Animal nutrition

Time to eat

The big picture

- **Autotrophy** vs. **heterotrophy**
- Why do we need food?

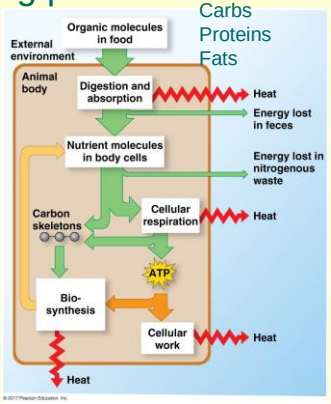
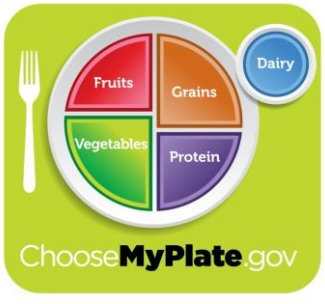


Fig. 40.19

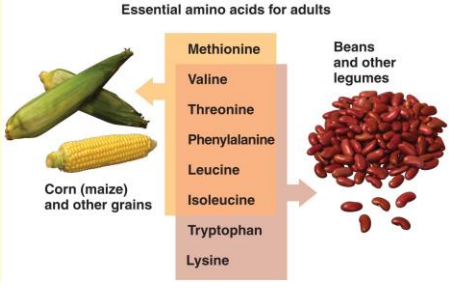
Essential nutrients

- **Malnourished** vs. **undernourished**
- What's essential?
  - Stuff that ….
  - Amino acids
  - Vitamins
  - Minerals
  - Fatty acids



Essential amino acids

- Humans cannot synthesize **8** of the 20 AA's needed to make proteins; also difficult to store
- Can lead to protein deficiency, especially in infants
- Some obvious sources of AA's?
  - Also…



Vitamins

- _____ molecules required in very small amounts; 13 are essential
- Solubility influences over-dosage concerns

Table 41.1 Vitamin Requirements of Humans

Vitamin	Major Dietary Sources	Major Functions in the Body	Symptoms of Deficiency
Water-Soluble Vitamins			
B_1 (thiamine)	Pork, legumes, peanuts, whole grains	Coenzyme used in removing CO_2 from organic compounds	Beriberi (tingling, poor coordination, reduced heart function)
B_2 (riboflavin)	Dairy products, meats, enriched grains, vegetables	Component of coenzymes FAD and FMN	Skin lesions, such as cracks at corners of mouth
B_3 (niacin)	Nuts, meats, grains	Component of coenzymes NAD^+ and $NADP^+$	Skin and gastrointestinal lesions, delusions, confusion
B_5 (pantothenic acid)	Meats, dairy products, whole grains, fruits, vegetables	Component of coenzyme A	Fatigue, numbness, tingling of hands and feet
B_6 (pyridoxine)	Meats, vegetables, whole grains	Coenzyme used in amino acid metabolism	Irritability, convulsions, muscular twitching, anemia
B_7 (biotin)	Legumes, other vegetables, meats	Coenzyme in synthesis of fat, glycogen, and amino acids	Scaly skin inflammation, neuromuscular disorders
B_9 (folic acid)	Green vegetables, oranges, nuts, legumes, whole grains	Coenzyme in nucleic acid and amino acid metabolism	Anemia, birth defects
B_{12} (cobalamin)	Meats, eggs, dairy products	Production of nucleic acids and red blood cells	Anemia, numbness, loss of balance
C (ascorbic acid)	Citrus fruits, broccoli, tomatoes	Used in collagen synthesis; antioxidant	Scurvy (degeneration of skin and teeth), delayed wound healing
Fat-Soluble Vitamins			
A (retinol)	Dark green and orange vegetables and fruits, dairy products	Component of visual pigments; maintenance of epithelial tissues	Blindness, skin disorders, impaired immunity
D	Dairy products, egg yolk	Aids in absorption and use of calcium and phosphorus	Rickets (bone deformities) in children, bone softening in adults
E (tocopherol)	Vegetable oils, nuts, seeds	Antioxidant; helps prevent damage to cell membranes	Nervous system degeneration
K (phylloquinone)	Green vegetables, tea; also made by colon bacteria	Important in blood clotting	Defective blood clotting

Minerals

- _____ nutrients required in small amounts

Table 41.2 Mineral Requirements of Humans*

Mineral		Major Dietary Sources	Major Functions in the Body	Symptoms of Deficiency
More than 200 mg per day required	Calcium (Ca)	Dairy products, dark green vegetables, legumes	Bone and tooth formation, blood clotting, nerve and muscle function	Impaired growth, loss of bone mass
	Phosphorus (P)	Dairy products, meats, grains	Bone and tooth formation, acid-base balance, nucleotide synthesis	Weakness, loss of minerals from bone, calcium loss
	Sulfur (S)	Proteins from many sources	Component of certain amino acids	Impaired growth, fatigue, swelling
	Potassium (K)	Meats, dairy products, many fruits and vegetables, grains	Acid-base balance, water balance, nerve function	Muscular weakness, paralysis, nausea, heart failure
	Chlorine (Cl)	Table salt	Acid-base balance, formation of gastric juice, nerve function, osmotic balance	Muscle cramps, reduced appetite
	Sodium (Na)	Table salt	Acid-base balance, water balance, nerve function	Muscle cramps, reduced appetite
	Magnesium (Mg)	Whole grains, green leafy vegetables	Enzyme cofactor; ATP bioenergetics	Nervous system disturbances
Iron (Fe)		Meats, eggs, legumes, whole grains, green leafy vegetables	Component of hemoglobin and of electron carriers; enzyme cofactor	Iron-deficiency anemia, weakness, impaired immunity
Fluorine (F)		Drinking water, tea, seafood	Maintenance of tooth structure	Higher frequency of tooth decay
Iodine (I)		Seafood, iodized salt	Component of thyroid hormones	Goiter (enlarged thyroid gland)

*Additional minerals required in trace amounts include cobalt (Co), copper (Cu), manganese (Mn), molybdenum (Mo), selenium (Se), and zinc (Zn). All of these minerals, as well as those in the table, can be harmful in excess.

Fig. 41.3

Feeding categories

- Herbivores
- Carnivores
- Omnivores
- Are these strict categories?

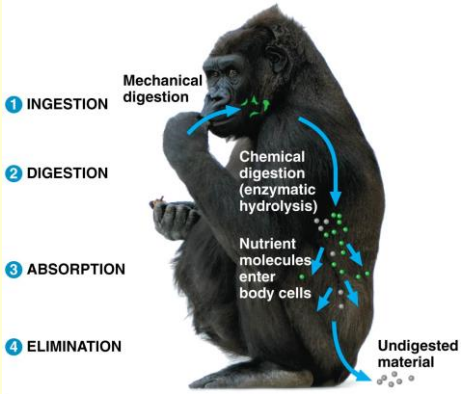
Feeding mechanisms

- Filter feeders
- Substrate feeders
- Fluid feeders
- Bulk feeders

Fig. 41.5

Food processing overview

- 4 stages



Ingestion adaptations

- Diet vs. dentition

Red-bellied black snake fang

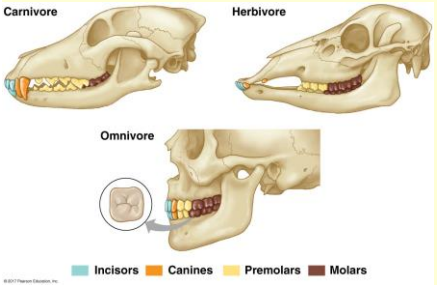


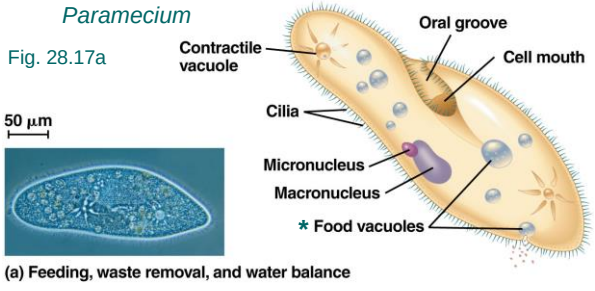
Fig. 41.15

Digesting food instead of yourself

- Use specialized compartments
- **Intracellular** digestion

Paramecium

Fig. 28.17a



(a) Feeding, waste removal, and water balance

Extracellular digestion

- Food breakdown in compartments that are continuous with the outside of the body
- **Complete digestive tracts** or **alimentary canals**
- Unidirectional; specialized regions

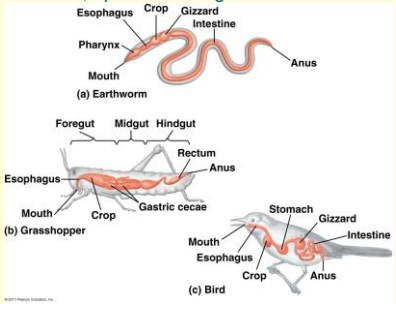


Fig. 41.7

Digestion in humans

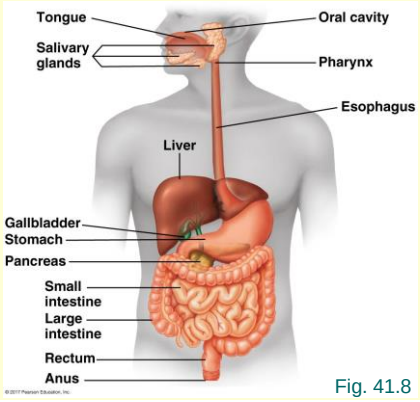
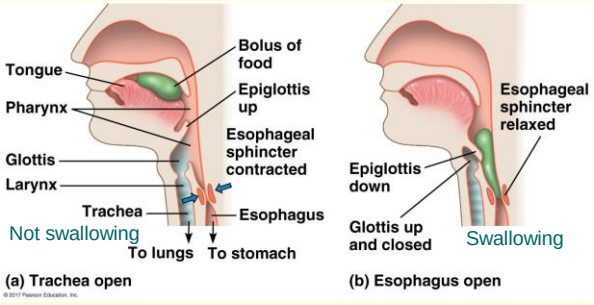


Fig. 41.8

Down the hatch

- Salivary amylase hydrolyzes starch and glycogen



Peristalsis

Fig. 41.09

Digestion in the stomach

- Storage and preliminary digestion
- Gastric juice has a pH of 2
- **Pepsin** hydrolyzes protein
- Why not the stomach itself?
- Result: **acid chyme**

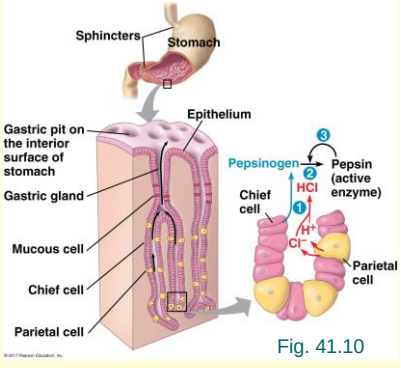
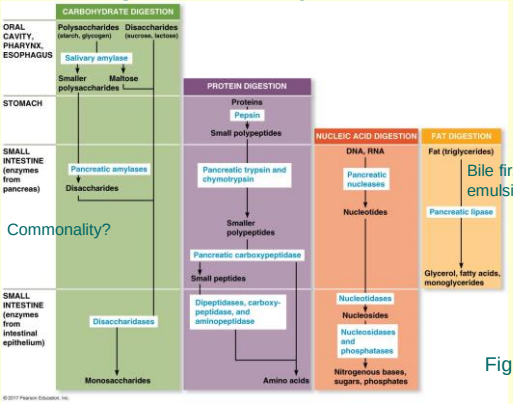


Fig. 41.10

Digestive enzymes at work



Commonality?

Bile first emulsifies fats

Fig. 41.11

Small intestine structure

- Increasing surface area for what?

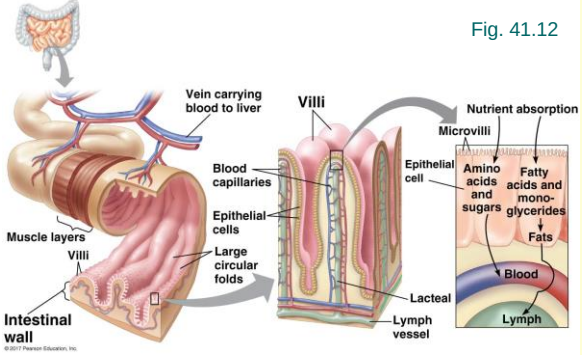


Fig. 41.12

Absorption in the large intestine

- Water recovery, bacteria (microbiome)

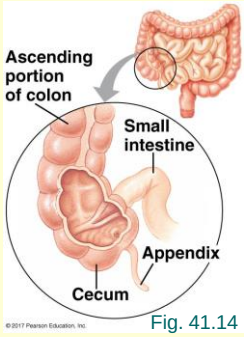


Fig. 41.14

Digestion adaptations

- Diet vs. alimentary canal

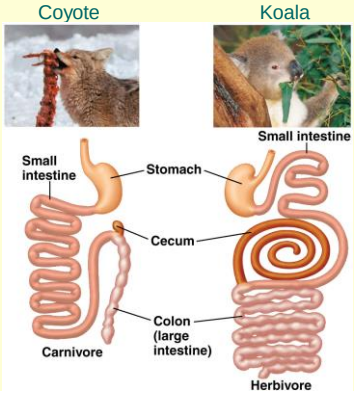


Fig. 41.16

Ruminant digestion

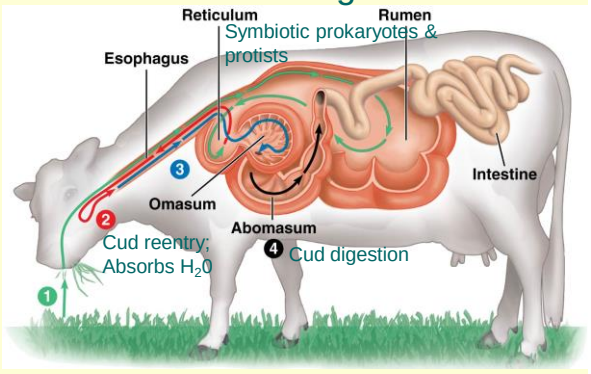


Fig. 41.19