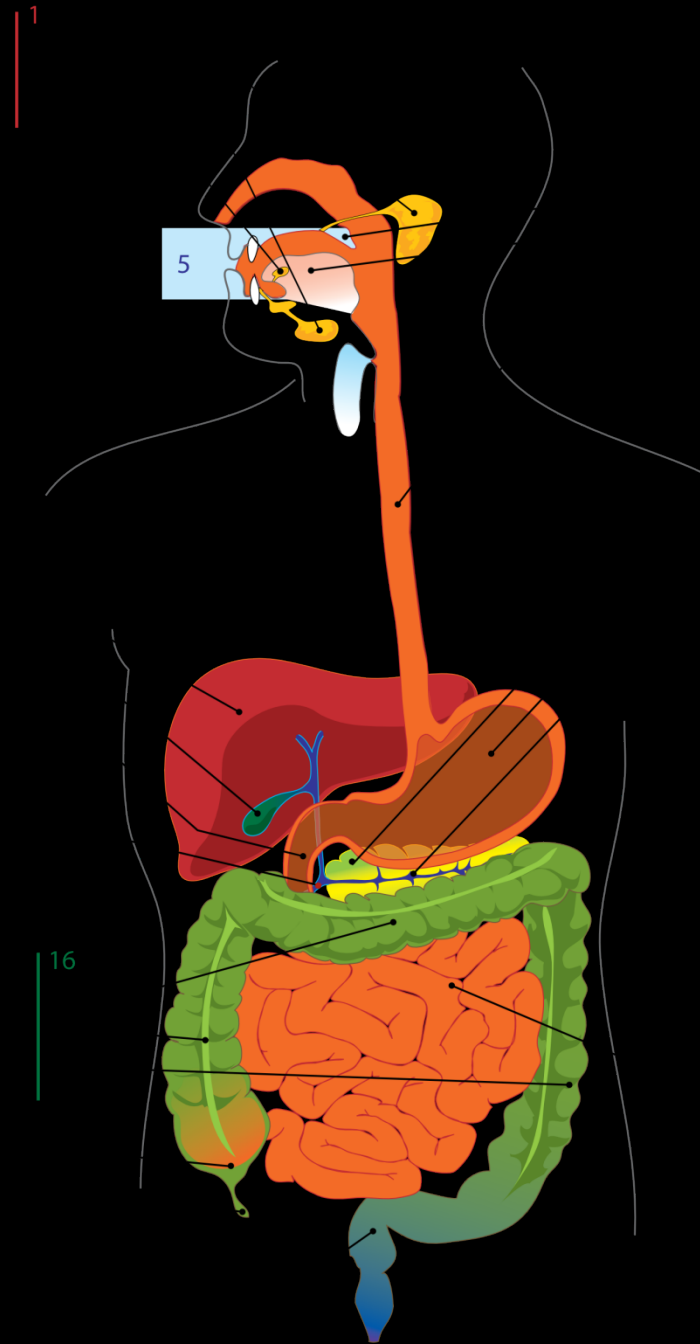


# Digestive System

# Digestive System



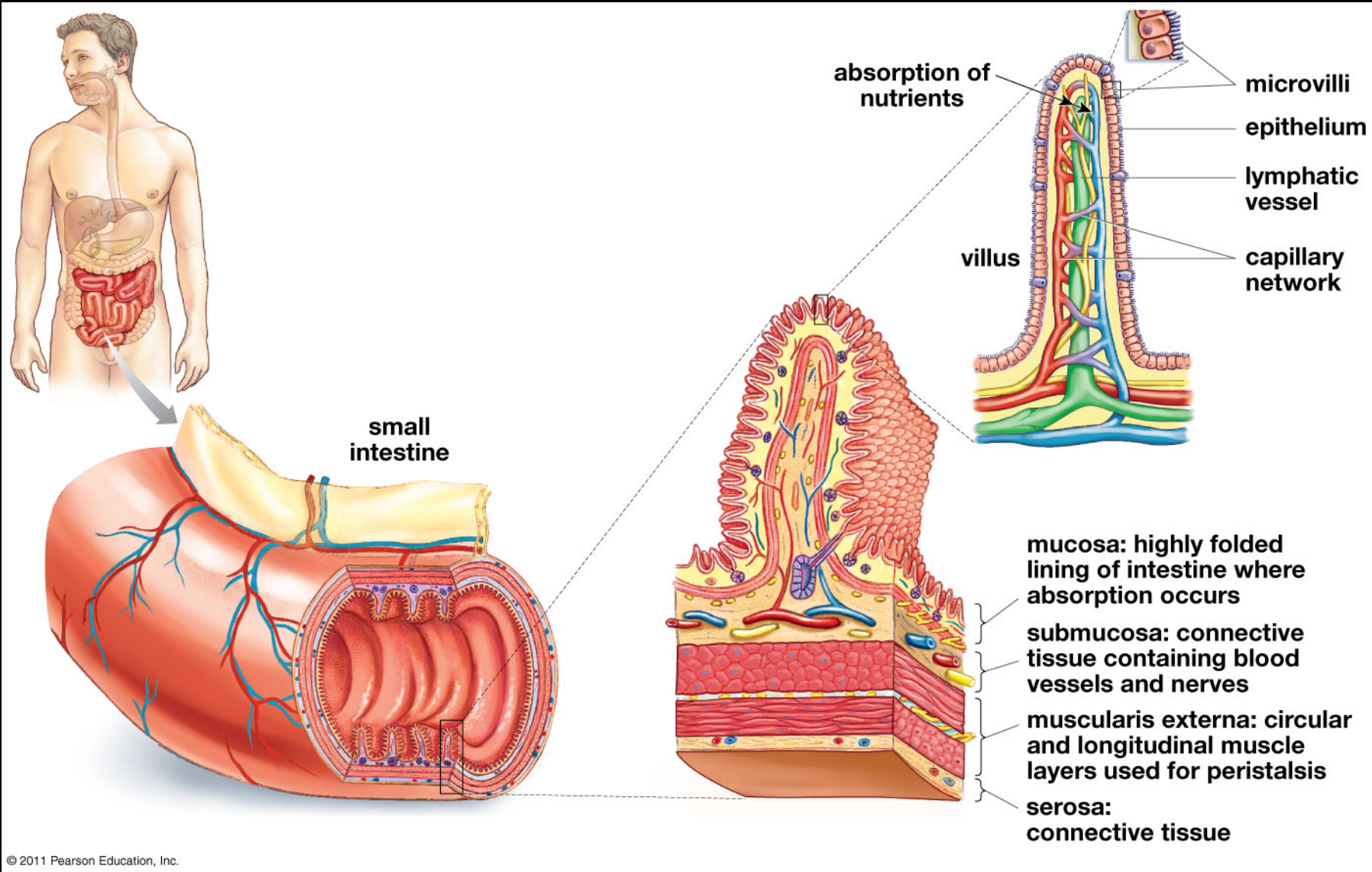
# Digestive System

**Table 31.1**

## Minerals Required by the Human Body

Mineral	Sources	Functions	Symptoms of Deficiency
<b>Major Minerals</b>			
Calcium (Ca)	Dairy products, leafy green vegetables	Maintenance of bones, muscle contraction, nerve signal transmission	Retarded growth in children; osteoporosis in adults
Chloride (Cl)	Table salt	Water balance, digestion	Very rare
Magnesium (Mg)	Broccoli, leafy green vegetables, whole-grain wheat products	Component of bones, teeth; nerve signaling, muscle contraction	Irregular heartbeat, muscle spasms, seizures
Phosphorus (P)	Dairy products, meat, whole grains	Component of bone, nucleic acids, ATP	Bone loss in older women
Potassium (K)	Numerous fruits and vegetables, dairy products	Nerve signal transmission, fluid balance	Muscle cramps, irregular heartbeat, paralysis
Sodium (Na)	Table salt	Nerve signal transmission, fluid balance	In rare instances, muscle cramps, shock
Sulfur (S)	Protein-rich foods (eggs, meat)	Detoxification of drugs; component of some amino acids, vitamins	Unknown when dietary protein is adequate
<b>Trace Minerals</b>			
Chromium (Cr)	Liver, nuts, whole grains	Helps activate insulin	Elevated glucose, insulin levels
Copper (Cu)	Liver, seafood, nuts, legumes	Enzyme activation, hemoglobin synthesis	Ricketts-like skeletal problems, anemia
Fluorine (F)	Fluorinated tap water, toothpaste	Resistance to tooth decay	Increased tooth decay
Iodine (I)	Iodized table salt, seafood, dairy products	Synthesis of thyroid hormones	Goiter, mental retardation in children of iodine-deficient mothers
Iron (Fe)	Whole grains, beef, fish, beans, nuts	Synthesis of hemoglobin	Iron deficiency anemia
Manganese (Mn)	Whole grains, nuts, leafy green vegetables	Enzyme activation	Never observed in humans
Molybdenum (Mo)	Dairy products, grains, legumes	Enzyme activation	Increased heart rate, night blindness, edema
Selenium (Se)	Seafood, liver, eggs	Enzyme activation	Muscle pain, weakness, vascular deterioration
Zinc (Zn)	Meat, poultry, fish, eggs, beans	Enzyme activation in many processes	Stunted growth, diarrhea

# Digestive System



# Digestive System

**Table 31.2**

## Vitamins in the Human Diet

Vitamins	Sources	Functions	Symptoms of Deficiency
<b>Water-Soluble Vitamins</b>			
Thiamin (B <sub>1</sub> )	Whole grains, legumes, nuts	Coenzyme in cellular respiration	Beriberi
Riboflavin (B <sub>2</sub> )	Dairy products, leafy green vegetables	Coenzyme in cellular respiration	Skin lesions; blurred vision
Niacin	Peanuts, poultry, beans	Part of cellular respiration enzyme	Pellagra, mental disorders
Vitamin B <sub>6</sub>	Whole grains, dairy products, nuts, leafy green vegetables	Part of coenzyme in amino acid synthesis	Anemia, twitching, skin disorders
Pantothenic acid	Nuts, beans, dairy products, eggs	Coenzyme in fat synthesis	Numbness, fatigue
Folic acid	Leafy green vegetables, beans, orange juice	Coenzyme in hemoglobin production, DNA formation	Spina bifida in mothers deficient in folic acid
Vitamin B <sub>12</sub>	Dairy products, eggs, meat	Coenzyme in nucleic acid formation, red blood cell maturation	Pernicious anemia
Biotin	Eggs, fish, poultry	Coenzyme in synthesis of fat, amino acids	Scaly, inflamed skin, poor growth
Vitamin C	Citrus fruits, green peppers, cauliflower, broccoli	Promotes collagen synthesis in bone, cartilage; antioxidant	Scurvy, poor wound healing
<b>Fat-Soluble Vitamins</b>			
Vitamin A	Liver, fish, eggs, fortified dairy products	Critical to vision	Night blindness, complete blindness in severe cases
Vitamin D	Can be produced by skin exposed to sunlight; fatty fish, fortified dairy products	Regulates bone metabolism; serves as transcription factor	Possible role in many diseases
Vitamin E	Vegetable oils, asparagus, eggs, almonds	Antioxidant; helps protect cell membranes	In infants, hemolytic anemia (rare)
Vitamin K	Liver, leafy green vegetables; some production by bacteria in gut	Production of compounds used in blood clotting	Blood-clotting problems in newborns

# Digestive System

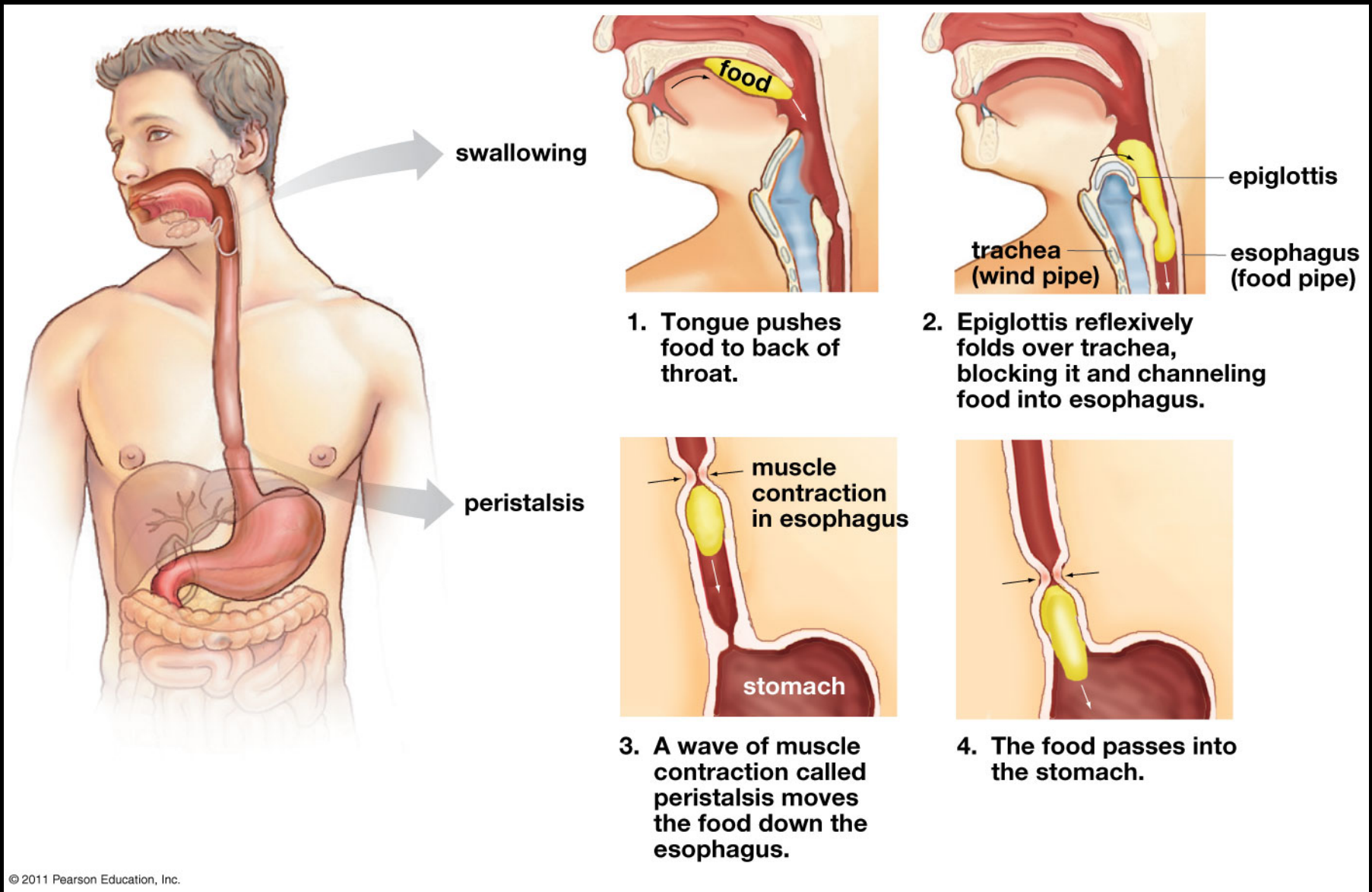
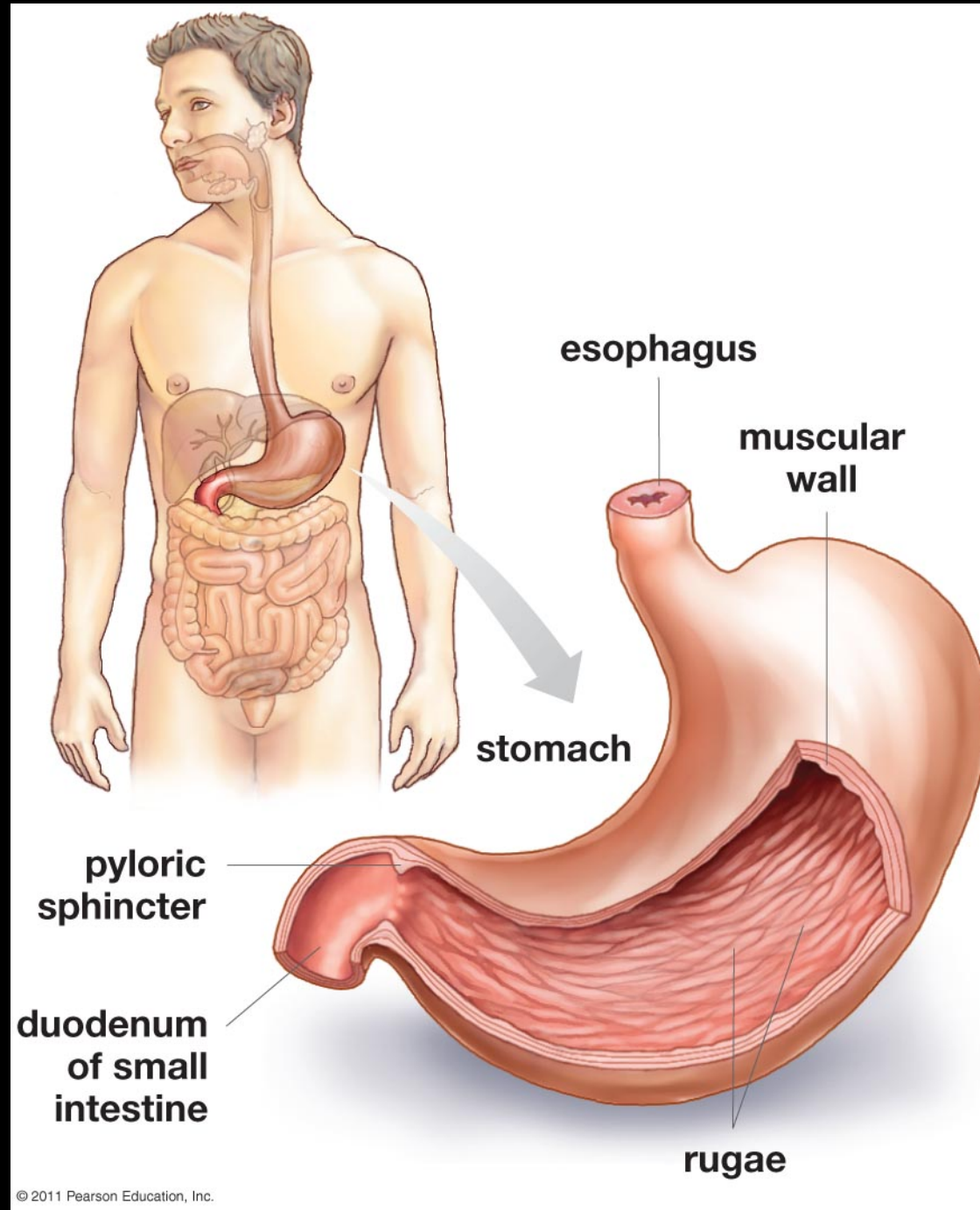


Fig. 31.3

# Digestive System



# Digestive System

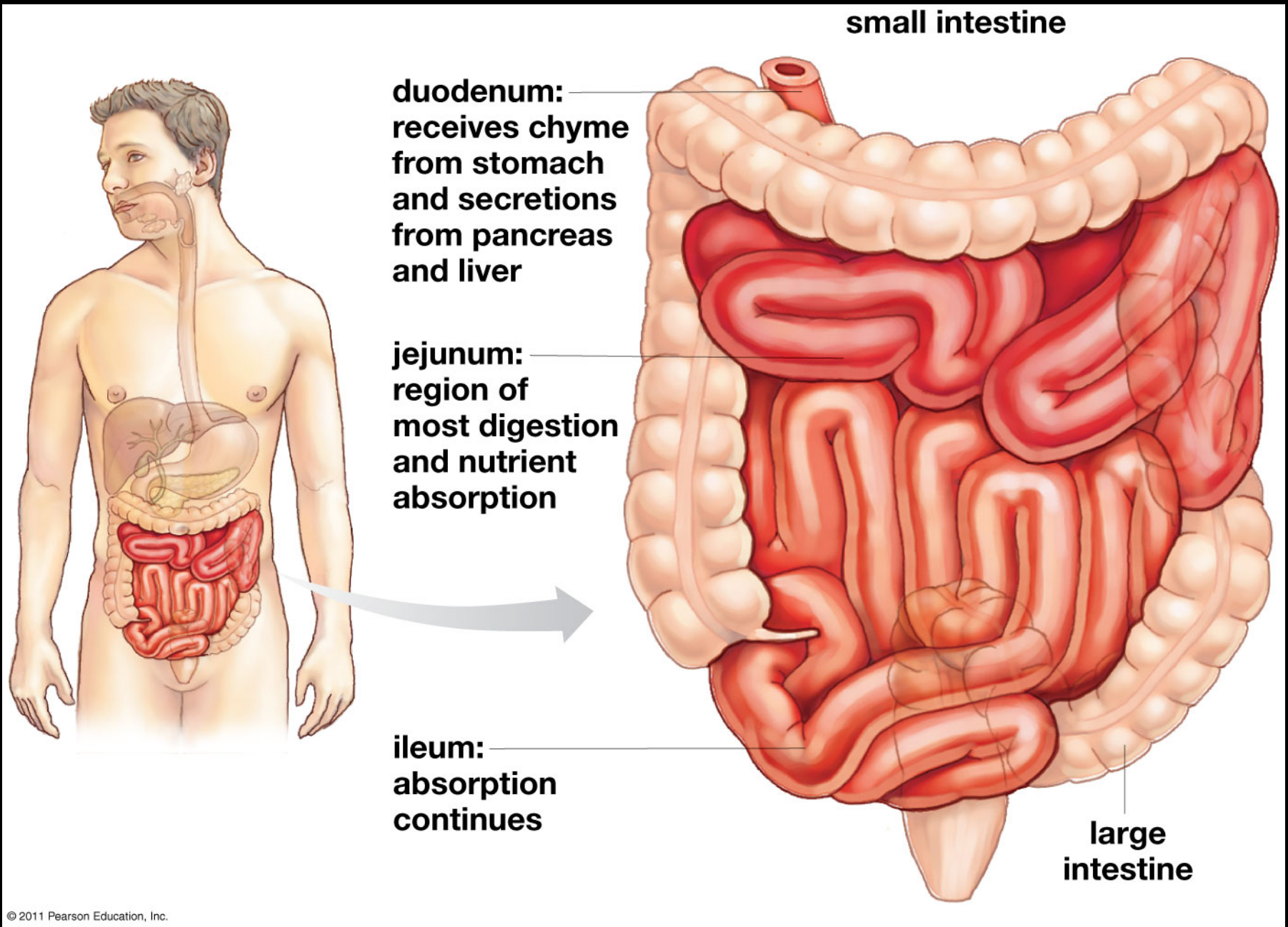


Fig. 31.5



# Digestive System

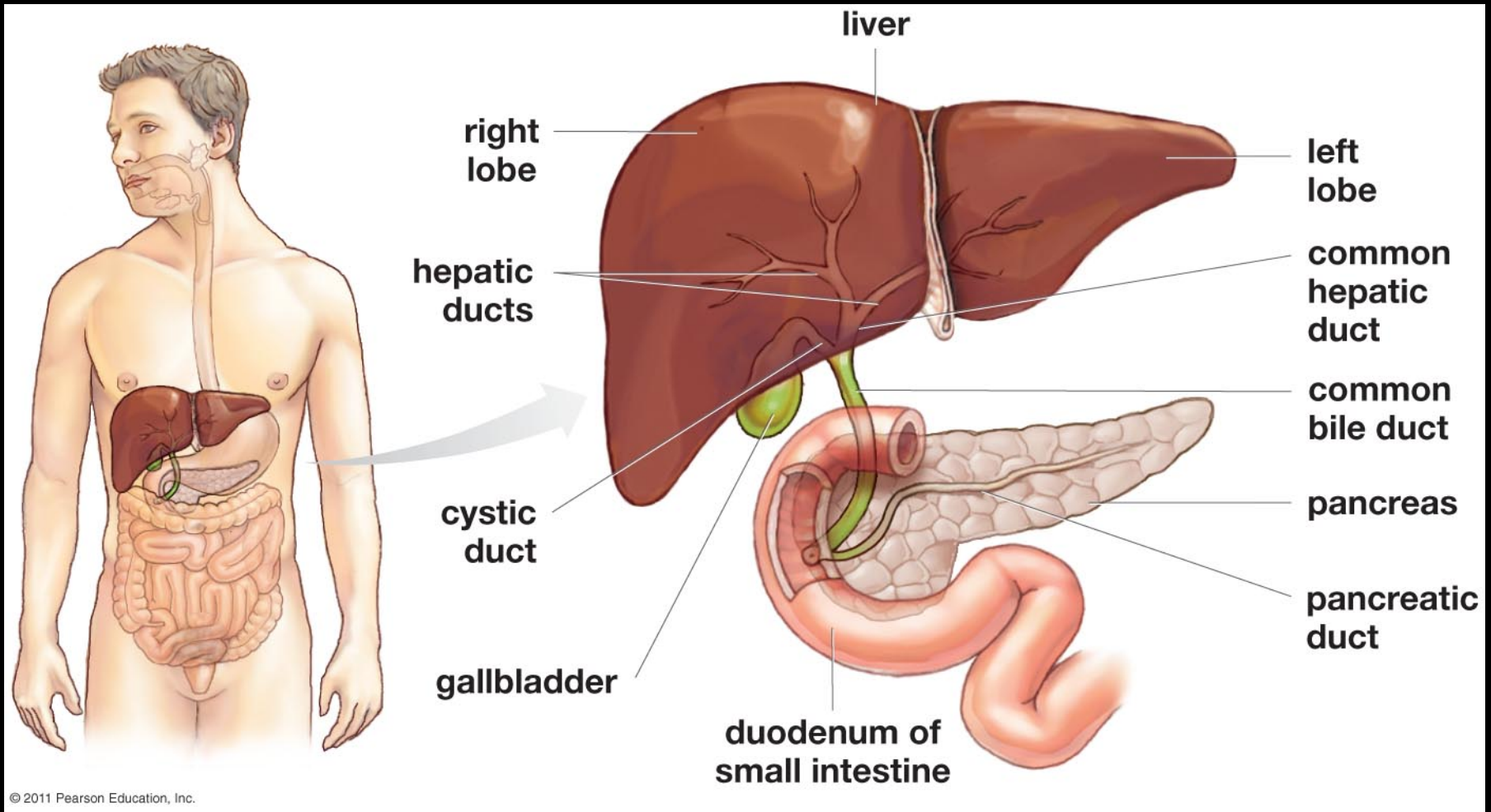
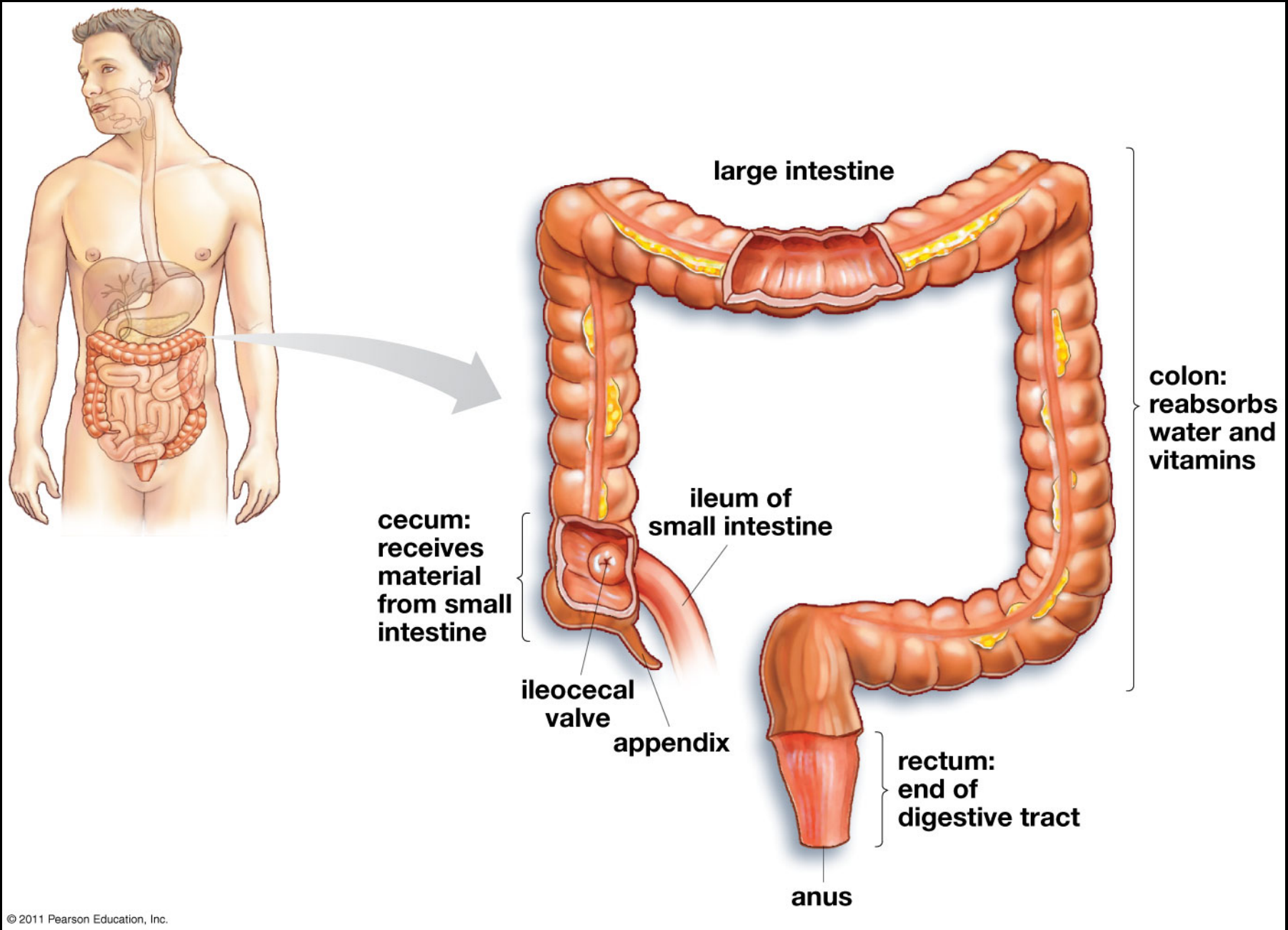


Fig. 31.6

# Digestive System



# Digestive System



# Digestive System

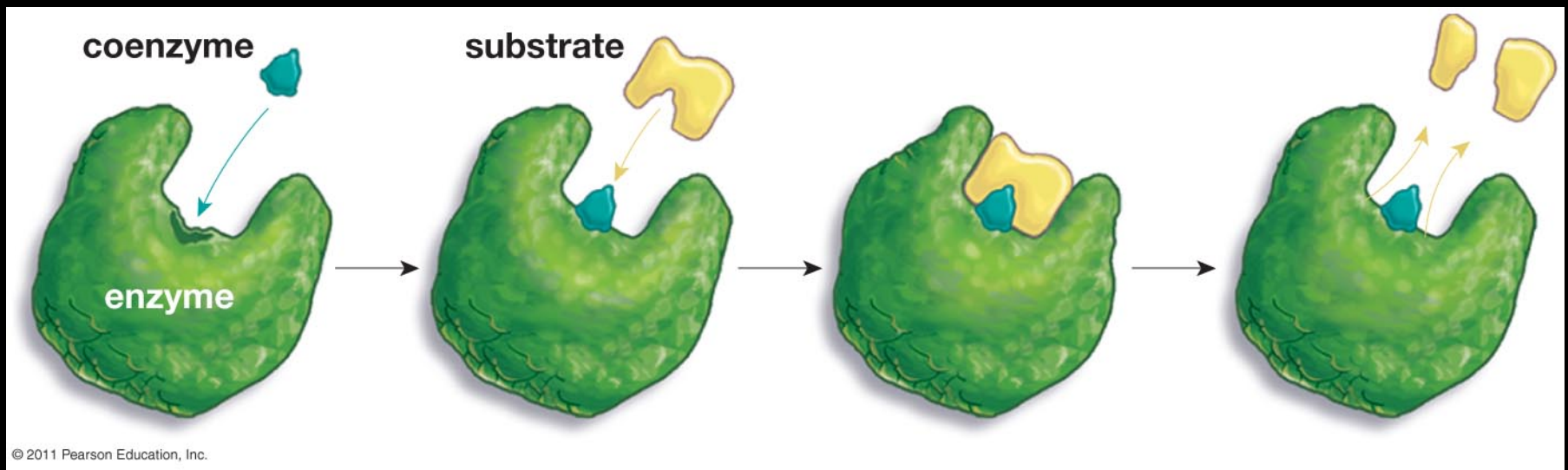


Fig. 31.9

# Digestive System

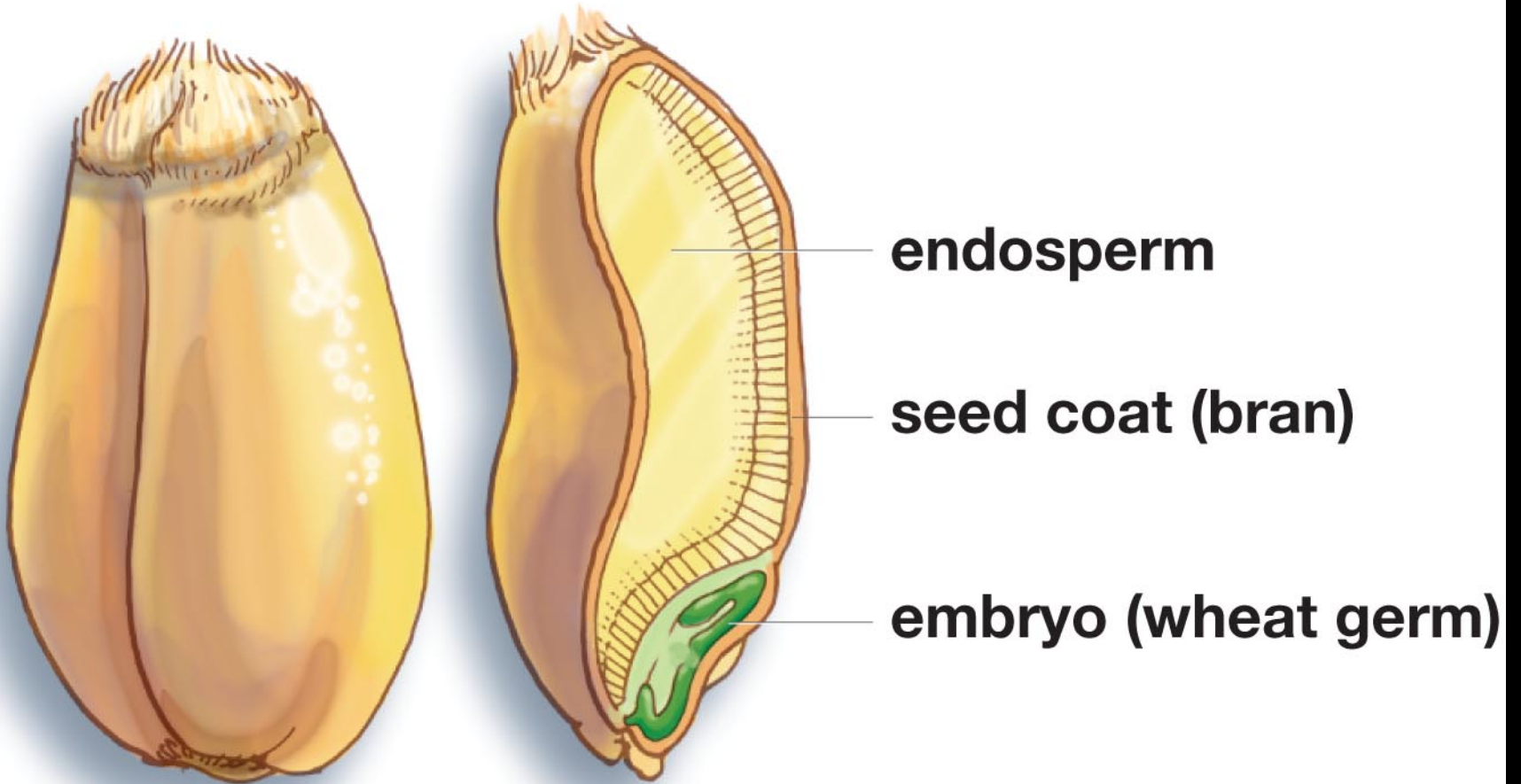


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Fig. 31.10

# wheat



**endosperm**

**seed coat (bran)**

**embryo (wheat germ)**

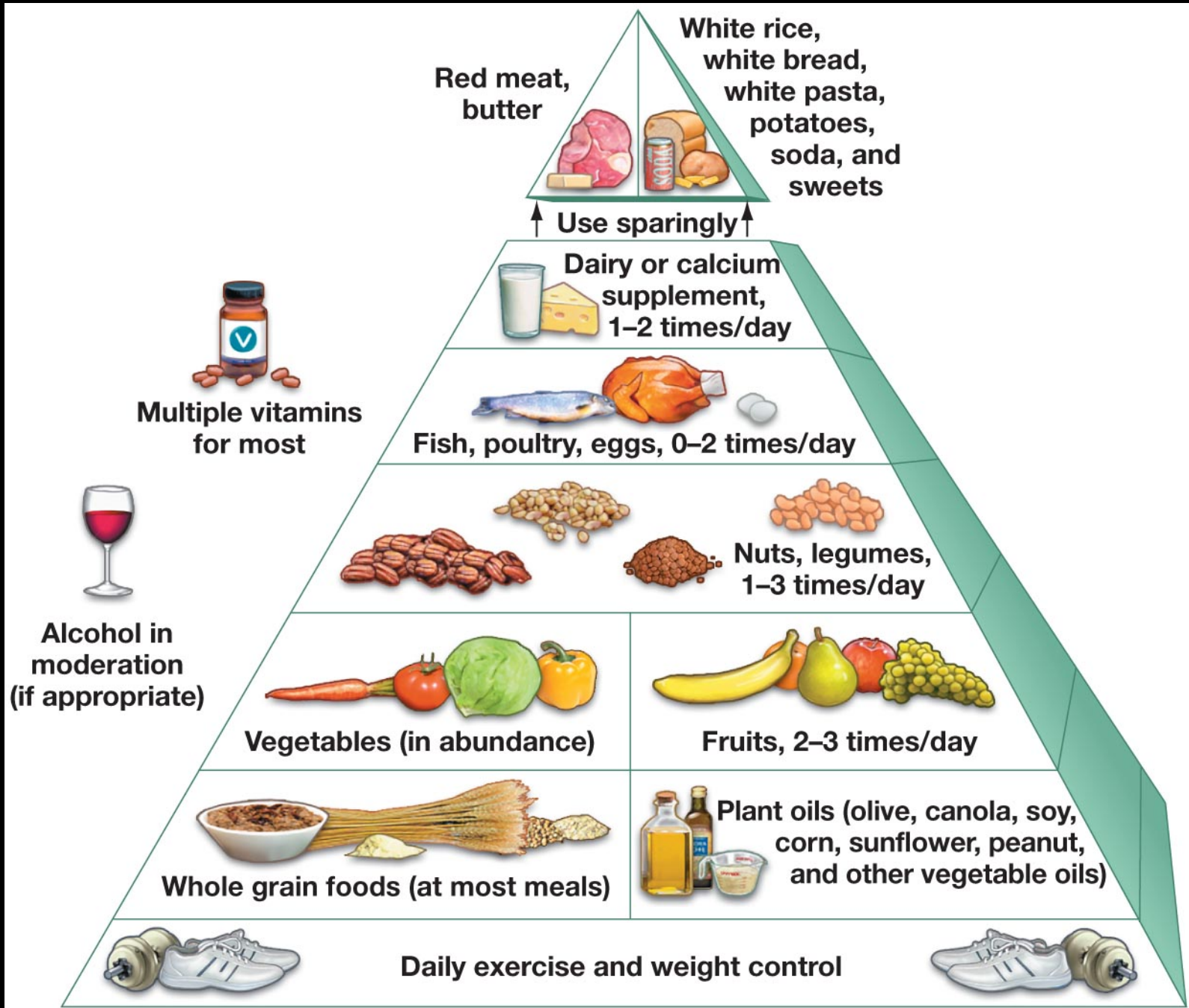


Fig. 31.13

# Digestive System

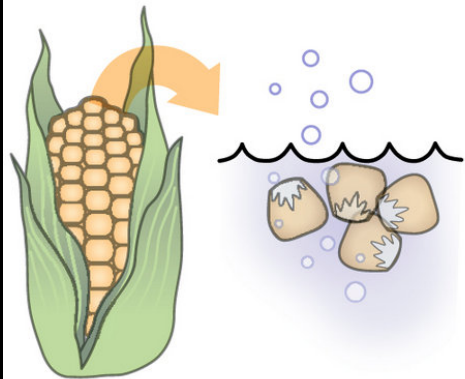


# High-fructose corn syrup (HFCS)

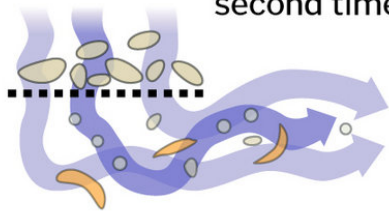
## Refining sweetness

Corn is converted to high-fructose corn syrup by adding enzymes, creating what has been called a “biological novelty” for the human body.

**1** Kernels are steeped in 122° F water for 30 to 40 hours.

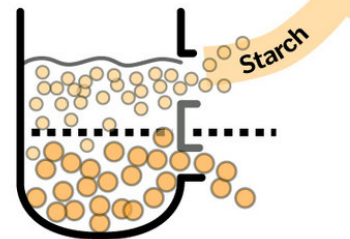


**2** Steeped corn is ground, breaking the germ loose from other components.



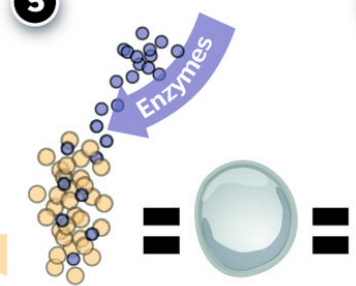
**3** Spinning separators pump germ away for refining into corn oil; remaining watery mixture is ground a second time.

**4** Gluten and starch are suspended in liquid; a centrifuge removes gluten, leaving starch.



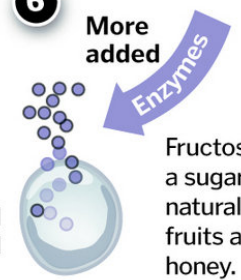
Some starch is dried and sold as cornstarch.

**5** Adding enzymes converts starch to glucose; further enzyme treatment increases level of sweetness until syrup becomes fructose.



Adding enzymes converts starch to glucose; further enzyme treatment increases level of sweetness until syrup becomes fructose.

**6** Adding low- to medium-sweetness glucose to fructose makes high-fructose corn syrup. Fructose is a sugar found naturally in fruits and honey.

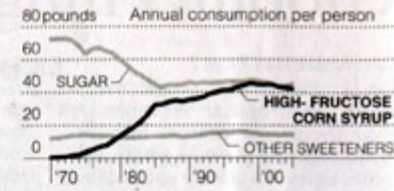


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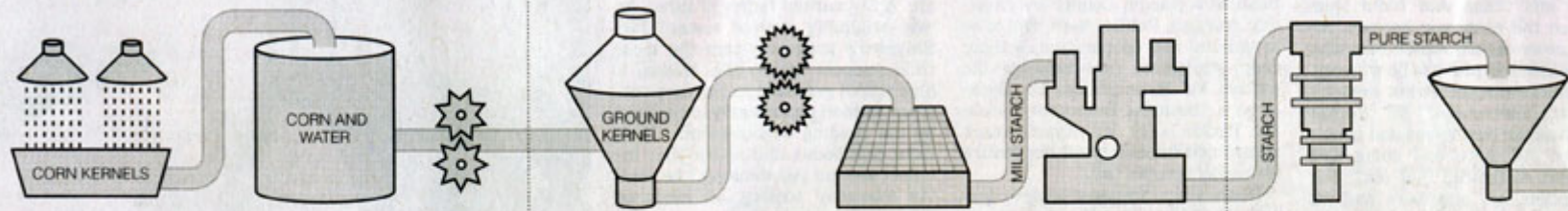
# High-fructose corn syrup (HFCS)

## Creating a Ubiquitous Sweetener

Corn syrup is found in many food products, including "all-natural products." Though demonized by many as a leading cause of obesity in the United States, evidence suggests that it may be no different than the refined sugar it often replaces. Although the components of high-fructose corn syrup occur naturally in foods, it takes a number of mechanical and chemical processes to turn corn into it.



**Corn to Cornstarch** A corn kernel is roughly 80% starch. The extraction of its starch is largely a mechanical process.



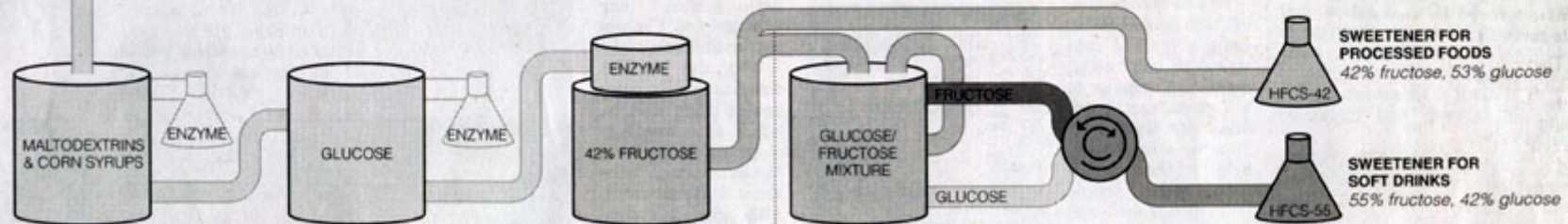
**Preparing corn for processing** Dry kernels are cleaned and then steeped in water. Once softened, the corn is coarsely ground to break apart the germ.

**Separating corn's components** After a cyclone separator removes the corn's oil-rich germ, fine grinding releases starch from the fiber, which is then caught in screens. A centrifuge separates the gluten (protein) from the starch.

**Purification and preparation** The starch is further purified and hydrated for processing.

HYDRATED STARCH

**Cornstarch to High-Fructose Corn Syrup** Cornstarch is a complex carbohydrate composed of very long chains of glucose sugars. Chemical processing is needed to convert the starch to fructose and glucose, the main components of high-fructose corn syrup.



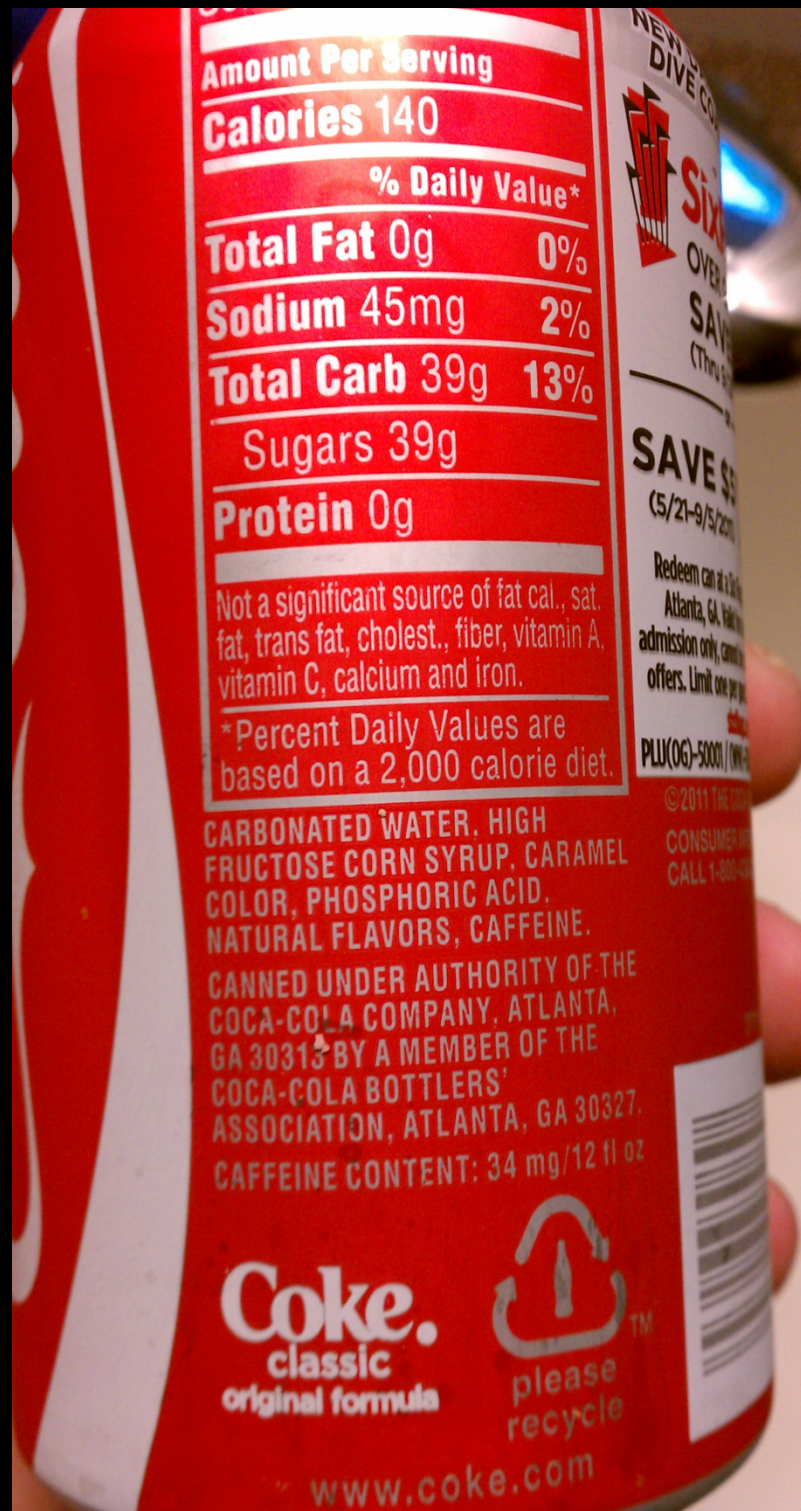
**Processing with enzymes** The hydrated cornstarch goes through three enzyme processes that break down the long chains of starch into simple glucose. The last enzyme changes some of the glucose into fructose, making 42% high-fructose corn syrup.

**Separation and blending** The fructose is separated from the glucose. Blending the two creates a 55% fructose solution.

Sources: Corn Refiners Association; United States Department of Agriculture

Tommy McCall for The New York Times

# Is this food?



# Another way of teaching?



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