Chapt. 41 – Animal Nutrition

A nutritionally adequate animal diet satisfies three needs:
Fuel (**chemical energy**)
Organic raw materials for **biosynthesis** (especially carbon-based molecules)
Essential nutrients (substances that the animal needs, but cannot **synthesize** from any precursors on its own)

A nutritionally inadequate animal diet fails to satisfy the three basic needs we just covered
Undernourishment – insufficient **calories** (**energy**)
Overnourishment – too many **calories** & too much stored **fat**
Malnourishment – a diet missing one or more **essential nutrients**

Energy

Energy in **nutrients** is measured in **Calories** (kcal = energy to raise the temperature of 1 L of water 1º C)

An "average" human body uses about 1,550 Calories/day

Principal categories of **nutrients**:

Lipids – found in lipid membranes, *etc*.; including **essential fatty acids**
9 Calories per gram (a principal energy source)

Proteins – building blocks and enzymes; animals require 20 amino acids, including **essential amino acids [Fig. 41.10 – Read through it, but you do not need to memorize it]**
4 Calories per gram (usually a secondary energy source, since the breakdown of proteins produces urea, a potentially toxic compound)

Carbohydrates – C-based building blocks and energy
4 Calories per gram; can be a very quick energy source (*e.g*., glucose)

Vitamins – essential organic molecules required in small quantities
[Table 41.1 – Read through it, but you do not need to memorize it]

Water-Soluble Vitamins – excess excreted by kidneys

Fat-Soluble Vitamins – can be stored in fat tissues

Minerals – essential elements and inorganic molecules (similar to mineral macro- and micro-nutrients required by plants, but also including selenium, iodine, *etc*.)
[Table 41.2 – Read through it, but you do not need to memorize it.]

The Food Guide Pyramid (U.S. Dept. Agriculture); see: http://www.mypyramid.gov

Food processing

Ingestion – food is brought into the digestive tract

Digestion – mechanical and chemical breakdown (especially via **enzymatic hydrolysis**, *i.e.*, splitting macromolecules into their constituent monomers)

Absorption – cells uptake small molecules that can be used in biochemical reactions and biosynthesis

Elimination – undigested material passes out of the body

Food Processing in Humans **[Fig. 41.15]**

Begins in the **mouth**…

Salivary glands produce **saliva** that lubricates the **bolus** of food

Saliva contains **amylase**, which hydrolyzes **starch**

Saliva also contains some **antibodies** to help prevent infections

Saliva helps dissolve acids and sugars, so that they can be detected by the **taste buds**

The muscular **tongue** manipulates the **bolus** and passes it to the **pharynx [Fig. 41.16]**

This triggers the **swallowing reflex**

The **larynx** moves upward and tips the **epiglottis** over the **glottis**

The **esophogeal sphincter** relaxes, allowing the **esophagus** to open

Once the **bolus** has entered the **esophagus**, the **larynx** moves back down, opening the **trachea**

Peristalsis (rhythmic contractions) carries the **bolus** to the **stomach**

The **stomach** is in the upper **abdominal cavity**, just below the **diaphragm**

The **stomach** secretes **gastric juice** and mixes it with swallowed food

Gastric juice contains **hydrochloric acid** and **pepsin**

Mucus coating helps prevent digestion of the **stomach** itself

Food and **gastric juice** become **acid chyme**

Acid chyme is kept in the **stomach** by the **pyloric sphincter**

Digestion continues in the **small intestine**

Small diameter, muscular tube

In the first section, **digestive secretions** are added from the **pancreas**, **gallbladder**, and **intestine** itself

Pancreatic juice: **[Fig. 41.19]**

Sodium bicarbonate, which **neutralizes** the **acid chyme**

Amylases, **lipases**, **nucleases**, **proteases** (**hydrolytic enzymes**)

Bile:

Produced in the **liver**, stored in the **gall bladder**, and contains **bile salts**

A detergent that helps disperse fats into droplets, thereby aiding their digestion (since they arrive essentially intact to the first portion of the small intestine)

Most absorption of nutrients occurs in the **small intestine [Fig. 41.23]**

Folds, **villi**, and **microvilli** create a very large surface area for absorption

Capillaries line the core of each **villus**, surrounding a **lacteal** (part of the **lymphatic system**)

Most nutrients are absorbed into **capillaries** that converge in the **hepatic portal vessel** (leads to the liver)

Fats are absorbed into the **lacteals**, which lead through the **lymphatic system** to large **veins** of the **circulatory system**

The **small intestine** meets the **large intestine** (**colon**) at a T-junction

One arm of the T is a **cecum** and its **appendix**, whereas the other arm leads upward

Much of the remaining water is absorbed from the contents of the **large intestine**

Populations of bacteria inhabit the **large intestine**; some produce **vitamins** (*e.g.*, B complex and K)

The final compartment is the **rectum**

Undigested material is eliminated along with large quantities of bacteria (dead and alive)

Digestive Systems are Adapted to their Owners' Lifestyles

Sponges and heterotrophic protists use **intracellular digestion [See Fig. 33.4]**

Hydras and most other animals use **extracellular digestion [See Fig. 41.13]**

Extracellular digestion in a tube (**complete digestive tract** or **alimentary canal**) is the most efficient and effective **[See Fig. 41.14]**

The animal can eat frequently, even while digesting the previous meal

Specialized compartments and digestive organs can contribute to the process sequentially

Like earthworms, birds lack teeth, so their muscular **gizzards** help break apart hard food particles

Animal digestive systems cannot break down **cellulose [Fig. 41.28]**

Ruminant animals (cows, sheep, *etc*.) have stomachs with several **chambers**

The first two are fermentation vats with microbes that produce **cellulase**

Vertebrate dentition generally matches the diet **[Fig. 41.26]**

An adult human has 32 teeth:
Incisors for cutting
Canines for tearing
Premolars and **molars** for grinding

Vertebrate intestines generally match the diet **[Fig. 41.27]**

Digestive enzymes generally match the diet
E.g., most adult mammals do not produce **lactase**