

Scientists' Ideas on "Is It Living?"

Purpose:

The purpose of this assessment probe is to elicit students' ideas about living and nonliving things. The probe is designed to find out what attributes children focus on when considering if something is or was once living.

Explanation:

Differentiating between living and nonliving is not a simple black and white task. There is no single criterion used to identify whether something is living. Additionally, some of the characteristics that are used to identify living things are not easily observable, such as extracting energy from food as opposed to being able to watch an organism "eat." Living things are made up of one or more cells and carry out basic life processes (e.g. acquire or make food, grow, respire, reproduce, react to stimuli, move, and eliminate waste). Not all living things show all of these characteristics all of the time. The tree, boy, rabbit, grass, seed, egg, bacteria, cell, mushroom, potato, leaf butterfly, pupae, and hibernating bear can be considered living. Each is made up of one or more cells and is capable of performing one or more life processes. The tree, boy, rabbit, grass, bacteria, mushroom, butterfly, and hibernating bear are also complete living organisms. Some of the items listed are living organisms in various developmental stages of their life cycle such as the seed, egg (recognize that an egg from the supermarket is "once living"), and pupae. The potato and leaf are parts of a living plant. By themselves they are capable of carrying out some life processes for a limited time.

The remaining items-cloud, fire, wind, Sun, feather, molecule, river, mitochondria, rock, and fossil-are nonliving. The feather was once part of a living thing, partially made up of acells as well as materials made by cells. However, by itself, it cannot sustain life. The mitochondria are parts of a cell that carry out the process of releasing energy from food but by themselves they are not living. Some things can be living without being a complete organism. For example, a leaf is a part of a complete plant. With a source of water and air, some leaf cuttings can continue to carry out life processes, develop roots, and eventually become an entire plant.

**From: Uncovering Student Ideas in Science: 25 Formative Assessment Probes by Page Keeley, Francis Eberle, and Lynn Farrin*

CTS Summary Sheet for Characteristics of Living Things

I. Identify Adult Content Knowledge: This section helps users identify what all adults, including teachers, should know in science by the end of their K-12 education to be considered literate science literate. It also provides content explanations for science ideas encountered in the media, public issues, and other popular science venues in which an adult understanding of science is important.

IA: *Science for All Americans:*

→ Chapter 5, *Diversity of Life*, pages 60-61; *Cells*, pages 62-64. (Grades 3 and up)

NOTES:

- Organisms are typically classified based on similarities and differences but many classification systems differ (some on color, some on shape) – scientists don't always agree on how things should be classified
- Anatomy is the primary way to classify things because of the characteristics of those organisms and their similar anatomy
- Frameworks for understanding relationships –Disruptions in our environment:
 - minor in nature - organisms can adapt and can assist in the change to return the environment to where it was or where it will be in a state of equilibrium
 - major in nature – organisms may die; may adapt to survive to maintain diversity but the environment will drastically change
 - examples: super bugs – antibiotics have caused some bacteria to evolve into those that are resistant to the drugs we have come to depend on
- We adults must be aware so as to not be swayed by the media – don't believe everything you hear – question what doesn't make sense or doesn't seem logical
- Two food webs that humans depend on:
 - Ocean – microscopic plants and animals
 - Land – plants and animals

IB: *Science Matters:*

→ Chapter 15, *The Chemical Factories of Life*, pages 213-219.

NOTES:

Cell – the basic unit of life

Two functions: 1. reproduce itself and 2. support chemical reactions to sustain life

Many parts of the cell have specific functions:

1. Nucleus: Contains DNA (the “front office” of a factory)
2. Cell membrane: interior and exterior (the walls and the partitions of the factory)
3. Organelles: supply energy, digest molecules, produce protein, support protein production (production system)
4. Energy production: (power plant)
 - a. Plants cells use photosynthesis and respiration
 - b. Animal cells use respiration

II. Consider Instructional Implications: This section helps users identify important considerations for K-12 grade span instruction, provides a broad overview of the big ideas, concepts, and skills for K-12 students related to the topic, and suggests effective instructional strategies and contexts.

IIA: *Benchmarks for Science Literacy:*

→ 5A, *Diversity of Life* general essay, page 101; grade span essays, pages 102-105.

→ 5C, *Cells* general essay, page 110; grade span essays, pages 111-113.
(Grades 3 and up)

NOTES:

- Students enter kindergarten knowing common attributes such as size, color, number of limbs
- Teachers must guide them to a more sophisticated understanding
 - Some attributes are more important than others
 - Gender, mammals vs non-mammals
- Understanding doesn't come from knowing bits but from seeing the big picture and how things relate to one another

IIB: *National Science Education Standards:*

→ Grades K-4, Standard C Essay, pages 127-129.

→ Grades 5-8, Standard C Essay, pages 155-156.

→ Grades 9-12, Standard C Essay, pages 181, 184.

NOTES:

- Build on a child's natural curiosity and questions
- Give opportunities to make observation in their own natural environment
 - Butterflies are common to our area that the children will see during the summer and those caterpillars that eat the weeds that are growing in the garden or on the school ground
 - Soil is a big draw for all kids
- Give direct experience – hands on so that they are interacting with the phenomenon – own cup with a caterpillar
- Getting to examine a cup of soil with all organisms inside

III. Identify Concepts and Specific Ideas/Student Content Knowledge: This section helps users identify the concepts, specific ideas, level of sophistication, and appropriate terminology related to a topic at different grade levels.

IIIA: *Benchmarks for Science Literacy:*

→ 5A, *Diversity of Life*, pages 102-105

Notes:

- Some animals are very much alike and some are very different
 - how they look and what they do
- Plants and animals have features that help them live in different environments
 - Fish have gills; whales have blubber; air bladders in some animals allow them to live on land but be adapted for water swimming; butterflies have a proboscis, complete metamorphosis
- Anthropomorphizing is an issue when living things are given human characteristics – offer reference books to compare from one source to another as well as the REAL thing
- Children naturally make observations but we need to move them to have a reason for that observation
 - Trying to find body parts and identify them
 - Recording accurately through words and pictures
- Ask questions and check answers with others
- Ability to use tools: hand lenses; eye droppers; science notebook; hands; stir sticks

IIIB: *National Science Education Standards*

→ Grades K-4, Standard C, *The Characteristics of Organisms*, page 129; *Life Cycles of Organisms*, page 129

Notes:

- Students need to learn characteristics of plants and animals and their basic needs (food, air, water, sunlight for plants) from the environment
 - Organisms have different structures and different behaviors
- All organisms have a life cycle that goes from birth – development – reproduction – death
 - Carry a close resemblance to their parents – genetics
- Nature vs nurture:
 - By nature you have certain genetic characteristics (hair color, eye color)
 - By nurture you have some learned behaviors such as riding a bike, playing a piano
- Learn about organisms in their environment and how all animals depend on plants – the things that they do eat ultimately go back to the plant
- Plants provide oxygen that animals breathe and animals provide carbon dioxide that plants breathe
 - Animals take on behaviors due to the environment in which they

live(goats climbing)

IV. Examine Research on Student Learning/Student Misconceptions: This section identifies related research so that users can examine developmental considerations, possible misconceptions and their sources, intuitive ideas and lines of reasoning, and difficulties encountered by students in understanding scientific ideas.

IVA: *Benchmarks for Science Literacy*

→ 5A, *Living and Nonliving*, page 341.

Notes:

- Students have limited understanding of plant and animals
 - They think that all animals are vertebrates (with a backbone)
 - They think that all plants don't include trees and bushes and grasses
- Difficulty understanding multiple classifiers
 - A bat is a mammal and a winged animal that flies
 - Students don't think Insects are animals
 - Or that humans are animals
- What it means to be "living" and "nonliving"
 - Things that move are living (even clouds and fire)

IVB. *Making Sense of Secondary Science: Research Into Children's Ideas*

→ Chapter 1, *The Concept of Living*, pages 17-21

→ Chapter 3, *Growth as a Criterion of Life*, page 36

→ Chapter 4, *Behavior as a Criterion of Life*, page 41

Notes:

- Animism: inanimate objects have souls
- Anthropomorphism: giving human characteristics to organisms and other objects
- There are no hard and fast rules about what can and cannot be taught at each grade level – introducing concepts without expecting mastery is desirable
- Children believe objects are capable of: sensation, emotion, and intention
 - Sun shines to make us warm
 - Spinach makes Popeye strong so he likes it rather than the nutritional content of the spinach
- Movement = living (rivers move so they are "alive")
- Children may use metaphors to explain: A cloud looks like an animal because it grows bigger or they may think the cloud is alive because it grows bigger
- Challenges for teachers: make sure students understand all criteria for living things: movement, respiration, sensitivity, growth, reproduction, exertion, nutrition
- Living things come from living things though seeds and eggs are not seen as living
- Children see growth through plants vs movement for animals
- MISCONCEPTIONS:

- Growth only happens if something gets bigger
- Non living things grow too like crystals
- Growth means just getting bigger based on activities – celebrate a birthday – eat cake – get bigger

V. Examine Coherency and Articulation/Connections to Other Topics: This section helps users examine the K-12 conceptual growth in understanding as a coherent flow of ideas build in sophistication over time, identify important prerequisites for learning, and examine connections between ideas within and across topics.

V. Atlas of Science Literacy

→ *Flow of Energy in Ecosystems, pages 78-79*

Notes:

- K-2: some animals and plants are alike in the way that they look and what they do and others are very different from one another
- K-2: some kinds of organisms that once lived on earth have completely disappeared although they were something like others that are alive today.

VI. Clarify State Standards and District Curriculum: This section helps the user clarify the meaning and intent of their own state standards or learning goals in their district curriculum by taking the previous five sections and linking the information to the context the user works in. It also helps the user identify important, key ideas in science that may be missing at the state or local level which should be addressed along with their standards.






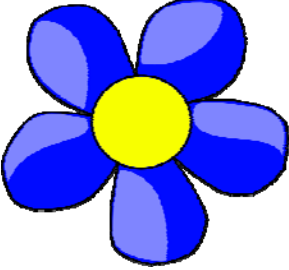
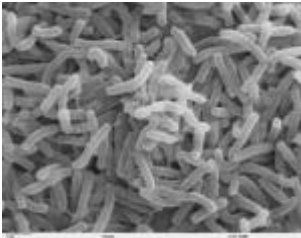


VI: Grade Level Expectations: LIVING SYSTEMS



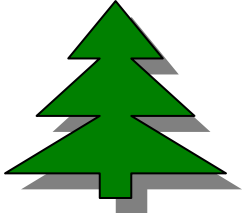






- 1.1.6: *Characteristics of Living Matter*
- 1.2.6: *Structure and Organization of Living Systems*
- 1.2.7: *Molecular Basis of Heredity*
- 1.3.8: *Life Processes and the Flow of Matter and Energy*
- 1.3.9: *Biological Evolution*
- 1.3.10: *Interdependence of Life*

Notes:

- 1.1.6: *Characteristics of Living Matter*
 - *Understand characteristics of living organisms*
 - *Identify observable characteristics of living organisms (spiders have eight legs; birds have feathers; plants have roots, stems, leaves, seeds, flowers)*
 - *Observe and describe characteristics of living organisms (same examples as above)*
- 1.2.6: *Structure and Organization of Living Systems*
 - *Know that living things are made of small parts*
 - *Observe and show how living things look different under a magnifier*
 - *Observe and identify the parts of an object seen under a magnifier*
 - *Illustrate or draw the small parts that make up the whole living thing*
- 1.2.7: *Molecular Basis of Heredity*
 - *Understand that plants and animals have life cycles*

- *Observe and describe the life cycle of plant or animal*
- *1.3.8: Life Processes and the Flow of Matter and Energy*
 - *Know that most living things need food, water, and air*
 - *Observe and record that most living things need food, water, and air.*
 - *Observe and record or demonstrate that plants need light*
- *1.3.10: Interdependence of Life*
 - *Know that plants and animals need a place to live*
 - *Observe and show how organisms live in specific places (fish live in a pond)*
 - *Describe how animals depend on plants or other animals for food*
 - *Describe how animals depend on plants or other animals for shelter*

<p>1. Rabbit</p> 	<p>2. Starfish</p> 	<p>3. Dragonfly</p> 
<p>4. Mushroom</p> 	<p>5. People</p> 	<p>6. Flowers</p> 
<p>7. Bacteria</p> 	<p>8. Rocks</p> 	<p>9. Sun</p> 

<p>10. Wind</p> 	<p>11. River</p> 	<p>12. Tree</p> 
<p>13. Seed</p> 	<p>14. Egg</p> 	<p>15. Feather</p> 
<p>16. Fire</p> 	<p>17. Leaf</p> 	<p>18. Fossil</p> 

ANIMALS

NOT ANIMALS

Organisms

LIVING	NON-LIVING