DIGESTION & NUTRITION

**Mechanical**
- Mouth-tongue with taste buds
- teeth -20 to 32
- palate-hard, soft
- Epiglottis-swallow
- Esophagus-peristalsis
- sphincters
- Stomach-3 layers muscle
- Small intestine-villi&microv.
- Large intestine- defecation

**Chemical**
- Salivary glands(3 pr)
  - amylase (starch)
- Goblet cells –mucous
- Gastric glands—HCl & pepsin (proteins)
- Bile-emulsifies fats
- NAHCO3—more basic
- Pancreatic enzymes-all 3
- Intestinal enzymes- all 3
- Bacteria-break & build (K)

Main Parts—Digestive System
### Order & Terms

<table>
<thead>
<tr>
<th>Order</th>
<th>Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lips</td>
<td>Enzymes</td>
</tr>
<tr>
<td>Mouth-tongue, teeth</td>
<td>Tonsils—tonsillitis</td>
</tr>
<tr>
<td>Pharynx (By epiglottis)</td>
<td>Dental caries—bacteria</td>
</tr>
<tr>
<td>Esophagus (cardiac S.)</td>
<td>Bolus</td>
</tr>
<tr>
<td>Stomach (pyloric S.)</td>
<td>pH scale</td>
</tr>
<tr>
<td>Duodenum/pancreas</td>
<td>Ulcer—Helicobacter pylori</td>
</tr>
<tr>
<td>Small Intestine</td>
<td>18’—4.5’</td>
</tr>
<tr>
<td>Colon (large intestine)</td>
<td>Surface area-ABSORP.</td>
</tr>
<tr>
<td>Rectum to Anus</td>
<td>Lacteal</td>
</tr>
<tr>
<td>(Diarrhea &amp; Constipation)</td>
<td>hormone</td>
</tr>
</tbody>
</table>

**Fig. 12.4**

- adventitia
- muscularis
- lumen
- mucosa
- submucosa
- circular muscle
- longitudinal muscle
- serosa

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ACCESSORY Organs

- Pancreas—both endocrine & exocrine gland
- Liver—removes bilirubin (from RBC) as bile, stores Fe & fat sol. ADEK vit., regulates sugar in blood (glycogen), makes plasma proteins, bile, urea (N) & cholesterol
- XXX Jaundice, hepatitis (A,B & C), cirrhosis
- Gallbladder—concentrates and stores bile from liver cells
Fig. 12.10

- Sinusoid
- Central vein
- Hepatic portal vein
- Bile duct
- Hepatic artery from intestinal capillaries

Fig. 12.11

1. Small intestine absorbs products of digestion.
2. Nutrient molecules travel in hepatic portal vein to liver.
3. Liver monitors blood content.
Chemical Digestion

- Macromolecules broken down by Enzymes
- Define ENZYMES
- Conditions: correct substrate
- temperature-warm
- pH (optimal)
Fig. 12.13

Carbohydrates—ready source of energy
Complex ones are better = bulk of food
Fiber—Insoluble—laxativelike
Soluble (oat bran) combo with bile acids and cholesterol
Protein—8 are essential (required)
Lipids—less than 30% or plaque (cause disease)
(( olestra (fake fat)—can’t digest it))
**Table 12.6** Fat-Soluble Vitamins

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Function</th>
<th>Food Sources</th>
<th>Too Little</th>
<th>Too Much</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Antioxidant synthesized from beta-carotene; needed for healthy eyes, skin, hair, and mucous membranes, and for proper bone growth</td>
<td>Deep yellow/orange and leafy, dark green vegetables, fruits, cheese, whole milk, butter, eggs</td>
<td>Night blindness, impaired growth of bones and teeth</td>
<td>Headaches, dizziness, nausea, hair loss, abnormal development of fetus</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>A group of steroids needed for development and maintenance of bones and teeth</td>
<td>Milk fortified with vitamin D, fish liver oil; also made in the skin when exposed to sunlight</td>
<td>Rickets, bone decalcification and weakening</td>
<td>Calcification of soft tissues, stiffness, possible renal damage</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Antioxidant that prevents oxidation of vitamin A and polyunsaturated fatty acids</td>
<td>Leafy green vegetables, fruits, vegetable oils, nuts, whole-grain breads and cereals</td>
<td>Unknown</td>
<td>Diarrhea, nausea, headaches, fatigue, muscle weakness</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>Needed for synthesis of substances active in clotting of blood</td>
<td>Leafy green vegetables, cabbage, cauliflower</td>
<td>Easy bruising and bleeding</td>
<td>Can interfere with anticoagulant medication</td>
</tr>
</tbody>
</table>
Table 12.7 Water-Soluble Vitamins

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Functions</th>
<th>Food Sources</th>
<th>Too Little</th>
<th>Too Much</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin C</td>
<td>Antioxidant; needed for forming collagen; helps maintain collagen, bones,</td>
<td>Citrus fruits, leafy green vegetables, tomatoes, potatoes, cabbage</td>
<td>Sorey, delayed wound healing, infections</td>
<td>Gout, kidney stones, diarrhea, decreased copper</td>
</tr>
<tr>
<td>Thiamine</td>
<td>Part of coenzyme needed for cellular respiration; also promotes activity</td>
<td>Whole-grain cereals, dried beans, peas, sunflower seeds, nuts</td>
<td>Beriberi, muscular weakness, enlarged heart</td>
<td>Can interfere with absorption of other vitamins</td>
</tr>
<tr>
<td>(vitamin B1)</td>
<td>of the nervous system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riboflavin</td>
<td>Part of coenzymes, such as FAD; aids cellular respiration, including</td>
<td>Nuts, dairy products, whole-grain cereals, poultry, leafy green vegetables</td>
<td>Dermatitis, blurred vision, growth failure</td>
<td></td>
</tr>
<tr>
<td>(vitamin B2)</td>
<td>oxidation of protein and fat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Niacin</td>
<td>Part of coenzymes NAD and NADP; needed for cellular respiration, including</td>
<td>Peanuts, poultry, whole-grain cereals, leafy green vegetables, beans</td>
<td>Pellagra, diarrhea, dermatitis, dermatitis</td>
<td></td>
</tr>
<tr>
<td>(niacinamide)</td>
<td>oxidation of protein and fat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Folic acid</td>
<td>Coenzyme needed for production of heme and formation of DNA</td>
<td>Dark leafy green vegetables, nuts, beans, whole-grain cereals</td>
<td>Megaloblastic anemia, spina bifida</td>
<td></td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>Coenzyme needed for synthesis of hormones and hemeoglobin; CNS control</td>
<td>Whole-grain cereals, bananas, beans, peel, nuts, leafy green vegetables</td>
<td>Rarely, convulsions, vomiting, somnolence, muscular weakness</td>
<td>Insomnia, neuropathy</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>Part of coenzyme A needed for oxidation of carboxylates and tetratropine</td>
<td>Nuts, beans, dark green vegetables, poultry, fluids, milk</td>
<td>Rarely, loss of appetite, mental depression, numbness</td>
<td></td>
</tr>
<tr>
<td>Panthenic acid</td>
<td>aids in the formation of heme and certain neurotransmitters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>Complex, cobalt-containing protein, coenzyme needed for synthesis of</td>
<td>Dairy products, fish, poultry, eggs, fortified cereals</td>
<td>Pellorous anemia</td>
<td></td>
</tr>
<tr>
<td>vitamin</td>
<td>amino acids and fatty acids</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biotin</td>
<td>Coenzyme needed for metabolism of amino acids and fatty acids</td>
<td>Generally in foods, especially eggs</td>
<td>Skin rash, nausea, fatigue</td>
<td></td>
</tr>
</tbody>
</table>

VITAMINS

- **Define**—organic compound body uses for metabolic reasons—can make them all
- **Antioxidants**—free radicals made are unstable and carry an extra electron= damage (A, C, E)
- **Vitamin D**—by skin in sun, modified by kidneys and liver to calcitrol to absorb Ca
<table>
<thead>
<tr>
<th>Mineral</th>
<th>Functions</th>
<th>Food Sources</th>
<th>Too Little</th>
<th>Too Much</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Macrominerals</strong> (more than 100 mg/day needed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium (Ca^{2+})</td>
<td>Strong bones and teeth, nerve conduction, muscle contraction</td>
<td>Dairy products, leafy green vegetables</td>
<td>Started growth in children, low bone density in adults</td>
<td>Kidney stones; interferes with iron and zinc absorption</td>
</tr>
<tr>
<td>Phosphorus (PO_{4}^{3-})</td>
<td>Bone and soft tissue growth; part of phospholipids, ATP and nucleic acids</td>
<td>Meat, dairy products, sunflower seeds, food additives</td>
<td>Weakness, confusion, pain in bones and joints</td>
<td>Low blood and bone calcium levels</td>
</tr>
<tr>
<td>Potassium (K^+)</td>
<td>Nerve conduction, muscle contraction</td>
<td>Many fruits and vegetables, bran</td>
<td>Paralysis, irregular heartbeat, eventual death</td>
<td>Vomiting, heart attack, death</td>
</tr>
<tr>
<td>Sodium (Na^+)</td>
<td>Nerve conduction, pH and water balance</td>
<td>Table salt</td>
<td>Lethargy, muscle cramps, loss of appetite</td>
<td>Edema, high blood pressure</td>
</tr>
<tr>
<td>Chloride (Cl^-)</td>
<td>Water balance</td>
<td>Table salt</td>
<td>Not likely</td>
<td>Vomiting, dehydration</td>
</tr>
<tr>
<td>Magnesium (Mg^{2+})</td>
<td>Part of various enzymes for nerve and muscle contraction, protein synthesis</td>
<td>Whole grains, leafy green vegetables</td>
<td>Muscular spasm, irregular heartbeat, convolution, confusion, personality changes</td>
<td>Diarrhea</td>
</tr>
<tr>
<td><strong>Microminerals</strong> (less than 20 mg/day needed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc (Zn^{2+})</td>
<td>Protein synthesis, wound healing, fetal development and growth, immune function</td>
<td>Meats, legumes, whole grains</td>
<td>Delayed wound healing, night blindness, diarrhea, mental lethargy</td>
<td>Anemia, diarrhea, vomiting, renal failure, abnormal cholesterol levels</td>
</tr>
<tr>
<td>Iron (Fe^{2+})</td>
<td>Hemoglobin synthesis</td>
<td>Whole grains, meats, prune juice</td>
<td>Anemia, physical and mental sluggishness</td>
<td>Iron toxicity disease, organ failure, eventual death</td>
</tr>
<tr>
<td>Copper (Cu^{2+})</td>
<td>Hemoglobin synthesis</td>
<td>Meat, nuts, legumes</td>
<td>Anemia, stunted growth in children</td>
<td>Damage to internal organs if not excreted</td>
</tr>
<tr>
<td>Iodine (I^-)</td>
<td>Thyroid hormone synthesis</td>
<td>Iodized table salt, seafood</td>
<td>Thyroid deficiency</td>
<td>Depressed thyroid function, anxiety</td>
</tr>
<tr>
<td>Selenium (SeO_{4}^{2-})</td>
<td>Part of antioxidant enzyme</td>
<td>Seafood, meats, eggs</td>
<td>Vascular collapse, possible cancer development</td>
<td>Hair and fingernail loss, discolored skin</td>
</tr>
</tbody>
</table>

**MINERALS**

**Macro**—(Need more than 100 mg/day)
- Ca—need 1000-1500/day or osteoporosis
- vitamin D and Mg help to prevent it
- Na—need 500 mg/day BUT we often get 8X as much! (X blood pressure )
- + P,K,Cl, Mg

**Micro**—(need less than 20mg/day)
- Zn,Fe,Cu,I,Se—specific necessary roles
Fig. 12.18

Persons with obesity have
- weight 20% or more above appropriate weight for height.
- body fat content in excess of that consistent with optimal health, probably due to a diet rich in fats.
- low levels of exercise.

Fig. 12.19

Persons with bulimia nervosa have
- recurrent episodes of binge eating characterized by consuming an amount of food much higher than normal for one sitting and a sense of lack of control over eating during the episode.
- an obsession about their body shape and weight, but often without exercising.
- increase in fine body hair, halitosis, and gingivitis.

Body weight is regulated by
- a restrictive diet, excessive exercise.
- purging (self-induced vomiting or misuse of laxatives).
Eating Disorders

- Obesity—(20% over ideal), mod,(40%+) severe (100%+)—on increase hormonal, metabolic, social
- Bulimia—binge & purge (affect heart & kidneys & could lead to death
- Anorexia—unreal fear of gaining weight actually starving; distorted brain

Persons with anorexia nervosa have

- a morbid fear of gaining weight; body weight no more than 85% normal.
- a distorted body image so that person feels fat even when emaciated.
- in females, an absence of a menstrual cycle for at least three months.

Body weight is kept too low by either/or

- a restrictive diet, often with excessive exercise.
- binge eating/purging (person engages in binge eating and then self-induces vomiting or misuses laxatives).
Tap. 237

Digestion

Absorption

lacteal

hepatic portal vein

Defecation

feces

anus

d.
e.
f.
g.
h.
i.
j.
k.