Nutrition and Digestion
Classes of Nutrients

- Carbohydrates
- Lipids
- Proteins
- Minerals
- Vitamins
- Water
Macronutrients

• Carbon-containing compounds

• Energy and raw material

• Includes carbohydrates, lipids, & proteins

• Body needs substantial amounts
Carbohydrates

• Should supply 45-65% of daily energy
• Includes fruits, vegetables, whole grains
Proteins

- Should supply 10-35% of daily energy
- Proteins made of 20 amino acids
- Essential amino acids must come from diet
Fats

• Should supply 20-35% of daily energy

• Types of fats
  – Monosaturated (good)
  – Polyunsaturated (good)
  – Saturated (bad)
  – Trans fats (bad)
Vitamins

• Play vital role in body function

• Most are derived from diet

• Required in small amounts

• Excess of some can be toxic
Minerals

• Inorganic substances

• Transported as ions

• Variety of uses
Water

• No set amount daily
• Body must maintain normal hydration
Digestion

• Breaking of food particles into molecules
• Unnecessary in autotrophs
• Two types of digestion
  – Intracellular
  – Extracellular

NO DIGESTION (autotrophs)  Plants
Organisms with Intracellular & Extracellular Digestion

**INTRACELLULAR AND EXTRACELLULAR DIGESTION**
(hydra, jellyfish, corals, sea anemones, comb jellies, flatworms)

- Digestive cavity
- Daphnia (water flea)
- Food vacuole
- Food particles
- Flagellum

Hydra
Extracellular Digestion
Fungi

EXTRACELLULAR DIGESTION
No digestive system (fungi and some bacteria)

Fungal hyphae invading plant cell
Cross-section of plant cells

Mushroom
Extracellular Digestion
Most Animals

EXTRACELLULAR DIGESTION
Digestive system (most animals)

Bird

Earthworm

Human
Extracellular Digestion

• In organisms with & without a digestive system
  – Fungi – no digestive system
  – Most animals – digestive system

• Relies on enzymes (chemical digestion)

• Mechanical digestion may also be present
<table>
<thead>
<tr>
<th>Source</th>
<th>Enzyme</th>
<th>Substrate</th>
<th>Digestion Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salivary gland</td>
<td>Amylase</td>
<td>Starch, glycogen</td>
<td>Disaccharides</td>
</tr>
<tr>
<td>Stomach</td>
<td>Pepsin</td>
<td>Proteins</td>
<td>Short polypeptides</td>
</tr>
<tr>
<td>Small intestine</td>
<td>Peptidases</td>
<td>Short peptides</td>
<td>Amino acids</td>
</tr>
<tr>
<td>Pancreas</td>
<td>Lactase, maltase, sucrase</td>
<td>Disaccharides</td>
<td>Glucose, monosaccharides</td>
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<tr>
<td></td>
<td>Pancreatic amylase</td>
<td>Starch, glycogen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trypsin, chymotrypsin, carboxypeptidase</td>
<td>Proteins</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lipase</td>
<td>Triglycerides</td>
<td>Fatty acids, glycerol</td>
</tr>
</tbody>
</table>
Digestive system: digests food and absorb nutrients

There are two ways of digests food:
1) Mechanical digestion- chewing and mixing by stomach breaks food into small chunks

2) Chemical digestion- enzymes break down large molecules into smaller ones
   - salivary amylase digests starch
   - stomach pepsin digests protein
   - small intestine has many enzymes, including some from pancreas, also bile from liver

Absorption - small intestine has villi and microvilli
   - large intestine reabsorbs water
The Digestive Process

- Chewing
- Saliva breaks down food
- Epiglottis blocks the trachea
- Muscles push the food down
- Food mixes with acid
- Digestion and absorption of nutrients
- Waste enters the colon
The bolus enters the pharynx, and the soft palate closes the nasal cavity.

The larynx rises up to meet the epiglottis. The bolus presses on the epiglottis and bends it downward, closing the opening to the windpipe.

The bolus enters the esophagus.
You have a trap door called the epiglottis to cover your windpipe when you swallow.
Epiglottis

• Folds over opening to larynx

• Directs food into esophagus

• Esophagus moves food toward stomach
  – Peristalsis = slow rhythmic squeezing
  – Gravity helps movement
Peristalsis

- Relaxed longitudinal muscles
- Contracted circular muscles
- Bolus
- Sphincter closed

(a) Longitudinal (lengthwise) muscles relax while circular muscles contract, pushing the bolus ahead.

(b) Sphincter open
Stomach

- Muscular sac
  - Churns & mixes food

- Gastric glands
  - Pepsin
    - Protein enzyme
  - Gastrin
    - Hormone
    - Controls gastric juices
  - Hydrochloric acid
  - Mucus
Food in the Stomach

• Mixed with gastric juices

• Churned by muscles

• Leaves as paste (chyme)

• Process takes 2-6 hours
Oral cavity
Tongue
Mouth
Salivary glands
Pharynx
Esophagus
Diaphragm
Liver
Gall bladder
Stomach
Pancreas
Small intestine
Large intestine (colon)
Rectum
Anus
Small Intestine

- Site of most digestion
- Absorption of amino acids, lipids and monosaccharides

- Site of nutrient absorption

- Area of association with accessory organs
  - Liver
  - Pancreas
  - Gall bladder
Small intestine: duodenum, jejunum and ileum
Duodenum: continues to break down food enzymes from the pancreas and bile from the liver;
Ileum and jejunum: absorb nutrients into the blood stream also uses peristalsis.

Pancreas-secretes digestive system enzymes into duodenum; produces insulin.

Liver- process nutrients absorbed from small intestine; releases bile into duodenum and it process the breakdown fat and detoxify body.

Gallbladder-stores and secrets bile; release bile into small intestine to breakdown fats

Nutrients from the food pass into the bloodstream through the small intestine walls.
Pancreas:
• Secretes many enzymes
• Empties into duodenum
• Alkaline solution to help neutralize acids
• Helps you digest food by breaking down sugars

Liver:
• Secretes bile - emulsifies fats

Gallbladder
• Stores bile
• Releases bile into duodenum
• Storage tank for bile (a greenish-yellow liquid) that helps your body break down and use fats
• Located under your liver
• Shaped like a pear
Absorption in Small Intestine

• Absorption means taking into the body via the blood stream

• Villi & microvilli: Projections to increase surface area

• Energy helps nutrients cross membranes

• Nutrients diffuse into capillaries
  – Blood capillaries for all but lipids
  – Lacteals pick up lipids
Hormones Control Digestive Enzymes

1. Gastrin in stomach stimulates release of gastric juice, which contributes to the production of chyme.

2. Chyme in small intestine stimulates intestinal cells in mucosa to produce secretin and CCK.

3. Secretin stimulates release of sodium bicarbonate from pancreas. CCK stimulates release of digestive enzymes from pancreas.

4. Sodium bicarbonate neutralizes acids in small intestine.

5. Secretin increases rate of bile secretion in the liver.

6. CCK signals gall-bladder to contract and pour contents into small intestine.
Large Intestine

- Areas of Colon
  - Cecum
  - Rectum
  - Terminates at anus
The Digestive System

Functions

- Digests food
- Absorbs nutrients for the body

Components

- Esophagus
- Stomach
- Small intestine
- Large intestine
- Pancreas
- Liver
- Gall Bladder