MODULE #12: Phylum Arthropoda

Class Arachnida

Are you ready for chills to run up and down your spine? Well, you had better be, because in this section, we are going to discuss class Arachnida (uh rak' nih duh), the class that contains spiders. For some reason, most people have a revulsion against spiders. This is probably because spiders typically live in the dark and attack their prey quickly with no warning. This seems to strike to the very core of some people's greatest fears.

Although spiders are greatly feared, there are only a few that are actually harmful. Many spider bites can hurt, but only a few spiders, like the black widow or the brown recluse, are poisonous to human beings. In fact, many spiders are actually quite beneficial to humans and to the ecosystem in general. Spiders help keep the population of insects in check. If it were not for these fearsome little arthropods, insects would overrun most ecosystems!

Organisms in class Arachnida have five common characteristics:

ØFour pairs of walking legs
ØA cephalothorax instead of separate head and thorax
ØUsually have four pairs of simple eyes
ØNo antennae
ØRespiration done through organs known as “book lungs”

You probably know the first characteristic. It is usually the first thing taught to students as a means by which to separate arachnids from insects. Arachnids have eight legs (four pairs), while insects have six legs (three pairs).

The second characteristic listed tells you that arachnids have only two body segments: a cephalothorax and an abdomen. Remember that some arthropods have three segments (head, thorax, and abdomen). If you look back at Figure 12.1, you can count the “bumps” on the spider to see that there are four pairs of simple eyes, just as the third characteristic indicates. Unlike crayfish, spiders do not have antennae. Finally, spiders breathe through book lungs, which we will discuss in a later section.

Since spiders are representative of class Arachnida, we will take an in-depth look at them. As we mentioned at the close of the previous section, we will present a lot of information in this section for which you will not be held responsible on the test. Instead of requiring you to memorize a lot of this material, we just want you to get a good appreciation for the organisms in this class. How will you know what information you will be responsible for on the test? Read through this section, and then use the “On Your Own” questions and the study guide to help you determine this. For example, we will present the anatomy of the spider in a little while, pointing out many of the key organs in the spider's body. However, if you look at the study guide, you will see no diagram that asks you to point out the major organs in a spider. Thus, even though we point out all of the major features of spider anatomy, you will not be held responsible for it on the test. However, the study guide does ask you the characteristics that set arachnids apart from other arthropods, so that is something you will need to know for the test.

The Spider

The figure below shows two different spiders. They probably illustrate the most striking difference between the various species of spiders: some spiders spin webs, others do not.

FIGURE 12.6
The Tarantula and the Garden Spider
Photos from www.clipart.com

Tarantula

Garden Spider

Spiders are cunning predators that use many different means to catch their prey. Although their most common means of catching prey involves weaving a web (we will discuss this in a moment), many spiders do not use webs to hunt. Tarantulas, for example, stalk their prey, sneaking up and pouncing on unaware creatures. Although the tarantula strikes fear into the heart of most people who see it, the common species of this spider is not poisonous to humans. Of those that are, the poison usually results only in a stinging rash accompanied by swelling. Nevertheless, partly because of their size and partly because of their reputation, tarantulas are some of the most feared organisms on the planet. Some people use this to their advantage. For example, a jewelry store owner had been robbed several times. To curb the robberies, he placed several large tarantulas in his showcase window after business hours each night. He also posted a sign that said, “Danger! This area is patrolled by tarantulas.” Not surprisingly, the robberies stopped.

Of course, spiders are best known for weaving webs because this is the way that most of them capture prey. They weave these webs out of spider silk, one of the most incredible substances in all of creation. Spider silk is a very flexible substance, but at the same time it is very strong. Most man-made materials are either strong or flexible. It is very difficult to engineer a substance that is both. You've probably played with an abandoned web at one time, plucking the silk and watching it vibrate. This is a great illustration of spider silk's flexibility. What you probably don't know, however, is the strength of spider silk. It is rather easy to break the strands of a web, because the silk strands are so thin. However, if you were to weave a rope out of spider silk, it would be stronger than a steel pipe of the same size, yet it would be almost as flexible as a rope. A spider silk rope that is just a bit thicker than a garden hose, for example, can support the weight of two full Boeing 737 airplanes!

To illustrate just how incredible spider silk is, we want you to read about one application that scientists use it for today. In physics research, scientists are trying to develop a process called “laser-induced nuclear fusion.” If it could ever be developed, it would result in a

limitless, safe, and completely clean source of energy. This process involves taking a laser and inducing a nuclear reaction that turns hydrogen into helium. This is a violent reaction but, when done on a tiny sample, it is controllable. To hold the sample in place, scientists need a strong substance that is very lightweight. Do you know what scientists use to hold the sample? They use spider silk. Spider silk gives them the strength that they need but does not weigh much at all. As a result, it is an ideal substance for use in laser-induced nuclear fusion systems! The “lowly” spider may one day help us develop clean and inexpensive energy.

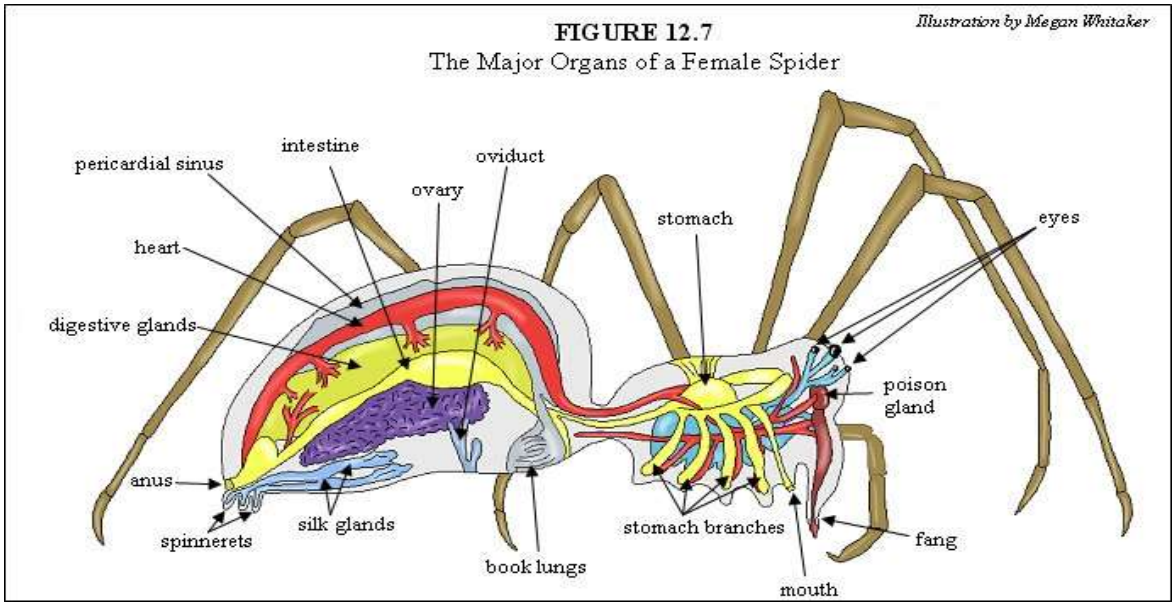
There is a host of different ways that spiders use their silk to catch their prey. Most weave webs. Some species of spider build a sheet web, which is a single, flat sheet of sticky silk. The spider hangs on the underside of the sheet and, when an insect gets caught, it paralyzes the creature and pulls it through the web. Some spiders spin tangles of webs that have no real discernible pattern. These webs are typically called tangle webs. The most geometrically stunning web is the orb web, like the one pictured in Figure 12.6. This web consists of concentric circles of sticky silk that are supported by “spokes” of nonsticky silk. These webs can span great distances, making them very efficient traps. The spider sits at the center of the web with its legs on the spokes. When an insect gets caught in the web, it begins to struggle. The spider can tell which part of the web that the insect is in because the spoke nearest the insect will shake more than the others. When the spider senses which spoke is shaking the most, it follows the spoke until it finds the insect.

Of course, there are spiders that produce silk but do not weave webs. The trap door spider digs a shallow hole in the ground and then weaves a “trap door” out of silk. The trap door is attached to the ground at one end but is free to move everywhere else. The spider holds on to tiny “handles” that it weaves into the trap door and keeps it slightly ajar. When an insect or crustacean walks by, the spider jumps out of the trap door, startling and killing its prey. It then drags it back into the hole and closes the trap door, feasting on its catch. Other spiders spin single strands of silk with very sticky ends. They launch the silk at their prey, catching them and reeling them in.

Now think about this for a moment. Consider the fact that spider silk is a marvelous material which is both strong and flexible. Then realize that spiders use this to create such engineering marvels as orb webs, trap doors, or projectiles that can be reeled back in! Is there anything more marvelous in all of creation? Well, believe it or not, there is! As you study more and more science, you will see that these kinds of engineering marvels exist all over creation, and there are some even more awesome than the wonder of spider silk and how it is used. Through examples such as this one, we know that life is no accident. Such incredible systems cannot develop by chance. Creation clearly tells us what an awesome God we have!

The Major Points of Interest in Spider Anatomy

Figure 12.7 is a sketch of the major systems in a spider. We will not discuss all of them, because many organs in the spider are pretty much the same as those in the crayfish. Of course, the most striking difference between the organs of a spider and those of a crayfish is the presence of silk glands and spinnerets. When a spider spins silk, it produces that marvelous substance in its silk glands and uses its spinnerets to spin the silk.



Regardless of how a spider catches its prey, once the prey is caught, most spiders behave similarly. Spiders sink their fangs into the prey and use their poison glands to inject a paralyzing poison into the prey. This immobilizes the creature, and the spider then secretes digestive enzymes into its body. The tissues that these enzymes partially digest are then sucked through the mouth and into the stomach. The poison of a spider is rarely harmful to humans. It is usually a very weak poison, designed to paralyze tiny prey. There are, however, a few species (the black widow and brown recluse spiders, for example) that have a bite which can be deadly to humans.

The book lungs of a spider do the same job that the gills do in a crayfish, except of course for the fact that gills extract dissolved oxygen gas from the water, while the spider's book lungs extract oxygen from the air. Air enters the exoskeleton through a slit in the abdomen, which is called a spiracle (spear' uh kuhl). There, it encounters an organ that has several thin layers, almost like the pages of a book. As the air mingles with these “pages,” oxygen is absorbed by the blood and carbon dioxide is released.

If you are interested in learning more about spiders, please visit the course website that we discussed in the “Student Notes” section at the beginning of this book. You will find links to information on many aspects of spider biology, including more information on the wonders of spider silk.

Classes Chilopoda and Diplopoda

It seems natural to discuss classes Chilopoda (kye lah' puh duh) and Diplopoda (duh plah' puh duh) right after class Arachnida, because the members of these classes are likely to make your skin crawl as well. Class Chilopoda is home to the arthropods normally called “centipedes,” and class Diplopoda contains those arthropods usually called “millipedes.” Although often used interchangeably, these two terms refer to two completely different creatures.

The term “centipede,” which in Latin means “hundred legs,” refers to the members of class Chilopoda. These arthropods have flat bodies that are divided into several segments, each of which contains a pair of legs. Their common name is misleading, however, because centipedes do not have anywhere near 100 legs. The head of a centipede contains antennae for sensory perception and several mouth parts. The body segment directly behind the head contains the first pair of legs, which have poisonous claws. These claws immobilize the insects and small animals that the centipede eats. The common centipedes with which you are familiar are rather small, but certain tropical species can reach lengths of up to one foot long. Although the bite of a centipede is painful to humans, it is rarely dangerous.

The term “millipede,” which in Latin means “thousand legs,” refers to the members of class Diplopoda. Once again, unlike their common name implies, these arthropods do not have anywhere near 1,000 legs. They do have many more legs than centipedes, however, because each of their body segments contains two pairs of legs instead of just one. This is not the only difference between centipedes and millipedes, however. Millipedes have bodies that are rounded, rather than flat. Typically, their antennae are shorter than those of centipedes, and they do not have the poisonous claws that centipedes have. In fact, while centipedes are fierce predators, millipedes are typically docile. They move along the ground slowly, eating vegetation and organic debris. Often, when threatened, millipedes will simply roll into a ball, hoping that their strong exoskeletons will protect them.

Centipede photo © Corel, Inc. *Millipede photos by Dr. Jay L. Wile*

FIGURE 12.8
Centipede and Millipede

A centipede is a fierce predator with a pair of legs on each body segment.

A millipede is a docile arthropod that curls up in a ball when threatened. It has two pairs of legs per segment.