

Digestive System and Nutrition



Chapter 34

BIOL 1000

Dr. Mohamad H. Termos

Nutrition:

- Nutrient—substance used by the body for growth, maintenance, and repair
 - Carbohydrates
 - Lipids
 - Proteins
 - Water
 - Vitamins
 - Minerals

Nutrition: Carbohydrates

- Simple sugars-
 - Glucose, fructose, galactose
 - Disaccharides
 - Sucrose = glucose + fructose
 - Maltose = 2 glucose
 - Lactose = glucose + galactose
- Starch – long chains of glucose

Nutrition and Human Health

- *Fiber*

- Indigestible carbohydrates from plants
- Beans, peas, nuts, fruits, and vegetables
- Technically, fiber is not a nutrient for humans
 - Cannot be digested
 - Soluble fiber combines with bile acids and cholesterol in the small intestine and prevents them from being absorbed

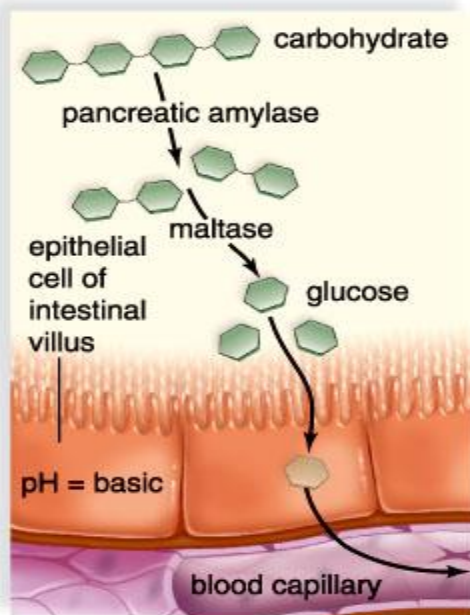


Nutrition: Proteins

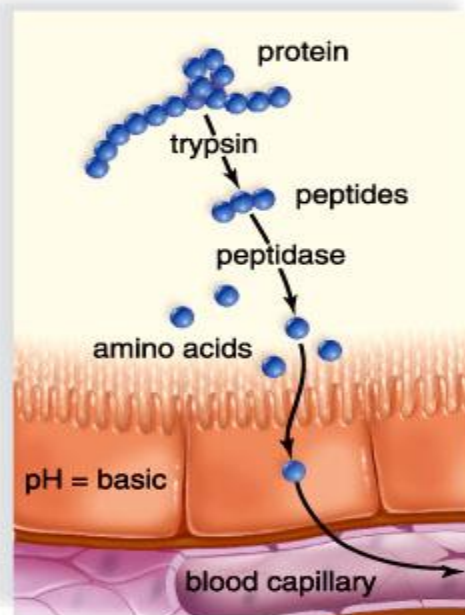
amino acids → polypeptides → Proteins

- 20 amino acids – 9 are essential
- Dietary sources:
- Vegetables are incomplete sources of amino acids

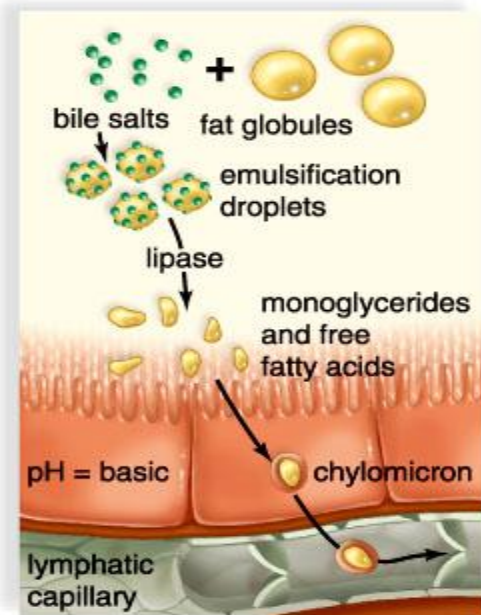
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a. Carbohydrate digestion



b. Protein digestion

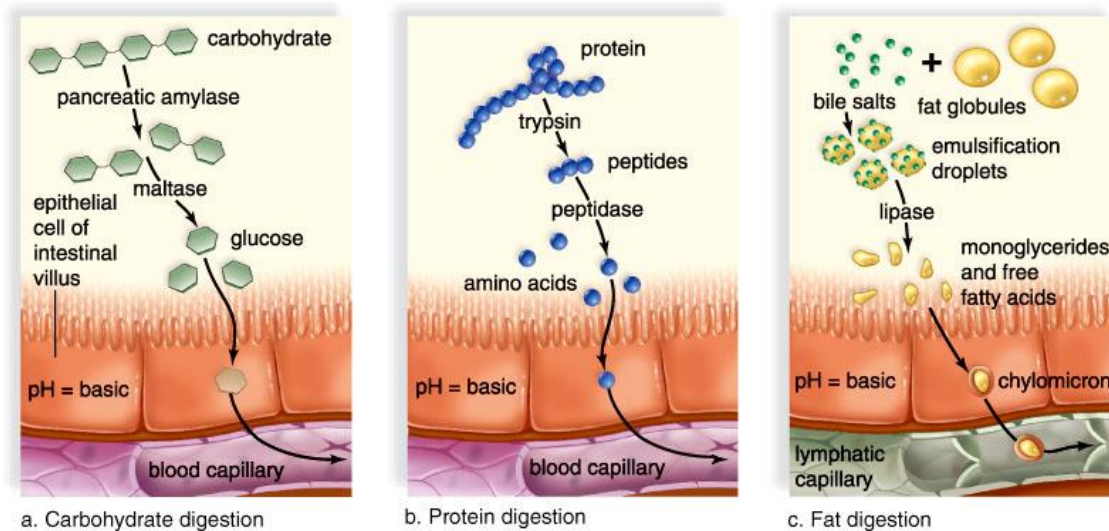


c. Fat digestion

Nutrition: Lipids

- Fat, oils, and cholesterol
- Triglycerides = glycerol + 3 Fatty acids
 - Partially broken down to be small enough to be absorbed
 - Strategies are used to absorb fat and be able to transport it (hydrophobic)
- Cholesterol is made by the body and found in animal foods

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Nutrition: Vitamins

- Water- no digestion needed; just absorbed
- Vitamins
 - Organic compounds the body is unable to produce, but are required
- Minerals
 - Inorganic substances
 - Calcium, sodium, iron

Digestive System

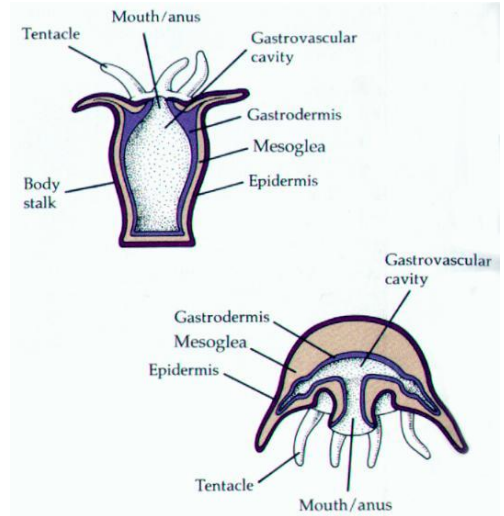
Food is a mixture of the different nutrients

Digestive System Functions:

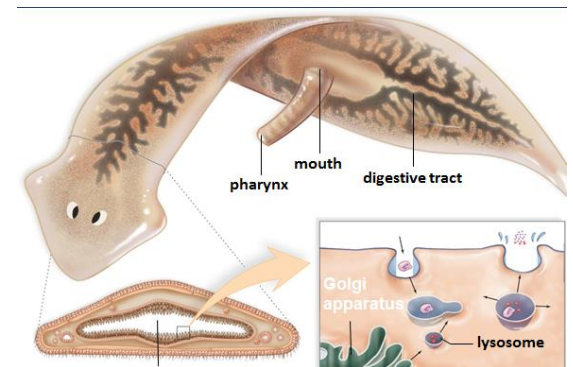
1. Ingest food
2. Break food down into smaller molecules
3. Absorb Molecules
4. Eliminate remains

Digestive Tracts

- Some have NO digestive tract
- An **incomplete digestive tract** has a single opening
 - Food enters through mouth and pharynx
 - Gastrovascular cavity branches throughout the body
 - Wastes exit through mouth and pharynx
 - Lacks specialized parts
 - Examples:



Jellyfish

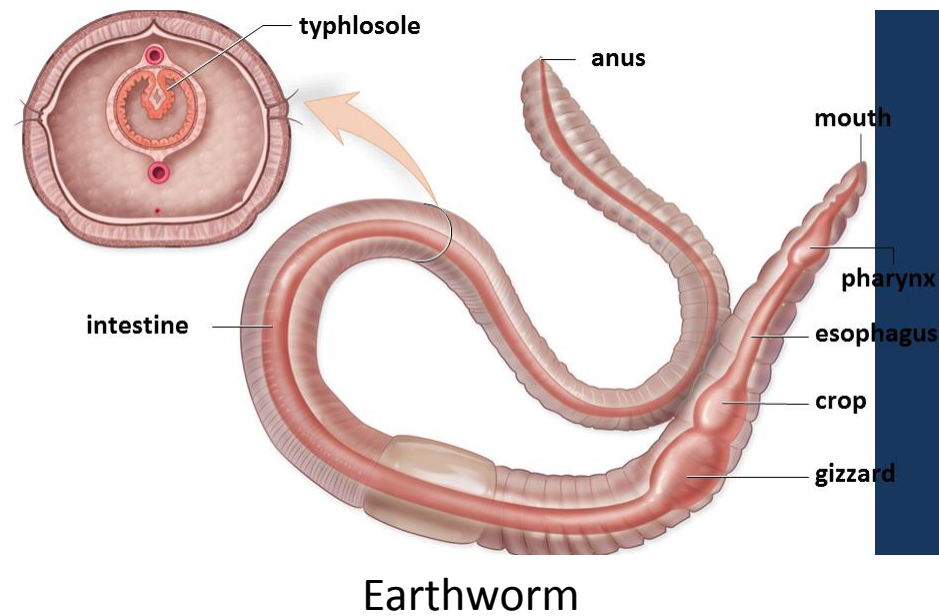


Planarian

<http://www.youtube.com/watch?v=w0QzSYQGsnA>

Digestive Tracts

- A **complete digestive tract** has two openings
 - Food enters through mouth
 - Wastes exit through anus
 - Specialization of parts
 - Examples:

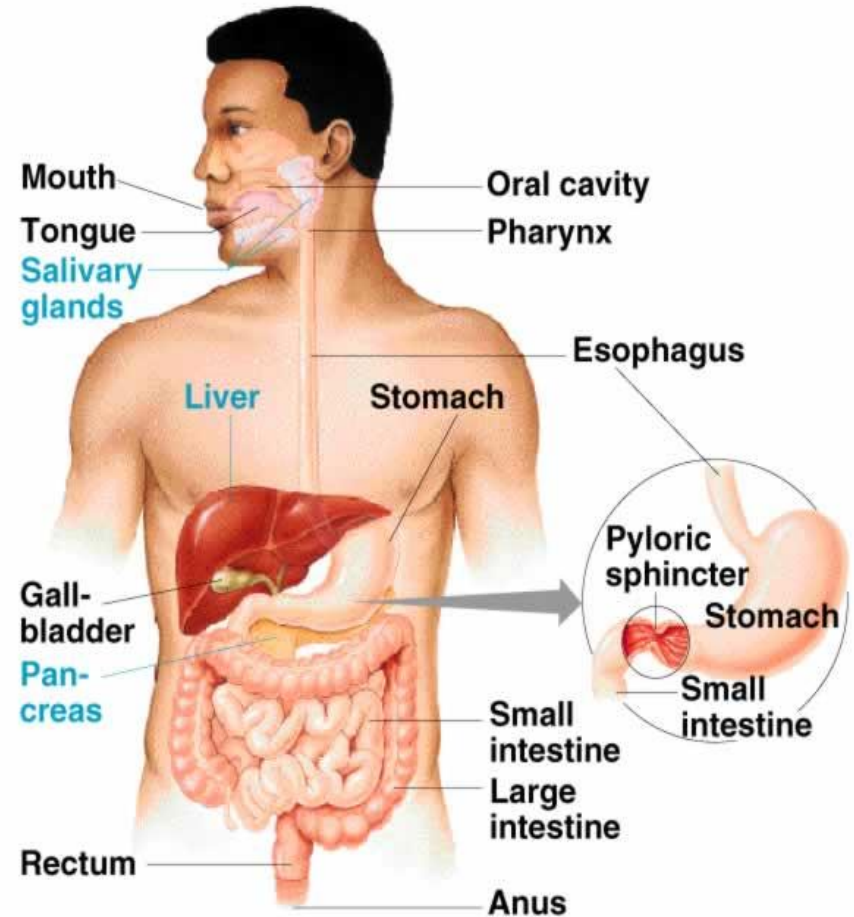


The Human Digestive System

The digestive system breaks down the food that we eat and absorbs water and nutrients from it. The digestive system includes a 14 feet long tube that goes through our body!

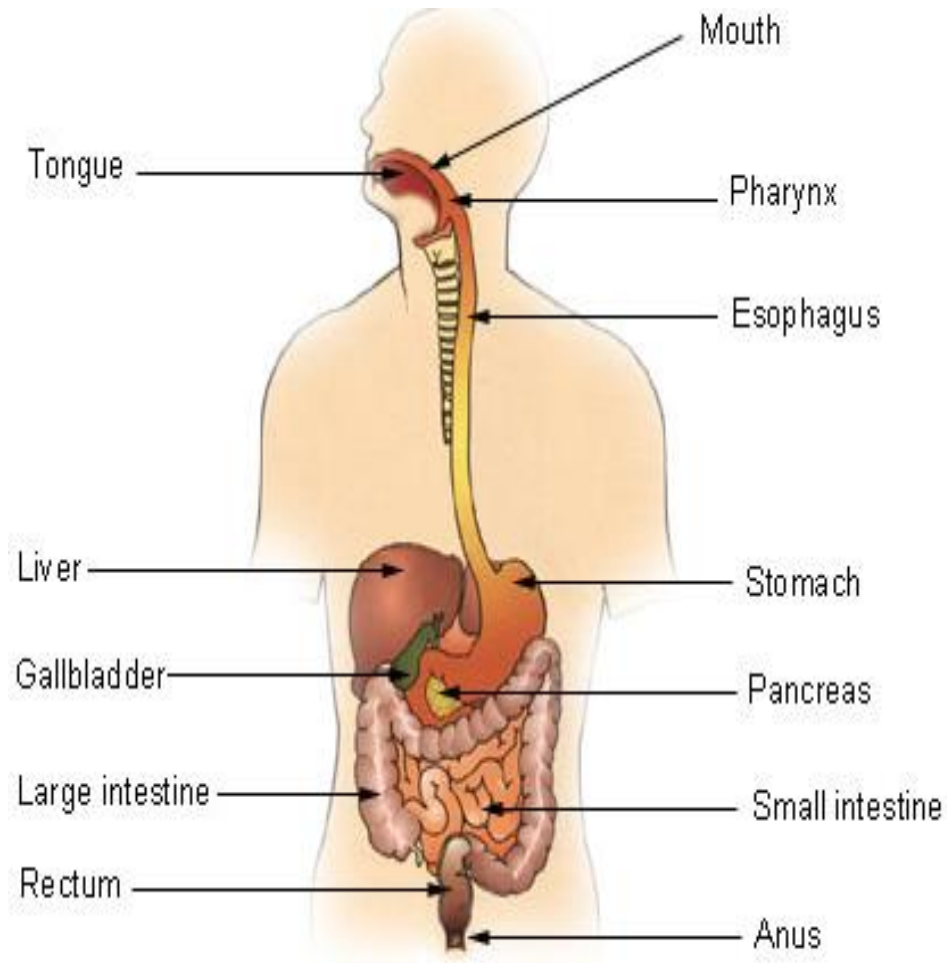
Digestion is the process of breaking things down into small components.

Absorption is the process of bringing those small components out of the digestive tract, and into our body (cells).



Parts of the Digestive System

The digestive tract, or alimentary canal, has many different parts. When a piece of food is eaten, it enters at the mouth, then passes through the pharynx, and down the esophagus. The food will then dump into the stomach, before it progresses into the small intestine. Next, it enters the large intestine, before it enters the rectum and exits the body through the anus.



The Human Digestive System

- **Mouth**

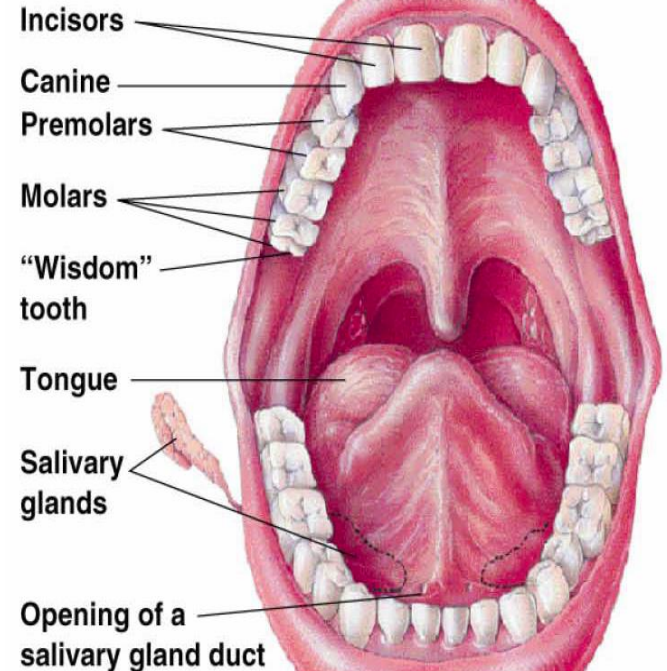
- Saliva

- Three major pairs of **salivary glands**
- **Salivary amylase**
- **Other functions:**

- Tongue is composed of striated muscle

- Mixes chewed food with saliva
- Forms mixture into a ***bolus***

TEETH

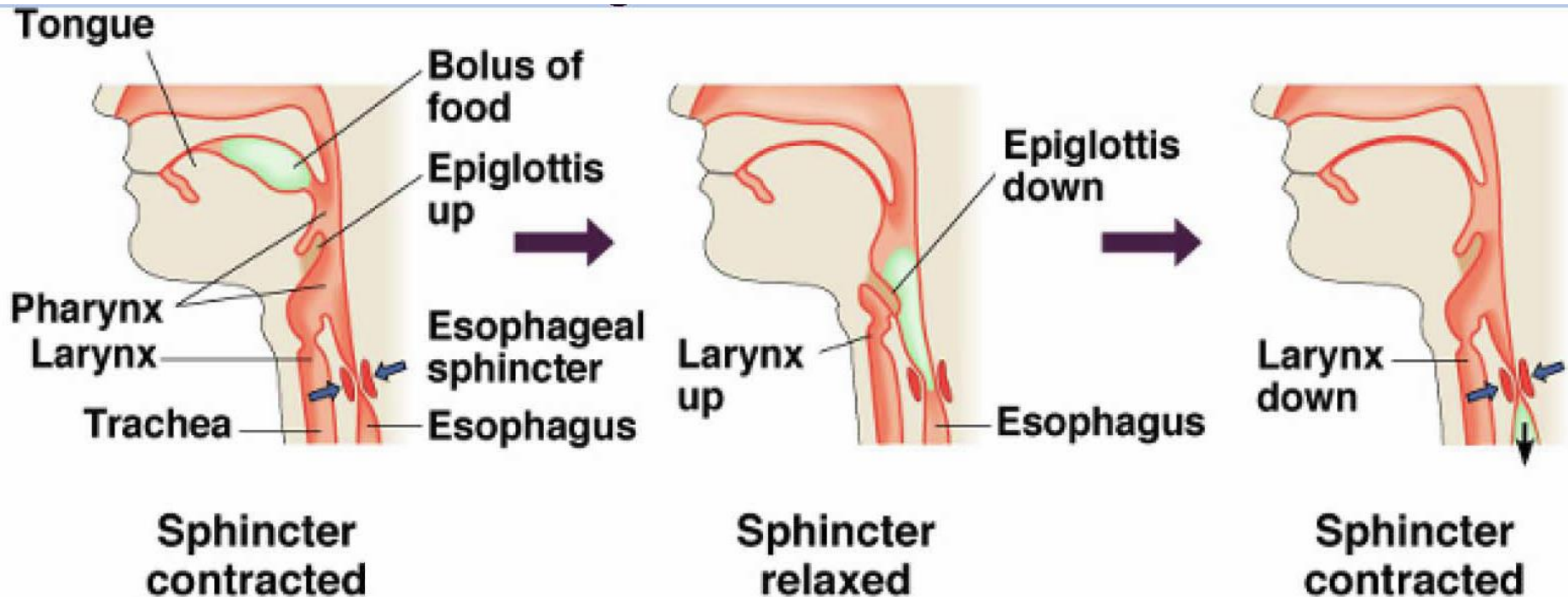


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Swallowing

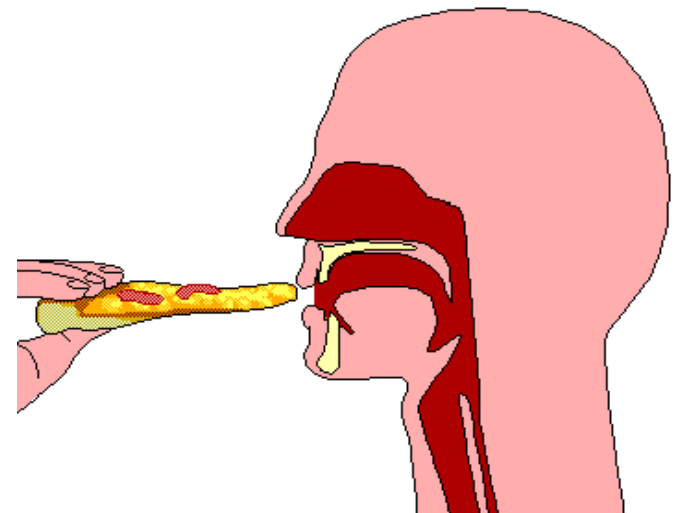
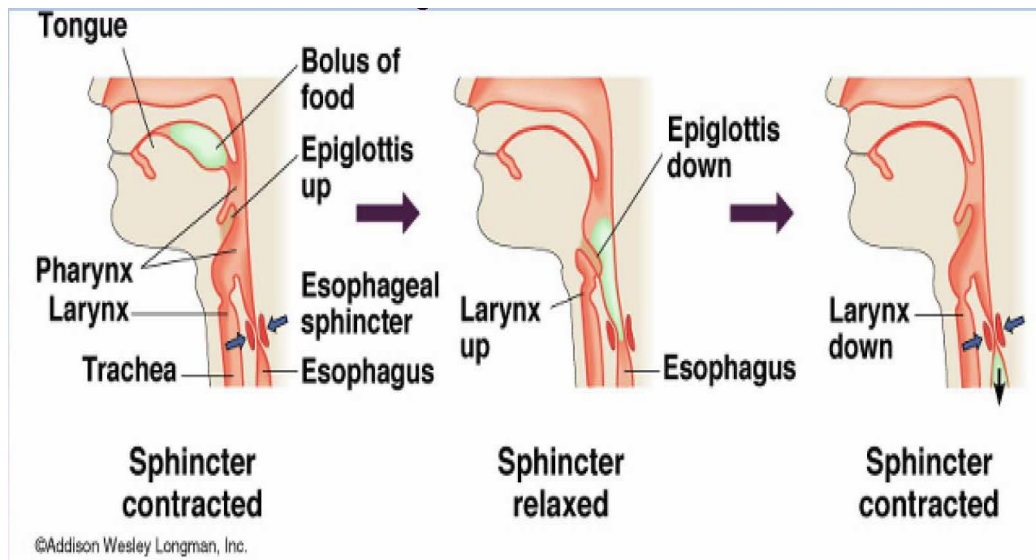
The tongue in the mouth also begins the swallowing reflex.

Swallowing pushes the bolus of food from the mouth through the pharynx and into the esophagus. Normally, the epiglottis is raised, allowing air to pass in and out of the trachea.



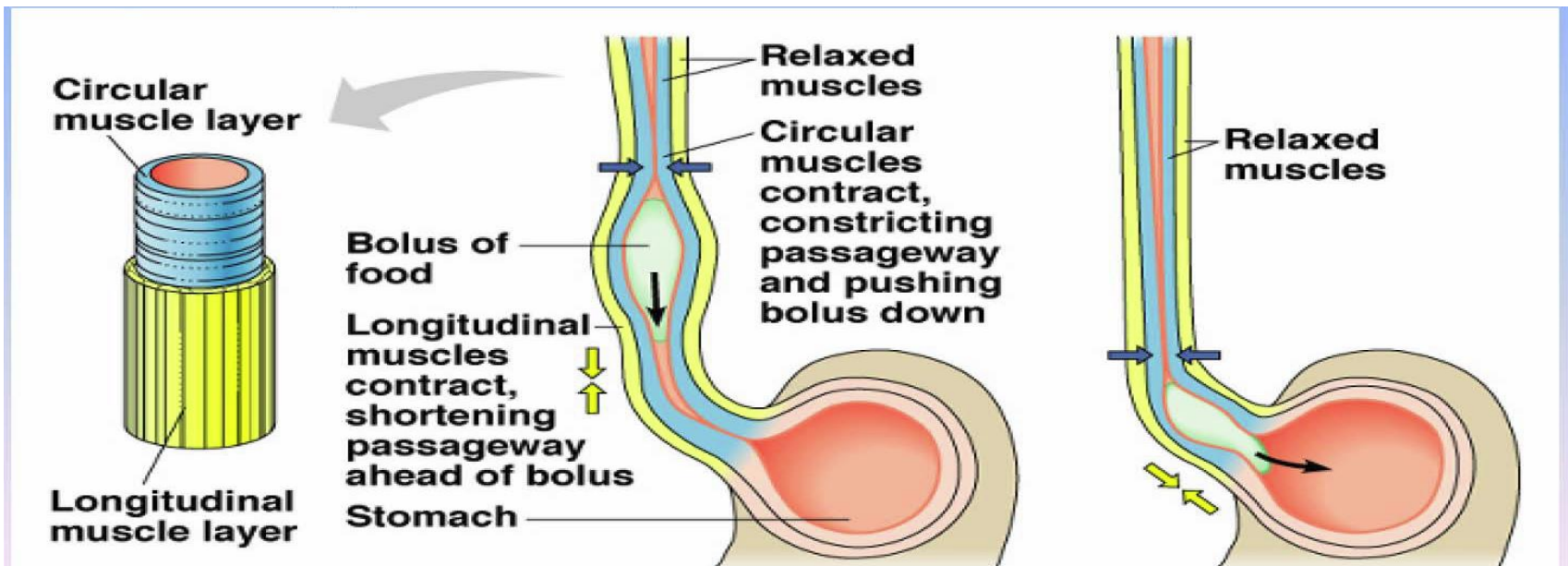
Swallowing

As we move food towards the back of the mouth, the epiglottis lowers, opening the passageway to the esophagus, while closing the route to the trachea to prevent choking. Additionally, the esophageal sphincter opens to allow food into the esophagus, and closes after the food bolus passes. This way, the food cannot come back in that direction, you will see that sphincters will become very important “one way doors” for the rest of the digestive tract.



The Esophagus

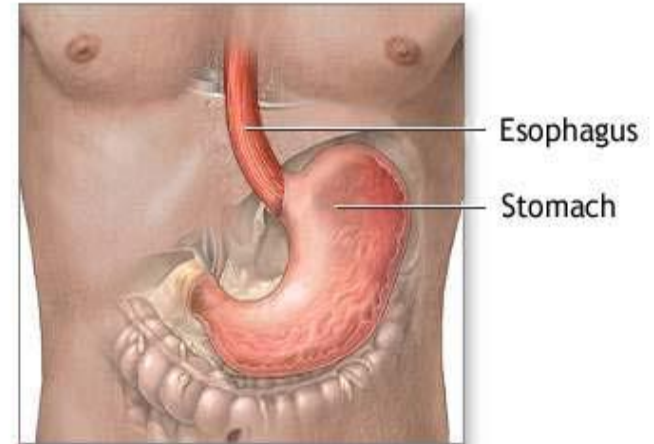
The esophagus is the long tube that brings the food bolus from the mouth down to the stomach. It moves the food in that direction by constricting the circular and longitudinal smooth muscle layers that surround it. Circular muscles constrict directly above the food bolus, pushing it downwards. Longitudinal muscles constrict along the sides of the bolus, inching the bolus towards the stomach below. This is called *peristalsis*.



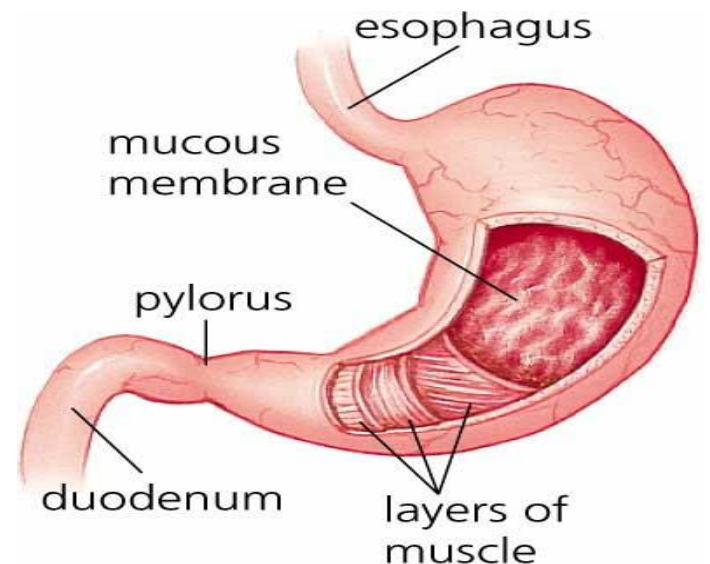
The Stomach

The stomach has many functions: it must store, mix, and further dissolve the food brought to it by the esophagus, in addition to killing bacteria that may have been consumed, and begin the digestion of proteins. For these varied functions, the walls of the stomach are lined with many different cells.

Mixing of the stomach's contents is done by the smooth muscle that surrounds the stomach walls. Food is kept inside the stomach by tightening the pyloric sphincter.



ADAM.

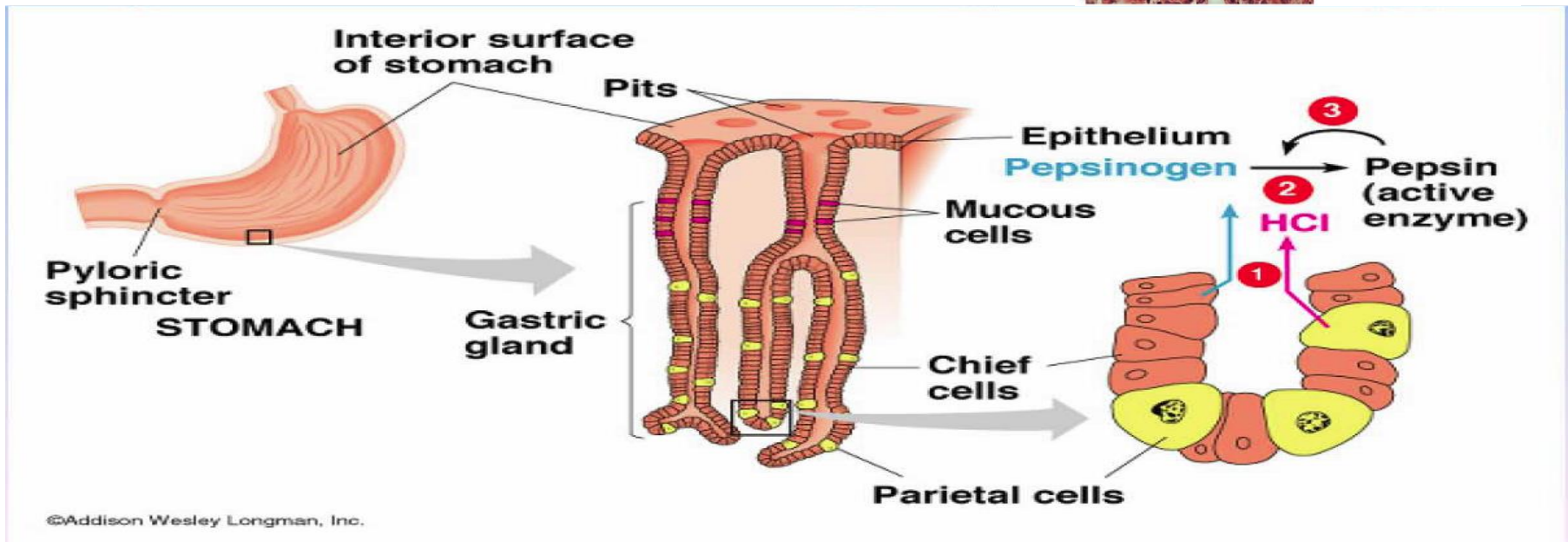
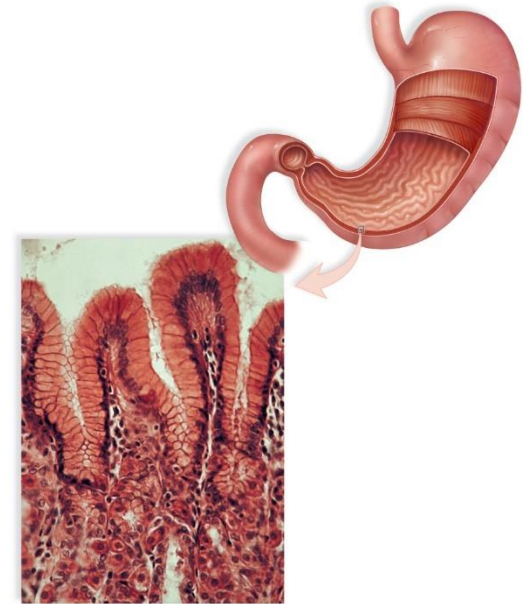


Carlyn Iverson

The Stomach

Cells of the stomach:

- The mucous cells secrete water and mucous to help moisten and lubricate the food.
- The parietal cells secrete hydrochloric acid (HCl) to kill bacteria and help dissolve the food.
- The chief cells make pepsinogen, which gets turned into pepsin by HCl. Pepsin is an enzyme that digests proteins.

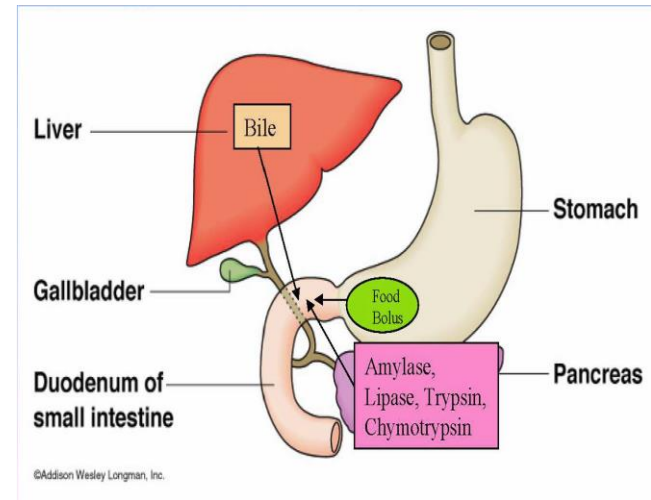
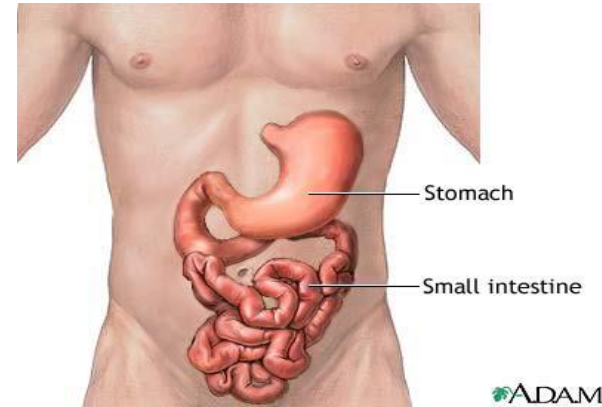


The Small Intestine (Duodenum, Jejunum, Ileum)

Six meters long, 2.5 cm diameter. Location of most food digestion and absorption. The duodenum is the first part. The stomach slowly pushes small bits of food through the pyloric sphincter into the duodenum into which the liver and pancreas start secreting digestive enzymes.

The liver secretes bile to help solubilize fats. The gall bladder stores bile and releases out extra amounts after a meal.

The pancreas secretes pancreatic amylase for carbohydrate digestion, lipase for fat digestion, trypsin, and chymotrypsin for protein digestion.

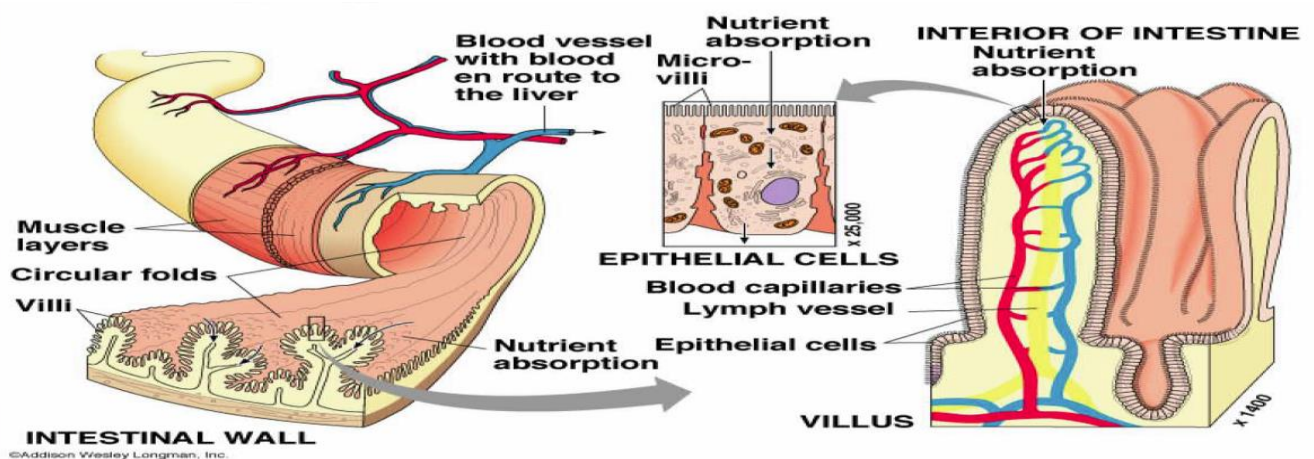


The Small Intestine



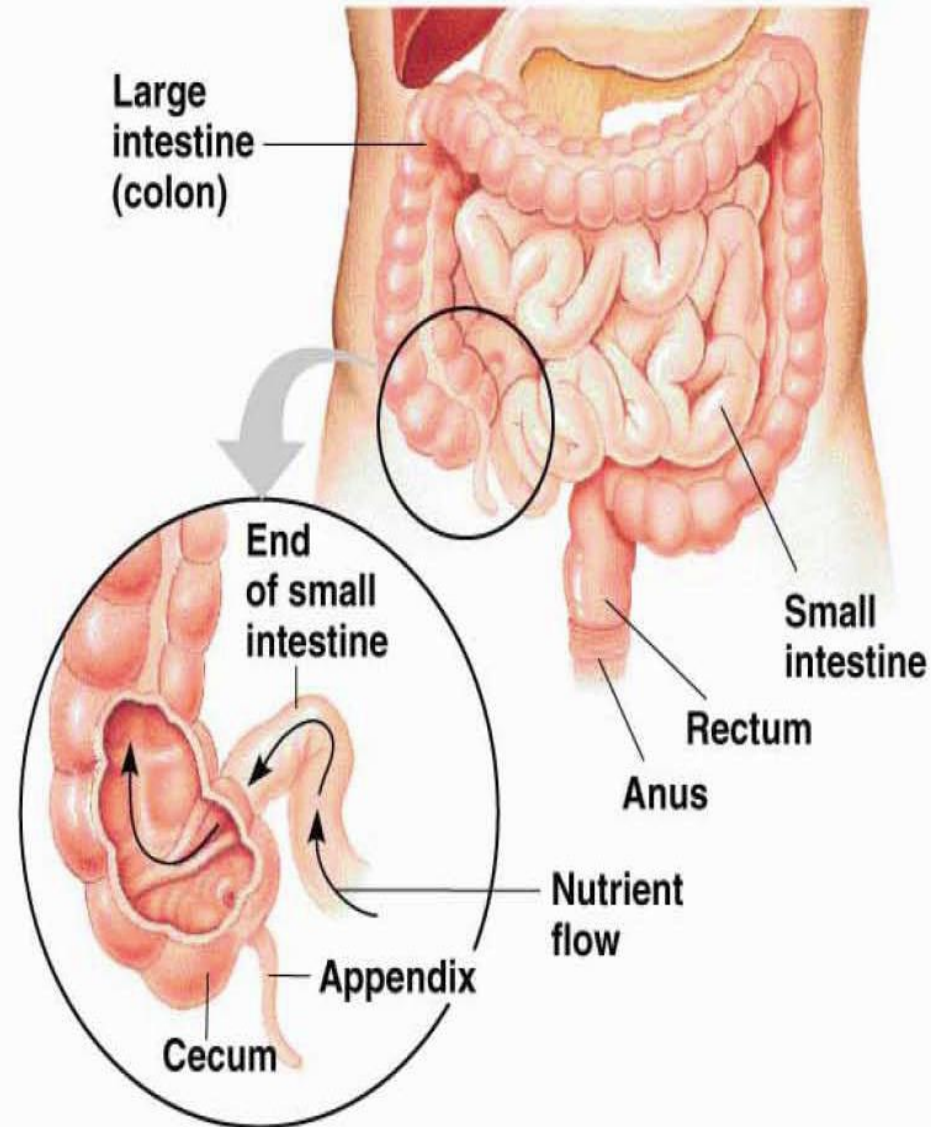
The enzymes from the liver and pancreas digest the food into small nutritious molecules which will be absorbed by the small intestine. The walls of the small intestine are highly folded into structures called villi which help increase the surface area and in turn increase absorption efficiency.

Villi contain blood and lymph vessels (lacteal) to carry the newly absorbed nutrients straight to the liver for processing and storage. The small intestine must also propel food along its length, so it is also surrounded by smooth muscles that work similar to those in the esophagus.



The Large Intestine

1.5 meter. The leftovers from small intestine enter the cecum (1st part of large intestine). Along its course through the large intestine, most of the water is absorbed, as well as any remaining nutrients. Here, the leftovers are also packaged and stored before excretion as feces through the anus.



Bacterial Flora

- The bacterial flora of the large intestine consist of:
 - Bacteria surviving the small intestine that enter the cecum and
 - Those entering via the anus
- These bacteria:
 - Colonize the colon
 - Ferment indigestible carbohydrates
 - Release irritating acids and gases (flatus)
 - Synthesize B complex vitamins and vitamin K

Functions of the Large Intestine

- Other than digestion of enteric bacteria, no further digestion takes place
- Vitamins, water, and electrolytes are reclaimed
- Its major function is propulsion of fecal material toward the anus
- Though essential for comfort, the colon is not essential for life

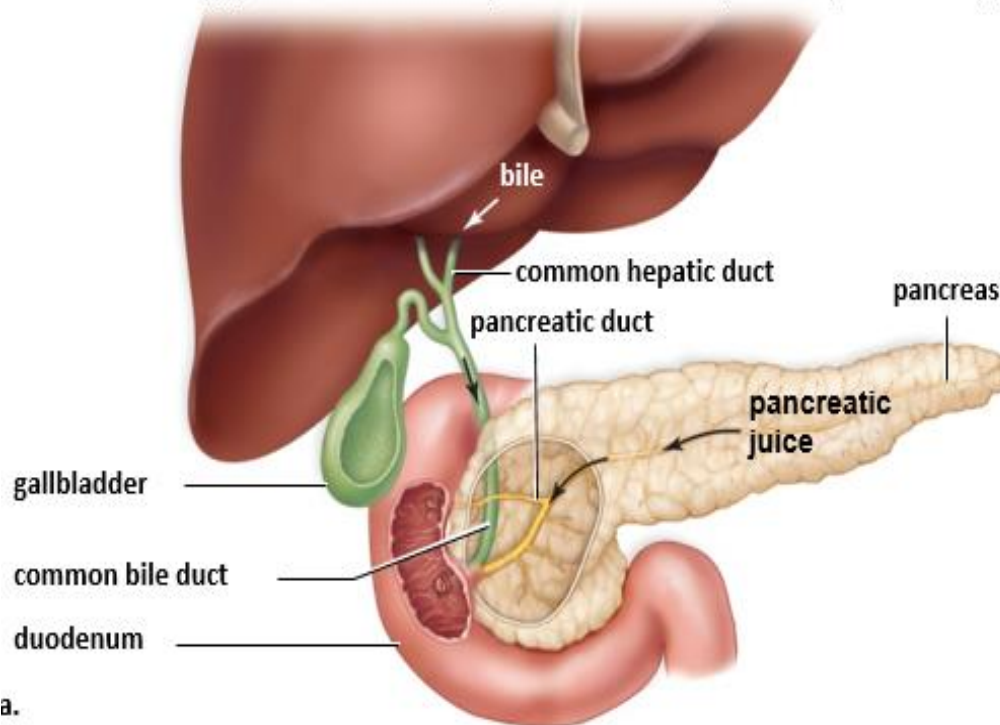
Accessory organs

Liver: Largest gland. Functions in detoxification of the blood, storage of iron and some vitamins, production of plasma proteins, storage of glucose as glycogen, production of urea, removal of *bilirubin*, and regulation of blood cholesterol levels

Gallbladder: Muscular sac attached to liver. Stores excess bile. Gallstones form when the cholesterol in bile crystallizes

Pancreas: Secretes insulin and glucagon. Secretes Sodium bicarbonate (neutralizes acid), pancreatic amylase, trypsin, and lipase

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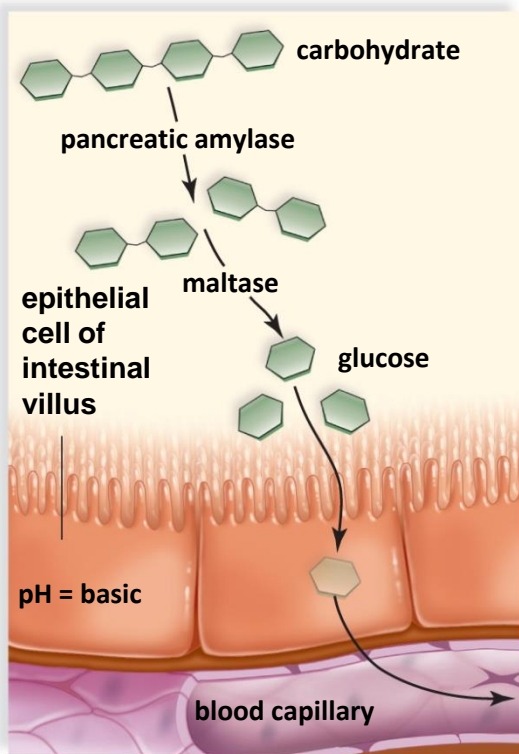
Digestive Enzymes

Below is a table of the digestive enzymes secreted into the small intestine, and the molecules they are able to digest.

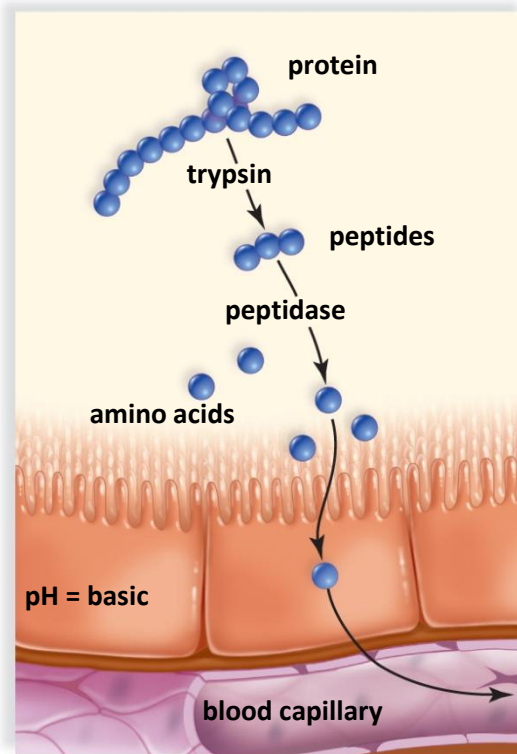
ENZYMATIC DIGESTION IN THE SMALL INTESTINE			
CARBOHYDRATES			
Starch (a polysaccharide)	Pancreatic amylase	Maltose (a disaccharide)	Maltase Sucrase Lactase (etc.)
		Disaccharides	Monosaccharides
PROTEINS			
Polypeptides	Trypsin Chymotrypsin	Smaller polypeptides	Aminopeptidase Carboxypeptidase Dipeptidase
		Small polypeptides and dipeptides	Amino acids
FATS			
Fat globules	Bile salts	Fat droplets (emulsified)	Lipase
		Fat droplets	Fatty acids and glycerol

Digestion and Absorption of Nutrients

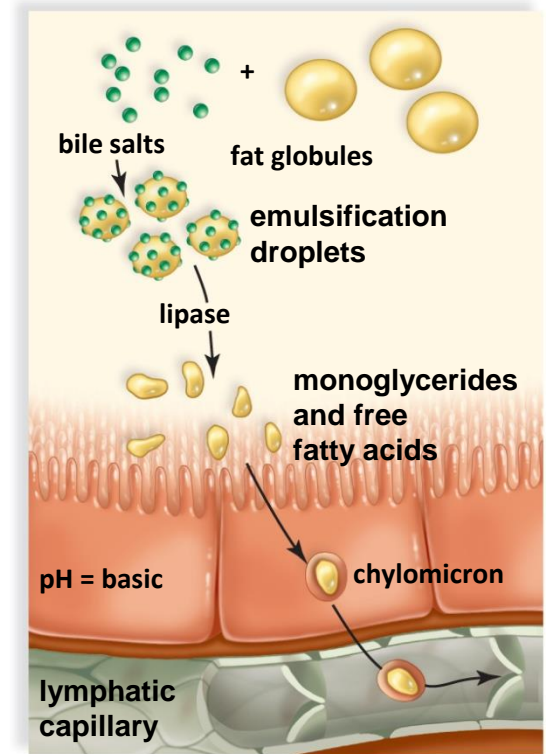
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a. Carbohydrate digestion



b. Protein digestion

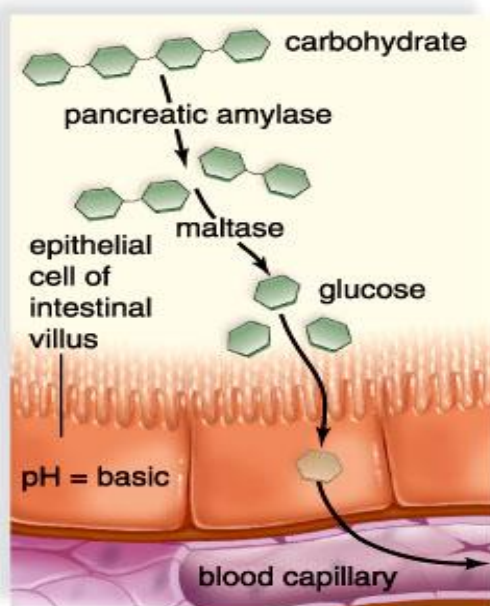


c. Fat digestion

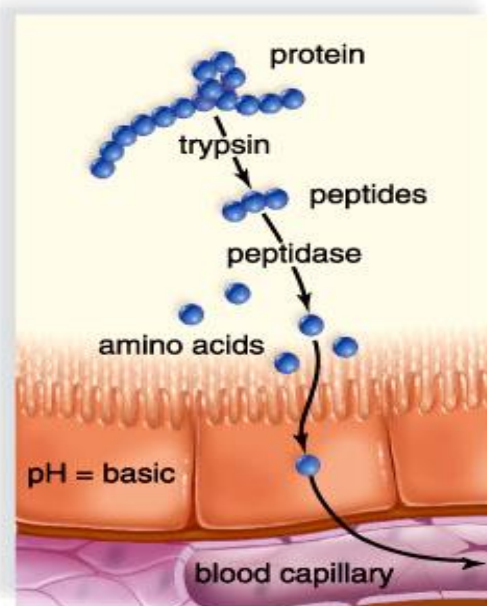
Nutrition: Carbohydrates

- Salivary amylase – starch \rightarrow maltose
- Pancreatic amylase – starch \rightarrow maltose
- Maltase – maltose \rightarrow glucose

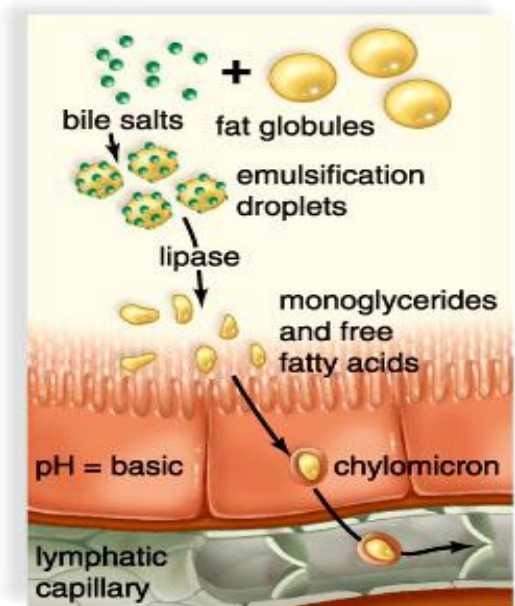
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a. Carbohydrate digestion



b. Protein digestion

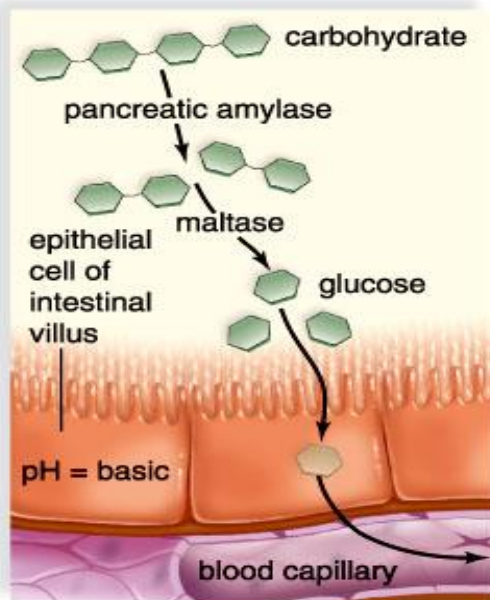


c. Fat digestion

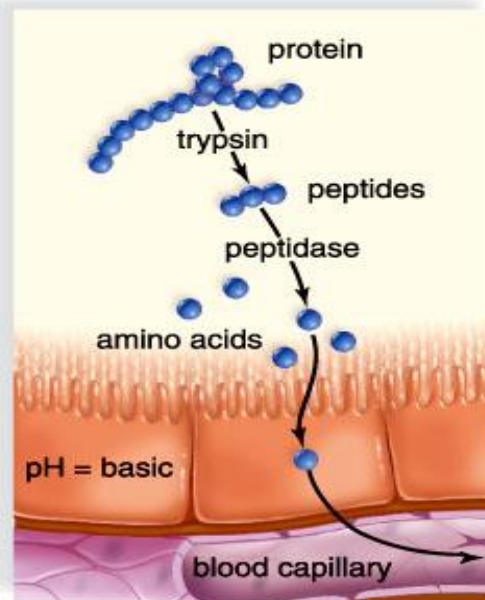
Nutrition: Carbohydrates

- After being absorbed from the digestive tract all sugars are converted to glucose
 - Glucose is the preferred direct energy source in cells.
- Plants store glucose as starch.
- Animals store glucose as glycogen.

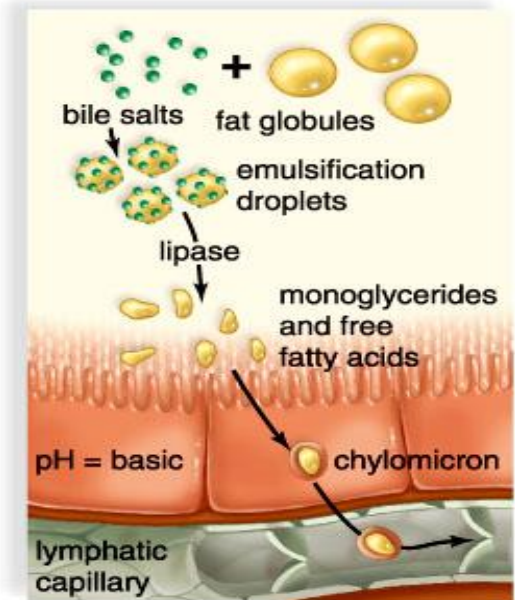
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b. Protein digestion

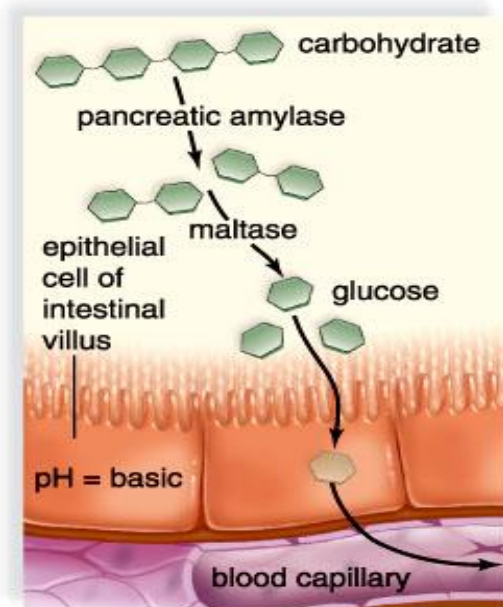


c. Fat digestion

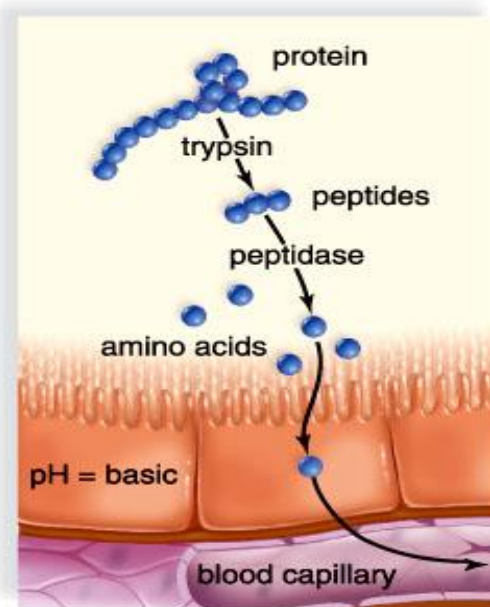
Nutrition: Proteins

- Proteins → peptides → amino acids
- Enzymes that break down proteins:
 - Pepsin- in the stomach
 - Trypsin- small intestine
 - Peptidases- small intestine

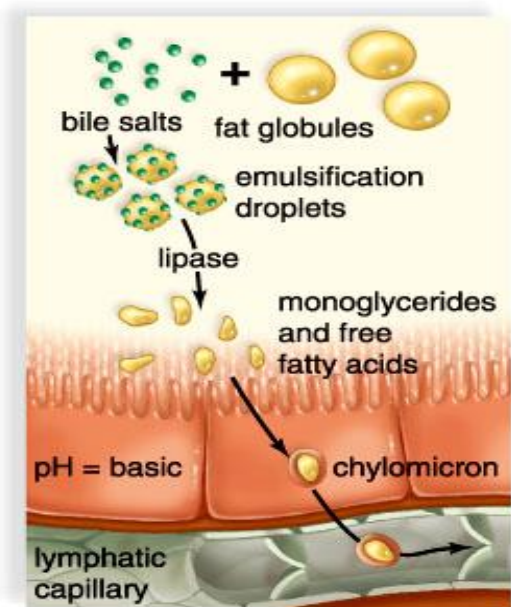
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b. Protein digestion

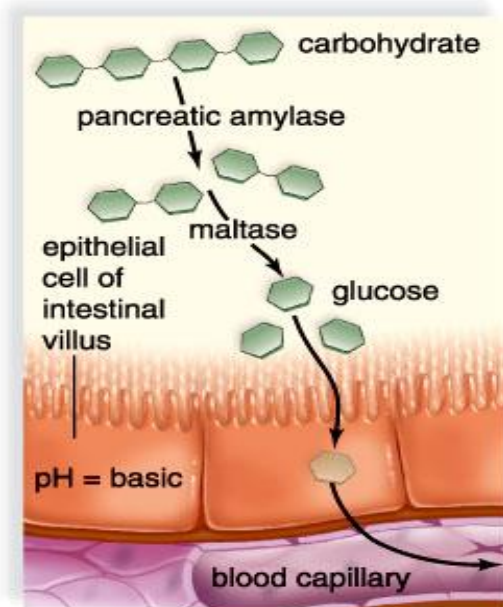


c. Fat digestion

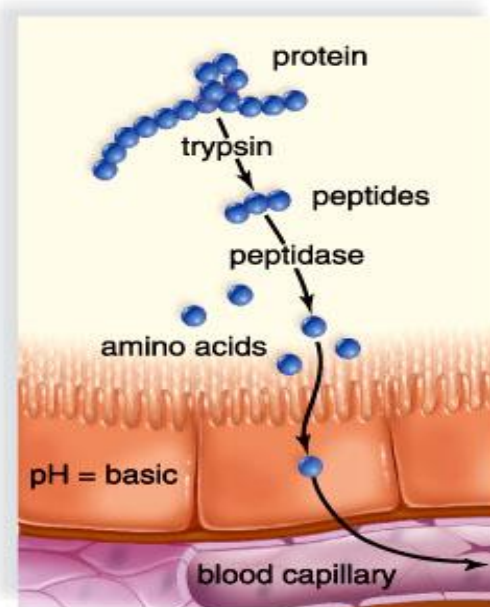
Nutrition: Lipids

- Fat, oils, and cholesterol
- Triglycerides = glycerol + 3 Fatty acids
- Bile converts: Fat → fat droplets
- Lipase converts: Fat droplets → glycerol + FA

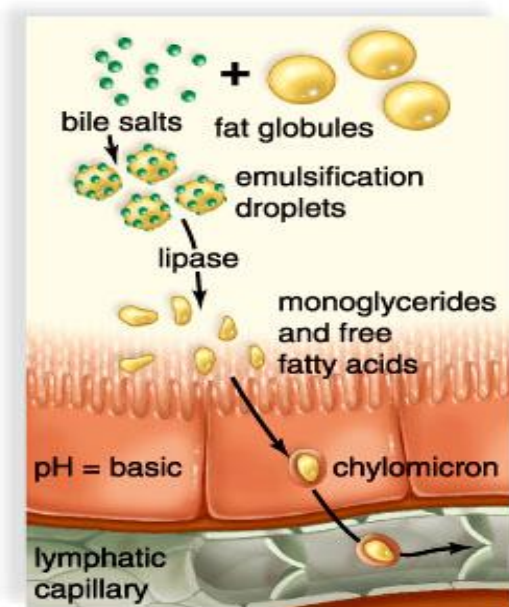
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a. Carbohydrate digestion



b. Protein digestion



c. Fat digestion

Nutrition: Vitamins

- Water- no digestion needed; just absorbed
- Vitamins
 - No digestion
- Minerals
 - No digestion