Section E: Evolutionary Adaptations of Vertebrate Digestive Systems

1. Structural adaptations of digestive systems are often associated with diet
2. Symbiotic microorganisms help nourish many vertebrates
1. Structural adaptations of digestive systems are often associated with diet

- The digestive systems of mammals and other vertebrates are variations on a common plan.
- However, there are many intriguing variations, often associated with the animal’s diet.
• Dentition, an animal’s assortment of teeth, is one example of structural variation reflecting diet.

• Particularly in mammals, evolutionary adaptation of teeth for processing different kinds of food is one of the major reasons that mammals have been so successful.
• Nonmammalian vertebrates generally have less specialized dentition, but there are exceptions.
  • For example, poisonous snakes, like rattlesnakes, have fangs, modified teeth that inject venom into prey.
    • Some snakes have hollow fangs, like syringes, other drip poison along grooves in the tooth surface.
• All snakes have another important anatomic adaptation for feeding, the ability swallow large prey whole.
  • The lower jaw is loosely hinged to the skull by an elastic ligament that permits the mouth and throat to open very wide for swallowing.
• Large, expandable stomachs are common in carnivores, which may go for a long time between meals and therefore must eat as much as they can when they do catch prey.

• For example, a 200-kg African lion can consume 40 kg of meat in one meal.
• The length of the vertebrate digestive system is also correlated with diet.

• In general, herbivores and omnivores have longer alimentary canals relative to their body sizes than to carnivores, providing more time for digestion and more surface areas for absorption of nutrients.

• Vegetation is more difficult to digest than meat because it contains cells walls.
2. Symbiotic microorganisms help nourish many vertebrates

• Much of the chemical energy in the diet of herbivorous animals is contained in the cellulose of plant cell walls.
  • However, animals do not produce enzymes that hydrolyze cellulose.
  • Many vertebrates (and termites) solve this problem by housing large populations of symbiotic bacteria and protists in special fermentation chambers in their alimentary canals.
  • These microorganisms do have enzymes that can digest cellulose to simple sugars that the animal can absorb.
• The location of symbiotic microbes in herbivores’ digestive tracts varies depending on the species.

• The hoatzin, an herbivorous bird that lives in South American rain forests, has a large, muscular crop that houses symbiotic microorganisms.

• Many herbivorous mammals, including horses, house symbiotic microorganisms in a large cecum, the pouch where the small and large intestines connect.
• The symbiotic bacteria of rabbits and some rodents live in the large intestine and cecum.

• Since most nutrients are absorbed in the small intestine, these organisms recover nutrients from fermentation in the large intestine by eating some of their feces and passing food through a second time.

• The koala also has an enlarged cecum, where symbiotic bacteria ferment finely shredded eucalyptus leaves.

• The most elaborate adaptations for a herbivorous diet have evolved in the ruminants, which include deer, cattle, and sheep.
(1) When the cow first chews and swallows a mouthful of grass, boluses enter the rumen and (2) the reticulum.

- Symbiotic bacteria and protists digest this cellulose-rich meal, secreting fatty acids.
- Periodically, the cow regurgitates and rechews the cud, which further breaks down the cellulose fibers.

(3) The cow then reswallows the cud, which moves to the omasum, where water is removed.

(4) The cud, with many microorganisms, passes to the abomasum for digestion by the cow’s enzymes.