MODULE #12: Phylum Arthropoda

Introduction

As you have already learned, invertebrates make up the vast majority of the animal kingdom. In this module, we will study the most populous phylum of invertebrates, phylum Arthropoda (ar thrah' poh duh). This phylum contains crayfish, lobsters, spiders, scorpions, and insects. In fact, it contains more species than all of the other phyla in kingdom Animalia combined! Obviously, then, this important phylum deserves an in-depth look.

Arthropods are all around us. They crawl on the ground, fly in the air, and skim across the water. They have an amazing effect on the environment. Arthropods, for example, help plants reproduce by carrying pollen from one plant to another. They also produce many useful items such as silk, wax, honey, and drugs. Although arthropods are very necessary for the earth's ecosystem, they can also be quite dangerous. Some arthropods transmit deadly diseases, while others have been responsible for the destruction of millions of acres of crops. A study of these important animals promises to be quite interesting!

General Characteristics of Arthropods

Although this phylum is vast and diverse, there are many common characteristics that unite arthropods. These characteristics are important to know and understand.

Common Characteristic #1: An Exoskeleton

All arthropods have an exoskeleton.

Exoskeleton – A body covering, typically made of chitin, that provides support and protection

As the definition states, the exoskeleton is generally made of chitin (kye' tin). This chemical has the useful property of being both tough and flexible. In addition to chitin, there is usually a mineral substance in the exoskeleton of an arthropod that makes it hard. The hard, tough exoskeleton can be thought of as a suit of armor that an arthropod wears. It is flexible enough to move with the creature, but it is tough enough to provide a good measure of protection.

Unlike suits of armor, however, exoskeletons also serve another purpose. The invertebrates that we have studied so far have not needed any support. They either float in the water (like medusae), attach themselves to an object (like sponges), or build themselves a container (like clams). The arthropods, however, must be able to move about or fly. As a result, their fleshy bodies must have support. People (and all vertebrates) get their support from their skeleton, a network of bones that runs inside the body. Arthropods get their support from their exoskeleton. Thus, you could say that while people (and all vertebrates) have their skeletons on the inside, arthropods have their skeletons on the outside. That's where the term “exoskeleton” comes from.

Although the exoskeleton is necessary for the existence of arthropods, it comes at a cost. You see, the exoskeleton is heavy. It is so heavy, in fact, that it limits the growth potential of an arthropod. As an arthropod increases in size, the amount of exoskeleton must increase as well. This causes the arthropod to get quite heavy. For each arthropod, there comes a point at which the creature's muscles just aren't strong enough to carry around the weight of the

exoskeleton. Thus, each arthropod is limited as to how big it can get. Class Crustacea (kruh stay' shuh) contains the largest arthropods, some of which can grow to 12 feet. The other classes of arthropods contain species that rarely get much larger than 11 inches.

Not only does the exoskeleton limit the growth potential of an arthropod it also makes it hard for the arthropod to grow during its life cycle. The exoskeleton is secreted by the arthropod's epidermis and forms around the body, but it cannot grow. Thus, as the body gets bigger, the exoskeleton gets more and more constricting. As a result, an arthropod must molt several times throughout the course of its lifetime.

Molt – To shed an old outer covering so that it can be replaced with a new one

Most arthropods molt by secreting enzymes that eat away at the exoskeleton, weakening it. They then take in water, swelling the body until the exoskeleton breaks away. This is done while a new exoskeleton is being produced under the old one. Once the old one is gone, the arthropod's new exoskeleton will be larger than the body of the arthropod because of the swelling that was caused by the excess water that was taken in. As a result, once the arthropod gets rid of the excess water, the body has room to grow again. As the arthropod continues to grow, however, it will once again get constricted, at which time it will molt again.

Common Characteristic #2: Body Segmentation

Like the organisms in phylum Annelida, arthropods are segmented. This segmentation is quite different from the annelids' segmentation, however. In arthropods, the body is divided into three major divisions: the head, the thorax (thor' aks), and the abdomen. These divisions can sometimes be further segmented. In addition, some arthropods have the thorax and head united in a single segment called the cephalothorax (sef uh loh thor' aks).

Thorax – The body region between the head and the abdomen

Abdomen – The body region posterior to the thorax

Cephalothorax – A body region composed of the head and thorax fused together

This segmentation is necessary in order to allow the exoskeleton to shift with the movements of the body. The segments can move back and forth, like “joints” in the “armor.”

Common Characteristic #3: Jointed Appendages

The term “arthropoda” actually means “joint-footed.” Needless to say, then, one of the features common to all arthropods is that their appendages are jointed. This, of course, is not unusual. Without joints, there would be no way to bend the appendages, which would make walking and grasping things much more difficult! Vertebrates, therefore, have jointed appendages as well. However, the setup is quite different from that of an arthropod. In a vertebrate (such as a person), the muscles form over the joint and move the joint from above. Because arthropods have exoskeletons, however, the muscles form under the exoskeleton, moving the joints from underneath.

Common Characteristic #4: A Ventral Nervous System

In order to react to stimuli, seek out prey, and seek protection from predators, arthropods have a nervous system. Two ganglia form a brain, much like that of an earthworm, but more complex. Again, like an earthworm, a ventral nerve cord runs from the ganglia to the posterior. The fact that it is placed at the bottom of the body (that's why we call it “ventral”) is no accident. This placement provides maximum protection. It is protected not only by the exoskeleton, but also by the bulk of the body. Instinctively, arthropods do everything they can to avoid exposing their undersides, because instinct tells them that this negates the body's ability to protect the ventral nerve cord.

The nervous system is fed with information through various sensory organs. Antennae in the head region provide touch, taste, and smell sensations to the nervous system. In addition, all arthropods have some sort of eyes. There are two different types of eyes in phylum Arthropoda: compound eyes and simple eyes.

Compound eye – An eye made of many lenses, each with a very limited scope

Simple eye – An eye with only one lens

Now don't be fooled by their names. First of all, no eye is simple. It takes an enormous amount of engineering to come up with a system that can detect light, turn that light energy into electrical signals, send the electrical signals to the brain (or ganglia), and have the brain convert those signals into an image! Only God can create such a marvel. Also, a “simple” eye is not necessarily less desirable than a compound eye. For example, the human eye has only one lens; thus it is a simple eye. Nevertheless, it is a marvelously-engineered organ and provides better overall sight than the eye of any other species. Some animals can see farther than people can, and some can see in less light, but when you consider all factors such as range, sharpness, sensitivity, and color depth that the human eye provides, there is simply nothing else like it in creation!

Spiders have simple eyes. Because there is only one lens and because that lens is small, the eye does not cover much area. If you want to get an idea of what a spider sees, take a look through a thin straw. That's the kind of area that a spider's eye covers. Flies, on the other hand, have compound eyes. As a result, their sight covers a greater area, but, since the lenses are individual, the image is rather strange. A fly sees many versions of the same image, each slightly tilted with respect to the other, because the lenses are slightly tilted relative to one another. Thus, the fly gets a “mosaic” view of the world, whereas a spider gets a “tunnel” view.

Common Characteristic #5: An Open Circulatory System

Arthropods have quite an unusual circulatory system. In order to bring vital substances to every cell in the body, a heart in the dorsal (upper) region of the body pumps blood into short vessels that empty out into different cavities of the body! This allows blood to flow right over all of the cells in that cavity. In a sense, then, arthropods are always bleeding internally.

Open circulatory system – A circulatory system that allows the blood to flow out of the blood vessels and into various body cavities so that the cells are in direct contact with the blood

Of course, once released to flow throughout the body, the blood has to be collected again and then recycled back into the heart. You will learn more about how this circulatory system works when you study crayfish anatomy in depth.