Animals: Digestion and Nutrition

Do you like pizza?

Let’s eat something
**Outline**

1. Key concepts
2. Nutrition
3. Comparison of different animals’ digestive systems
4. Human digestive system
5. Key terms
6. Conclusions

**Key Concepts**

Food can be

1. Sources of energy
   - A. Carbohydrates
   - B. Fats
   - C. Proteins
2. Sources of nutrients for growth and metabolism
   - A. Protein
   - B. Minerals
   - C. Vitamins
   - D. Lipids

Digestion – breakdown of food into molecules that can be absorbed by the body cells.
Nutrition
Undernourished:
Diet is deficient in calories

Kwashiorork

How come you are sooo fat?
Overnourishment
Homeostasis of fat
Leptin and other genes
Malnourished &
Essential nutrients

“8” Essential amino acids
#9 histidine
### Table 41.1a Vitamin Requirements of Humans

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Major Dietary Sources</th>
<th>Major Functions in the Body</th>
<th>Symptoms of Deficiency or Extreme Excess</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water-Soluble Vitamins</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin B₁ (Thiamin)</td>
<td>Pork, liver, lentils, whole grains,</td>
<td>Component of deoxynucleoside triphosphates,</td>
<td>Peripheral neuropathy, bloody diarrhea.</td>
</tr>
<tr>
<td>Vitamin B₂ (Riboflavin)</td>
<td>Dairy products, meats,</td>
<td>Component of deoxyribonucleoside triphosphates,</td>
<td>Jaundice, discolored skin, night blindness.</td>
</tr>
<tr>
<td>Niacin (B₃)</td>
<td>Nuts, meats, grains,</td>
<td>Component of deoxyribonucleoside triphosphates,</td>
<td>Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td>Vitamin B₆ (Pyridoxine)</td>
<td>Meats, vegetables,</td>
<td>Component of deoxyribonucleoside triphosphates,</td>
<td>Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td>Pantothenic acid (B₅)</td>
<td>Meat, milk, eggs,</td>
<td>Component of deoxyribonucleoside triphosphates,</td>
<td>Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td>Folic acid (B₉)</td>
<td>Green vegetables,</td>
<td>Component of deoxyribonucleoside triphosphates,</td>
<td>Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td>Vitamin B₁₂</td>
<td>Eggs, liver,</td>
<td>Component of deoxyribonucleoside triphosphates,</td>
<td>Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td>Biotin</td>
<td>Legumes, potatoes,</td>
<td>Component of deoxyribonucleoside triphosphates,</td>
<td>Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td>Vitamin C (Ascorbic acid)</td>
<td>Fruits and vegetables,</td>
<td>Component of deoxyribonucleoside triphosphates,</td>
<td>Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td></td>
<td>meats</td>
<td>Component of deoxyribonucleoside triphosphates,</td>
<td>Kwashiorkor, beriberi,</td>
</tr>
</tbody>
</table>

### Table 41.1b Vitamin Requirements of Humans

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Major Dietary Sources</th>
<th>Major Functions in the Body</th>
<th>Symptoms of Deficiency or Extreme Excess</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fat-Soluble Vitamins</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A (Retinol)</td>
<td>Previtamin A (beta-carotene) in dark green and yellow vegetables and fruits,</td>
<td>Component of retinol in the body,</td>
<td>Night blindness, Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Dairy products, egg yolks,</td>
<td>Component of retinol in the body,</td>
<td>Night blindness, Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td>Vitamin E (Tocopherol)</td>
<td>Vegetable fats, nuts, seeds,</td>
<td>Component of retinol in the body,</td>
<td>Night blindness, Kwashiorkor, beriberi,</td>
</tr>
<tr>
<td>Vitamin K (Phylloquinone)</td>
<td>Green vegetables,</td>
<td>Component of retinol in the body,</td>
<td>Night blindness, Kwashiorkor, beriberi,</td>
</tr>
</tbody>
</table>

### Table 41.2a Mineral Requirements of Humans

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Major Dietary Sources</th>
<th>Major Functions in the Body</th>
<th>Symptoms of Deficiency or Extreme Excess</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calcium (Ca)</strong></td>
<td>Dark green vegetables, lentils,</td>
<td>Component of bone structure and function,</td>
<td>Osteoporosis, rickets, muscular dystrophy.</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>Dairy products, meats,</td>
<td>Component of bone structure and function,</td>
<td>Osteoporosis, rickets, muscular dystrophy.</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>Protein from meat sources,</td>
<td>Component of bone structure and function,</td>
<td>Osteoporosis, rickets, muscular dystrophy.</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>Fruits, vegetables,</td>
<td>Component of bone structure and function,</td>
<td>Osteoporosis, rickets, muscular dystrophy.</td>
</tr>
<tr>
<td>Chloride (Cl)</td>
<td>Table salt</td>
<td>Component of bone structure and function,</td>
<td>Osteoporosis, rickets, muscular dystrophy.</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>Table salt</td>
<td>Component of bone structure and function,</td>
<td>Osteoporosis, rickets, muscular dystrophy.</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>Whole grains, green leafy vegetables,</td>
<td>Component of bone structure and function,</td>
<td>Osteoporosis, rickets, muscular dystrophy.</td>
</tr>
<tr>
<td>Iodine (I)</td>
<td>Meats, eggs, lentils, whole grains,</td>
<td>Component of bone structure and function,</td>
<td>Osteoporosis, rickets, muscular dystrophy.</td>
</tr>
</tbody>
</table>

*All of these minerals are also harmful when consumed in excess.*
Table 41.2b: Mineral Requirements of Humans

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Major Dietary Sources</th>
<th>Major Functions in the Body</th>
<th>Symptoms of Deficiency*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine (I)</td>
<td>Drinking water, tea, seafood</td>
<td>Maintenance of teeth and (probably) bone structure</td>
<td>Higher frequency of tooth decay</td>
</tr>
<tr>
<td>Zinc (Zn)</td>
<td>Meats, seafood, grains</td>
<td>Component of certain digestive enzymes and other proteins</td>
<td>Growth failure, skin abnormalities, reproduction failure, impaired immunity</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>Seafood, nuts, legumes, organ meats</td>
<td>Enzyme activator in iron metabolism, melanin synthesis, electron transport</td>
<td>Anaemia, cardiovascular abnormalities</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>Nuts, grains, vegetables, fruits, tea</td>
<td>Enzyme activator</td>
<td>Abnormal bone and cartilage growth</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>Seashells, dairy products, inland salt</td>
<td>Component of thyroid hormones</td>
<td>Growth retardation</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>Meat and dairy products</td>
<td>Component of vitamin B12</td>
<td>None, except in B12 deficiency</td>
</tr>
<tr>
<td>Selenium (Se)</td>
<td>Seaweed, nuts, whole grains</td>
<td>Enzyme activator, antioxidant functioning in close association with vitamin E</td>
<td>Muscle pain, possibly heart muscle deterioration, impaired glucose metabolism</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>Brown's meat, fish, seaweed, nuts, some vegetables</td>
<td>Enzyme activator</td>
<td>Deficient in叙述of chromium-containing compounds</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>Legumes, grains, some vegetables</td>
<td>Enzyme activator</td>
<td>Deficient in叙述of molybdenum-containing compounds</td>
</tr>
</tbody>
</table>

*All of these minerals are also harmful when consumed in excess.

Digestive systems of different animal types

1. Intracellular digestion - “paramecium”
   - Digestive cavity has only one opening, highly branched digestive cavity. They cannot feed, digest and eliminate at the same time. Food cannot be processed continuously. Nutrient molecules come to cells by diffusion.

2. Simple sac - “hydra”
   - Digestive cavity has two openings. Food moves in one direction. The crop stores food. Gizzard grinds food. Intestine digests and absorbs nutrients. Circulatory system transports nutrients to all cells of the body.

Comparison

Flatworms: Digestive cavity has only one opening, highly branched digestive cavity. They cannot feed, digest and eliminate at the same time. Food cannot be processed continuously. Nutrient molecules come to cells by diffusion.

Earthworms: Digestive cavity has two openings. Food moves in one direction. The crop stores food. Gizzard grinds food. Intestine digests and absorbs nutrients. Circulatory system transports nutrients to all cells of the body.
Comparison
Grasshopper Digestive cavity has two openings. Food moves in one direction. In the mouth, food is chewed by a pair of mandibles (tooth-like appendages) and starch can be digested (salivary glands). The crop stores food. The mouth, esophagus and crop together are called the foregut.

The midgut is the place of major digestion and absorption. Nutrient molecules across the walls of the midgut and become dissolved in the blood (Circulatory system transports nutrients). Water is reabsorbed from the hindgut.

Incomplete System
Incomplete Sac-like gut cavity Flatworms

The digestive systems of the earthworm and grasshopper
Complete digestive tracts (Alimentary canals)
Evolutionary adaptations

Ruminant digestive system

Tasks Involved in Complete Digestive Systems

1. Mechanical processing and motility
2. Secretion of enzymes
3. Digestion
4. Absorption
5. Elimination
Human Digestive System

1. Mouth – breakdown & digestion (salivary glands – more than 1 liter of saliva a day contain salivary amylase)
2. Pharynx - passage way
3. Esophagus - moves food to stomach
4. Stomach
5. Small intestine
6. Large intestine
7. Rectum - control over elimination
8. Anus

Accessory Organs
- Salivary glands
- Liver
- Gallbladder
- Pancreas

The Stomach (2 liters of food can be stored)

1. Mix food & storage
2. Protein digestion Pepsin – an enzyme
3. Controlling passage of food - mechanically breaks down large food particles
4. Gastric fluid
- HCl (hydrochloric acid) – PH 2 strong acid
  a. kill bacteria
  b. destroy extracellular matrix that binds cells
- A nutrient broth (acid chyme)

Structure of the Small Intestine

Small intestine – major digestive region, 6 meters long digestion and absorption
- Duodenum (first 25 cm)
  The lining of small intestine is densely folded into villi, and villi are further folded into microvilli to increase the surface area for absorption. (300 m²)
Absorption in the Small Intestine

Active transport across membrane

The Large Intestine (Colon)

Large intestine — 1.5 meters long
A. reabsorb 90% water, minerals reabsorbed into blood
B. waste prepared for elimination (feces become more solid)
C. Symbionts (rich flora of mainly harmless bacteria such as E. coli)
Accessory organs

1. Pancreas
2. Liver – secrete bile for fat absorption
3. Gallbladder – store, concentrate bile from liver (bile contains no digestive enzymes but bile salts act as detergents and help the digestion of fat)
Control of digestion

1. Sight, smell, taste or thought:
   a. mouth → amylase
   b. stomach: food → gastrin (hormone) → circulate → gastric juice
   C. small intestine:
      chyme enters duodenum → secretin of enterogastrone (secretin) > bicarbonate > enterogastrone (cholecystokinin) digestive enzymes from pancreas & bile from liver/gallbladder.
**In Conclusion**

1. Nutrition refers to the processes by which the body takes in, digests, absorbs, and uses food.

2. A complete digestive system includes a tube that connects a mouth to an anus and regional specializations between them.

3. Mechanical and chemical processing of foods begins in the mouth and continues throughout certain structures.

4. Starch digestion starts at the mouth, and protein digestion starts in the stomach.

5. In absorption, cells of the intestine actively transport glucose and most amino acids out of the gut lumen.

6. Nutritionists advise a daily food intake in certain proportions.

7. To maintain a particular body weight, and overall health, caloric intake must balance energy output.