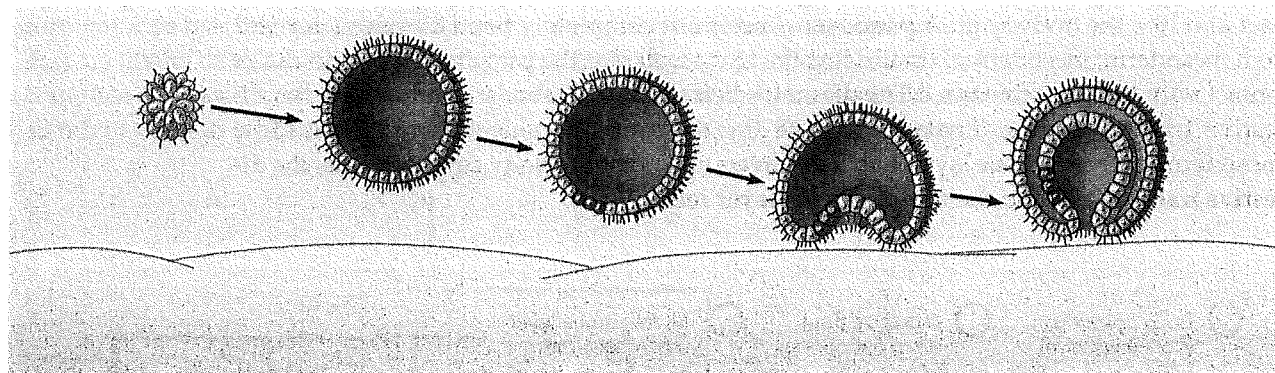


Exercise 2 (Module 18.2)

Using Module 18.2 as a guide, label this series of sketches showing how animals may have evolved from colonial protists. Identify: **colonial protist, somatic cells, reproductive cells, digestive cavity, "proto-animal"**



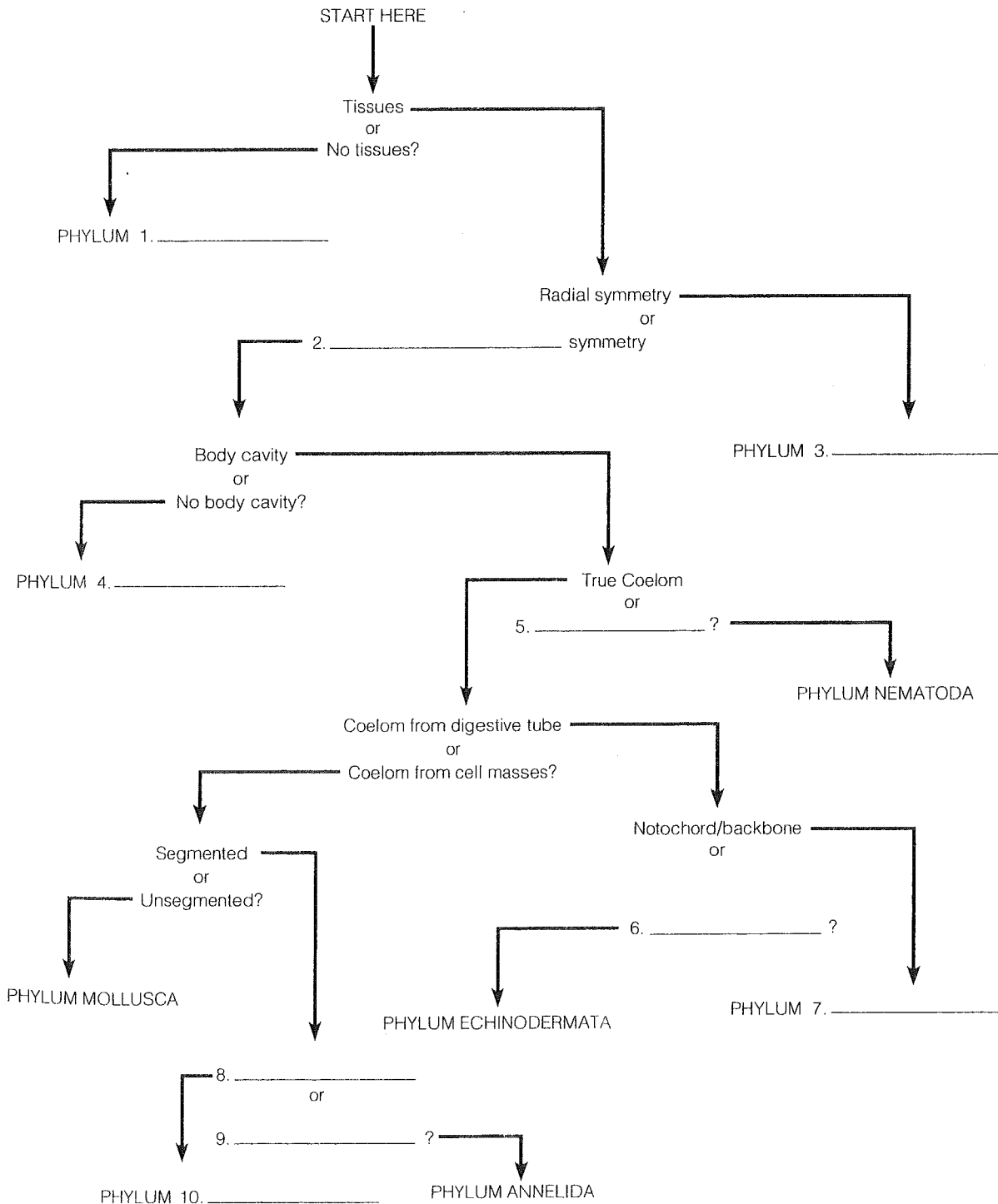
Exercise 3 (Module 18.3)

Symmetry—radial or bilateral—is an important feature of an animal’s body plan. Compare animals having bilateral symmetry with those having radial symmetry by completing the following table.

<i>Animals with Radial Symmetry</i>	<i>Animals with Bilateral Symmetry</i>
Examples: sea anemone, jelly	1.
	2.
	3.
No anterior or posterior ends	4.
No distinct head	5.
	6.
Encounter environment equally from all directions	7.

Exercise 5 (Module 18.4)

Module 18.4 introduces an animal phylogenetic tree based on body plan (tissues, symmetry, body cavity, and so on.) Suppose you found an animal and wanted to know to which phylum it belonged. You could use what biologists call a "key," a series of questions that leads you to the animal's identity. Such a key is given below, in the form of a flowchart. Before you can use this key, you will need to complete it. Some questions and phylum names are given; others are missing. Using information from this module, fill in the blanks to complete the key. You can get some answers by looking at the pictures in Module 18.4. (You might want to try out the key by "keying out" a real animal. Try it on yourself!)



Exercise 6 (Modules 18.5–18.6)

Sponges and cnidarians are the simplest animals. Complete the following description of these two phyla by filling in the blanks.

Sponges, Phylum ¹ _____, and cnidarians, Phylum ² _____, are both simple animals. Most sponges and cnidarians live in the ³ _____, but some are found in fresh water. Sponges are usually irregular in shape, but all cnidarians are characterized by ⁴ _____ symmetry. This means their body parts are arranged in a circle around a central axis.

Sponges are by far the simpler of the two animals. A sponge is a simple tube perforated by tiny ⁵ _____. The body wall consists of ⁶ _____ layers of cells. The outer layer functions to protect the sponge. A gelatinous middle layer contains wandering amoebocytes and a skeleton made of flexible spongin or more rigid mineral-containing particles. The sponge's inner layer consists of cells called choanocytes bearing ⁷ _____, which move to create a current of water that ⁸ _____ the sponge through the small pores and ⁹ _____ through a larger central opening. The choanocytes trap ¹⁰ _____ from the water and then engulf them by phagocytosis. The amoebocytes pick up food from the choanocytes and distribute it to other cells. They also make the ¹¹ _____ fibers.

Unlike other animals, sponges lack both ¹² _____ and muscles. In fact, their cells are relatively unspecialized, so the cell layers are not considered true ¹³ _____. It is likely that sponges are early offshoots of ancient colonial ¹⁴ _____ called choanoflagellates.

Cnidarians—animals such as ¹⁵ _____, sea anemones, and corals—are a bit more complicated. They have a ¹⁶ _____ cavity, muscles, and a ¹⁷ _____ system that enables them to respond to stimuli and coordinate muscle action. Unlike sponges, their cells are organized into ¹⁸ _____, groups of cells adapted to perform specific functions. But unlike more complex animals, they have only ¹⁹ _____ tissue layers, and most of their activities are carried out at the tissue level, not by the organs and ²⁰ _____ of more complex creatures.

Cnidarians are radially symmetrical and come in two shapes. A ²¹ _____ is a tube with tentacles radiating from one end. It is usually fixed in place. A ²² _____ is a disk with a fringe of tentacles on the edge. ²³ _____ are medusas and are able to move about in the water. Some cnidarians, such as the freshwater form called a ²⁴ _____, illustrated in the text, exist only in the polyp form; some cnidarians exist only as medusae. Others have both medusa and polyp stages in their life cycles.

A cnidarian captures small prey and pushes it into its mouth with its ²⁵ _____. Special cells called ²⁶ _____ on the tentacles (characteristic only of cnidarians) sting and entangle the prey. The mouth of a polyp faces upward, in the center of the tentacles. A jelly's mouth is ²⁷ _____, in the center of the umbrella. The mouth leads to a digestive sac called the ²⁸ _____ cavity. Food is digested here, and fluid in the cavity circulates food particles around the body. The fluid in the cavity also keeps the flimsy body "inflated" and gives the cnidarian its shape. Because the gastrovascular cavity has only one opening, ²⁹ _____ are expelled through the mouth.

Exercise 7 (Modules 18.6–18.8)

Review and compare the structures and lifestyles of cnidarians, flatworms, and roundworms by completing this chart.

	<i>Cnidarians</i>	<i>Flatworms</i>	<i>Roundworms</i>
1. Phylum name			
2. Examples			
3. Type of body symmetry			
4. Number of tissue layers			
5. Body shape(s)			
6. Body cavity			
7. Digestive tract			
8. Where they live			
9. Importance to humans			

Exercise 8 (Module 18.9)

This module discusses several of the structural and functional characteristics of mollusks, a varied and successful group of animals. Match each of the statements on the left with a mollusk body structure on the right.

- | | |
|---|-----------------------|
| _____ 1. Modified to form a lung in land snails | A. Coelom |
| _____ 2. Lacking in slugs | B. Radula |
| _____ 3. Used by a clam to capture food | C. Gill |
| _____ 4. Divided into hinged halves in bivalves | D. Foot |
| _____ 5. Functions in locomotion in most mollusks | E. Mantle |
| _____ 6. Extracts oxygen from the water | F. Circulatory system |
| _____ 7. Rasping organ used to scrape up food | G. Shell |
| _____ 8. Distributes nutrients, water, and oxygen around the body | |
| _____ 9. Missing or internal in squids and octopuses | |
| _____ 10. Outgrowth of the body surface that drapes over the animal | |
| _____ 11. Modified to form tentacles in cephalopods | |
| _____ 12. Body cavity around heart, kidney, and reproductive organs | |
| _____ 13. Long projections on the back of a sea slug | |
| _____ 14. "Crawling" movements of this structure propel gastropods | |
| _____ 15. Used by a clam for digging and anchoring in mud or sand | |
| _____ 16. Shoots out a jet of water to propel a squid | |
| _____ 17. Eyes of a scallop are along the edge of this structure | |
| _____ 18. A one-piece coiled structure in snails | |
| _____ 19. Lacking in terrestrial snails and slugs | |
| _____ 20. Secretes the shell | |

Exercise 9 (Module 18.10)

This module discusses annelids, the segmented worms, and the importance of segmentation. Review by filling in the blanks.

The next time you dig up an earthworm, or see one wriggling on the sidewalk, pause to appreciate its beauty and complexity. Earthworms are segmented worms of the phylum ¹_____. The name, which means "ringed," refers to the repeating ringlike ²_____ that make up the worm's body. There are three main groups of annelids. Most live in the ³_____, but many species live in ⁴_____ and moist soil.

The most distinctive external characteristic of annelids is segmentation. Internally, each segment is separated from adjacent ones by membranous ⁵_____. The ⁶_____ system consists of a simple brain, a ventral nerve cord, and clusters of nerve cells in each segment. There are blood vessels serving each segment, and ⁷_____ structures, which dispose of fluid wastes, are also repeated. A dorsal heart (actually an enlarged blood vessel) pumps blood via a ⁸_____ circulatory system. The main blood vessels and the ⁹_____ system are unsegmented.

What are the advantages of a segmented body? It probably is an adaptation to facilitate ¹⁰_____. It gives the body greater ¹¹_____ and ¹²_____. Longitudinal and ¹³_____ muscles in each segment enable an earthworm to burrow, obtaining nutrients from the soil that passes through its digestive tract. Earthworms stir up the soil, and their ¹⁴_____ improve its texture.

The largest group of annelids are the ¹⁵_____. Most of these worms live in the ¹⁶_____, where they wriggle along the bottom, burrow in the mud, or construct protective ¹⁷_____. The mobile polychaetes move by means of segmental ¹⁸_____. In tube-dwellers, these appendages are modified for ¹⁹_____ and respiration.

The third group of annelids are the ²⁰_____. Some suck ²¹_____, but most are free-living ²²_____ that eat small animals. Most leeches live in ²³_____, but some are found in the sea or on land. Leeches have sharp ²⁴_____, and they secrete an anesthetic that enables them to slice painlessly through the skin and an anticoagulant that keeps blood flowing freely. The latter substance is useful in drug form for dissolving ²⁵_____.

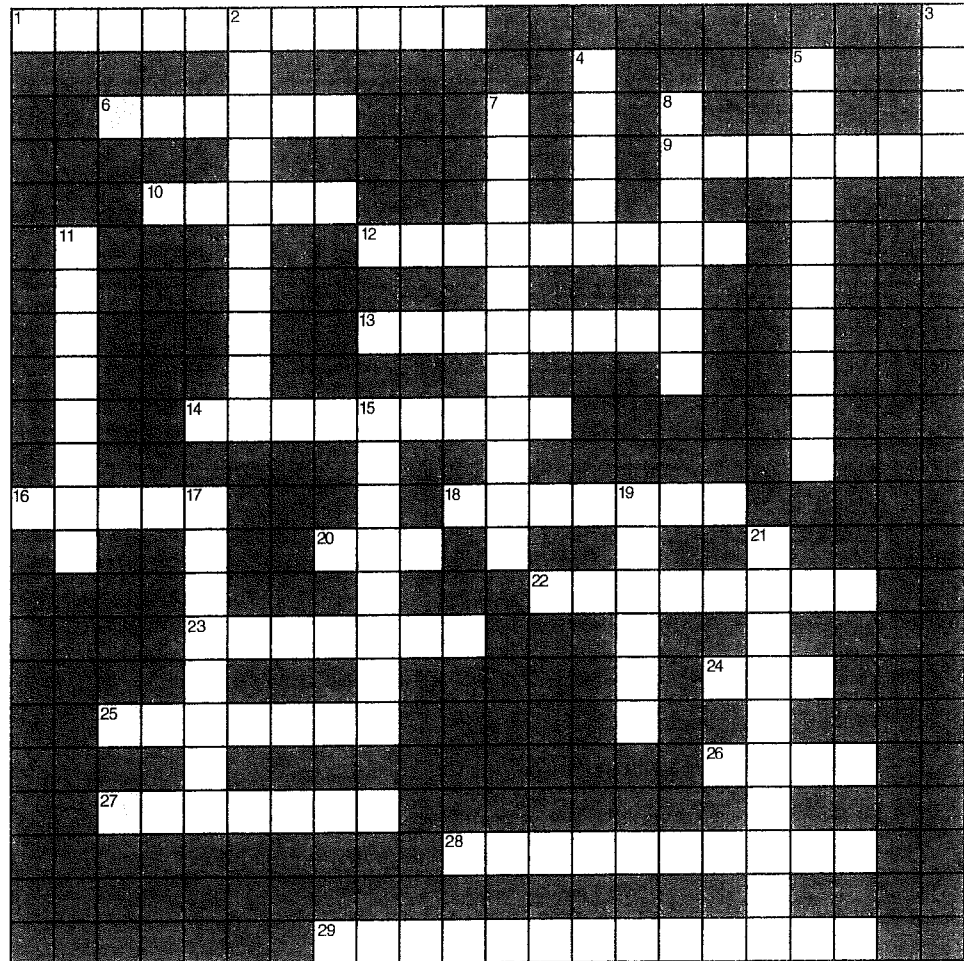
Annelids are not the only segmented animals. ²⁶_____ are segmented; this is seen clearly in the abdomen and in the thorax of an insect, where wings and legs are repeated. Animals with backbones are also segmented. In humans, segmentation is most clearly seen in the backbone and in the abdominal muscles.

Exercise 10 (Modules 18.11–18.12)

These modules discuss Phylum Arthropoda, and Class Insecta, the arthropods that are the largest and most diverse group of animals. Review your knowledge of arthropods and insects by completing the crossword puzzle.

Across

1. Crabs and lobsters are ____.
6. The arthropod exoskeleton is made of ____ and protein.
9. ____ make up the largest order of animals.
10. An insect has ____ pairs of legs.
12. The ____ crab is a "living fossil" related to spiders.
13. ____ are sensory appendages on the head.
14. ____ are marine filter-feeding crustaceans.
16. Insects are the only invertebrates with ____.
18. Arthropods have ____ appendages.
20. A spider might hunt insects or catch them in a ____.
22. The ____ is an arachnid with pincers and a sting at the end of its tail.
23. ____ is shedding the old exoskeleton and growing a larger one.
24. Much of insect success can be attributed to their ability to ____.
25. A lobster uses its ____ for defense.
26. Arthropods have an ____ circulatory system.
27. The ____ are the most diverse group of arthropods.
28. ____ are multi-legged carnivores.
29. Many insects undergo ____ during their development.

**Down**

2. Crabs, grasshoppers, and tarantulas are all representatives of phylum ____.
3. ____ are wingless social insects related to bees and wasps.
4. Scorpions, spiders, ____, and mites are all arachnids.
5. The study of insects is called ____.
7. Every arthropod has a hard external skeleton called an ____.
8. An insect's body consists of head, thorax, and ____.
11. Many people are ____ to dust mites.
15. Unlike ____, which have similar segments the length of the body, most arthropods are divided into distinct groups of segments.
17. The arthropod body consists of groups of ____.
19. An insect's wings and legs are attached to its ____.
21. ____ are wormlike plant-eaters with many short legs.

Exercise 13 (Modules 18.15–18.16)

New information—especially discoveries in genetics and the new science of “evo-devo”—have shaken the animal phylogenetic tree a bit. In the revised tree, which is thought to more accurately reflect evolutionary history, characteristics such as body cavity and segmentation are not as important as other more obscure characteristics such as feeding method and details of embryological development. Study the revised tree in Module 18.15 and then see if you can identify the structural characteristics that characterize each of the following branches of the tree.

- | | |
|--|--------------------------------|
| _____ 1. Sponges | A. Embryological development |
| _____ 2. Everything but sponges | B. Presence of true tissues |
| _____ 3. Cnidaria | C. Feeding structure and larva |
| _____ 4. All protostomes and deuterostomes | D. Radial symmetry |
| _____ 5. Protostomes | E. Bilateral symmetry |
| _____ 6. Deuterostomes | F. Molting of exoskeleton |
| _____ 7. Lophotrochozoa | G. Lack of true tissues |
| _____ 8. Ecdysozoa | |

Test Your Knowledge

Multiple Choice

- Which of the following is *not* a characteristic of all animals?
 - They are multicellular.
 - They have tissues, organs, and organ systems.
 - They are eukaryotes.
 - They ingest their food.
 - They are heterotrophic.
- A ____ is the simplest animal discussed in this chapter to have ____ .
 - sponge . . . bilateral symmetry
 - flatworm . . . a body cavity
 - roundworm . . . a complete digestive tract
 - jelly . . . a complete digestive tract
 - snail . . . a body cavity
- Which of the following animals does *not* have a body cavity?
 - flatworm
 - ant
 - mouse
 - clam
 - earthworm
- Which of the following phyla include numerous parasites and pests?
 - roundworms and flatworms
 - mollusks and roundworms
 - annelids and flatworms
 - annelids and roundworms
 - mollusks and flatworms
- Animals probably evolved from colonial protists. How do animals differ from these protist ancestors?
 - Animals are eukaryotic.
 - Animals have more specialized cells.
 - Animals are heterotrophic.
 - Animals are autotrophic.
 - Animals are able to reproduce.
- Which of the following animals is *not* segmented?
 - leech
 - human
 - lancelet
 - lobster
 - snail
- Phylum ____ includes the largest number of species.
 - Mollusca
 - Chordata
 - Annelida
 - Arthropoda
 - Echinodermata
- The water vascular system of a sea star functions in
 - movement of the tube feet.
 - circulation of nutrients around the body.
 - pumping water for swimming movements.
 - waste disposal.
 - keeping all parts of the body moist at low tide.

9. A ____ is a chordate, but not a vertebrate.
 - a. squid
 - b. shark
 - c. tunicate
 - d. beetle
 - e. frog
10. Zoologists have traditionally placed chordates and echinoderms on one major branch of the animal phylogenetic tree, and mollusks, annelids, and arthropods on another major branch. Which of the following is the basis for this separation into two branches?
 - a. whether or not the animals have a skeleton
 - b. type of symmetry
 - c. whether or not the animals have a body cavity
 - d. how the body cavity is formed
 - e. whether or not the animals are segmented
11. Which of the following are most numerous and successful on land?
 - a. mollusks and chordates
 - b. annelids and arthropods
 - c. arthropods and chordates
 - d. annelids and chordates
 - e. mollusks and arthropods
12. Which of the following has been suggested to explain the Cambrian explosion of animal diversity?
 - a. increase in atmospheric oxygen levels
 - b. development of more complex predator-prey relationships
 - c. variation in expression of *Hox* genes
 - d. evolution of hard skeletons
 - e. all of the above
13. According to the information in this chapter, the largest existing invertebrate is
 - a. a mollusk
 - b. a whale
 - c. an arthropod
 - d. a cnidarian
 - e. a sponge
14. Which of the following are all suspension feeders?
 - a. clams, sponges, and tunicates
 - b. barnacles, cnidarians, and sponges
 - c. lancelets, cnidarians, and clams
 - d. cnidarians, sponges, and sea stars
 - e. barnacles, sea stars, and tunicates

Essay

1. Describe the characteristics that separate animals from the other groups of living things.
2. Describe some of the characteristics that biologists consider important when deciding the phylum into which an animal should be classified.
3. What kinds of animals have a body cavity? What kinds lack a body cavity? Describe some of the advantages of having a body cavity.
4. Describe how the mantle, mantle cavity, and shells of snails, clams, and squids are modified for their different ways of life.
5. In terms of numbers of individuals and numbers of species, it could be argued that insects are the most successful creatures on Earth. What are some characteristics or adaptations that have made them so successful?

Apply the Concepts

Multiple Choice

1. Compare the two phylogenetic trees in Modules 18.4 and 18.15. The tree based on molecular data most drastically revises which of the following relationships?
 - a. cnidaria and all other phyla
 - b. annelids and mollusks
 - c. sponges and all other phyla
 - d. annelids and arthropods
 - e. chordates and echinoderms
2. Which of the following includes the largest number of species?
 - a. animals that are segmented
 - b. animals with radial symmetry
 - c. animals with bilateral symmetry
 - d. animals that are unsegmented
 - e. animals with a notochord
3. Which of the following is radially symmetrical?
 - a. a doughnut
 - b. an automobile
 - c. a spoon
 - d. a peanut butter sandwich
 - e. a wristwatch

4. A marine biologist dredged up a small animal from the bottom of the ocean. It was uniformly segmented, with short, stiff appendages and soft, flexible skin. It had a complete digestive system and a circulatory system but no skeleton. Based on this description, this animal sounds most like
 - a. a lancelet.
 - b. a crustacean.
 - c. a mollusk.
 - d. a roundworm.
 - e. an annelid.
5. "Pill bugs" or "sow bugs," often found under rocks and logs in moist places, are perhaps most noticed for their ability to roll up into a ball when disturbed. Sow bugs are really crustaceans, not insects. Therefore, a sow bug does *not* have
 - a. an exoskeleton.
 - b. gills.
 - c. three pairs of legs.
 - d. antennae.
 - e. jointed appendages.
6. Which of the following is thought to be most closely related to you?
 - a. sea star
 - b. snail
 - c. earthworm
 - d. jelly
 - e. ant
7. Planarian worms, tapeworms, and flukes are all in the Phylum Platyhelminthes, but flukes lack sensory structures such as eyes, and tapeworms don't even have a digestive system. How can such different animals be placed in the same phylum?
 - a. Phylum Platyhelminthes isn't a true clade; it is a catch-all for unrelated species.
 - b. Whether or not an animal has a digestive system isn't important in classification.
 - c. Roundworms are *very* different from planarian worms and are in the same phylum.
 - d. Flukes and tapeworms worms may have lost some structures because they are parasites.
 - e. These three worms are *not* in the same phylum.
8. A zoologist referred to a group of animals as "the insects of the sea." What group do you think she was talking about?
 - a. mollusks
 - b. cnidarians
 - c. arachnids
 - d. echinoderms
 - e. crustaceans
9. Dragonflies, like most insects, have two pairs of wings. In flies, the rear pair of wings is modified into a pair of balancing structures called halteres. In beetles, the front pair of wings are more like hard protective shells. If the evolution of wings is like evolution of other parts of the insect body, what genetic differences probably account for these differences in insect wings?
 - a. These three insects do not share a common ancestor, so you would not expect their wings to be similar.
 - b. These insects probably have the same "wing" genes, but changes in homeotic genes alter their timing.
 - c. These insects probably each have different "wing" genes, so their wings develop differently.
 - d. Insect wings are actually modified legs, so mutations to "leg" genes shaped the different structures.
 - e. Insect wings are shared ancestral characters; genetic changes would not affect them.
10. You would expect to find the greatest number of phyla of animals _____ and the greatest number of species of animals _____.
 - a. on land . . . in the sea
 - b. in fresh water . . . in the sea
 - c. in the sea . . . on land
 - d. in the sea . . . in fresh water
 - e. on land . . . in fresh water
11. Most insects go through a process of complete metamorphosis. Which of the following "advertisements" most accurately summarizes this process?
 - a. "Little and Lethal"
 - b. "Feeders and Breeders."
 - c. "Eaters and Skeeters"
 - d. "Wingers and Stingers"
 - e. "Fighters and Biters"