Review

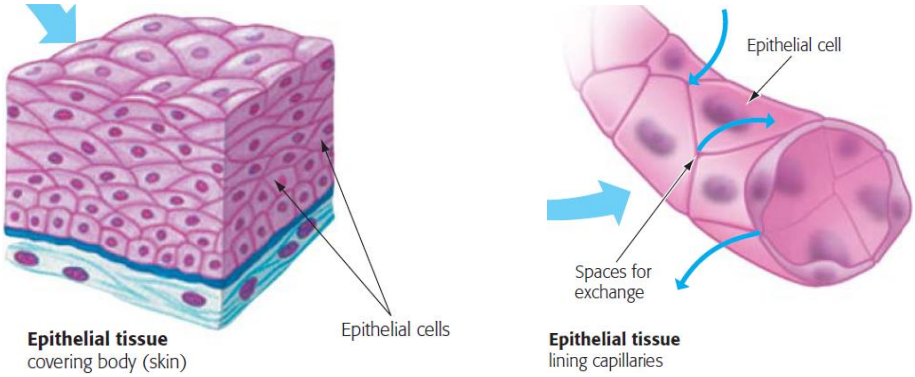
Chapter 21. Unifying Concepts of Animal Structure and Function

- **The structural organization of animals:**
  Life is characterized by a hierarchy of organization.
  Cell → tissue → organ → organ system
- **Anatomy (解剖):** The study of the structure of an organism's parts.
  Physiology (生理学): The study of the function of an organism's parts.
- **Tissue (组织):** An integrated group of similar cells, performs a specific function.

Epithelial tissue (上皮组织), connective tissue (结缔组织), muscle tissue (肌肉组织), nervous tissue (神经组织)

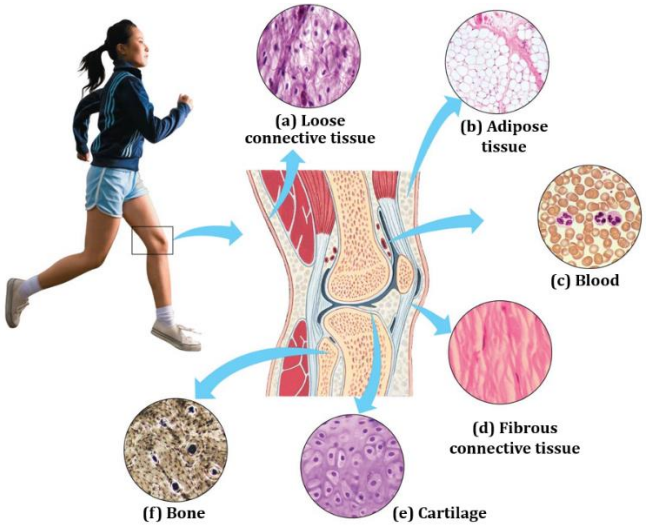
（1）**Epithelial tissue:** A tissue that covers the surface of the body and lines organs.

- ✧ The skin's **multiple layers** of epithelial cells serve a protective role;
- ✧ The lining of capillaries contains a **single, leaky layer** of epithelial cells that promote exchange.
- ✧ About 80% of all cancers arise in epithelial tissue.



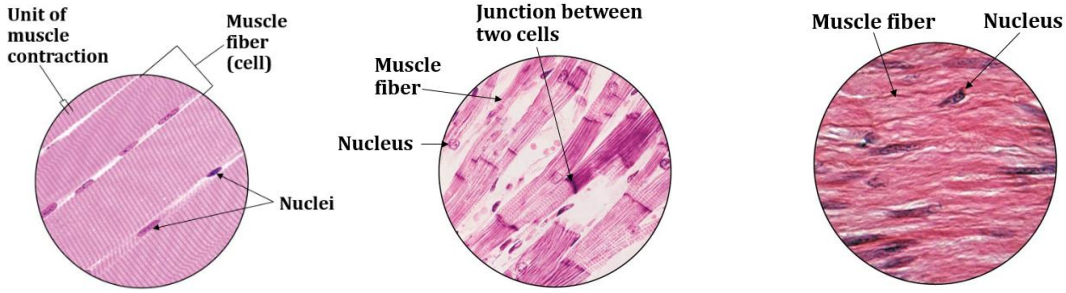
（2）**Connective tissue:** A tissue contains cells scattered throughout a material called the **extracellular matrix (胞外基质)**. To support and join other tissues.

- ✧ **Loose connective tissue (疏松结缔组织):** A tissue binds epithelia to underlying tissues.
- ✧ **Fibrous connective tissue (纤维结缔组织):** A tissue has a dense matrix of collagen (胶原). It forms tendons (肌腱), which attach muscles to bones, and ligaments (韧带), which join bones together at joints.
- ✧ **Cartilage (软骨):** A tissue has a strong but flexible matrix. It has no blood vessels.
- ✧ **Bone:** A rigid connective tissue with a dense matrix of collagen fibers hardened with deposits of calcium salts.
- ✧ **Adipose tissue (脂肪组织):** A tissue stores fat in closely packed cells of a sparse matrix.
- ✧ **Blood:** A tissue consists of cells suspended in a liquid matrix called plasma (血浆)。



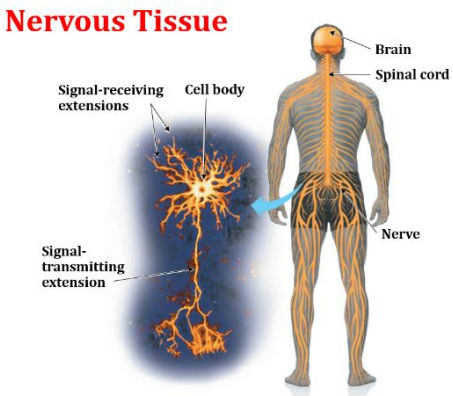
（3）**Muscle tissue:** A tissue consists of bundles of long, thin, cylindrical (圆柱形) cells known as muscle fibers (肌纤维). Each muscle fiber has specialized proteins arranged into a structure that contract (pull inward) when stimulated by a signal from a nerve.

- ✧ **Skeletal muscle (骨骼肌):** Moves skeleton. It's responsible for voluntary movements, such as walking and talking.
- ✧ **Cardiac muscle (心肌):** It's found only in heart tissue. The contraction of the cardiac muscle produces a coordinated heartbeat. It's responsible for involuntary movements.
- ✧ **Smooth muscle (平滑肌):** It's found in many organs and can contract slowly for a long period of time. It's responsible for involuntary movements. Named for its lack of obvious stripes.



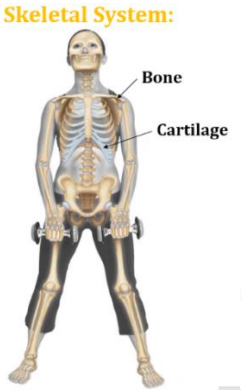
（4）**Nervous tissue:** A tissue found in brain and spinal cord (脊髓), as well as in the nerves that connect these organs to all other parts of body.

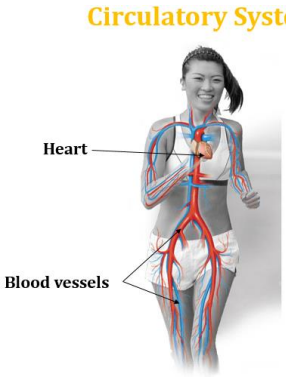
- ✧ **Neuron (nerve cell 神经元):** The basic unit of nervous tissue.

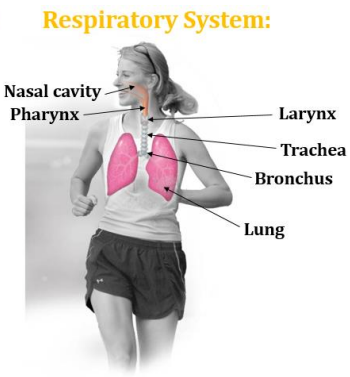


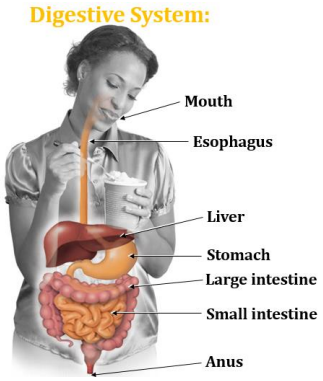
- **Organs:** It consists of two or more tissues packaged into one working unit that performs a specific function. It performs functions that none of its component tissues can carry out alone.
  - ✧ **Organ system:** Teams of organs that work together to perform viral body functions.

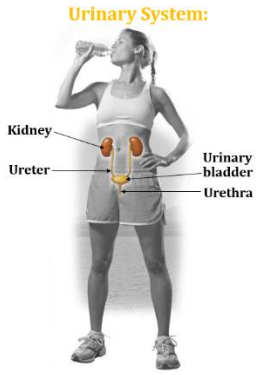
（1）**skeletal system (骨骼系统):** Supports body and anchors muscles.
（2）**circulatory system (循环系统):** Transports substances throughout body.
（3）**respiratory system (呼吸系统):** Exchanges O_2 and CO_2 between blood and air.
（4）**digestive system (消化系统):** Breaks down food and absorbs nutrients.
（5）**urinary system (泌尿系统):** Rids body of certain wastes.
（6）**muscular system (肌肉系统):** Moves the body.
（7）**endocrine system (内分泌系统):** Secretes hormones.
（8）**reproductive system (生殖系统):** Produces gametes and offspring.
（9）**integumentary system (表皮系统):** Protects body.
（10）**lymphatic and immune system (淋巴及免疫系统):** Defends against disease.
（11）**nervous system (神经系统):** Processes sensory information and controls responses.

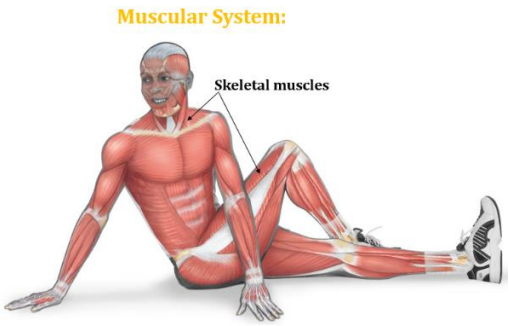


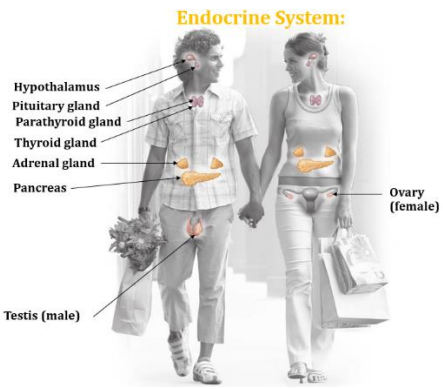


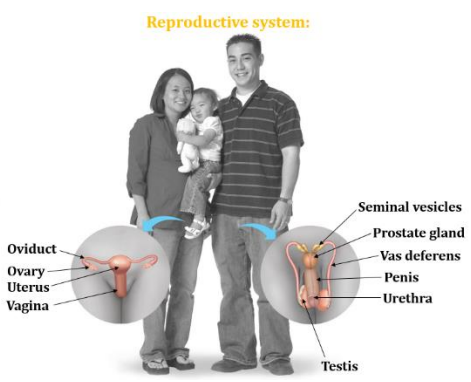


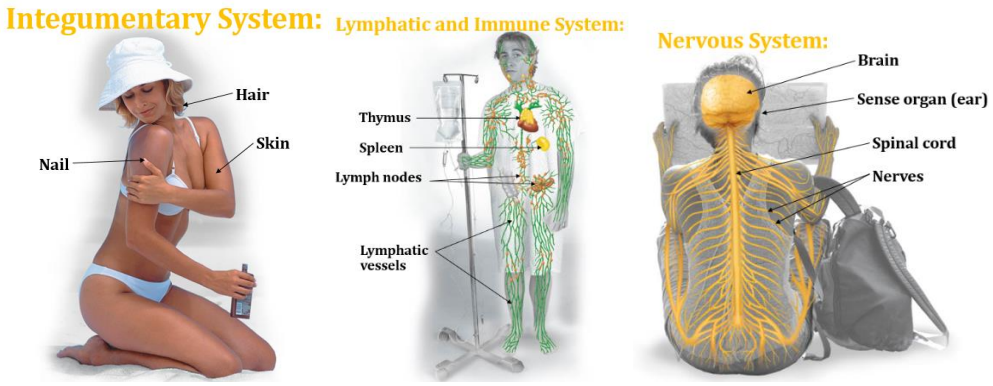




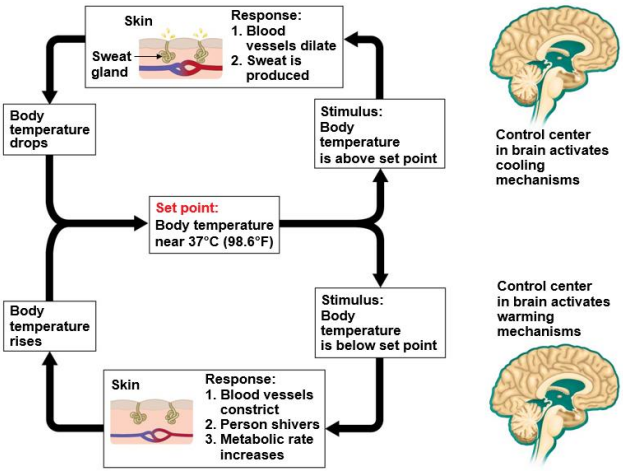




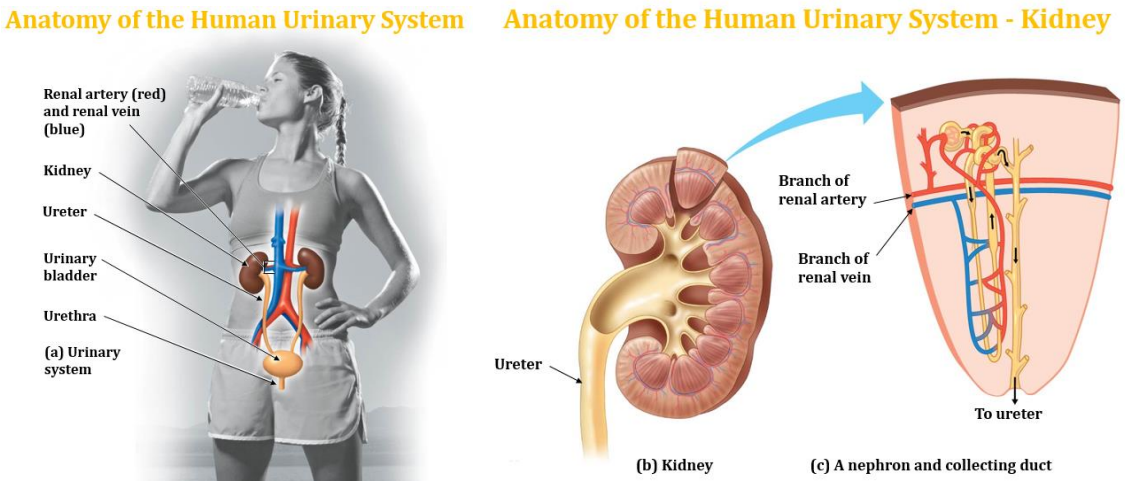


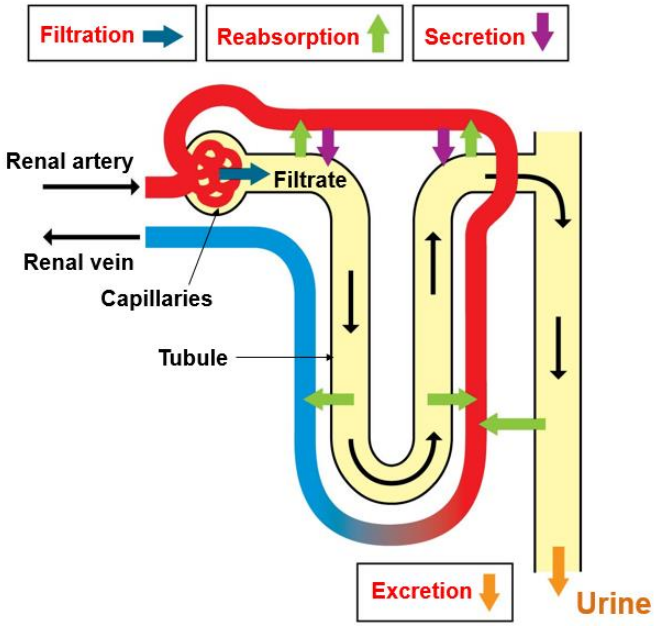


- **Exchange with the external environment:**
  Every organism is an open system that continuously exchanges chemicals and energy with its surroundings.
- **Regulating the internal environment:**
- **Homeostasis (体内平衡):** It's the tendency to maintain relatively constant conditions in the internal environment even when the external environment changes. It's a dynamic state, an interplay between outside forces that tend to change the internal environment and control mechanisms that oppose such changes.
  - **Interstitial fluid (组织液)**—internal environment： It fills the spaces between cells and exchanged nutrients and wastes with microscopic blood vessels.
- **Negative and positive feedback**
  - **Negative feedback:** A form of regulation in which the results of a process inhibit that same process. It's the most common mechanism of homeostatic control in animals.
  - **Positive feedback:** A form of regulation in which the results of a process intensify that same process.
- **Thermoregulation (体温调节):** The homeostatic mechanism that controls temperature.
  - **Endotherms (恒温动物):** The organisms that have the ability to maintain a body temperature substantially warmer than the surrounding environment.
  - **Ectotherms (变温，冷血动物):** The organisms obtain their body heat primarily by absorbing it from their surroundings.
  - **Fever:** An abnormally high internal temperature, is a body-wide response that usually indicates an ongoing fight against infection.



- **Osmoregulation (渗透调节):** The control of the gain or loss of water and dissolved solutes, such as the ions of NaCl and other salts.
- **Homeostasis in the urinary system**



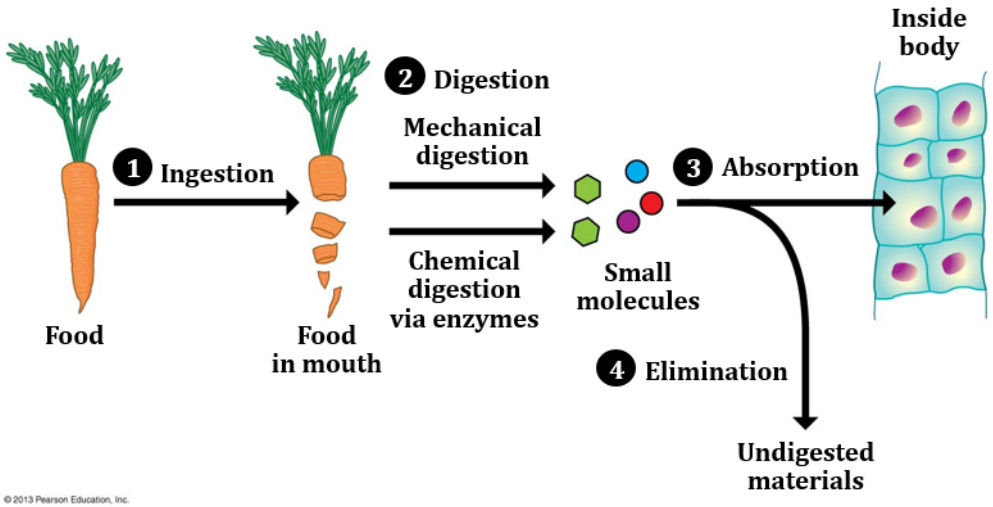


- ✧ **Filtration:** Water and other small molecules are forced out of the blood when it passes through capillary walls (毛细血管壁) into the kidney tubule (肾小管), forming filtrate.
- ✧ **Reabsorption:** Reclaims water and valuable solutes from the filtrate and returns them to the blood.
- ✧ **Secretion:** Certain substances, such as some ions and drugs, are transported into the filtrate.
- ✧ **Excretion:** Urine passes from the kidneys to the outside.

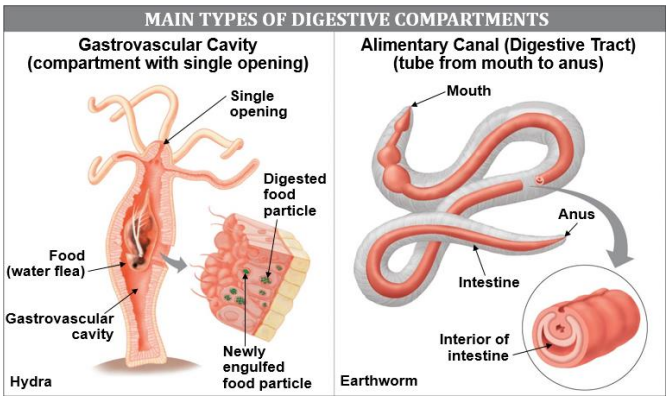
Chapter 22. Nutrition and Digestion

An overview of animal nutrition

- **Animal diets:**
  - **Herbivores (食草动物):** Animals feed mainly on plants and/or algae.
  - **Carnivores (食肉动物):** Animals feed mainly on other animals.
  - **Omnivores (杂食动物):** Animals feed on animals as well as plants and/or algae.
- **The four stages of food processing:** ingestion, digestion, absorption, elimination
  - **Ingestion (摄取):** Another word for eating.
  - **Digestion (消化):** The breakdown of food into molecules small enough for the body to absorb.
  - **Absorption (吸收):** The uptake of small nutrient molecules by cells lining the digestive tract.
  - **Elimination (排泄):** The disposal of undigested materials left over from food.



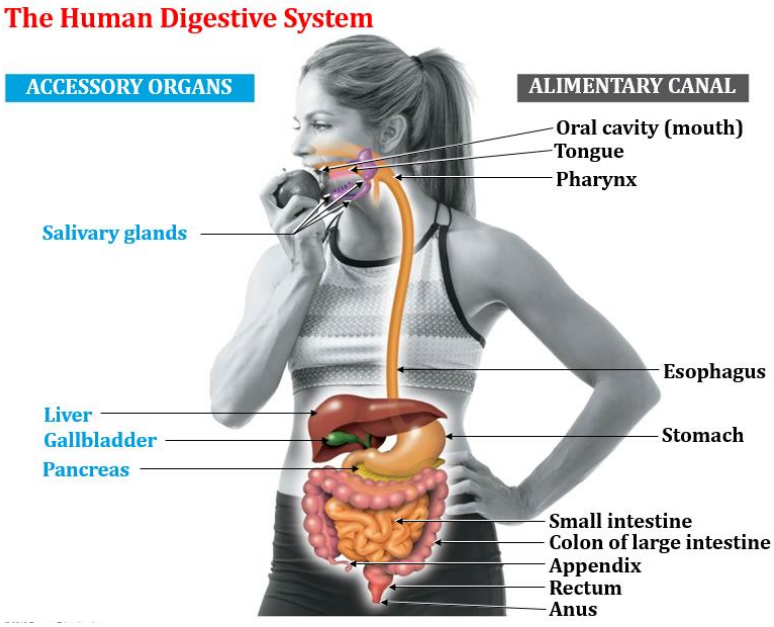
- **Digestive compartments**
  - **Food vacuole:** The food vacuole fuses with a lysosome containing enzymes, forming a digestive compartment.
  - **Gastrovascular cavity (腔肠):** A digestive compartment with a single opening that functions as both the entrance for food and the exit for undigested wastes.
  - **Alimentary canal/digestive tract (消化道):** A digestive tube with two separate openings—a mouth at one end and an anus at the other end.



A tour of the human digestive system

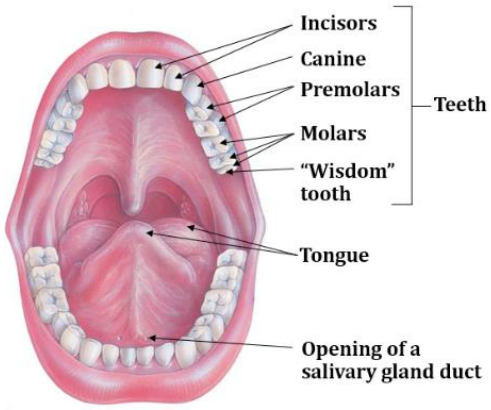
- **System map**

  Mouth (oral cavity) → pharynx (咽) → esophagus (食管) → stomach → small intestine → large intestine (colon (结肠) and rectum (直肠)) → anus (肛门)



（1）**Mouth:** Ingest food and begins to digest it.

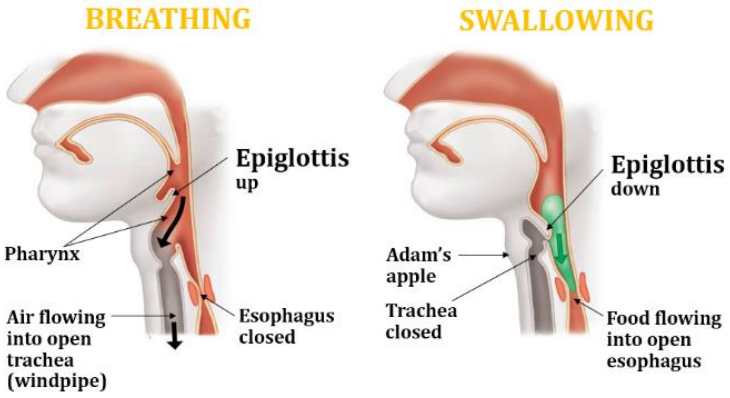
- ✧ Chewing makes food easier to swallow and exposes more surfaces of the food to digestive juices.
- ✧ An adult human has 32 teeth.
- ✧ Chemical digestion begins in the mouth with the secretion of saliva (唾液) from salivary glands (唾液腺). Saliva contains the digestive enzyme salivary amylase (唾液淀粉酶), it breaks down starch.
- ✧ The tongue shapes the food into a ball and pushes the food ball to the back of the mouth.
- ✧ Swallowing moves the food into the pharynx.



（2）**Pharynx:** It located in throat, is an intersection of the pathways for swallowing and breathing. It connects the mouth to the esophagus.

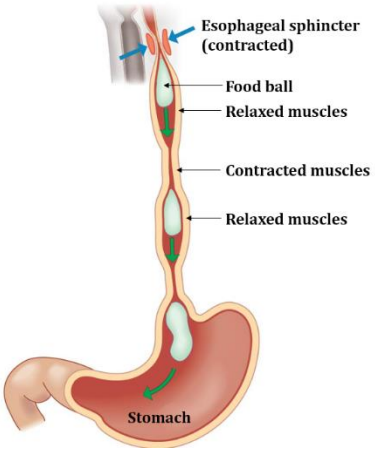
- ✧ When not swallowing, the trachea (气管) entrance is open and can breathe.

- ✧ When swallowing, a reflex moves the opening of the trachea upward and tips a door-like flap called the epiglottis (会厌) to close the trachea entrance



（3）**Esophagus:** A muscular tube that connects the pharynx to the stomach.

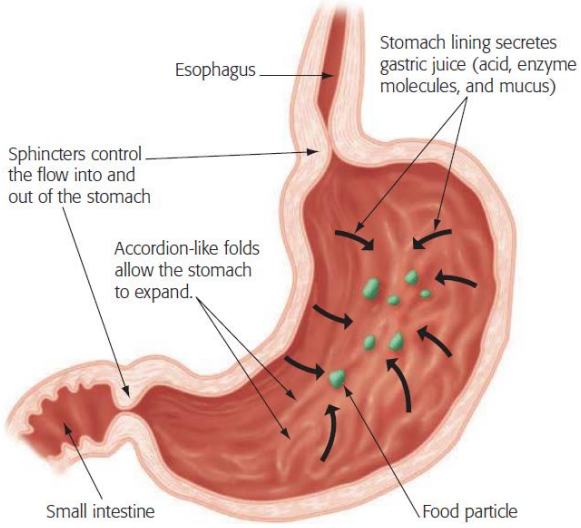
- ✧ Esophagus moves food by peristalsis (蠕动), alternating waves of muscular contraction and relaxation that squeeze the food ball along the esophagus.



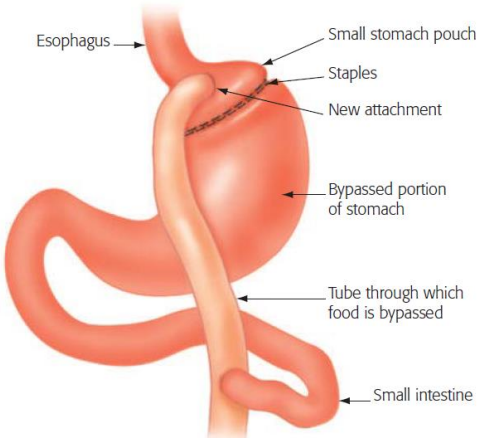
（4）**Stomach:** A large organ that acts as an expandable storage tank, holding enough food.

- ✧ The cells lining the stomach's interior secrete a digestive fluid called gastric juice (胃液)：strong acid-hydrochloric acid, digestive enzymes, mucus).
- ✧ Mucus (粘液) coating the stomach lining helps protect it from gastric juices and from abrasive materials in food. Stomach replaces its lining completely about once every three days.
- ✧ Stomach ailments (胃病)
  - ◆ gastroesophageal reflux disease (胃食管返流疾病/反酸): Occasional backflow of chyme, harm to the lining of the esophagus.
  - ◆ gastric ulcers (胃溃疡): The stomach lining is eroded by gastric juice faster than it can regenerate. The cause of most ulcers is the infection of the stomach lining by an acid-tolerant bacterium called *Helicobacter pylori* (幽门螺旋杆菌).
  - ◆ Weight loss surgeries—gastric bypass (胃绕道减肥手术)

▼ **Figure 22.9 The human stomach.**

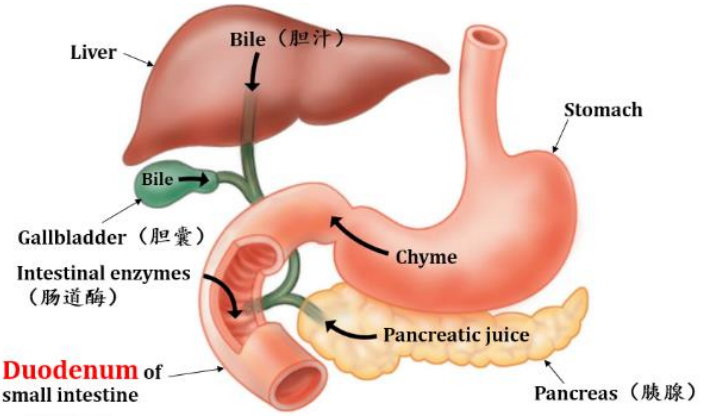


▼ **Figure 22.10 Gastric bypass surgery.** An incision is made in the small intestine about 18 inches from where it joins the stomach. The free end of the intestine is then attached to the smaller stomach pouch, which now has a significantly reduced capacity to store food.



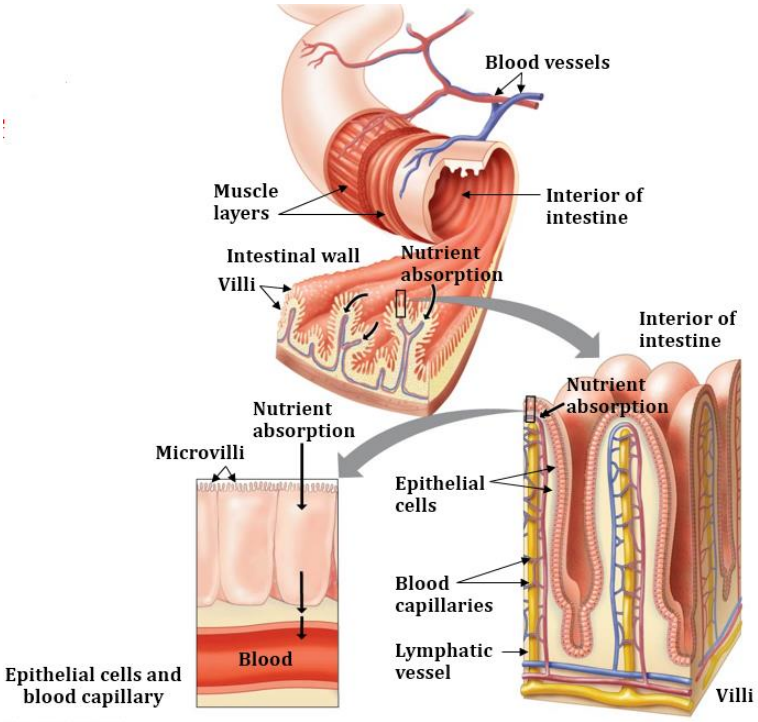
（5）**Small intestine:** The major organ for chemical digestion and for absorption of nutrients into the bloodstream. The longest part of the alimentary canal. It's small in diameter (2.5cm).

- ✧ Chemical digestion
  - ◆ The enzymes are mixed with chyme in the first 25cm or so of the small intestine—duodenum (十二指肠).
  - ◆ The duodenum receives digestive juices from the pancreas (胰腺), liver, gallbladder (胆囊), and the intestinal lining (肠粘膜).
  - ◆ Pancreas: A large gland that secretes pancreatic juice into the duodenum via a duct. Pancreatic juice neutralizes the stomach acid that enters the duodenum, and it contains enzymes that aid in digestion.
  - ◆ Bile (胆汁): A juice produced by the liver, stored in the gallbladder, and secreted through a duct into the duodenum. It contains salts that break up fats into small droplets that are more susceptible to dismantling by digestive enzymes.



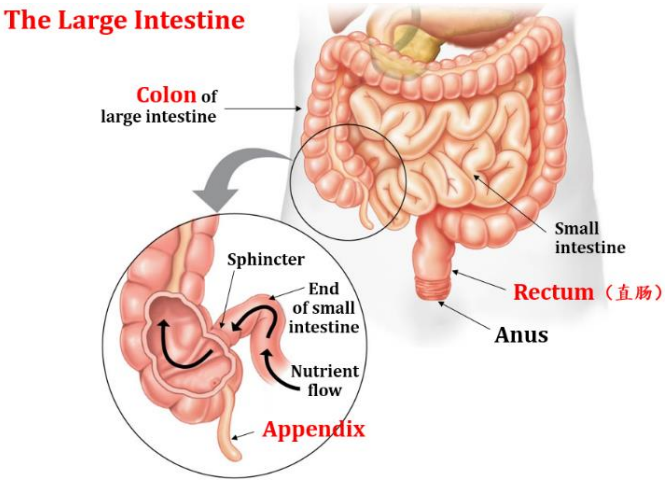
- ✧ Absorption of nutrients
  - ◆ Until nutrients actually cross the tissue lining the alimentary canal and enter the bloodstream, they are still outside the body.
  - ◆ The surface area of this epithelium is huge: The intestinal lining has large folds—villi; Each cell of the epithelium also has microscopic projections—microvilli, which add even more surface area.

◆ After nutrients have crossed the cell membranes of the microvilli, they are finally inside the body, where the bloodstream and lymph carry them away to distant cells.



（6）Large intestine: It's shorter than the small intestine but almost twice as wide.

- ✧ Sphincter (括约肌): It controls the passage of what's left of a meal.
- ✧ Appendix (阑尾): It contains white blood cells that make minor contributions to the immune system. → appendicitis (阑尾炎)—a bacterial infection of the appendix。
- ✧ Colon (结肠): The main portion of the large intestine. The primary function is to absorb water from the alimentary canal. → diarrhea (腹泻)—unable to reabsorb water efficiently; constipation (便秘)—occurs when peristalsis moves feces along too slowly and the colon reabsorbs so much water that the feces become too compacted； Celiac disease and Crohn's disease.
- ✧ Rectum (直肠): The last 15cm of the large intestine, stores feces until they can be eliminated. Two rectal sphincters, one voluntary and the other involuntary, regulate the opening of the anus.



Human nutritional requirements

- **Food as fuel**
  - ✧ Cells can extract energy stored in the organic molecules of food through the process of cellular respiration and expend that energy as cellular work.
  - ✧ Calories: A measure of the energy stored in the food as well as the energy expend during the daily activities. One calorie is the amount of energy required to raise the temperature of a gram of water by 1℃.
  - ✧ Metabolic rate: The rate at which your body consumes energy.
  - ✧ Basal metabolic rate (BMR 基础代谢率): The overall metabolic rate. The amount of energy it takes to maintain your basic body functions, plus any energy consumption above that base rate.
- **Food as building material**
  - ✧ Essential nutrients (必需营养素): Cannot be made from any other materials, so the body needs to receive them in preassembled form.

  (1) Essential amino acids (必需氨基酸): 8 essential amino acids. They must be obtained from the diet because human cells cannot make them. Animal proteins can provide adequate amounts of all the essential amino acids. While most plant proteins are deficient in one or more of the essential amino acids.

  (2) Vitamins: Organic molecules that are required in the diet in very small amounts. There are 13 vitamins essential to human health. Most are needed because they assist enzyme.

  (3) Minerals: The smaller amounts of 21 other chemical elements that are acquired mainly in the form of inorganic nutrients.

  (4) Essential fatty acids: The required fatty acids that cannot make by the body and must obtain in diet. Most diets furnish ample amounts of the essential fatty acids, so deficiencies are rare.

Nutritional disorders

- **Malnutrition (营养不良):** Health problem caused by an improper or insufficient diet. It may be caused by inadequate intake or medical problems such as metabolic or digestive abnormalities.
- **Eating disorders (饮食失调)**
  - ✧ **Anorexia nervosa (神经性厌食症):** It's characterized by self-starvation due to an intense and irrational fear of gaining weight, even when the person in underweight.
  - ✧ **Bulimia (暴食症):** A behavioral pattern of binge eating followed by purging through induced vomiting (催吐), abuse of laxatives (泻药) or excessive exercise.
- **Obesity:** It's defined as having a too-high body mass index (BMI 身体质量指数), a ratio of weight to height. Obesity increases the risk of heart attack, diabetes, cancer, and several other diseases.

Exercises:

1) If a person is suffering from heat stroke, which organ system is failing?
A) skeletal system
B) digestive system
C) nervous system
D) circulatory system
Answer: C

12) Which of the following generally makes skeletal muscle different from both smooth and cardiac muscle?
A) Skeletal muscles are made of cells called "fibers."
B) Skeletal muscle cannot be contracted voluntarily.
C) Skeletal muscle can be contracted voluntarily.
D) Skeletal muscle cells have nuclei.
Answer: C

18) Imagine an invertebrate that lives in an estuary where salinity varies cyclically with the tides. If this animal practices homeostasis with respect to the salt concentration of its body fluids, its salt concentration will show _____.
A) no fluctuations
B) slight, continuous fluctuations
C) a more concentrated state than the surrounding water at all times
D a more diluted state than the surrounding water at all times
Answer: B

21) Which of the following is most likely to be responsible if, when your blood sugar level rose, the level went back down?
A) the use of the sugar for energy by your cells
B) a homeostatic mechanism based on negative feedback
C) type 2 diabetes
D) a homeostatic mechanism based on positive feedback
Answer: B

26) Which of the following is a physiological response that takes place in many animals when they get too hot?
A) slowing of the heart rate
B) constriction of blood vessels in the skin
C) contraction of muscles
D) increased blood flow to the skin
Answer: D

30) Reabsorption is the movement of substances from the _____ to the _____.
A) blood... nephron

B) filtrate... blood
C) kidney... urinary bladder
D) blood... filtrate
Answer: B

35) In humans, goosebumps (鸡皮疙瘩) are a vestige of a mammalian adaptation related to _____.
A) thermoregulation
B) water conservation
C) osmoregulation
D) positive feedback
Answer: A

17) Which of the following is the usual cause of heartburn?
A) backflow of chyme from the stomach into the esophagus
B) retention of food at the bottom of the esophagus by a sphincter that is reluctant to open
C) irritation of the lower esophagus by substances in spicy food
D) compression of the lower esophagus by an overfilled stomach
Answer: A

18) Which of the following mechanisms helps prevent gastric juice from digesting the stomach lining?
A) mucus coating the inside surface of the stomach
B) contractions of the stomach constantly moving chyme into the small intestine
C) the continuous secretion of gastric juice
D) the inactivation of pepsin by hydrochloric acid
Answer: A
21) How does Helicobacter pylori cause gastric ulcers in humans?
A) It neutralizes the acids of the stomach.
B) It causes the production of excess acid in the stomach.
C) It damages the stomach's mucus coat.
D) It causes the stomach to produce stronger acids.
Answer: C

25) Someone with liver failure will, in particular, have problems with the digestion and absorption of _____.
A) minerals
B) fats
C) carbohydrates
D) proteins
Answer: B

26) Which of the following nutrients begins undergoing chemical digestion in the mouth?
A) amino acids

B) protein
C) starch
D) glucose
Answer: C

Use the following information to answer the following questions.

Several years ago, scientists discovered a mutation in zebrafish larvae that prevented the absorption of lipids from dietary fat. Larvae carrying this mutation died shortly after they hatched because all cells need fat to carry out their normal functions. More recent studies have determined that the mutation leading to this disorder occurs in a single gene on chromosome 10. When a normal gene is inserted into embryos carrying the mutation, these fish are able to process fats normally when they hatch. To discover more about the gene's function, researchers examined and compared cells from normal and mutant fish larvae under a microscope. A major difference was noticed in the intestinal cells. The Golgi apparatus in the intestinal cells of mutant larvae is much larger than those of normal larvae. As the Golgi apparatus processes fats and proteins, the lipids become trapped, resulting in the abnormally large size of the organelle.

1) Assuming that the digestive system of zebrafish works like that of a human, what substance do zebrafish need to make fats more easily digested by enzymes?
A) chyme
B) bile
C) lipase
D) pepsin
Answer: B

2) Assuming that the digestive system of zebrafish works like that of a human, which portion of the digestive tract is specialized for absorption of the nutrients?
A) stomach
B) small intestine
C) large intestine
D) pharynx
Answer: B