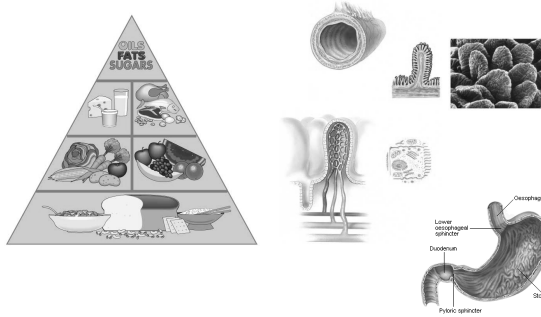


## Chapter 34: Nutrition and Digestion




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**Nutrition:** Process of acquiring / processing nutrients into usable form

**Function of Nutrients:**

1) Fuel cellular metabolism

- ❖ Measured in calories (energy required to raise 1 g of water 1 °C)
  - Calorie = 1000 calories (kilocalorie)
  - Human at rest = 1550 calories burned/day



2) Building blocks to construct complex molecules

3) Molecules to assist in metabolic reactions

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**Nutrient Classifications:**

1) Carbohydrates:

- Energy source (~ 46% for humans)
  - Body cells burn glucose (some exclusively)
- Energy storage (short-term): Glycogen (liver / muscles)
- Obtained via animal products (e.g. muscle) and plants (starch)

2) Lipids:

- Energy source (~ 38% for humans)
- Energy storage (long-term): Fats
  - 1 pound = 3600 Calories (Carbs = 1600 Calories / pound)
  - Hydrophobic; no excess water storage
- Provide building materials (e.g. phospholipids, cholesterol)

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Nutrient Classifications:

3) Proteins:

- Energy source (~ 16% for humans)
  - Urea: Byproduct of protein breakdown
- Provide building materials (amino acids)
  - Essential amino acids: Can not be synthesized by body (9 / 20 amino acids)

4) Minerals (Elements / Inorganic molecules - Table 34.3):

- Structural material (e.g. calcium, iron, iodine)
- Assist in physiological functions (e.g. sodium, potassium, calcium)
  - Sodium, potassium, calcium, magnesium, etc are also called electrolytes

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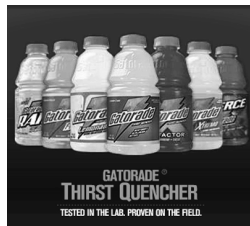
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## Electrolytes

- Required to maintain certain functions
  - ❖ Muscles, neurons, etc.
- Imbalance causes death
  - ❖ Excess water drinking leads to fatal electrolyte imbalance
  - ❖ Sport drinks contain electrolytes to prevent water intoxication



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Nutrient Classifications:

5) Vitamins (Organic compounds - diverse group):

- Water-soluble: Cleared from body (urine)
  - Vitamin C = Maintenance of connective tissues
  - B-vitamin complex = Coenzymes
- Water-insoluble: Stored in body (fat)
  - Vitamin A = Produces visual pigments
  - Vitamin D = Promotes bone growth
  - Vitamin E = antioxidant
  - Vitamin K = Regulates blood clotting

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## Vitamin deficiencies

- Vitamin A : blindness

- ❖ We consume beta carotene, which is converted to Vitamin A in our bodies.

- ❖ Beta Carotene is found in red/orange vegetables.



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## Vitamin deficiencies

- Vitamin B complex

- ❖ Several different vitamin B

- Thiamin (Vitamin B1)
- Niacin (Vitamin B2)
- Pantothenic acid (Vitamin B6)
- Vitamin B12
- Biotin
- Choline

- Deficiencies lead to diseases beriberi, pellagra, anemia, & mental disorders.

- ❖ Sources: grains, legumes, animal products



Hand of someone with pellagra

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## Vitamin deficiencies

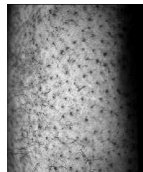
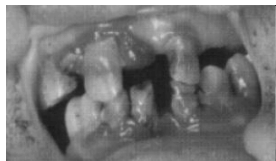
- Vitamin C

- ❖ Ascorbic acid

- ❖ Deficiencies lead to Scurvy

- Especially affected sailors

- Professional sailors always carried limes or other citrus fruits to ward off scurvy



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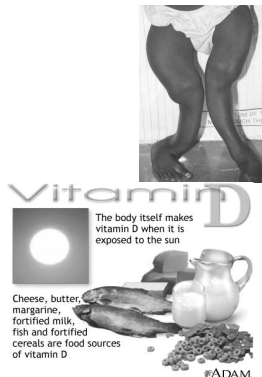
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## Vitamin deficiencies

- Vitamin D : Rickets

- ❖ Caused by lack of calcium absorption in bones.

- ❖ Sunlight, eggs, cod liver oil, dairy products




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## Vitamin deficiencies

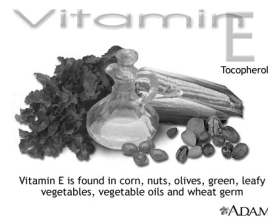
- Vitamin E

- ❖ Anemia, neurological problems

- ❖ Deficiencies are very rare

- Mainly due to genetic disorders that prevent the absorption of fat.

- ❖ Seeds, green leafy vegetables, oils




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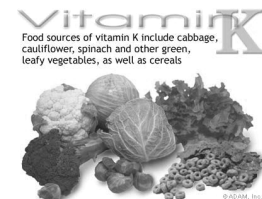
## Vitamin deficiencies

- Vitamin K

- ❖ Bleeding, hemorrhages

- ❖ Deficiencies rare due to production of vitamin K with the help of intestinal bacteria (E. coli).

- Excessive use of broad spectrum antibiotics can result in deficiencies.




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## Fat soluble vitamins can lead to overdoses

- Fat soluble vitamins are stored in the fatty tissues in the body
  - The reason why deficiencies are rare with modern diets.
  - Overdoses are becoming more common due to supplements, retinol, etc.
- Vitamin A : 15,000 IU per day or more can be toxic
  - Especially toxic to developing fetuses = birth defects
  - Liver damage

Each single tablet provides the following:

	Amount	% Daily Value
Vitamin A (Acetate)	5000 IU	100%
Vitamin C (Ascorbic Acid)	150 mg	250%
Vitamin D2	400 IU	100%
Vitamin E (dl-Alpha Tocopherol Acetate)	50 IU	167%
Vitamin B1 (Thiamine Mononitrate)	12.5 mg	833%
Vitamin B2 (Riboflavin)	12.5 mg	735%
Vitamin B3 (Niacin)	50 mg	250%
Vitamin B6 (Pyridoxine HCL)	12.5 mg	625%
Folic Acid	400 mcg	100%
Vitamin B-12	50 mcg	833%
Biotin	75 mcg	25%
Vitamin B5 (dl-Calcium Pantothenate)	25 mg	250%
Calcium (Calcium Phosphate, Carbonate)	100 mg	10%
Iron (Iron Acid Chelate)	18 mg	100%
Iodine (Iodine)	150 mcg	100%
Magnesium (Oxide)	20 mg	5%
Zinc (Oxide)	9 mg	60%
Copper (Glucuronate)	130 mcg	6.50%
Manganese (Mnino Acid Chelate)	2 mg	100%
Boron (Citrate)	1 mg	*
Choline (Bitartrate)	30 mg	*
Inositol	30 mg	*
PABA	12.5 mg	*
Citrus Bioflavonoids	10 mg	*
Peppermint	10 mg	*
Betaine HCL	12.5 mg	*
Atalax (leaf) Medicago Sativa	5 mg	*
Chamomile (leaf) Matricaria Recutita	5 mg	*
Rose Hips (leaf) Rosa Canina	5 mg	*
Rutin	12.5 mg	*
Parsley (leaf) Petroselinum Sativum	5 mg	*
Acerola Extract Malpighia Glabra	500 mcg	*

\*Daily Value Not Established

## Fat soluble vitamins can lead to overdoses

- More than 15,000 IU of Vitamin D per day can lead to overdoses
  - Most deaths are due to children eating sugar coated vitamins.

Each single tablet provides the following:

	Amount	% Daily Value
Vitamin A (Acetate)	5000 IU	100%
Vitamin C (Ascorbic Acid)	150 mg	250%
Vitamin D2	400 IU	100%
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Rutin	12.5 mg	*
Parsley (leaf) Petroselinum Sativum	5 mg	*
Acerola Extract Malpighia Glabra	500 mcg	*

\*Daily Value Not Established

## Fat soluble vitamins can lead to overdoses

- More than 1,500 IU of Vitamin E per day can lead to overdoses
  - Excess leads to anticoagulation in blood.

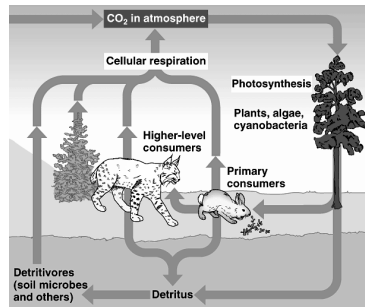
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Rutin	12.5 mg	*
Parsley (leaf) Petroselinum Sativum	5 mg	*
Acerola Extract Malpighia Glabra	500 mcg	*

\*Daily Value Not Established

## Nutrient acquisition

- Herbivore  
❖ Eat plants
- Carnivore  
❖ Eat animals
- Omnivore  
❖ Eat plants & animals




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Digestion: Mechanical and chemical breakdown of food

- Required to absorb nutrients (complex  $\rightarrow$  simple)

Tasks of Digestive System:

- 1) Ingestion = Food enters system (mouth)
- 2) Mechanical Breakdown = Food physically broken down
- 3) Chemical Breakdown = Food broken down via enzymes  
❖ Increased surface area (enzyme attack)
- 4) Absorption = Nutrients from digestive cavity into body
- 5) Elimination = Indigestible material cleared

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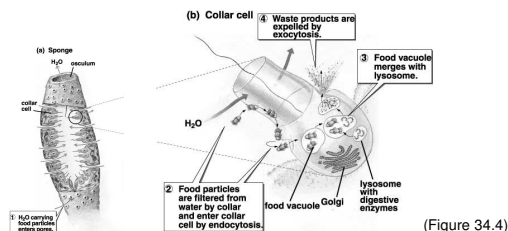
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Animal Digestive Systems:

- 1) Intracellular Digestion (e.g. protists, sponges)
  - Cells engulf microscopic particles (no specialized system)

- 1) Enclosed in food vacuole
- 2) Lysosomes (organelle w/ enzymes) breakdown food
- 3) Waste expelled (exocytosis)




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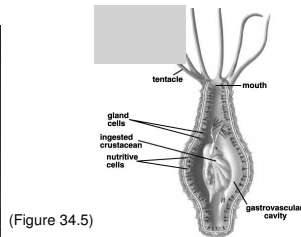
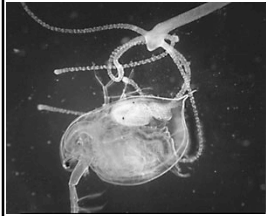
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### Animal Digestive Systems:

#### 2) Sac Digestion (e.g. jellyfish)

- ❖ Chamber present (gastrovascular cavity); single opening
  - Extracellular Digestion (enzymes released into chamber)
- ❖ Food enters / waste exits same opening



(Figure 34.5)

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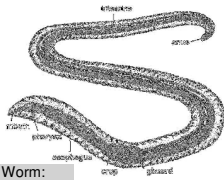
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### Animal Digestive Systems:

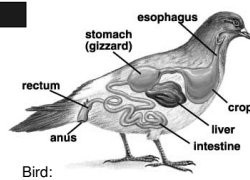
(Figures 34.6 & 34.7)

#### 3) Tube Digestion (e.g. worms, arthropods, vertebrates)

- Tube present; two openings (mouth, anus)
  - Efficient digestion of food (one-way system):
    - ❖ Crop / Stomach #1 = Food storage
    - ❖ Stomach #2 / Gizzard = Mechanical digestion
    - ❖ Intestines = Chemical digestion / Absorption



Worm:



Bird:

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### gizzard

- Many toothless animals (i.e., birds) will swallow stones to aid digestion.
  - ❖ Stones help grind food inside the gizzard




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## Crop

- Pigeons, doves and flamingoes produce crop milk
- ❖ A secretion produced by the crop that is used to feed the young.




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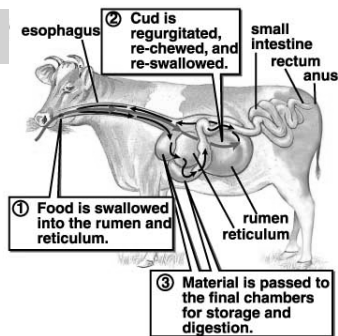
## Highly Specialized Tube Digestion:

(Figures 34.6)

Ruminants Digest Cellulose...

Rumination:  
Regurgitating & re-chewing food

- Mixes food with cellulase
- ❖ Cellulase produced by bacteria in the rumen




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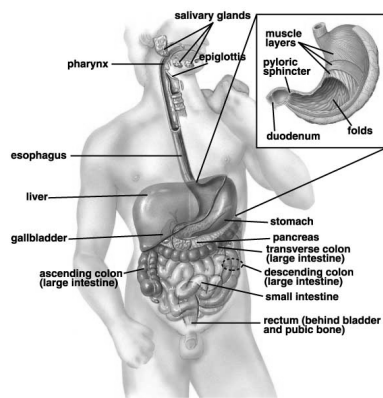
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## Human Digestive System:



(Figure 34.9)

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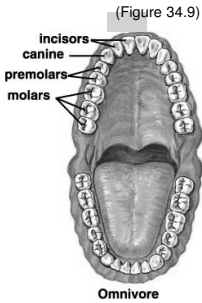
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Process of Human Digestion:

1) Breakdown of Food begins in Mouth

- Mechanical breakdown = Teeth
  - ❖ Incisors: Snip food
  - ❖ Canines: Tear food
  - ❖ Premolars/Molars: Grind food
- Chemical Digestion = Salivary Glands
  - ❖ Amylase: Enzyme → Carbohydrates




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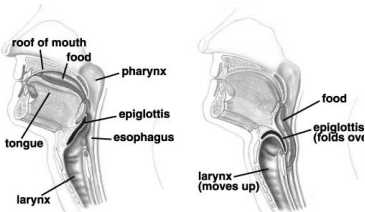
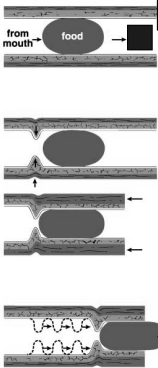
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Process of Human Digestion:

2) Esophagus conveys food to stomach

- Peristalsis: Rhythmic contraction of smooth muscle; propels food
- Bolus: Compacted food


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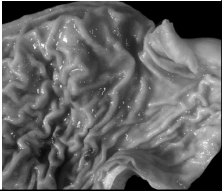
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Process of Human Digestion:

3) Stomach:

- Stores food (2 - 4 liters = 0.5 - 1 gallon)
- Mechanically breaks down food (smooth muscle → churns)
- Chemically breaks down food
  - ❖ Acidic environment (pH 1 - 3 → HCl secretion)
  - ❖ Pepsin: Enzyme → Proteins
    - Bleeding Ulcers
- Chyme = Thick, acidic liquid
- Water, Alcohol, Drugs (e.g. aspirin) absorbed through stomach wall




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Process of Human Digestion:

4) Small Intestine = Chemical digestion & absorption:

- Longest portion of digestive system (~ 3.5 m)
- Chemical Digestion:
  - Pancreas (pancreatic juice)
    - Bicarbonate ion = neutralizes chyme
    - Amylase = Enzyme → carbohydrates
    - Lipase = Enzyme → lipids
    - Proteases = Enzymes → proteins
  - Liver (bile)
    - Bile stored / concentrated in gallbladder
      - Bile salts = Assist in breakdown of fats
        - Emulsify fats (separate into small droplets)

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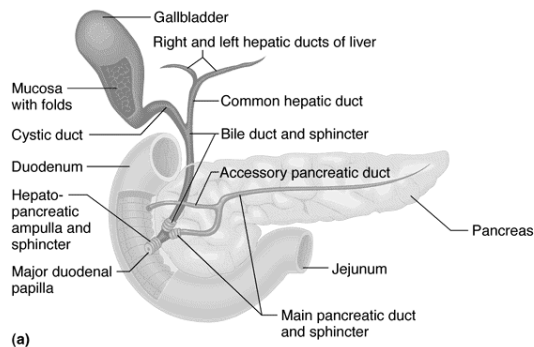
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Small Intestine and Related Organs:




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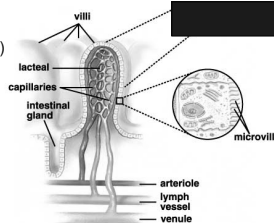
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Process of Human Digestion:

4) Small Intestine = Chemical digestion & absorption:

- Absorption:
  - ❖ Large surface area (2200 square feet)
  - Villi: Finger-like projections tube surface
  - Microvilli: Projections of cell membrane
- Blood / lymph vessels (lacteals) run up villi (nutrient absorption)
  - ❖ Requires energy (ATP)
- Movements:
  - ❖ Segmentation (mixing)
  - ❖ Peristalsis (propulsion)




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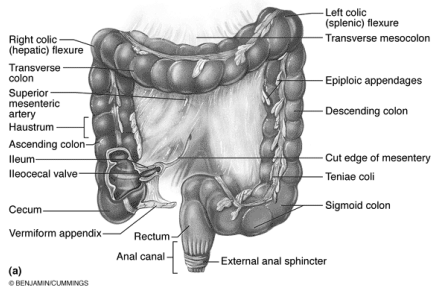
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Process of Human Digestion:

5) Large Intestine = absorption & elimination:

- ~ 1.5 m long (colon & rectum):




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Process of Human Digestion:

5) Large Intestine = absorption & elimination:

- ~ 1.5 m long (colon & rectum):
- Contain bacteria:
  - ❖ Produce Vitamin B complexes and Vitamin K
- Absorbs water, vitamins, salts
- Movement via peristalsis & defecation
  - ❖ Feces = Indigestible waste (semi-solid)

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Control of Digestion:

1) Nervous System:

- Food stimuli activates digestive system (e.g. smell, taste, stretch)
  - ❖ Secretes saliva (mouth), HCl (stomach)

2) Endocrine System:

- Gastrin: Stimulates HCl secretion (stomach)
- Secretin: Stimulates bicarbonate release (pancreas)
- Cholecystokinin: Stimulates bile release (gallbladder)

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