# Life's Characteristics

Look around you and you can see life everywhere. There are many forms of multicellular life, such as insects, birds, dogs, cats, and humans. But there are also many single-celled organisms, such as bacteria and fungi, that are invisible to the naked eye.

But what is this thing called life? What makes one thing alive and another one not? Look at the organisms in this illustration and see if you can identify the characteristics that show each organism is alive.

# What Is Life?

Surprisingly, there is no firm scientific definition of life. There is no single test that can establish the presence or absence of life nor one single characteristic that applies to all organisms. However, one can begin to define life by listing the characteristics that most living creatures share. For example, most of Earth's life forms exhibit the following traits:

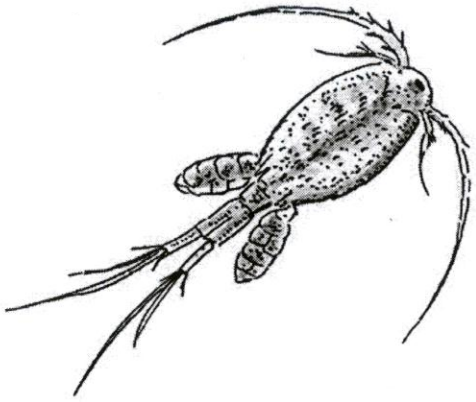
- have carbon-based chemistry.
- have a membrane or wall that creates an internal environment.
- use energy to maintain an internal state.
- require liquid water.
- are able to extract energy from the environment.
- carry out metabolic processes resulting in the exchange of gases and solid materials (i.e., consuming raw materials and producing wastes).
- exhibit some type of growth, cell division, reproduction, or replication.
- are able to undergo population evolution and adaptation to the environment.

Some nonliving objects, such as fire, possess many of these characteristics and some arguably living organisms, such as viruses, possess only a few. Are some characteristics more fundamental than others?

Two characteristics are particularly useful in helping distinguish living from nonliving things: the ability to reproduce (sexually or asexually) and the ability to produce and perpetuate genetic variation among offspring. Put another way, life is a self-contained chemical system capable of undergoing Darwinian evolution.

This large-scale, long-term view of life acknowledges that individual organisms must still carry out many of the small-scale, short-term functions listed above. In fact, many of the tests that scientists design to detect life on other planets look for byproducts related to these short-term functions. So while detecting life depends on finding many immediately recognizable characteristics, for life to persist on Earth, it must evolve and adapt to changing conditions.

Few of the characteristics on this list lend themselves to quick, one-time tests, and many require multiple observations over a period of time. Some Earth organisms leave traces after death. One way astrobiologists search for extraterrestrial life is to search for biosignatures—large scale, telltale signs of life, such as the presence of gases produced by life.



# What Is It?

In this experiment, give your Mystery Matter something to eat and drink. Then, use your lists of characteristics of life to decide whether you think it is an organism.

## Procedure

1. Use the hand lens to take a close look at the Mystery Matter. Record your observations.

2. On a separate sheet of paper, make a chart like the one on this page titled "Experimental Results." Leave enough room in each category to record your observations for each flask.

3. Number each of your four Erlenmeyer Flasks and assemble the test setups as follows:

   - place the funnel in the mouth of flask 1
   - add the amount of Mystery Matter listed in the chart below
   - add the amount of sugar listed in the chart below

| Flask | Mystery Matter | Sugar | Hot Water |
|---|---|---|---|
| 1 (control) | ¼ tsp | None | ½ cup |
| 2 | ¼ tsp | ¼ tsp | ½ cup |
| 3 | ¼ tsp | ½ tsp | ½ cup |
| 4 | ¼ tsp | 1 tsp | ½ cup |

4. Repeat the above procedure using flasks 2-4.

5. Use the measuring cup to pour the amount of hot water listed into each flask and gently agitate each flask to mix everything together.

6. Dip a glucose strip into flask 1. Record the results. Repeat with flasks 2-4.

7. Squeeze all the air out of a balloon and slip it over the mouth of one of the flasks. Do the same with the remaining three flasks.

8. Gently agitate the contents of each flask to mix the materials. Make sure none of the materials remain clumped at the bottom of the flasks.

9. Record the appearance of the flasks. Predict what will happen in each flask after one hour and after 24 hours.

10. After 30 minutes, gently agitate the contents of the flasks. Record your observations of the balloons and the contents. Repeat after an hour.

11. After 24 hours, record your observations of the balloons and the contents.

12. Remove the balloons. Test the flasks with glucose strips and record your results.

13. Provide an explanation for any changes you see. Using what you know about the characteristics of life, what can you conclude about the Mystery Matter?

### Experimental Results

| Time | Turbidity | Froth | Balloon Inflation | Glucose Presence |
|---|---|---|---|---|
| Initially | | | | |
| 30 min. | | | | |
| 60 min. | | | | |
| 24 hrs. | | | | |