What Is Life?

Astrobiologists begin their assessment of whether a planetor moon is a promising candidate for life by seeing if any liquid water, energy sources, and nutrients are present. Many astrobiologists use the availability of liquid water as the primary criterion for judging whether a planet is a candidate for life. While other liquids do exist (e.g., ammonia, methane, or ethane), they exist at temperatures far below the level conducive for life. The life discovered to date seems to be limited to a temperature range of about minus 15°C to 115°C. Under the right conditions, water can be liquid over this entire range. Furthermore, water is an important vehicle for transporting and delivering dissolved chemicals as well as being an important chemical reactant in its own right.

All life requires energy. Organisms use either light energy or chemical energy to run their life processes.

Nutrients are the raw materials organisms need to construct andmaintain their bodies. While the solid planets and moons in our solarsystem all have the same general composition, local conditions and processes have led to variations in the concentrations and availability of different chemical compounds. As a result, nutrients required by life are more available on some planets and moons than on others.

Once students understand life's common requirements, they are ready to think about how a planet might provide those essentials. Habitable planets are ones that are able to provide organisms a dependable supply of liquid water, nutrients, and energy. Since chemistry works by the same rules throughout the universe, most scientists think that extraterrestrial life will use the same things for their life processes as life on Earth does. Consequently, when searching for extraterrestrial life, astrobiologists search both for direct evidence of life and for habitable conditions.

Procedure

1. Distribute the activity page. Ask each student to answer question 1. Lead a class discussion and catalog the ideas for all to see.
2. Give each group of students a hand lens and one pair of objects. Have students follow the instructions on their activity sheet and examine 2 sets of objects.
    - Live ant in a container and plastic ant (available at toy and joke shops)
    - Live flower and similar kind of sil or plastic flower
    - Live leaf and similar kind of silk, paper or plastic leaf
    - Live tree leaf and dead tree leaf of the same kind
    - Live grass and dead grass of the same kind
    - Live grass and dead grass of the same kind
    - A dead house fly and plastic fly (available at toy and joke shops)
    - Live cricket from a pet shop and a plastic cricket
    - Live earthworm from the yard or bait shop and a gummy worm (candy)

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3. Have student groups develop a common set of characteristics that can be use to identify life. They should record this list on the back of their activity sheet. What tells them that something is alive?

4. Ask students to test their working definitions of life by playing an abbreviated version of the familiar game, 20 Questions. Model an example that uses an ambiguous mystery object to demonstrate the need for clear questioning. Have the class ask you five to ten questions to determine whether your object is living or non-living. Any time a student asks you a poorly phrased question, challenge the student to clarify his or her actual meaning.An icicle is a good choice because it shows many of the attributes of life. For instance, it grows, requires water, consumes raw materials, has a complex internal structure made up of ice crystals, divides in two when it breaks, responds to its environment, and produces waste products when it drips and when the water evaporates or sublimates. Fire is another good example because it takes in nutrients (fuel and oxygen), gives off energy (light and heat), grows, expands its geographical coverage, moves, reproduces, and produces waste products (heat, carbon dioxide, and smoke). So, how can scientists justify that icicles and fire are not alive? Icicles and fire do not have cell membranes or walls, do not use energy to maintain an internal state, and do not have heritable traits that can be transferred. Consequently, they may meet a limited definition for life, yet they do not meet certain fundamental criteria.

5. Have each group think of something either living or non-living. When it is their turn, the class can ask the group ten (or five, depending on time) yes-no questions to determine whether the mystery object is alive or not. The class may not ask direct questions such as “Is it alive?” but, instead, should ask about what the mystery object looks like, does (or does not do), uses or produces.

6. Optional: Continue on to Extremophiles Activity.

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Think About It

Question

1. What tells you that something is alive?

2. Identify your first two items here by name and by drawing a sketch of each:

One object is alive, the other is not. How can you tell?

3. Identify your second two items here by name and by drawing a sketch of each:

One object is alive, the other is not. How can you tell?