Biology 20: Chapter 8
Nutrients and the Digestive System

Nelson Pages 240 - 279
8.1 Essential Nutrients

- Proteins, carbohydrates, lipids (fats), vitamins, minerals, and nucleic acids

- 3 major nutrient categories:
  1. Carbohydrates
  2. Lipids
  3. Proteins

Nutrition with Tim and Moby
http://www.brainpop.com/health/nutrition/nutrition/
# Organic and Inorganic Nutrients

<table>
<thead>
<tr>
<th>Organic</th>
<th>Inorganic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>Minerals</td>
</tr>
<tr>
<td>Lipids (fats)</td>
<td>Water</td>
</tr>
<tr>
<td>Proteins</td>
<td></td>
</tr>
<tr>
<td>Vitamins</td>
<td></td>
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</tbody>
</table>

**Macronutrients:** needed in large quantities by the body
1. Carbohydrates

- Energy nutrients
- Plants synthesize carbohydrates
  - Photosynthesis

\[6\text{H}_2\text{O} + 6\text{CO}_2 \xrightarrow{\text{light}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2\]
Carbohydrate Chemistry

- The most important energy source for the body; produced by plants.
- Exist as single sugars or chains of many sugar units.
- Classified by # of sugars they contain.
- Single sugars contain 1 carbon: 2 hydrogen: 1 oxygen.
  - How many carbons does a triose sugar have?
  - A hexose sugar?
- Sugars are often identified by the “-ose” suffix
a.) **Monosaccharides**

- Are *simple sugars* (single sugar units).
- Contain 3-6 carbons.
  - Glucose, galactose, fructose
Isomers – same chemical formula but different arrangement of atoms

- Formula: $C_6H_{12}O_6$
- Rotate between straight chain or ring structure

Many monosaccharides differ only in the spatial arrangement of atoms—that is, they are isomers. For example, glucose, galactose, and mannose have the same formula ($C_6H_{12}O_6$) but differ in the arrangement of groups around one or two carbon atoms.

These small differences make only minor changes in the chemical properties of the sugars. But they are recognized by enzymes and other proteins and therefore can have important biological effects.
b. Disaccharides

- Two monosaccharides form a **disaccharide**
  - **Maltose** = 2 glucose units
  - **Sucrose** = 1 glucose and 1 fructose.
  - **Lactose (milk sugar)** - 1 glucose and 1 galactose.
Dehydrolysis Synthesis

- **Dehydrolysis synthesis** (dehydration synthesis) – water molecule is extracted from 2 monosaccharide sugar molecules, bonds 2 sugars together. Requires energy. (opposite process is hydrolysis).
c.) **Polysaccharides**

- Are carbohydrates formed by **more than 2** monosaccharides.
- Formed by **Dehydrolysis synthesis**.
  - **Starch**
    - Many glucose subunits
    - A flat structure
  - How plants store energy; made in leaves and stored in roots.
Glycogen

- Animals store carbohydrates in the form of glycogen (a polysaccharide)
  - Stored in liver and muscles
    - When glucose concentration in blood ↓, glycogen is converted back into monosaccharide glucose units
      - For energy
Cellulose

- Contains many glucose; not a coiled structure. Exists in flat sheets.

- Cellulose
  - Cannot be digested by humans "fiber/roughage"
  - Holds water in large intestine, thus, helps eliminate wastes
Cows

- Ruminant animals (e.g., cows) cannot digest plant cell walls
- 1st stomach houses bacteria to help digest cellulose
- Cow then digests food, chews it again, and then diverts it to 2nd second stomach
Importance of Carbohydrates

- food energy for cells, used in cellular respiration
- disaccharides and polysaccharides must be broken down into monosaccharides before they can be used in cellular respiration
- excess carbohydrates are stored as glycogen or fat
- 1-2% of cell mass is carbohydrate
Testing for Carbohydrates

**Benedicts test:** Blue (copper) reagent turns orange -- -- brick red when exposed to heat if reducing sugars (carbohydrates) are present.

**Starch test:** *Iodine* (red/brown) turns black in the presence of starch.
Tasks to be completed:

- Complete the practice problems 1-10 in section 8.1
- Complete the chapter 8.1 Review Questions 1-6 on page 253
2. **Lipids**

- Vary in chemical composition
- Includes fats, oils, waxes, steroids, phospholipids...

- **Fats and oils are triglycerides;** at room temperature, fats are solid(s), and oils are liquid (l).

- Formed by dehydration synthesis.
a. Composition of Triglycerides

- Formed by combining 1 glycerol (3C alcohol) with 3 fatty acids.

  **Unsaturated**: double bonds, more easily broken down (oils), from plant sources, reduce plaque build-up but high poly-unsaturated products may cause cancer (breast and colon).

  **Saturated**: no double bonds, not easily broken down (fats), from animal sources, solids at room temperature, fats accumulate on arteries.
Saturated and Unsaturated fats

1 double bond = monounsaturated (Olive oil and canola oil)
multiple double bonds = polyunsaturated
<table>
<thead>
<tr>
<th>Saturated Fats</th>
<th>Monounsaturated Fats</th>
<th>Polyunsaturated Fats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef</td>
<td>Milk</td>
<td>Soybean</td>
</tr>
<tr>
<td>Pork</td>
<td>Butter</td>
<td>Safflower</td>
</tr>
<tr>
<td>Lamb</td>
<td>Cheese</td>
<td>Sunflower</td>
</tr>
<tr>
<td>Poultry</td>
<td>Yogurt</td>
<td>Cottonseed</td>
</tr>
<tr>
<td>Coconut oil</td>
<td></td>
<td>Corn</td>
</tr>
</tbody>
</table>

Linoleic Acid (Omega-6)

- Soybean
- Safflower
- Sunflower
- Corn
- Wheat germ

Linolenic Acid (Omega-3)

- Flaxseed
- Soybean
- Rapeseed (canola)
- Pumpkin
- Walnut

Sesame
Peanut
Others
b. Characteristics of lipids

- **Insoluble in water** and are hydrophobic.
- Lipids have **twice the Energy** as carbohydrates or proteins.
- Polar end (negative end; replaces a fatty acid) is soluble in water.
- Non-polar end is insoluble; Suited for cell membranes.
c. **Waxes**

- Long, stable molecules are insoluble in water
- Waterproof coating for plant leaves and animal fur/feathers
d. **Liposomes**

- What are liposomes?
- How are they used to fight cancer?
- How are they used in gene therapy?


e) Functions of lipids

- Subcutaneous fat (under the skin) used for body temperature control.
- **Energy storage.**
- Protective coatings for organisms.
- Cell-surface recognition.
- Products include soaps, detergents, hormones, pheromones.

Cholesterol: **LDL** (low density lipoproteins- “bad”) and **HDL** (high Density lipoproteins- “good”). HDL break down LDL and carry it to the liver.

Absorption of vitamins (A, D, E, K).
Testing for Lipids

- Translucence test.
- Sudan 4 dye test.
Fats and Diet:

- Saturated Fats are stable, thus stay in the body longer.
- Saturated Fats increase the risk of various types of cancer: breast, colon, prostate.
- Saturated Fats contribute to obesity, which is linked to high blood pressure, and adult diabetes.
So What Should I Eat?

The current scientific thinking on fat consumption goes something like this:

- Limit fat intake to about **30 percent** of the total calories you consume.
- Do not try to cut fat intake altogether, because you do need the essential fatty acids.
- A gram of fat has nine calories, meaning that if you consume 2,000 calories in a day your total fat intake should hover around \((2000 \times 30\% / 9\text{\,calories/gram})\) **67 grams of fat**.
- When consuming fat, try to focus on **mono-unsaturated fats** like olive oil and canola oil, or on essential fatty acids.
- When consuming essential fatty acids, try to balance your intake of **omega-6 and omega-3** fatty acids. Do that by consuming tuna/salmon/trout or omega-3 oils like flax seed oil.
Assignments to be completed:

- Read Section 8.1 in Text - pages 242-253
- Complete the practice problems 1-10 in section 8.1
- Complete the chapter 8.1 Review Questions 1-6 on page 253
- Complete the Fats and Health Case Study in the textbook – Page 248 - 249
- Complete the “How Fats work” readings and questions in workbook
- Complete the “Cholesterol: new Advice” readings and questions in workbook
3. Proteins

- Large macromolecules (polymers) made up of hundreds of amino acids chemically bonded together.

- Sequencing on amino acids is regulated by genes located on your chromosomes.

- There are 20 different amino acids found in proteins; 8 are essential and must be supplied by your diet.
Proteins

- Essential Amino Acids occur primarily in animal sources.

Proteins are essential for building, maintaining and repairing body tissues.

- Too much protein = **Kidney Failure** (clogs kidney with wastes).

- Too little = **kwashiorkor** (bellies swell because of water retention).
a. Formation of Proteins

- When proteins are made a **water molecule is released**, the covalent bond between the acid and amino group is a peptide bond. This occurs in the ribosome.

- **Amino acids are joined using peptide bonds**; the order and type of amino acid determines the type of protein.

Dehydration synthesis of proteins
b. Classification of Proteins

- **Dipeptide** = two amino acids
- **Polypeptide** = a chain of 3 or more amino acids
- **Protein** = larger amino acid chain
Protein Organization

There are 4 levels of organization:

- Primary
- Secondary
- Tertiary
- Quaternary
1. Primary Proteins
- amino acids (AA’s) organized in **linear arrangement**.
- Determined by DNA in the nucleus of the cell.
- A single cell in the order changes the function of the protein (e.g. sickle cell anemia).

2. Secondary Proteins
- AA’s are arranged in **coils**.
- Hydrogen bonds between negative and positive end pull together into spiral.
3. Tertiary Proteins

- occur because of R-group interactions.

4. Quaternary Proteins

- interactions between more than 1 protein.

**Hemoglobin molecules** = 4 globin molecules bonded together.
c. Functions of Proteins

There are 7 functions of proteins in the body.

1. **Enzymes**: pepsin (in stomach)

2. **Storage of amino acids**: albumins (in blood).

3. **Transport**: hemoglobin.

4. **Movement**: muscle fiber proteins.

5. **Structural**: collagen

6. **Hormones**: insulin

7. **Protective**: antibodies.
Denaturation and coagulation

- Exposing proteins to excess heat, radiation, or a change in pH can alter bonds and shape of protein

- **Denaturation**
  - *temporary* change in shape

- **Coagulation**
  - *Permanent* change in protein shape
  - Bonds holding a protein molecule are disrupted
    - Example: frying an egg.
e. Testing for Proteins

- **Biuret test**: blue reagent turns violet when peptide bonds are present.
Nucleic Acids

- found in DNA and RNA.
- Contain Nitrogen and are processed by liver into uric acid (urea).
4. Vitamins

- **Organic molecules** needed in small quantities.

- needed to create **coenzymes** for biochemical reactions.

**Important vitamins:**

- **Vitamin A**: “beauty” vitamin (skin/hair/nails) and visual pigment (at night).

- **Vitamin B**: energy metabolism.

- **Vitamin C**: bones/teeth, immune system, Connective tissue.

- **Vitamin D**: calcium absorption (bones/teeth).
5. Minerals

- **Inorganic elements** needed in small amounts.

- **Common minerals:**
  - **Calcium:** growth of bones/teeth (rickets).
  - **Iron:** blood hemoglobin (Anemia)
  - **Iodine:** produce thyroxin (goiter).
  - **Potassium/sodium:** nerve impulse (nerve disorders).
Assignments to be completed:

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8.2 Enzymes – Textbook Reference - Pages 254 - 258

Enzymes, Energy of Activation, Lock and Key Model vs. Induced Fit model:
http://www.sumanasinc.com/webcontent/animations/content/enzymes/enzymes.html
Enzymes and Chemical Reactions

- Living systems depend on chemical reactions
- All chemical reactions in body called metabolism
- The rate of these reactions needs to be controlled
- Almost every reaction requires an enzyme

ENZYMES: functional 3-D proteins that act as biological catalysts

- Enzyme names often end with -ase and are named for their substrates
Catalysts:

- a substance that increases the rate of a chemical reaction without...
  - becoming part of the product
  - being changed itself

- each enzyme usually controls just one reaction; that is they are reaction-specific
  - ie. enzymes that break down cornstarch cannot breakdown beef protein

Example of enzyme function:

- digestion of egg whites (protein) **outside body**: 20 hours with strong acid at 100°C
- **inside body**: 2 hours with enzymes at body temp (37.5°C)
1. **Energy of Activation**

- a reaction will usually not proceed unless some energy is put into it

  - the energy that must be supplied to cause a rxn is called the **energy of activation**

  - enzymes **lower** the necessary **energy of activation**
Energy of Activation (Page 254)
2. The Lock and Key Model (See Figure 2 – Page 254)

- describes how enzymes act as keys to “lock” or “unlock” substrates
- **SUBSTRATE(S):** reactant(s) in an enzymatic rxn
- **ACTIVE SITE:** region on enzyme where substrate(s) attach
ENZYME ACTIVITY - A LOCK AND KEY DIAGRAM
3. Induced- Fit Model

- replaces lock and key model of enzymes
- the enzyme **changes shape** to improve fit between active site and substrate which in turn **increase rates of chemical reaction** (analogy: handshake)

check out:

- [http://programs.northlandcollege.edu/biology/Biology111/animations/enzyme.swf](http://programs.northlandcollege.edu/biology/Biology111/animations/enzyme.swf)
4. FACTORS AFFECTING ENZYME ACTIVITY

- normally reactions are rapid
- Eg. $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} \text{ and } \text{O}_2$
- 600,000 times a sec!!
- rate of enzyme action is affected by various factors:

  a) **Temperature**

  - increase temp; increase activity, to a point
  - activity declines rapidly after a certain temperature
  - enzyme is **denatured** at high temps
  - active site can no longer bind substrate molecules
b) pH (see figure 3 - P255)

- enzyme has an **optimum pH** (works best at this pH)
- change in acidity or basicity can alter enzyme shape
- active site can no longer bind substrate molecules
- [http://www.kscience.co.uk/animations/model.swf](http://www.kscience.co.uk/animations/model.swf)
c) Substrate Concentration (Figure 4- P255)

- the greater the number of substrate molecules, the greater the rate of reaction, up to a point

D) END PRODUCT CONCENTRATION

- as enzymes work, they produce an end product
- some are poisonous to enzymes in high concentrations
- enzyme activity will then decrease to avoid this build up (feedback inhibition) – see figure 7 – page 257

- [http://programs.northlandcollege.edu/biology/Biology11_11/animations/enzyme.swf](http://programs.northlandcollege.edu/biology/Biology11_11/animations/enzyme.swf)
Textbook figure 7 - p257
E) COMPETITIVE AND NON-COMPETITIVE INHIBITORS

- **Competitive Inhibitors** (figure 6 – Page 256)
  - molecule so close to enzyme’s substrate that it competes for the active site
  - inhibitor binds to enzyme and will not allow product to be produced

- **Non-Competitive Inhibitors**
  - a chemical binds to a regulatory site causing the active site to change shape.
  - [http://programs.northlandcollege.edu/biology/Biology111/animations/enzyme.swf](http://programs.northlandcollege.edu/biology/Biology111/animations/enzyme.swf)
  - An enzyme that changes shape due to a chemical binding to the regulatory site is known as allostERIC activity
Competitive Inhibition
f) **Coenzymes**
- molecule that assists an enzyme to complete a reaction (organic) eg: vitamins

g) **Cofactors**
- inorganic enzyme helpers; eg: minerals: $\text{Mg}^{2+}$, $\text{K}^+$
6. Regulation of Enzyme Activity

- **Negative Feedback/Feedback Inhibition** (P257)

  - Enzymes participate in a **metabolic pathway** where the substrate is modified by a **number of enzymes** before producing a final product.

  - As the **final product accumulates** within the cell, it **binds to the regulatory site** of an enzyme in the pathway, changing its shape, and thus preventing the substrate from binding.

  - The final product is no longer produced until concentrations are reduced.
b. Precursor Activity (P257)

Accumulation of substrate molecules causes these molecules to attach to the regulatory site of one of the enzymes in a pathway, which improves fit between enzyme and substrate --- increases reaction rate.
FIGURE 8 - PAGE 257 - SUMMARY OF FEEDBACK INHIBITION AND PRECURSOR ACTIVITY
Tasks to be completed:

- Read Section 8.2 in your textbook
  - pages 254-258
- Complete section 8.2 Questions
  - Number’s 1-13 – page 258
- Workbook Questions
DIGESTION

- What happens:
  Polymers → monomers → absorbed → mitochondria → ATP

- Cells require the following materials:
  - Monosaccharides
  - Amino acids
  - Fatty acids and glycerol

- Other types of nutrients are too large to pass through the digestive tract into the bloodstream
This process takes place in 4 steps

- **ingestion**
- **chemical breakdown (digestion)**
- **absorption of nutrients**
- **egestion (elimination of wastes)**

There are two types of digestion:

- **Physical digestion** – breaking of food into smaller pieces, increasing its surface area
- **Chemical digestion** – breaking chemical bonds in food, using enzymes

OVERVIEW OF DIGESTION ANIMATION:
http://www.biocourse.com/mhhe/bcc/resources/concept.xsp?id=00012109&type=MOVIE
A mammalian (human) digestive system has two parts:

**Alimentary canal** –

- a continuous, coiled, and hollow muscular tube that food passes through
- measures from 6.5 to 9m in length

The movement of materials is as follows:

(IN) MOUTH ➔ PHARYNX ➔ ESOPHAGUS ➔ STOMACH ➔ SMALL INTESTINE ➔ LARGE INTESTINE (COLON) ➔ RECTUM ➔ ANUS (OUT)
Accessory Organs:

- Makes the chemicals needed for digestion and send them into the alimentary canal:

  - **Salivary glands, liver, gallbladder, pancreas**
DIGESTION: A CLOSER LOOK

- Starting where it all begins....

1) The Mouth

- Physical digestion

- teeth → chewing action

- Important for physical digestion

- Each tooth is covered with enamel

- Hardest substance in body

- 8 sharp, dagger – shaped incisors
  - Front of mouth
  - Cut food
Premolars
- Broad, flattened
- Grind food

Molars
- Broader and flatter than premolars
- Have cusps
- Crush food

Wisdom teeth
- Do not usually emerge until 16 to 20 years of age

tongue \rightarrow manipulation and taste
Chemical digestion

- **Salivary amylase** breaks down starch (polysac) into maltose (disac) – only starch digestion takes place in the mouth.
- Salivary glands in the mouth secrete saliva.
- Components of saliva:

<table>
<thead>
<tr>
<th>Component</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>water</td>
<td>Dissolves ions in food for taste</td>
</tr>
<tr>
<td>mucus</td>
<td>Eases the passage of food by making it slippery</td>
</tr>
<tr>
<td>Salivary amylase</td>
<td>Chemical digestion Starch → maltose</td>
</tr>
</tbody>
</table>
Mixture of saliva and food = **bolus**

Swallowing moves materials to the **pharynx** (throat)

This is an intersection that leads to the **trachea** and the **esophagus**

The **epiglottis** prevents food from entering the trachea
The esophagus

- Straight, muscular tube, runs behind trachea (windpipe)
- Assists passage of bolus by creating waves of muscular contractions called **peristalsis** (involuntary)
- [http://www.westga.edu/~lkral/peristalsis/](http://www.westga.edu/~lkral/peristalsis/)
3) The Stomach

- The **cardiac sphincter** muscle controls the movement of material from the esophagus to the stomach (sphincters insure one movement of food)
- J-shaped organ that can store up to 1.5 L of food
- The walls of the stomach secrete **gastric juice**
## Gastric Juice Secretion:

<table>
<thead>
<tr>
<th>Component</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mucus</strong></td>
<td>• Protects the walls of the stomach</td>
</tr>
<tr>
<td><strong>Hydrochloric acid</strong> (HCl)</td>
<td>• Kills bacteria in food</td>
</tr>
<tr>
<td></td>
<td>• Helps with physical breakdown of food</td>
</tr>
<tr>
<td><strong>Rennin</strong></td>
<td>• Starts to break down milk proteins (causes coagulation)</td>
</tr>
<tr>
<td></td>
<td>• Slows movement of milk proteins</td>
</tr>
<tr>
<td></td>
<td>• Lots in children, decreases in adulthood</td>
</tr>
<tr>
<td><strong>Pepsinogin (inactive)</strong></td>
<td>• Pepsinogin is activated at low pH’s</td>
</tr>
<tr>
<td><strong>Pepsin (active)</strong></td>
<td>• Breaks down proteins into polypeptides (chemical digestion)</td>
</tr>
</tbody>
</table>
Physical digestion – churning of the stomach breaks up food

Chemical digestion – proteins → polypeptides – milk proteins → coagulation

The stomach is mainly a storage tank, very little chemical digestion takes place

Alcohol and some drugs (aspirin) are absorbed into the blood

It takes 2-6 hours for the stomach to empty

Food leaves the stomach through the pyloric sphincter

Material leaving the stomach is called chyme
Peptic Ulcers (Page 262):

- What are Ulcers?
- What is the cause of Ulcers?
- How do you treat ulcers?
ASSIGNMENTS TO BE COMPLETED:

- Read pages 259-270 in Textbook
- Complete Section 8.3 Questions: 2-12 – Page 263
- Label diagrams of digestive system in workbook – color diagrams according to instructions
- Begin completing the summary of digestive enzymes charts
4) The Small Intestine

- Major digestive organ
- Site of final preparation of food to be absorbed into the blood transport system
- Average length is 7m
- 3 subdivisions of small intestine
  - **duodenum** (first 25 cm) – chyme enters here
  - **jejenum** (middle 2.5 m)
  - **ileum** (last 3.6 m)
Main functions:

- break down food chemically
- absorb digested foods into **blood** and **lymph**
- make certain hormones
- small amounts of chyme enter periodically, soaked in pepsin and HCl
- secretions then work to break down the chyme into absorbable units
- the pancreas, liver and the small intestine itself release secretions into the **duodenum**
Accessory Organ: Pancreas

- enzyme-rich pancreatic juice is secreted
- contains enzymes that breakdown all 3 major nutrient types
  - **pancreatic amylase** – completes digestion of starch into maltose
  - **trypsinogen** - converted into **trypsin** (active form) in the small intestine by the enzyme **enterokinase**
    - long chain polypeptides → shorter chains
  - **lipase** -
    - triglycerides → fatty acids and glycerol
pancreatic juice also contains **bicarbonate ions**, which neutralizes the HCl of the chyme: raising the pH to about 8 or 9

the pancreas is stimulated by:

- acids enter duodenum and cause **prosecretin** to be activated to **secretin**
- secretin stimulates pancreas to release pancreatic juices including bicarbonate ions
Accessory Organs: The Liver and Gallbladder

- The liver produces **bile**, which **emulsifies fats** (emulsification is a physical process that breaks up fat globules).

- **Bile (not an enzyme)** is composed of:
  - **Bile salts** (emulsify fats)
  - **Bile pigments** (colours feces) – products of old RBC’s processed by liver
  - **Cholesterol**
bile is sent to the gallbladder where it is stored

Gallbladder stimulated by intestinal secreted hormone **cholecystokinin** (CCK)

from the gallbladder, bile is sent to the duodenum through the bile duct

if bile salts crystallize, a **gallstone** forms preventing bile from entering the duodenum

leads to build up of pigments in tissues resulting in **jaundice** and decreased fat digestion
What are other functions of the liver? Use page 267 to find out!
Disorders of the liver:

- Jaundice (P268) –

- Cirrhosis (P 268) –
The small intestine itself secretes enzymes

Secretion is called **intestinal juice**:

- **Peptidase (an erepsin):**
  - breaks down polypeptides into amino acids (completes protein digestion)

- **maltase:** maltose $\rightarrow$ glucose + glucose

- **sucrase:** sucrose $\rightarrow$ glucose + fructose

- **lactase:** lactose $\rightarrow$ glucose + galactose

In addition, mucus protects the intestine and slows food movement
thus chyme entering from the stomach is mixed with 3 secretions in the duodenum:

1. Pancreatic secretions
2. Bile from the gall bladder (liver)
3. Intestinal secretions

The small subunits will be absorbed into the blood:

- Monosac’s, a.a’s, water soluble vitamins, minerals, and water

Lymph: fatty acids and glycerol

At the end of the ileum, all that remains is some water and indigestible food matter, and bacteria
5. The large Intestine (Colon)

Functions:

» Resident bacteria metabolize some of the remaining nutrients, releasing gases (methane, H₂S)

» Resident bacteria also make some vitamins (K and some B)

» Absorbs most water from feces and has limited nutrient absorption; vitamins, some ions

» The solid dried out product (feces) is delivered to the rectum

» Mucus is produced by the walls along the way to ease the passage
- **Fibre** increases the strength of colon contractions that move feces towards the rectum (adds bulk)

- **Appendicitis** –
Rectum

- storage site of feces
- when feces enter, the walls expand, and send a message to the brain

The Anus

- voluntary sphincter that is external passage for wastes (defecation)
ASSIGNMENTS TO BE COMPLETED:

- Read pages 259-270 in Textbook
- Complete Section 8.4 Questions: 1-4, 7-9 – Page 270
- Label diagrams of digestive system in workbook – color diagrams according to instructions
- Continue to complete the summary of digestive enzymes charts
- Digestion Review Worksheet from workbook.
Absorption of Nutrients

- subunits of the three major nutrient groups must be absorbed into the bloodstream:
  - vitamins, minerals, water absorbed “as is”

3 sites of absorption

1. Stomach –
- alcohol and some drugs absorbed into bloodstream

2. Small Intestine –
- majority of absorption occurs along the length of this organ
not a smoothly lined organ; has ridges and furrows on inner surface

on ridges are fingerlike projections called villi

cells on villus surface have minute projections called microvilli
If the small intestine was a smooth tube, it would have to be 500-600 m in length to get the same surface area!

The lining cells absorb most nutrients by active transport

i) **Absorption into bloodstream (capillaries)**

- Monosaccharides, amino acids, water-soluble vitamins, minerals, water
ii) **Absorption into lymph**

- Fatty acids, glycerol, fat-soluble vitamins
- Fats are absorbed passively by diffusion
- Lymph will eventually empty into bloodstream

3. **Large Intestine**

- Absorbs mostly *water*, some *vitamins* and some *ions*

- Digestion & Absorption of Carbohydrates animation:

  - [http://wps.prenhall.com/wps/media/objects/488/500694/CDA40_1/CDA40_1d/CDA40_1d.htm](http://wps.prenhall.com/wps/media/objects/488/500694/CDA40_1/CDA40_1d/CDA40_1d.htm)
Hepatic Portal System

- Blood leaving the duodenum flows through the portal vein to the liver.
- Liver removes excess glucose from the blood (converts glucose to glycogen) and deaminates excess amino acids.
- Blood then continues to heart the hepatic vein.
CONTROL OF DIGESTION:

- Digestion controlled by nervous and hormonal systems (endocrine) → biology 30

- Hormones:

  - Secretin:
    - Acid increase in stomach
    - Walls of stomach stretch or partially digested protein
    - Release of Secretin
    - Travels in blood to Pancreas
    - Causes release of Pancreatic Juice (bicarbonate ions)

  - Gastrin:
    - Release of Gastrin
    - Travels in blood to Parietal cells of stomach
    - Release HCl
The speed of digestion is also regulated:

- After a large meal:
  - Increase activation of stretch receptors → increased muscle contractions → faster emptying

- After a Fatty Meal (KFC special):
  - Small intestine secretes enterogesterone
  - Slows peristalsis
  - Time for fat digestion and absorption
ASSIGNMENTS TO BE COMPLETED:

- Read pages 259-270 In Textbook
- Label diagrams of digestive system in workbook – color diagrams according to instructions
- Continue to complete the summary of digestive enzymes charts
- Digestion Review Worksheet from workbook.
- Chapter 8 Review (Unit Exam Preparation)
  - Pages 278-279
  - Numbers 1-9, 12-19