

Comparison of Digestive Systems

Introduction

Organisms depend on nutrients to maintain metabolic needs. All animals are consumers (a.k.a. heterotrophs), meaning they do not have the ability to manufacture their own food; therefore, they must consume other organisms as food. The primary purpose of the digestive system is to break down the consumed foods and transfer nutritional components to the body's cells for use in production of the body's fuel and ATP as well as to manufacture other biomolecules.

There are three categories animals can be placed into based on their diets: herbivore, carnivore, and omnivore. Herbivores consume plant matter, whereas the primary diet of a carnivore is other animals. Omnivores consume both plant and animal matter. In vertebrates, the structures that vary between organisms based on diet often include differences in dentition and gut length.

Herbivore

Herbivores consume algae or plant matter such as seeds, leaves, and fruits. Because some of these materials are low in easily accessible energy, herbivores have evolved two alternatives for releasing the nutrients: foregut and hindgut gastric fermentation. Gastric fermentation utilizes bacteria that breakdown the hard to digest cellulose, the plant cell wall's primary component.

In animals that use foregut (a.k.a. pre-gastric) fermentation, the stomach is modified into four chambers/compartments where the first chamber is the rumen. This rumen provides a place for the bacterial breakdown of food. Ruminants regurgitate the partially digested mass from their rumen, known as "cud," and continue to chew the plant matter to break it down further. Examples of foregut ruminants include cows, sheep, camels, and deer. Camels are known to "spit" when angry, but in actuality, they projectile vomit their cud.

In those animals that utilize hindgut fermentation (a.k.a. post-gastric) such as rabbits, rhinos, and horses, the microbial digestion occurs in the large intestine (colon) and/or a large cecum. These organisms are known as monogastric animals, because they lack the multi-chambered stomachs of the ruminants. The post-gastric fermentation process is less efficient (20% – 65% fiber digestion) than pre-gastric fermentation (52% - 80%); therefore, some monogastric animals practice coprophagy (the consumption of feces) to increase the absorption from nutrients of the food that has already passed through their system. Because this process is not efficient, monogastric herbivores have to consume large amounts of food to meet their nutritional needs, sometimes spending up to 16 hours per day grazing.

Herbivore teeth are usually broad and flat and are used to grind plant matter. The lower incisors and canines are modified for biting off vegetation, and herbivores often lack upper incisors and canine.

Carnivore

Carnivores consume other organisms. Because meat is easily digested compared to plant material, the digestive system of a carnivore is typically shorter than an herbivore of comparable size. In carnivores, the caecum is sometimes reduced and may be partially replaced by the appendix.

Because meat is so easily digested, carnivores and omnivores have lost the ability to synthesize some amino acids. These amino acids, building blocks of proteins, which cannot be synthesized, are known as “essential” amino acids.

True carnivores lack enzymes in their saliva to help them digest food. They cannot “chew” by moving their jaws side to side but instead rip the meat into smaller pieces when possible and swallow their food quickly. When the food reaches the stomach, digestive enzymes in the stomach begin to break down the food into absorbable units. The food then moves to the small intestine where most of the absorption occurs and then through the large intestine where waste is eliminated.

Generally, carnivores have pointed incisors and canines designed for killing prey and ripping muscle. The premolars and molars are designed to crush food.

Omnivore

Omnivores consume both plant and animal matter. The length of their digestive system more closely resembles that of an herbivore as compared to a carnivore. However, omnivores lack the fermenting vats found in herbivores. Examples of omnivores include humans, pigs, and bears.

Omnivore dentition is relatively unspecialized as compared to herbivores and carnivores. They contain teeth designed for biting (incisors), tearing (canines), grinding (premolars), and crushing (molars).