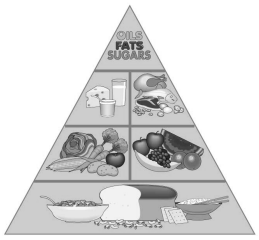
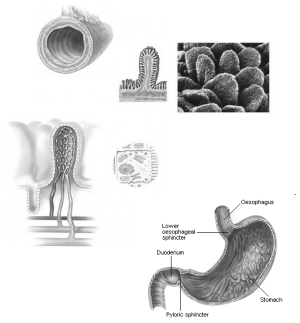
Chapter 34:
Nutrition and Digestion





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

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)

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

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

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

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.

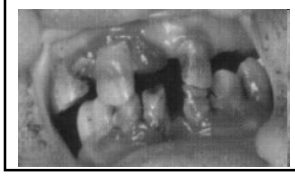
Vitamin deficiencies

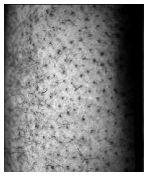
- Vitamin B complex
  - ❖Several different vitamin B
    - ➢Thiamin (Vitamin B1)
    - ➢Niacin (Vitamin B2)
    - ➢Pantothenic acid (Vitamin B6)
    - ➢Vitamin B12
    - ➢Biotin
    - ➢Choline
- Deficiencies lead to diseases beriberi, pellagra, anemia, & mental disorders.
  - ❖Sources: grains, legumes, animal products

Hand of someone with pellagra

Vitamin deficiencies

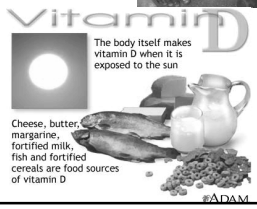
- Vitamin C
  - ❖Ascorbic acid
  - ❖Deficiencies lead to Scurvy
    - ➢Especially affected sailors
    - ➢Professional sailors always carried limes or other citrus fruits to ward off scurvy





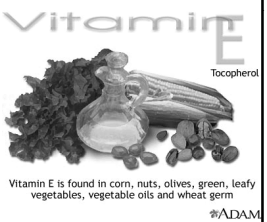
Vitamin deficiencies

- Vitamin D : Rickets
  - ❖Caused by lack of calcium absorption in bones.
  - ❖Sunlight, eggs, cod liver oil, dairy products



Vitamin deficiencies

- Vitamin E
  - ❖Anemia, neurological problems
  - ❖Deficiencies are very rare
    - ➢Mainly due to genetic disorders the prevent the absorption of fat.
  - ❖Seeds, green leafy vegetables, oils



Vitamin E is found in corn, nuts, olives, green, leafy vegetables, vegetable oils and wheat germ

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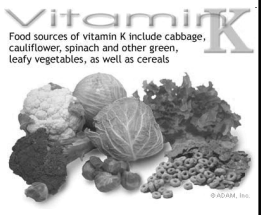
Vitamin deficiencies

- 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.



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 (d-Calcium Pantothenate)	25 mg	250%
Calcium (Calcium Phosphate, Carbonate)	100 mg	10%
Iron (Amino Acid Chelate)	18 mg	100%
Iodine (Kelp)	150 mcg	100%
Magnesium (Oxide)	20 mg	5%
Zinc (Oxide)	9 mg	60%
Copper (Gluconate)	130 mcg	6.50%
Manganese (Amino Acid Chelate)	2 mg	100%
Boron (Citrate)	1 mg	*
Choline (Bitartrate)	30 mg	*
Inositol	30 mg	*
PABA	12.5 mg	*
Citrus Bioflavinoids	10 mg	*
Pectin	10 mg	*
Betaine HCL	12.5 mg	*
Alfalfa (leaf) Medicago Sativa	5 mg	*
Chamomile (leaf) Matricaria Recutita	5 mg	*
Rose Hips (leaf) Rosa Canina	5 mg	*
Rutin	12.5 mg	*
Parsley (leaf) Petoselinum Sativum	5 mg	*
Acercola Extract Malphighia 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
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Rutin	12.5 mg	*
Parsley (leaf) Petoselinum Sativum	5 mg	*
Acercola Extract Malphighia 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.

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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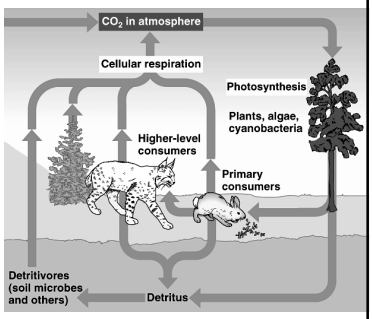
*Daily Value Not Established

Nutrient acquisition

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



Digestion: Mechanical and chemical breakdown of food

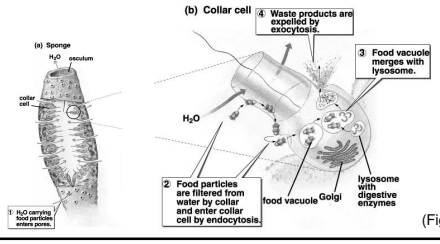
- Required to absorb nutrients (complex → simple)

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

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)

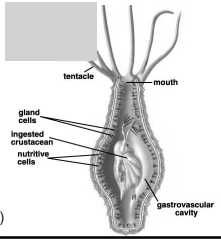


(Figure 34.4)

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

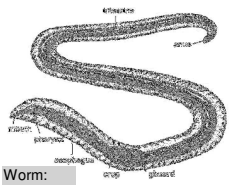


(Figure 34.5)

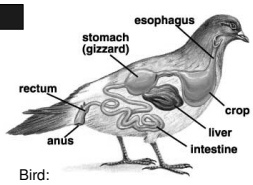
Animal Digestive Systems: (Figures 34.6 & 34.7)

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:

gizzard

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

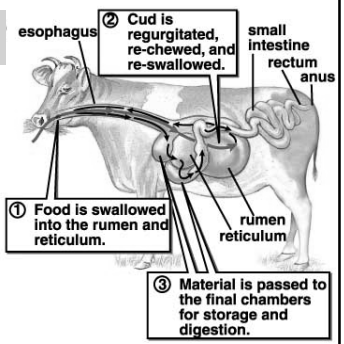
Crop

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

Highly Specialized Tube Digestion: (Figures 34.6)

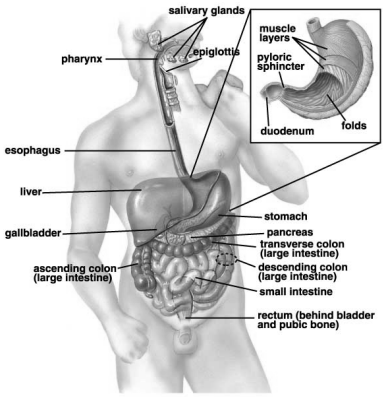
Ruminants Digest Cellulose...

Rumination: Regurgitating & rechewing food



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

Human Digestive System:

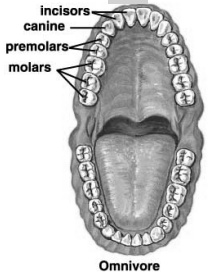


(Figure 34.9)

Process of Human Digestion:

1) Breakdown of Food begins in Mouth

(Figure 34.9)



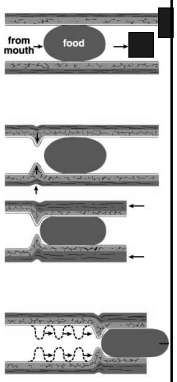
- Mechanical breakdown = Teeth
  - ❖ Incisors: Snip food
  - ❖ Canines: Tear food
  - ❖ Premolars/Molars: Grind food
- Chemical Digestion = Salivary Glands
  - ❖ Amylase: Enzyme → Carbohydrates

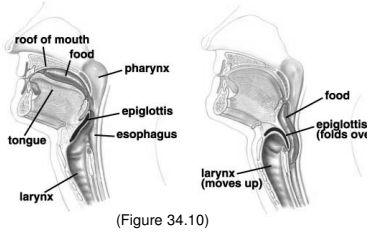
Process of Human Digestion:

2) Esophagus conveys food to stomach

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

(Figure 34.11)



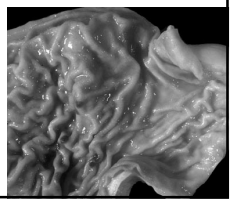


(Figure 34.10)

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

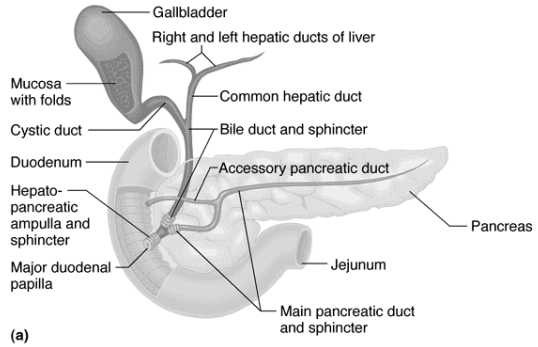


Process of Human Digestion:

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)

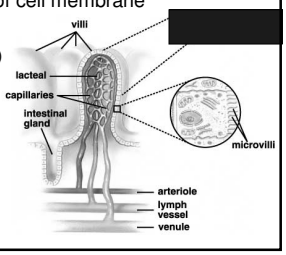
Small Intestine and Related Organs:



Process of Human Digestion:

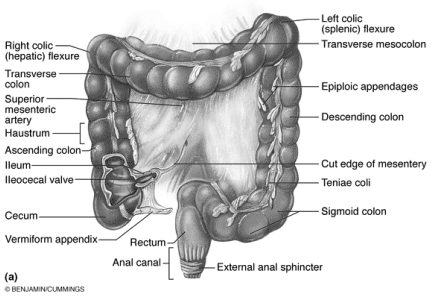
4) Small Intestine = Chemical digestion & absorption:

- 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)



Process of Human Digestion:

5) Large Intestine = absorption & elimination:
   - ~ 1.5 m long (colon & rectum):



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)

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)