Organization Of The Body

- Levels of organization in the body include cells, tissues, organs, and organ systems
    - Cells
    - Basic unit of structure and function in living things
    - Specialized cells (eg. Bone cells, blood cells, and muscle cells) perform particular functions
    - Tissues
    - A group of cells that perform a single function
    - Four types of tissues:
        - Epithelial (type of tissue that lines the interior and exterior body surfaces)
            - Function: protection, absorption, excretion of materials
            - Locations: skin, lining of digestive system, certain glands
        - Connective (type of tissue that provides support for the body and connects its parts)
            - Function: binding of epithelial tissue to structures, support, transport of substance
            - Locations: under skin, surrounding organs, blood, bones
            - Many connective tissue cells produce collagen
                - Long, tough fiber-like protein
                - Most common protein in body
                - Gives tissue strength and resiliency, helping them keep their shape even
                    - Under pressure
        - Nervous (type of tissue that transmits nerve impulses throughout the body)
            - Function: receiving and transmitting nerve impulses
            - Locations: brain, spinal cord, nerves
        - Muscle (type of tissue that makes movements of the body possible)
            - Function: voluntary and involuntary movements
            - Location: skeletal muscle, heart
    - Organs
    - Group of tissues that work together to perform a single function or several related functions
    - Eg. EYE: epithelial tissue, nervous tissue, muscle tissue, and connective tissue
    - All work for one function (sight)
    - Organ Systems
    - Group of organs that perform closely related functions
    - The organ systems interact to maintain homeostasis in the body as a whole
    - Eg. Nervous system = Brain and spinal cord
    - Page 864= 11 human organ systems

Homeostasis

- Maintaining a controlled, stable environment
- Homeostasis describes the relatively constant internal physical an chemical conditions that organisms
    - Maintain despite changes in internal and external environments.
- Feedback Inhibition (or "negative feedback"): process in which a stimulus produces a response that
    - Opposes the original stimulus
    - Keeping internal conditions within certain range, never allow them to go too far to 1 side or the other
    - From 5 senses

Examples:

1. Body temperature
    - Hypothalamus (which is part of brain)
        - Contains the nerve cells that monitor both the temperature of the skin at the surface of the body and the temperature of the organs in the body's core
        - Conditions

    1. If nerve cells sense a low temperature (below 37°C) the hypothalamus produces chemicals that signal cells throughout the body to speed up activity, cellular respiration (heat is produced)

2. Shivers: when your body temperature goes well below normal, hypothalamus releases chemicals that signal muscles just below the surface of skin contract involuntarily (i.e. shiver)
3. When your body is too hot (above 37C), the hypothalamus reduces cellular activity, which may lead to you feeling sluggish on a hot day

The Liver and Homeostasis

- Liver

1. Part of digestive system because produces *bile,* which aids in digestion of fats
2. Important in homeostasis
    - When proteins are broken down for energy, ammonia, toxic byproduct is produced.The liver quickly converts ammonia to urea, which is much less toxic. The kidney then removes the urea from the blood.
    - Glucose is obtained from foods we eat, cells take glucose from blood to serve as a source of energy. After a meal, level of glucose in the blood begins to rise. Liver then takes the glucose out of the blood to keep levels of glucose from rising too much. As glucose is used by the body, the liver releases the stored glucose in order the keep the level of glucose from dropping too low.

Food and Energy

- Molecules in food containing chemical energy that cells used to produce ATP. Food also supplies raw materials your body needs to build and repair tissues.

Energy

- Energy of a food can be measured by burning it.
- When food is burned most of the energy is converted to heat, which is measured in terms of calories.
- *Calorie*: the amounts of heat needed to raise temperature of 1 g of water by 1°C
- *Dietary Calorie*: equal to 1000 calorie (kilocalorie = kcal)

Raw Materials

- Chemical pathways, including cellular respiration, can extract images from almost any type of food
- Different raw materials are needed to make enzymes, the lipids in cell membranes, and even DNA
- Food contains at least 45 substances that the body needs but cannot manufacture

Nutrients

- Substances in food that supply energy and raw materials your body uses for growth, repair, and maintenance
- Nutrients that the body needs include water, carbohydrates, fats, proteins, vitamins and minerals

Water: Most important nutrient

- Water makes up the bulk of blood, extracellular fluid, and other bodily fluids
- On hot days or when you take part in strenuous exercise, sweat glands remove water from your tissues and release it as sweat on the surface of your body
- Water is also lost from the body in urine and with every breath you exhale
- Humans need to drink at least 1 L of fluid each day… Or else dehydration

Carbohydrates

- Simple and complex carbohydrates are a major source of energy
- Simple carbohydrates (monosaccharides, disaccharides)= sugars found in fruits, honey, and sugarcane.
- Complex carbohydrates (polysaccharides): starch found in greens, potatoes, vegetables.
- Starches are broken down by the digestive system into simple sugars
- Excess blood sugar
    - Converted into glycogen, which is stored in the liver and skeletal muscles
    - May also be converted to an stored as body fat

Whole-grain breads, bran, and fruits and vegetables contain complex carbohydrate, *cellulose*, called *fiber*

- Nobody cannot breakdown fiber (cellulose) but needs it in your diet
- Bulk supplied by fiber keeps muscles move food and wastes through digestive system
- Fiber can help reduce the risk of heart disease and type II diabetes

Fats : Lipids

Fats help the body absorbs fat-soluble vitamins (Vitamins A,D,E,K) and are part of cell membranes, nerve cells, and hormones

- Store energy
- Fats usually form when a glycerol molecule combines with fatty acids
- "Essential fatty acids"= fatty acids that cannot be made by the body
- Fats are classified:
    - Unsaturated:
        - One or more double bonds between carbon atoms in the fatty acid
        - Usually liquid at room temperature (vegetable oil)
    - Saturated:
        - only single bond between carbon atoms in the fatty acid
        - each carbon atom has the maximum number of hydrogen atoms
        - usually solid at room temperature (butter)

- Foods manufactures often modify unsaturated fats in vegetable oils by adding hydrogen to them (*trans fat*)
    - Trans fat= solid at room temperature
    - Longer shelf life than unsaturated
    - May be associated with heart disease

Proteins

- Supply raw materials for growth and repair of structures such as skin and muscle
- Many enzymes that control cellular chemistry by increasing the rate of chemical reactions are made of proteins
- Have regulatory and transport functions (eg. Insulin – control blood glucose, hemoglobin- transport oxygen)
- Polymers of amino acids
- Body able to synthesize only 12 of the 20 amino acids used to make proteins
- Essential amino acids must be obtained from foods you eat
- Food such as meat, fish, eggs, and milk generally contain all eight essential amino acids
- Foods derived from plants, such as grains and beans, do not

Vitamins

- Organic molecules that the body needs in very small amounts are called vitamins
- Proteins, fats, and carbohydrates as the building blocks of the body, vitamins help put them together
- Most must obtained from food; bacteria that live in large intestines are able to synthesize vitamins K and B_{12}
- Two types of vitamins: fat-soluble and water-soluble
    - Fat- soluble
        - Vitamins A, D, E, and K
        - May be stored in fatty tissues for future use
    - Water soluble
        - Vitamins C and B

    Cannot be stored, so must be gotten everyday.
- Excessive amounts of the fat-soluble vitamins A, D, and K can be toxic

Minerals

- Inorganic nutrients the body needs, usually in small amounts, are called minerals
- EX Calcium: required to produce the cost of phosphate that makes up bones and teeth
- EX. Iron: you need to make hemoglobin
- Constant supply of minerals in the diet is needed to replace those lost in sweat, urine, and digestive wastes

Nutrition and a Balanced Diet

- Balanced diet provides nutrients in adequate amounts + enough energy for person to maintain healthful weight
- Fat = 9 Calories/gram
- Carbohydrates and Protein= 4 Calories/gram

Ingestion:

- Macromolecules (carbs, lipids, proteins)

Digestive System

- "Alimentary canal": a one-way tube that passes though the body
- Function: converts food into small molecules that can be used by cells of body.
- Food is processed by digestive system in 4 phases—ingestion, digestion, absorption, and elimination
  1. Ingestion: process of putting food into mouth
  2. Digestion: process of food breakdown; 2 types:
     - *A.* Mechanical digestion: Physical breakdown
     - *B.* Chemical digestion: Enzymes chemically break down food into small molecules body can use
  3. Absorption: the broken down small food molecules are absorbed by small intestine cells
  4. Elimination: eliminates substances in food that body cannot digest and absorb

The Process of Digestion

-During digestion, food travels through the mouth, esophagus, stomach, and small intestine.

-Mechanical digestion and chemical digestion are the two processes by which food is reduced to molecules that can be absorbed.

- Both mechanical digestion and chemical digestion start in the mouth

MOUTH

- Chewing begins the mechanical digestion
  - Increases the speed of chemical digestion (more surface area)
  - Saliva begins the chemical digestion

Teeth

- Anchored in the bones of jaw
- Protected by coating of mineralized enamel
- Perform much of mechanical work of digestion
- Incisors, cuspids, and bicuspids= cut into and tear the food
- Molars= grind and crush food into fine paste that can be swallowed
- Tongue moves food around so that it comes in contact with teeth

Saliva : Secreted by salivary glands

- Help moisten food to make it easier to chew
- Release controlled by nervous system and can be triggered by scent of food
- Saliva eases passage of food and begins process of chemical digestion
- Contains enzymes
  - Salivary Amylase: begins the breakdown of chemical bonds in starches, forming sugars
  - Salivary Lysozyme: Enzyme that fights infection by digesting the cell walls of many bacteria that may enter the mouth with food

ESOPHAGUS

- Bolus passes through a tube, called the esophagus, into the stomach
- Not drawn by gravity thanks to peristalsis

Peristalsis: Contraction of smooth muscles that provide force that moves food through the esophagus towards stomach

STOMACH: Chemical digestion : Salivary amylase gets deactivated when in stomach

- Large muscular sac that continues the chemical and mechanical digestion of food
- Lining of stomach contains millions of microscopic gastric glands, released many substances into stomach:

Pepsin: Enzyme, breaks proteins into smaller polypeptide fragments;activated in, functions best in acidic condition
Mucus: Fluid that lubricates and protects the stomach wall

- If they fail, acids may erode the stomach lining and cause sore called *peptic ulcer.*
- For years, physicians thought that the primary cause of ulcers was too much stomach acid. They prescribed drugs that reduced symptoms but did not cure stomach ulcers.
- Peptic ulcers are a result of infection with the bacterium *Helicobacter pylori.* Many stomach ulcers can be cured with antibiotics that kill bacteria.

Cardiac sphincter: Stops stomach acids from leaking out

Stomach: Mechanical digestion

- Alternating contractions of stomach's 3 smooth muscle layers thoroughly churn and mix the swallowed food.
- Churning causes further breakdown of chunks of swallowed food and allows enzymes greater access to food
- Chyme: Mixture with oatmeal-like consistency produced by the churning
- After an hour or 2 , pyloric valve, located between stomach and small intestine, opens, and chyme begins to spurt into the small intestines.

Small Intestine

- **Duodenum**: First part of the small intestine
  - Where almost all of the digestive enzymes enter the intestine
    - Most of the chemical digestion absorption of the food you eat occurs in the small intestine
    - As chyme is pushed through the pyloric valve, it enters the *duodenum* and mixes with
      - Enzymes and digestive fluids from the pancreas, liver, and even the lining of the
      - Duodenum itself

Pancreas : Gland just behind the stomach

- 3 functions:
  - Produce hormones that regulate blood sugar levels (*insulin*)
  - Produces enzymes that break down carbohydrates, proteins, lipids, and nucleicacids
  - Produces sodium bicarbonate, a base that quickly neutralizes stomach acid as
  - Chyme enters the duodenum.
- Enzymes produced by the pancreas would be destroyed by strong acid, and therefore the sodium bicarbonate is necessary for digestion to proceed

Liver

- Assists the pancreas in fat digestion
- Produces *bile*, a fluid loaded with lipids and salt
  - Bile is stored in a small pouch-like organ called the *gallbladder*
  - When fat is present in the duodenum, the gallbladder releases bile through
    - Duct into the small intestine.
  - Fats tend to glob together, which makes fat digestion by enzymes such as
    - Lipase difficult
- Bile breaks up these globs into smaller droplets that disperse in the watery environment of the small intestine

Absorption and Elimination

- Most nutrients from food are absorbed through the walls of the small intestine. The large intestine absorbs water and several vitamins and prepares wastes from elimination from the body.

Absorption from the Small Intestines

- PH of 8-9
- More Narrow= allows and makes all foods to be digested and absorbed
- Under first set of cells, there are capillaries to transfer nutrients to blood
- Most of chemical digestion and all of absorption occurs
- Contains large bumps -Villi
- Microvilli (on top of villi) *:* More Villi= More Surface Area
- *Pyloric Sphincter* : Sends Chyme (pH 3-4) to Small Intestine (Connects stomach to small Intestine)

- After leaving duodenum, most chemical digestion has been completed. Chyme now has a rich mixture of small and medium sized nutrient molecules that's ready to be absorbed. Chyme moves along rest of small intestine.
    - Connected to liver through gallbladder (duodenum)
    - Connected stomach (chyme), pancreas, gallbladder (stores bile), liver (produces bile)
- Small intestine specially adapted for absorption: enormous surface area from folded
        - surface and fingerlike projections (*villi*)
    - Villi are covered with tiny projections called *microvilli*
        - Inside Microvilli *;* Lacteal
            - Absorbs digestive end products of digestion
            - Glycerol + Fatty acids
        - Capillaries surrounding Lacteal for anything else
- Nutrient molecules are rapidly absorbed into the cells lining the small intestine.
    - Most of the products of carbohydrate and protein digestion are absorbed into the capillaries in the villi
    - Most fats and fatty acids are absorbed by lymph vessels
- When chyme is ready to leave small intestine, it is nutrient-free.
- Complex organic molecules digested and absorbed, leaving water+cellulose+other indigestible substances.
- As material leaves small intestine and enters large intestine, it passes by a small sac like organ,appendix
    - Some mammals: appendix processes cellulose and other materials
    - Humans: notice their appendix when it is clogged and inflamed (*appendicitis*)
        - Remedy: remove infected organ before it ruptures

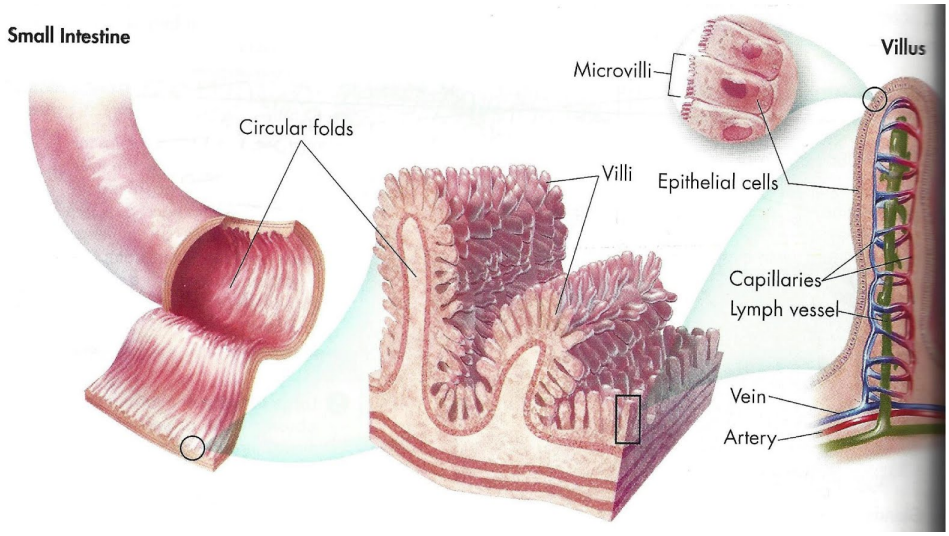
Absorption from the large Intestine

- Chyme leaves the small intestine to the large intestine (*colon*)
- Shorter than the small intestine, but larger diameter
- Primary function: removes water from the undigested material that is left
    - Water is absorbed across the wall, leaving undigested materials
- Rich colonies of bacteria produce compounds that the body is able to absorb and use (EX: Vitamin K)
    - When large doses of antibiotics are given to fight infection, they can destroy these bacteria, and vitamin K deficiency can occur

Elimination

Concentrated waste material (*feces*) that remains after most of water has been removed passes into the *rectum* and is eliminated from the body through the *anus*

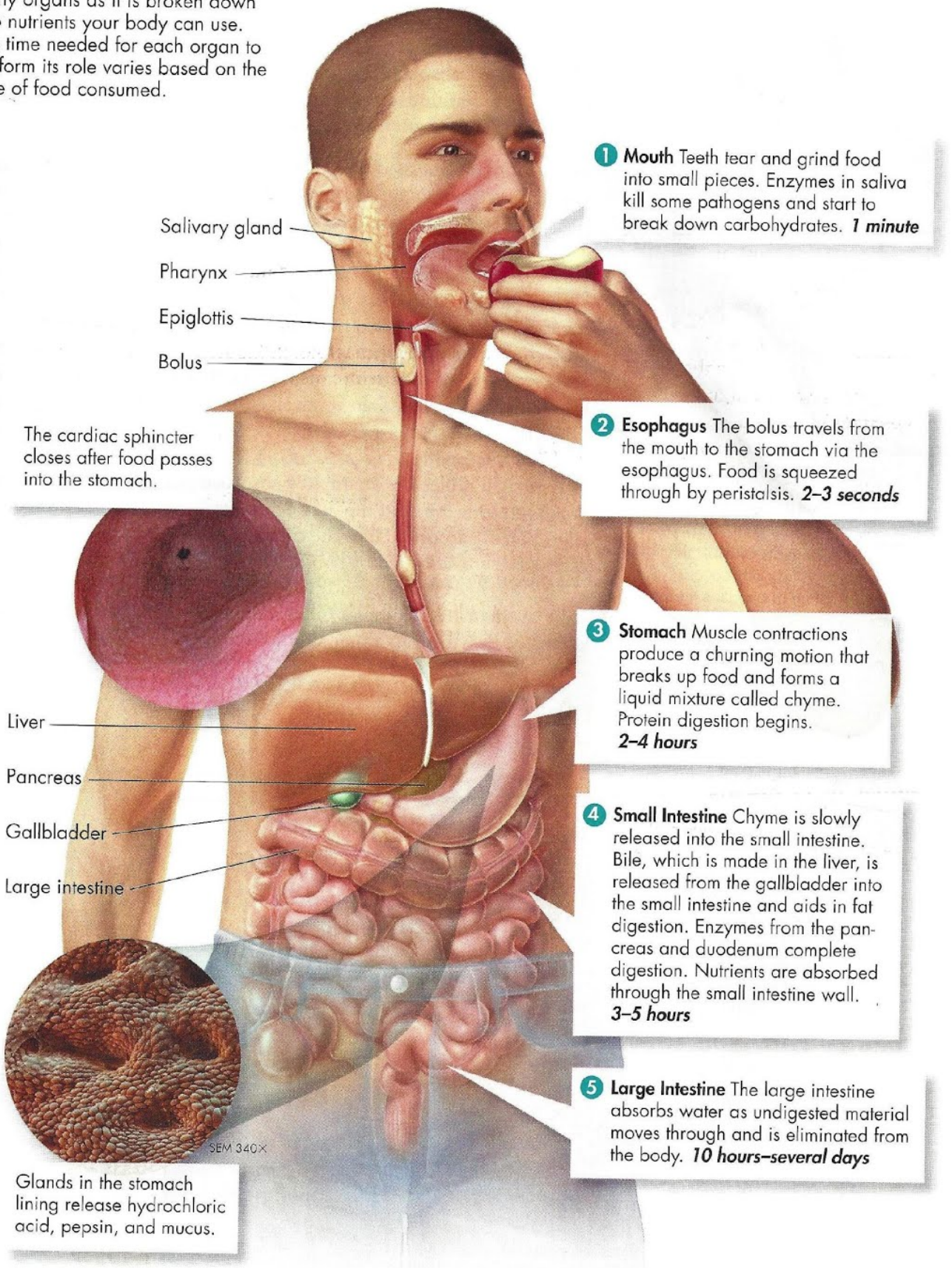
- If something interferes, you usually will notice it right away
    - If not enough water= diarrhea
    - If too much water= constipation



VISUAL SUMMARY

THE DIGESTIVE SYSTEM

FIGURE 30–15 Food travels through many organs as it is broken down into nutrients your body can use. The time needed for each organ to perform its role varies based on the type of food consumed.



1 Mouth Teeth tear and grind food into small pieces. Enzymes in saliva kill some pathogens and start to break down carbohydrates. ***1 minute***

2 Esophagus The bolus travels from the mouth to the stomach via the esophagus. Food is squeezed through by peristalsis. ***2–3 seconds***

The cardiac sphincter closes after food passes into the stomach.

3 Stomach Muscle contractions produce a churning motion that breaks up food and forms a liquid mixture called chyme. Protein digestion begins. ***2–4 hours***

4 Small Intestine Chyme is slowly released into the small intestine. Bile, which is made in the liver, is released from the gallbladder into the small intestine and aids in fat digestion. Enzymes from the pancreas and duodenum complete digestion. Nutrients are absorbed through the small intestine wall. ***3–5 hours***

5 Large Intestine The large intestine absorbs water as undigested material moves through and is eliminated from the body. ***10 hours–several days***

Glands in the stomach lining release hydrochloric acid, pepsin, and mucus.