Nutrition

[Note: This is the text version of this lecture file. To make the lecture notes downloadable over a slow connection (e.g. modem) the figures have been replaced with figure numbers as found in the textbook. See the full version with complete graphics if you have a faster connection.]

Homeostasis of nutrients in Heterotrophs

- **Appetite is how the body tells the animal it needs a nutrient.**

Leptin is a 146 amino acid peptide that is produced by adipocytes when fat content is high. When leptin binds to its receptors it depresses appetite and increases fat burning (activity and heat).

- **The first line of storage for excess energy is in the liver and muscle in the form of glycogen.**

[See Fig. 5.6b]

liver and muscle make glycogen

[See Fig. 41.1]

liver and muscle break down glycogen

Three states of abnormal nutrition

1) Undernourished = diet too low in calories. The body will start breaking itself down.

2) Overnourished = diet too high in fat and carbohydrates. The body will start storing too much fat, leading to heart disease and diabetes

Fat is especially dangerous because 1 gram of fat is 9.5 kcal and 1 gram of carbohydrates is only 4 kcal

3) Malnourished = diet missing essential nutrients.

Essential nutrients are compounds that our body cannot make. *We must get them from the things we eat.*

Four classes of essential nutrients

1) Amino acids. Humans cannot make 8 different amino acids. Amino acids are needed to make proteins and cannot be stored in the body.

2) Fatty acids. The body cannot make certain unsaturated fatty acids (double bonds).

3) Vitamins. There are 13 vitamins discovered so far that the body needs. They come in two classes:

A) Water soluble vitamins like vitamin C that cannot be stored and so must be ingested daily. Lack of vitamin C leads to scurvy (degeneration of skin, teeth, vessels, weakness, slowing of healing, weak immune system)

B) Fat soluble vitamins like vitamin D are stored in fat. Can overdose more easily. Lack of vitamin D leads to rickets (bone deformity, softening).

4) Minerals. 17 known so far for humans. Like Ca for bones & Fe for blood.

[See Fig. 41.3]

Three dietary categories of animals

1) <u>Herbivores</u> = plants & algae.

e.g. gorillas, cows, rabbits

2) <u>Carnivores</u> = animals.

e.g. sharks, hawks, spiders

3) <u>Omnivores</u> = anything & everything!

e.g. crows, cockroaches, humans

Adaptations are signs of diet and give clues to functions of organs

EXAMPLE #1

Dentition (configuration of teeth) shows patterns that correlate with diet

[See Fig. 41.16]

Adaptations are signs of diet and give clues to functions of organs

EXAMPLE #2

Digestive tract shows patterns that correlate with diet

cecum contains symbiotic bacteria that aid in digestion--especially cellulose

[See Fig. 41.17]

Adaptations are signs of diet and give clues to functions of organs

EXAMPLE #3:

Digestive tract of ruminants is specialized for processing large quantities of nutrient-poor plant material.

[See Fig. 41.18]

Four ways of eating

1) Suspension feeding (filter food) e.g. baleen whales, clams

2) Substrate feeding (crawl in food) e.g. worms, caterpillars

3) Fluid feeding (suck food) e.g. hummingbirds, mosquitoes

3) Bulk feeding (large chunks) e.g. pythons, humans

Specialized organs for the four stages of food processing make up the alimentary canal (complete digestive tract)

1) Ingestion takes place in mouth, pharynx, esophagus

2) Digestion takes place primarily in stomach, crop, gizzard, part of intestine.

3) Absorption takes place primarily in the intestine

4) Elimination occurs in rectum, anus

[See Fig. 41.10]

Two locations for digestion

Intracellular ***Extracellular***

[See Fig. 41.8]

[See Fig. 41.9]

The human digestive system

[See Fig. 41.11]

The Oral Cavity (Mouth)

1) Salivation starts the process off, about 1L/day in humans. Saliva contains mucin, buffers, antibacterial compounds, and amylase to act on starch and glycogen.

2) Chewing breaks up food and makes it easier for enzymes to work.

3) The tongue tastes the food to determine if it's OK to swallow and needed by the body, and forms it into a bolus.

[See Fig. 41.12]

The Swallowing Reflex

[See Fig. 41.12]

Three functions of the stomach

1) Storage for food and water of ~2 liters.

2) Churning of ingested material to make acid chyme mixture in ~20 minutes.

3) Secretion of gastric juice:

a) mucin, gastrin hormone by mucous cells

b) pepsinogen (a zymogen) by chief cells

c) HCl by parietal cells.

[See Fig. 41.11]

Structure of the small intestine

- **The "small intestine" isn't really that small. It's about 6 meters long in humans.**

- **The first 25 cm is called the duodenum where chyme is mixed with secretions from the pancreas (exocrine function), liver, gallbladder, and gland cells.**

- **The liver produces bile salts which are stored in the gallbladder. These act like detergents to break up fats.**

[See Fig. 41.11]

Pathways and locations of digestion

[See Fig. 41.13]

[See Fig. 41.14]

Absorption occurs primarily in small intestine (jejunum & ileum).

- Surface area of small intestine is ~300 m^2 (size of tennis court)
- amino acids & sugars enter capillaries ⇒ hepatic portal vessel (flow of ~1L/min!) ⇒ liver ⇒ storage/conversion
- glycerol & fatty acids are coated with proteins in epithelial cells and become chylomicrons ⇒ lacteals ⇒ lymphatic system (near heart)

[See Fig. 41.15]

- **Food in stomach ⇒ gastrin ⇒ gastric juice**
- **Acid chyme in duodenum ⇒ secretin ⇒ bicarb. from pancreas**
- **AA or FA in duodenum ⇒ CCK ⇒ enzymes by pancreas & contraction of the gallbladder**
- **chyme in duodenum ⇒ other enterogastrones ⇒ inhibition of peristalsis in stomach**

[See Table 41.3]

The large intestine (colon) primarily absorbs remaining water.

- Slowest step in gastrointestinal tract: 12-24 hours for 1.5 meter length.
- flora of E. coli digest feces. Generate methane, hydrogen sulfide, some vitamins.
- viruses or bacterial infection ⇒ decrease water absorption ⇒ diarrhea
- slowing of peristalsis ⇒ increased water absorption ⇒ constipation

[See Fig. 41.11]