5: Circles

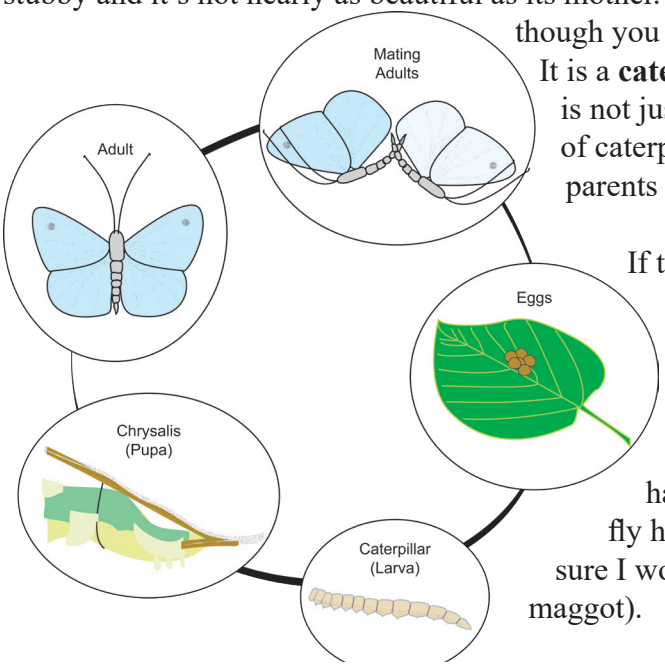
As you can see, this lesson is about circles. So what do circles have to do with science? Oh, if you only knew! Today you will learn what insects, clocks and planets all have in common.

Circle 1: Insect Life Cycles

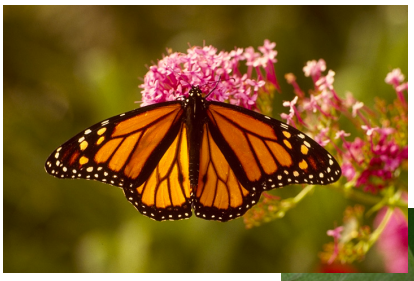
It seems that God likes circles because he has used them as a theme throughout nature. Here is an example. Take a few minutes to look at the circle of drawings at the bottom of the page. Afterward, I'll describe what you are seeing. This is called the **life cycle** of a butterfly. Notice that the word *cycle* sounds like the word *circle*. In fact, they come from the same Greek word (*kyklos*) and they have the same basic meaning.

Notice in this cycle how butterflies start out as eggs from an adult female that have been fertilized by an adult male when the two **mate** with each other. The female then deposits the **fertilized eggs** in a safe place, such as the underside of a leaf.

In time, the eggs hatch. The new insect **hatchling** has no wings and no antennae. Its legs are stubby and it's not nearly as beautiful as its mother. In fact, it can be an ugly little thing (although you might think that some of them are pretty). It is a **caterpillar**, or butterfly **larva**. Of course, it is not just *any* caterpillar. It's a particular kind of caterpillar. The kind depends on the kind of parents it had.

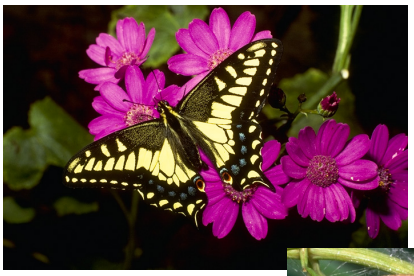


If the larva is that of a beetle rather than that of a butterfly, it's called a **grub**. (It's sometimes incorrectly called a "grub worm," but it's not a worm. It's an insect.) If it is a larval fly, it's called a **maggot**. Once again, each kind of beetle has its own different grub and each kind of fly has its own special maggot (although I'm sure I wouldn't feel that special if I were called a maggot).



If you live in one of the many places where there are monarch butterflies (left), you will see their caterpillars (below) eating milkweed.

When that larva has been alive for a certain period of time (the time is different for every kind of insect) and has grown to full size, it takes on a protective cover. In butterflies, that cover is the hard skin of the pupa. This pupa stage is also called a **chrysalis**. Unlike butteflies, moths and many other insects spin a tough, silken **cocoon** for protection of the pupa. Inside the protective covering, the insect changes or **metamorphoses** into an adult and comes out of its protective cover.



If you live on the West Coast of the United States, you may see the anise swallowtail (left), its caterpillar (below) and its chysalis (bottom left)

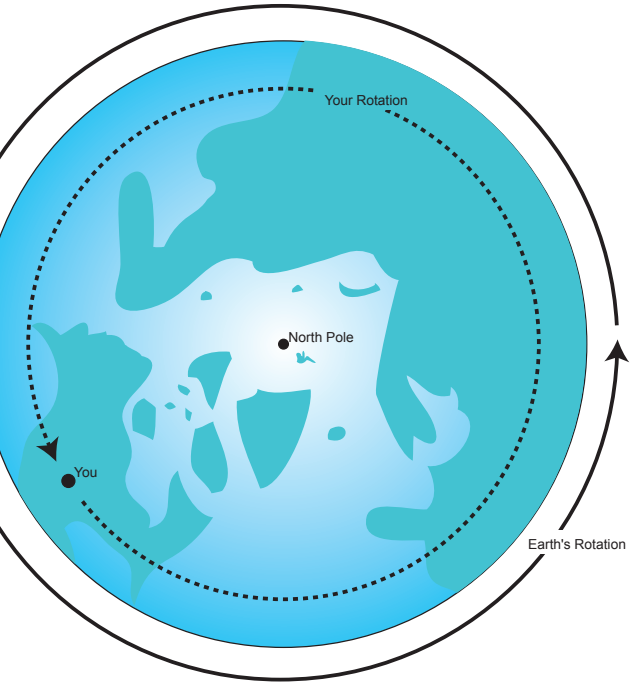
When the adult butterfly comes out, it sits until its wings harden and fill out. Then it flies away on its new wings. In the adult stage, the female will mate with a male of its same species and produce fertilized eggs. The story started with fertilized eggs, and ends with fertilized eggs. And so the cycle begins all over again.

Every insect has its own unique life cycle. For example, there are some insects (perhaps 10% of the different **species**) that do not go through a larval or pupal stage. The young, called **nymphs**, look just like tiny adults. They shed their outside coating, the **exoskeleton** ("outside skeleton"), several times during their life. This shedding is called **molting**. Each time the insect molts, it can grow a little larger before molting again. Praying mantises are among these molting insects. Their life cycle never includes a larva. There are yet other insects that have larvae and pupae, but the pupae do not develop in a protective cover. Most of these insects live in water until they become adults.

praying mantis

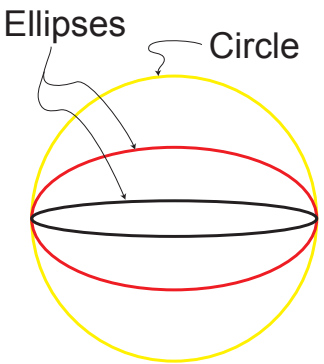
Circle 2: Earth Motions

Now remember, we began talking about insects as an example of circles in nature. The insect life cycle is just one of many. Another very different example is the rotation of the Earth on its axis. So now we will leave off talking about insects to talk about the motions of the Earth. Just hang with me and soon you will understand what I'm getting at.



If you put a dot on the globe and **rotated** it on its axis, you would see that the spot traces out a circle every time the globe spins. In fact, every spot on the earth traces out a complete circle every 24 hours. Look at the diagram to see how this works.

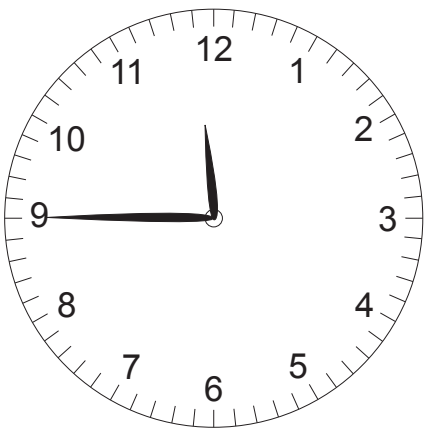
Even when natural motions are not exactly circular, they are often from the same family of shapes called *ellipses*. **Ellipses** are circles that have been smooshed, so that they are slightly flattened in one direction.



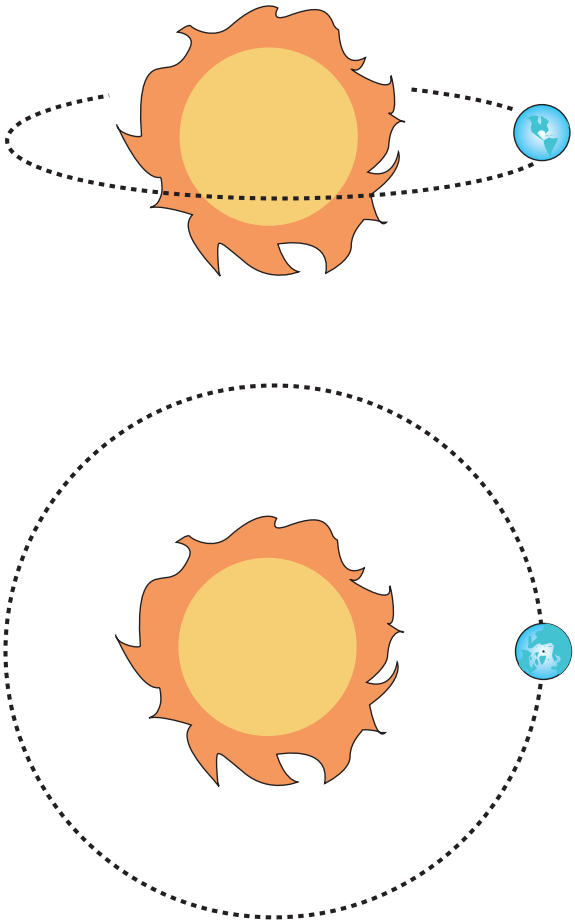
God made the earth revolve around the sun every 365 days. Although this motion can be described as approximately circular, it is not *exactly* a circle. It is very slightly elliptical. (See Figure, next page.)

Circle 3: The Clock Face

As I already said, things that happen over and over again are called cycles. Some things happen in daily cycles, some in monthly or yearly cycles. Because so many things in nature happen in cycles, it is important to have a way to measure a portion of a cycle.



For example, hands go around a clock in a circular pattern, so we divide the face of the clock using numbers and tick marks. That way we can measure accurately how far the hands have gone. So then, the numbers and tick marks on the face of the clock are a way of measuring the distance around the circle. You might also say that they measure portions of the 12-hour cycle.



The pathway of the Earth around the sun is almost circular. In the drawing on top we're looking at the circle from one edge, so it looks like an ellipse. Many people think that the elliptical shape of the Earth's path is the reason for hot summers and cold winters. That is really not true. The seasons have to do with the tilt of the Earth, not the shape of its path.

To describe hours, minutes and seconds on the face of the clock, we divide the clock face using different kinds of marks. Numbers mark the hours and the five-minuteses (I made that word up). Little tick marks mark the minutes and seconds. All these marks are just different ways of dividing a circle into equal portions.

Portions of Circles (Arcs)

Over the centuries, scientists, engineers and mathematicians have come to agree to divide circles into 360 equal parts called **degrees**. We abbreviate this as "360°." This gives us a way of communicating a portion of a circle (called an **arc**). If you have half a circle, you have an arc of 180°, which is half of 360°. A quarter of a circle is an arc of 90°, which is one quarter of 360°. Get it? Okay then, how many degrees are in one tenth of a circle?

Being created in God's image, people like circles, too. We use them to decorate our houses in the form of wreathes, glass globes and circular windows. People even wear circular jewelry such as rings, bracelets, or hoop earrings and maybe hoop nose rings (or, maybe not). Circles are used in architecture and landscaping.

There are some spiffy things about circles that you should know. For example, if you wanted to enclose the most yard in the smallest amount of fencing, what shape would you make your fence? You guessed it. It would have to be a circle. (I don't recommend it. Just imagine what the shape of the nextdoor neighbor's yard would be!) Likewise, if you wanted to make a pitcher that could contain the absolute most lemonade using the absolute least glass, you would make it the shape of a perfect **sphere**. (I don't recommend that either. However, it does explain why little teapots are always short and stout!)

So this is your introduction to themes in nature. Get used to it. All of nature is built around central themes that occur again and again in different sciences. As an explorer, one of your jobs will be to see if you can discover new themes that others have not seen before. These make some of the greatest discoveries of all time!