Digestive Compartments:

- **Intracellular Digestion**

Food vacuoles—cellular organelles in which hydrolytic enzymes break down food—are the simplest digestive compartments. The hydrolysis of food inside vacuoles, called intracellular digestion, begins after a cell engulfs solid food by phagocytosis or liquid food by pinocytosis. Newly formed food vacuoles fuse with lysosomes, organelles containing hydrolytic enzymes. This fusion of organelles brings food in contact with these enzymes, allowing digestion to occur safely within a compartment enclosed by a protective membrane. A few animals, such as sponges, digest all their food in this way.

▼ **Figure 33.3 Anatomy of a sponge.** In the main diagram, portions of the front and back wall are cut away to show the sponge's internal structure.

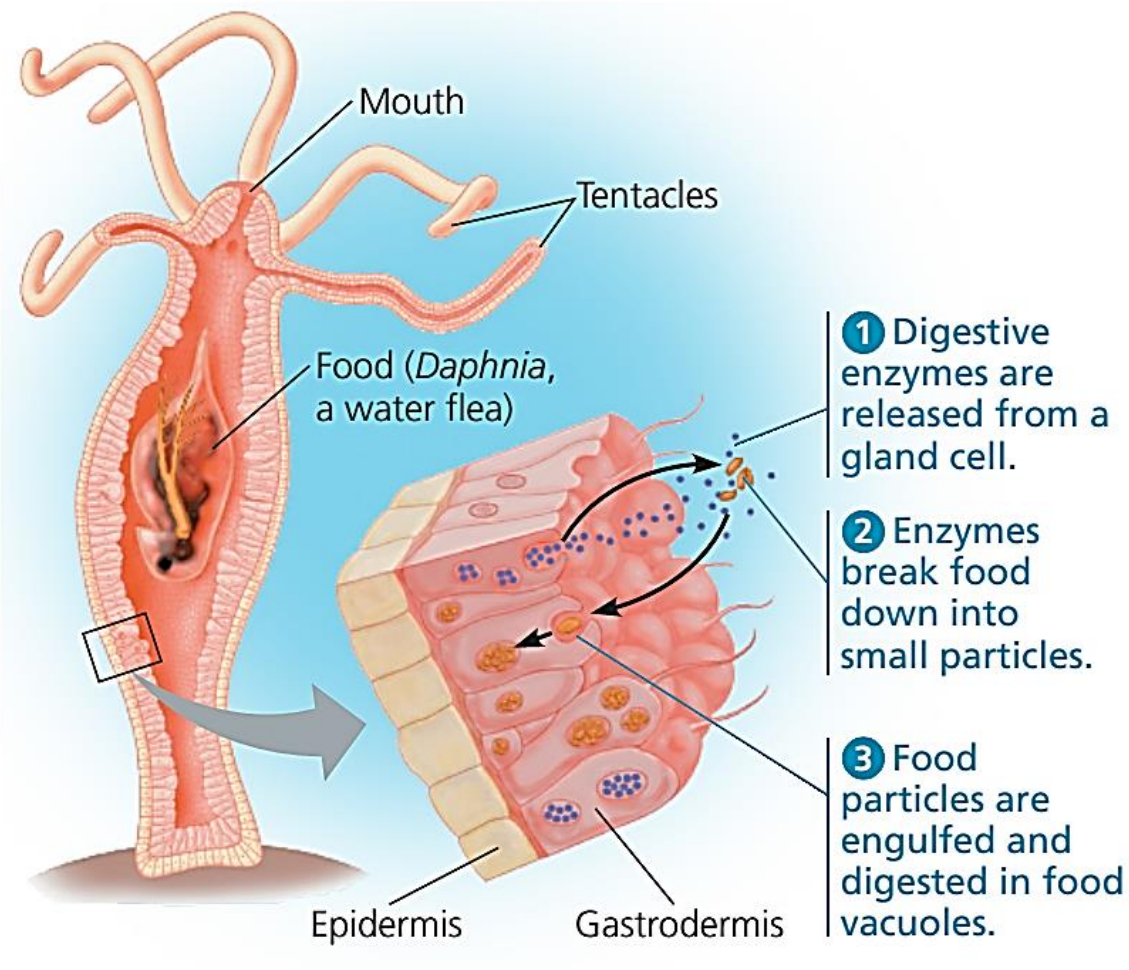
Azure vase sponge (*Callyspongia plicifera*)

- **Extracellular Digestion**

In most animal species, hydrolysis occurs largely by extracellular digestion, the breakdown of food in compartments that are continuous with the outside of the animal's body. Having one or more extracellular compartments for digestion enables an animal to devour much larger pieces of food than can be ingested by phagocytosis.

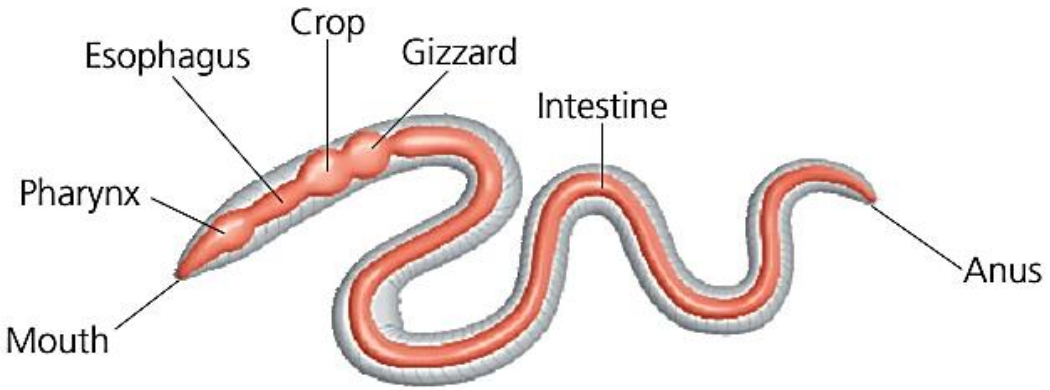
Animals with relatively simple body plans typically have a digestive compartment with a single opening. This pouch, called a gastrovascular cavity, functions in digestion as well as in the distribution of nutrients throughout the body (hence the vascular part of the term). Small freshwater cnidarians called hydras provide a good example. The hydra—a carnivore—uses its tentacles to stuff captured prey through its mouth into its gastrovascular cavity. Specialized gland cells of the hydra's gastrodermis, the tissue layer that lines the cavity, then secrete digestive enzymes that break the soft tissues of the prey into tiny pieces. Other cells of the gastrodermis engulf these food particles, and most of the hydrolysis of macromolecules occurs intracellularly. After the hydra has digested its meal, undigested materials that remain in its gastrovascular cavity, such as exoskeletons of small crustaceans, are eliminated through its mouth. Many flatworms also have a gastrovascular cavity.

▼ Figure 41.6 Digestion in a hydra. Digestion begins in the gastrovascular cavity and is completed intracellularly after small food particles are engulfed by specialized cells of the gastrodermis.

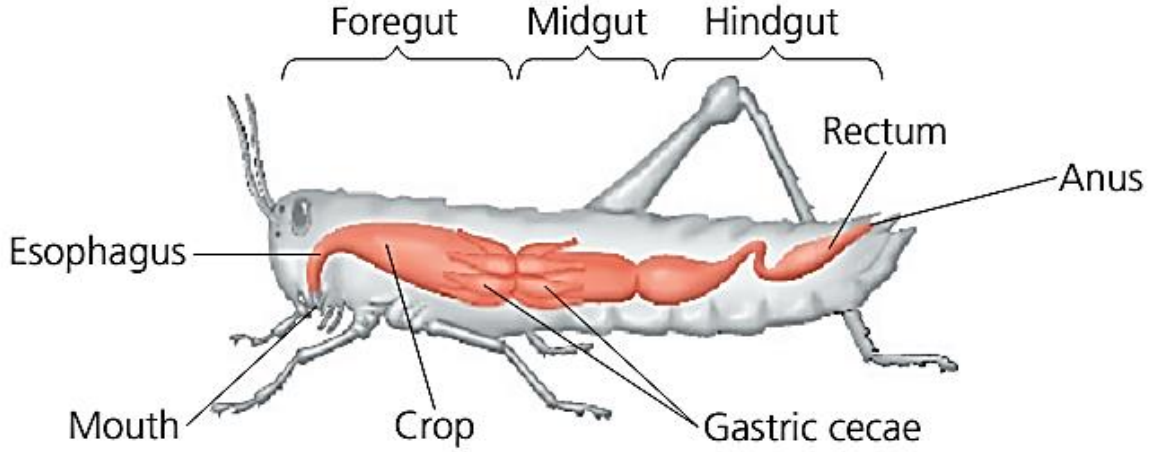


Rather than a gastrovascular cavity, animals with complex body plans have a digestive tube with two openings, a mouth and an anus (Figure 41.7). Such a tube is called a complete digestive tractor, more commonly, an alimentary canal. Food moves along the alimentary canal in a single direction, encountering a series of specialized compartments that carry out stepwise digestion and nutrient absorption. An animal with an alimentary canal can ingest food while earlier meals are still being digested, a feat that is likely to be difficult or inefficient for an animal with a gastrovascular cavity.

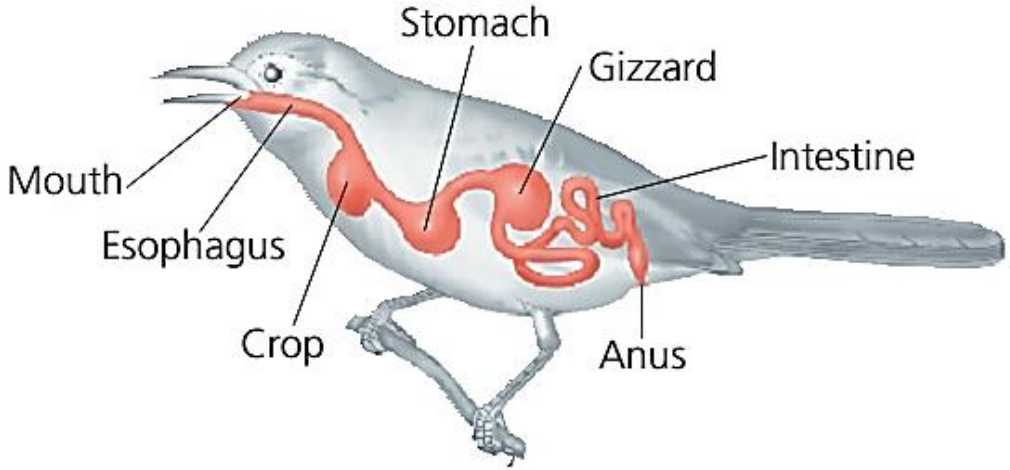
▼ Figure 41.7 Variation in alimentary canals. These examples illustrate how the organization and structure of compartments for digestion, storage, and absorption differ among animals.



(a) Earthworm. The muscular pharynx of an earthworm sucks food in through the mouth. Food passes through the esophagus and is stored and moistened in the crop. Mechanical digestion occurs in the muscular gizzard, which pulverizes food with the aid of small bits of sand and gravel. Further digestion and absorption occur in the intestine before wastes are eliminated through the anus.



(b) Grasshopper. A grasshopper has several digestive chambers grouped into three main regions: a foregut, with an esophagus and crop; a midgut; and a hindgut. Food is moistened and stored in the crop, but most digestion occurs in the midgut. Pouches called gastric cecae (singular, *ceca*) extend from the beginning of the midgut and function in digestion and absorption.



(c) **Bird.** Many birds have a crop for storing food and a stomach and gizzard for mechanically digesting it. Chemical digestion and absorption of nutrients occur in the intestine.

Organs specialized for sequential stages of food processing form the mammalian digestive system