Learning unit 9: Animal nutrition

9.1 Introduction

To complete the learning unit, you will need to refer to pages 978–1000 chapter 42 in Campbell et al. (2015)

Nutrition in animals involves taking in food material that will be chewed in to smaller pieces, broken down by chemical processes, and then absorbed by the body to provide energy and organic molecules.

Although there is a common need for nutrition in animals, there are diverse diets, for example herbivores (which mainly consume plants), carnivores (which consume other animals), and omnivores (which consume animals and plants).

9.2 Learning outcomes

By the end of this learning unit you should be able to

• give a basic description of animal nutrition, specifically in terms of nutritional requirements, food types, feeding mechanisms and food processing

• explain animal nutrition with specific regard to:

- the essential nutrients for biosynthesis

- the mechanisms by which food is ingested

- the way in which food is processed

- the digestive system of a mammal

9.3 An animal's diet should be the source of energy and essential nutrients

Recommended reading: pages 979–982 of chapter 42 in Campbell et al. (2015)

Nutrition does not just involve taking in any kind of food material, an adequate diet has to satisfy three nutritional needs which are: chemical energy which plays a role in cellular processes (i.e. production of ATP); provides organic building blocks for macromolecules, and also to essential nutrients.

9.3.1 Essential nutrients

Essential nutrients include: essential amino acids, essential fatty acids, vitamins, and minerals.

Animals require amino acids to make up proteins. The amino acids have to be obtained from the animals food source, thus they are called essential amino acids.

Essential fatty acids (i.e. linoleic acid) are fatty acids that cannot be synthesised in the body, thus a diet of unsaturated fatty acids is required.

Vitamins are fat-soluble or water-soluble organic molecules that have diverse functions in the body.

Minerals are inorganic nutrients that are required in small amounts in the body. These minerals can be magnesium that is present in enzymes and help in their functioning to iodine that is require in producing thyroid hormones.

9.3.2 Dietary deficiencies

Malnutrition is lack of essential nutrients or the supply of less chemical energy than what the body requires in diet.

Insufficient intake of essential nutrients can cause deformities, disease, and even death. This can affect herbivores, carnivores alike.

Undernutrition is a diet that fails to provide adequate sources of chemical energy. This means that the body is not getting enough nutrients to sustain its self. The body will start to use up stored carbohydrates and fats, ultimately muscle proteins will start to be broken down causing a decrease in size and stature.

9.3.3 Assessing nutritional needs

Determining the ideal diet for animals requires consideration on genetically morphology and the surrounding environment that animal is exposed to.

9.4 The main stages of food processing

Recommended reading: pages 983–983 of chapter 42 in Campbell et al. (2015)

In order for the body to take up nutrients from food, it first has to process the food. Food processing stages are divided into: ingestion, digestion, absorption, and elimination. Ingestion is the act of eating or feeding. Digestion is a stage whereby food is broken down into small molecules that can be taken up by the body; this involves chewing and chemical processes. In the third stage we have absorption whereby the body takes up the digested food as forms of amino acids and simple sugars. Undigested material passes out of the digestive system through the process of elimination.

9.4.1 Digestive compartments

Digestive compartments entail sections within an animal's body that are specialized to perform a specific function in food processing.

Intracellular digestion comprises of food vacuoles that contain hydrolytic enzymes that breakdown food. The food enters the cell by phagocytosis, forming a food vacuole, the food vacuole then fusses with lysosomes containing hydrolytic enzymes allowing digestion to occur.

Extracellular digestion occurs in most animal species, and these animals mostly have more than one digestive compartment. Animals with a simple body plan that only one opening (e.g. hydra). Gastrovascular cavity is a pouch that functions in digestion and as well as in the distribution of nutrients throughout the body. Most animals have a digestive tube extending between two openings (a mouth and an anus). This type of complete digestive tract is commonly known as an alimentary canal.

9.5 Important organs that form mammalian digestive system

Recommended reading: pages 986–991 of chapter 42 in Campbell et al. (2015)

Most animals have a digestive system that consists of the alimentary canal as well as various accessory glands that secrete digestive juices through ducts and into the canal. Accessory glands found in mammalian digestive systems include: three pairs of salivary glands, pancreas, liver, and the gallbladder.

9.5.1 The oral cavity, pharynx, and oesophagus

Ingestion occurs in the oral cavity, where teeth mechanically digest food for ease of swallowing. Presence of food stimulates a nervous reflex that causes the salivary glands to deliver saliva through ducts into the oral cavity. Swallowed food passes the pharynx then passes down to the esophagus which connects to the stomach.

9.5.2 Digestion in stomach

The stomach is composed of elastic walls and it is capable of storing food and initiates digestion of proteins. The stomach secretes gastric juices the chemically digest foods.

Gastric juices consist of two components that help carry out chemical digestion namely: hydrochloric acid and pepsin.

9.5.3 Digestion in the small intestine

Most of the enzymatic hydrolysis of the macromolecules from food occurs in the small intestine. The first 25 cm of the small intestine forms the duodenum. At this point chime from the stomach mixes with digestive juices from the pancreas, liver, and gallbladder.

Pancreatic secretions include production of an alkaline solution rich in bicarbonate as well as several enzymes that neutralises the acidity of chime.

Bile production by the liver assists in the digestion of fats and other lipids. This bile is produced by the liver and stored in the gallbladder.

Secretions of the small intestine occur in the duodenum with presence of hydrolytic enzymes. The remaining sections of the small intestine (jejunum and ileum) are mainly involved in absorption of nutrients and water.

9.5.4 Absorption in the small intestine

Most of the absorption in the small intestine occurs across the highly folded surface. The intestine is studded with finger-like projections called villi. In turn each epithelial cell of a villus has microscopic projections on its surface called microvilli. There are capillaries and veins that carry nutrient-rich blood away from the villi converging in to hepatic portal vein.

9.5.5 Absorption in the large intestine

Absorption in the large intestine forms the last section of the alimentary canal. Sections of the large intestine are: the colon, cecum, and rectum whereby feces (waste product of digestion) are eliminated from the alimentary canal.

9.6 Evolutionary adaptations of vertebrate digestive systems

Recommended reading: pages 992–993 of chapter 42 in Campbell et al. (2015)

Animals have different form to suit their diet, for example the dental formula.

9.6.1 Stomach and intestinal adaptations

A carnivore has a larger stomach than herbivores, but has a shorter alimentary canal compared to herbivores and omnivores. This is because vegetation is hard to breakdown due to the presence of cell wall around plant cells.

9.6.2 Mutualistic adaptations

Some digestive adaptations involve mutualistic symbiosis, for example microorganisms help herbivores digest plants. Most of the locations of mutualistic microbes in alimentary canal vary, depending on the type of herbivore.

9.7 Feedback circuits regulate digestion, energy storage, and appetite

Recommended reading: pages 994–997 of chapter 42 in Campbell et al. (2015)

9.7.1 Regulation of digestion

As food enters the stomach, it stretches the stomach walls, triggering the release of the hormone gastrin which stimulates the production of gastric juices. This is an example of positive feedback mechanisms.

9.8 Activity 9.1

Do this activity and add it to your portfolio.

Refer to your textbook and answer the following questions:

b. Try and find examples of herbivores, carnivores, omnivores and consider the type of nutritional benefits they get from their diet.
d. How do animals provide nutrients for their bodies in times of food shortage or great demand?
f. Why do you think that determining an ideal diet for humans is more difficult than in laboratory animals?
h. What kind of organisms would use intracellular digestion and extracellular digestion?

9.9 Feedback on activity 9.1

b. This question requires you to be able to distinguish between herbivores, carnivores and omnivores, and by doing so Identify what kind of nutrients are obtained from the different food sources
d. At this point you need to know what kind of mechanisms come into play when the body requires energy to sustain itself. This includes learning the sequence of breaking down of the body's own glycogen, fat and protein.
f. You have to understand that an animal's nutrition is dependent on its environment and constant monitoring of its activities. Laboratory animals can be manipulated and kept in an environment that will be easy to monitor and thus determine on basis of trial which diet is best for the animal. Humans are most likely not influenced by same environment and cannot be monitored daily without external influences.
h. At this point you need to know that there are organisms that engulf food into their cells and use cellular enzymes to break them down to molecules that can be used as part of their daily nutrition. Whilst some animals have organs that help with digestion, and these animals usually have a more complex digestive system with different compartments.

9.10 Summary

Food provides animals with energy for ATP production, carbon skeletons for biosynthesis and essential nutrients, vitamins and minerals.

Food processing in animals involves ingestion, digestion, absorption and elimination. Evolution adaptations are associated with the type of food that an animal consumes i.e. the type of dentition and type of alimentary canal of the organism.

Vertebrates store excess calories in glycogen, and fat which can be tapped into when the animals is in demand.