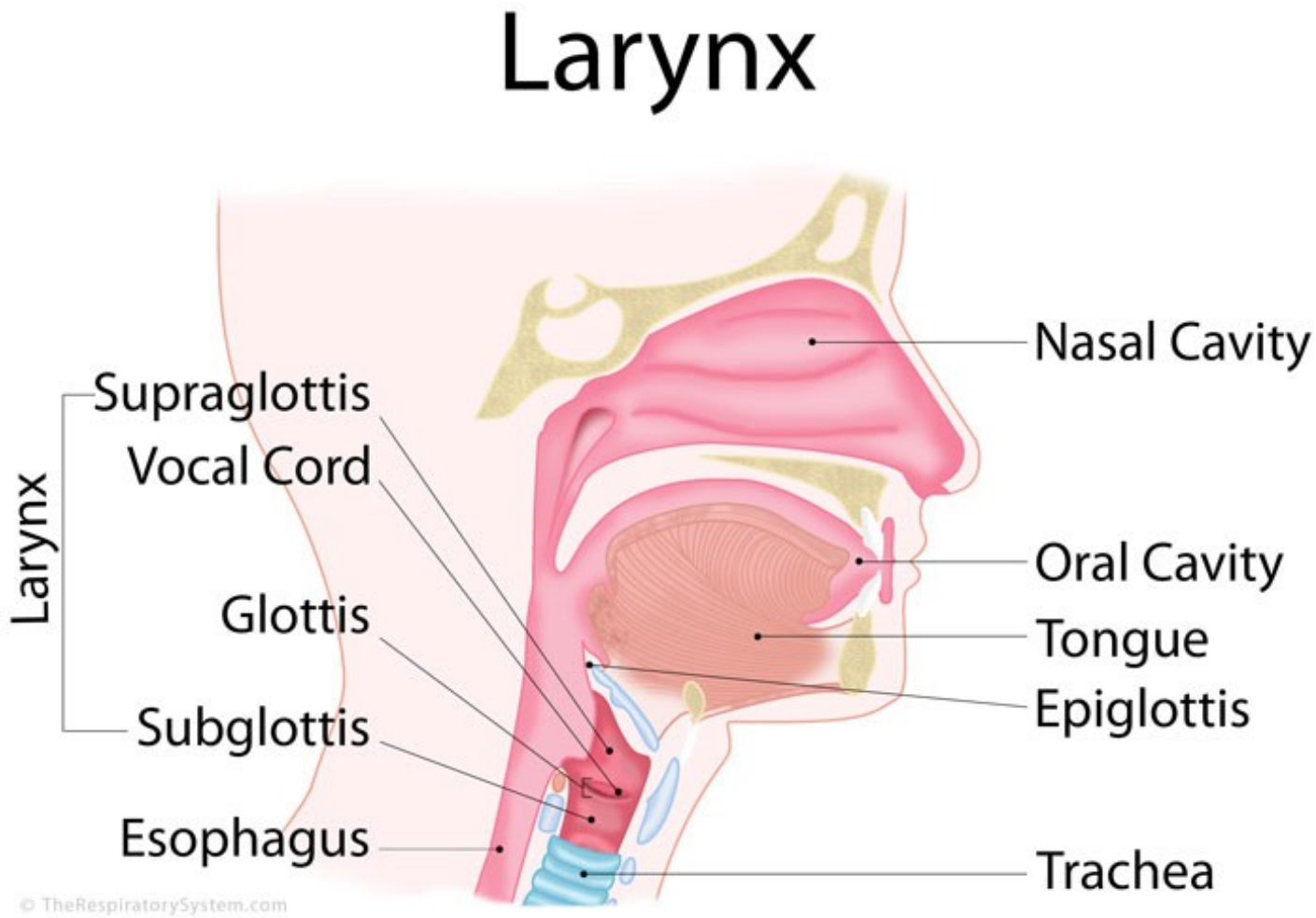
- The upper respiratory tract consists of the nose and the pharynx.
- Primary functions
  - receive the air from the external environment
  - filter, warm, and humidify air before it reaches the delicate lungs where gas exchange will occur.



the larynx, the trachea, and the bronchi

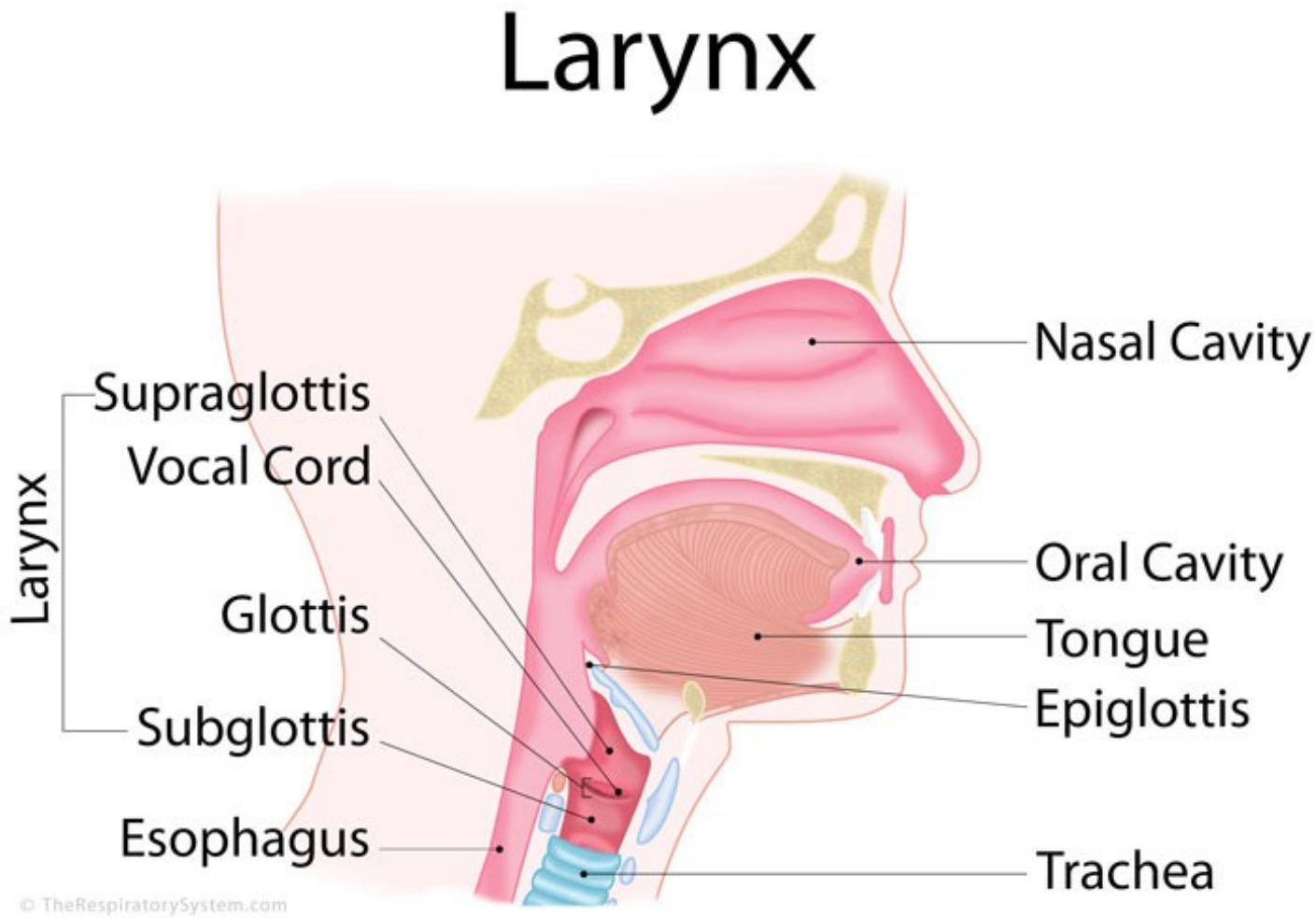
- The lower respiratory tract includes
  - the larynx
  - the trachea
  - the bronchi





Larynx

- The larynx contains two important structures:
  - the epiglottis
  - the vocal cords

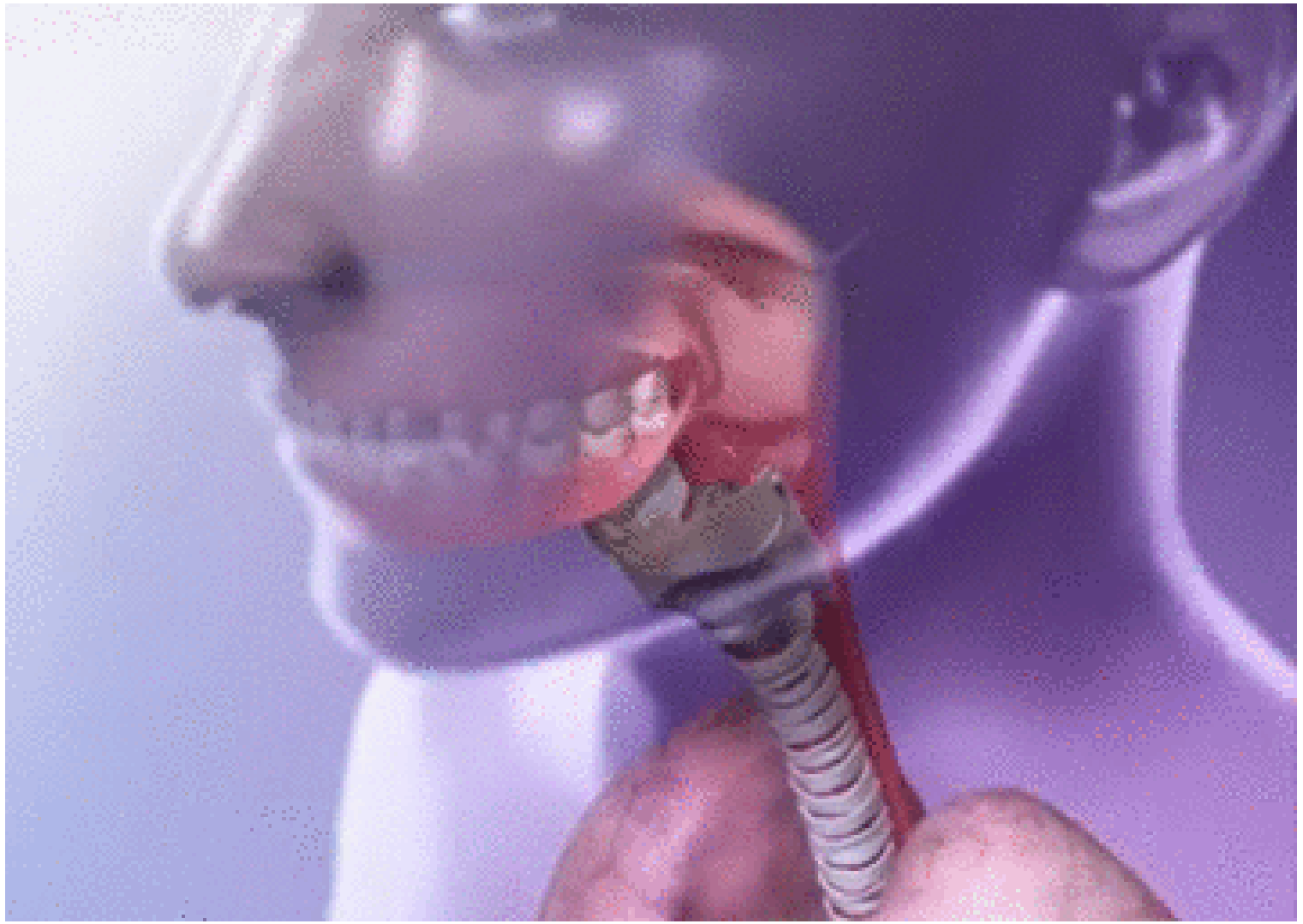


Larynx

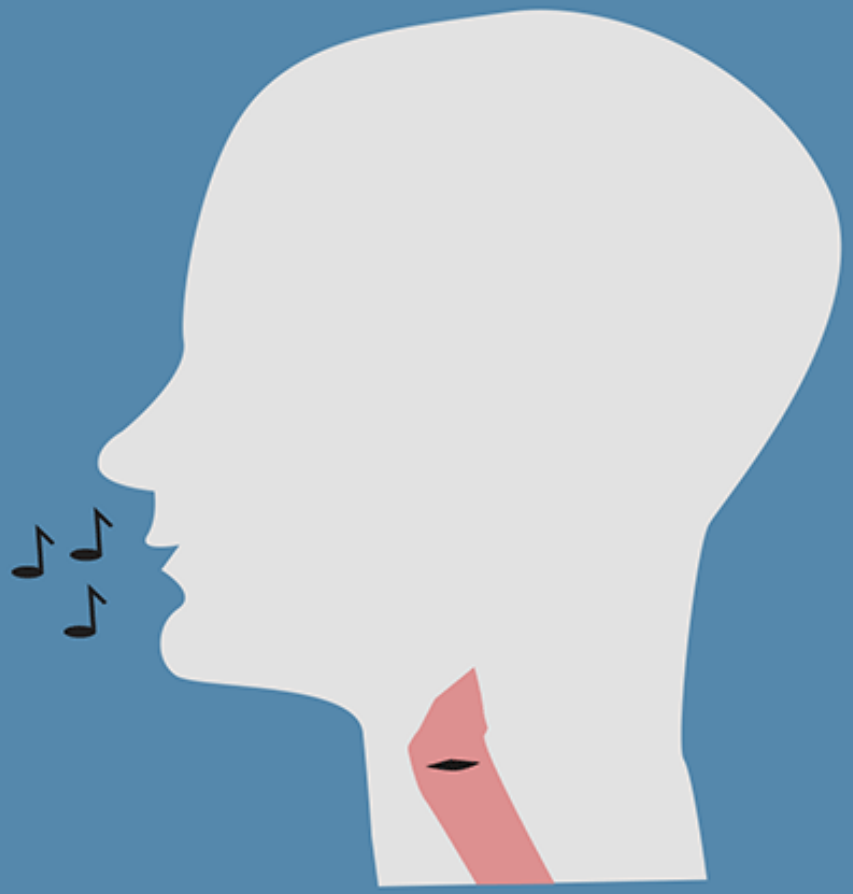
- The larynx (the voice box) functions:
  - Protection of the trachea
  - Produce sounds (vocalization) via the vocal cords

The epiglottis

- The epiglottis is a flap of cartilage located at the opening to the larynx.
- During swallowing, the epiglottis moves downward closing of the airways, to prevent chocking.

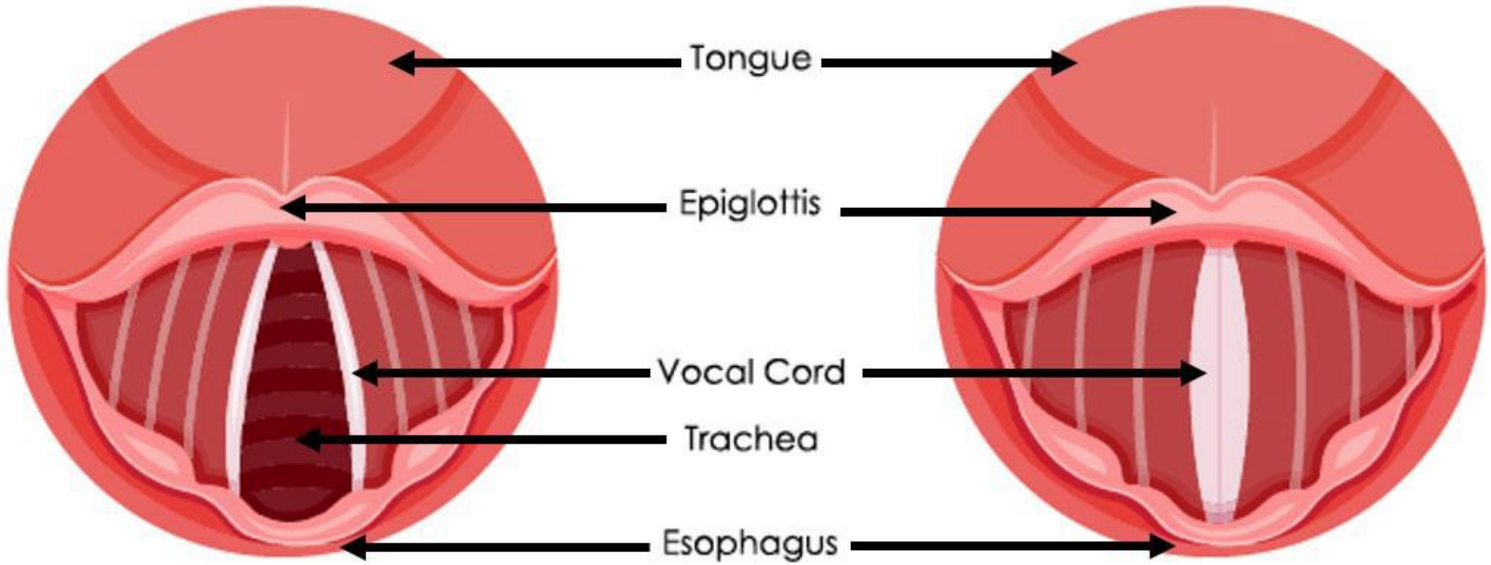


The vocal cords



- The vocal cords consist of two folds of connective tissue that stretch and vibrate when air passes through them, causing vocalization.

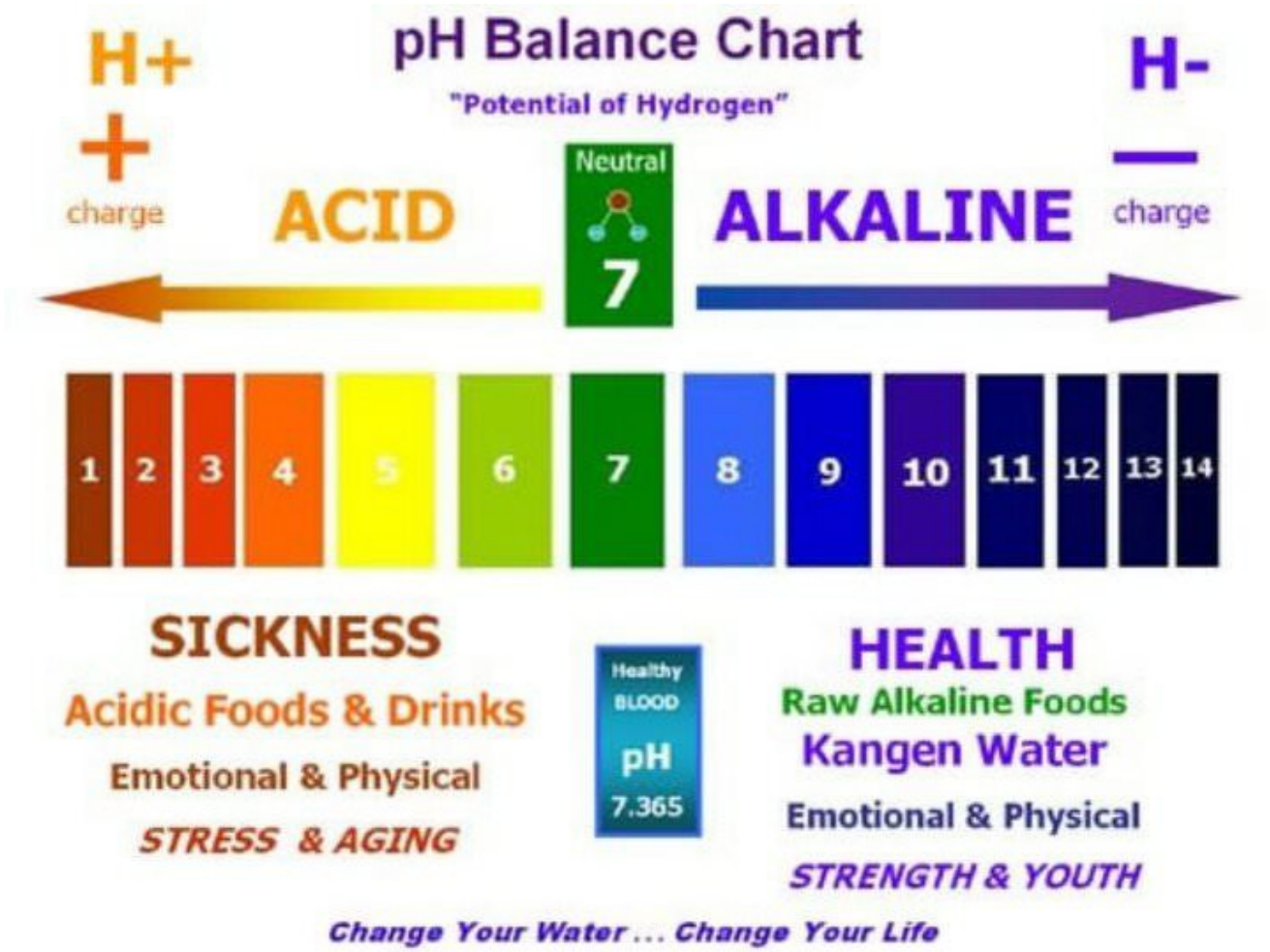
The vocal cords



- ***The length the vocal cords are stretched determines what PITCH the sound will have.***
- ***The strength of expiration from the lungs also contributes to the VOLUME of the sound.***

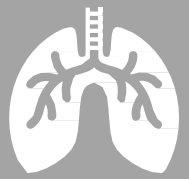
Acid-base Balance

- Blood is normally slightly basic, with a normal **pH** range of 7.35 to 7.45.
- Usually the body maintains the **pH** of blood close to 7.40.



Acid-base Balance

Breathing plays a major role in acid-base balance in the body.



Changes in pulmonary ventilation (breathing rate, depth of respiration) can help adjust pH when disturbances in pH occur.

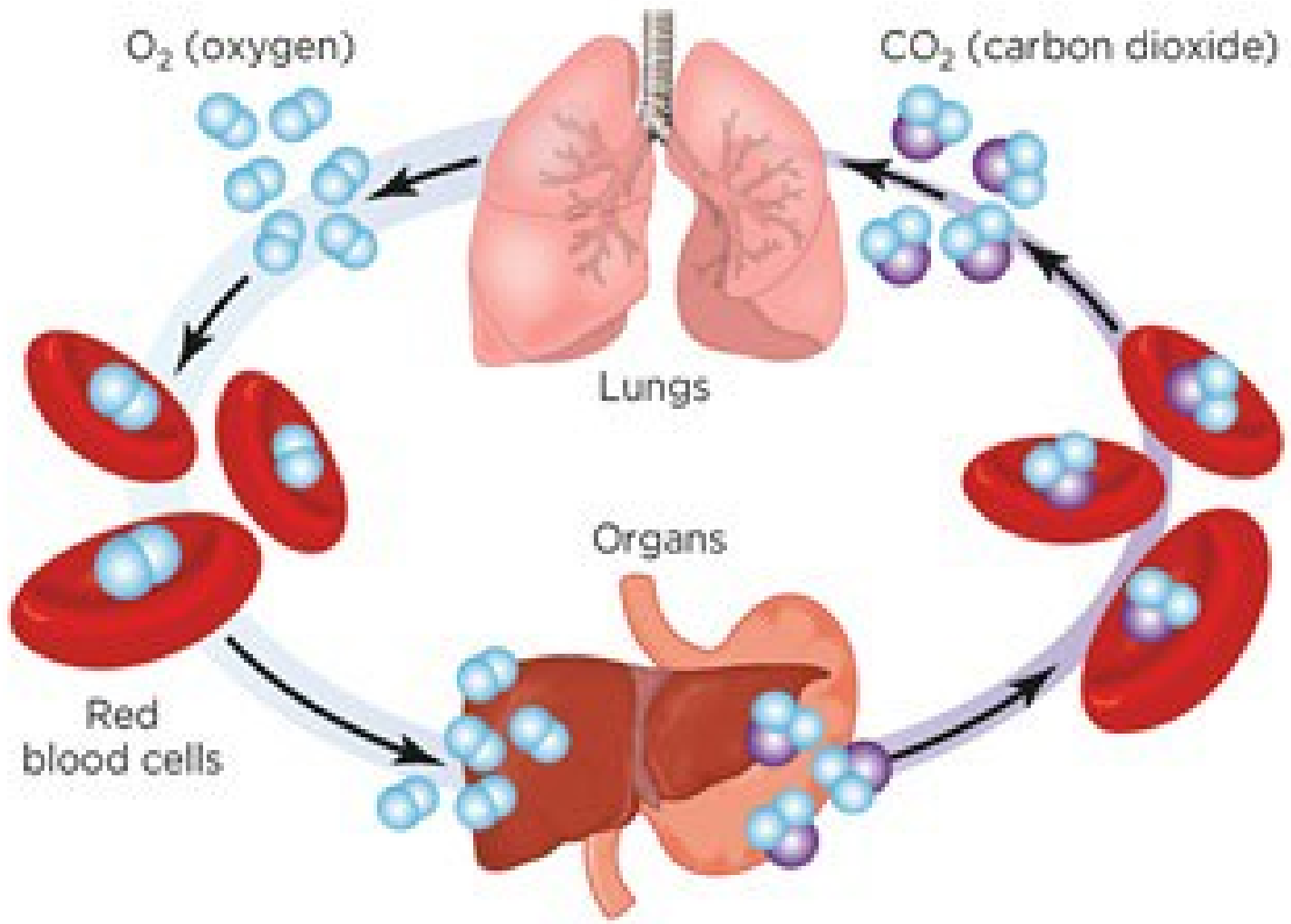
Acid-base Balance

The two main organs that help balance the pH of blood are the:

Lungs - removes carbon dioxide (an acid) through breathing (respiration).

Kidneys - removes acids through urine (excretion).

Fig 1. **Gas exchange in humans**



CO_2 is transport

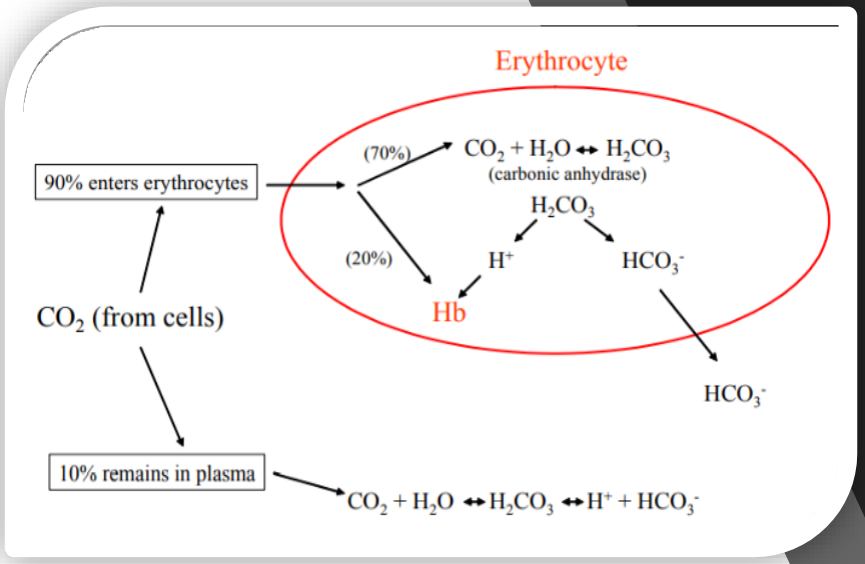
CO_2 is transported in the blood stream by three different means:

- ✓ •as dissolved CO_2 gas in the plasma
- ✓ •in the form of bicarbonate in the blood plasma
- ✗ •by binding to hemoglobin in the erythrocytes

•Both methods of transporting ***CO_2 in the plasma*** can influence the pH of the plasma.

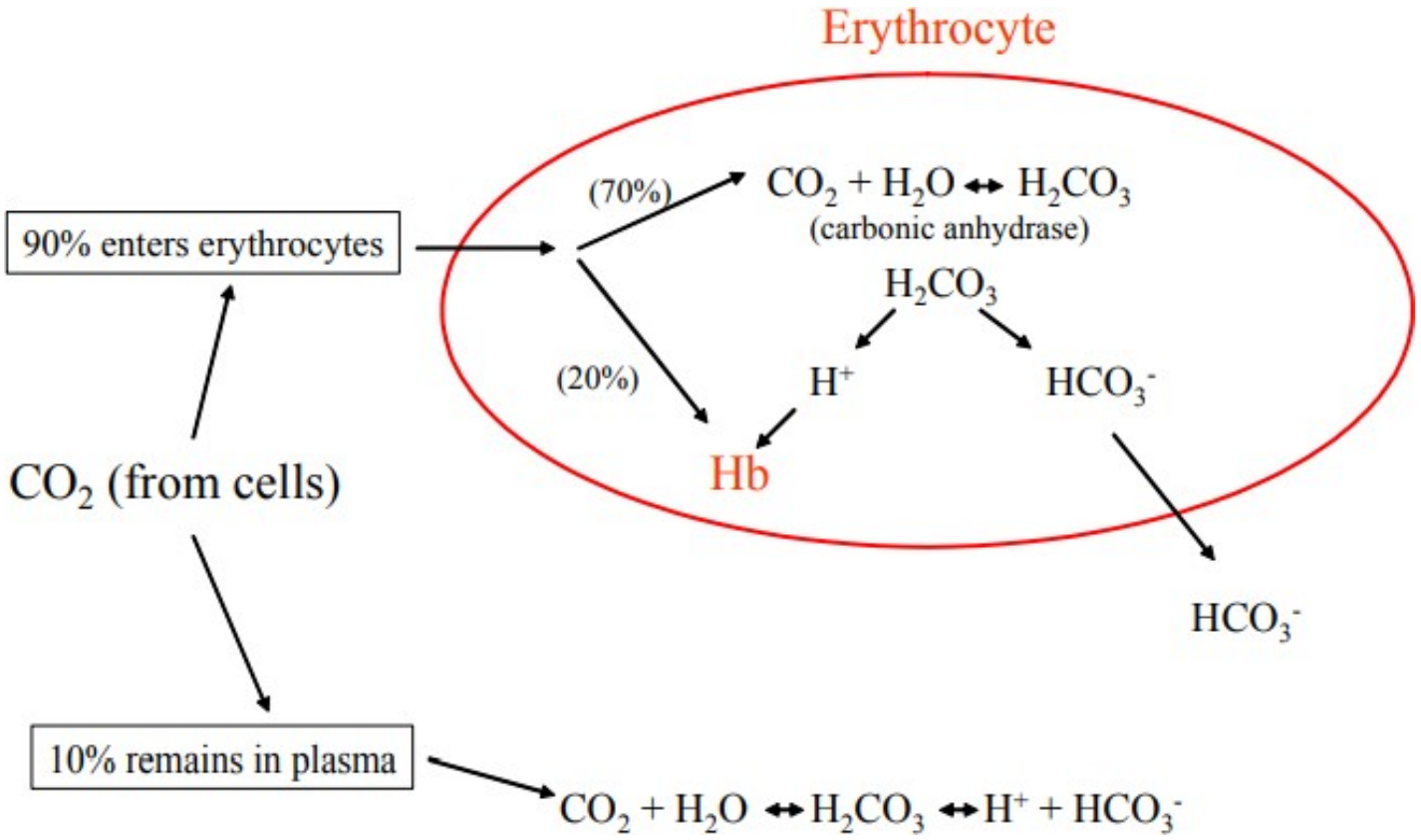
What happens to CO_2

- ~ 90% of the CO_2 is absorbed by the erythrocytes.
- ~ 20% binds to hemoglobin
- ~ 70% reacts with water to form carbonic acid
  - The carbonic acid formed subsequently dissociates into H+ and bicarbonate.
  - H+ binds to specific amino acid side chains on the hemoglobin
  - The bicarbonate is transported out to the blood plasma.
  - The bicarbonate formed acts as a buffer against pH changes.
    - In other words, if the concentration of hydrogen ions increases, bicarbonate will bind to the free hydrogen ions to form carbonic acid.



CO_2 is transport

- Some of the CO2 dissolved in the plasma can react spontaneously with water to form carbonic acid.
- Thus increased CO2 in the plasma tend to decrease plasma pH through increased carbonic acid formation.



- Carbon Dioxide (CO_2) reversibly reacts with water to form Carbonic Acid (H_2CO_3).
- Carbonic acid dissociates into bicarbonate and hydrogen ions.

Carbon Dioxide Exchange and pH Balance.

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$$

Carbon Dioxide | Water | Carbonic Acid | Hydrogen Ion | Carbonate Ion

- When you hold you breath OR if you are not getting enough oxygen…
  - CO_2 levels **increase**
  - Carbonic Acid (H_2CO_3) levels **increase**
  - Hydrogen Ion (H^+) levels **increase**
  - pH levels **decrease**
  - Becomes **more acidic**

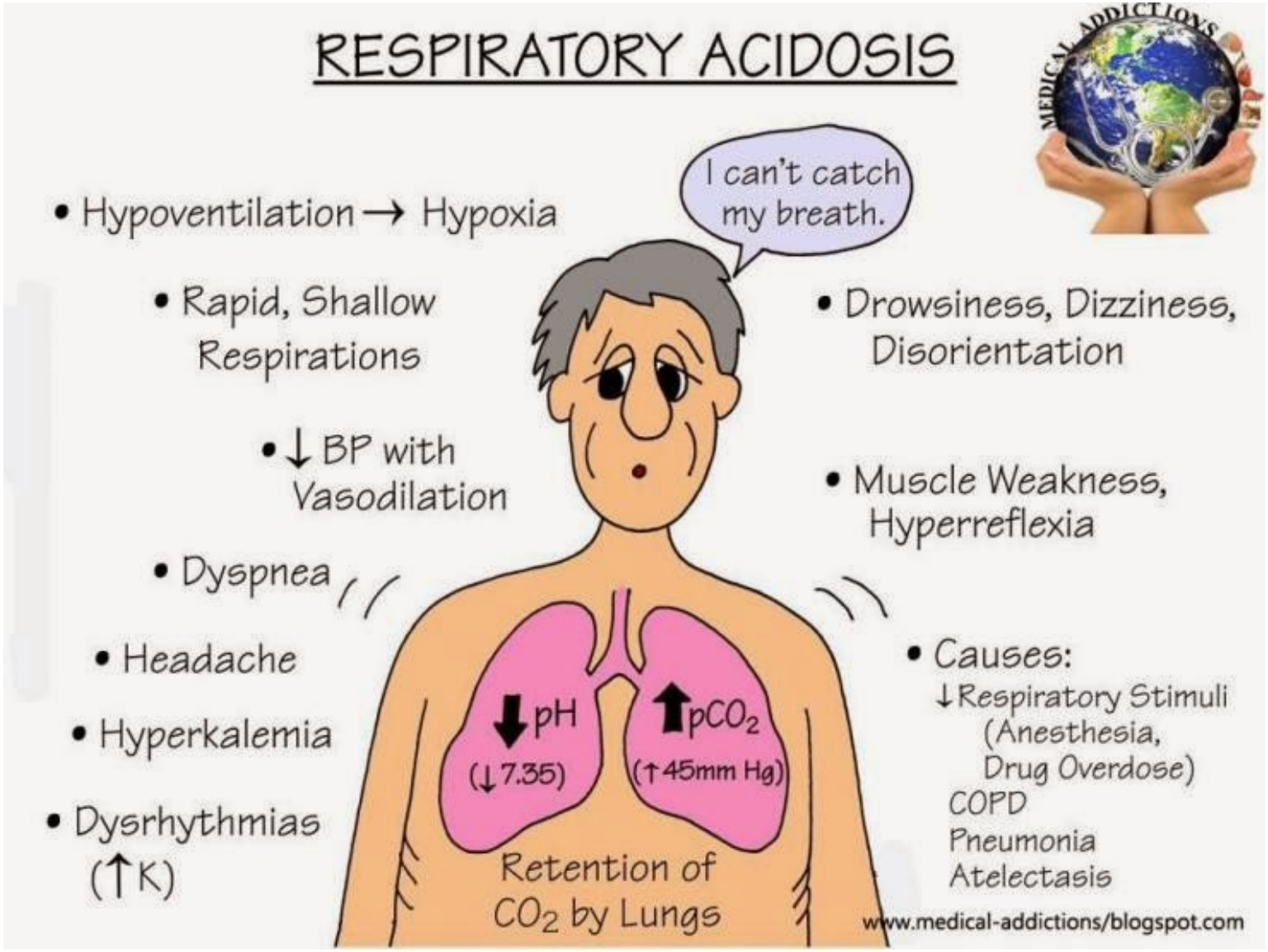
Carbon Dioxide Exchange and pH Balance.

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$$

Carbon Dioxide Water Carbonic Acid Hydrogen Ion Carbonate Ion

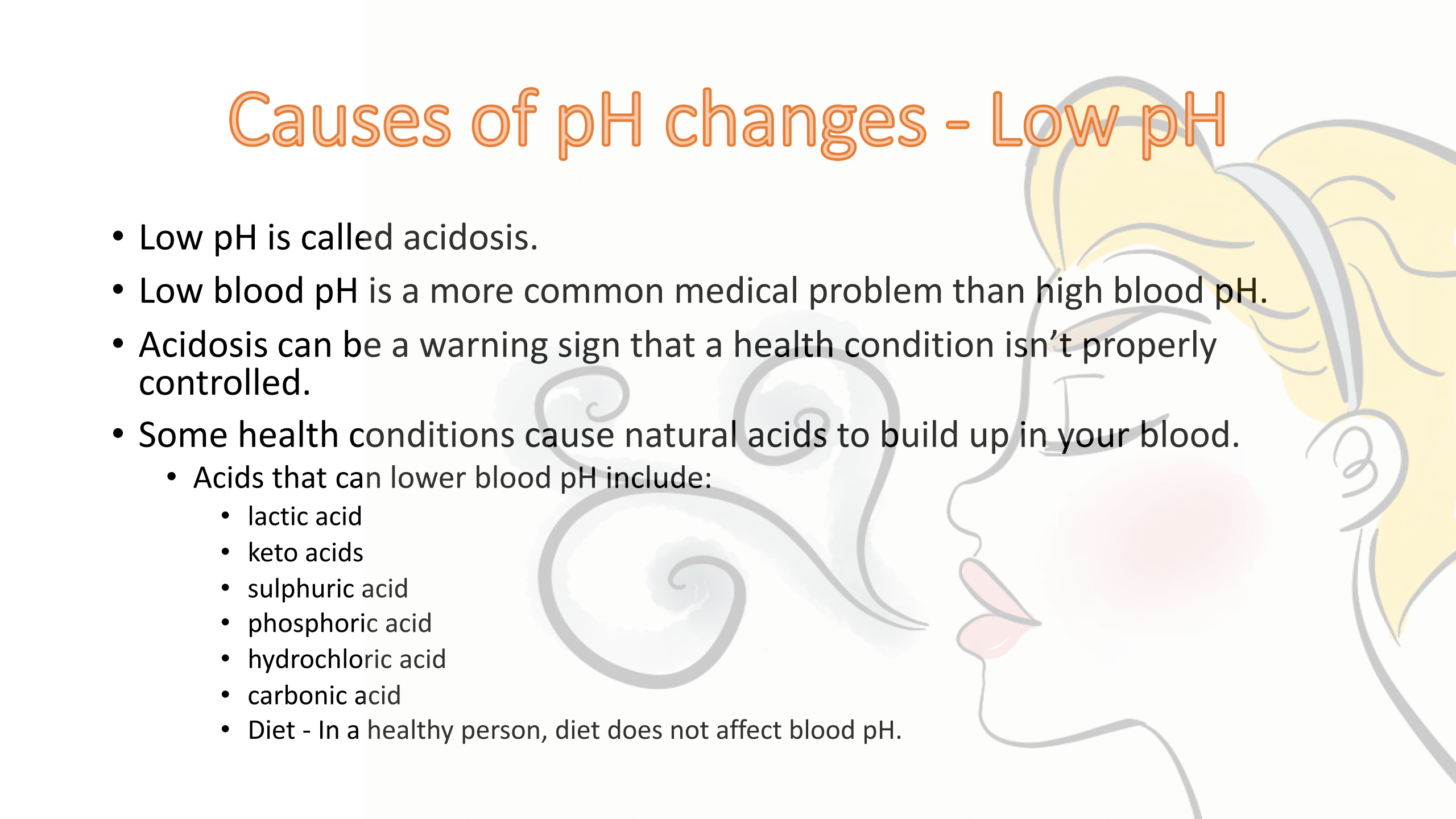
RESULT OF HOLDING YOUR BREATH or NOT GETTING ENOUGH OXYGEN

- carbon dioxide accumulates in the blood.
- the pH of the blood decreases, becoming more acidic!
- Blood pH balance
- Acidosis is when your blood pH drops below 7.35 and becomes too acidic.
- Alkalosis is when your blood pH is higher than 7.45 and becomes too alkaline.



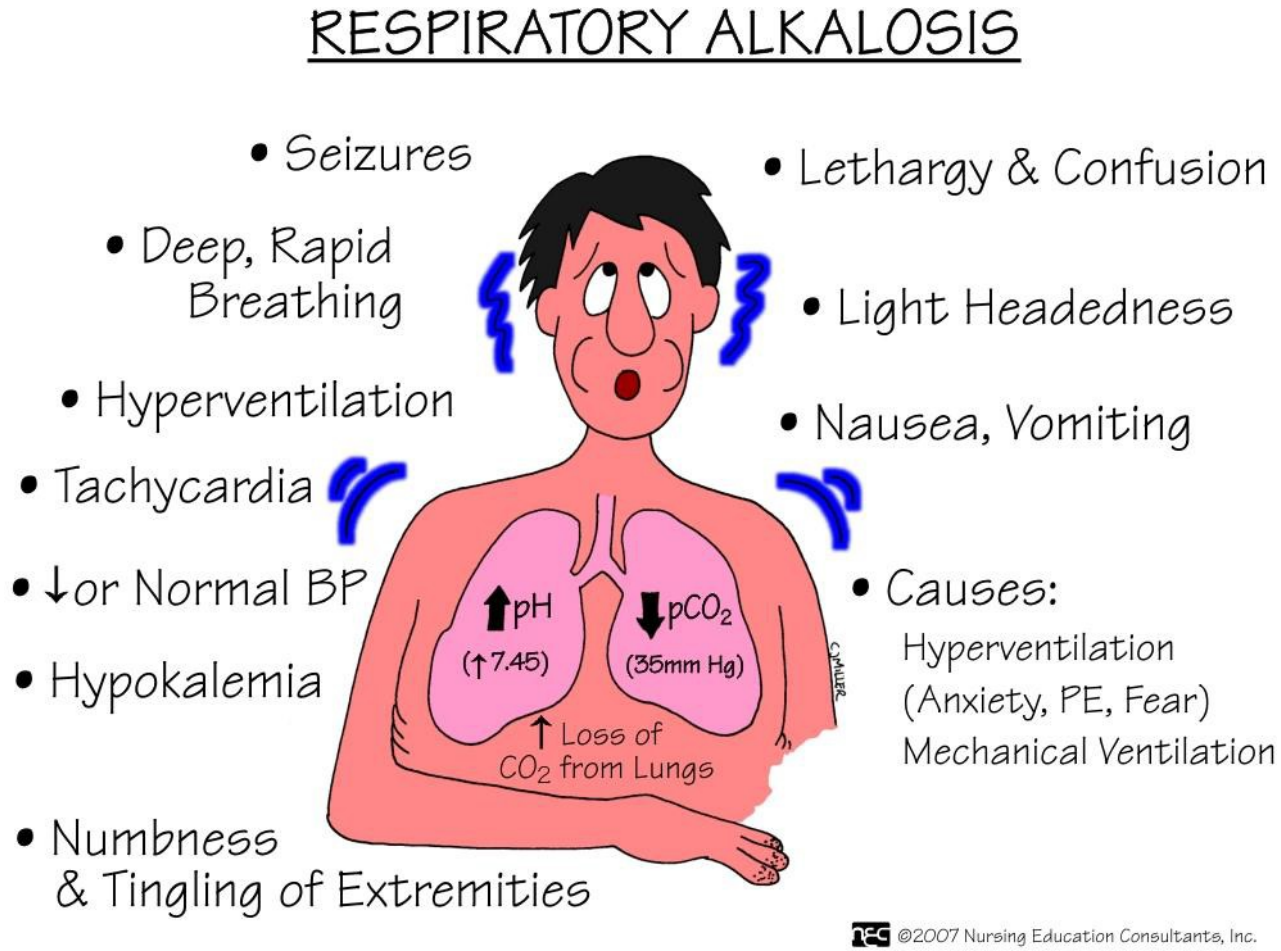
Causes of pH changes - Low pH

- Low pH is called acidosis.
- Low blood pH is a more common medical problem than high blood pH.
- Acidosis can be a warning sign that a health condition isn't properly controlled.
- Some health conditions cause natural acids to build up in your blood.
  - Acids that can lower blood pH include:
    - lactic acid
    - keto acids
    - sulphuric acid
    - phosphoric acid
    - hydrochloric acid
    - carbonic acid
    - Diet - In a healthy person, diet does not affect blood pH.



RESULT OF RAPID BREATHING or HYPERVENTALATION

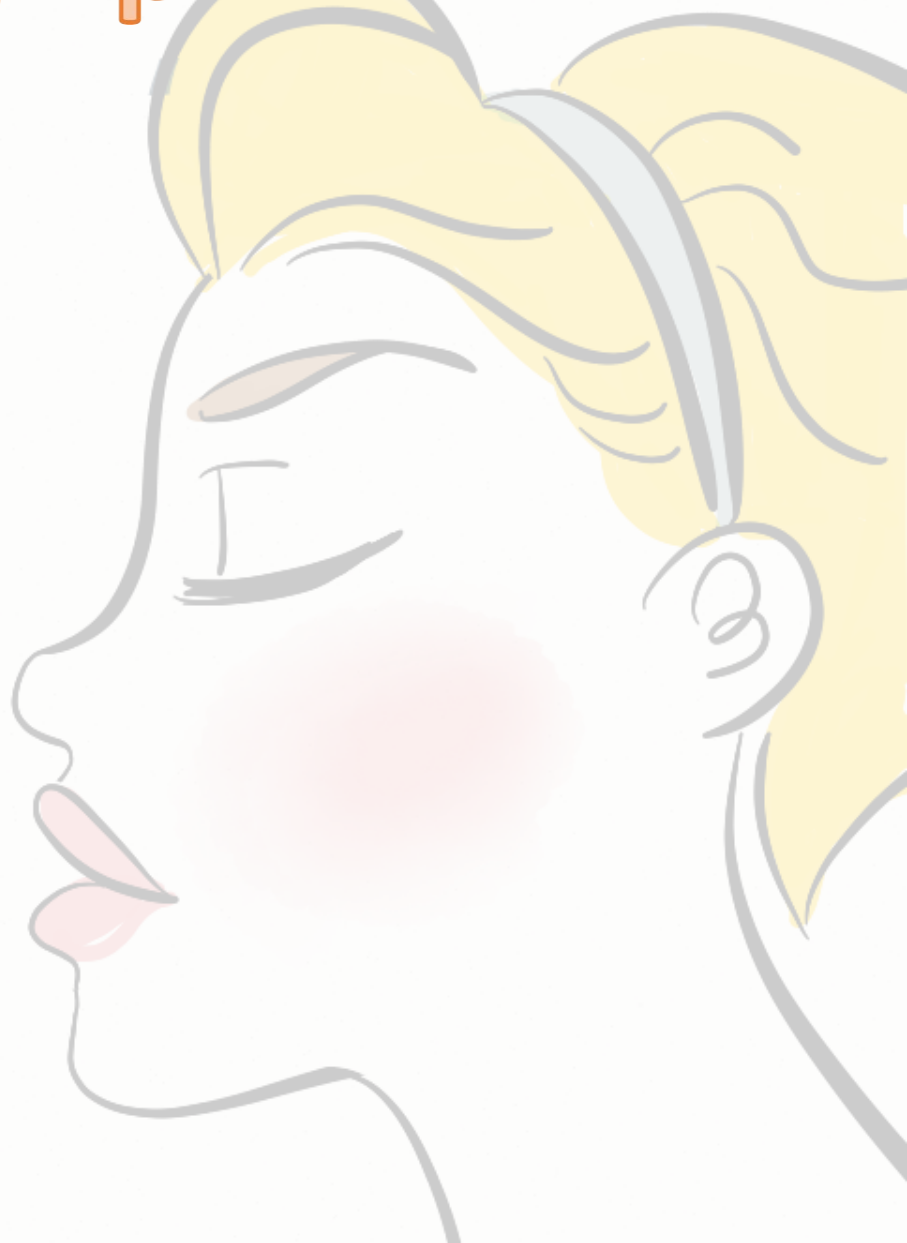
- **Alkalosis is caused by an overabundance of bicarbonate or a low level of carbon dioxide.**
- People may have irritability, muscle twitching, muscle cramps, or even muscle spasms.



Causes of pH changes - High pH

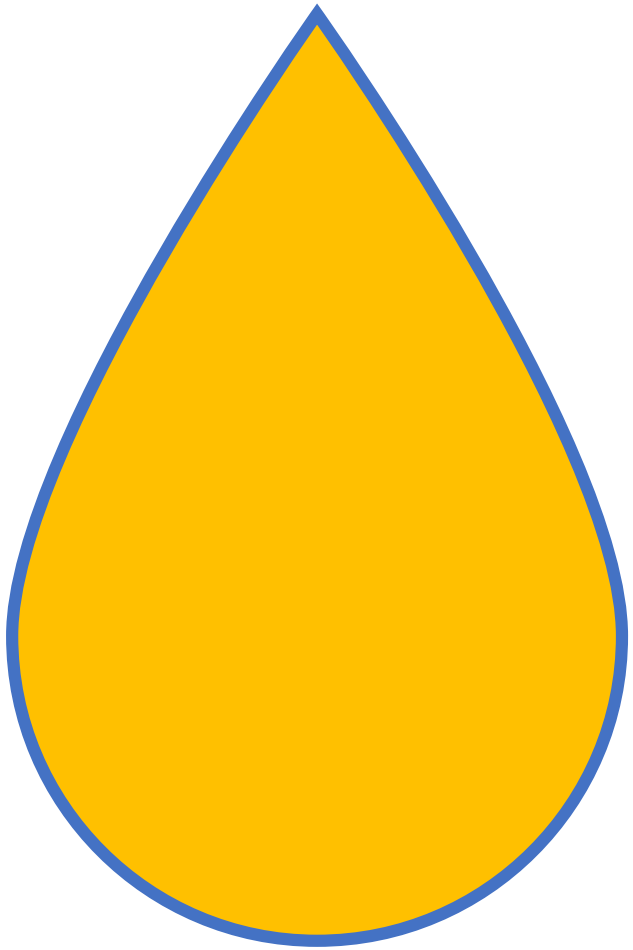
Alkalosis happens when your blood pH is higher than the normal range.

- There are several causes of high blood pH.
  - Dehydration (Fluid loss)
    - Losing too much water from your body can increase blood pH.
    - This happens because you also lose some blood electrolytes (salts and minerals) with water loss.
    - These include sodium and potassium.
- Causes of fluid loss are excess:
  - sweating
  - vomiting
  - diarrhea
  - Diuretic drugs may cause you to urinate too much
  - Kidney problems
    - - kidneys may not remove enough alkaline substances (such as bicarbonate) through the urine



The Urinary System

By Scientist Cindy



What is the Urinary System?

- The **Urinary System** is a group of organs in the body concerned with filtering out excess fluid and other substances from the bloodstream.
  - The substances are filtered out from the body in the form of **urine**.
  - Urine is a liquid produced by the kidneys, collected in the bladder and excreted through the urethra.
  - Urine is used to extract excess minerals or vitamins from the body.

Functions of the Urinary System

Excretion – the process of eliminating waste products

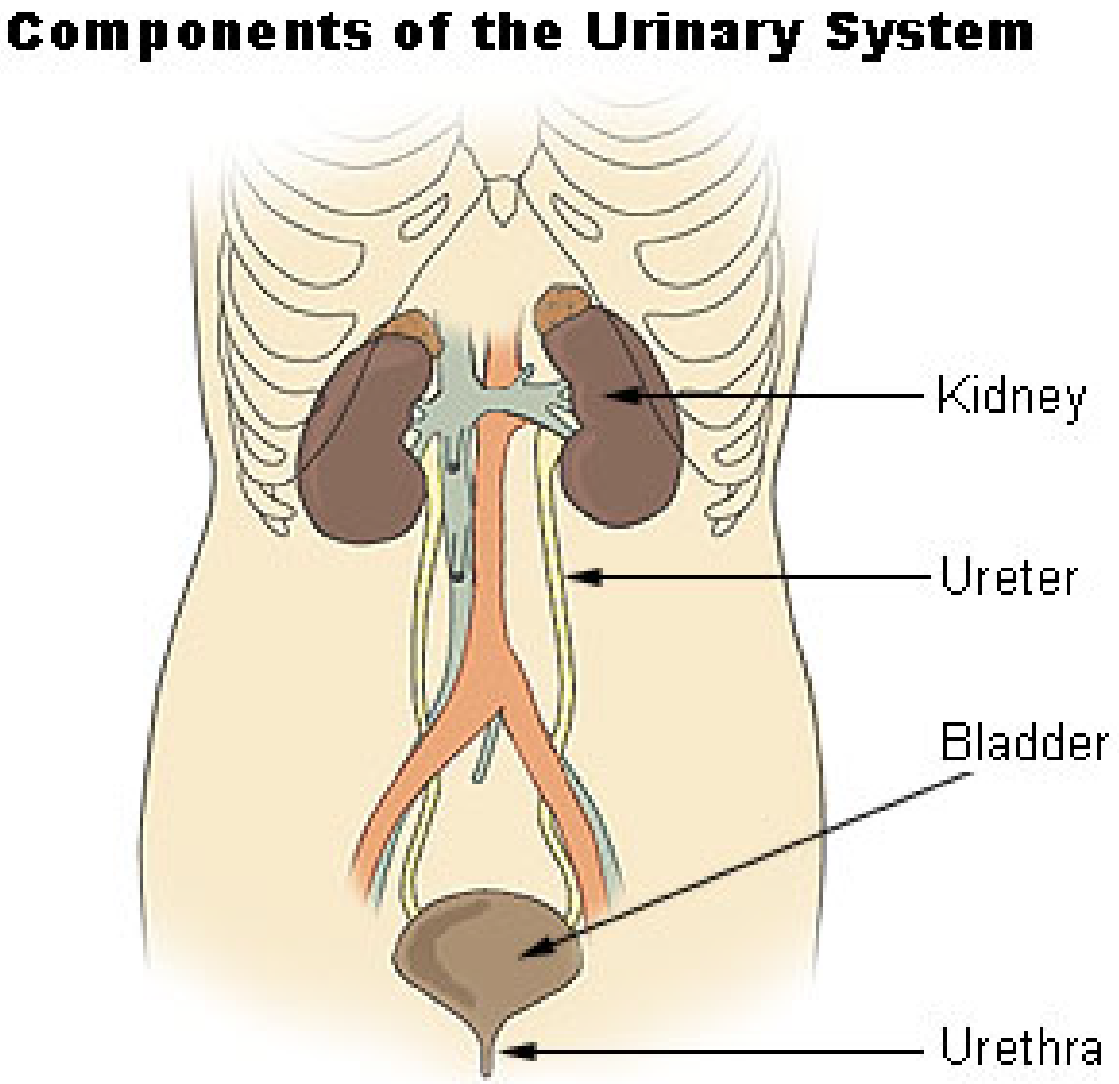
Maintains an appropriate fluid volume – regulating the amount of water that is excreted in the urine.

Regulates the concentrations of various electrolytes in the body fluids

Maintaining normal pH of the blood.

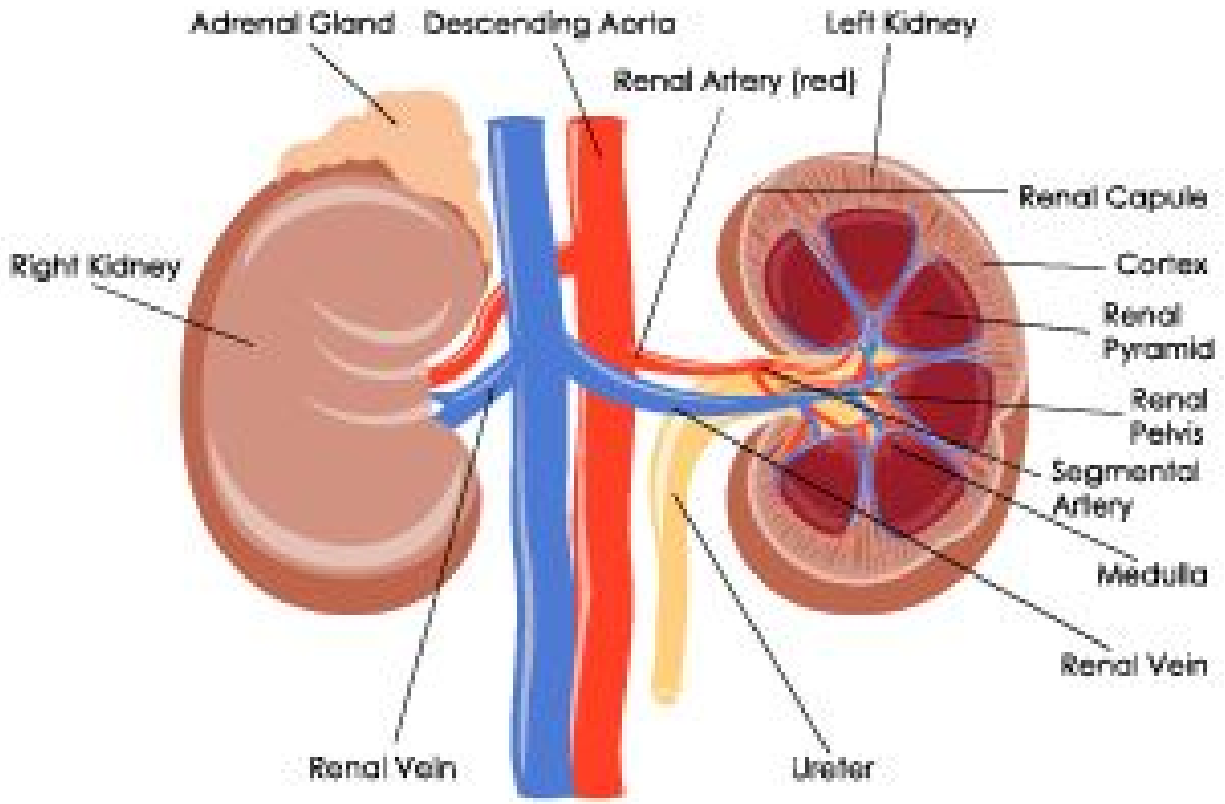
The Urinary organs

- The Urinary organs include
  - the kidneys
  - The ureters
  - The bladder
  - The urethra



The kidneys

- The kidneys are the most important excretory organ.
- The primary function of the kidneys is to maintain a stable internal environment (homeostasis) for optimal cell and tissue metabolism.
  - The kidneys removes unwanted urea, mineral salts, toxins, and other waste products from the blood.
  - The kidneys conserve water, salt, and electrolyte concentration.
  - At least one kidney must function properly for life to be maintained.



KIDNEY

Six important roles of the kidneys are:

Regulation of plasma ionic composition

Regulation of plasma osmolarity

Regulation of plasma volume

Regulation of plasma hydrogen ion concentration (pH)

Removal of metabolic waste products and foreign substances from the plasma

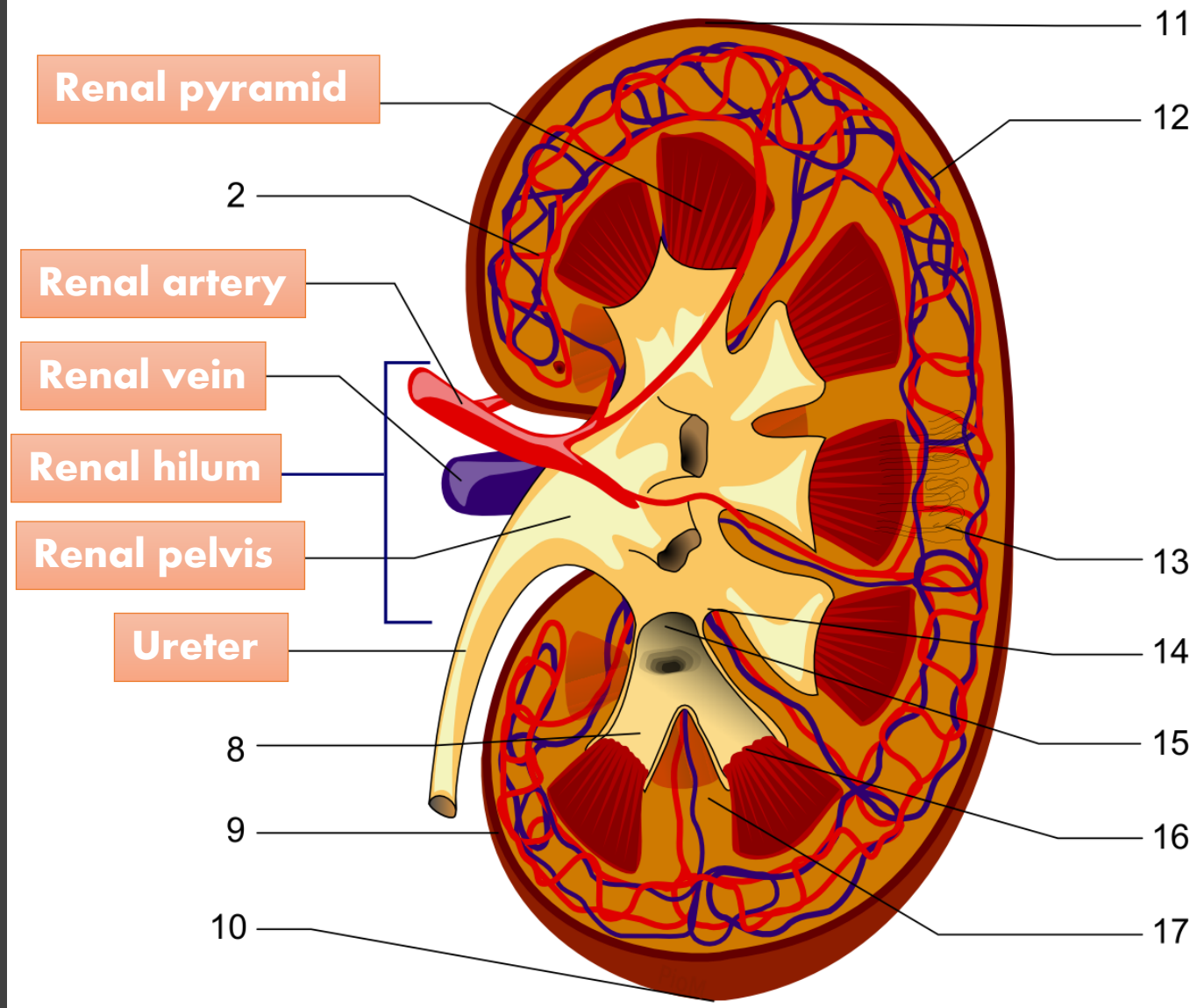
Secretion of Hormones

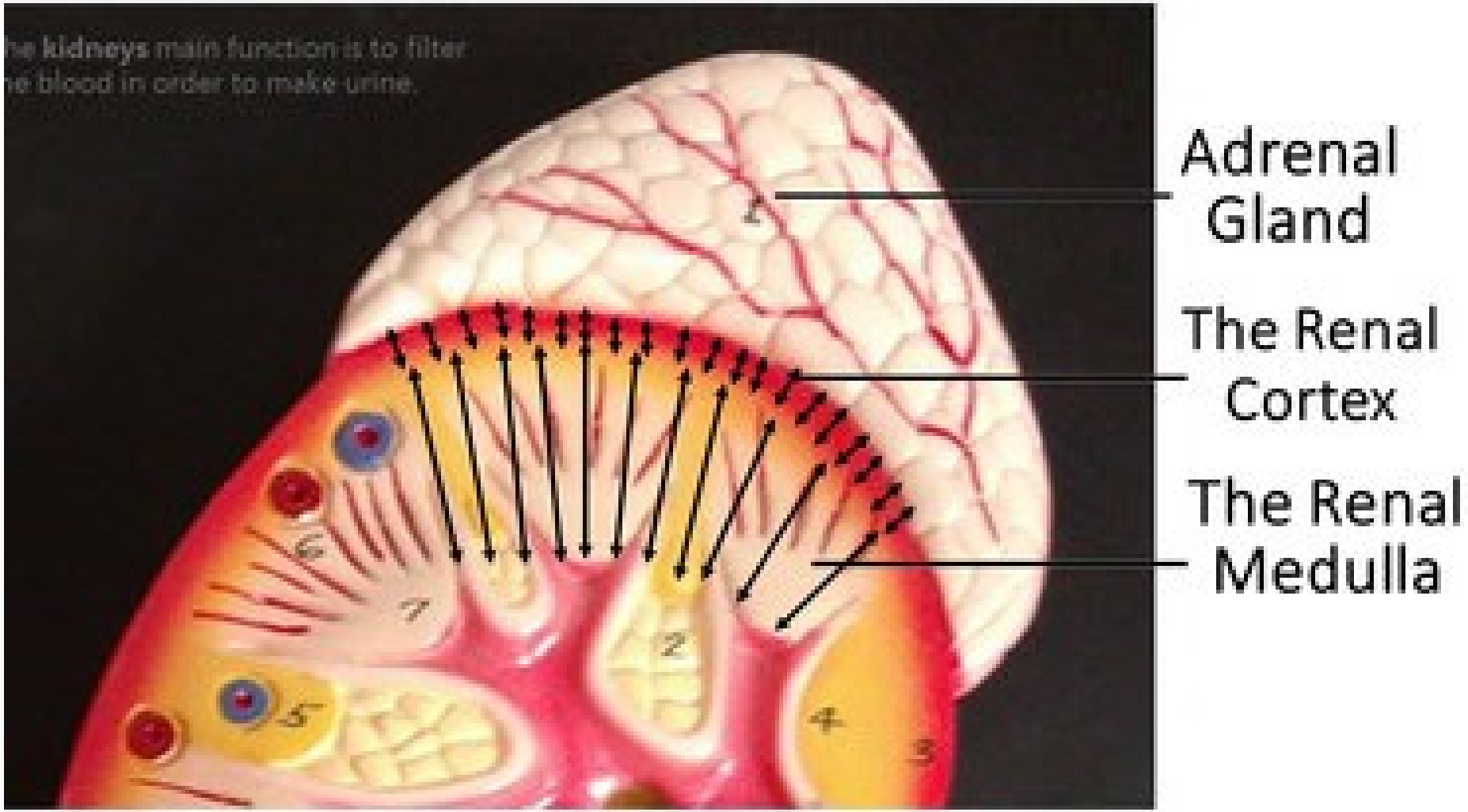
ROLES OF THE KIDNEYS
- Removal of waste

- The kidneys get rid of
  - **Urea** - metabolic waste from the liver
  - **Ammonia** - metabolic waste from the liver
  - **Creatinine -** metabolic waste from the muscles
  - **Uric acid -** metabolic waste from the break down of nucleotides.
    - Uric acid is insoluble and too much uric acid in the blood will build up and form crystals that can collect in the joints and cause gout.

Kidneys And Their Structure

1. Renal pyramid
2. Interlobar artery
3. Renal artery
4. Renal vein
5. Renal hilum
6. Renal pelvis
7. Ureter
8. Minor calyx
9. Renal capsule
10. Inferior renal capsule
11. Superior renal capsule
12. Interlobar vein
13. Nephron
14. Minor calyx
15. Major calyx
16. Renal papilla
17. Renal column





The Renal Cortex
The Renal Medulla

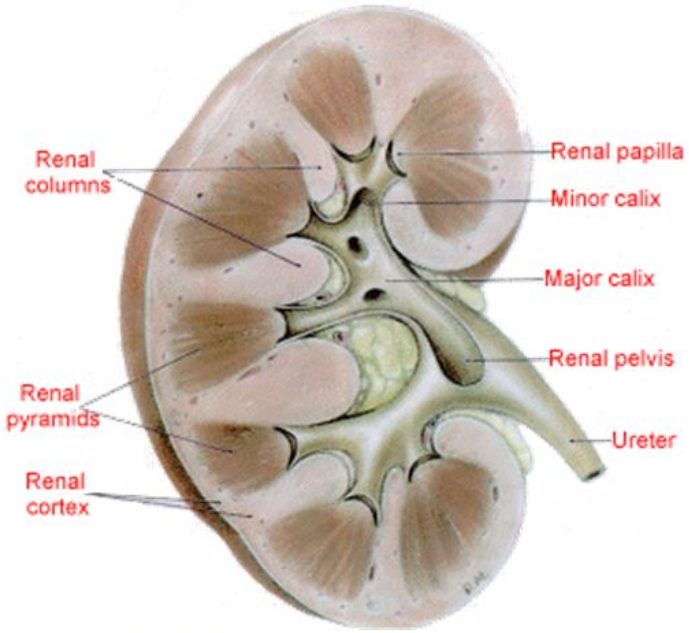
Kidneys And Their Regions

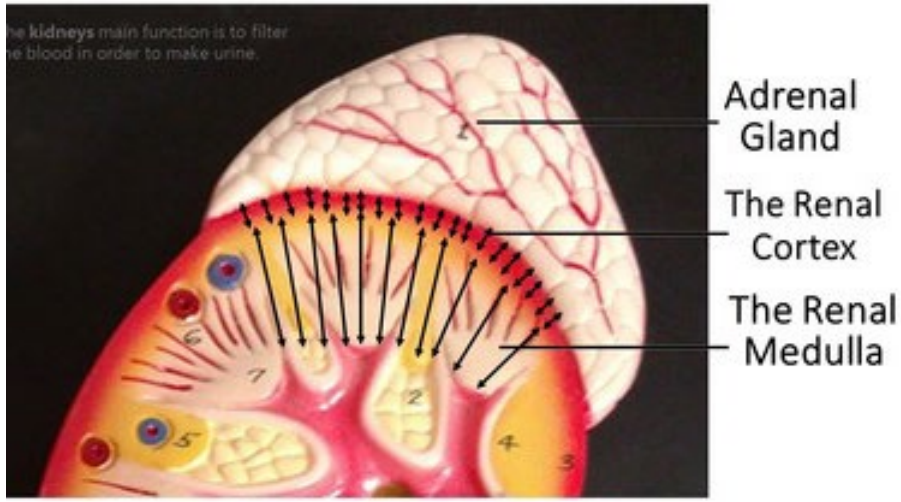
regions of the kidney

- There are three major regions of the kidney:
  - **renal cortex**
  - **renal medulla**
  - **renal pelvis**
- The outer, granulated layer is the renal cortex
- The inner radially striated layer is the renal medulla
- The renal medulla contains the renal pyramids
- The renal pelvis are continuous with the ureters

Regions of the Kidney

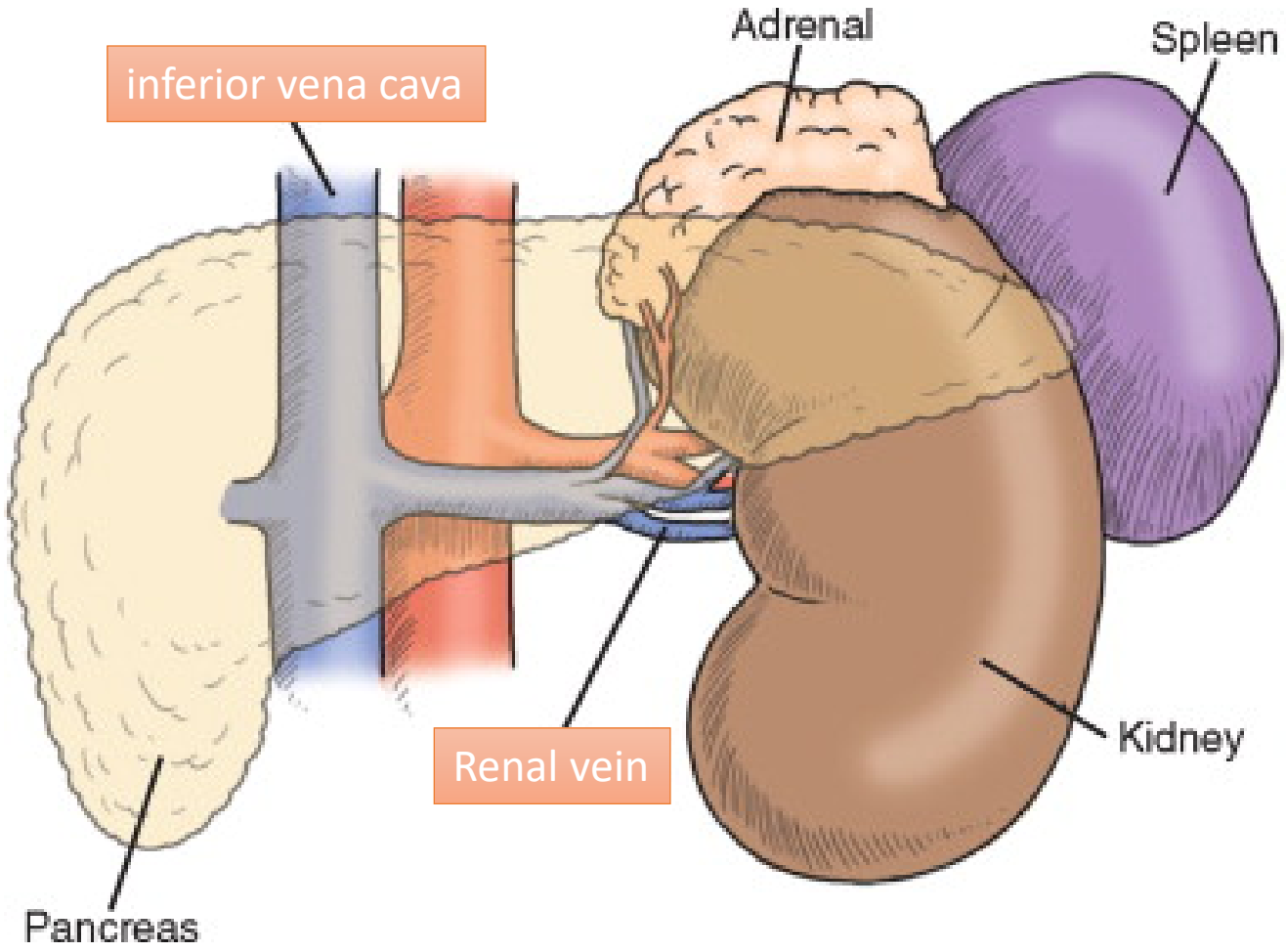
- Renal cortex – outer region
- Renal medulla – inside the cortex
- Renal pelvis – inner collecting tube

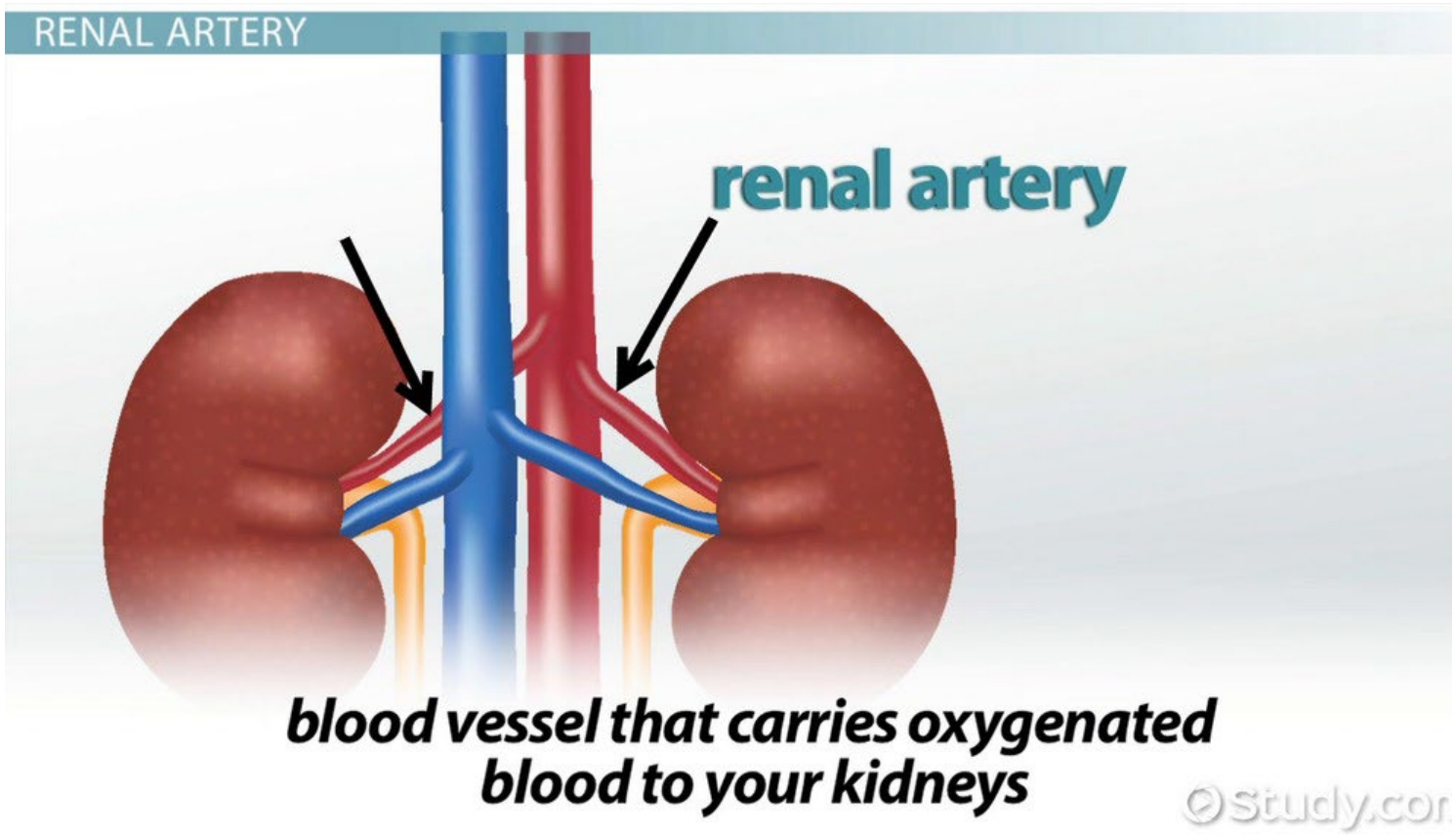




Renal Vein

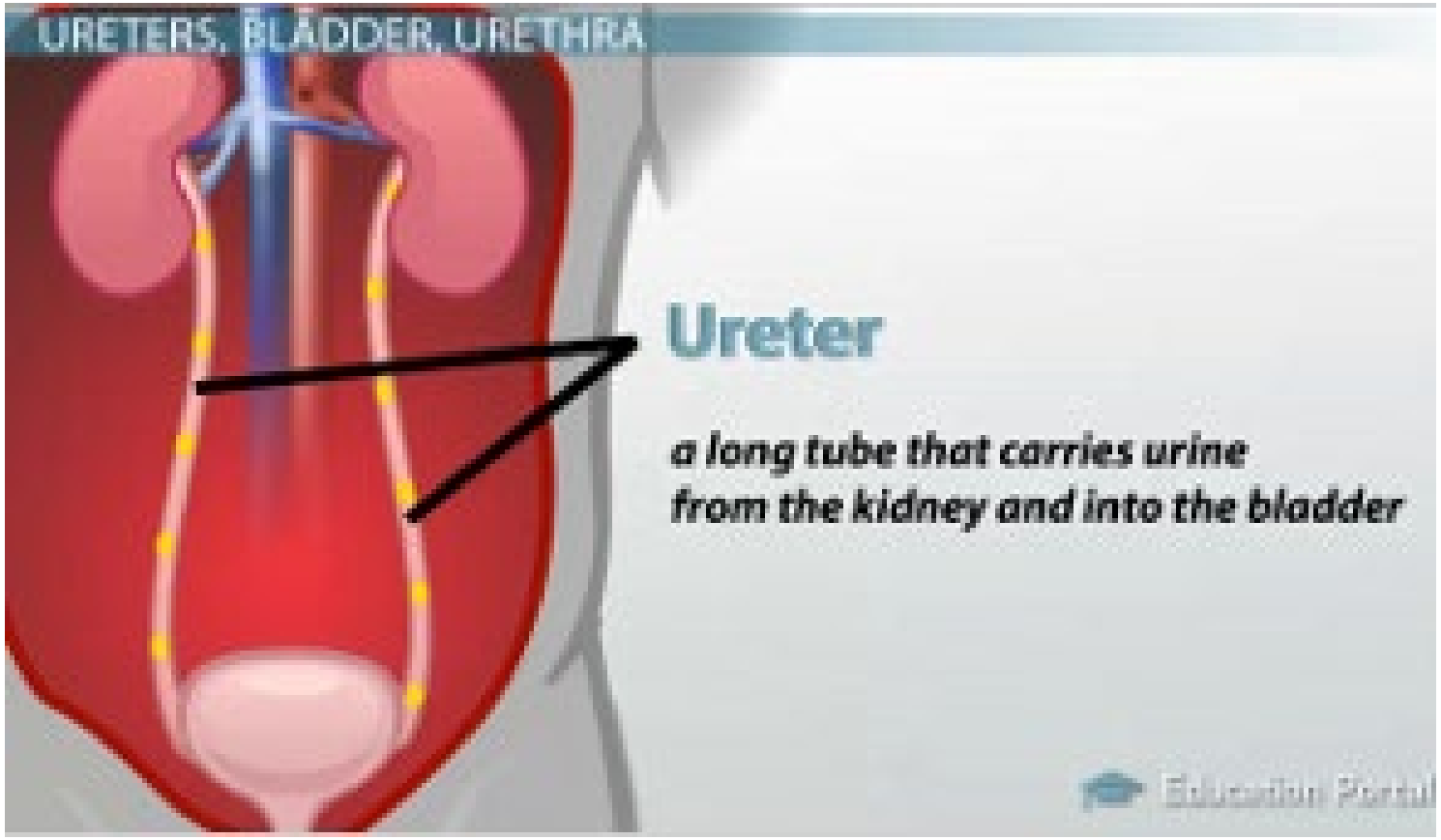
- The **renal veins** are veins that drain the kidney.
- They connect the kidney to the inferior vena cava.





Renal Artery

- The **renal arteries** arise off the abdominal aorta and supply the kidneys with blood.
- The renal arteries carry a large portion of the total blood flow to the kidneys.
- Up to a third of the total cardiac output can pass through the renal arteries to be filtered by the kidneys.

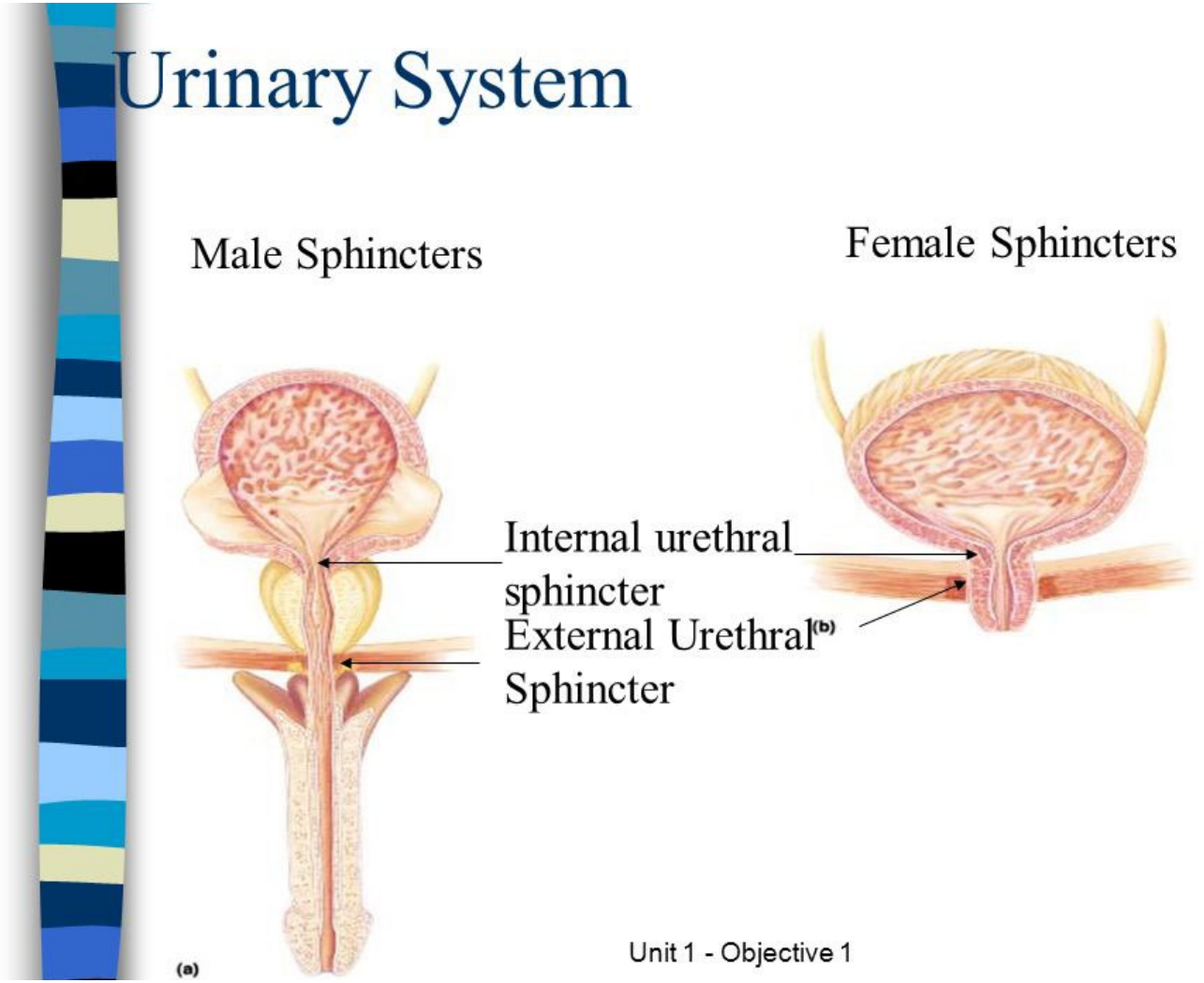


Ureters

- The **ureters** are two tubes that drain urine from the kidneys to the bladder.
- Muscles in the walls of the ureters send the urine in small spurts into the bladder
- After the urine enters the bladder from the ureters, small folds in the bladder mucosa act like valves preventing backward flow of the urine.

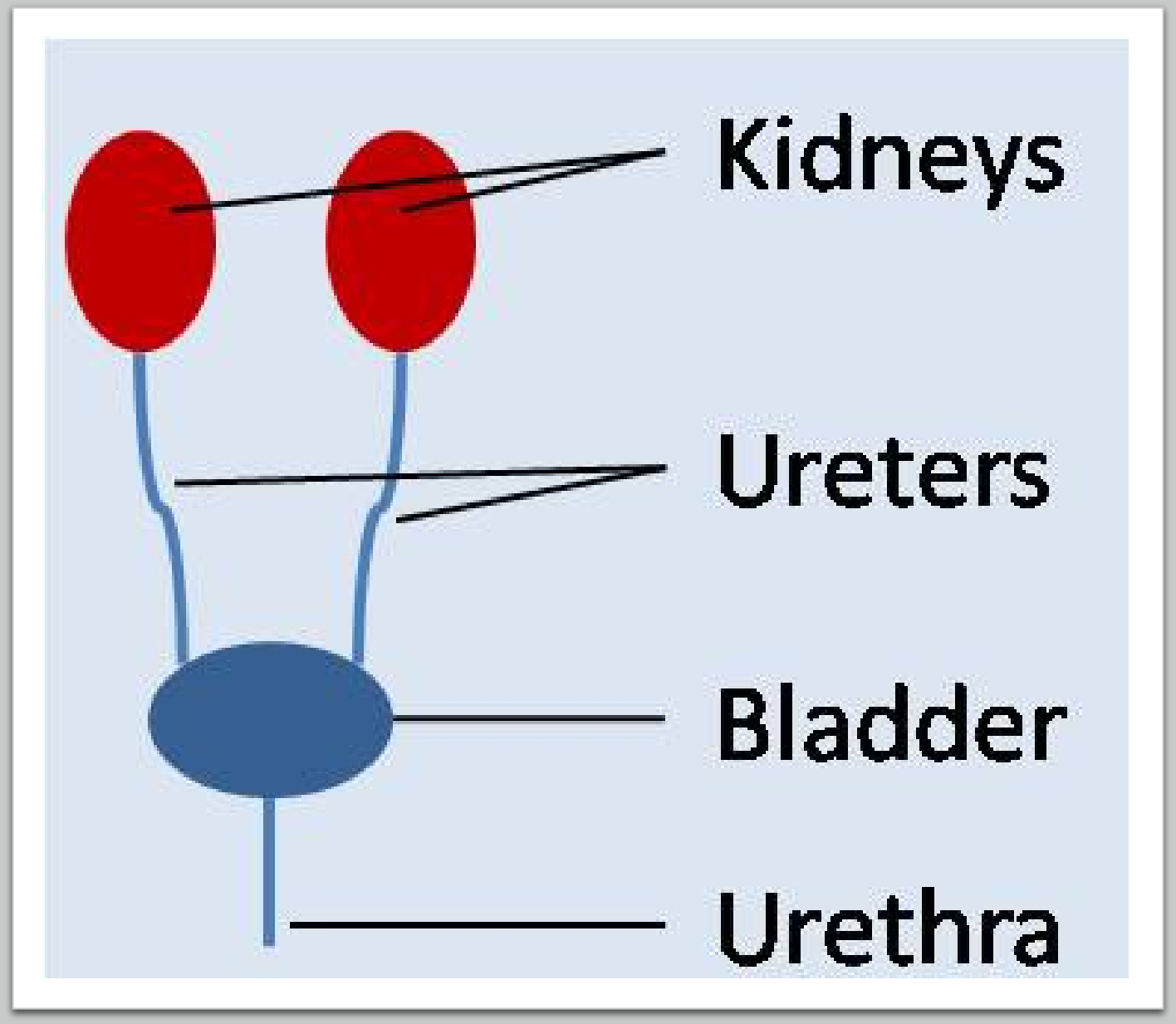
Urinary Sphincters

- The outlet of the bladder is controlled by a sphincter muscle.
  - A full bladder stimulates sensory nerves in the bladder wall that relax the sphincter and allow release of the urine. *However, relaxation of the sphincter is also in part a learned response under voluntary control.*
  - The released urine enters the urethra.

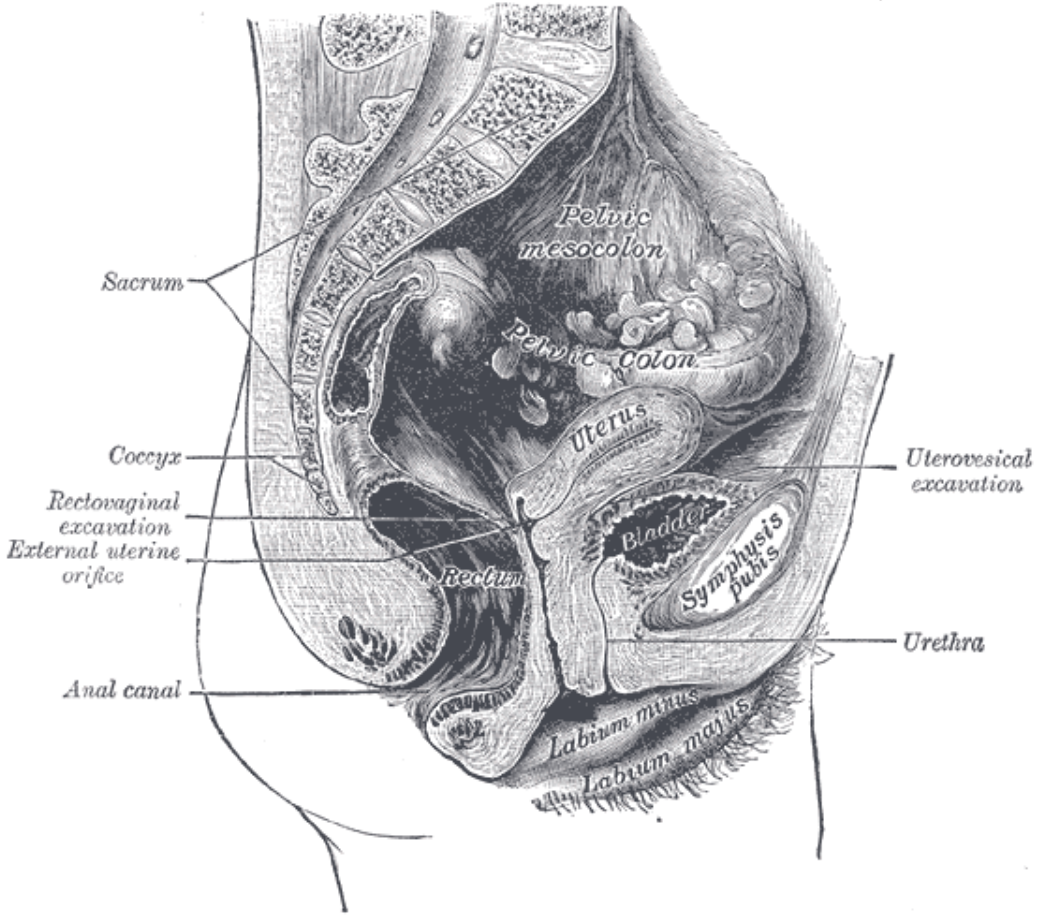


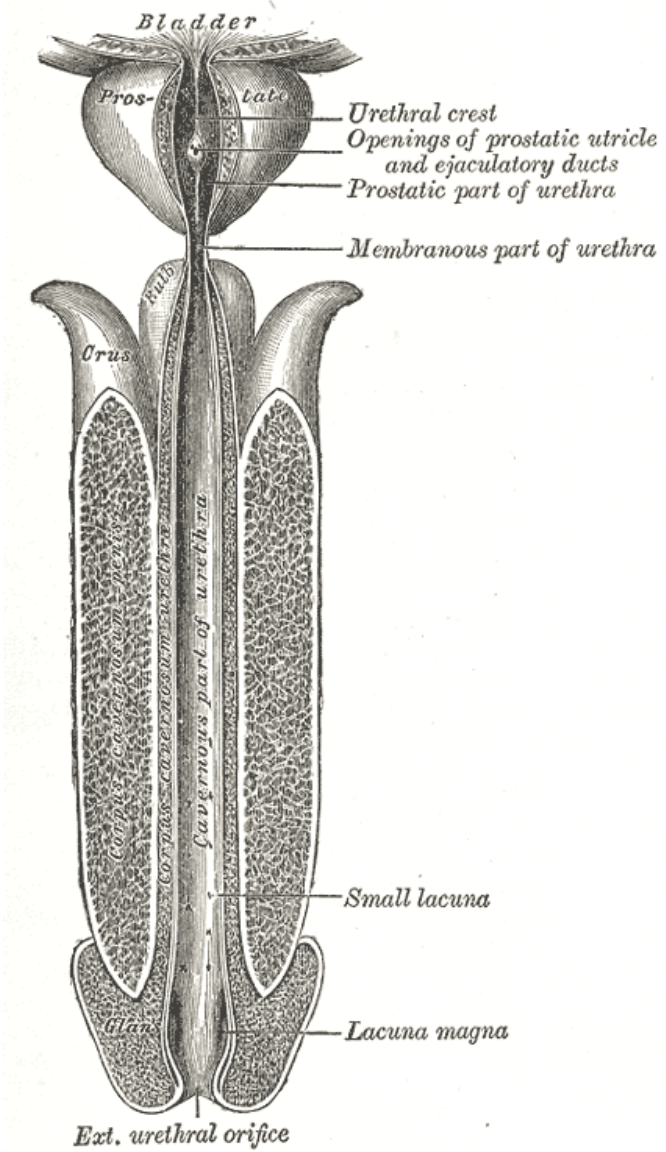
The **urethra**

- The **urethra** is a muscular tube that connects the bladder with the outside of the body.
- The function of the urethra is to remove urine from the body.



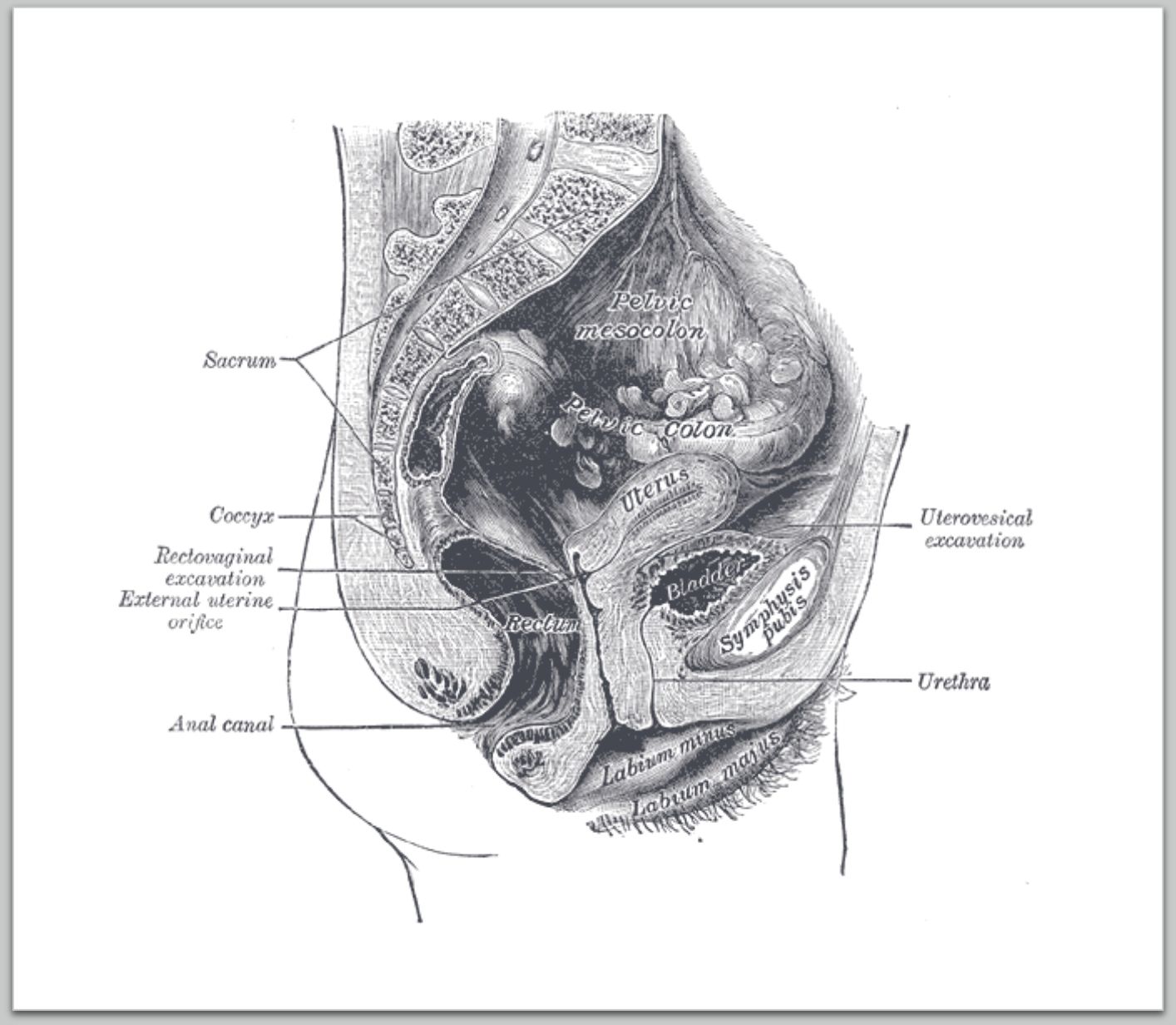
The female urethra is much shorter than the male urethra.





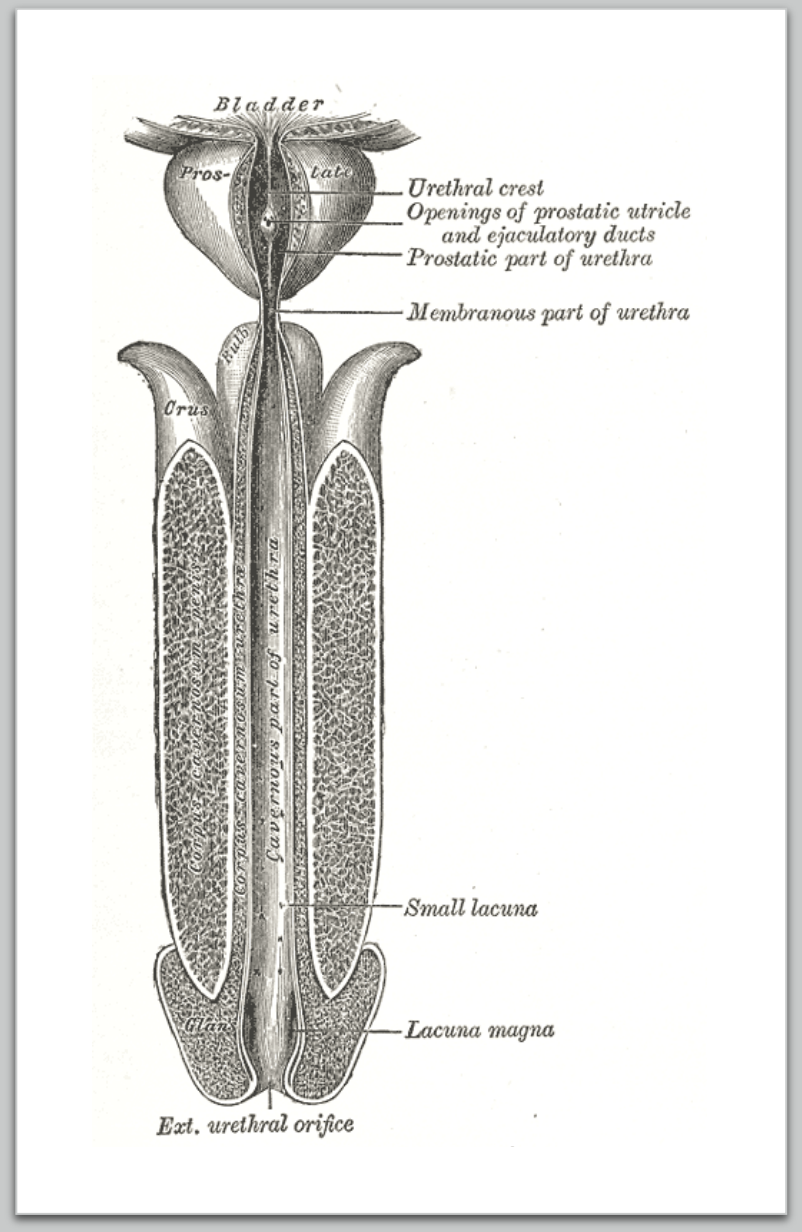
The Female Urethra

- The female urethra is much shorter than the male urethra.
- Women tend to be more susceptible to infections of the bladder (cystitis) and the urinary tract (UTI).

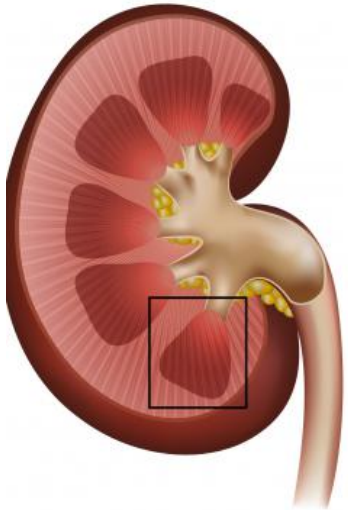


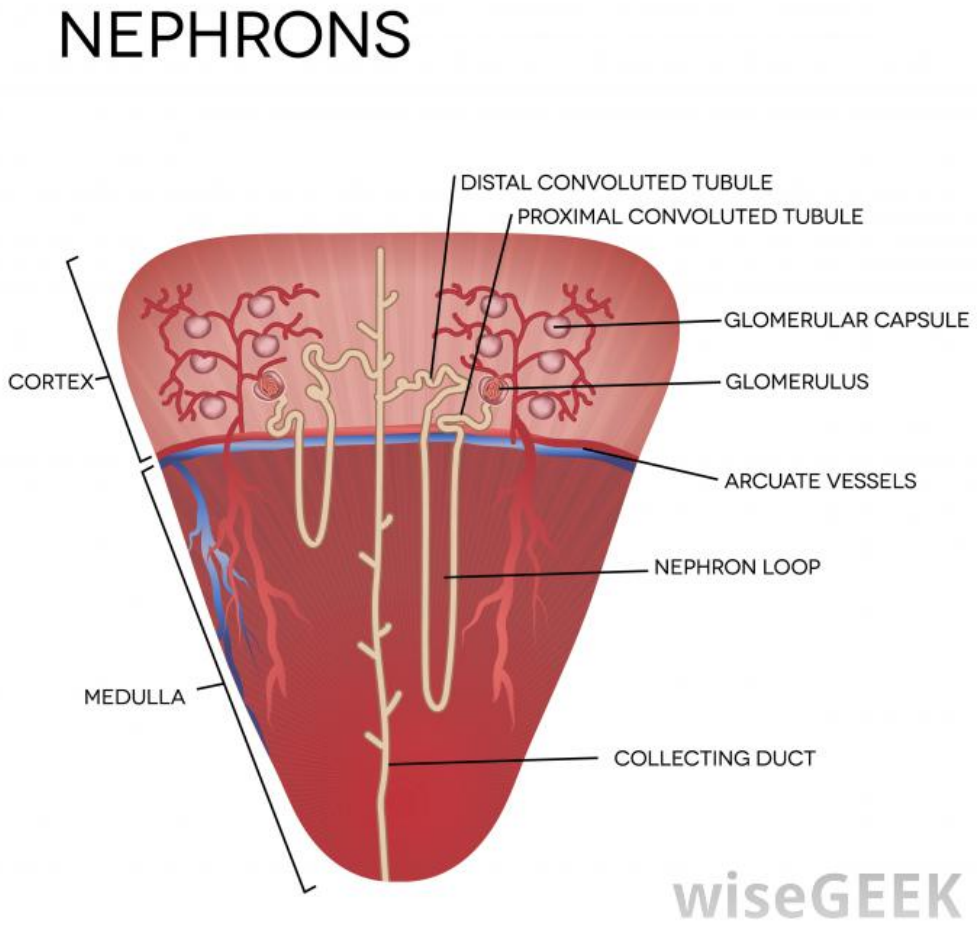
Male urethra

- In the human male, the urethra is a common pathway for semen as well as urine.
- The **urethral sphincter** is much stronger in males
  - meaning that they can retain a large amount of urine for twice as long as females



Nephrons

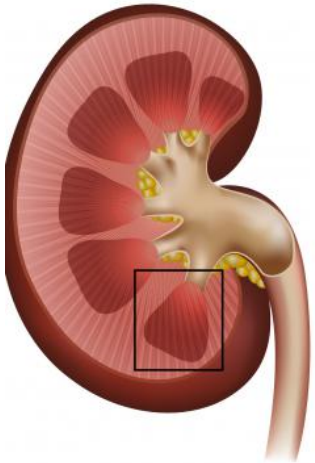


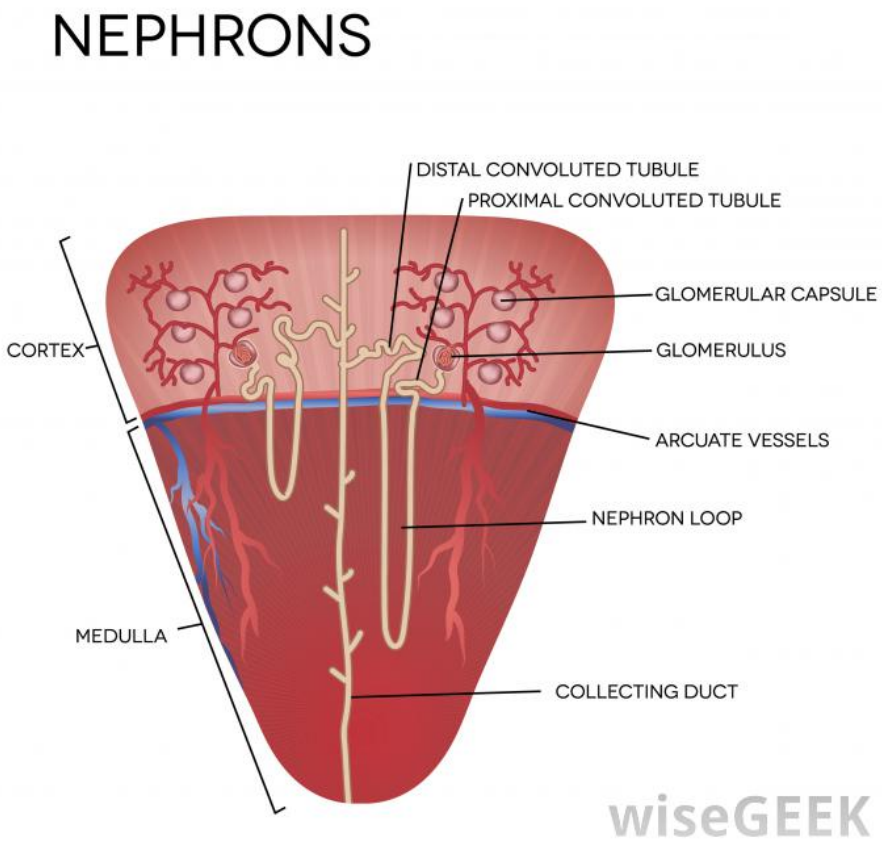


- A nephron is the basic structural and functional unit of the kidney.
- Its chief function is to
  - regulate water and soluble substances by filtering the blood
  - reabsorbing what is needed and excreting the rest as urine.

Nephrons

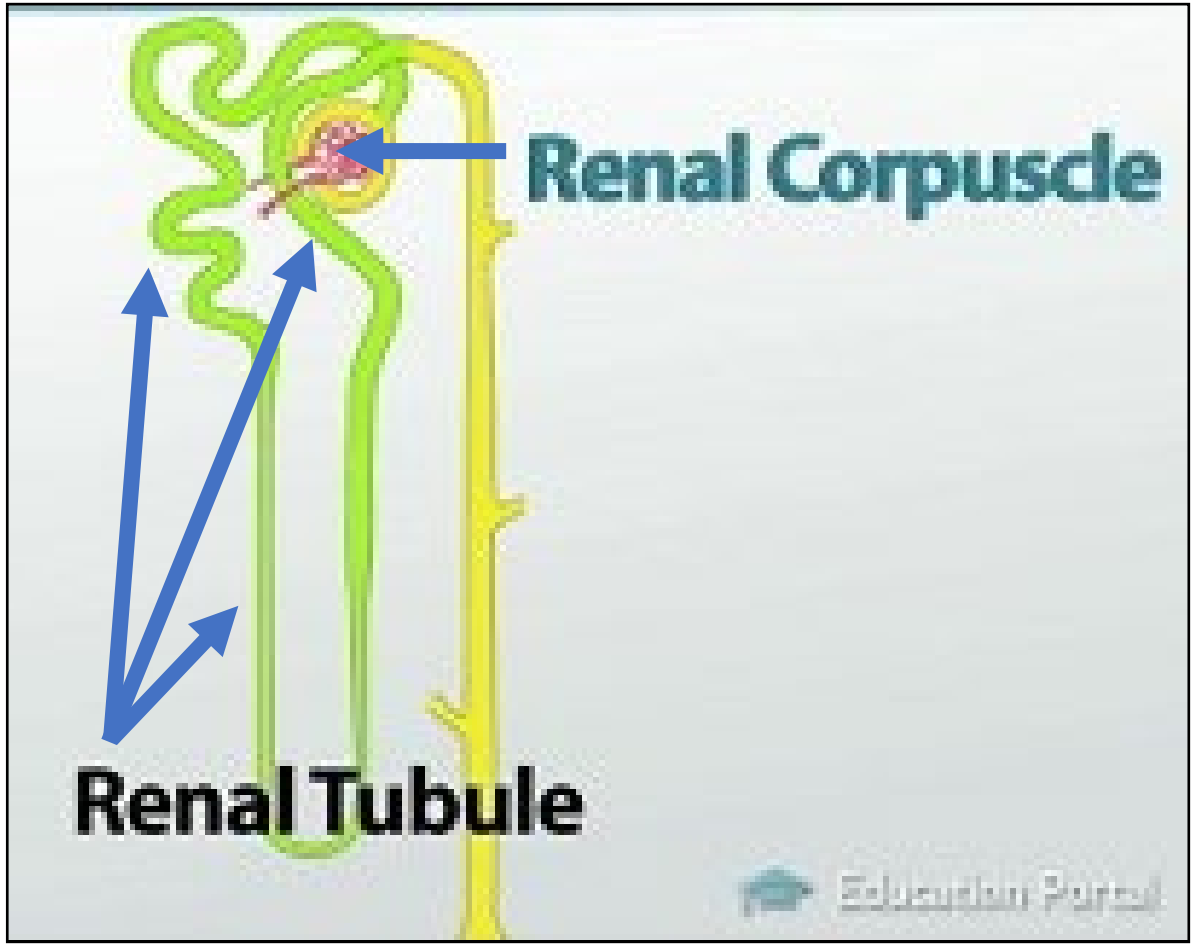
- Nephrons
  - Eliminate wastes from the body
  - Regulate blood volume
  - Regulate blood pressure
  - Control levels of electrolytes and metabolites
  - Regulate blood ph



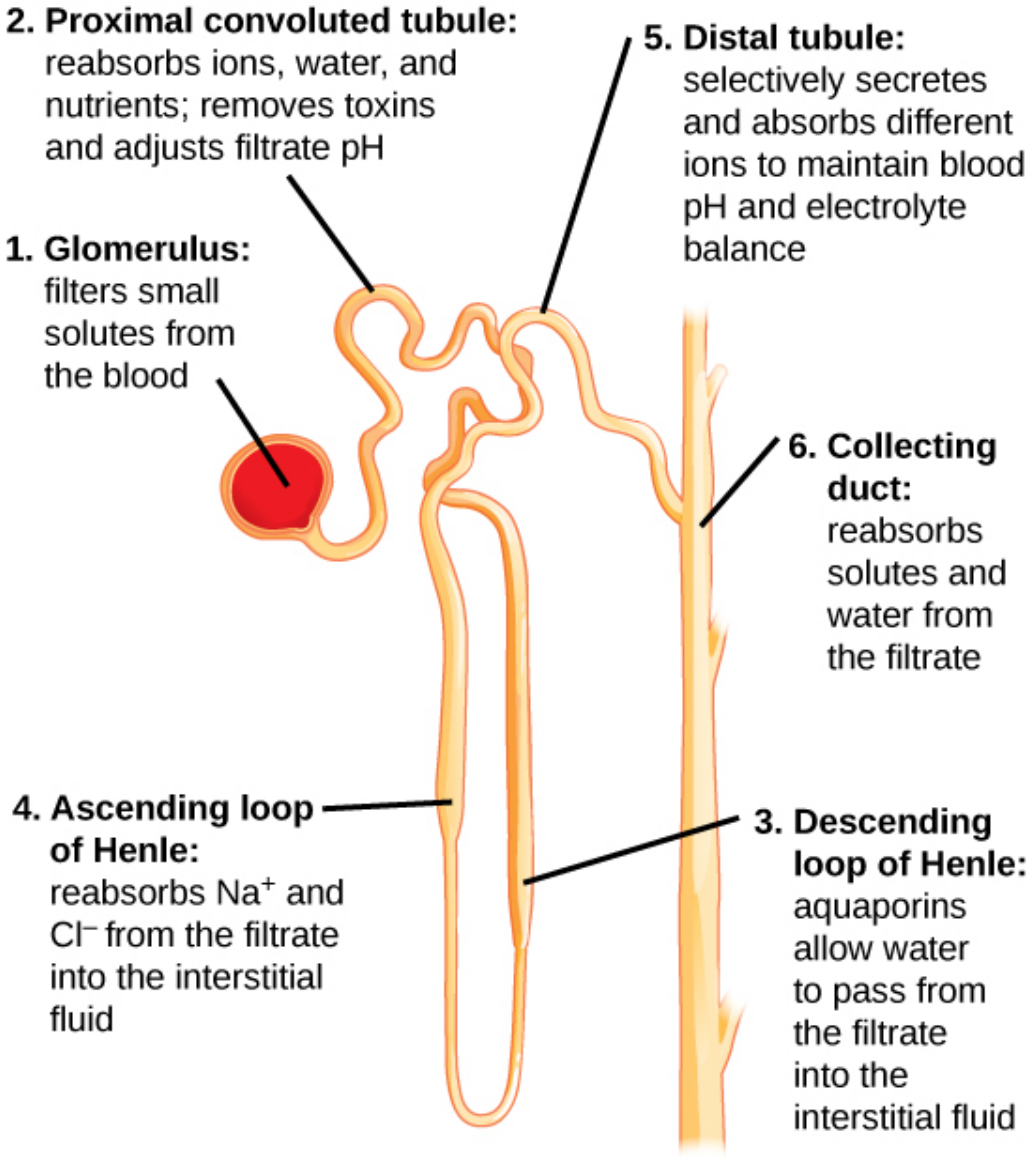


Nephrons

- Each nephron is composed of
  - an initial filtering component (the renal corpuscle)
  - a tubule specialized for reabsorption and secretion (the renal tubule).

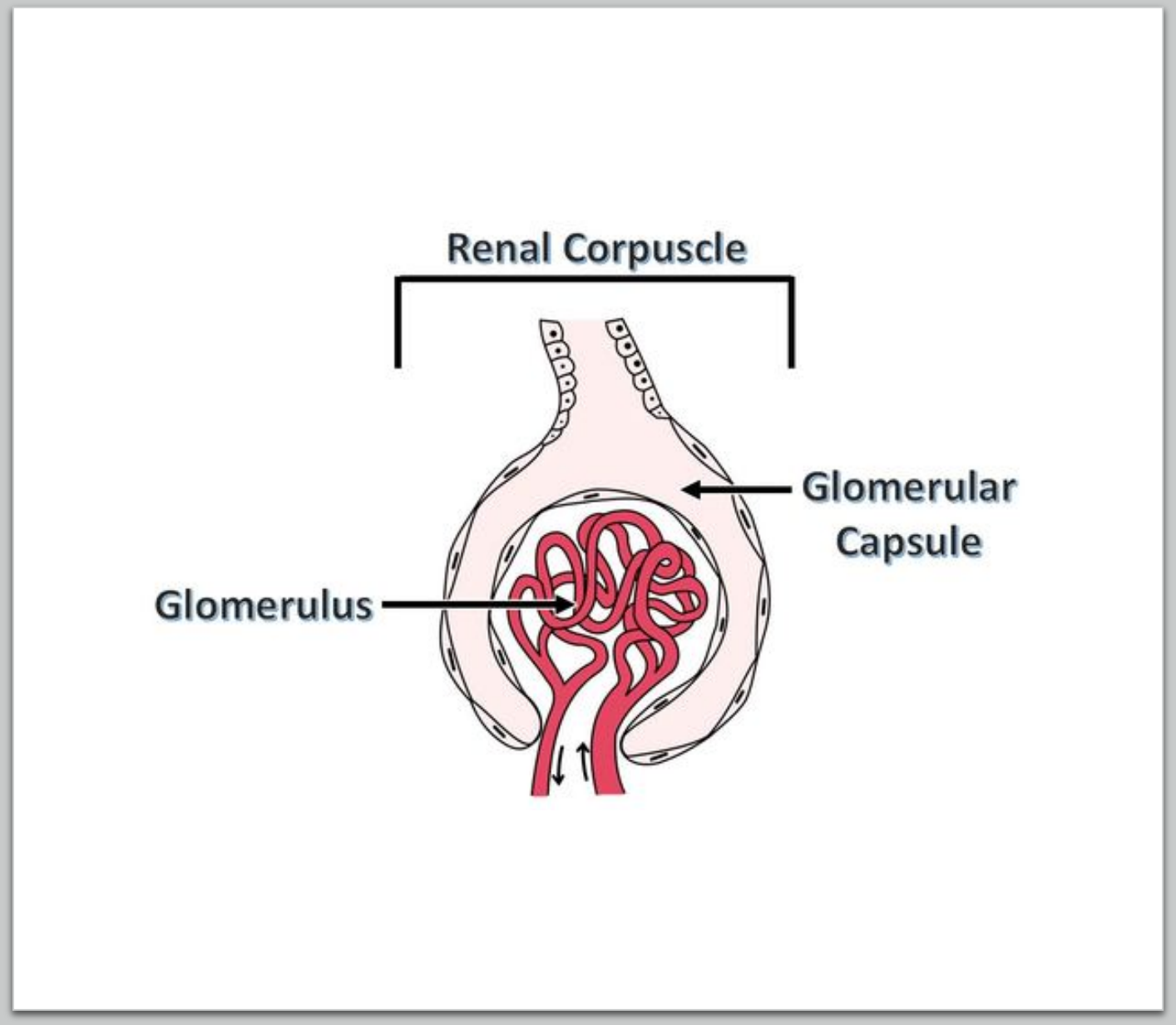


Renal Tubules



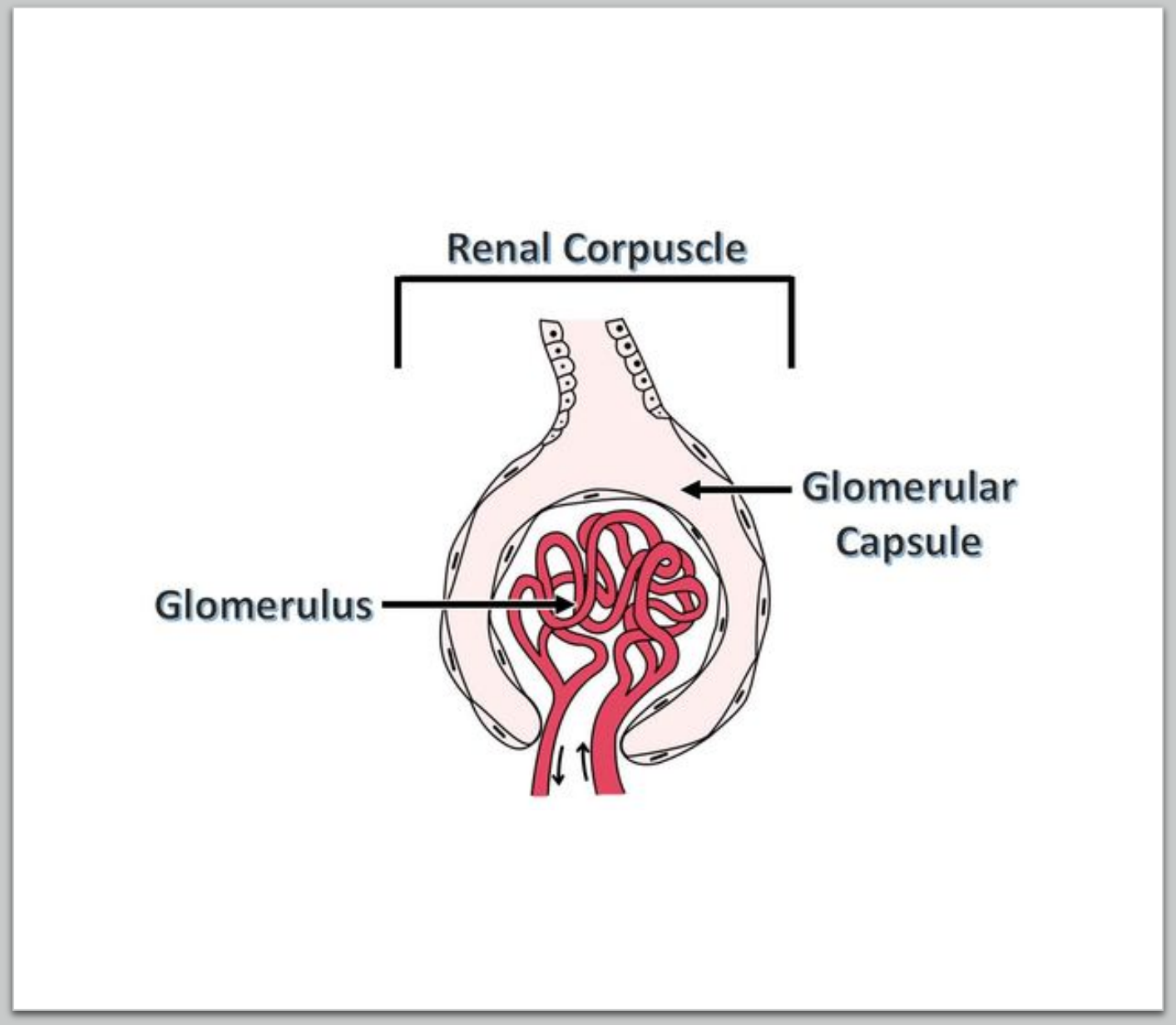
Renal Corpuscle

- Together, the **Glomerulus** and **Glomerular Capsule or Bowman's Capsule** are called the **Renal Corpuscle**.
- Between the visceral and parietal layers of the **Renal Corpuscle** is the **Bowman's space.**



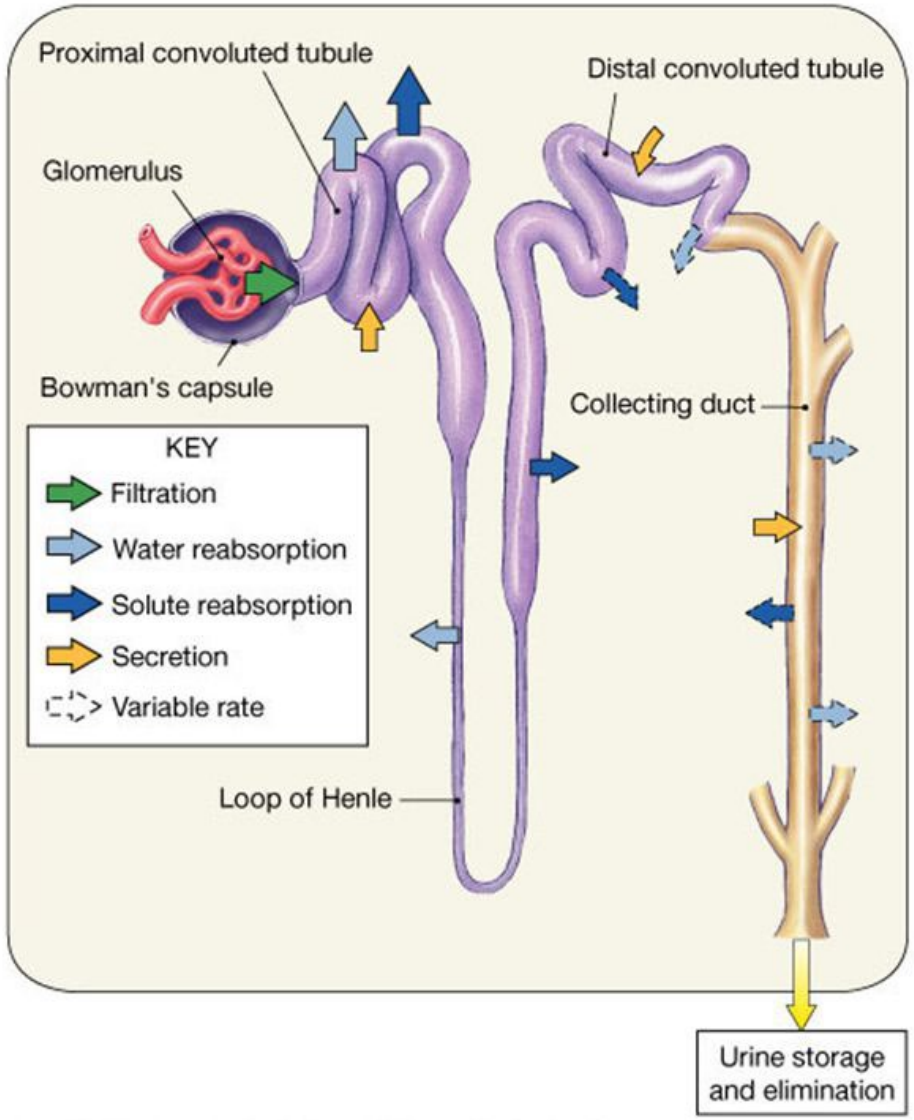
The Renal Corpuscle

- The renal corpuscle
  - Filters out large solutes from the blood
  - Allows water and small solutes to move on to the renal tubule



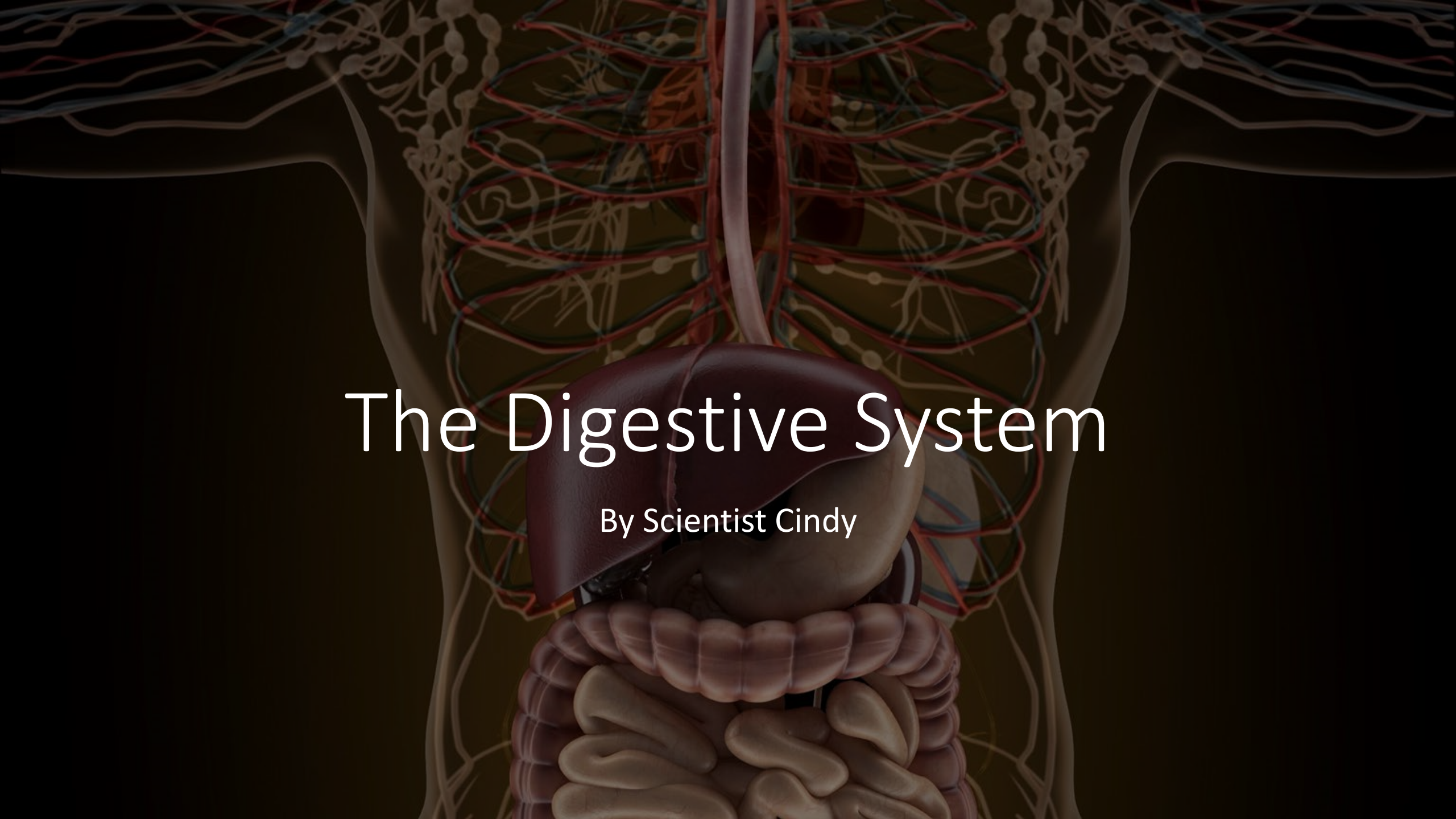
Collecting ducts

- Each distal convoluted tubule delivers its filtrate to a system of collecting ducts.
- As the urine travels down the collecting duct, as much as three-fourths of the water from urine can be reabsorbed as it leaves the collecting duct by osmosis.



Tubular Secretion

- Urine is a collection of substances that have not been reabsorbed during glomerular filtration or tubular reabsorbtion.

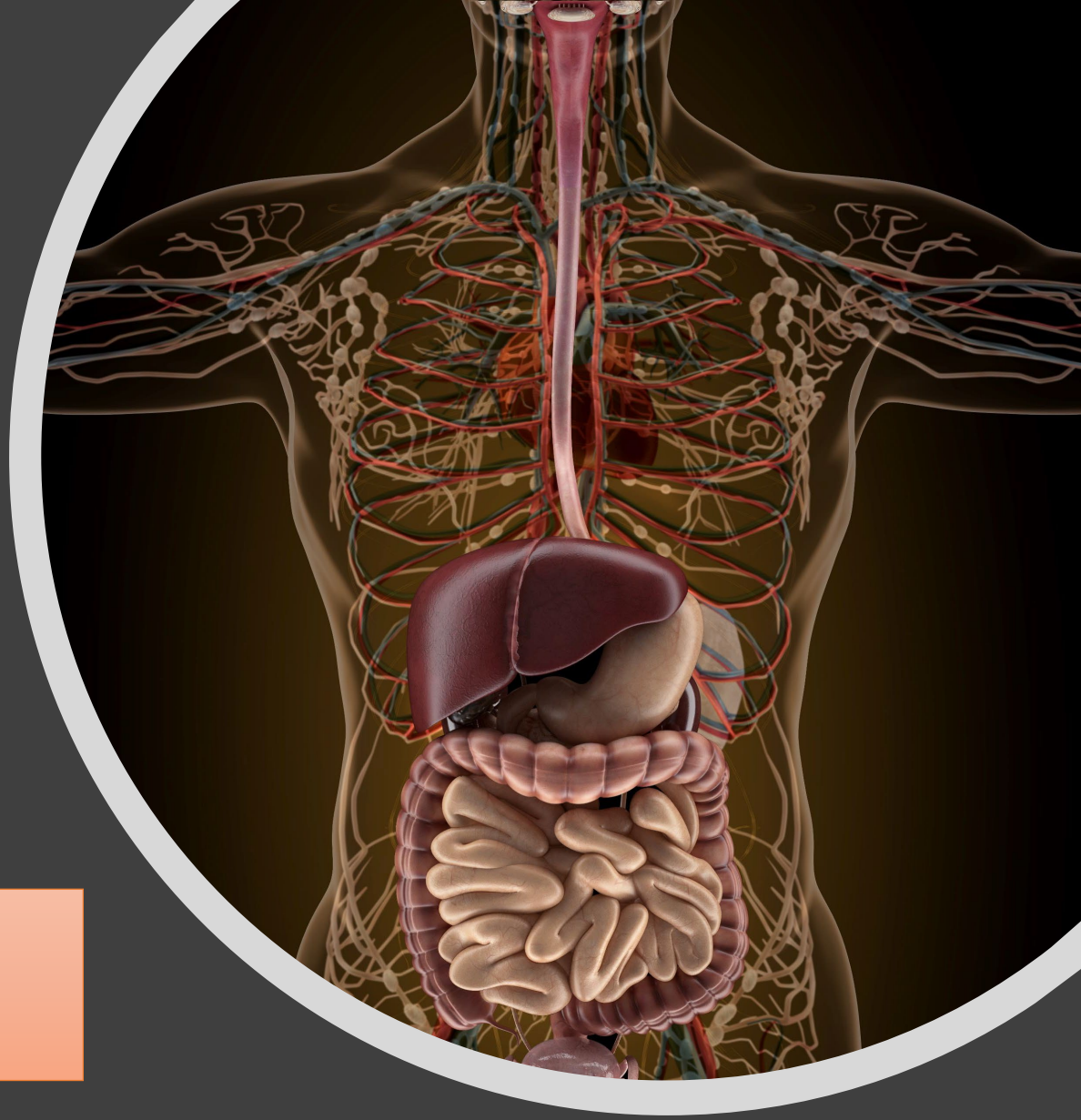


The Digestive System

By Scientist Cindy

FUNCTIONS OF THE DIGESTIVE SYSTEM

- 2 functions of the digestive system :
  - Digestion
  - Absorption

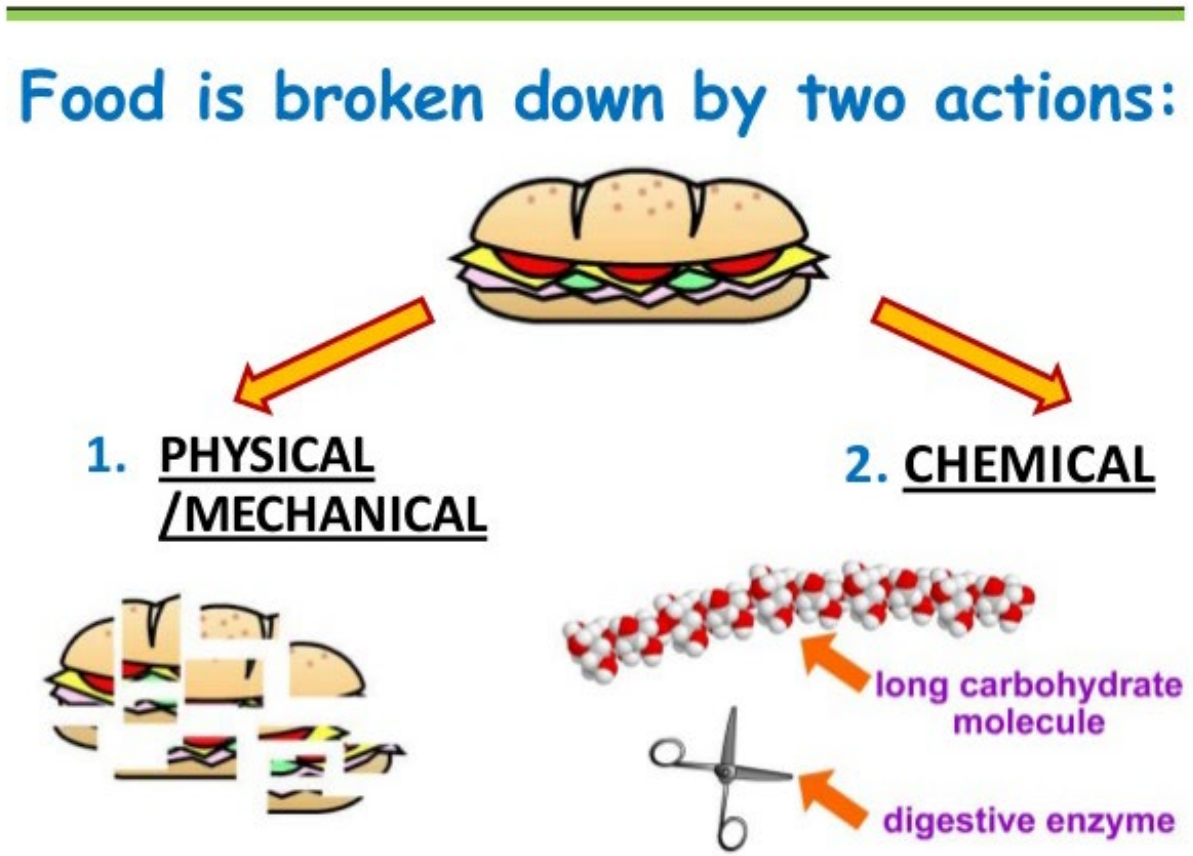


The **Gastrointestinal System** is responsible for

the breakdown and absorption of various foods and liquids needed to sustain life.

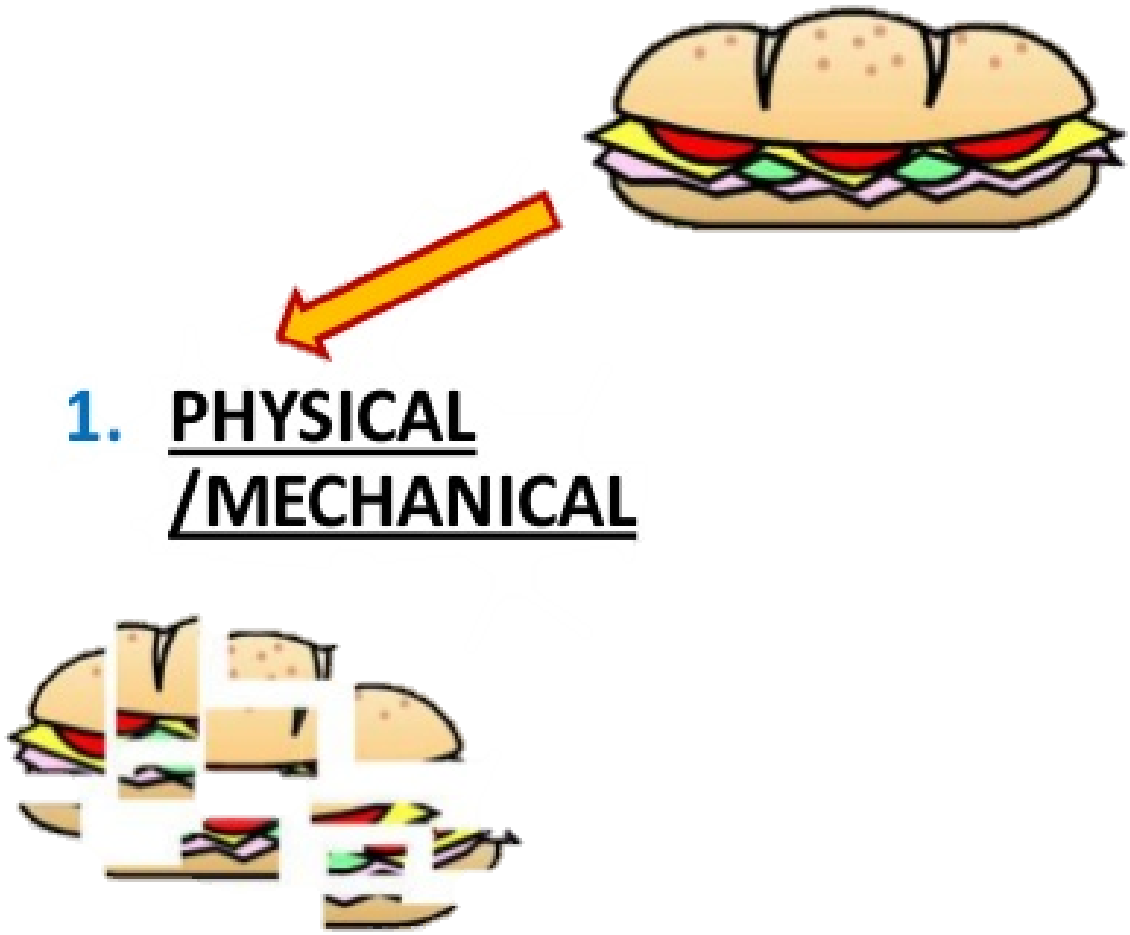
FUNCTIONS OF THE DIGESTIVE SYSTEM

- During digestion, two main processes occur at the same time;
  - Mechanical Digestion
  - Chemical Digestion



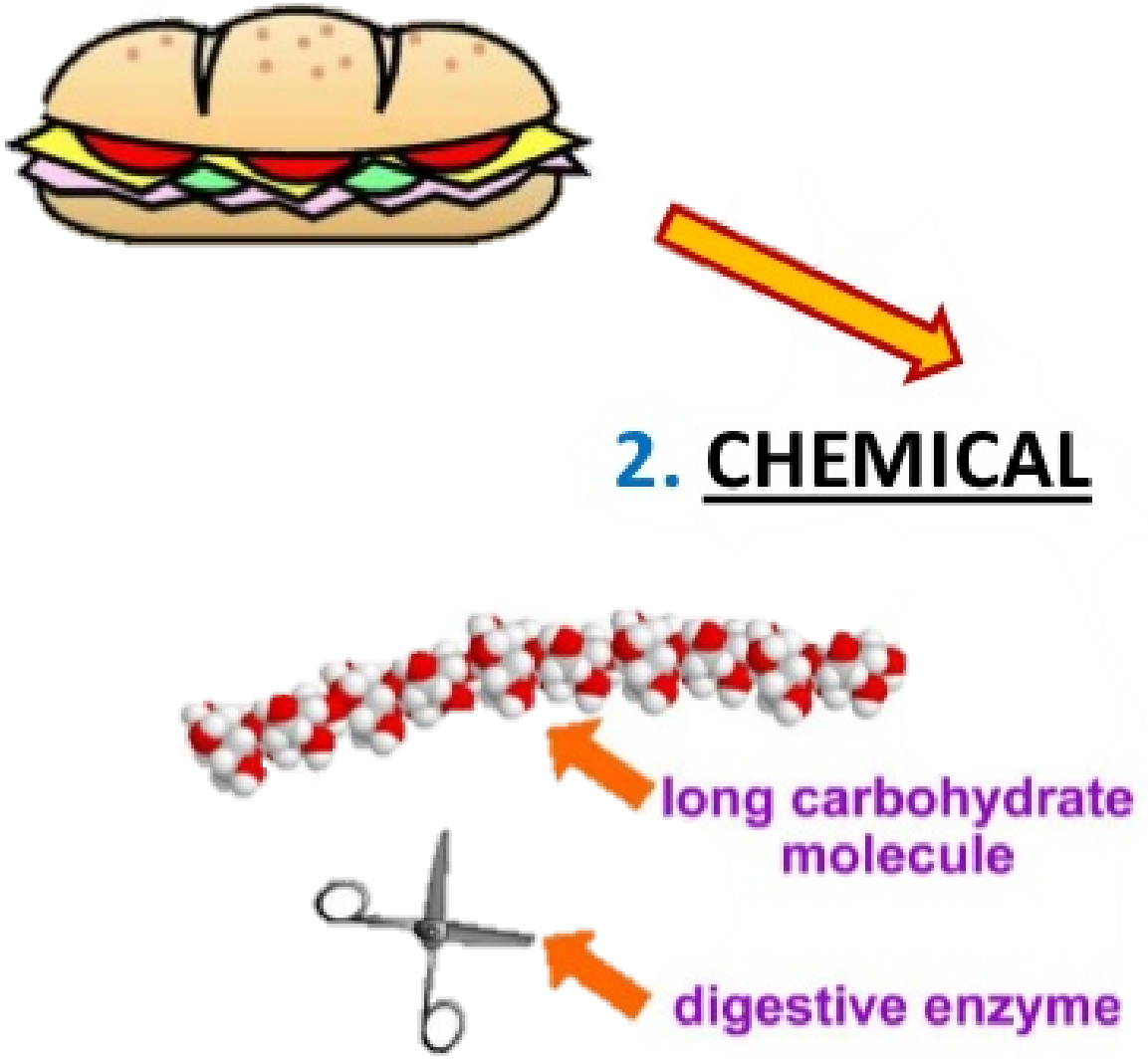
Mechanical Digestion:

- **Mechanical Digestion**: larger pieces of food get broken down into smaller pieces while being prepared for chemical digestion.
- Mechanical digestion starts in the mouth and continues into the stomach.



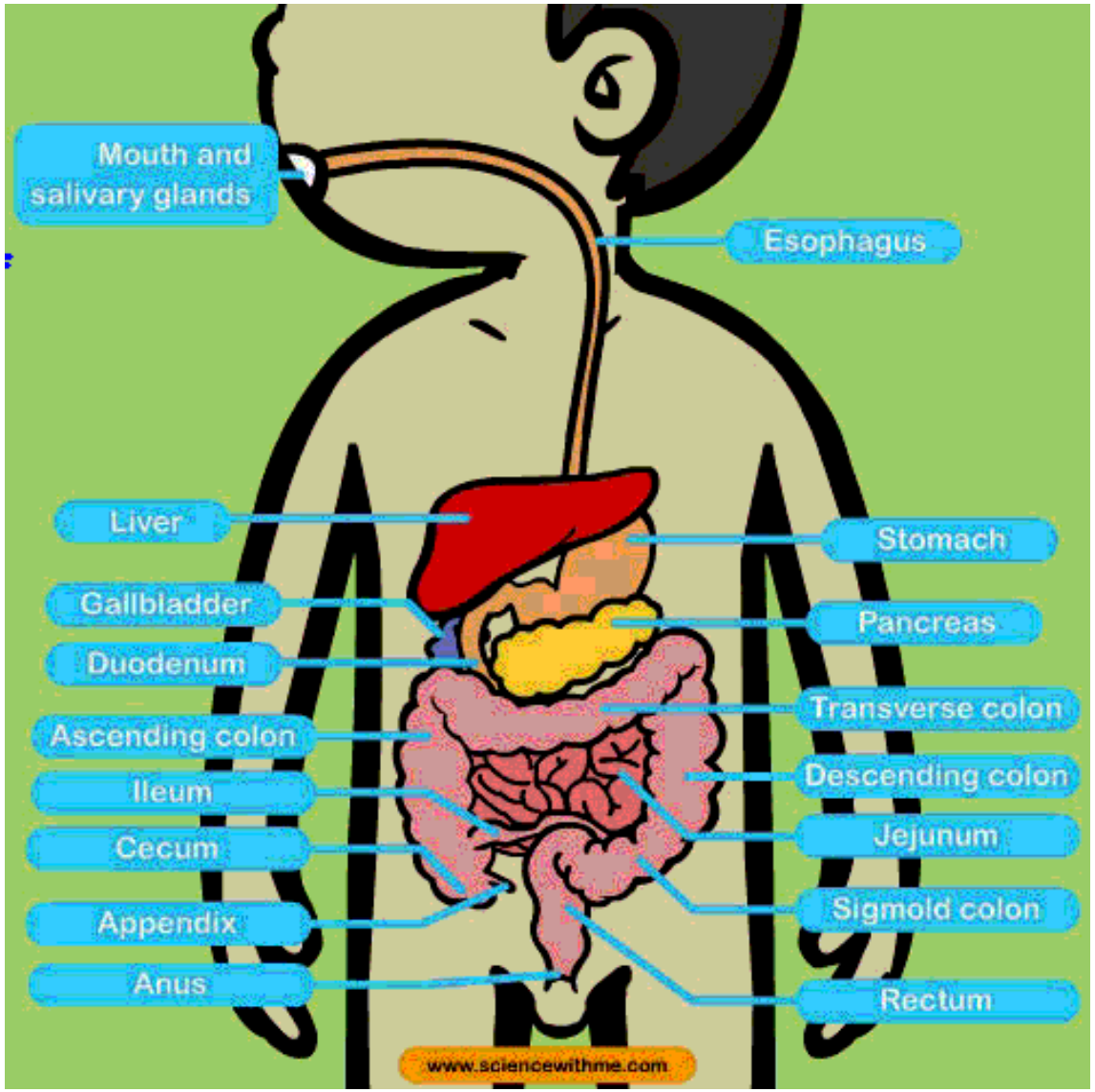
Chemical Digestion:

- **Chemical Digestion**: starts in the mouth and continues into the intestines.
- Several different enzymes break down macromolecules into smaller molecules that can be absorbed.



The GI Tract

- The GI tract includes
  - The Mouth
  - The Esophagus
  - The Stomach
  - The Small Intestine (Duodenum, Jejunum, Ileum)
  - The Large Intestine (Colon)
  - Rectum
  - Anus



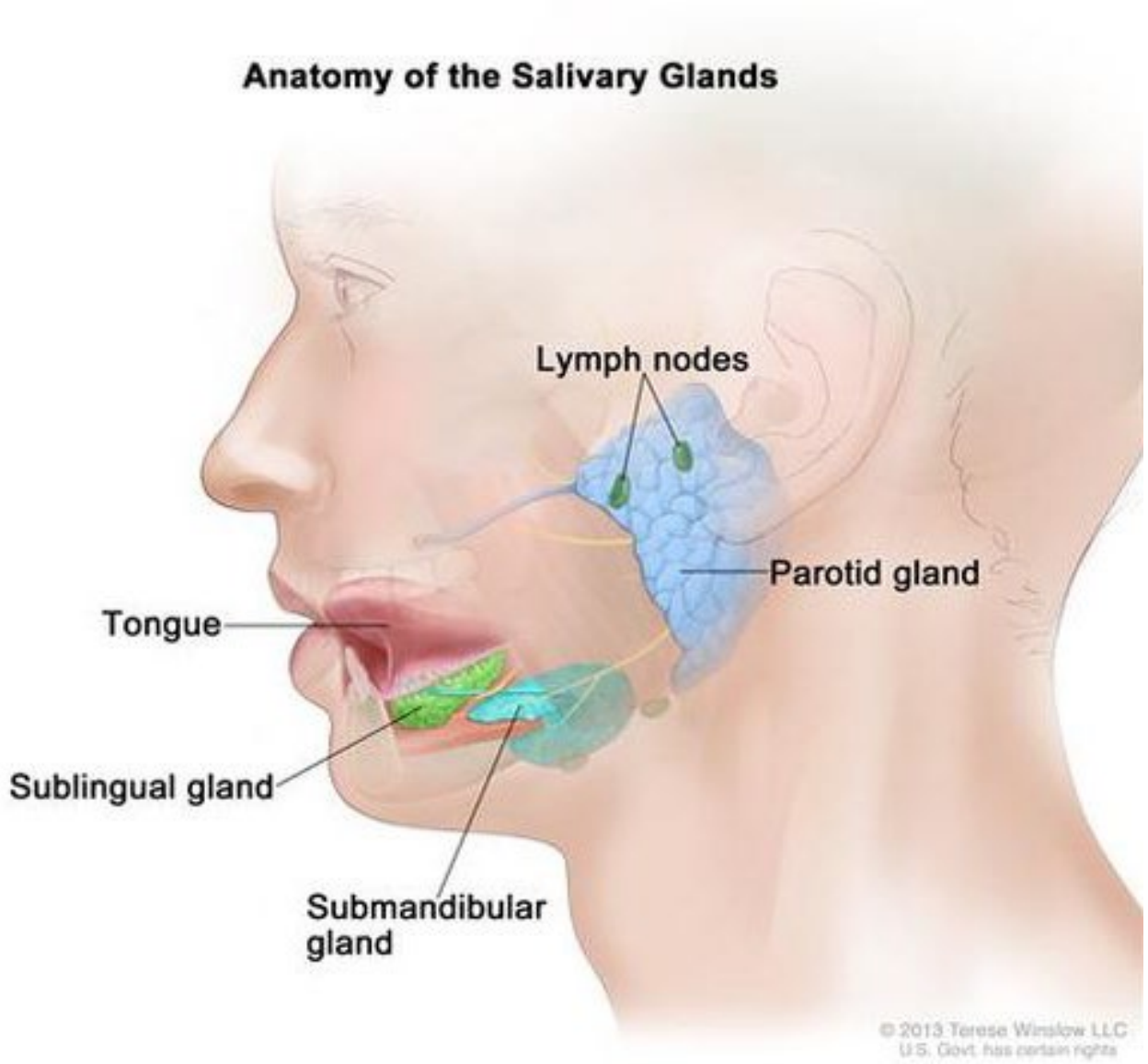
Accessory Organs

1. Salivary glands
2. Tongue
3. Teeth
4. Liver
5. Gallbladder
6. Pancreas
7. Vermiform appendix

Salivary glands

- The 3 salivary glands –
  - Parotid Gland
  - Submandibular Gland
  - Sublingual Gland

- The Salivary Glands are exocrine glands that produce saliva which begins the process of digestion with amylase, and moistens the food creating a bolus.



Tongue and Teeth

Tongue

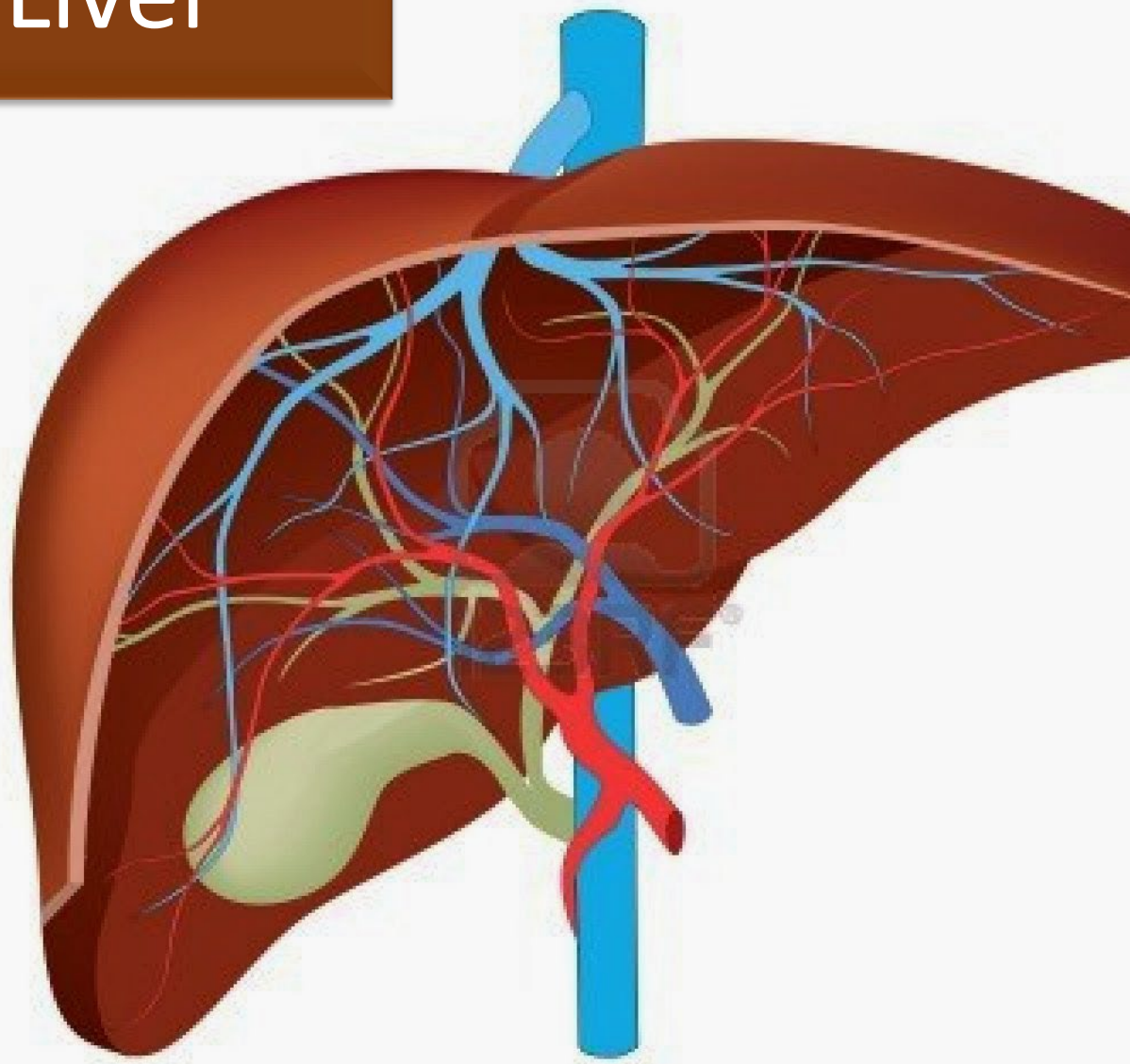
- Manipulates food for chewing/swallowing
- Main taste organ, covered in taste buds

Teeth

- For chewing food up

Liver

- Produces and excretes bile required for emulsifying fats.
  - Some of the bile drains directly into the duodenum and some is stored in the gall bladder.
- Helps metabolize proteins, lipids, and carbohydrates.
- Urea is formed in liver from amino acids and compounds of ammonia.
- Breaks down insulin and other hormones.
- Produces coagulation factors.



Liver

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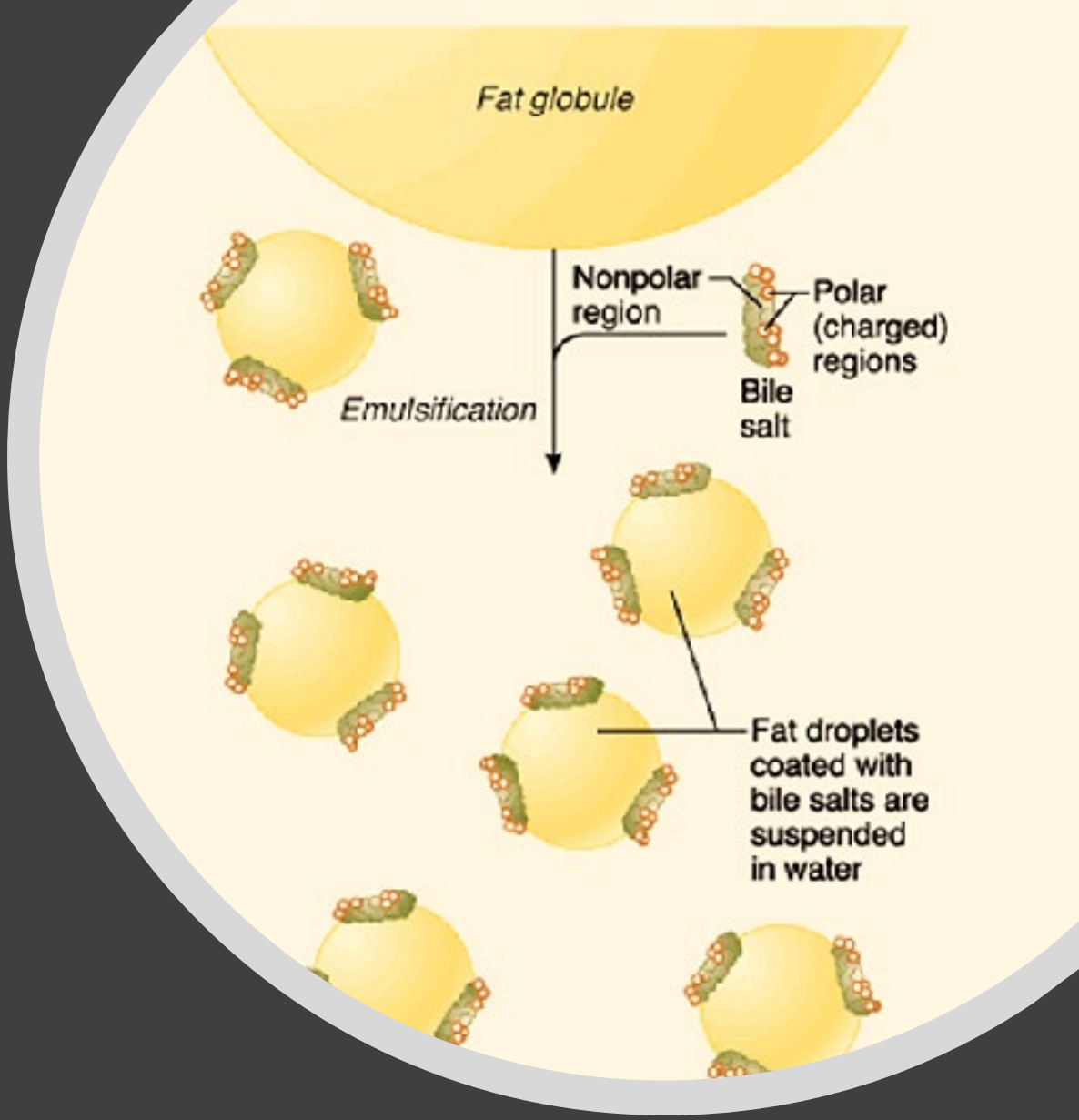
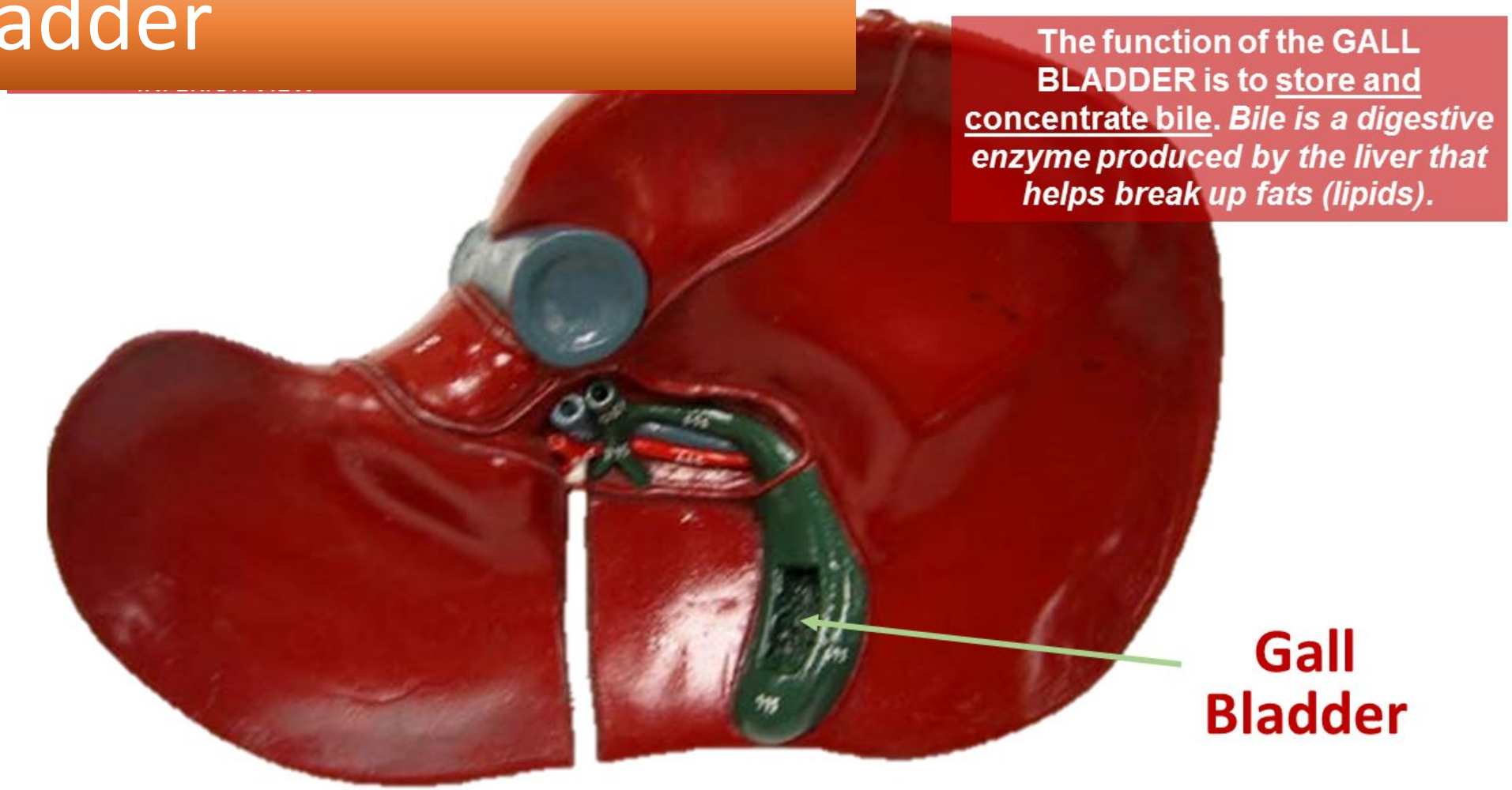


FUNCTION:

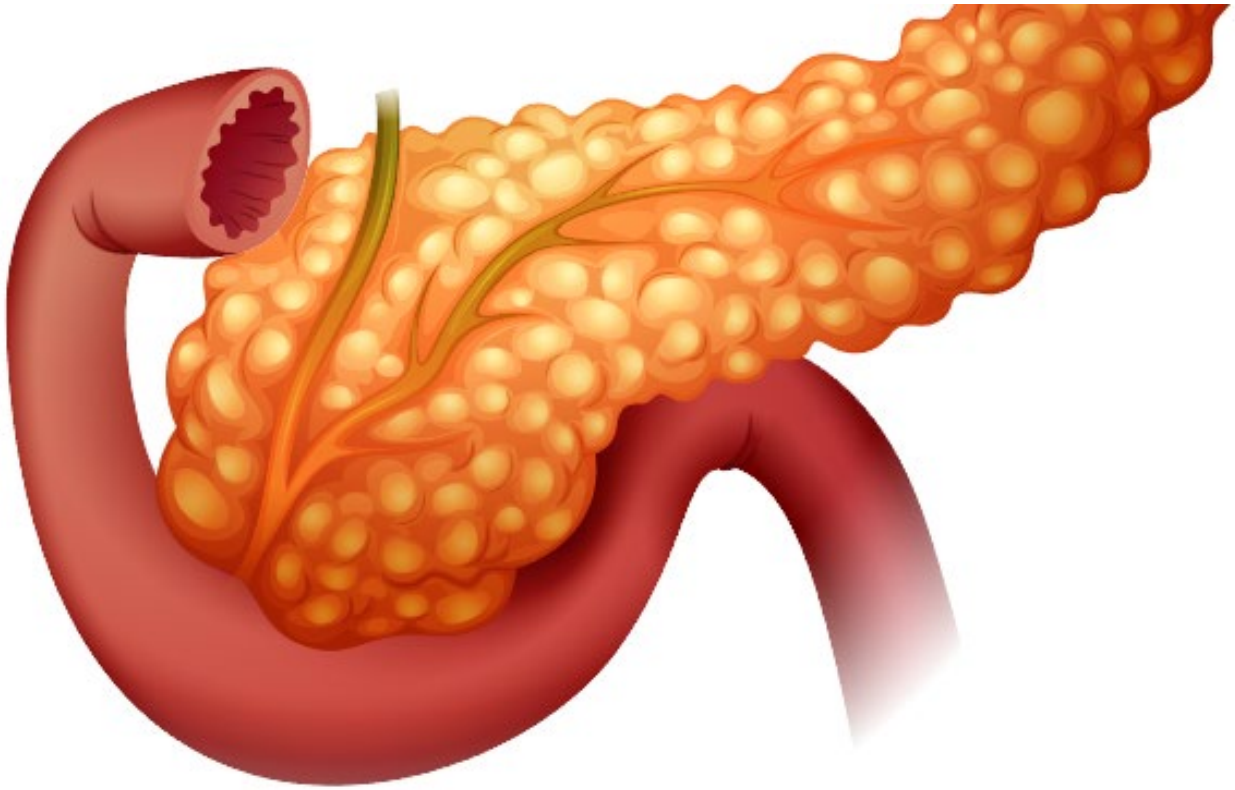
- Bile storage – Stores and Concentrated Biles from the Liver

Gallbladder



PANCREAS

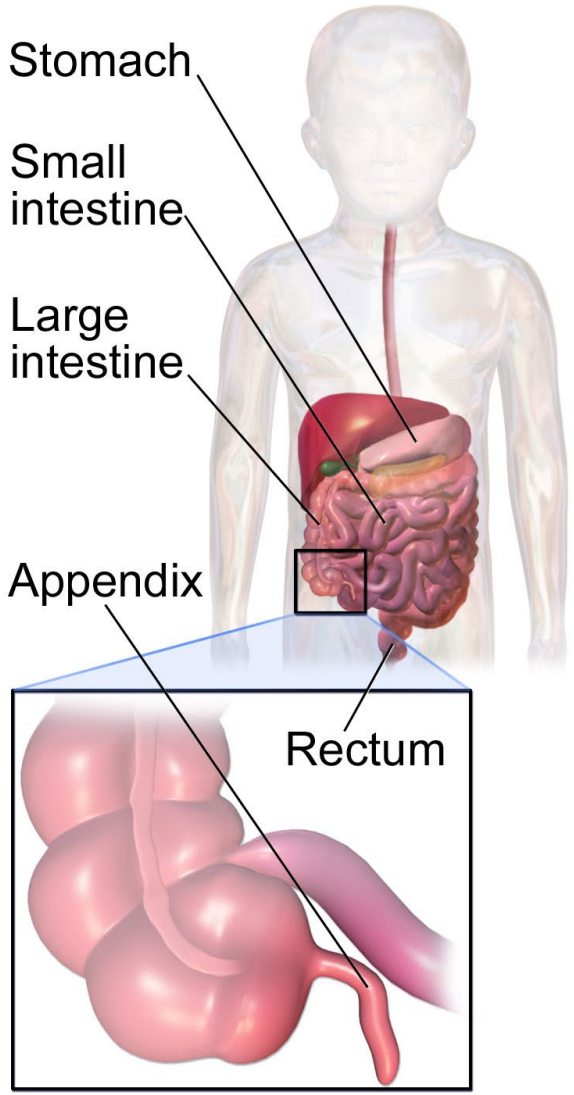
- Releases pancreatic juice into the duodenum.
- Pancreatic juice has many digestive enzymes.



Vermiform Appendix

There are a few theories on what the appendix does.

- Vestigal organ
- Immune function
- Helps maintain gut flora



Location of the Appendix

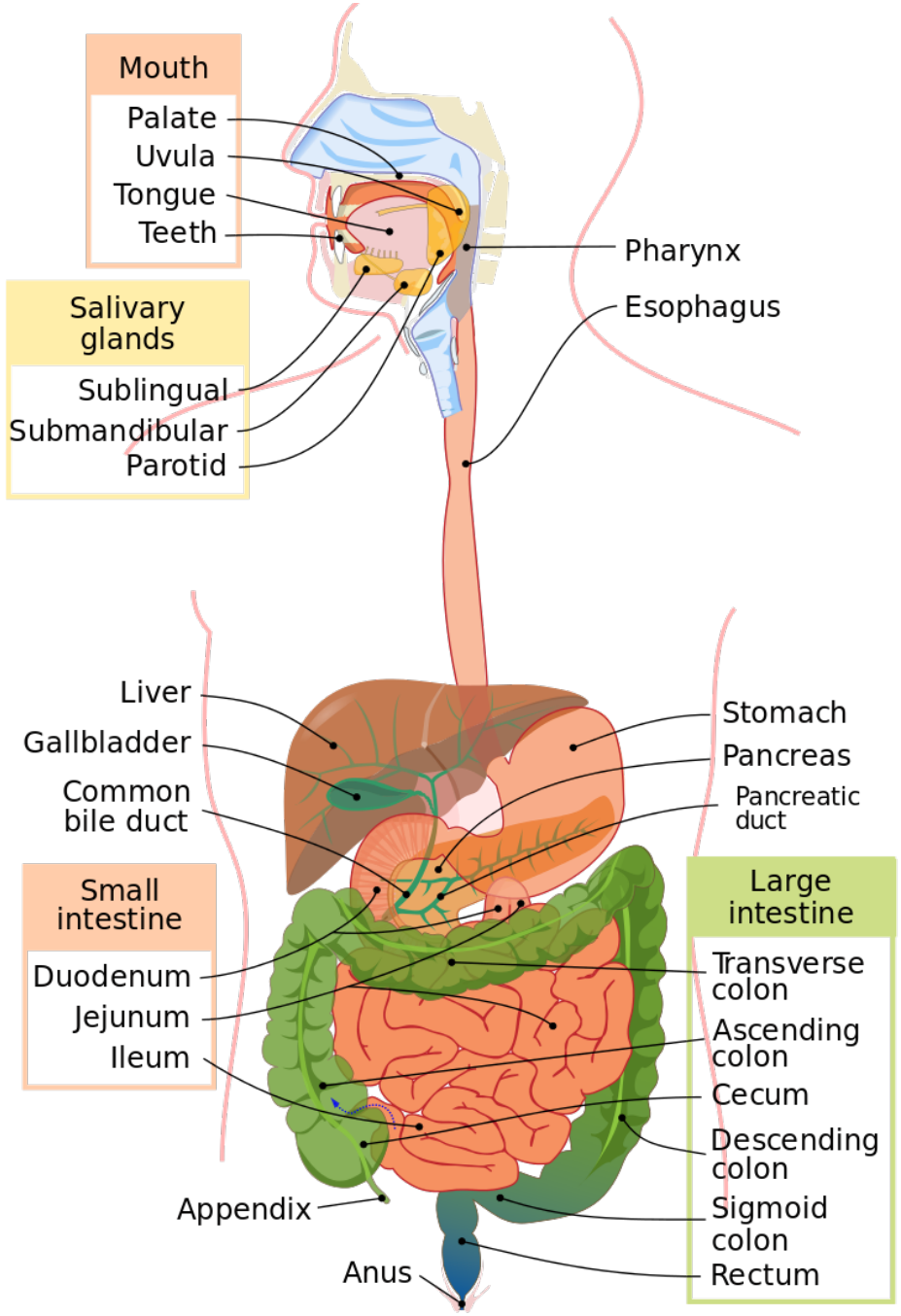
The **gastrointestinal tract**

- The **gastrointestinal tract**, is also called the digestive tract, alimentary canal, or gut

- It is the system of organs that
  - takes in food
  - digests it
  - expels waste

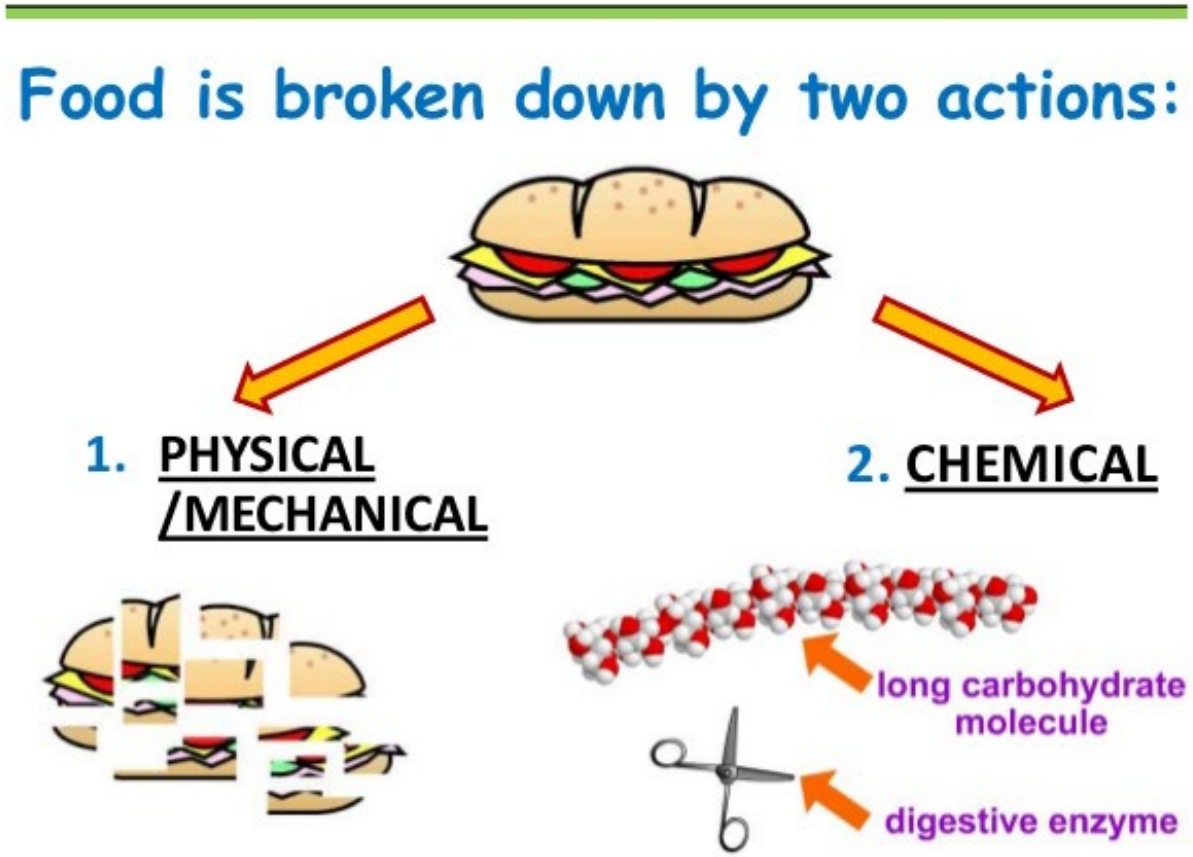
The alimentary canal

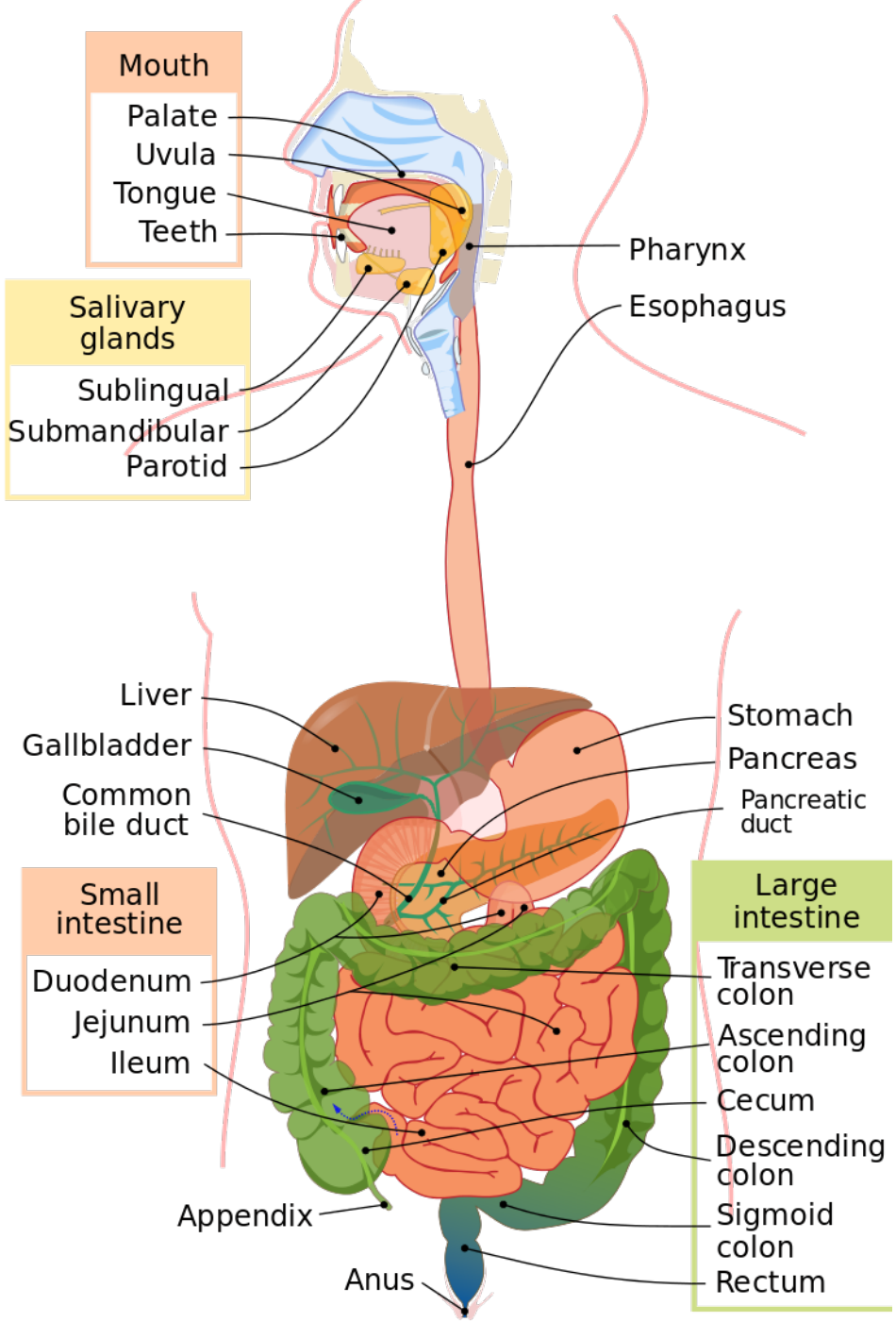
The alimentary canal is the long tube of organs that runs from the mouth (where the food enters) to the anus (where indigestible waste leaves).



2 Processes of Digestion

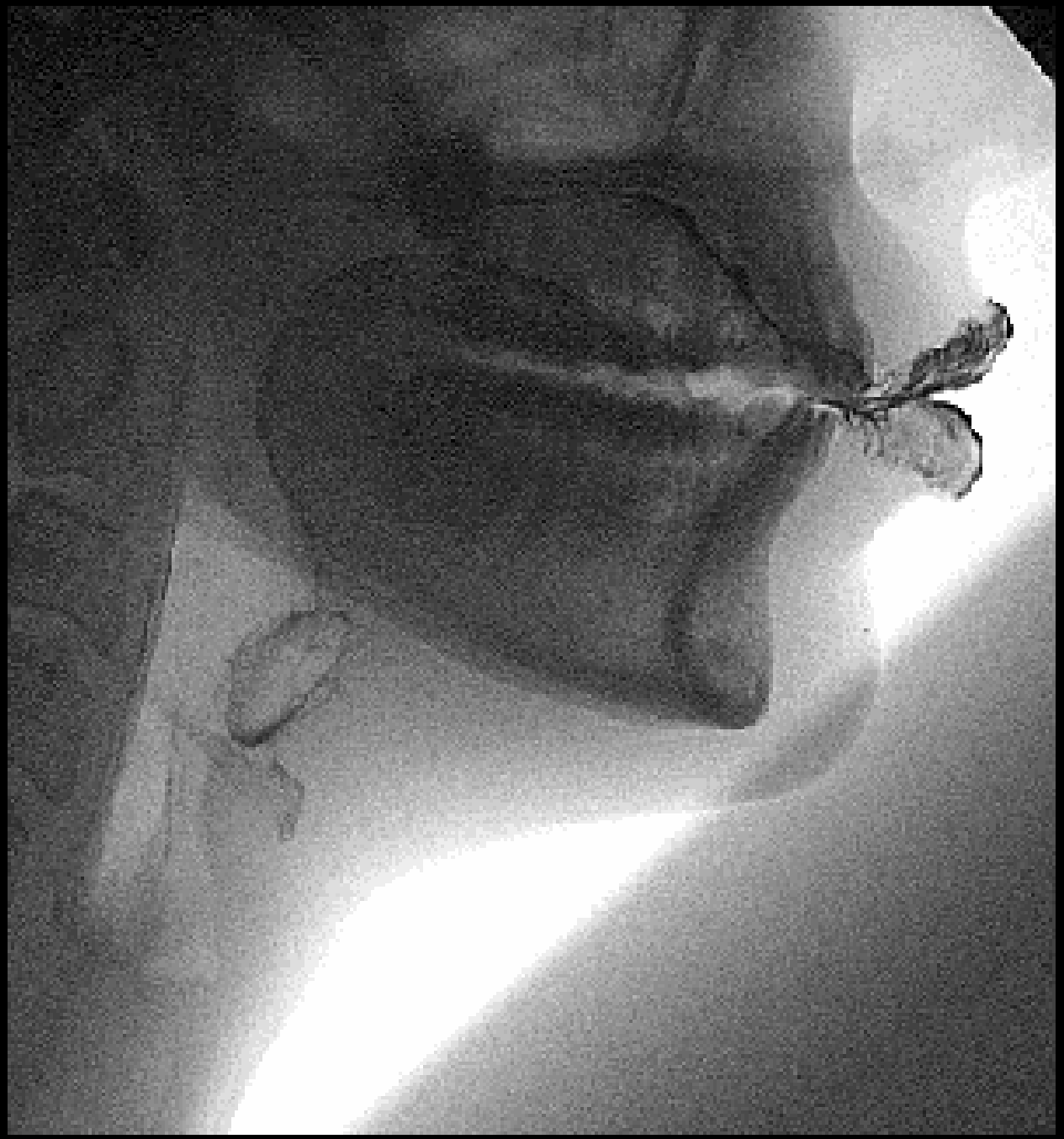
- During digestion two main processes occur at the same time:
- **Mechanical Digestion**:
  - larger pieces of food get broken down into smaller pieces while being prepared for chemical digestion.
  - Mechanical digestion starts in the mouth and continues in to the stomach.
- **Chemical Digestion**:
  - several different enzymes break down macromolecules into smaller molecules that can be more efficiently absorbed.
  - Chemical digestion starts with saliva and continues into the intestines.





Digestive System Basics

- The average adult digestive tract is about thirty feet (30') long.
- While in the digestive tract the food is really passing *through* the body rather than being *in* the body.
- The smooth muscles of the tubular digestive organs move the food efficiently along as it is broken down into absorb-able atoms and molecules.
- During absorption, the nutrients that come from food (such as proteins, fats, carbohydrates, vitamins, and minerals) pass through the wall of the small intestine and into the bloodstream and lymph.
- In this way nutrients can be distributed throughout the rest of the body.
- In the large intestine there is re absorption of water and absorption of some minerals as feces are formed.
- The parts of the food that the body passes out through the anus is known as feces.



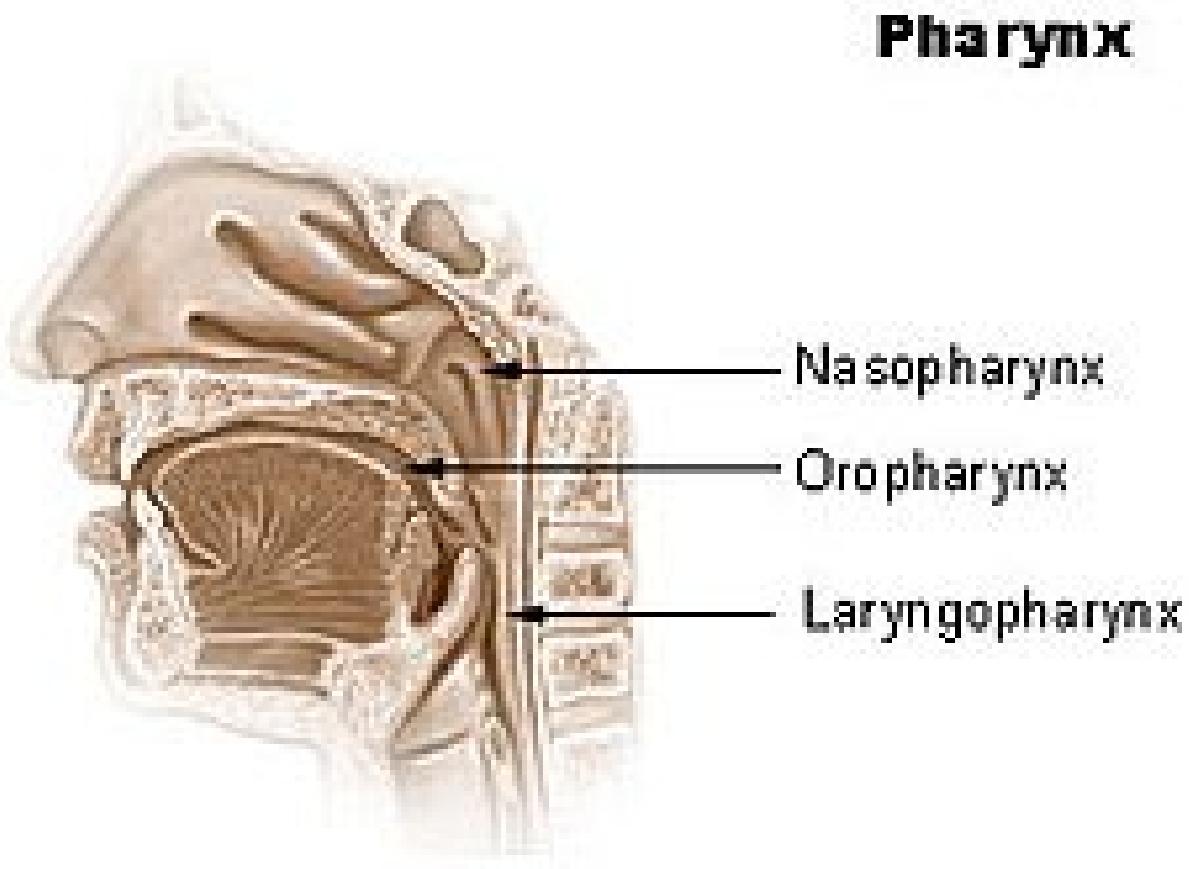
Mastication

Digestion begins in the mouth.

- Saliva moistens the food while
- Teeth chew it up and make it easier to swallow.
- Amylase, which is the digestive enzyme found in saliva, starts to break down starch into simpler sugars before the food even leaves the mouth.

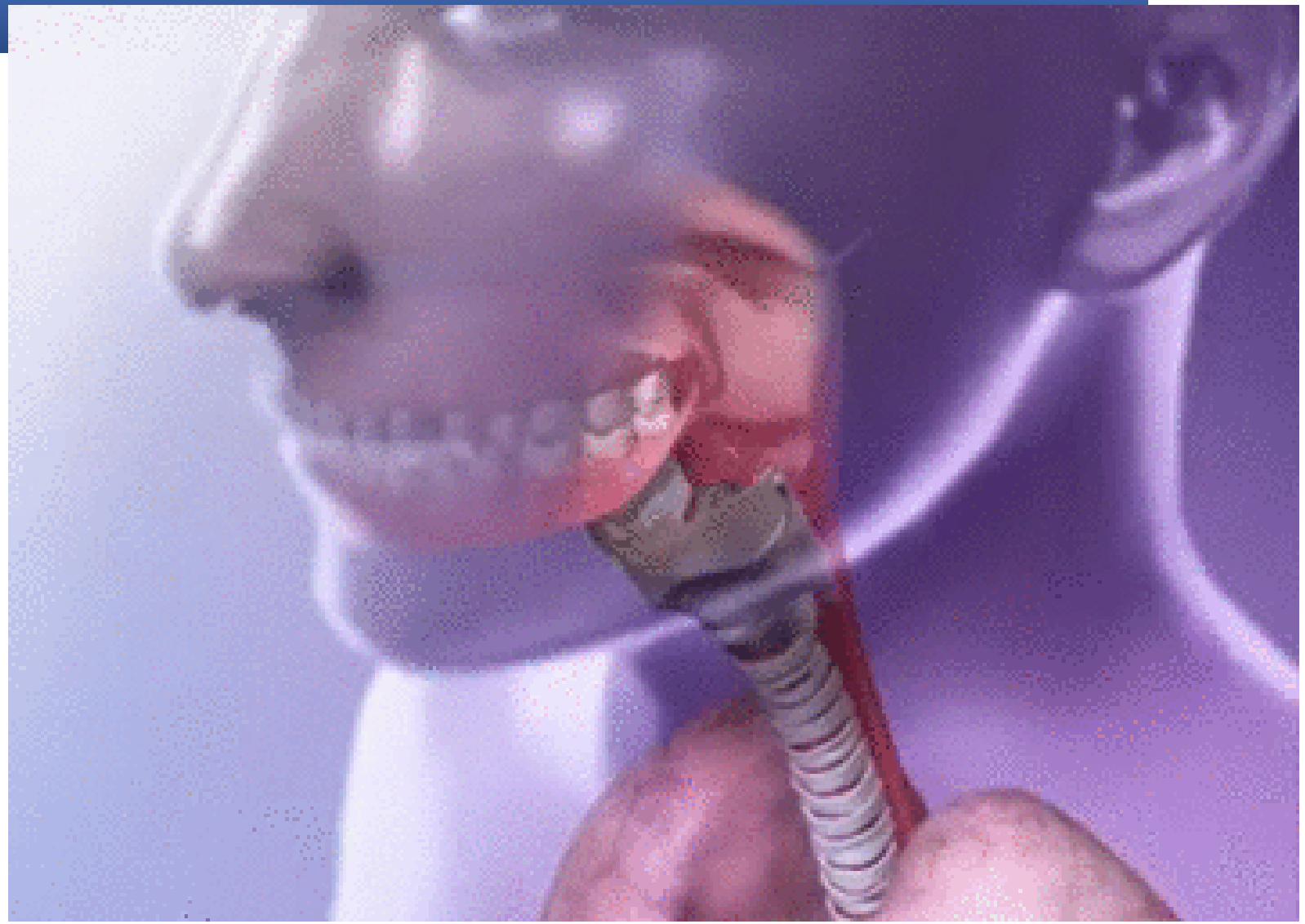
The Pharynx (Throat)
(Nasopharynx, Oropharynx, Laryngopharynx)

- **Swallowing your food happens when the muscles in your tongue and mouth move the food into your oropharynx, then on to the laryngopharynx.**
- **The pharynx is a common passageway for air (in the respiratory system) and for food (in the digestive system).**



THE EPIGLOTTIS

- A small flap of skin called the epiglottis closes over the pharynx to prevent food from entering the trachea and thus choking.
- For swallowing to happen correctly a combination of 25 muscles must all work together at the same time.

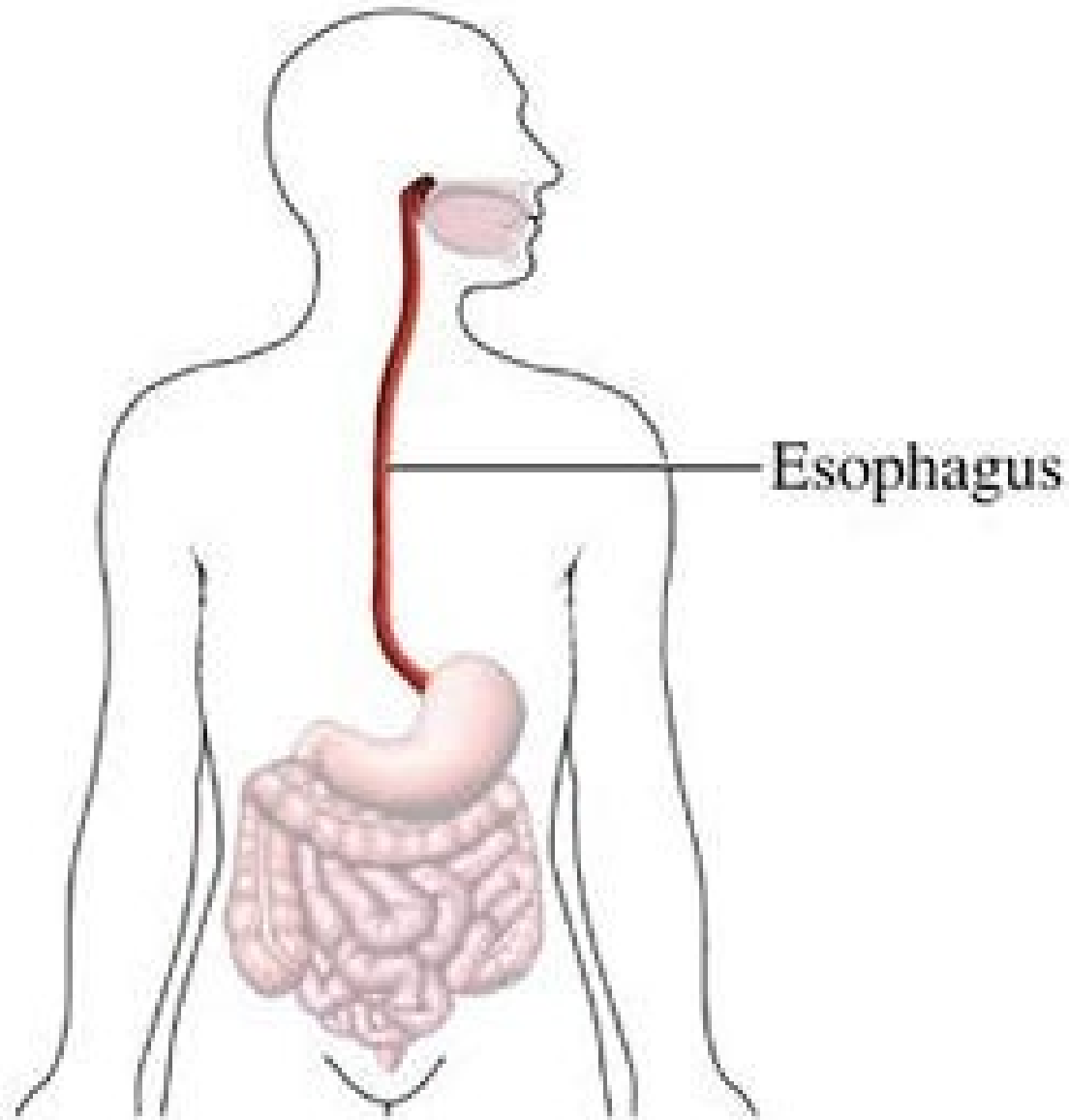


ENZYME SUMMARY

Carbohydrate Digestion:	**Enzymes are Secreted From….**	**Where Does it Occur?**
	Salivary glands	Mouth
	Pancreas	Small intestine
Protein Digestion:		
	Gastric glands	Stomach
	Pancreas	Small intestine
Nucleic Acid Digestion:		
	Pancreas	Small intestine
	Pancreas	Small intestine
Fat Digestion:		
	Pancreas	Small intestine

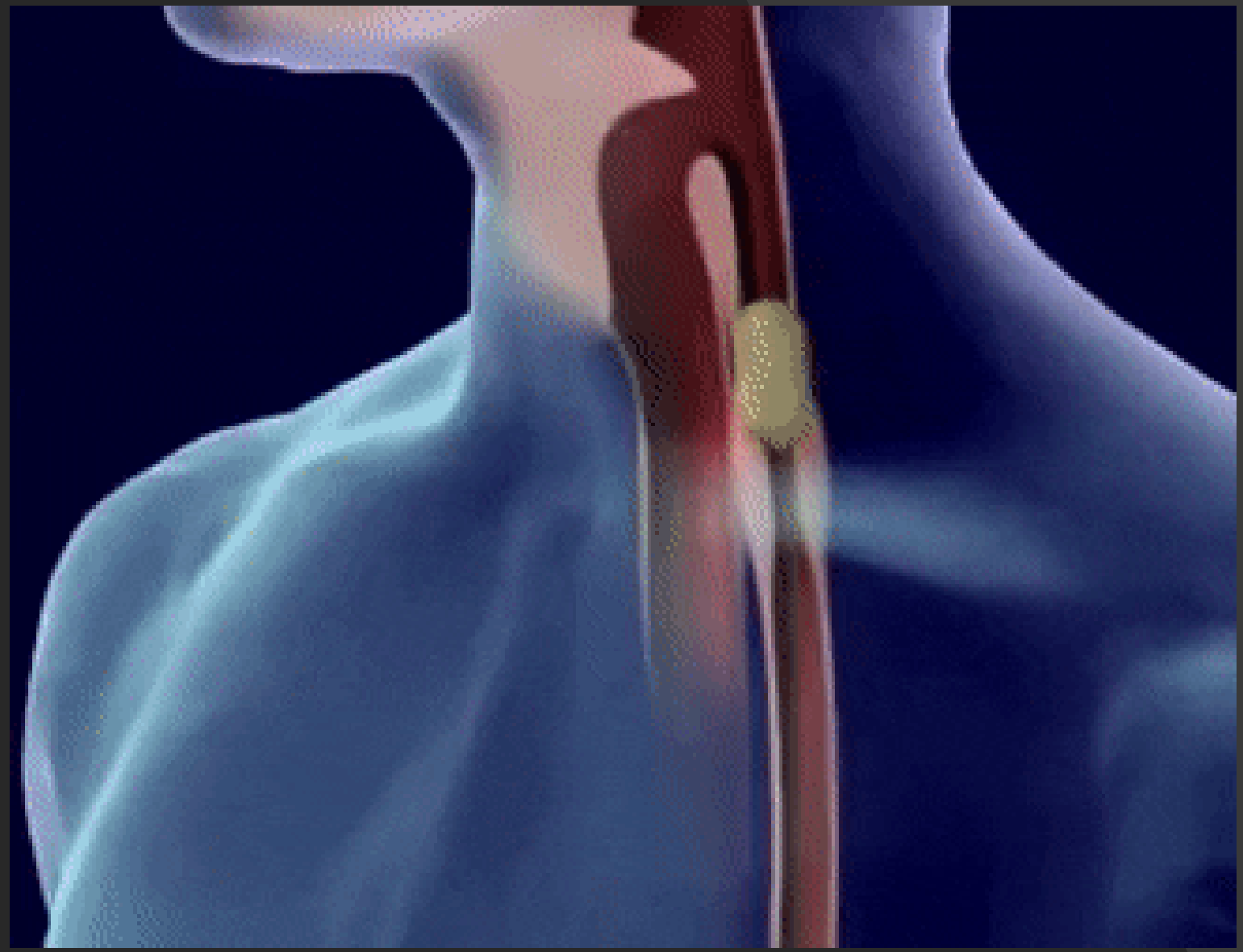
ESOPHAGUS

- The **esophagus** is the muscular tube through which food passes from the pharynx (throat) to the stomach.
- This is where the second stage of digestion is initiated (the first stage is in the mouth with teeth and tongue masticating food and mixing it with saliva).



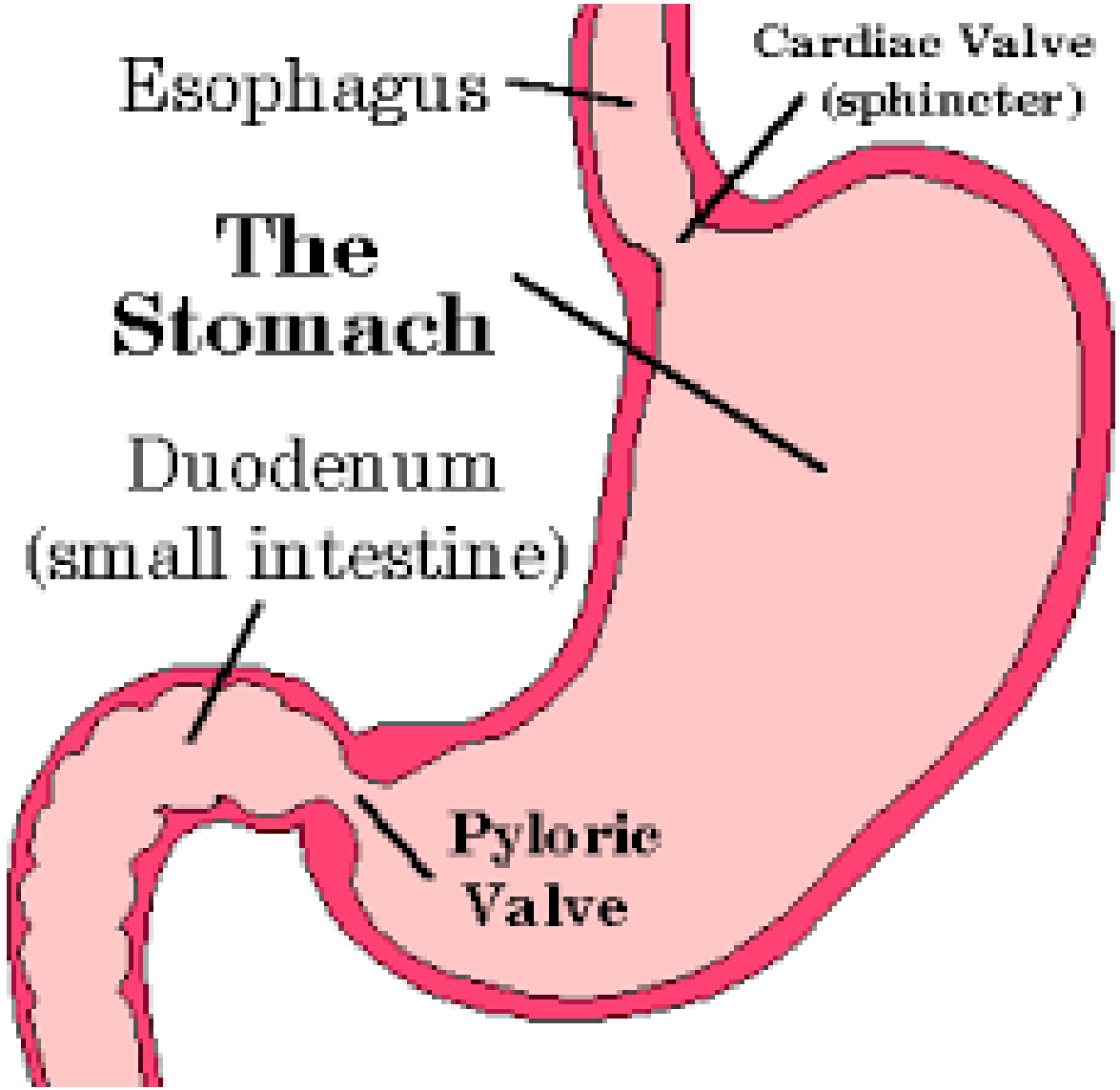
peristalsis

- After passing through the throat, the food moves into the esophagus and is pushed down into the stomach by the process of *peristalsis.*
- *peristalsis* is the involuntary wavelike muscle contractions that occur along the G.I. tract.
- *peristalsis* is how food is pushed through the G.I. tract
- The esophagus is lined with mucus membranes, and uses peristaltic action to move swallowed food down to the stomach.



CARDIAC SPHINCTER

- This part of the esophagus is called the lower esophageal sphincter a.k.a. the cardiac sphincter.
- This aids in keeping food down and not being regurgitated.



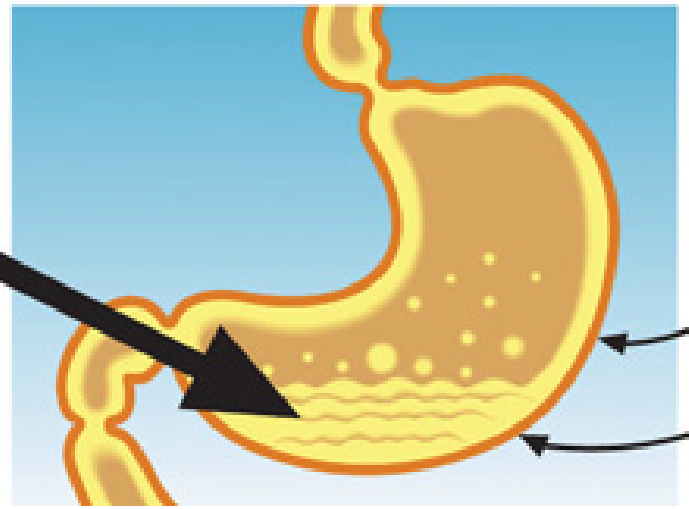
Chemical Digestion of proteins

Mechanical Digestion

Acid (Hydrochloric)

Pepsin (Enzyme)

Gastric juices

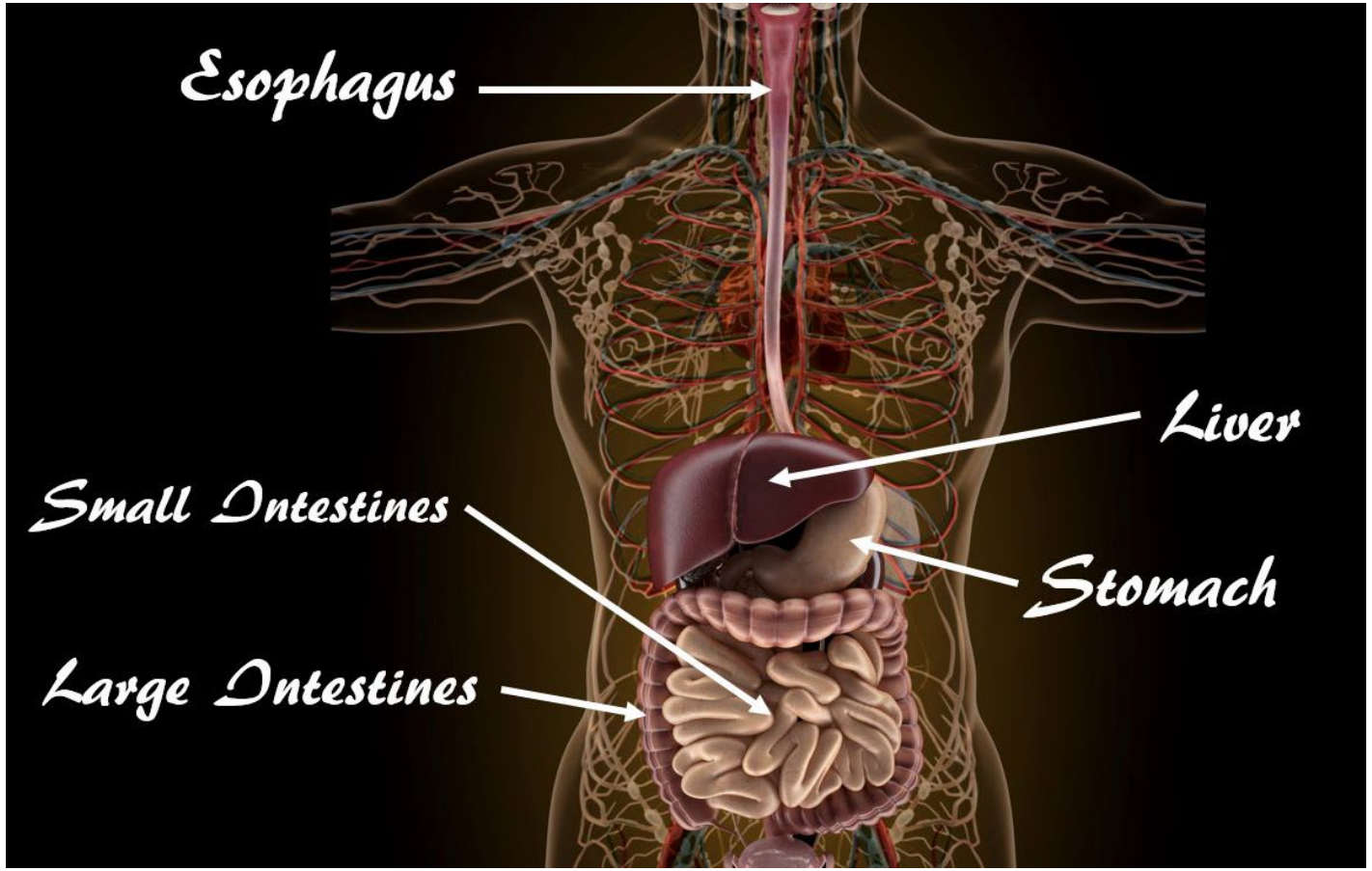


Muscular contractions (Peristalsis)

The **stomach**

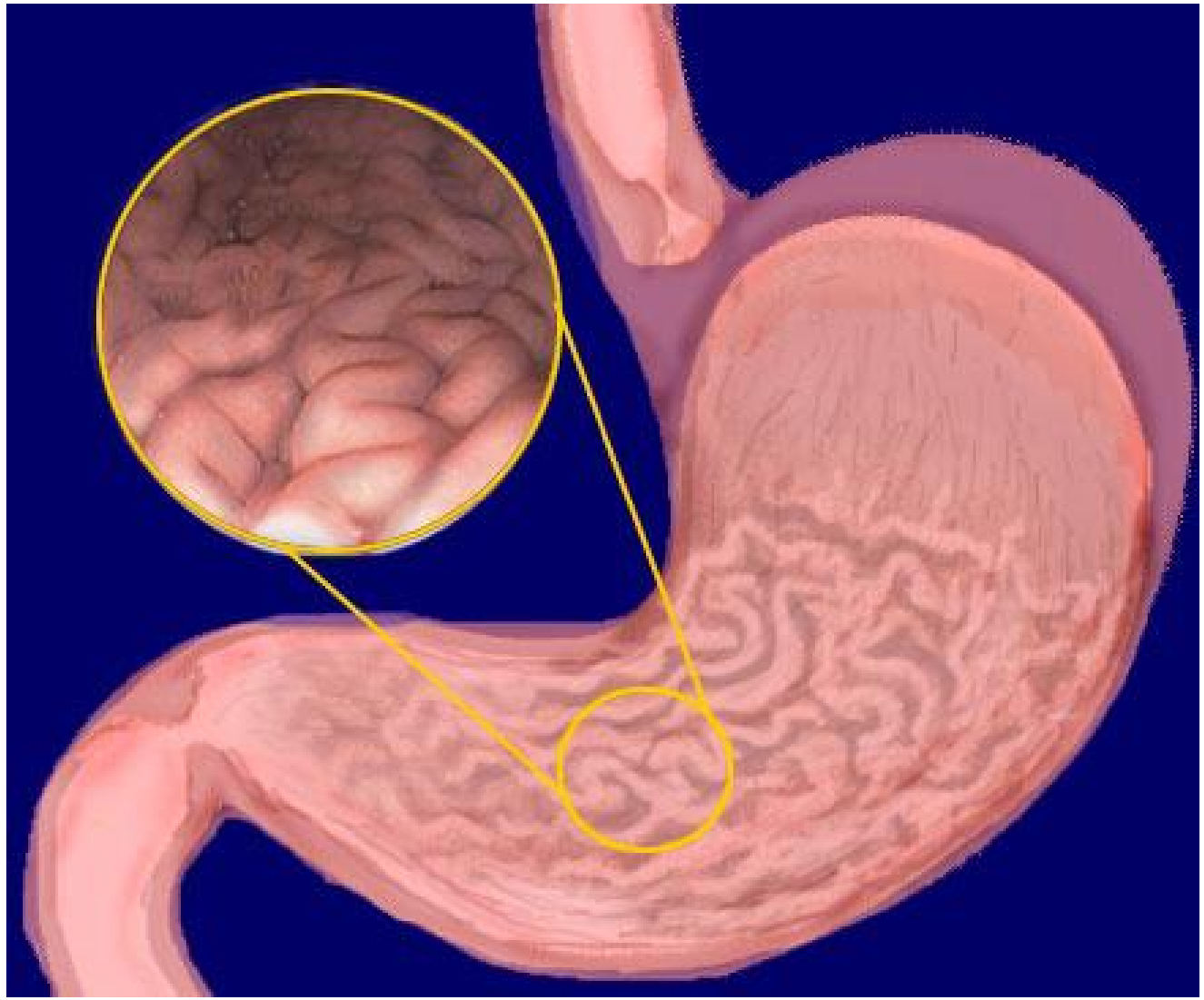
The **stomach** is a thick walled organ that lies between the esophagus and the first part of the small intestine (the duodenum).

- It is on the left side of the abdominal cavity.
- The fundus of the stomach lying against the diaphragm.



The **stomach**

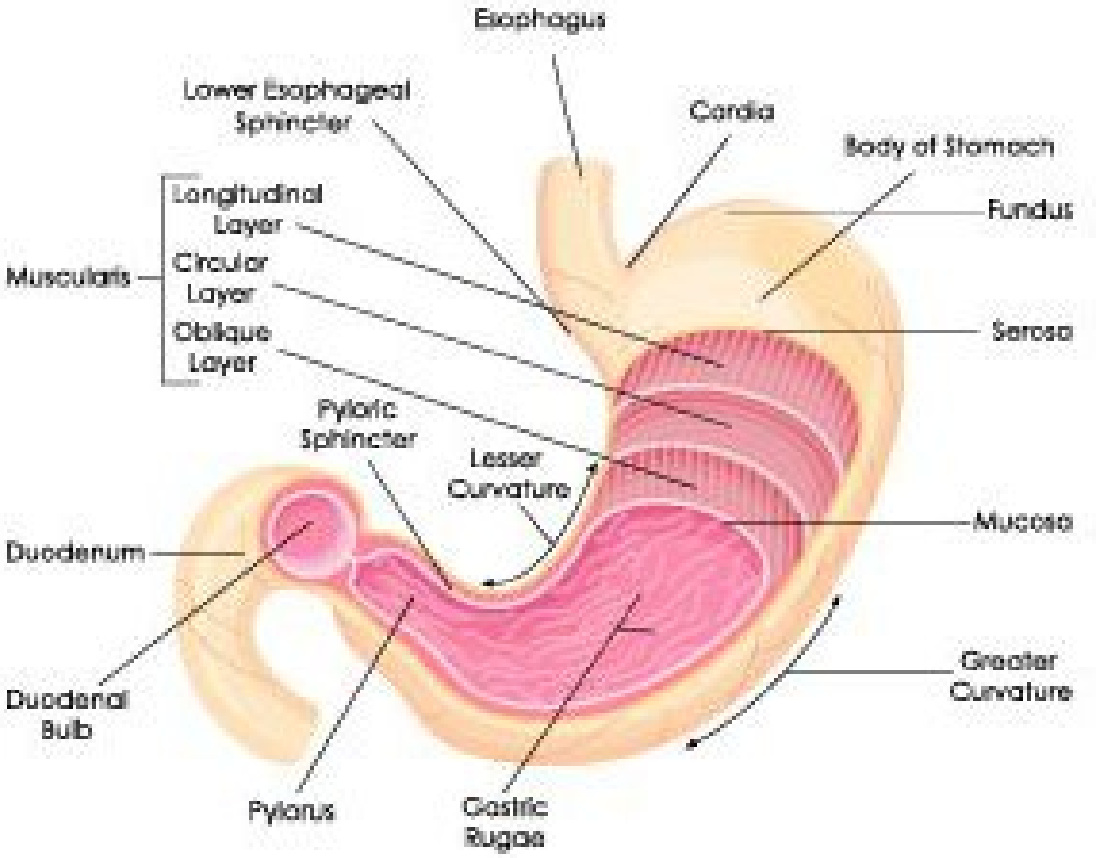
- On the inside of the stomach there are folds of skin call the gastric rugae.
- Gastric rugae make the stomach very extendable, especially after a very big meal.



The stomach

The stomach is divided into four sections, each of which has different cells and functions.

- 1) Cardiac region, where the contents of the esophagus empty into the stomach,
- 2) Fundus, formed by the upper curvature of the organ,
- 3) Body, the main central region, and
- 4) Pylorus or atrium, the lower section of the organ that facilitates emptying the contents into the small intestine.

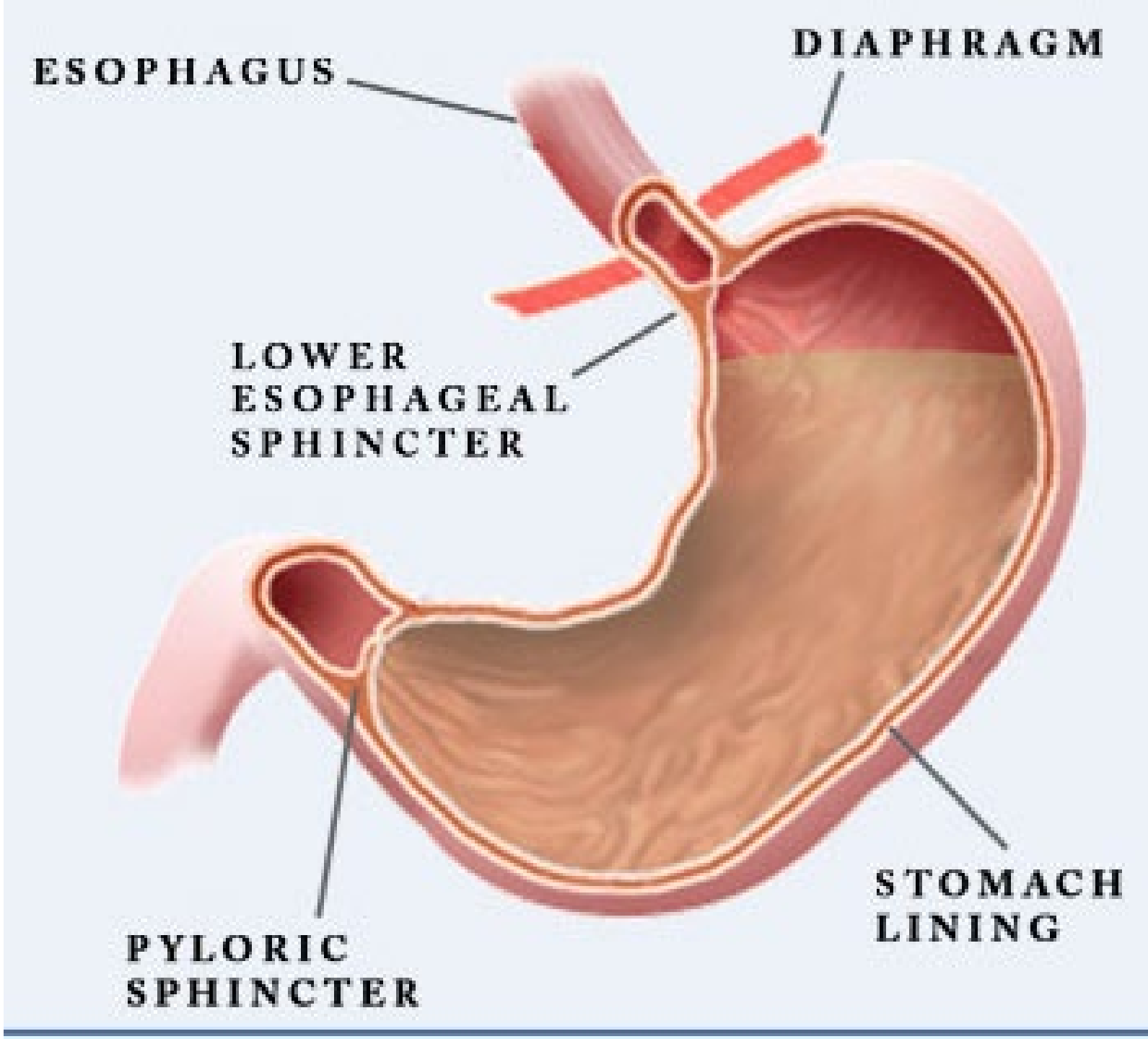


STOMACH

Stomach Sphincters

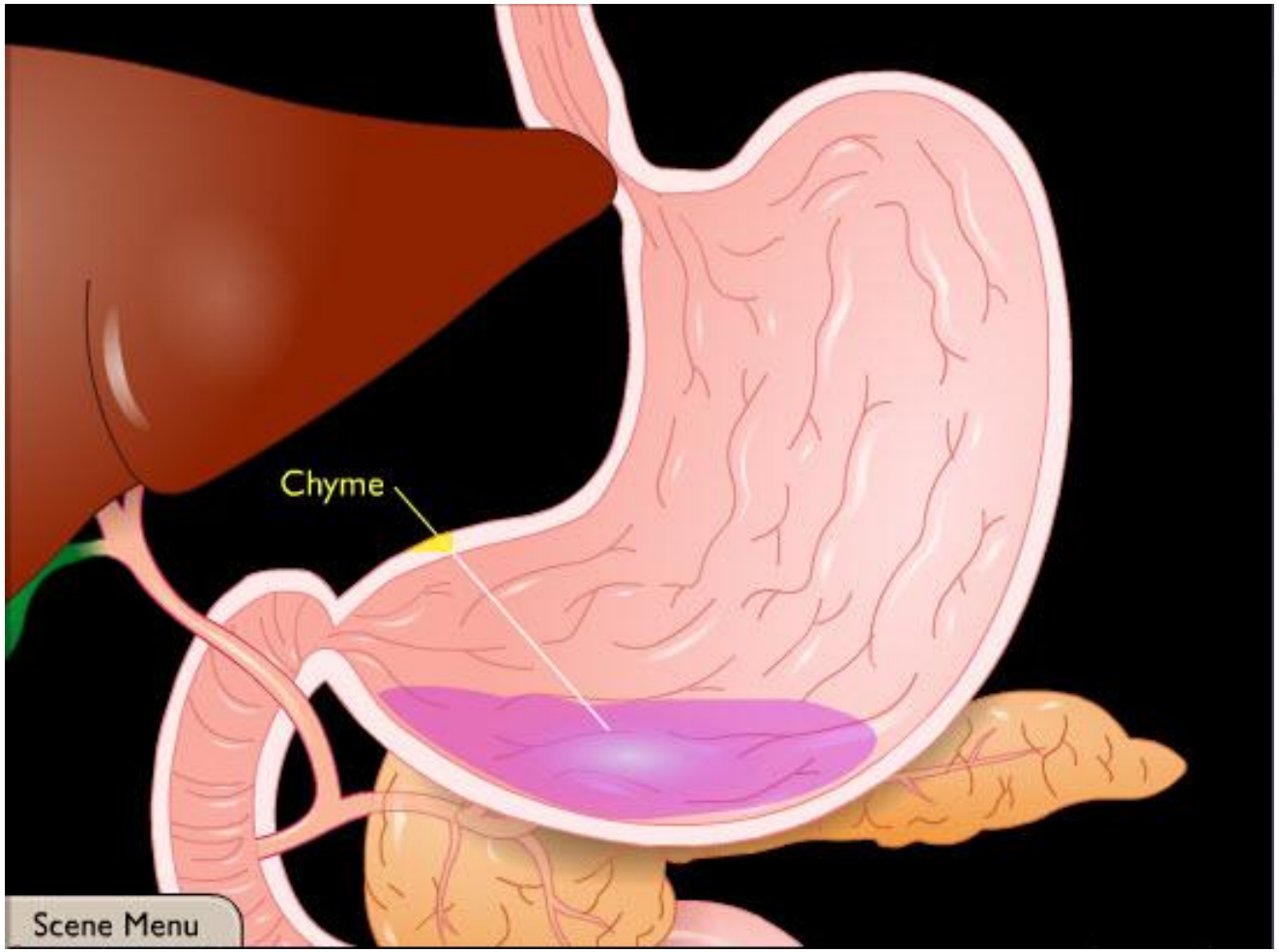
Two smooth muscle valves, or sphincters, keep the contents of the stomach contained.

- 1) Cardiac or esophageal sphincter
- 2) Pyloric sphincter



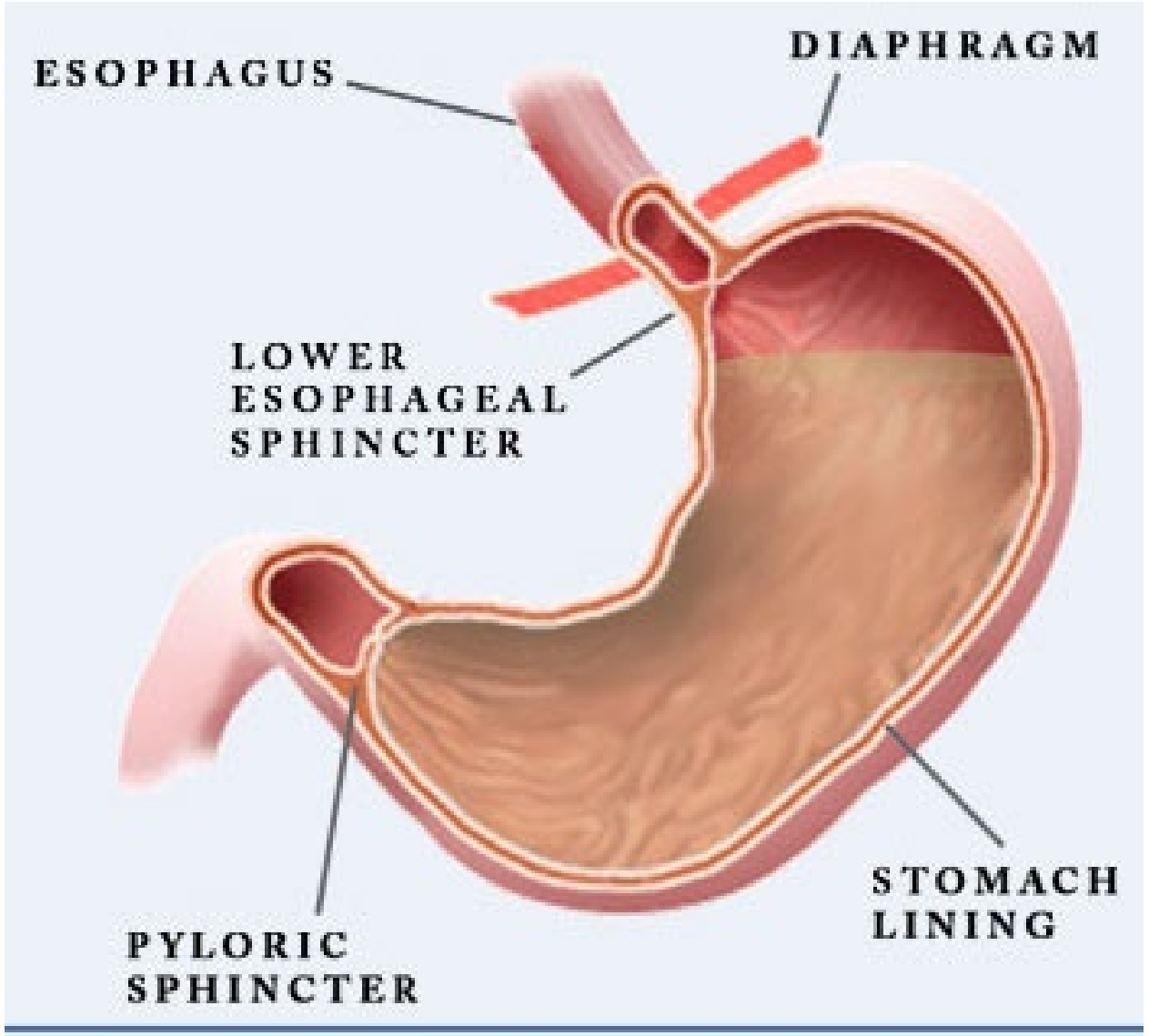
Chyme

- After receiving the **bolus** (chewed food) the stomach undergoes smooth muscular contractions (peristalsis) mixed and churned with gastric juices the bolus is transformed into a semi-liquid substance called **chyme**.



Digestion in the stomach

- Stomach muscles mix up the food with enzymes and acids to make smaller digestible pieces.
- The pyloric sphincter, a walnut shaped muscular tube at the stomach outlet, keeps chyme in the stomach until it reaches the right consistency to pass into the small intestine.
- The food leaves the stomach in small squirts rather than all at once.



Digestion in the stomach

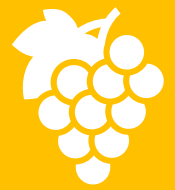
Water, alcohol, salt, and simple sugars can be absorbed directly through the stomach wall.

However, most substances in our food need a little more digestion and must travel into the intestines before they can be absorbed.

Small Intestines

The small intestine is the site where most of the chemical and mechanical digestion is carried out.

Tiny projections called villi line the small intestine which absorbs digested food into the capillaries.

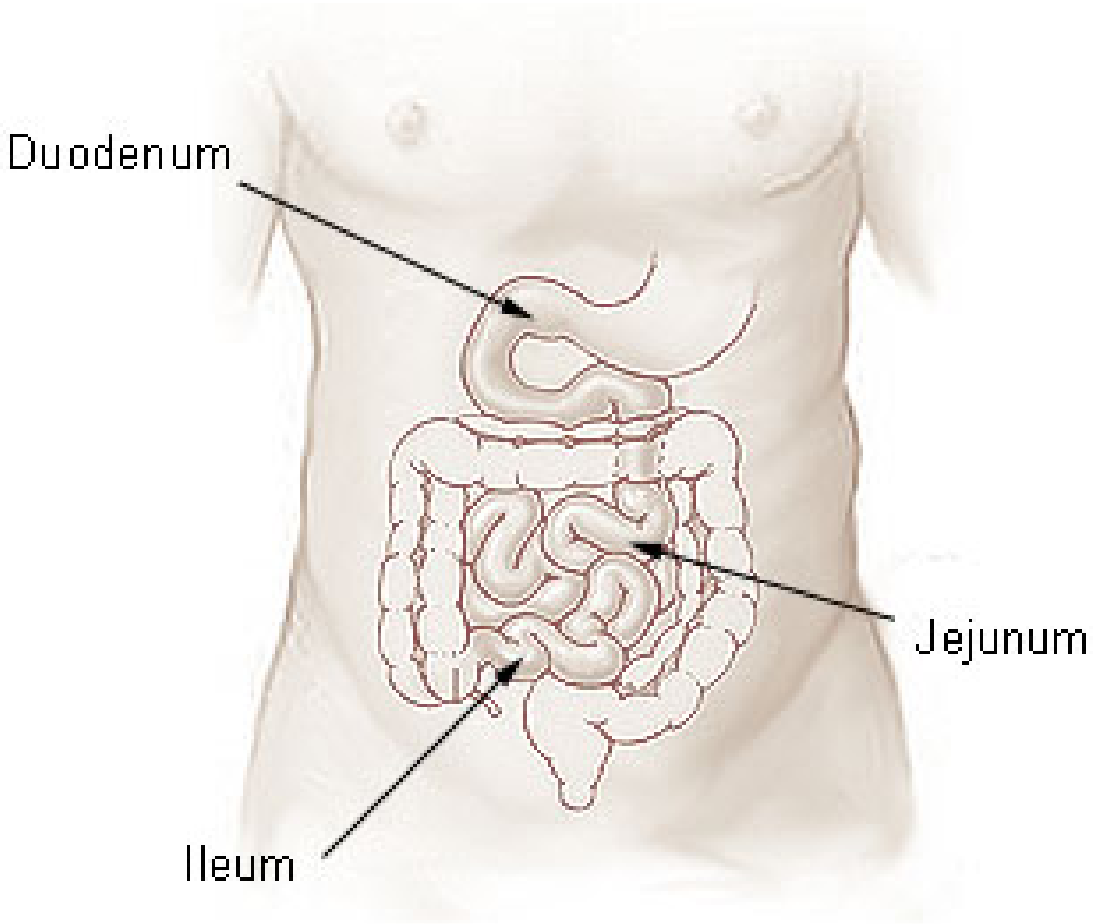


Most of the food absorption takes place in the jejunum and the ileum.

The three main sections of the small intestine

The three main sections of the small intestine are

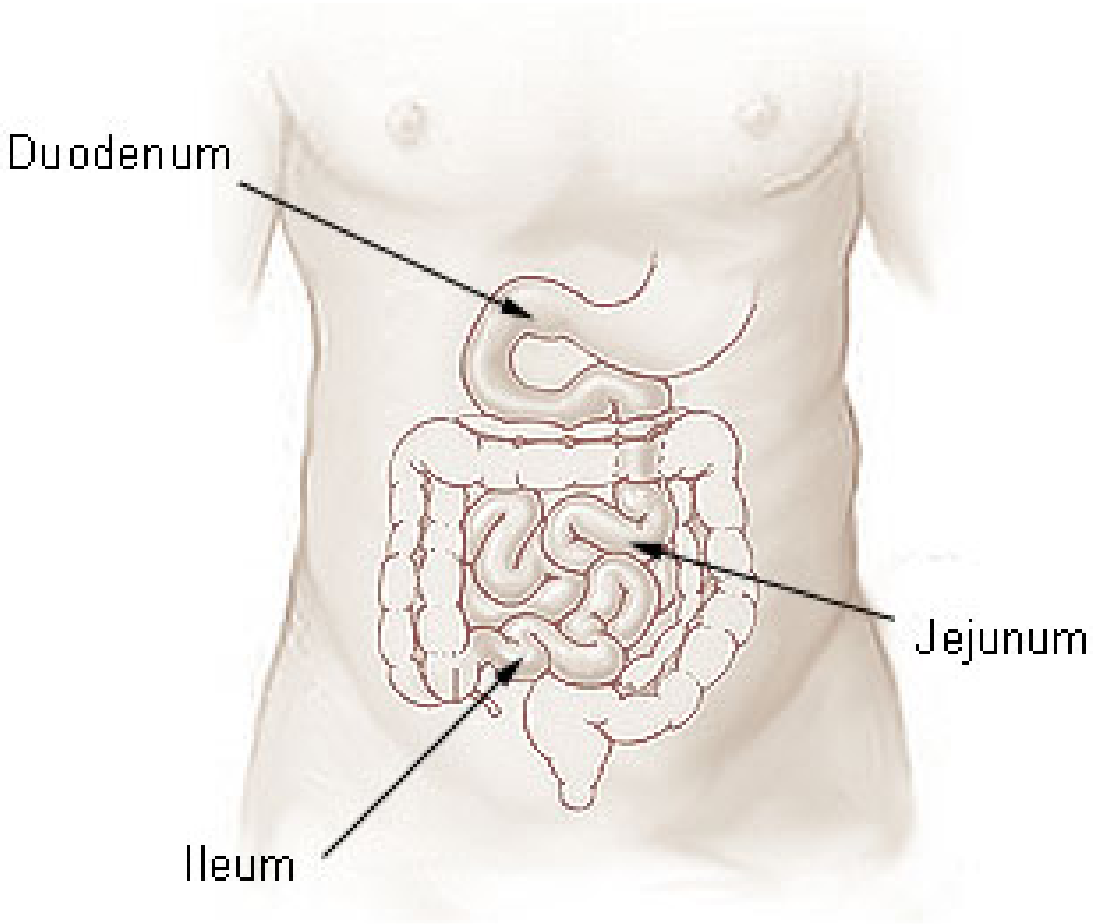
- the duodenum
- the jejunum
- the ileum



The duodenum

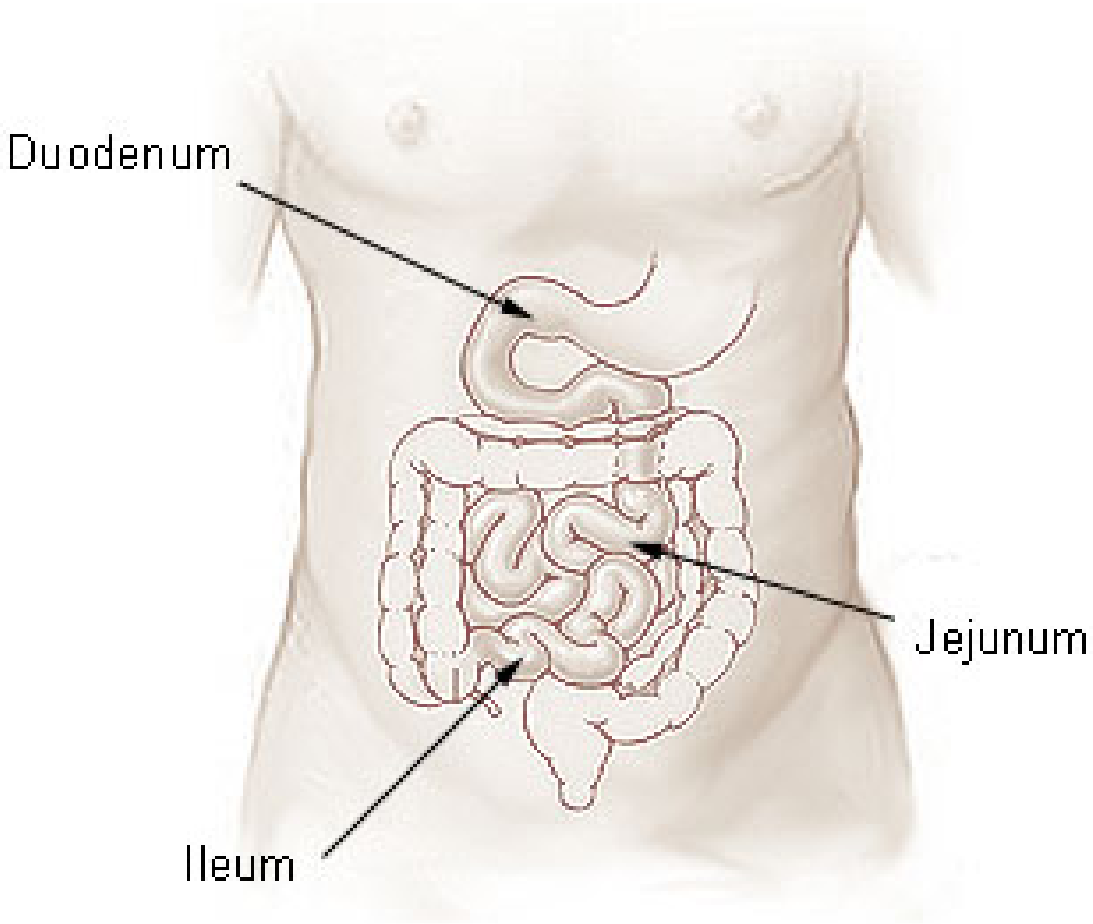
The duodenum

- It is the first and shortest part of the small intestine.
- The duodenum is also where the bile and pancreatic juices enter the intestine.
- Most digestion occurs HERE!



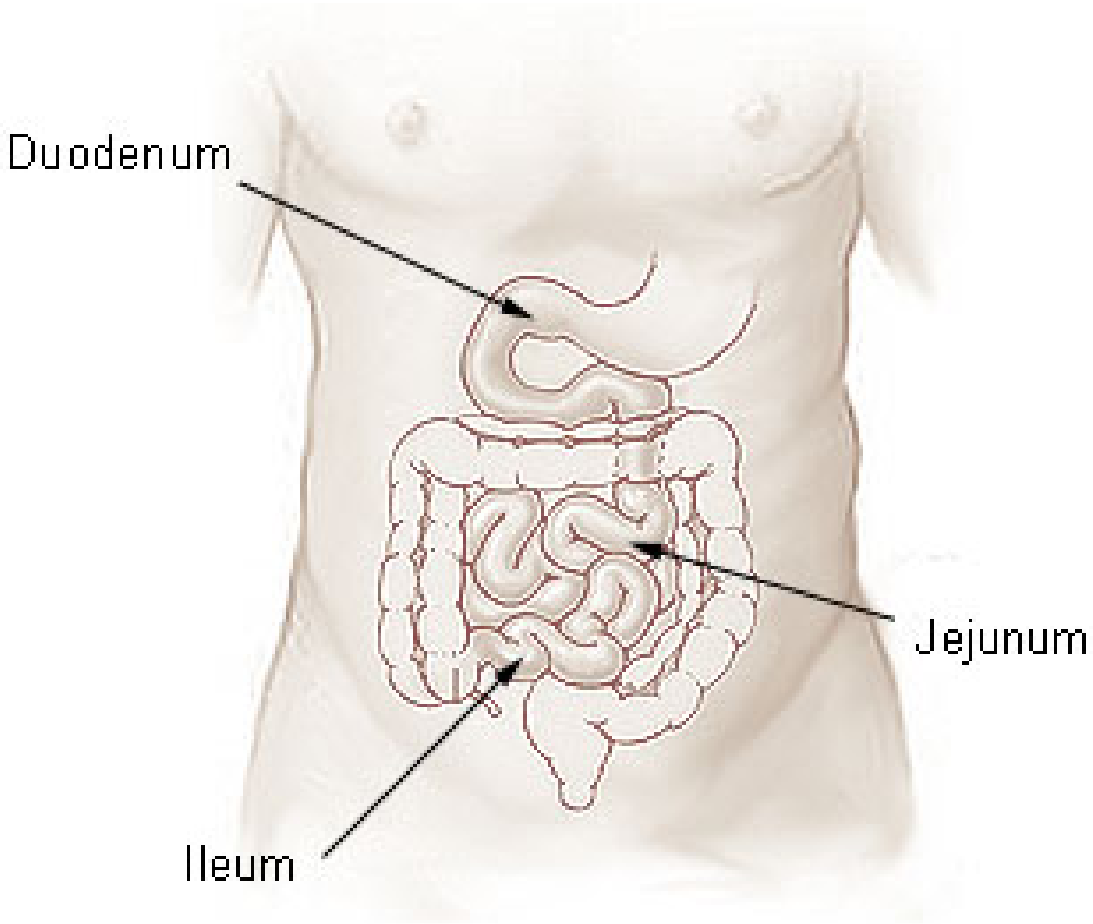
The jejunum

- The jejunum is a part of the small intestines that lies after the duodenum and before the ileum.
- The inner surface of the jejunum, its mucous membrane, is covered in projections called villi, which increase the surface area of tissue available to absorb nutrients from the gut contents.



The ileum

- The cells that line the ileum contain the protease and carbohydrate enzymes responsible for the final stages of protein and carbohydrate digestion.

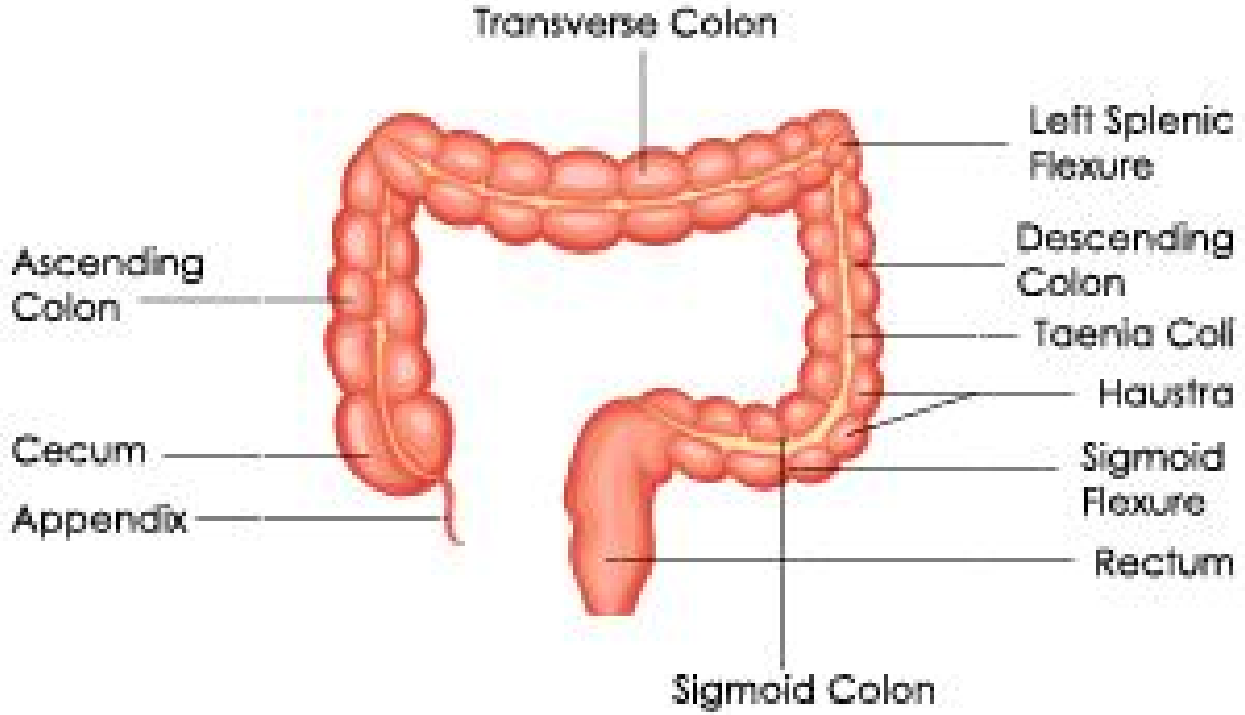


The large intestine (colon)

- The large intestine (colon) extends from the end of the ileum to the anus. It is about 5 feet long, being one-fifth of the whole extent of the intestinal canal.
- It's caliber is largest at the commencement at the cecum, and gradually diminishes as far as the rectum, where there is a dilatation of considerable size just above the anal canal.

The large intestine

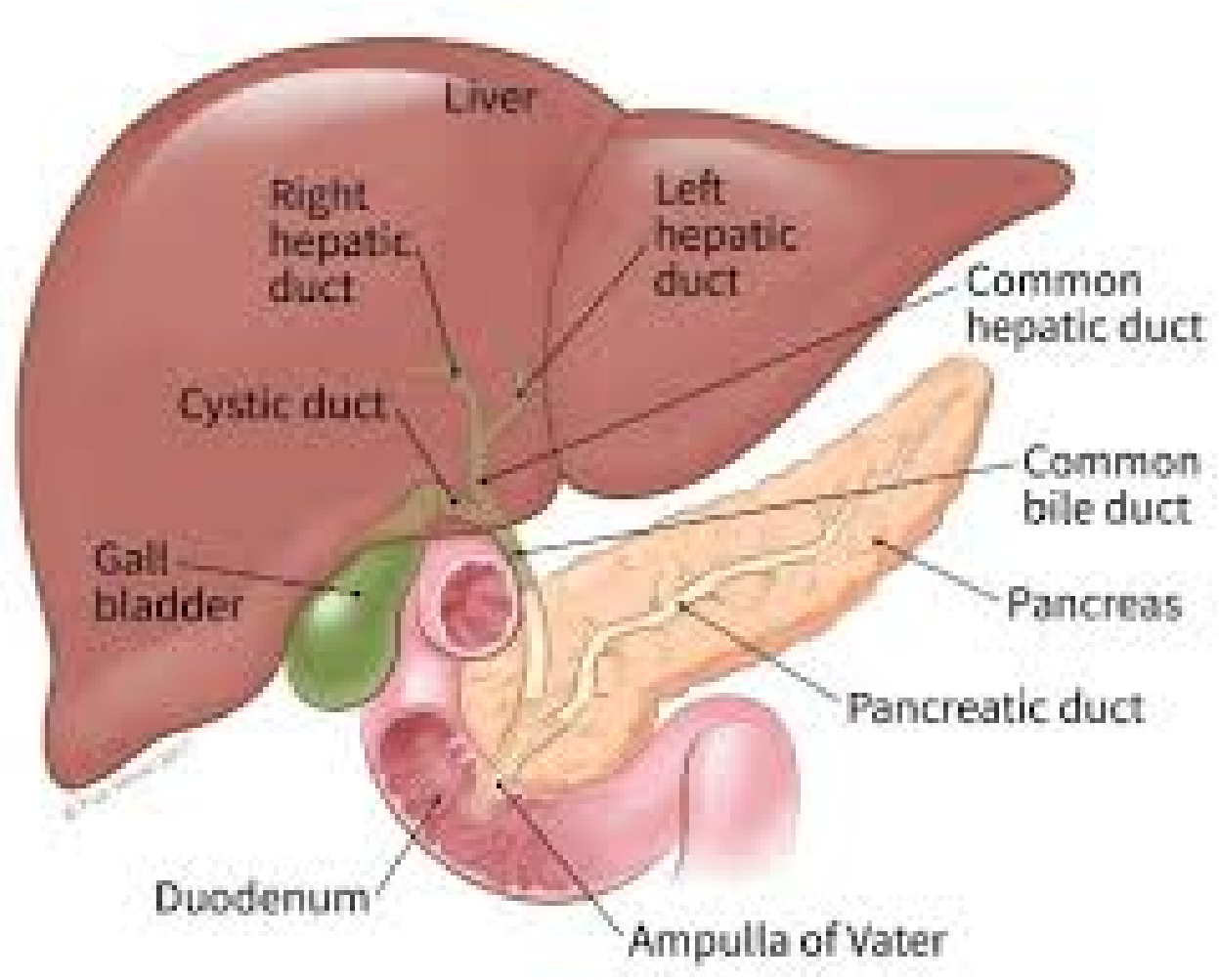
- The large intestine is divided into the cecum, ascending colon, transverse colon, the descending, sigmoid colon (flexure) rectum, and anal canal.



LARGE INTESTINE

Ductal System

- The bile produced in the liver is collected in bile canaliculi, which merge from bile ducts.
- These eventually drain into the right and left hepatic ducts.
- The right and left hepatic ducts merge to form the common hepatic duct.



Anus

- The Anus has two anal sphincters
  - Internal Anal Sphincter
  - External Anal Sphincter
- These hold the anus closed until defecation occurs.
  - The internal sphincter - consists of smooth muscle and its action is involuntary
  - The external sphincter The other consists of striated muscle and its action is voluntary.