

Name: _____

Period: _____ Date: _____

They say
(summary)

I say
(response,
question,
extension)

Properties of Living Things

In the previous unit, we discussed how science builds and organizes testable explanations and predictions about the universe (adapted from *Wikipedia*). In this course, we'll focus on just one branch science: **biology**. The word *biology* comes from *bio*, which means "life;" and the suffix *-ology*, which means "the study of."

So what is life? What, in this course, are we going to study? How do we know when something is "alive?"

On an intuitive level, the answer to this question is straightforward. When we encounter something that's moving on its own, it's usually alive (unless it's some inanimate object like a rock that's obeying gravity by rolling down a hill). When we see something reproduce itself, or when we see something eating, we can conclude that it's alive. By contrast, if something is just lying there, not doing anything, we assume that it's either never been alive, or that it's dead.

Because the question of *what is life* is so central to biology, we're going to move beyond this intuitive level, and look at the traits of organisms (living things) in a more systematic way. Here are nine properties that organisms have.

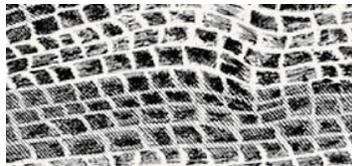
Organisms:

1. Are composed of one or more cells	4. Respond to their environment	7. Grow and develop
2. Are highly organized	5. Maintain stable, internal environments through a process called <i>homeostasis</i>	8. Are parts of evolving species
3. Are maintained by a constant flow of matter and energy	6. Reproduce by passing on their DNA	9. Are parts of Earth's biosphere

Let's look at each of these properties in more detail. For many of the descriptions that follow, we'll human beings as an example, since that's the species we're most familiar with.

1. Living things are composed of cells.

Take any organism. Take piece of it (or cut a slice of it) that's thin enough for light to pass through. View it under a microscope. In every living thing that's ever been known to exist, you'll find that the organism is built of tiny units that we call **cells**. Cells are the *basic units of life*



Cork (bark) cells, drawn by Robert Hooke

You can see a drawing of cells to the left. These tiny boxes are sections of cork (or bark), drawn in the 1600s with a very early microscope.

The large rectangle on the right is a cell from an aquatic plant. The small green ellipses inside the cell are parts that carry out photosynthesis.



A cell from a photosynthetic plant

Animals are also made of cells. So are fungi. Many types of organisms, including bacteria, yeast, and most algae, consist of just one cell. In fact, for the first few billions of years of life on Earth, that's all that life was: single-celled organisms.



Organization of muscles and glands in the human head

2. Living things are highly organized

This means that living things, and their parts, are arranged and ordered. Living things have lots of predictable structure. They're *not* randomly arranged. At any level that you look at life, from the entire organism, to specific parts of organisms, all the way down to the cells and molecules that make up organisms, you see high levels of organization.



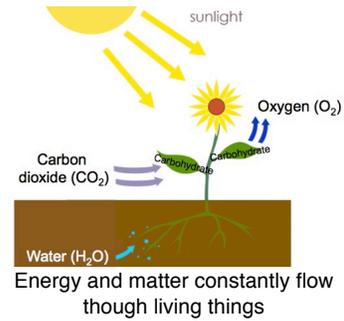
Organization in a geranium leaf

3. Living things are open systems, maintained by a constant flow of energy and matter:

Every day (if you're lucky), you eat food. That food contains *chemical energy* that keeps you alive. It also provides you with the atoms that make you up. If you stopped eating, you'd soon stop living. Similarly, as you breathe, oxygen is flowing into you. That flow can't stop for more than a few minutes, or life will end.

These flows of matter and energy into you are matched by flows of matter and energy out of you. Every time you exhale, you're breathing out carbon dioxide, a waste product. Urine removes waste products from your blood. Feces removes food you can't digest. Even sitting in a chair, you're releasing heat into the environment.

Now think of the plant shown above and to the right. As it performs photosynthesis, carbon dioxide and water are flowing into it. Using light energy from the sun, the plant combines these molecules to make sugars and other carbohydrates. Oxygen is released as a waste product. Like you, the plant is an open system, with matter and energy flowing through it.



Living things respond to their environments

4. Living things respond to their environment

Humans, like all animals, constantly respond to the environment. These responses might be quick reflexes, as is shown on the left when you touch a hot piece of metal. But these responses can also occur much more slowly. Even plants respond to their environments. That's what happens when a vine raps itself around a branch, or when a plant grows so that its leaves face toward the sunlight.

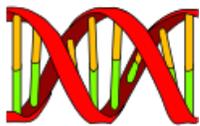
5. Living things maintain stable, internal environments through homeostasis

Humans can live in almost every environment imaginable, from the Saharan desert to the Alaskan tundra. But to stay alive, the conditions *inside* our bodies must stay within a very narrow range. Our body temperature has to stay very close to 37°C (98.6°F). The pH (amount of acidity) of our blood has to stay between 7.35 and 7.45. Levels of sugar and salt in the blood also have to be tightly regulated.

This process of regulation is called *homeostasis*. If you get too hot, you sweat. As the sweat evaporates, your body cools down. Your temperature stays right around 37°C. If your blood sugar becomes too acidic, your kidneys adjust the blood, moving it back to the right level.



When people get hot, perspiration leads to evaporative cooling: an example of *homeostasis*



A tiny segment of DNA, the molecule of heredity.

6. Living things reproduce by passing on their DNA

While not every living thing reproduces, every living thing is part of a species in which members of that species pass their genes on to the next generation. In every living thing on Earth, those genes are encoded in a chemical called DNA. If it has DNA, and can reproduce itself, it's almost certainly alive.

7. Living things grow and develop

Growing means *increasing in size*. **Developing** means *changing form* over the course of life.

In living things that consist of only one cell, most of what you see over the course of life is growth. A small daughter cell grows to become a full-sized adult cell, which then divides again.

In living things like human beings that consist of trillions of cells, life begins as a single, fertilized egg, which then grows and develops into embryo, and then into a vastly larger, adult organism.



A human embryo's form is very different from an adult's form



Cactus spines are an adaptation to keep away plant eating animals

9. Every living thing is a member of an evolving species.

A *species* is a group of organisms that can naturally interbreed with one another to successfully reproduce.

All humans are part of the same species. All grizzly bears are part of the same species. Grizzly bears and polar bears are two *different* species, because they don't naturally interbreed with one another.

A species is **adapted to its environment**. That means that the species has a suite of traits that enable it to survive and reproduce. Some obvious adaptations are:

- The spines of a cactus which discourage animals from eating it
- The talons of an eagle which enable it to grasp its prey

Through evolution, species change over time. Follow your ancestors back for a million years...and they're not human any more (they're a smaller-brained, upright walking hominids, but not human). Follow them back another 200 million years and they're not primates any more (they're more like a rodent than a tree-swinging primate). Go back another 500 million years ago and your ancestors are no longer air-breathing mammals (they're fish).

9. All living things are part of the Earth's biosphere

Astronomical discoveries might cause us to change this idea, but it's true for now: every living thing lives in the Earth's **biosphere**. The biosphere is a thin skin of life on the Earth's surface. It goes down a few hundred feet into the soil. It extends down to the deepest ocean trenches, which are over six miles (10 kilometers deep). It extends upward just above the highest mountains (about six miles, or 10 kilometers high).



The biosphere is the thin skin of life that covers Planet Earth

Application 1: Identify Which Property of Life

Write the property of life that applies to each example below. More than one may apply

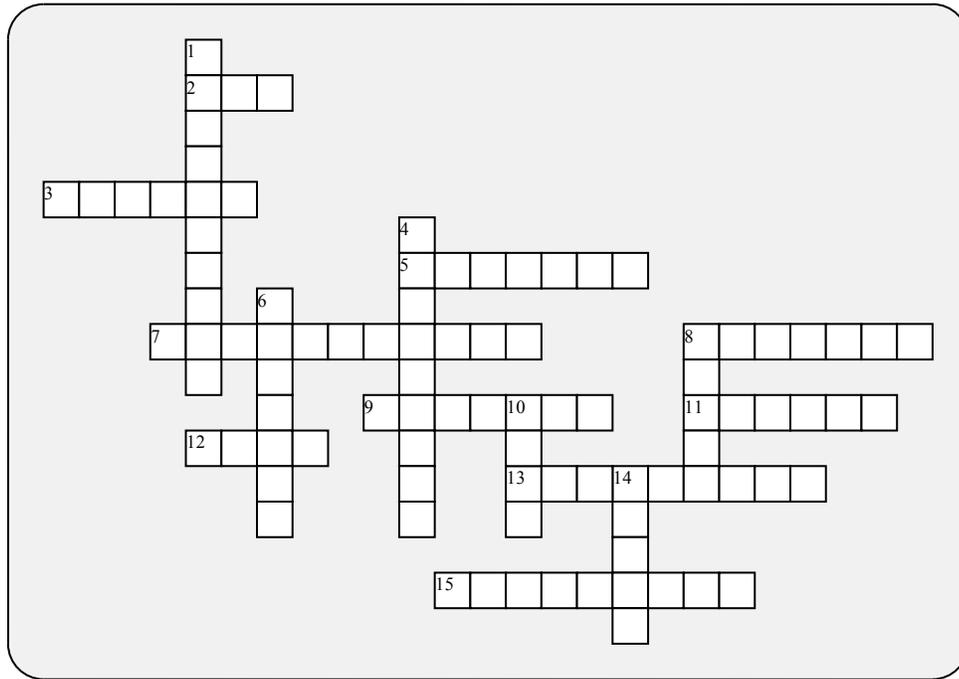
Made of cells	Respond to their environment	Growth and development
Highly organized	Homeostasis	Evolve
Use energy and matter	Reproduce	Part of the biosphere

Example	Property of Life
1. A bear follows the scent of food	
2. A mouse hides when it sees a cat	
3. A spider eats a fly	
4. Different plants have predictable patterns of veins in their leaves	
5. Earthworms are made of repeating segments	
6. Humans have two legs, a torso, arms, and a head	
7. Humans produce sperm and egg	
8. Insect bodies are in three segments	
9. Many sedimentary rocks contain fossils of species that have become extinct.	
10. Most species live for only a few million years.	
11. Plants need sunlight to perform photosynthesis	
12. Plants start from seeds. Soon, the seedling has stems, leaves, and a root.	
13. When a cell gets to be too big, it splits into two	
14. You start life as a fertilized egg. Then you're a ball of cells. Then specific body parts develop	
15. You're blood sugar goes down. You get hungry and eat.	
16. Your mouth starts to water when you smell French fries.	
17. No life has been found on Venus, Mars, or other planets	
18. In an animal, not being able to urinate can be fatal	
19. When it's cold, you shiver, or put on a sweater.	

Application 2: a) Find your own examples of properties of life b) Draw a picture that represents the property

Property of Life	Your own, original examples	Your Picture
Made of cells		
Highly organized		
Sustained by flows of energy and matter		
Response to the environment		
Homeostasis		
Reproduction		
Growth and development		
Evolution		
Part of the biosphere		

Properties of Life Crossword Puzzle



Across:

- 2 - The chemical that encodes your genes
- 3 - Increasing in size over the lifespan.
- 5 - Whether quickly or slowly, all living things _____ to their environment
- 7 - Keeping your internal conditions constant
- 8 - A group of organisms that can naturally interbreed to successfully reproduce
- 9 - The science or study of life
- 11 - Food provides animals like us with both matter and _____
- 12 - The basic unit of life
- 13 - change over time
- 15 - The thin skin of life on the surface of planet earth

Down:

- 1 - A trait that helps a species survive in its environment
- 4 - The opposite of random
- 6 - Changing in form over the course of your lifespan
- 8 - Secreting this onto your skin is a homeostatic move that cools down your body
- 10 - Because they require a constant flow of matter and energy, living things are _____ systems
- 14 - Plants get their energy from _____

Possible Answers:

DNA, adaptation, biology, biosphere, cell, develop, energy, evolution, growth, homeostasis, light, open, organized, respond, species, sweat