Lesson 2

Signs of life

Searching for life on planets beyond our solar system

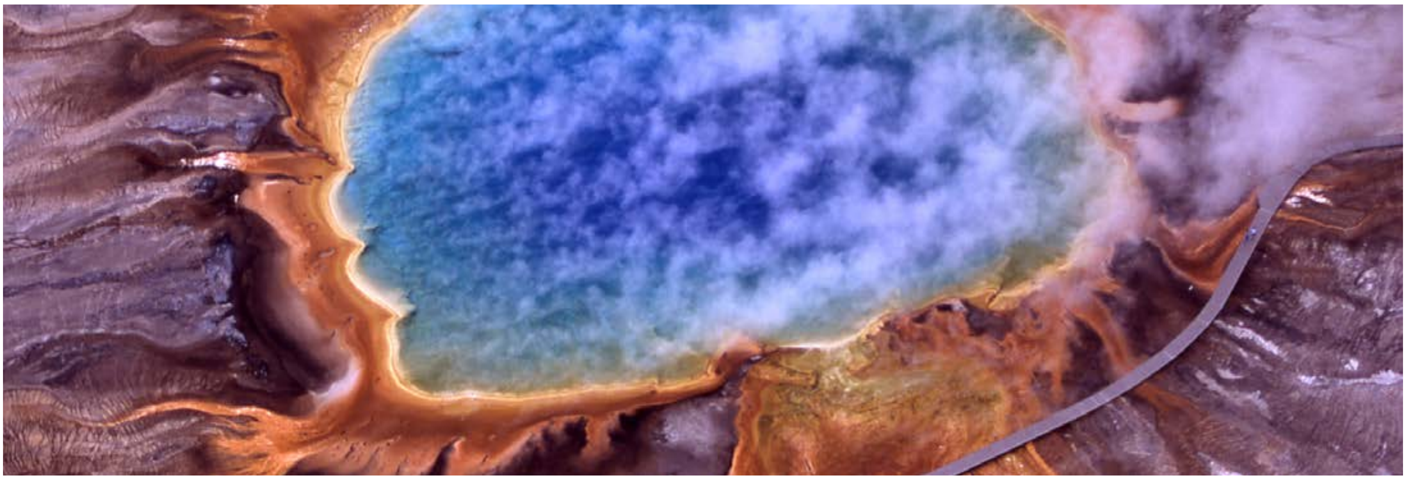
Curriculum links

England Animals including humans | Living things and their habitats | States of matter | Evolution and inheritance | Microorganisms (classification)

Scotland Biodiversity and interdependence | Processes of planet

Wales Interdependence of organisms | Sustainable earth | Properties of materials

Northern Ireland The variety of living things | Adaptations of living things



Grand prismatic spring By Jim Peaco, National Park Service via Wikimedia Commons

Background

Scientists are discovering planets orbiting stars in our galaxy and some may be Earth-like planets with conditions suitable for life. So, what are we looking for when studying these far-off worlds?
In this lesson, the children will learn that the presence of carbon dioxide can be a sign that life could exist. They will set up an investigation to collect carbon dioxide produced by a living organism, yeast.

Objectives

To learn:

- living things produce carbon dioxide
- carbon dioxide has been detected in the atmosphere of distant planets
- the presence of carbon dioxide may indicate life is present
- to work scientifically

Resources per group of four

Straws
Disposable cups x 4
Water
100ml vinegar
Effervescent vitamin C tablet
Half a cup of bicarbonate of soda
Balloons x 4
Sachet dried active yeast x 4
Plastic bottles 500ml x 4
Half a cup of granulated sugar
Teaspoon
Warm water 45–50°C
Thermometer
Activity sheets 2a and 2b

Advance preparation

Repeatedly inflate and deflate the balloons prior to conducting the yeast investigation.
Prepare warm water and store in a thermos flask.
Teachers may wish to prepare astrobiologist role badges for this lesson.

Activity

Introduction

Introduce the activity by explaining that scientists are searching for signs of life on planets beyond our solar system. For this they use powerful telescopes. Images of the Hubble Space Telescope, ESA's COROT telescope and the Spitzer Space Telescope can be shown on the whiteboard. (See links in teacher information) Explain that these telescopes are helping scientists to collect information about the atmospheres of stars and planets as well as providing superb images from space.

Activity a

Explain that living organisms produce carbon dioxide as a waste product and that scientists looking for signs of life beyond our solar system are using special telescopes to detect ingredients such as carbon dioxide in the atmospheres of distant planets. A variety of ways of producing carbon dioxide bubbles can be tried. The children use the straws to blow into the water, drop an effervescent vitamin C tablet into water and observe the bubbles or add vinegar to a teaspoon of sodium bicarbonate and watch the foam rise as carbon dioxide is produced.

Teachers should ensure that effervescent tablets are used only for demonstration purposes and children warned that the tablets are not to be consumed.

Activity b

Today we are going to use an organism called yeast, which produces carbon dioxide from a nutrient, sugar. Show the children how to set up the investigation:

1. Ensure the balloon has been stretched by repeatedly inflating and deflating.

2. Add the packet of yeast and a teaspoon of sugar to a cup of warm water (45–50°C) and stir.

3. Ensure the sugar and yeast have dissolved and pour the mixture into the bottle. You should see bubbles of carbon dioxide produced by the yeast as it feeds on the sugar.

4. Attach the balloon to the mouth of the bottle.

5. After a few minutes, the balloon should inflate.

Explain that yeast is a living organism and, as it feeds on the sugar, it produces carbon dioxide. Can the children investigate the conditions affecting the production of carbon dioxide by the yeast?

Each group then discusses the variables that could be changed in this investigation. They may suggest varying the amount of sugar or yeast, type of sugar or temperature of the water. They plan their investigation. What will they keep the same? What will they measure? What will they record? What do they think will happen and why? Photographs or videos of the stages of expansion of the balloons could be taken.

Plenary

The children present their results in tables, charts, posters, videos or PowerPoints, explain what their results mean and justify their conclusions. How might they improve their investigation? Emphasise that the presence of carbon dioxide in a planet's atmosphere does not prove the existence of life.

Teacher demonstration

Explain that one of the properties of carbon dioxide is that it is heavier than air and can be used to extinguish flames. Demonstrate this by adding vinegar to a few teaspoons of sodium bicarbonate in a jug. Wait for a couple of minutes for the reaction to take place. Gently 'pour' the gas (but not the liquid or foam) over a lighted candle or tea light in a shallow container and watch the flame being extinguished. Explain that the flame needs oxygen from the air in order to burn; carbon dioxide is heavier than air and sinks to the bottom of the container, replacing the air and extinguishing the flame. Could we test the gas produced in our investigations? Try carefully 'pouring' the gas from the balloons next to a burning tea light and observe the flame being extinguished. This demonstration does not of course prove that it is carbon dioxide and not another heavier than air gas but it shows one of the properties of carbon dioxide. The demo is visual and encourages thinking skills.

Care should always be taken when using tea lights. The children should be warned of the dangers of touching or being too close to naked flames.

Extension

The children could design their own extremophile, using the information on Activity sheet 2b, describing the conditions in which it lives and how it has adapted to those conditions, before finally giving it a name. They might research the Hubble Space Telescope or exoplanet HD 189733b.

Teacher information

Astrobiologist

Astrobiologists study the origin, evolution, distribution and future of life in the universe – both extraterrestrial life and life on Earth.

Telescopes

http://hubble.stsci.edu/the_telescope/hubble_essentials
http://www.bbc.co.uk/science/space/universe/exploration/kepler_mission
https://en.m.wikipedia.org/wiki/Kepler_(spacecraft)
http://www.spitzer.caltech.edu/
http://www.esa.int/Our_Activities/Space_Science/COROT_overview

Yeast

There are approximately 160 known species of yeast. Yeast is a fungus, a tiny organism; just one gram contains 25 billion cells. It can produce a large amount of carbon dioxide, provided it has the sugars it needs for food. It uses its own enzymes to break down more complex sugars, such as granulated sugar, into a form it can consume.

Extremophiles

As far as we know, Earth is the only planet that supports life and that life began at least 3.8 billion years ago, when Earth had cooled, forming a rocky outer layer. It may have begun either in a rocky pool or in the ocean. No life on our planet can survive without water. Some believe comets or asteroids may have brought the ingredients for life from space. Everywhere we look, life of some kind can be found. Scientists once believed that plants and animals could only exist close to Earth's surface where sunlight could reach. However, bacteria metabolising minerals and gases have been discovered several kilometres down in solid rock; they can live in strong acids, in hot springs on the floor of the deepest oceans, in boiling hot thermal pools, in the frozen wastes of Antarctica, in highly radioactive conditions and even in bubbles of methane gas. We call these survivors 'extremophiles' and it appears that wherever there is water, life can survive. Since life is so hardy, there is reason to believe that some form of alien life may exist in space. One marker is carbon dioxide, the gas that life can generate and which plants both give out and use to grow. Carbon is part of the main chemicals in the building blocks of life. In 2008, the Hubble Space Telescope discovered carbon dioxide in the atmosphere of a planet, HD 189733B, of similar size to Jupiter, orbiting another star.

For further information on extremophiles see: https://astrobiology.nasa.gov/
The Life of Extremophiles by Christopher Brooks, BBC Scotland http://www.bbc.co.uk/nature/21923937

Appendix

Lesson 2
Activity Sheet 2a

Our question is
We will change
We will measure
We will keep these things the same
Our results
We found out

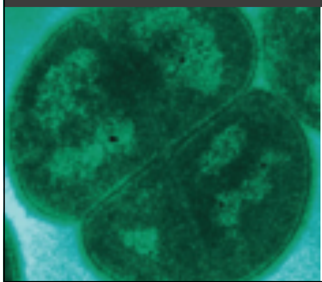
Appendix

Lesson 2
Activity Sheet 2b

Tardigrade

Tardigrades, or water bears, are water-dwelling tiny animals that can survive extreme environments. For example, they can withstand extremely low and high temperatures, extreme pressure and doses of radiation that would be lethal for most animals, and they can go without food or water for more than ten years.

Deinococcus radiodurans

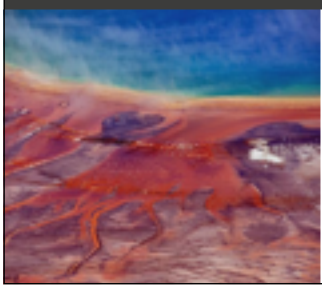


This one cell organism can survive high levels of radiation, almost 3,000 times as much as humans.

Hesiocaeca methanicola Methane worm

A species of worm that is flat and pinkish and 5cm long living in methane ice on the ocean floor.

Thermophile



These bacteria that can withstand extreme heat produce the vibrant colours around hot springs in Yellowstone National Park in the USA. The water in the geysers and springs at the park can get to temperatures as high as 70°C.

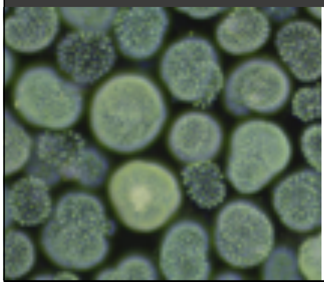
Appendix

Lesson 2
Activity Sheet 2b

Thermophilic algae

Thermophilic algae can survive and flourish in extremely high temperatures. The green algae seen here in Yellowstone National Park grow in water at around 50°C.

Microcystis



Microcystis is a type of bacterial algae that grows in waters with extremely high pH levels, such as Mono Lake in California. The cells are usually found organised into colonies like this and can produce and release harmful toxins.

Sea Sandwort

Honckenya peploides, commonly known as sea sandwort, is a halophile; this means it can grow in extremely salty conditions – most commonly found near the beach.

Microalgae Dunaliella salina

In this aerial view of a salt pond, the microalgae Dunaliella salina, which love extremely salty conditions, create the bright pink colouring.