Chapter 6

Digestion

6.1 – The Molecules of Living Systems

- In this section we will:

1. Describe the nature of carbohydrates, lipids & proteins
2. Explain how carbohydrates, lipids & proteins are synthesized and broken down
3. Describe and perform tests to identify macromolecules

Macromolecules

- Macromolecules are large, complex organic molecules
- These include carbohydrates, lipids, proteins, and nucleic acids
- These macromolecules are all created from smaller subunits

Assembling & Disassembling Molecules

- Macromolecules are assembled through dehydration synthesis
- They are broken down through hydrolysis reactions

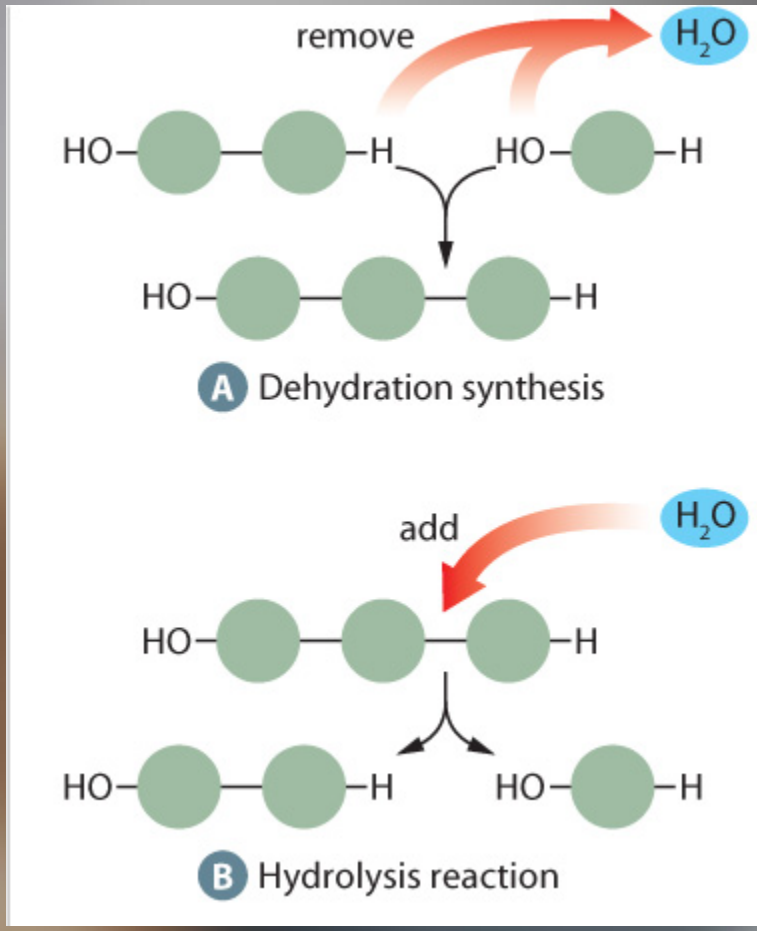


Figure 6.2 This simplified diagram shows how molecular subunits are put together (synthesized) to form macromolecules and broken apart through hydrolysis.

Carbohydrates

- Carbohydrates contain carbon, oxygen and hydrogen
- PRIMARY source of our body's energy
- They can be classified as simple sugars (made up of one or two individual sugar units), or polysaccharides (which are long chains of simple sugars)

mono and di - saccharides

- Monosaccharides are simple sugars such as glucose (blood sugar), fructose, and galactose (sweetest tasting)
- Disaccharides are 2 monosaccharides bonded together- examples are:
  - glucose+fructose - sucrose
  - glucose+galactose - lactose
  - glucose+glucose - maltose

Production of a Disaccharide

- Note that this is a form of dehydration synthesis

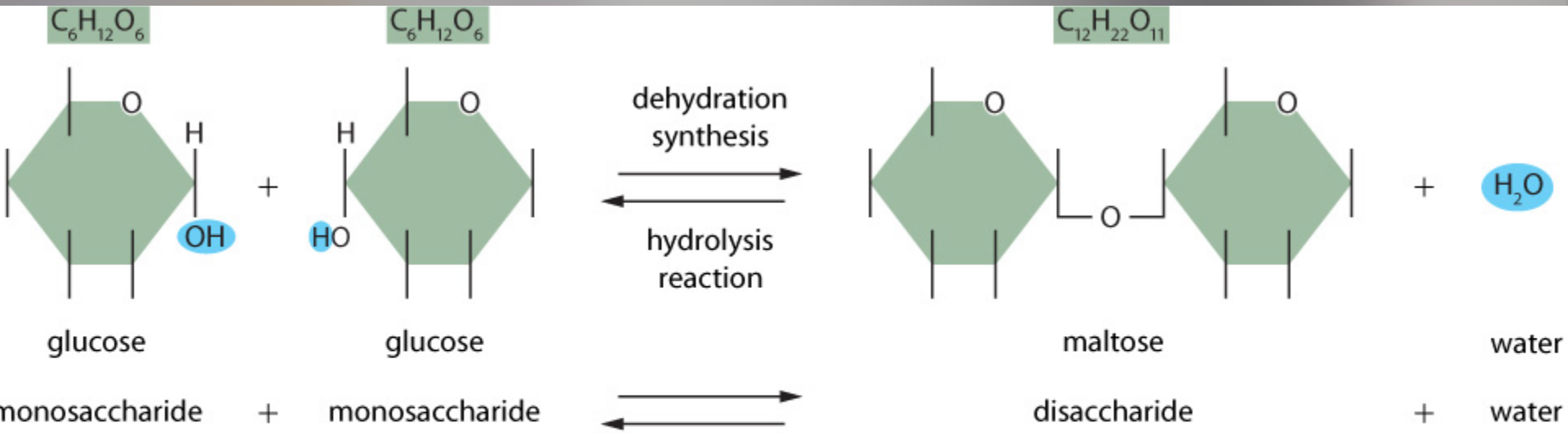


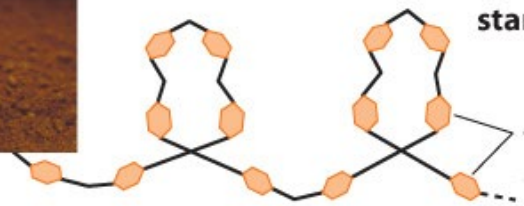
Figure 6.3 During the synthesis of maltose, a chemical bond forms between two glucose molecules, and the components of one water molecule are removed. During the hydrolysis of maltose, the components of one water molecule are added and the bond is broken, yielding two glucose molecules. (The double arrow indicates that the chemical reaction, represented by the chemical equation, can proceed in both directions—from left to right and from right to left.)

Examples of Polysaccharides

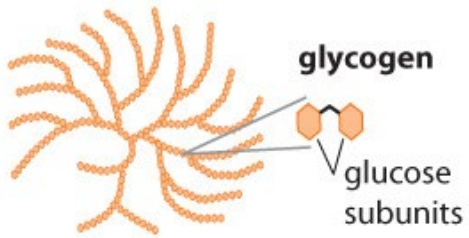
- All of these are examples of polysaccharides
- The way that the individual sugar units are arranged determines their shape and function

Figure 6.4 Compare the structural differences among starch, glycogen, and cellulose. Notice that all three polysaccharides consist of glucose subunits.

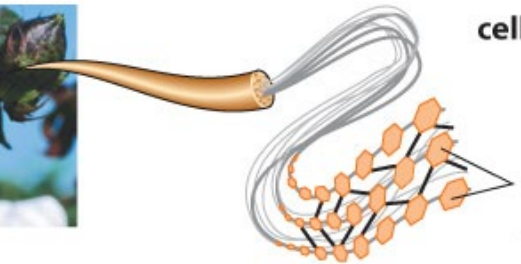
potato



liver



cotton



Carbohydrates

- Polysaccharides - large polymers of monosaccharaides (lots of monomers)
- Cellulose
  - Plant “fiber”
  - Indigestible by human enzymes
- Starches and glycogen
  - Quick energy storage
  - Starches are long chains of glucose in plant cells
  - glycogen is “animal starch”, composed of long chains of glucose stored in animal cells (muscle and liver)

Lipids

- General characteristics
  - Extremely diverse group including fats, oils, steroids, waxes, phospholipids
  - Common characteristic- nonpolar molecules which are insoluble in water (non-polar covalent bond of H and C)
  - Energy storage molecules
  - Also function as structural components (building membranes), insulation, cushioning of organs, and hormones

Lipids

- Lipids consist of glycerol (a 3-carbon chain) and fatty acids (whose composition may vary)

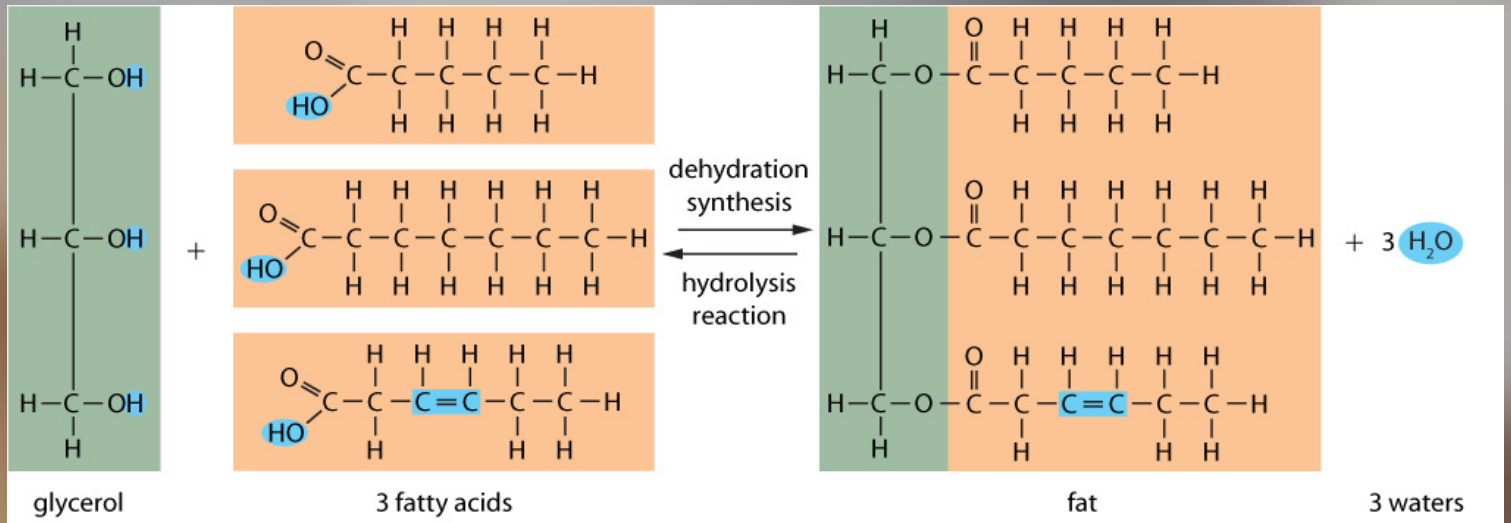


Figure 6.5 During the synthesis of a fat molecule, three fatty acid molecules bond with one glycerol molecule, and three water molecules are produced. What happens during the hydrolysis of a fat molecule?

Lipids

- Emulsification
  - Fats are nonpolar; they do not dissolve in water and tend to form “globules” (think of oil and vinegar salad dressing)
  - Emulsifiers break down the globules of fat into smaller droplets
  - Emulsifiers have a nonpolar end which attaches to the fat, and a polar end which interacts with water molecules so that the droplets can disperse
- Saturated and unsaturated fatty acids
  - Saturated have no double bonds between carbon atoms in the chain (all bonded to hydrogen), and tend to be more solid at room temperature and harder to break down
  - Rigid & straight (animal fat)
  - Unsaturated have at least one double bond between carbons
  - Polyunsaturated have multiple double bonds- the more polyunsaturated the fatty acids, the more liquid the fat will be at room temperature due to kinks in the chain and the easier it is to break down

AVOCADO: Hello I'm good fat

BACON: *lights cigarette* *punches avocado*

Proteins

- General characteristics
  - Composed of amino acids
  - An amino acid has a central carbon atom with a carboxyl group (COOH) at one end and an amino group at the other (NH_2)
  - There are 20 different amino acids
  - The portion of the molecule that varies between the different types is called the R group (“remainder”) which classifies the amino
  - Essential amino acids (9 out of 20) cannot be made by the body and must be consumed through food (histidine, isoleucine, valine)

Representative amino acids

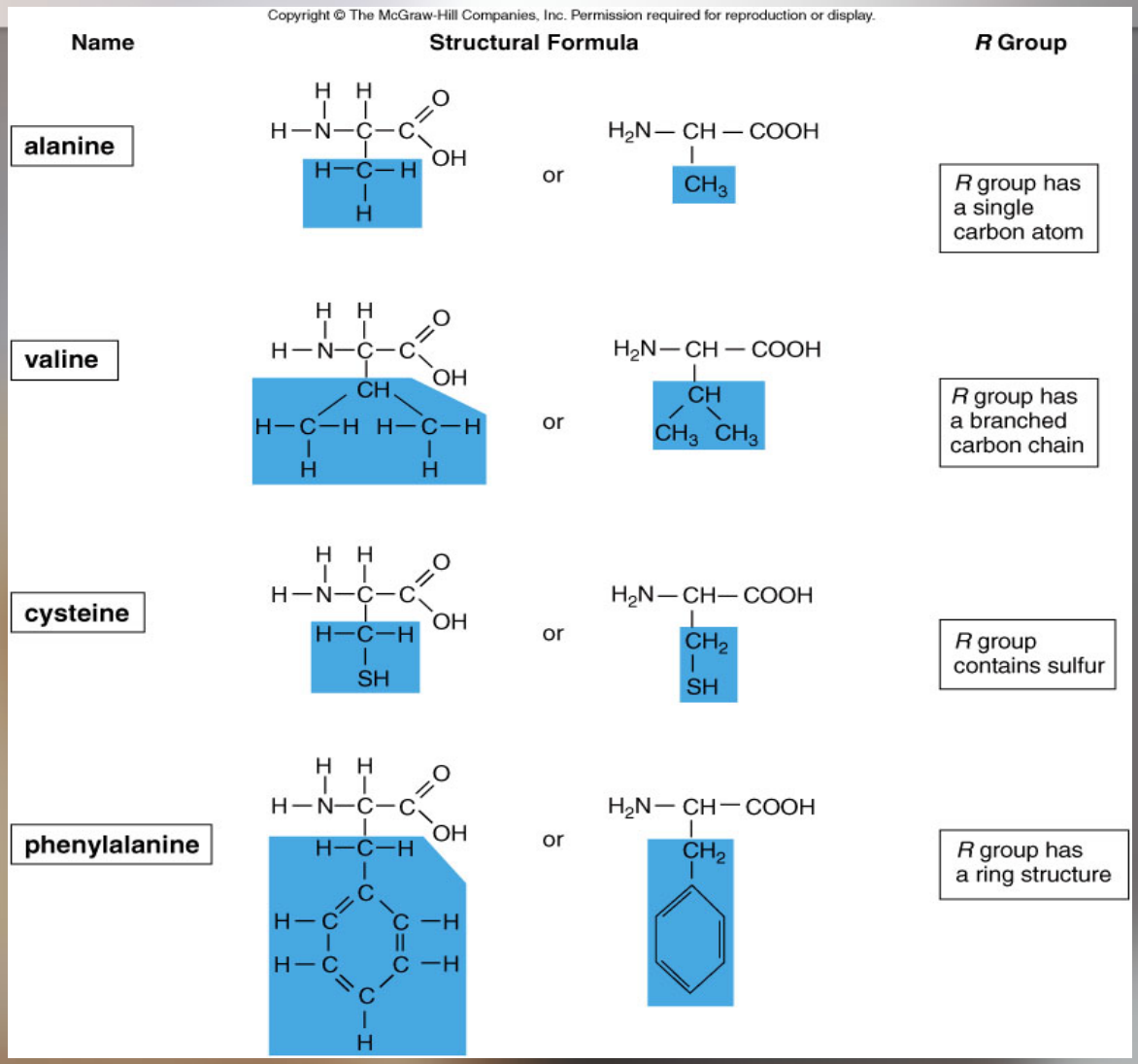


Fig. 2.24

Peptide Bonds (2:38)

Protein Synthesis

- The human body can synthesize 11 of the 20 amino acids
- We must then obtain the other 9 (known as essential amino acids) from our diet

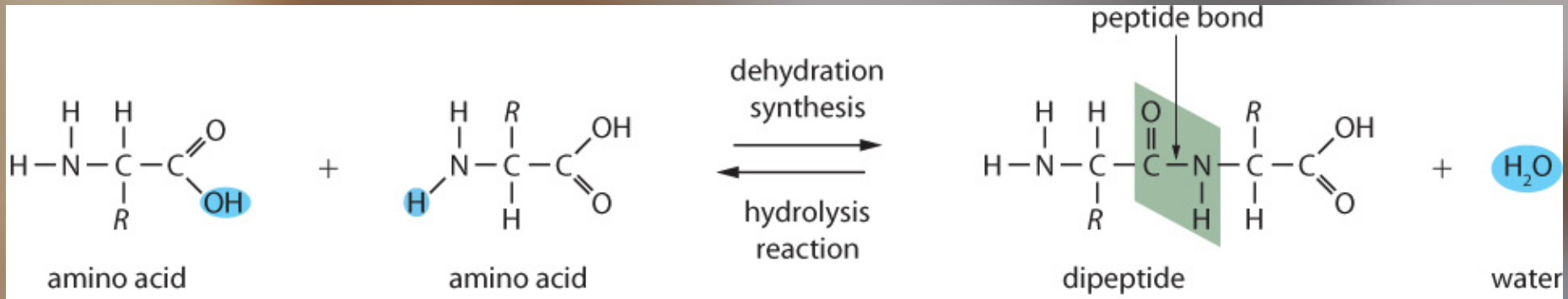


Figure 6.7 In dehydration synthesis, two amino acids bond to form a two-subunit molecule called a dipeptide. Hydrolysis breaks the peptide bond that links the amino acids. The *R* groups are shown here only as "*R*," because they do not take part in the reactions that make or break peptide bonds.

Examples of Proteins in your Body

- Biological catalysts-all enzymes are proteins
- Cell transport gates-part of the bilayer
- Antibodies - y shaped proteins that function in immune response
- Hormones - insulin, growth hormone
- Energy source - body uses protein when lipid and carbs are lacking
- Transport molecule - hemoglobin transports oxygen in blood

Protein Shapes

- As you can see, proteins can have many shapes
- The shape of a protein molecule is critical to its function

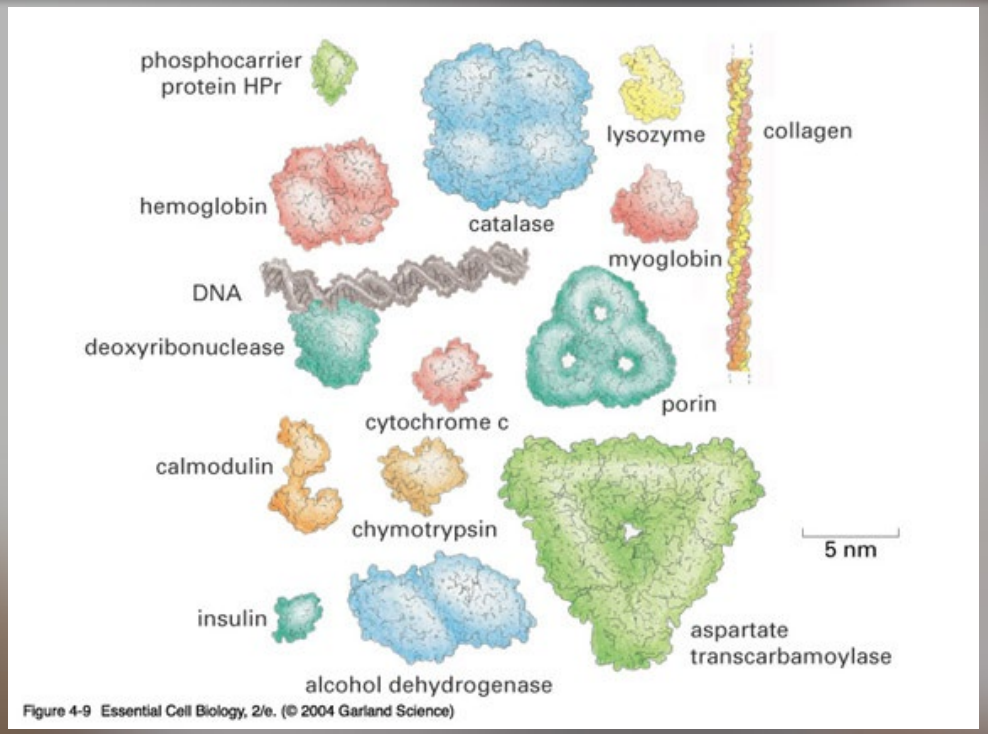


Figure 4-9 Essential Cell Biology, 2/e. (© 2004 Garland Science)

- Loss of the 3D structure of a protein is called denaturation
- [salt], temperature, pH can change the shape or denature proteins

Coagulation

- Proteins clump together into a solid like substance due to heat, acids, salts etc.
- Blood clots to prevent further bleeding
- Cooking an egg
- Permanent and irreversible (can't uncook your egg)

Testing for Macromolecules

- There are experimental tests we can perform to indicate whether or not a food sample contains different macromolecules
- These tests are:
  - Benedict's Test – for reducing (simple) sugars
  - Biuret Test – for proteins
  - Sudan IV Test – for lipids

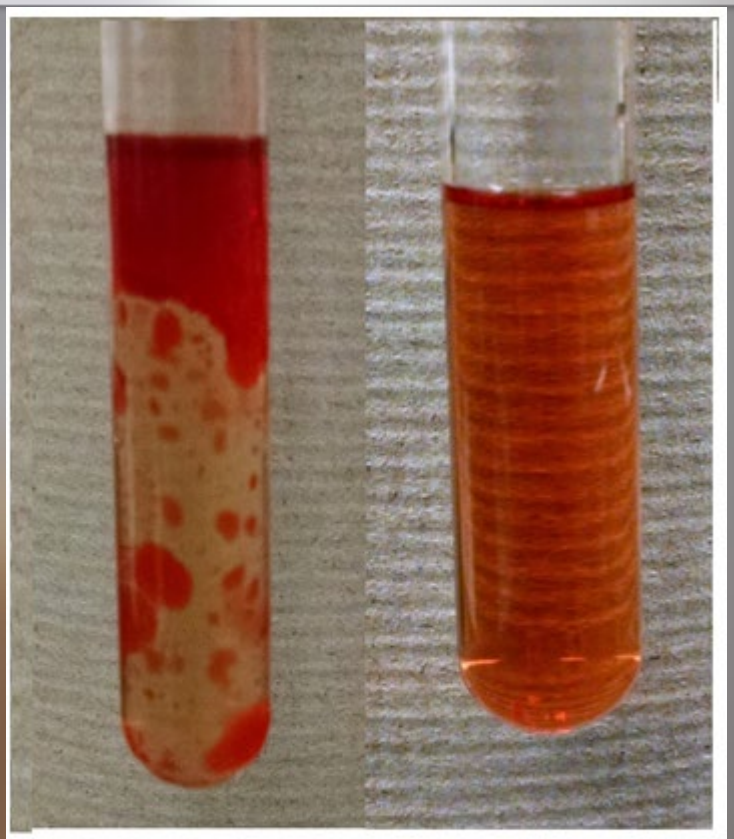
left to right: fructose glucose sucrose

Benedict's Test. Benedict's test was performed on three carbohydrates, depicted from left to right: fructose, glucose, and sucrose. The solution containing sucrose remains blue because sucrose is a nonreducing sugar (not a monosaccharide)

Biuret Test


30 mL
Biuret Reagent
Protein Test Solution
UN1824
For Laboratory Use Only.
Keep Out of Reach of Children.
Corrosive Storage Code White
50
40
30
20
10
50
40
30
20
10

Sudan IV test for lipids



positive result	negative result
- 2 layers - top layer is orange-red	- one layer - color is evenly distributed

Vitamins and Minerals

- Both vitamins and minerals are key components of chemical reactions in the body
- Vitamins are organic compounds that often help enzymes function
- Minerals are inorganic compounds that make up essential components of hemoglobin, hormones, enzymes and vitamins

Deficiency

- Night blindness: vitamin A deficiency
- Scurvy: Vitamin C deficiency (Vit C: helps maintain connective tissue)
- Rickets: Vitamin D deficiency (Vit D: helps with calcium and phosphorus absorption=healthy bones)
  - Government puts it in milk

Because we live in Canada

Water soluble vitamins: B and C

Lipid Soluble: A, D, E, K

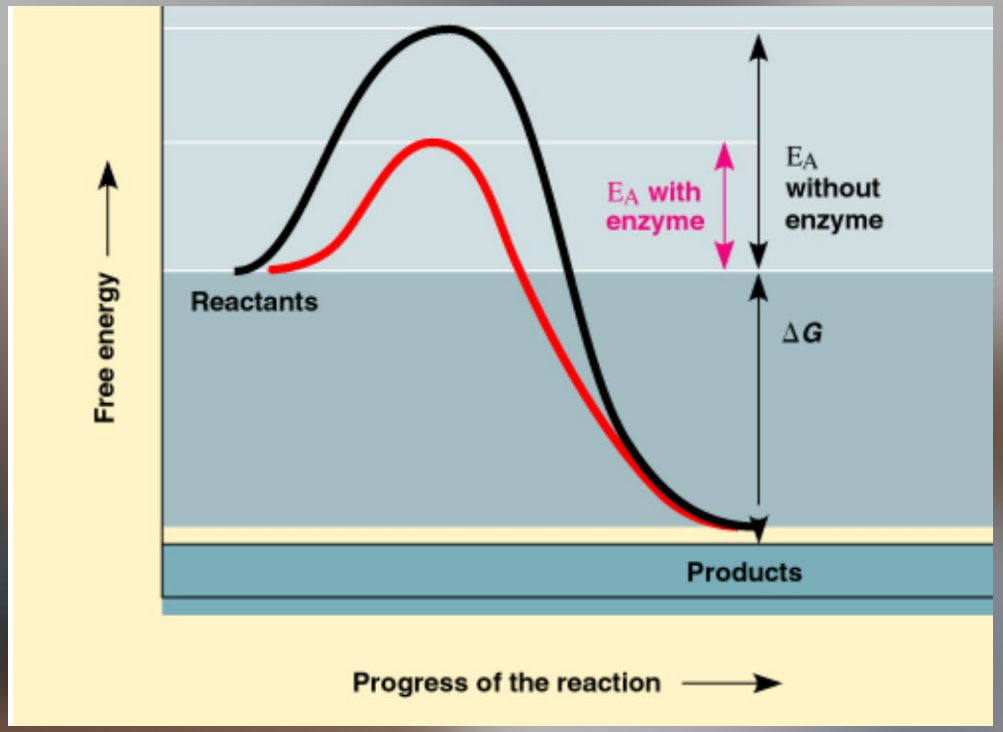
Enzymes

- Enzymes are biological catalysts
- They increase reaction rates by reducing the activation energy (amount of energy is required to start a reaction)
- A catalyst is a substance that speeds up the rate of reactions but isn't used up in the reaction

Activation Energy

- **Activation Energy**: the amount of energy needed to start a chemical reaction
- Enzymes **lower** activation energy

This is important because we save energy!

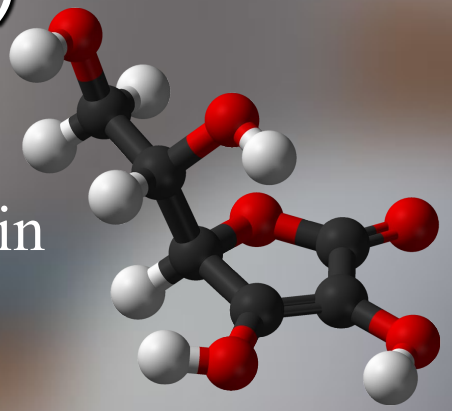


Enzyme Specificity

- Substrate: target molecule on which an enzyme acts
  - An enzyme binds to a substrate and stresses the bonds of that molecule in a way that makes a reaction more likely to occur.
- The key to an enzyme's activity is its shape.
  - Active Site: location on an enzyme where the substrate binds
  - Each substrate can only bind to one enzyme.
- Lock and Key model: the enzyme is the lock and the substrate is the key. Only the correctly sized key will fit the hole (active site) and open (turn on) the enzyme

Cofactors + Coenzymes

- Cofactors - inorganic chemical (ion) that are needed for an enzyme to carry out its activity
  - Ex) Zn, Cu, Mn, Fe, K, Mg
- Coenzymes - organic (non-protein) molecules that bind to an enzyme to help it function.
  - Ex) Vitamins-carry chemical groups between enzymes (NADP carry electrons)



Ascorbic acid – Vitamin C - CHO

How an Enzyme Works:

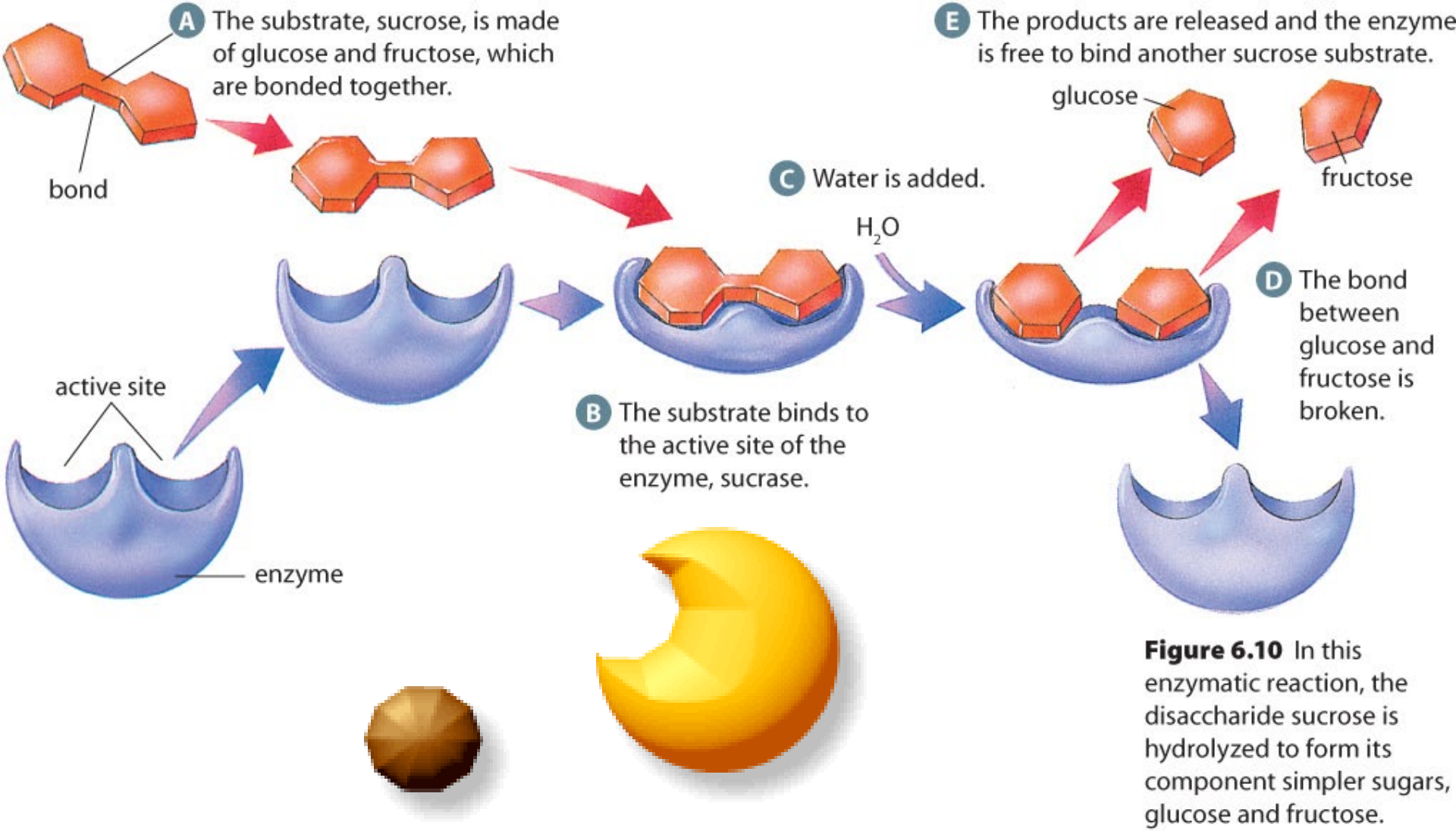
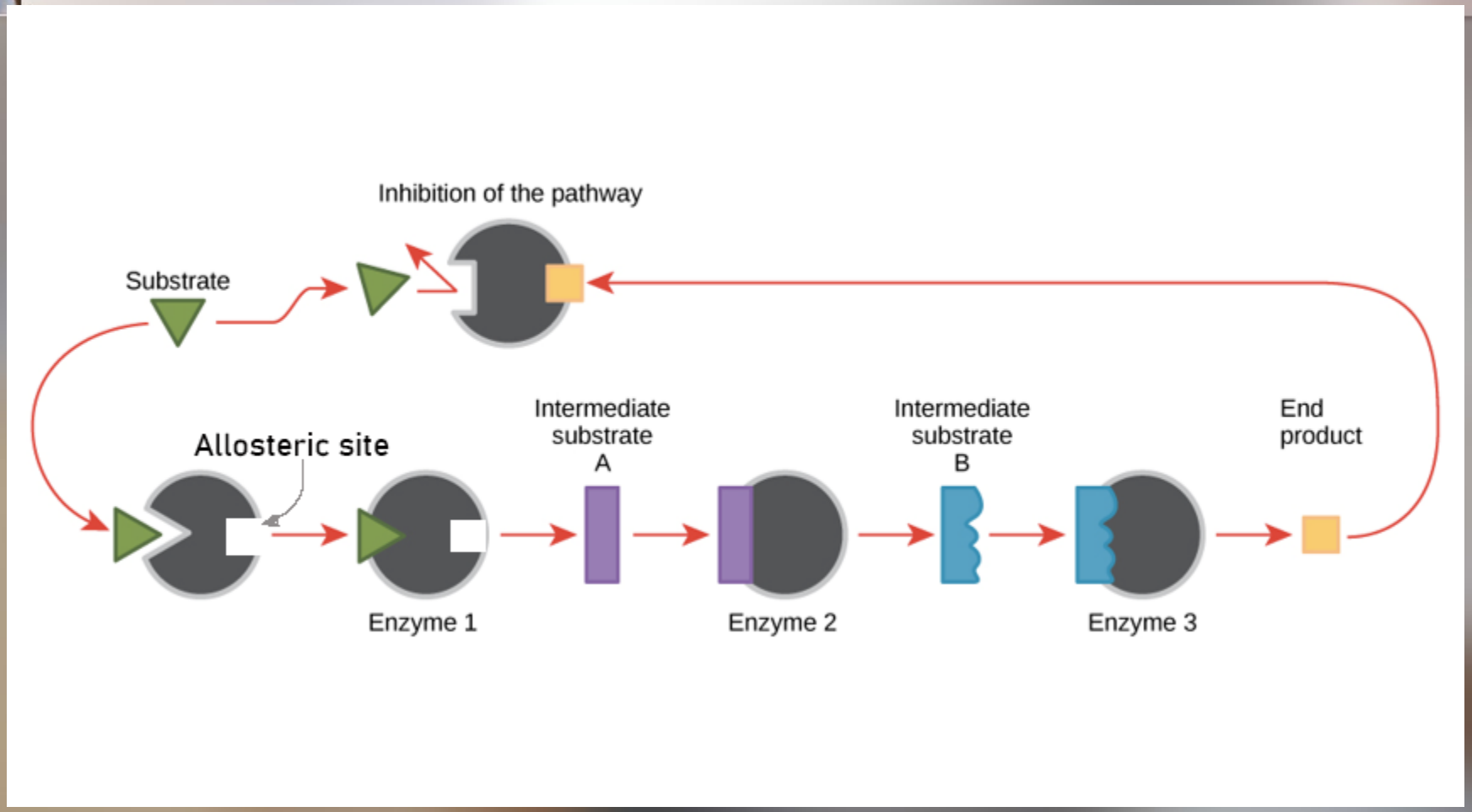


Figure 6.10 In this enzymatic reaction, the disaccharide sucrose is hydrolyzed to form its component simpler sugars, glucose and fructose.

Feedback Inhibition

- **Feedback inhibition** is a form of allosteric regulation in which the final product of a sequence of **enzymatic** reactions accumulates in abundance. With too much of this product produced, the final product binds to an site on the first enzyme in the series of reactions to **inhibit** its activity.

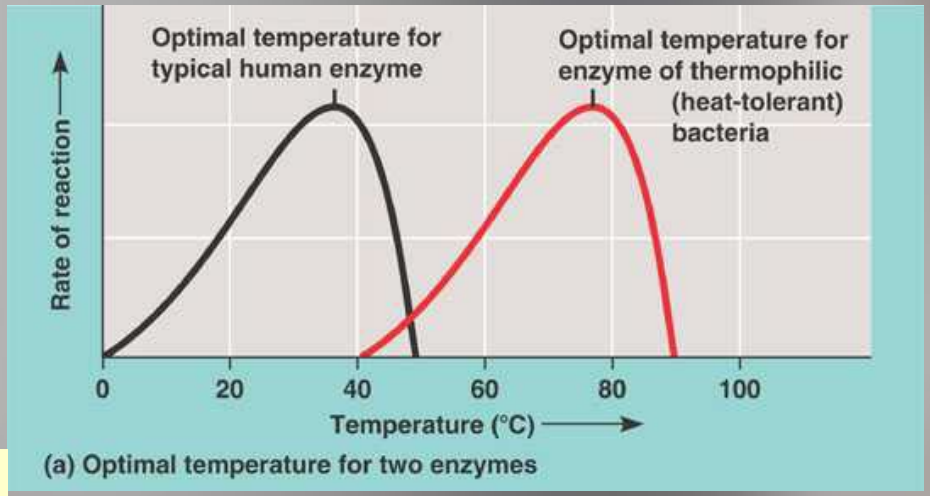
Feedback Inhibition

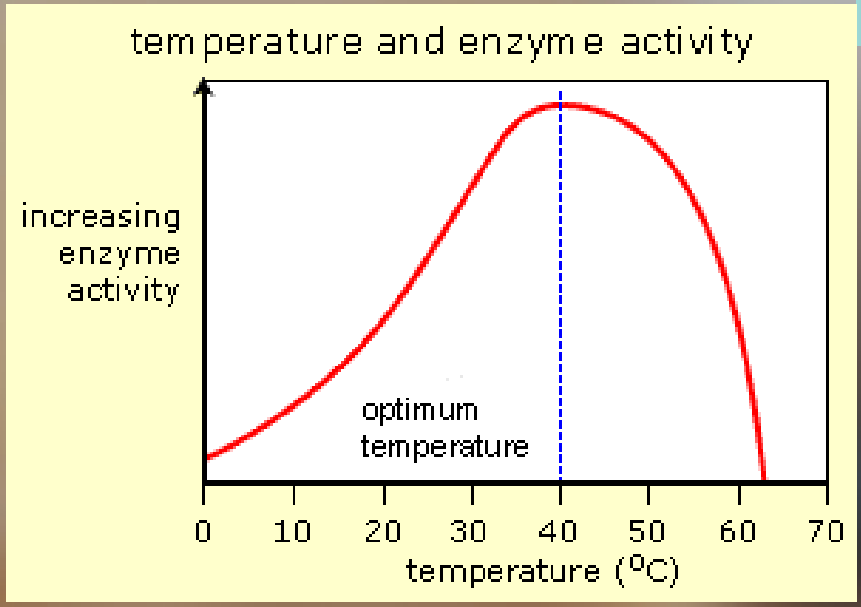


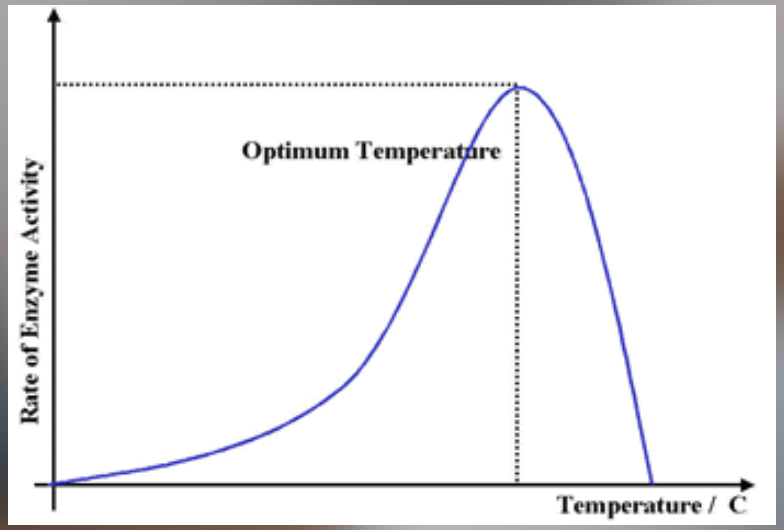
Example

Enzyme Activity

- Temperature:

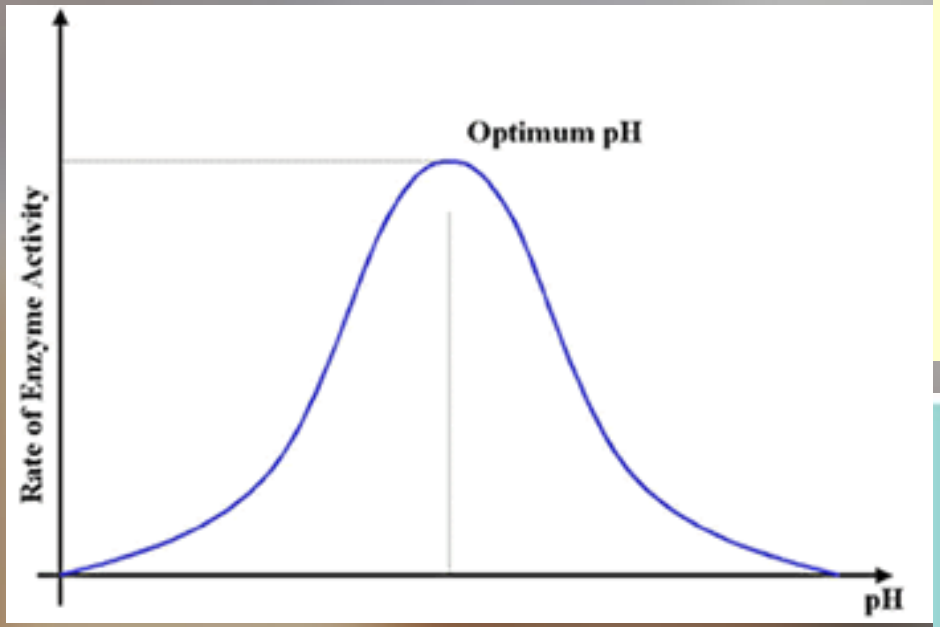


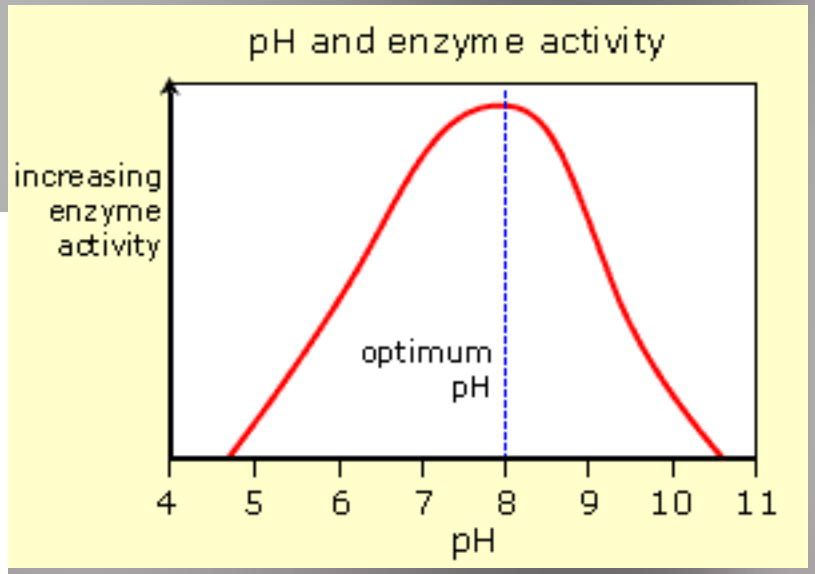


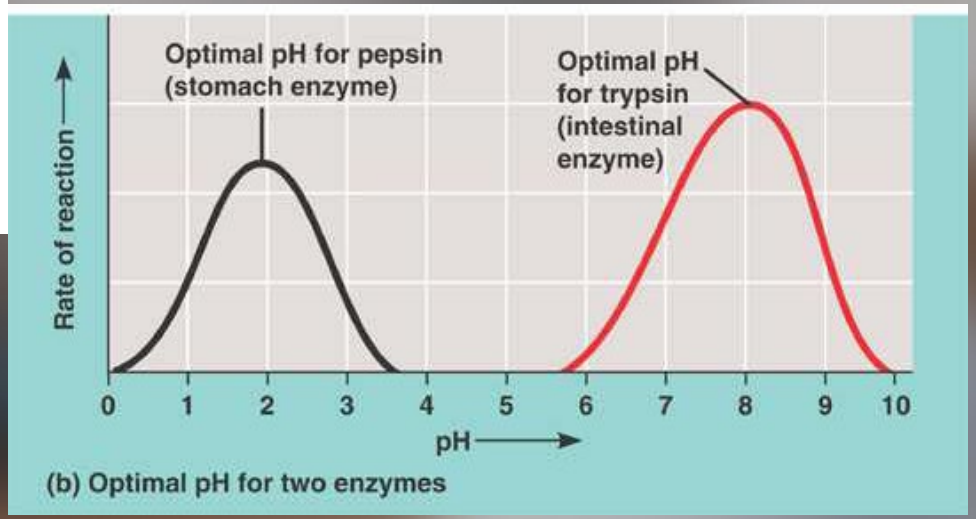


Enzyme Activity

- pH







Factors That Affect Enzymes

1. Temperature
2. pH
3. Competitive Inhibitors (fit into active sites)
4. Non-competitive Inhibitors (fit into other sites & change the shape of the enzyme)

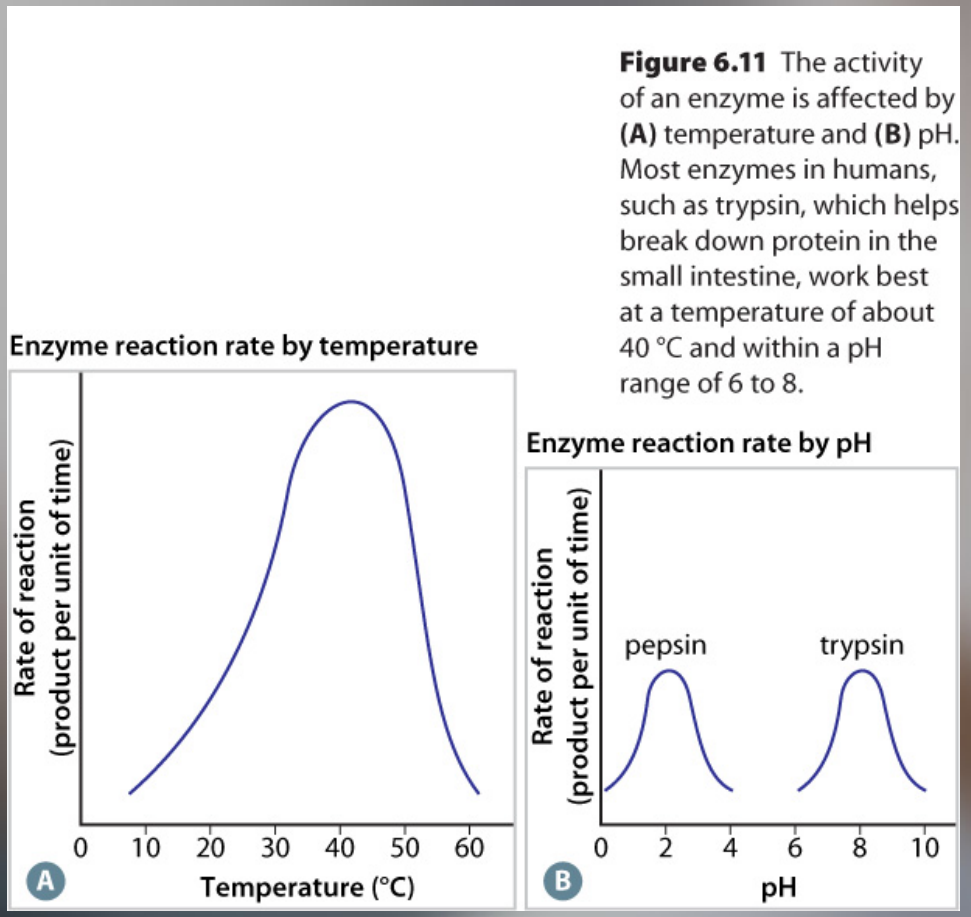
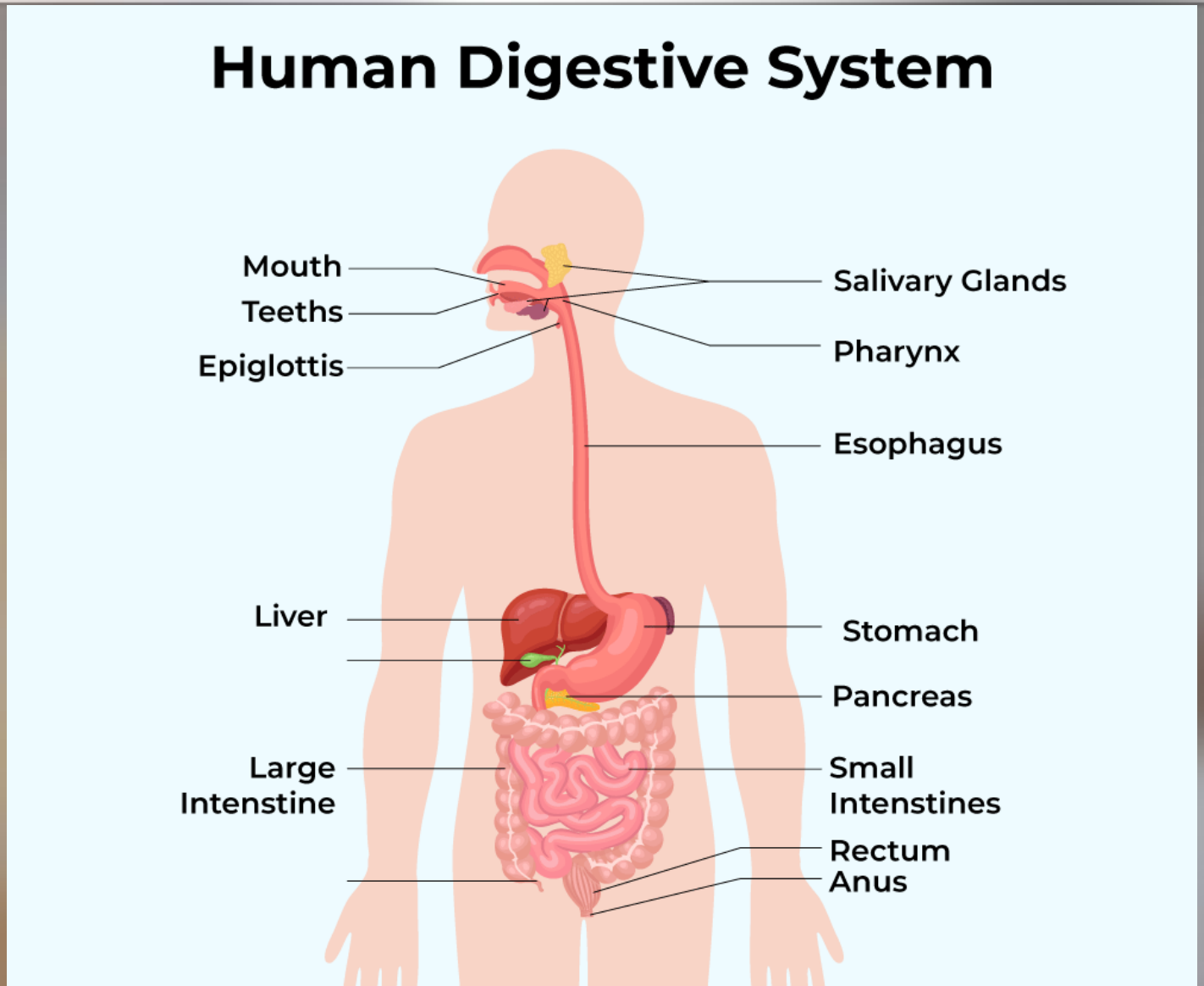


Figure 6.11 The activity of an enzyme is affected by **(A)** temperature and **(B)** pH. Most enzymes in humans, such as trypsin, which helps break down protein in the small intestine, work best at a temperature of about 40 °C and within a pH range of 6 to 8.

Review Videos

- Example
- Crash Course
- Stated Clearly Metabolism

6.2 – The Digestive System



Importance of Digestion

- We need to obtain our nutrients from the foods we eat
- However, the food that we eat contain the nutrients in forms that we may not be able to use directly
- Therefore, our digestive system breaks down the food into units that our cells can use

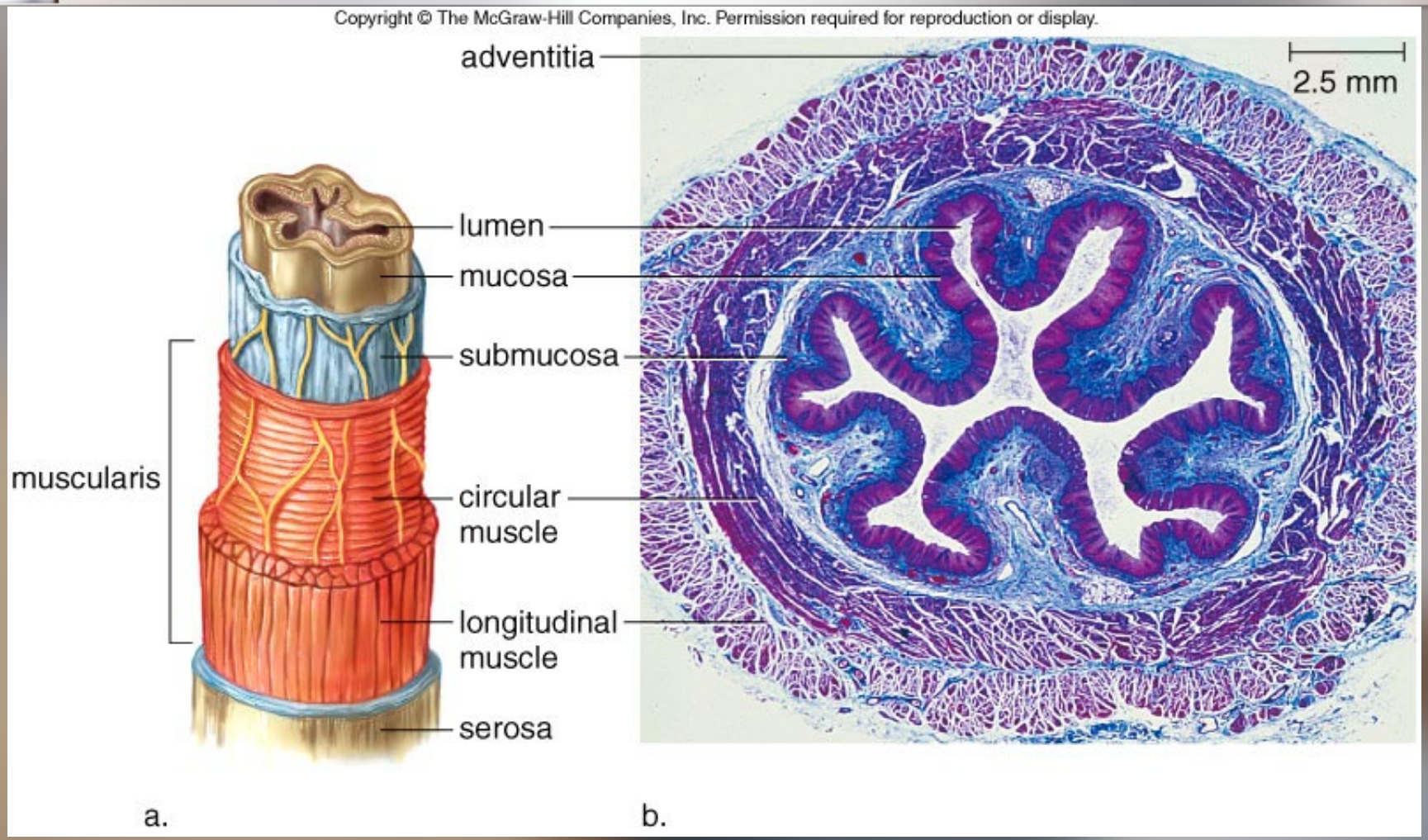
The Digestive Tract

- Overview of digestive tract
  - Begins at mouth and ends with the anus
  - Functions
    - Ingest food
    - Digestion
    - Absorption of nutrients
    - Elimination of wastes
  - 2 main processes:
    - Mechanical digestion
      - Breaks food into small pieces
        - Increases surface area for enzyme action
    - Chemical digestion
      - Enzymatic breakdown to small organic molecules

The Digestive Tract

- The wall of the digestive tract
  - Mucosa
    - Epithelium supported by connective tissue
    - Glandular epithelial cells produce enzymes
    - Goblet cells produce mucus
  - Submucosa
    - Loose connective tissue
    - Contains blood vessels
    - Lymph nodes
  - Muscularis - 2 layers of smooth muscle
    - Longitudinal – outer; runs along length of gut
    - Circular – inner; encircles tube

Wall of digestive tract



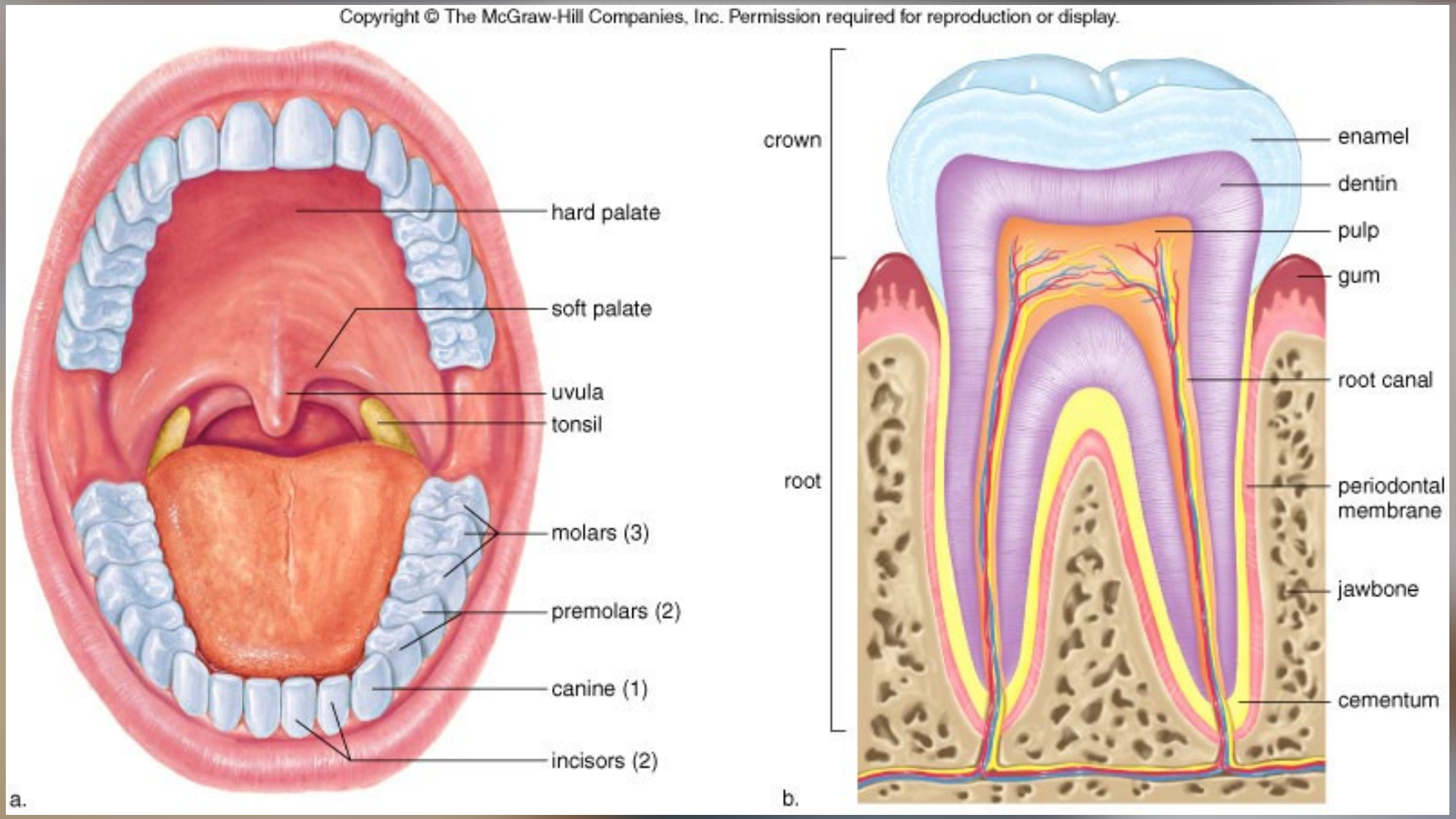
- Fig. 14.4

Serosa - epithelium tissue; lacking in esophagus

The Mouth

- **Physical digestion:** begins in the mouth where food is formed into a "bolus" through chewing and tongue motion
- **Chemical digestion:** Salivary amylase enzymes that begin the digestion of starches into disaccharides are secreted from the 3 salivary glands

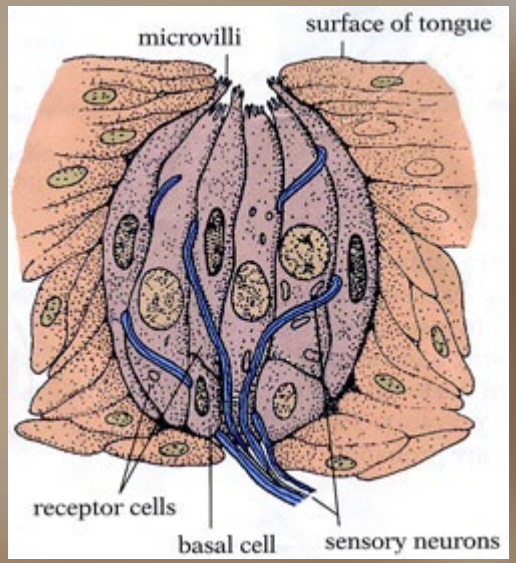
Adult Mouth and Teeth

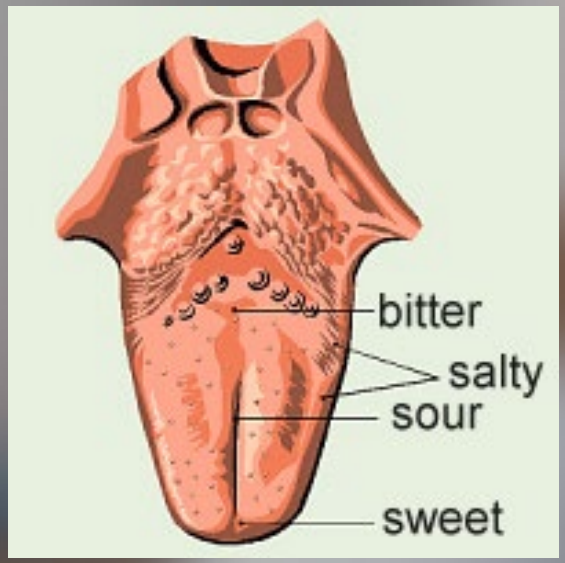


- Fig. 14.2

Taste

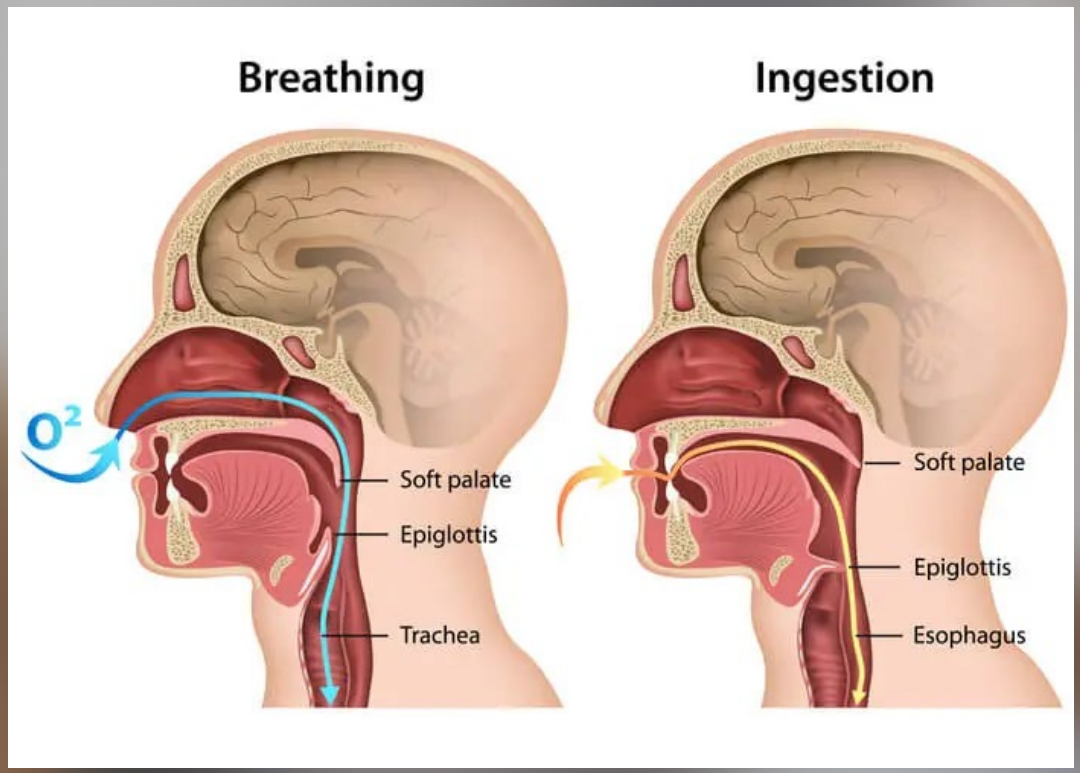
- Our tongue is covered with taste buds
- Taste buds are chemical receptors identify the taste of specific chemicals in our food





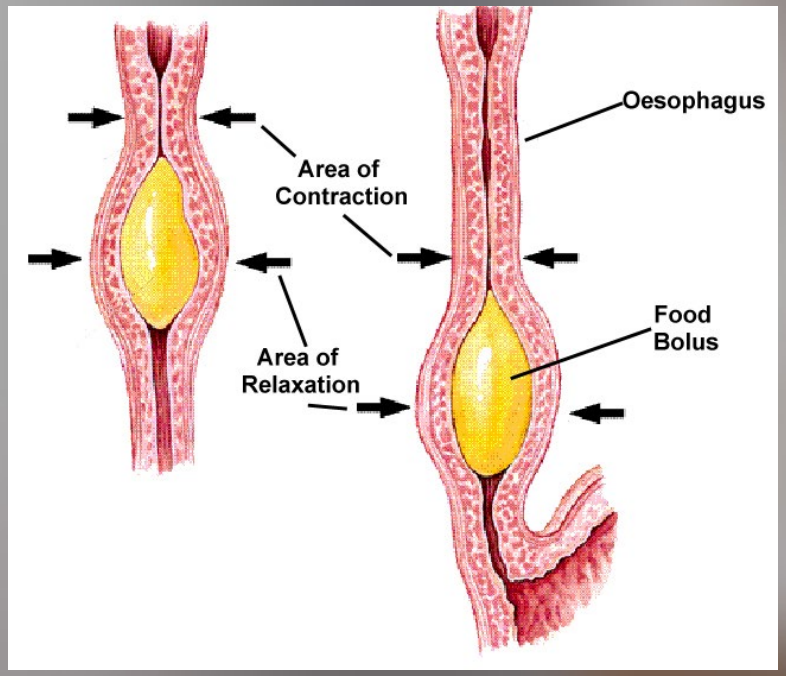
The Pharynx

- Pharynx – no digestion here
  - Space at the back of the throat
  - Receives air from nasal cavity and food from mouth
  - Swallowing reflex
    - Uvula closes off internal nostrils (nares)
    - Trachea moves upward under epiglottis
    - Airways close off
    - Bolus of food moves down esophagus

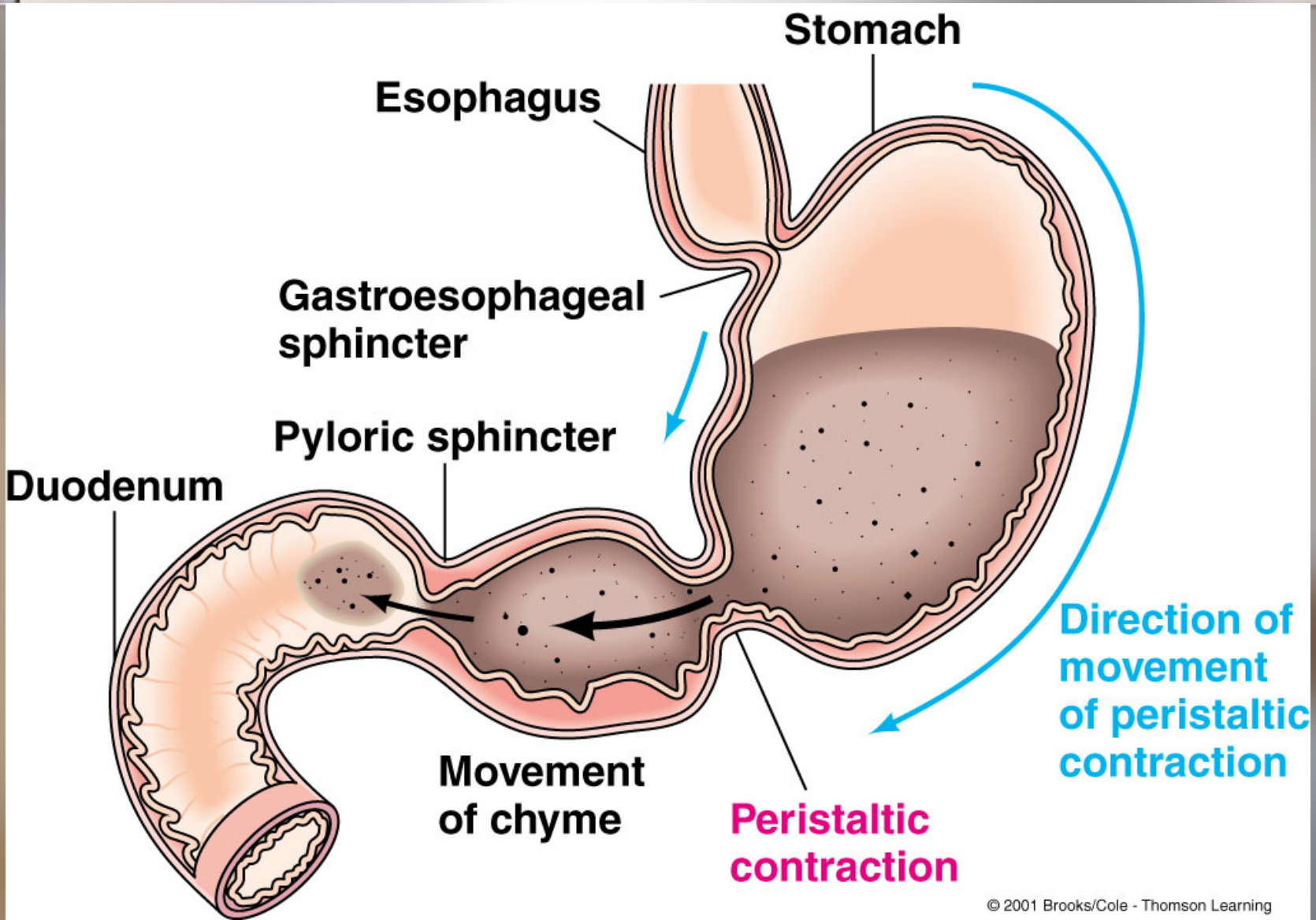


The Esophagus

- The tongue pushes the bolus of food into the esophagus
- The smooth muscle in the esophagus creates waves of muscle contractions, known as peristalsis, that push the food towards the stomach and enters through the esophageal sphincter

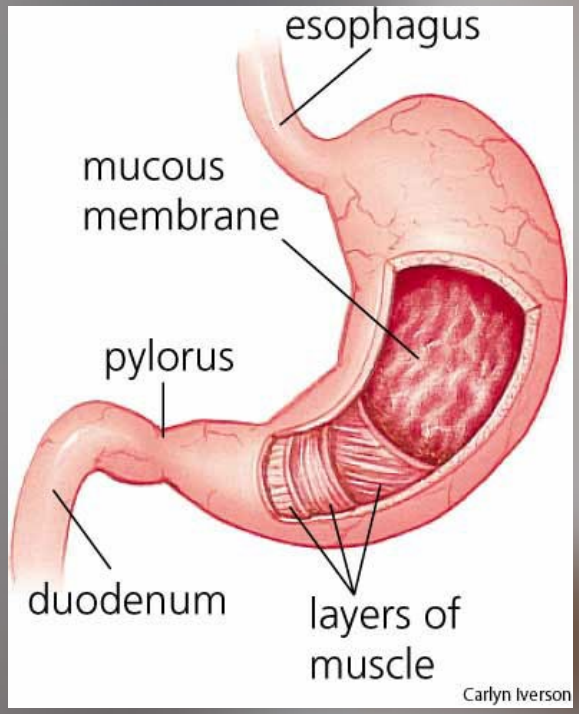


The Stomach

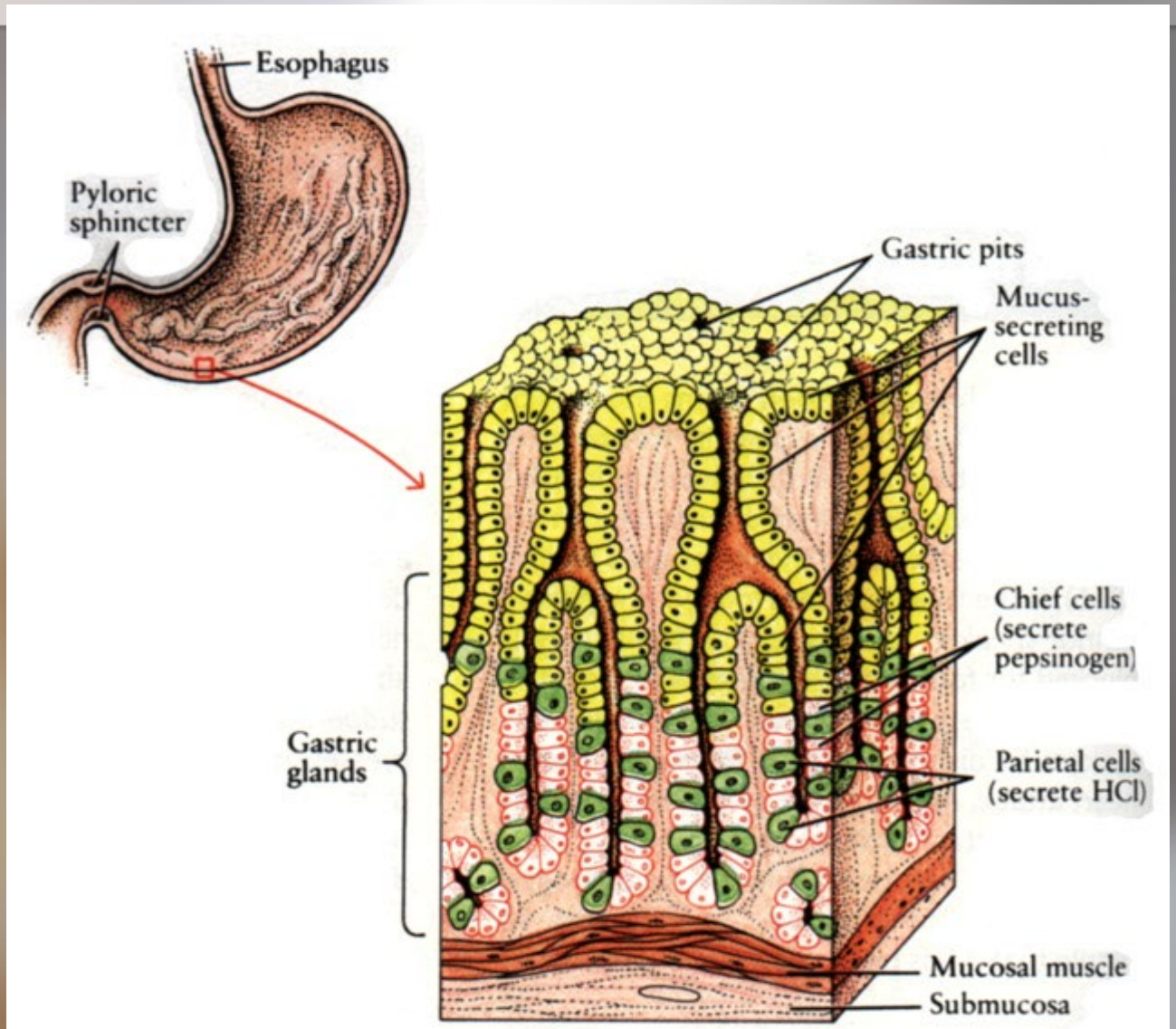

Stomach
Esophagus
Gastroesophageal sphincter
Pyloric sphincter
Duodenum
Direction of movement of peristaltic contraction
Movement of chyme
Peristaltic contraction
© 2001 Brooks/Cole - Thomson Learning

Stomach

- The stomach, a J-shaped organ, serves as a food storage site and the site of initial chemical protein digestion
- The stomach can hold about 1.5 L of food and contains about 500 mL of corrosive gastric juices
- Mucous secreted from cells lining the stomach protect the stomach wall from being digested by its contents
- Closed off on bottom by pyloric sphincter



Stomach

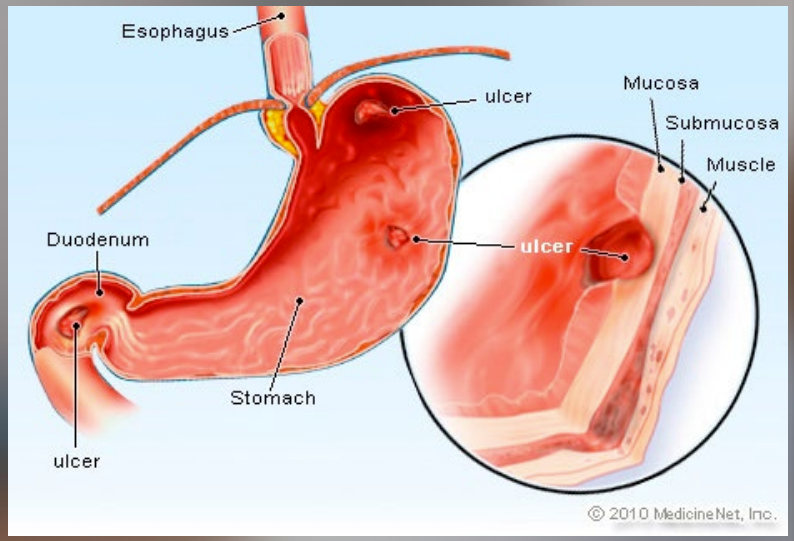

Esophagus
Pyloric sphincter
Gastric pits
Mucus-secreting cells
Chief cells (secrete pepsinogen)
Parietal cells (secrete HCl)
Gastric glands
Mucosal muscle
Submucosa

Stomach

- Gastric glands
  - Produce gastric juice
  - Chief cells
    - Secrete pepsinogen
      - Inactive form of protein enzyme
  - Parietal cells
    - Secretes HCl
      - Activates pepsinogen to pepsin
      - Decreases bacterial growth
  - Mucous cells
    - Produce thick protective mucus layer

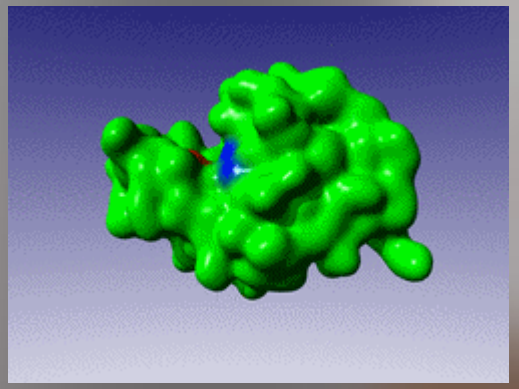
Stomach

- Disorders
  - Ulcers
    - Open sore in stomach wall
    - *Helicobacter pyloris* (*H. Pylori*)
    - Infection decreases mucus production
- Overall function of the stomach
  - Mechanical digestion
    - Mixing of food with gastric juice
    - Forms semi-liquid called chyme
  - Chemical digestion
    - Initiation of protein digestion
  - Storage of food



Protein Digestion

- Proteins and polypeptides are very large molecules
- An enzyme known as pepsin is produced by peptic cells in the stomach
- This enzyme works along with the hydrochloric acid in the stomach to break down the polypeptides into smaller units



Stomach (Con't)

- Another enzyme, rennin, is used to slow the movement of milk through the digestive system
- If the mucous lining of the stomach breaks down, an ulcer is formed
- This is dangerous because beneath the stomach lining there are many capillaries

Absorption in the Stomach

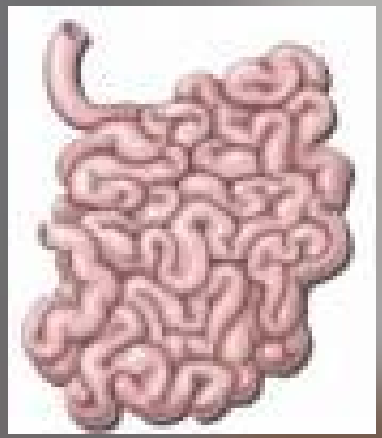
- Because very little of the thick liquid called *chyme* that is produced in the stomach is absorbed there
- The stomach absorbs small amounts of salts, water, anti-inflammatory medicines such as Aspirin, and alcohol

The Small Intestine

- Overview:
  - Approx. 2.5 cm wide and ~ 6-7 m long
  - Made of 3 parts:
    - Duodenum – first section of sm. intestine (25-30cm)
      – principal site of digestion (mostly chemical) of all nutrients
    - Jejunum – second section of sm. intestine (2-3m)
      – site of absorption of nutrients
    - Ileum – third section of sm. intestine (3-4 m)
      – finishes absorption
      – moves food waste toward lg. intestine

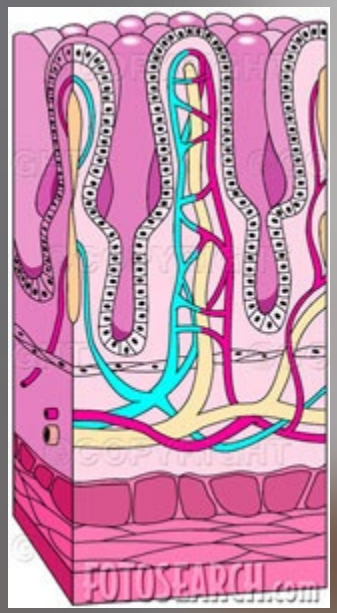
Duodenum

- The first 25-30 cm of the small intestine is known as the duodenum
- The presence of acids from the stomach here cause a release of bicarbonate ions (pH ~ 12) from the pancreas
  - These bicarbonate ions (basic) neutralize the acid (pH of gastric juices goes from 2.5 to 9.0)
- Receives bile from liver to emulsify fats (physics digestion)



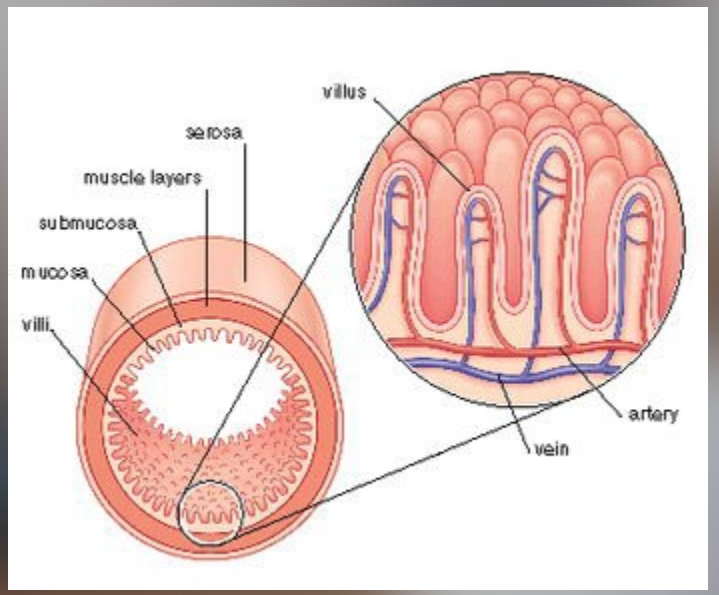
Jejunum / Ileum

- The stomach absorbs some water, vitamins and alcohol
- Most absorption takes place in jejunum and ileum
- The interior of the small intestine is lined with villi, which are small finger-like projections



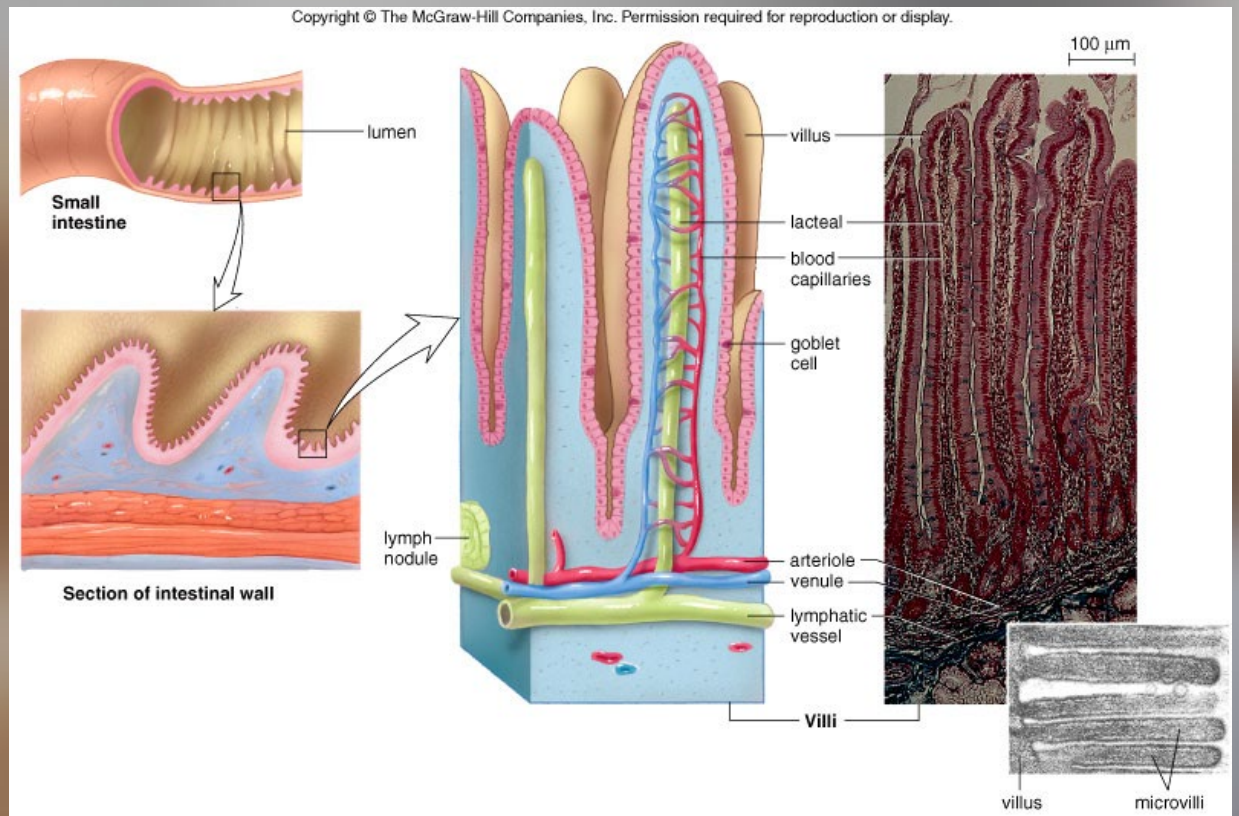
Jejunum / Ileum

- The villi increase the surface area of absorption
- The cell membranes of the lining of the small intestine also have folds, known as microvilli



Jejunum / Ileum

- The villi contains capillaries that absorb monosaccharides and amino acids
- The larger lipid molecules are absorbed by the lymph vessels



Digestion & Absorption of Macromolecules

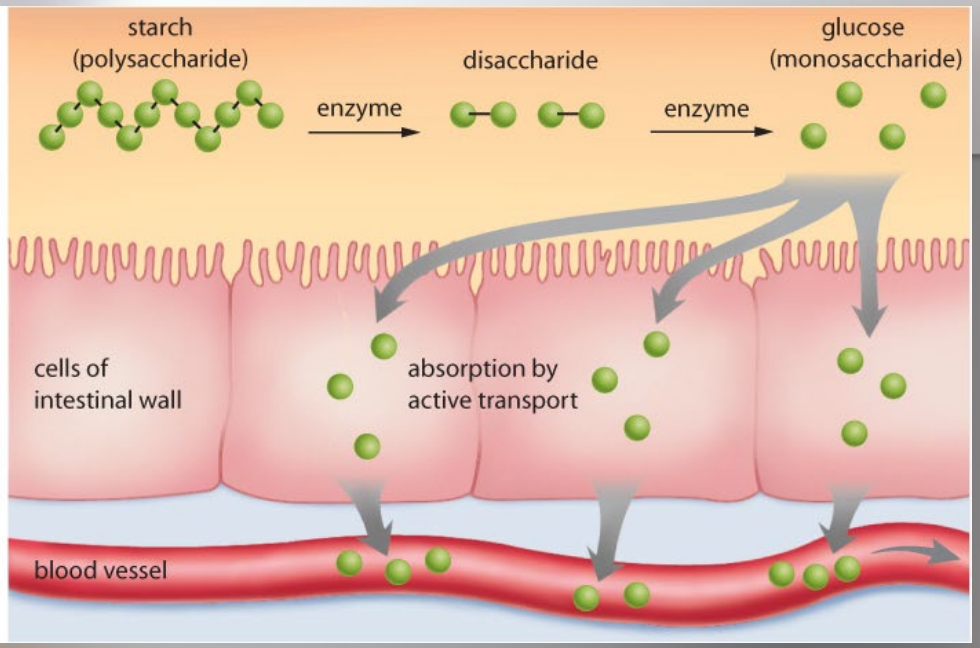


Figure 6.22 The monosaccharide glucose is actively transported into cells of the intestinal wall in order to move into the bloodstream.

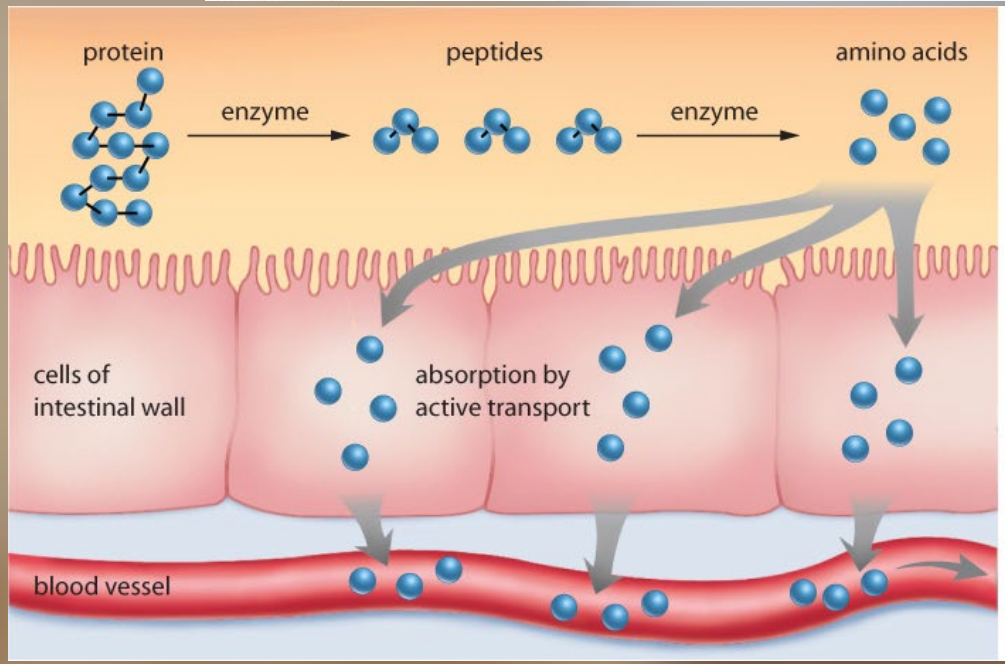
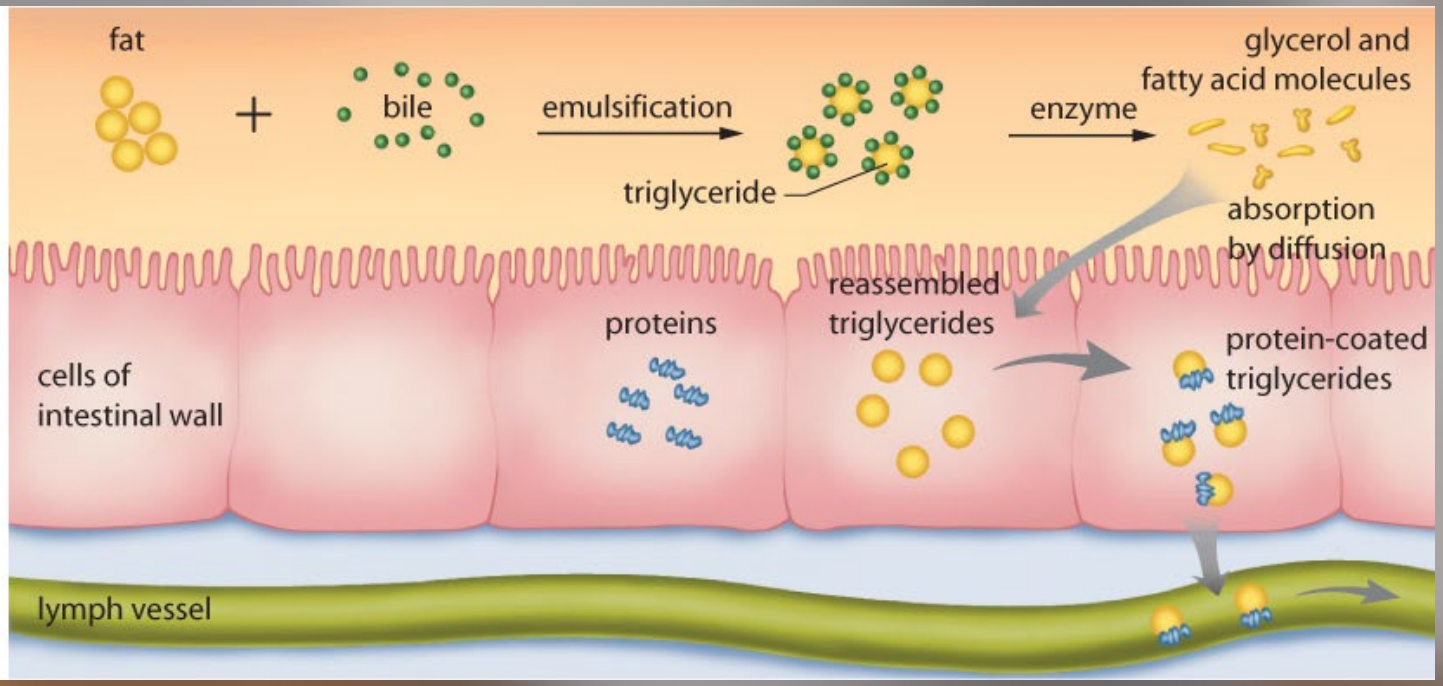


Figure 6.23 Amino acids are actively transported into the cells of the intestinal wall in order to move into the bloodstream.

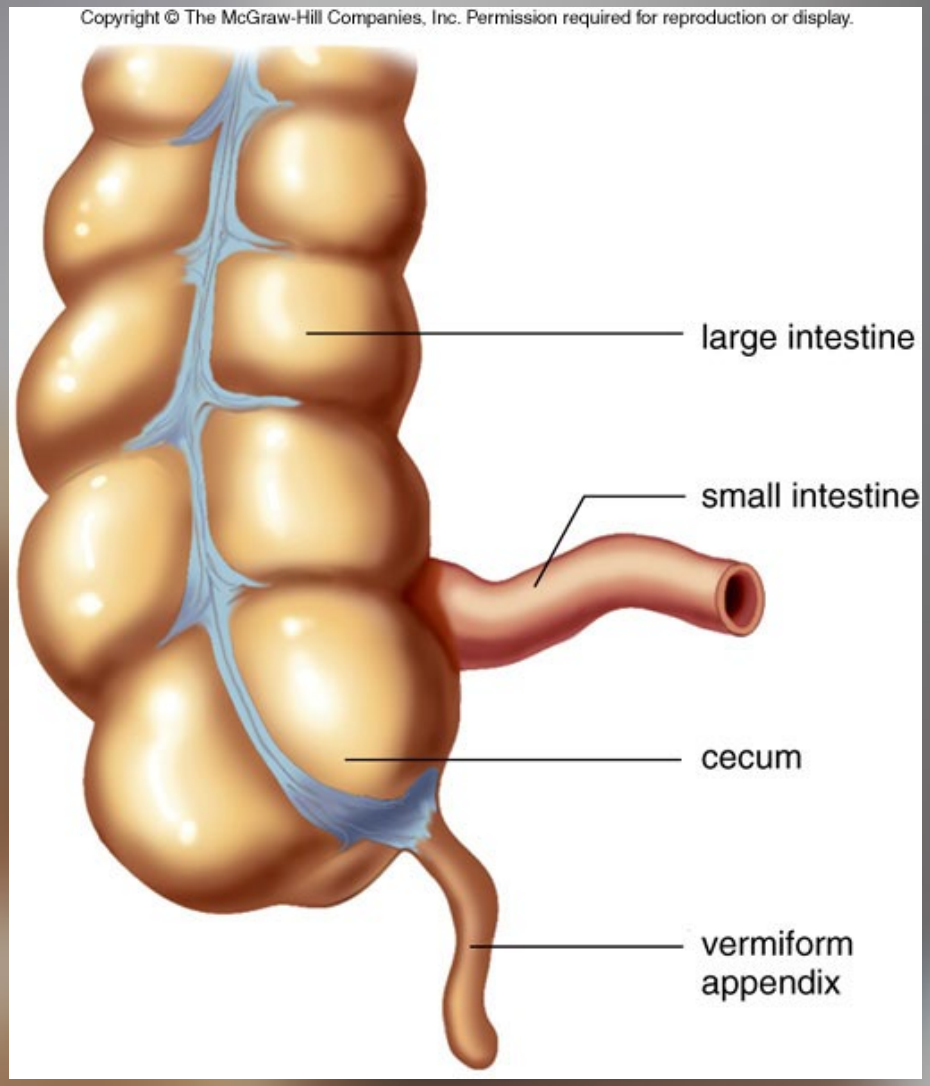
[Absorption Small Intestine Fuse School]

Figure 6.24
Glycerol and fatty acid molecules diffuse into the cells of the intestinal wall where they are resynthesized into fats, coated with proteins, and move into lymph vessels for eventual transport into the bloodstream.



Note: Food continues to move through the intestines (and all of the digestive tract), via peristalsis.

Junction of the Small and Large Intestine



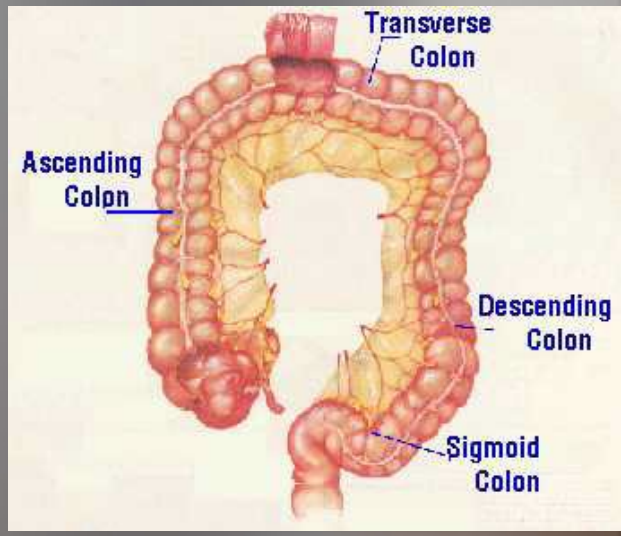
- Fig. 14.8

The Large Intestine / Colon

- The Large Intestine:
  - Cecum
    - Blind end of the large intestine
    - Appendix
      - Projection of cecum
      - May play a role in fighting infections
      - Rupture may cause peritonitis
  - Colon
    - Ascending, transverse, and descending portions
    - Absorption of water, salts
    - Terminates at the rectum

The Large Intestine / Colon

- Overview:
  - 8 cm wide and 1.5 m long
  - By the time food reaches the large intestine, it is completely digested – NO DIGESTION HERE
- Instead, the colon:
  - absorbs water
  - absorbs salt
  - contains bacteria that synthesize vitamins B & K
- The buildup of waste (with the help of cellulose / fiber) in the colon triggers nerve impulses that initiate a bowel movement

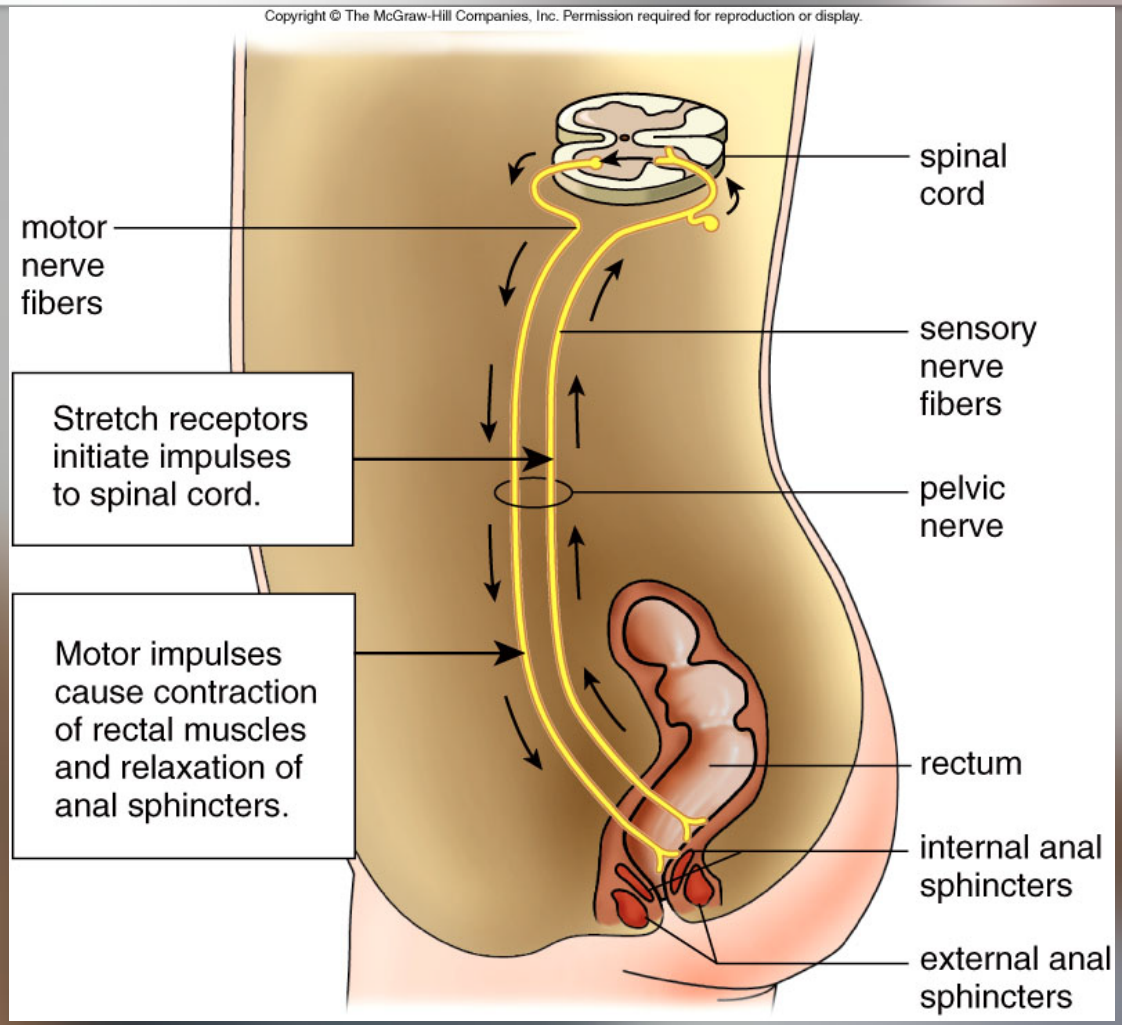


Defecation Reflex

- **Defecation reflex**
  - Feces forced into rectum by peristalsis
  - Stretching of walls initiates reflex
  - Rectal muscles contract
  - Anal sphincters relax
  - Defecation occurs

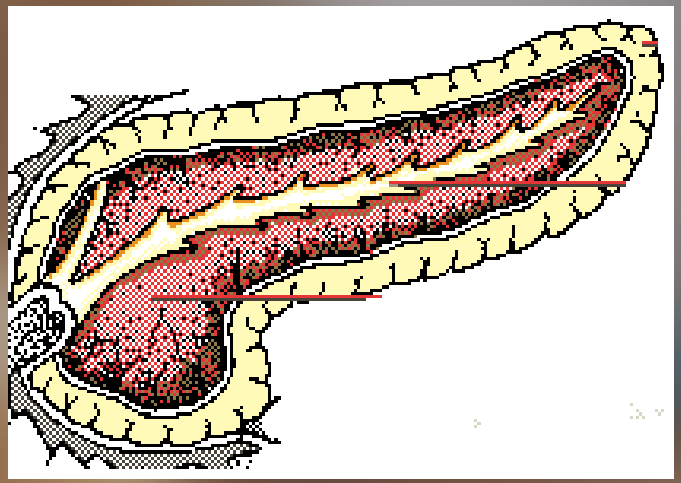
Gut Biome Science ABC
Vice Fecal Medicine 14:40 in
The large intestine 6:15
Your Poop…

Bacteria Kurzesagt



The Pancreas

- leaf shaped and sits behind the stomach
- secretes enzymes into small intestine for chemical digestion
- responsible for neutralization (in small intestine) of acidic chyme from the stomach



The Pancreas

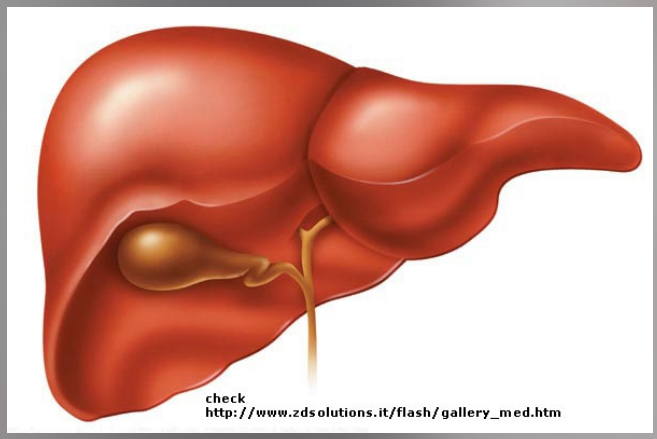
- The pancreas produces enzymes for digestion
- Trypsin and chymotrypsin act on partially digested proteins, breaking them down to shorter chains
- Other peptidases are also produced by the pancreas and small intestine
- Enzymes that break down nucleic acids are also produced by the pancreas and small intestine

More Pancreatic Enzymes

- The breakdown of carbohydrates is due to amylase (which breaks down starch), maltase (breaks down maltose) and lactase (which breaks down lactose)
- Lipase enzymes break down lipids into their fatty acids and glycerol

The Liver

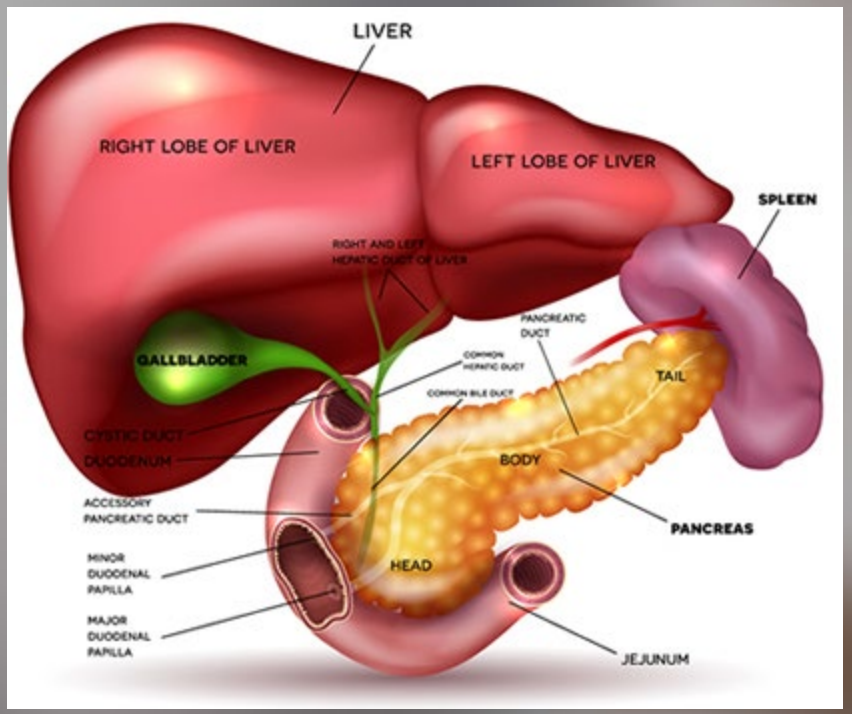
- Very large organ on right side
- Metabolizes (breaks down) and detoxifies wastes
- The liver produces bile salts (stored in gallbladder), which emulsify the fat (cause it to form tiny globules)
- These tiny globules of fat have a large surface area to volume ratio, and the lipase enzymes work on them more effectively
- Occasionally, a gallstone will form, which is crystallized bile salt



The liver also stores glycogen and vitamins!

The Gallbladder

- Attached behind the liver
- Stores bile (emulsifier of fats)
- Gallstones usually end up in the gallbladder and prevent the bile salts from aiding in fat digestion (and cause pain!)
- The pigments in bile are what give feces their characteristic brown color



Regulation of Digestion

1. Sensory and Nervous Stimuli:
   - Respond to taste, sight, smell, etc.
   - Activation of these senses stimulates saliva and gastric juice secretion (enzymes, HCl, HCO_3^-, etc.)
2. Mechanical Stimuli:
   - peristalsis stimulates gastric secretion
3. Hormonal Control

Regulation of Digestion

3. Hormonal Control:

A) GASTRIN

- produced when peptones (large proteins) are present in the stomach
- will increase gastric juice secretion
- will increase blood flow for digestion

B) SECRETIN

- produced when acidic chyme enters the first part of the small intestine (duodenum)
- stimulates bicarbonate ion secretion from the pancreas and inhibits HCl secretion in parietal cells
- regulates pH of duodenum

Regulation of Digestion

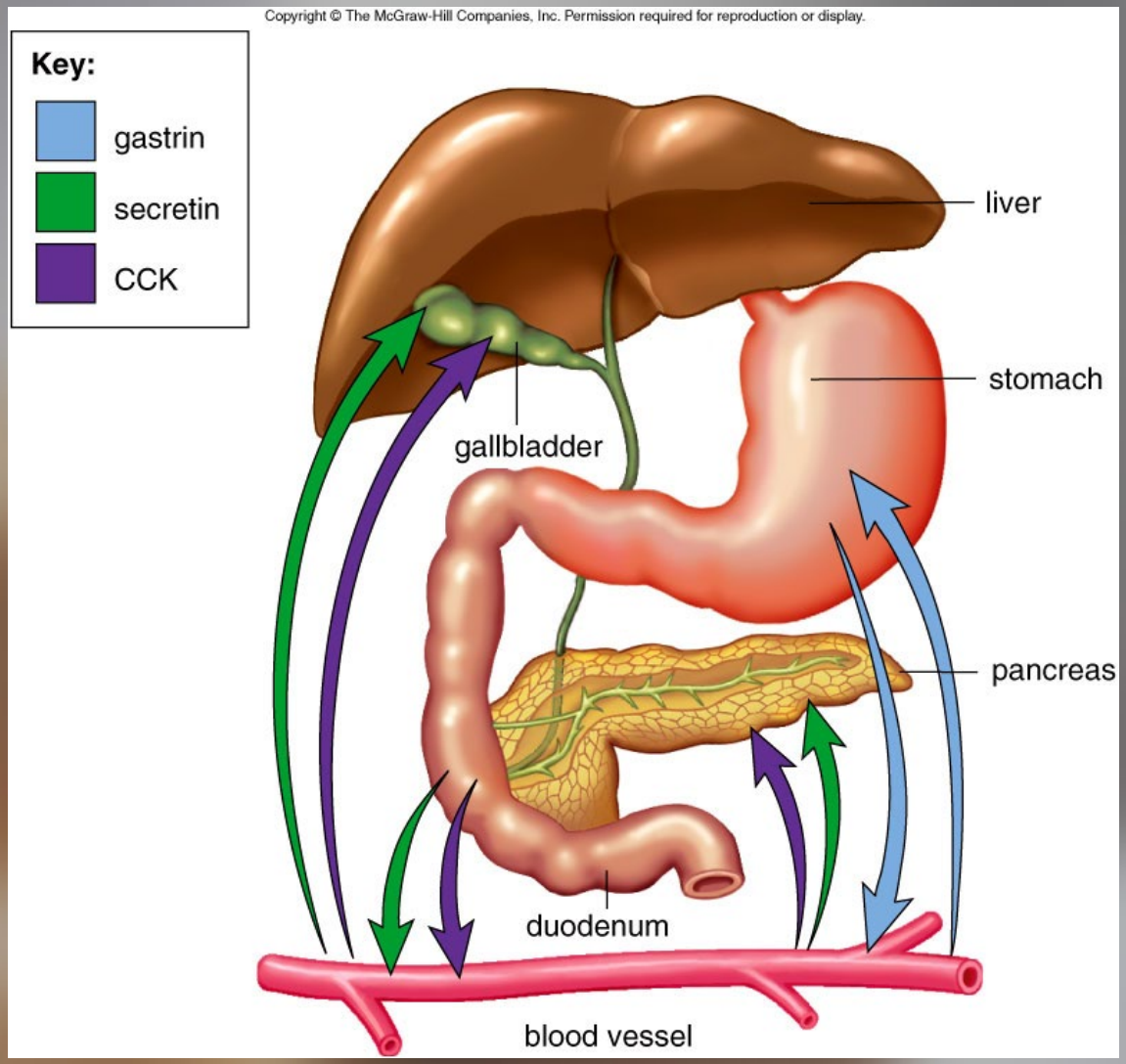
C) CHOLECYSTOKININ (CCK)

- produced when amino acids are in the small intestines
- increases bile secretion and pancreatic secretions
- decreases gastric emptying

Bill Nye Gastric hormones (30 min in)

Digestion hormones

Hormonal control of digestive gland secretions



- Fig. 14.7

The Digestive System is linked to many other systems:

- Nervous / Endocrine System (coordination, hormones, regulation)
- Circulatory System (O_2 and nutrient transport)
- Muscular and Skeletal System (provide structure, peristalsis)

Enzymatic Digestion

- enzymes are classified according to which molecules they break down
- carbohydrates, protein, and fats are broken down with the addition of enzymes as well as water (hydrolyzation)
- hydrolyzation is the opposite process of dehydrolysis synthesis / dehydration synthesis (process that makes carbs, protein, fats)

Enzymatic Digestion

1. Mouth
   - salivary glands secrete saliva which contains amylase (which function to break down carbohydrates)

Starch (complex carbs) —salivary amylase→ small chain carbs (dextrins)

Enzymatic Digestion

2. Stomach
   - site of initial protein digestion (chemical)
     i. Pepsinogen:
        - inactive protein-digesting enzyme secreted by peptic cells
        - moves through mucous lining of stomach until activated by HCl converting it into **pepsin**
        - pepsin breaks proteins into chains of amino acids called peptones

Pepsinogen $\xrightarrow{HCl}$ Pepsin $\xrightarrow{protein}$ Peptones

Enzymatic Digestion

2. Stomach (cont.)

ii. Rennin:

- coagulates protein in milk to slow its movement through the digestive tract
- this allows more time to digest and absorb nutrients

iii. Hydrochloric Acid:

- released from parietal cells
- functions to activate pepsinogen and convert it to pepsin
- kills microbes (helps in preventing internal infections)

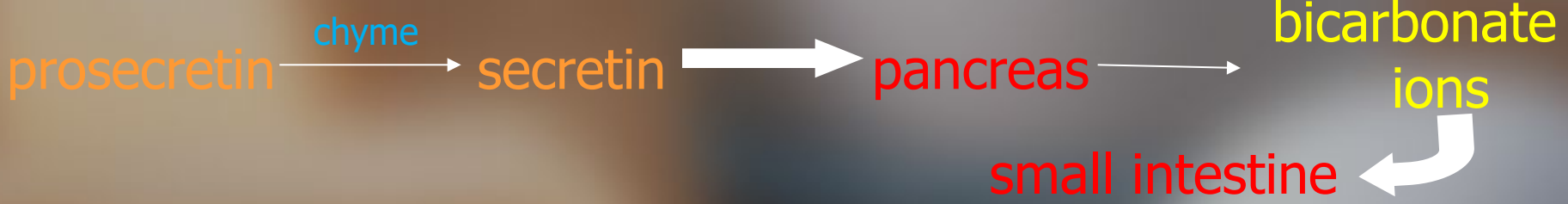
iv. Mucous:

- released from mucous cells to protect the stomach wall from HCl

Enzymatic Digestion

3. Small Intestines and Pancreas

- acidic **chyme** enters the small intestines through the pyloric sphincter, triggering a chemical **prosecretin** to be converted to **secretin**
- secretin is then absorbed into the bloodstream and carried to the pancreas
- once in the pancreas, secretin triggers the release of **bicarbonate ions** (which neutralize HCl and chyme by raising pH from 2 to ~9)



Enzymatic Digestion

3. Small Intestines and Pancreas (cont.)

- pancreatic and small intestine secretions contain about 28 different digestive enzymes; some of these include:
  - i. **Trypsinogen**:
    - **inactive protein-digesting enzyme**
    - **released from pancreas, travels to sm. intestine where it is converted into trypsin by enterokinase (another enzyme)**
    - **trypsin converts peptones (small chains of amino acids) into even shorter peptone chains**

trypsinogen —enterokinase→ trypsin → peptones

Enzymatic Digestion

3. Small Intestines and Pancreas (cont.)

ii. Erepsin:

- **group of enzymes from the small intestine and pancreas**
- **functions to complete protein digestion**

peptones $\xrightarrow{\text{erepsins}}$ amino acids

iii. Amylase enzymes:

- **from the pancreas**

iv. Disaccharases:

- **from the sm. intestine**

****amylase and disaccharase work together to complete digestion of carbohydrates**

Enzymatic Digestion

3. Small Intestines and Pancreas (cont.)

v. Lactase:

- **from the small intestine**

lactose $\xrightarrow{\text{lactase}}$ monosaccharides (absorbed)

- **low lactase results in lactose intolerance; cannot digest lactose (milk products) and can cause diarrhea**

vi. Lipases:

- **from the pancreas (digest lipids)**

  A) Pancreatic lipase – triglycerides broken down into glycerol and 3 fatty acids

  B) Cholesterol lipase – breaks down steroid cholesterol (e.g. testosterone)

  C) Phospholipases – break down phospholipids into glycerol, fatty acids, and phosphates

Enzymatic Digestion

4. Liver

- produces bile salts

bile salts $\xrightarrow{H_2O}$ bile

- (emulsify fats – physical digestion)
- this process increases surface area to speed up chemical digestion
- liver also stores glycogen and vitamins A, B_{12}, and D
- detoxifies (metabolizes) harmful chemicals into substances that can be removed by the kidneys in urine
- Jaundice = ? (complete in your notes)
- Cirrhosis = ? (complete in your notes)

6.3 – Health and the Digestive System

- Many disorders of the digestive system will affect the health of the whole body
- These disorders may be physiological in nature, or they may also be psychological

Inflammatory Bowel Disease

- This is a general class of disorders that result in an inflammation of the GI tract
- Some types of these diseases may cause ulcers to appear, and the presence of blood in the stool
- In some cases, surgery may be required to remove diseased portions of the digestive tract

Accessory Organ Disorders

- Hepatitis: Inflammation of the liver
- Cirrhosis: A chronic liver disease where healthy liver tissue is replaced by fat and scar tissue
- Gallstones: Crystals of cholesterol and minerals build up in the gall bladder or duct, preventing the flow of bile
- Jaundice: occurs when RBC's are broken down and a substance called bilirubin is produced, turning skin / eyes yellow

Psychological Disorders

- Anorexia nervosa
- Bulimia
- Obesity

The End