Organ Systems and Functions

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- Each animal species faces fundamental challenges such as obtaining nutrients and oxygen, fight against infectious agents, water balance and osmoregulation, and producing offsprings (reproduction).
- However, depending on the level of the organization of a given animal species, different mechanisms are used for same functions.

- For example; animals must exchange nutrients, waste products, and gases with their environment, which depends on body plans.
- The rate of exchange is proportional to membrane surface area involved in exchange, whereas the amount of material that must be exchanged is proportional to the body volume. A multicellular organization therefore works only if every cell has access to a suitable aqueous environment, either inside or outside the animal's body.

- Cells are organized into **tissues**, groups of cells with a similar appearance and a common function. Different types of tissues are further organized into functional units called **organs**. (The simplest animals, such as sponges, lack organs or even true tissues) Groups of organs that work together, providing an additional level of organization and coordination, make up an **organ system**.

Animal Nutrition

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Nutrition

- «a process in animals involving the intake of nutrient materials and their subsequent assimilation into the tissues»
- In general, animals fall into three categories:

- **Herbivores** eat mainly autotrophs (plants and algae).

- **Carnivores** eat other animals.

- **Omnivores** regularly consume animals as well as plants or algal matter.

- An animal's diet provides chemical energy, which is converted into **ATP** and powers processes in the body.
- Animals need a source of organic carbon and organic nitrogen in order to construct ***organic molecules***.
- **Essential nutrients** are required by cells and must be obtained from dietary sources.

Essential Nutrients

- There are four classes of essential nutrients:
  - Essential amino acids
  - Essential fatty acids
  - Vitamins
  - Minerals

Essential Amino Acids

Animals require 22 amino acids and they can synthesize about half from the molecules in their diet.

The remaining amino acids -the essential amino acids- must be obtained from food in preassembled form.

A diet that provides insufficient essential amino acids causes malnutrition called protein deficiency.

The essential 8 amino acids for human adults:

Isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.

Human infants also need also, histidine and arginine.

Essential Fatty Acids

- Animals can synthesize most of the fatty acids they need.
- The **essential fatty acids** are certain **unsaturated** fatty acids that must be obtained from the diet.
- Deficiencies in fatty acids are rare.

Vitamins

- Vitamins are organic molecules required in the diet in small amounts. Many vitamins function as coenzymes.
- 13 vitamins essential to humans have been identified.
- Vitamins are grouped into two categories: fat-soluble and water-soluble.
- B-C and A, D, E, K

Minerals

- **Minerals** are simple **in**organic nutrients, usually required in very small amounts (mg or micrograms). Minerals serve a variety of important functions including enzymes cofactors.

The main stages of food processing are ingestion, digestion, absorption, and elimination

- **Ingestion** is the act of eating. There are a variety of types of eating:
- Suspension feeders
- Substrate feeders
- Fluid feeders
- Bulk feeders

Suspension Feeders

Many aquatic animals are suspension feeders, which sift (filter) small food particles from the water.

3. *Fluid-feeders*: Live by sucking nutrient-rich fluids from a living host.
   Example: Mosquitos, leeches

Bulk feeders eat relatively large pieces of food. Most animals, including humans, are **bulk feeders**. Their adaptations include tentacles, pincers, claws, venomous fangs, jaws, and teeth that kill their prey or tear off pieces of meat or vegetation.

- *Digestion* is the *process of breaking food down into soluble molecules* – which are small enough to absorb. (mechanical – chemical)
  - In chemical digestion, enzymatic hydrolysis splits bonds in molecules with the addition of water.
- Absorption is uptake of nutrients by body cells.
- Elimination (=defecation) is the passage of undigested material out of the digestive compartment.

Digestive Compartments

- Most animals process food in special compartments. These compartments reduce the risk of an animal digesting its own cells and tissues.
- Intracellular digestion, food particles are engulfed by endocytosis and digested within the food vacuoles (sponges)
- Extracellular digestion is the breakdown of food particles outside of cells. It occurs in compartments that are continuous with the outside of the animal's body.

The mammalian digestive system

- The mammalian digestive system consists of an alimentary canal and accessory glands that secrete digestive juices through ducts.
- Mammalian accessory glands are the salivary glands, the pancreas, the liver, and the gallbladder.

- Food is pushed along by **peristalsis**, rhythmic contractions of smooth muscles in the wall of the alimentary canal.
- There are special valves called **sphincters** located between the different compartments of alimentary canal. These valves regulate the movement of material between compartments.

The Oral Cavity, Pharynx, and Esophagus

- The first stage of digestion is mechanical and takes place in the oral cavity.
- Salivary glands deliver saliva to lubricate food.
- Teeth chew food into smaller particles. This *mechanical digestion increases the surface area exposed to the enzyme: salivary amylase*. This enzyme initiates the breakdown of glucose polymers = *carbohydrate digestion*.

Chemical Digestion in the Stomach

- The stomach stores food and secretes gastric juice, which converts a meal to acid chyme.
- Gastric juice is made up of hydrochloric acid and the enzyme pepsin.
- There are 3 main types of cells in stomach epitelium tissue:
- *Parietal cells* secrete hydrogen and chloride ions separately.
- *Chief cells* secrete inactive pepsinogen, which is activated to pepsin when mixed with hydrochloric acid in the stomach.
- *Goblet cells secrete mucus which protects the stomach lining* from gastric juice.

Digestion in the Small Intestine

- The small intestine is the longest section of the alimentary canal.
- It is the major organ of digestion and absorption.
- It has 3 sections: Duedonum, Jejunum and Ileum.
- In the first portion -the duodenum- chyme from the stomach mixes with digestive juices from the pancreas, liver, gall-bladder, and the small intestine itself.
- *Most digestion occurs in the duodenum*; the jejunum and ileum function mainly in absorption of nutrients and water.

Pancreatic Secretions

- The pancreas produces proteases trypsin and chymotrypsin, protein-digesting enzymes and lipases (lipid digesting enzymes) that are activated after entering the duodenum.
- Its solution is alkaline and neutralizes the acidic chyme.

Bile Production by the Liver

- In the small intestine, *bile aids in digestion and absorption of fats*. Bile emulsifies fat. This is physical process, NOT a chemical digestion. *Fat emulsification increases the surface area for chemical digestion of fats by lipases*.
- Bile is made in the liver and stored in the gallbladder.

Secretions of the Small Intestine

- The epithelial lining of the duodenum, called the brush border, produces several digestive enzymes.
- *The small intestine has villi and microvilli that increase the surface area for absorption.* Villi and microvilli are exposed to the intestinal lumen.
- Each villus contains a network of blood vessels and a small lymphatic vessel called a lacteal.

Absorption in the Large Intestine

- The colon of the large intestine is connected to the small intestine.
- The cecum aids in the fermentation of plant material (in herbivores) and connects where the small and large intestines meet.
- The human cecum has an extension called the appendix, which plays a very minor role in immunity.

- Wastes of the digestive tract, the **feces**, become more solid as they move through the colon. Feces are stored in the **rectum** until they can be eliminated. Feces pass through the rectum and exit via the anus.
- Two **sphincters** between the rectum and anus control bowel movements.

Mutualistic Adaptations

- Many herbivores have *fermentation chambers (*RUMEN*)*, where *symbiotic microorganisms digest cellulose*.
- The most elaborate adaptations for an *herbivorous diet* have evolved in the animals called *ruminants*.