

Characteristics of Life - Advanced

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CHAPTER 1

Characteristics of Life - Advanced

- Identify the seven characteristics of living things.
- Define cell.
- Describe an adaptation.
- Explain a complex chemistry.
- Describe the importance of homeostasis.



What do a bacterium and a whale have in common?

Do they share characteristics with us? All living organisms, from the smallest bacterium to the largest whale, share certain characteristics of life. For example, all living things are made of cells and they must reproduce to make the next generation. Without these characteristics, there is no *life*.

Characteristics of Life

Biology examines the structure, function, growth, origin, evolution, and distribution of living things. It classifies and describes organisms, their functions, how species come into existence, and the interactions they have with each other and with the natural environment. Four unifying principles form the foundation of modern biology: cell theory, evolution, genetics and homeostasis.

A powerful introductory video, *Characteristics of Life*, choreographed to dramatic music, highlighting the wonder of life, and how it is defined can be seen at <http://vimeo.com/15407847> (3:40).



MEDIA

Click image to the left or use the URL below.

URL: <http://www.ck12.org/flx/render/embeddedobject/84744>

Most biological sciences are specialized areas of study. Biology includes biochemistry, cell biology, microbiology, immunology, genetics, physiology, zoology, ecology, evolutionary biology, and botany. Biochemistry is the study of the chemicals that make up life. Cell biology is the study of life at the level of the cell. Microbiology is the study of microscopic organisms. Immunology is the study of an organism's resistance to disease. Genetics is the study of

how organisms pass traits to their offspring. The study of how the human body works is called physiology. Zoology is the study of animals. The study of how organisms interact with their environment and each other is called ecology. Evolutionary biology is the study of how populations and species change over time. Botany is the study of plants. The four unifying principles are important foundations for each and every field of biology. Applied fields of biology such as medicine and genetic research involve many specialized areas of study.

What is Life?

Not all scientists agree exactly about what makes up life. Many characteristics describe most living things. However, with most of the characteristics listed below we can think of one or more examples that would seem to break the rule, with something non-living being classified as living or something living being classified as non-living.

There is not just one distinguishing feature that separates a living thing from a non-living thing. A cat moves but so does a car. A tree grows bigger, but so does a cloud. A cell has structure, but so does a crystal. Biologists define life by listing characteristics that living things share. Something that has all of the characteristics of life is considered to be alive. The duck decoy in **Figure 1.1** may look like a duck, act like a duck in that it floats about, but it is not alive. The decoy cannot reproduce, respond to its environment, or breathe.

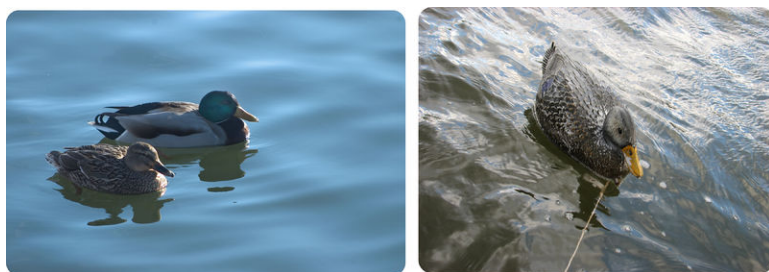


FIGURE 1.1

Is it a duck? Both of these objects move across the water's surface. But, how can you tell which one is alive and which is not? You can tell by seeing which of them have all of the characteristics of life.

An individual living creature is called an **organism**. There are many characteristics that living organisms share. They all:

- respond to their environment
- grow and change
- reproduce and have offspring
- have a complex chemistry
- maintain homeostasis
- are built of structures called cells
- pass their traits onto their offspring

Responding to the Environment

All living organisms respond to their environment. If you step on a rock, it will just lie there, but if you step on a turtle, it may move or even snap at you. Living things know what is going on around them, and respond to changes in the environment. An **adaptation** refers to the process of becoming adjusted to an environment. Adaptations may include structural, physiological, or behavioral traits that improve an organism's likelihood of survival, and thus, reproduction.

Growth and Change

All living organisms have the ability to grow and change. A seed may look like a pebble, but under the right conditions it will sprout and form a seedling that will grow into a larger plant. The pebble of course will not grow. Even the smallest bacteria must grow. This bacteria will reproduce by dividing into two separate bacterium. If the parent bacterium does not grow, then each subsequent generation will just be smaller than the previous generation. Eventually the bacteria will be too small to function properly.

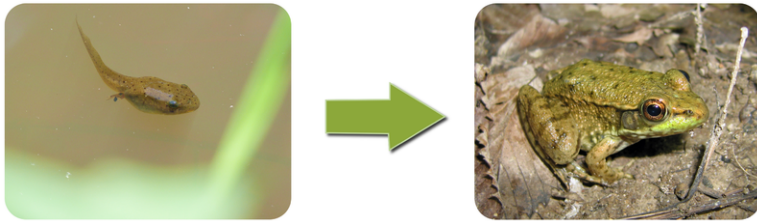


FIGURE 1.2

Tadpoles, like those shown here, go through many changes to become adult frogs.

Reproduction

All living organisms must have the ability to reproduce. Living things make more organisms like themselves. Whether the organism is a rabbit, or a tree, or a bacterium, life will create more life. If a species cannot create the next generation, the species will go extinct. **Reproduction** is the process of making the next generation and may be a sexual or an asexual process. **Sexual reproduction** involves two parents and the fusion of **gametes**, haploid sex cells from each parent. Sexual reproduction produces offspring that are genetically unique and increases genetic variation within a species. **Asexual reproduction** involves only one parent. It occurs without a fusion of gametes and produces offspring that are all genetically identical to the parent.

Have Complex Chemistry

All living organisms have a complex chemistry. A flower has a complicated and beautiful structure. So does a crystal. But if you look closely at the crystal, you see no change. The flower, on the other hand, is transporting water through its petals, producing pigment molecules, breaking down sugar for energy, and undergoing a large number of other biochemical reactions that are needed for living organisms to stay alive. The sum of all the chemical reactions in a cell is **metabolism**.

Maintain Homeostasis

A human body has a temperature of 37 degrees Celsius, (about 98.6 degrees Fahrenheit). If you step outside on a cold morning, the temperature might be below freezing. Nevertheless, you do not become an ice cube. You shiver and the movement in your arms and legs allows you to stay warm. Eating food also gives your body the energy it needs to keep warm. Living organisms keep their internal environments within a certain range (they maintain a stable internal condition), despite changes in their external environment. This process is called **homeostasis**, and is an important characteristic of all living organisms.

Built of Cells

If you look closely at any organism you can see that it is made of structures called **cells**. Organisms that are very different such as ferns, fish, and elephants all look similar at the cellular level. A cell is the basic unit of structure

and function of all living organisms. All living organisms are made of one or more cells: a simple bacterium will consist of just one cell, whereas you are made of trillions of cells.

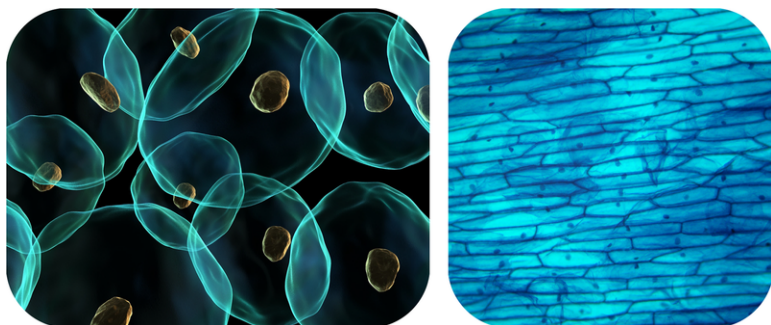


FIGURE 1.3

Representations of human cells (left) and onion cells (right). If you looked at human and onion cells under a microscope, this is what you might see.

Organisms are organized in the microscopic level from atoms up to cells. The matter is structured in an ordered way. Atoms are arranged into molecules, then into macromolecules, which make up organelles, which work together to form cells. Beyond this, cells are organized in higher levels to form entire multicellular organisms, as shown in **Figure 1.4**. Cells together form tissues, which make up organs, which are part of organ systems, which work together to form an entire organism. Of course, beyond this, organisms form populations which make up parts of an ecosystem. All of Earth's ecosystems together form the diverse environment that is Earth.

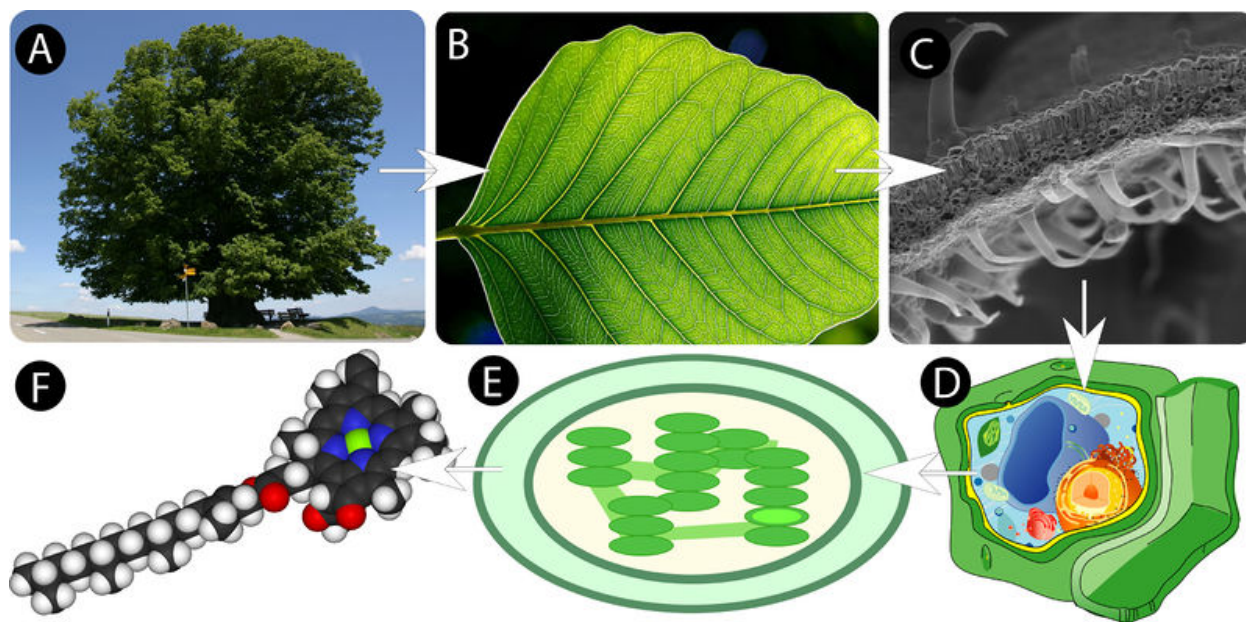


FIGURE 1.4

Levels of organization in a tree. (a) The tree is the organism; (b) a leaf is an organ; (c) a leaf tissue is made up of different types of cells; (d) a plant cell; (e) chloroplast is an organelle inside a plant cell; (f) chlorophyll is the photosynthetic molecule that is found in chloroplasts.

Vocabulary

- **adaptation:** The process of becoming adjusted to an environment; a characteristic which helps an organism survive in a specific habitat.
- **asexual reproduction:** Reproduction involving only one parent; occurs without a fusion of gametes; produces offspring that are all genetically identical to the parent.
- **cell:** The basic unit of structure and function of all living organisms.
- **gamete:** A sexually reproducing organism's reproductive cells, such as sperm and egg cells.
- **homeostasis:** The process of maintaining a stable environment inside a cell or an entire organism.
- **metabolism:** The sum of all the chemical reactions in a cell and/or organism.
- **organism:** An individual living creature; a life form consisting of one or more cells.
- **reproduction:** Process by which living organisms give rise to offspring; making the next generation.
- **sexual reproduction:** Reproduction involving the joining of haploid gametes, producing genetically diverse individuals.

Summary

- The seven characteristics of life include: responsiveness to the environment; growth and change; ability to reproduce; have a metabolism and breathe; maintain homeostasis; being made of cells; passing traits onto offspring.

Explore More

Use this resource to answer the questions that follow.

- <http://www.hippocampus.org/Biology> . → Non-Majors Biology → Search: **Defining Biology**

1. What does "biology" encompass?
2. What characteristics define life?
3. Define metabolism and homeostasis
4. Are viruses living? Explain your answer.

Review

1. What are the four unifying principles that form the foundation of modern biology?
2. Identify three of the seven characteristics of living things.
3. What is adaptation?
4. Distinguish between metabolism and homeostasis.
5. What is a cell?

References

1. Ducks: Jürgen from Sandesneben, Germany; Decoy: Peter Shanks (Flickr: BotheredByBees). [A duck decoy may look like a duck, but it does not have all the characteristics of life](#) . CC BY 2.0
2. Tadpole: Dan Century; Frog: Greg Schechter (Flickr:GregTheBusker). [Tadpoles go through visible changes that show growth and development, a characteristic of life](#) . CC BY 2.0

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4. (a) Taz (Flickr: sporkist); (b) Jon Sullivan, pdphoto.org; (c) Louisa Howard; (d) Mariana Ruiz Villarreal (Wikimedia: LadyofHats); (e) User:Ollin/Wikipedia; (f) Ben Mills (Wikimedia: Benjah-bmm27). [Illustrates how cells are organized to form multicellular organisms](#) . (a) CC-BY 2.0; (b) Public Domain; (c) Public Domain; (d) Public Domain; (e) Public Domain; (f) Public Domain