1.1 Living or non-living?

Lesson outcomes

At the end of this activity students will be able to:

- identify everyday things as living or non-living

What ideas might your students already have?

- some may not regard plants as living things
- students might attribute movement to living things
- they may not be sure how dead organisms fit in.

Key vocabulary:

Living, non-living.

Equipment list

Each CLASS will require:

- Internet access

Each STUDENT will require:

- ***Notebook***

Things to consider

- Familiarise yourself with the digital resource to decide the best way to support your students' learning and manage internet access. The learning experience has been designed to put technology into the hands of the students, with the teacher taking a facilitating role.
- Students will use ***Notebooking***. This could be presented in words, pictures and other media. It may be electronic or hard copy. Refer to the ***Notebooking*** section of the *Student Learning Professional Learning Module* for further information on getting your students started.
- What characteristics do all living things share? Is it the ability to move, reproduce, react to surroundings etc.? It is important students have adequate time to construct arguments and feel comfortable sharing their ideas as a class. Explain that you are just interested in getting a picture of what they already know.
- Do not impose formal classifications of features that make a living organism; let students use their own vocabulary. The characteristics of living things will be developed **Activity 1.2**.

Lesson plan

Step 1: Begin the lesson by showing the video Introduction to the *Characteristics of Life* (3:40) which shows a variety of living things and poses questions and contradictions to stimulate students' ideas.

Step 2: Introduce students to the first ***Notebook*** task 'Signs of life'. Students identify which things are living and which are non-living in the photo scenes.

Step 3: Conduct a ***Think-Pair-Square-Share***.

Think – Ask students to look at their lists of living things they identified and compile a list of the characteristics that all living things have in common.

Pair – Discuss with a partner and share lists.

Square – Now meet up with another pair of students and compare lists.

Share – Now bring the class together. Invite students to share their ideas with the whole class and encourage the class to ***Notebook*** any new ideas that they did not think of. Listing all ideas on a whiteboard is helpful – students can act as scribes.

1.2 Characteristics of life

Lesson outcomes

At the end of this activity students will be able to:

- recognise that the ability to move is not necessarily an indication that something is alive
- recall the seven characteristics of living things.

What ideas might your students already have?

Students should have some informal ideas from previous activities about what makes something living. These should now be expressed in more scientific terms.

Key vocabulary:

Characteristic, cell, reproduce, offspring, deoxyribonucleic acid (DNA), energy, stimuli, respond, homeostasis, trilobite, virus.

Equipment list

Each CLASS will require:

- internet access

Each GROUP will require:

- three samples of a potential new life form. Just before class prepare the following labelled samples of ‘sewer lice’ in 250 mL beakers, filled to 6 cm height with these mixtures:
- ‘Sewer lice **larvae** from pre-treated sewage’: mixture of 50% cola and soda water and 5-10 currants.

- ‘Sewer lice **pupae** from partially treated sewage’: mixture of 20% cola diluted with soda water and 5 sultanas.

- ‘Sewer lice **adults** from treated sewage’: soda water and 4 raisins.

- wide basin or tray
- ethanol (methylated spirits)
- 50 mL measuring cylinder
- 50 mL beaker
- paper dots from a hole punch machine
- forceps

Each STUDENT will require:

- safety glasses
- ***Notebook***

Things to consider

- It is important to approach the first activity with excitement at a possible new discovery and encourage students to use their imaginations and direct observations, rather than preconceived ideas of what might be in the samples.
- Try out the three recipes for ‘sewer lice’ so that you are prepared to guide students with observations. The ‘sewer lice’ will continue to be active for at least half an hour.
- Bring in sewer lice samples just before use, rather than having them in the room at the start of the lesson, to keep the element of surprise. Ideally a laboratory assistant could make these up just before you require them so that the solution does not lose its fizz.
- The second activity is a clear example of inanimate objects moving by themselves and begs the question of whether movement is a characteristic of life. The dots are obviously not living, but move due to the surface tension changes between the alcohol-soaked dots and water. This is a short but exciting activity, which can be done in groups, as indicated in the *Student Guide*, or as a teacher demonstration using a larger container, such as a glass trough. A straight-sided container is better than one with curved edges.
- Students will find the video engaging but quirky. Alert students might be able to spot the two spelling errors in the video.

Teacher content information

There is ongoing debate about what are the requirements of life. A very popular mnemonic has been MRS GREN, an acronym for:-

- Movement
- Respiration
- Sensitivity
- Growth
- Reproduction
- Excretion
- Nutrition

Students often list movement as a requirement; however it is difficult to see movement in plants unless you observe time-lapse photography or witness cytoplasmic streaming in plant cells.

In the commonly used university textbook 'Biology' by Campbell et al (2009), 'some properties of life' include:-

- Order – having a highly ordered structure
- Evolutionary adaptation – adaptations evolve over many generations by the reproductive success of those individuals with hereditable traits that are best suited to their environments.
- Response to the environment – responding to environmental stimuli
- Regulation – homeostasis
- Energy processing
- Growth and development
- Reproduction

Reference –Campbell, Neil A. et al. 2009, Campbell biology, Eighth Edition (Australian version), Frenchs Forest, N.S.W. Pearson Australia

In this activity we have chosen to include the cell theory and acknowledge the following characteristics of life; more scaffolded to Year 8 understanding:-

- Cells - Living things are made up of one or more cells
- Reproduce - Living things can reproduce and produce offspring
- Energy - Living things require energy for their daily activities. Plants obtain this energy from sunlight and make sugars to store energy for later. Animals eat other organisms to get their energy.
- DNA - Living things contain an information storing molecule called DNA, and this gives them the ability to adapt and evolve (change) over generations.
- Responsive - Living things respond to stimuli in their environment.
- Growth - Living things grow and develop
- Homeostasis – Living things maintain homeostasis (e.g. water balance, stable body temperature, blood volume).

Dancing Dots

Surface tension is a property shown by liquids, such as water, which creates a 'skin' on the surface that enables some objects to float, even though they are denser than water. Surface tension is also responsible for the ability of some insects, e.g. water striders, to run on the water surface.

Surface tension is caused by the attraction (cohesion) of water molecules. A water molecule is equally attracted to other water molecules on all its sides. A water molecule on the surface of the water is attracted to other water molecules beneath is as well as next to it, but there are no water molecules above it to attract it. The water molecules at the surface are therefore pulled closer together, causing them to act like a thin elastic film.

The paper dots move on the surface of the water because the alcohol from the dot weakens the surface tension of the water near the dot. This creates an adjacent area of stronger surface tension, which pulls on the dot and causes it to move. Once the alcohol has dissipated, the surface tension regains equilibrium and movement ceases.

Movement by an organism is in response to an environmental stimulus, whereas external forces (pressure, gravity, magnetism, temperature, etc.) cause the movement of non-living things. All atoms and molecules are in constant motion. The higher the temperature the faster they move and the more frequently they collide. At absolute zero (-273°C) the movement of all particles ceases.

Reference - This activity is described in 'A Simple, Inexpensive, Dynamic, & Hands-on Exercise for Prompting Discussion of the Characteristics of Living Things' by James E. Mickle & Patricia M. Aune
http://www.cals.ncsu.edu/plantbiology/Faculty/jmickle/pdf/mickle&aune2011.pdf

Lesson plan

Step 1: Introduce the lesson with a brief discussion of how scientists might determine if an unknown sample contained a living organism. Outline the scenario, ensuring that students have grasped the idea of larvae developing into pupae and then adult sewer lice. Before students begin, ensure they understand the difference between an observation and an inference.

Step 2: Divide students into small groups and assign work benches. Each group should appoint a scribe to ***Notebook*** observations. Groups should now collect the three freshly made up samples, make observations for about five minutes and then look at the discussion questions. Conclude with an informal discussion of ideas from different groups. Stress that there are no 'right' answers here.

Suggested question/s:

- Why is this not an observation?
- Does this mean that the sewer lice are living?
- What else would you need to observe to confirm that the lice are living?

Step 3: Introduce the 'Dancing dots' as a student activity or as a teacher demonstration. Discuss as a class why the dots move, even though they are obviously not living. You may want to discuss surface tension to explain to students how movement in this non-living situation can occur.

Step 4: Ask students to design and carry out a simple fair test to find out if the movement occurs without alcohol. Circulate to check experimental designs.

Step 5: Conclude the activity by discussing whether movement alone is a good way to distinguish living things.

Step 6: Follow the link to the digital activities. The video and the rollover wheel introduce the seven characteristics of living things. Invite students to complete the ***Notebook*** task where they sort items into living or non-living and justify their decisions using the characteristics of life.

Suggested questions:

- What characteristics of life does this object show?
- Does a seed or fruit have to be attached to the parent organism to be alive?
- Was this once alive? How do you know?
- When is something dead?
- Was it hard to decide if some of these examples were living or not?
- Which ones were difficult?
- Can the class think of other examples that are hard to group as living or non-living?

1.3 Plant life

Lesson outcomes

At the end of this activity students will be able to:

- design and set up a fair test to investigate the growth of bean seeds
- understand the differences between the dependent, independent and controlled variables.

Key vocabulary:

Germination, reliability, validity, lateral roots, cotyledon, embryo, radicle, plumule, testa, scientific method, hypothesis, controlled experiment, control, test situation, variable, aim, independent variable, dependent variable, controlled variable, replicated, conclusion.

Equipment list

Each PAIR will require:

- gas jar or straight sided jam jar
- two broad bean seeds
- paper towel
- cheap filler material like potting mix, rice hulls or sand
- marking pen or small label.

Each STUDENT will require:

- ***Notebook.***

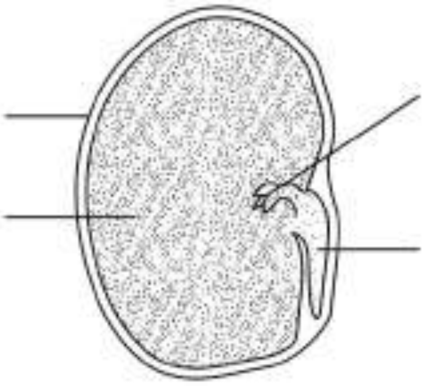
Things to consider:

- **Hints for growing beans:** Gas jars are ideal for this activity because the sides are vertical. Use kitchen paper cut to the height of the jar – a double layer works well. Roll the paper into a tube and insert it into the gas jar. Lightly fill the centre of the paper tube with potting mix or some other absorbent filler. Push a bean seed halfway down the jar, between the paper and the glass. This will enable both developing roots and shoots to be seen clearly and permit measurements as the seedling grows. On the other side of the jar, similarly position the other bean seed. Ensure the paper remains damp by regular watering but that there is never more than a centimetre of water in the bottom. This prevents the bean plant from developing mould.
- Organise a place for the beans to grow that has sunlight during the day but not enough to 'cook' the beans. Peas can also be used. Plan ahead so that you incorporate a weekly lesson during which there is time for watering and observations.
- If you are going to use **Activity 5.9** as an assessment task, ensure you make it clear to students that, although they are collecting data in pairs, they both must ***Notebook*** as they will be submitting an individual report.
- Make sure students understand a controlled experiment (fair test) and can consider how to make their experiment valid and reliable. They might suggest combining the class data - this would be replication. For the class to share data, you might want to set up a table on a noticeboard or in a class space on your computer network.

- Encourage students to think of quantitative observations e.g. length of shoot, length of radicle, number of lateral roots, as well as general qualitative observations. Tables should be organised at this stage to collect data efficiently. They may also like to draw diagrams and take photographs of the bean plants as they develop.
- Soak some broad beans overnight before this lesson. Use these soaked beans to easily remove the testa and show students the cotyledons, plumule and radicle.

Teacher content information:

Broad beans, like all legumes, are dicotyledons. This means the seeds have two cotyledons. Each contains starch that is broken down to glucose to provide an energy source for the germinating seedling until it develops leaves to enable photosynthesis to occur. The cotyledons are covered by a tough skin (testa). The seed contains an embryo consisting of a developing shoot (plumule) and root (radicle).



As you teach:

Step 1: Introduce the lesson by explaining that the students will grow broad bean plants and design an experiment to investigate the characteristics that these living things show over the next few weeks. You may want students to form pairs at this stage and discuss the design of the experiment and the observations they will make. This could be followed with a class discussion to share ideas and review whether their ideas would make a reliable fair test, based as much as possible on quantitative results.

Step 2: Before the students plant their beans, review the structure of a bean seed. If you have soaked spare seeds, the students might be interested in investigating their structure. This is easily done by removing the testa and separating the two cotyledons carefully. One of the cotyledons will contain the embryo and you can point out the plumule and radicle.

Step 3: Students position their broad beans in the jar and place it the selected growing area. In pairs, students design tables to collect their results over at least six weeks.

Suggested question/s:

- What will we need to do to make this a fair test?
- What is a variable?
- Give some examples of variables that might be important to control in this experiment.
- How will we know if the results are reliable?
- What do you think will emerge first, the root or the shoot? Why?
- What observations could you make as the beans grow?
- What measurements could you make?

Step 4: In subsequent lessons students will eagerly wish to monitor their bean seedling's progress. Ensure they take regular measurements and that the seedlings receive water to maintain a 1 cm level in the bottom of the jar.

Follow up:

Some students may want to take their beans home at the end of the unit. If they plant them in a pot and take care of them, students can enjoy the development of flowers and fruit on their bean plants and bring in photographs (or beans) to show to the class the following term.

1.4 Is Sammy alive?

Lesson outcomes

At the end of this activity students will be able to:

- discuss the characteristics needed for a person to be considered alive.

What ideas might your students already have?

Students will have varying ideas about how replacing body parts affects being alive and what being alive actually means.

Key vocabulary:

Technology, dialysis, synthetic, intravenous, prosthetic, transplant, intestine, aorta, prosthesis, heart-lung machine.

Equipment list

The CLASS will require:

- internet access

Each STUDENT will require:

- ***e-Notebook***

Things to consider:

- Enhance this activity's learning impact by enthusiastically introducing how science and technology have changed our lives (see *Student Guide*), before introducing the animation. It is important that students discuss their points of view freely in small groups, and are encouraged to justify their ideas by linking with the characteristics of life.
- At the second viewing of the animation, stop the video each time *Is Sammy alive?* appears on the screen and discuss each stage in his life.
- A video transcript of *Is Sammy Alive?* may assist some students (see Teacher content information).

Teacher content information

The following transcript exists in many places on the internet and regrettably; the original author is unknown. We have created an animation of this story to make it more engaging for students.

<u>Transcript of animation - Is Sammy alive?</u>

Sammy was a normal, healthy boy. There was nothing in his life to indicate he was any different from anyone else. When he completed high school, he obtained a job in a factory, operating a machine press. On this job he had an accident and lost his hand. It was replaced with an artificial hand that looked and operated almost like a real one.

Is Sammy Alive?

Soon afterward, Sammy developed a severe intestinal difficulty and a large portion of his lower intestine had to be removed. It was replaced with an elastic silicon tube.

Is Sammy Alive?

Everything looked good for Sammy until he was involved in a serious car accident. Both of his legs and his good arm were crushed and had to be amputated. He also lost an ear. Artificial legs enabled Sammy to walk again, and an artificial arm replaced the real arm. Plastic surgery enabled doctors to rebuild the ear.

Is Sammy Alive?

Over the next several years, Sammy was plagued with internal disorders. First, he had to have an operation to remove his aorta and replace it with a synthetic vessel. Next, he developed a kidney malfunction, and the only way he could survive was to use a kidney dialysis machine (no donor was found for a kidney transplant). Later, his digestive system became cancerous and was removed. He received nourishment intravenously. Finally, his heart failed. Luckily for Sammy, a donor heart was available, and he had a heart transplant.

Is Sammy Alive?

It was now obvious Sammy had become a medical phenomenon. He had artificial limbs, nourishment was supplied to him through his veins; therefore he had no solid wastes. Dialysis removed all waste material. The heart that pumped his blood to carry oxygen and food to his cells was not his original heart. But Sammy's transplanted heart began to fail. He was immediately placed on a heart-lung machine. This supplied oxygen and removed carbon dioxide from his blood, and it circulated blood through his body.

Is Sammy Alive?

The doctors consulted bioengineers about Sammy. Because almost all of his life-sustaining functions were being carried on by machine, it might be possible to compress all these machines into one mobile unit, which would be controlled by electrical impulses from Sammy's brain. This unit would be equipped with mechanical arms to enable him to perform manipulative tasks. A mechanism to create a flow of air over his vocal cords might enable him to speak. To do all this, they would have to amputate at the neck and attach his head to the machine, which would then supply all nutrients to his brain. Sammy consented and the operation was successfully performed.

Is Sammy Alive?

Sammy functioned well for a few years. However, a slow deterioration of his brain cells was observed and was diagnosed as terminal. So the medical team that had developed around Sammy began to program his brain. A miniature computer was developed: it could be housed in a machine that was humanlike in appearance, movement, and mannerisms. As the computer was installed, Sammy's brain cells completely deteriorated. Sammy was once again able to leave the hospital with complete assurance that he would not return with biological illness.

Is Sammy Alive?

If Sammy is not alive at the story's end, exactly when did he stop being alive?

Lesson plan

Step 1: Introduce this lesson with a discussion on how science and technology have improved our quality of life and helped save lives, using the stimulus material in the Student Guide. Ask students if they can think of other examples.

Step 2: The class should watch the animation together for an overview.

Step 3: Ask students to access the ***Notebook*** exercise. They may copy the table or download the ***e-Notebook***.

Step 4: Watch the video a second time but stop the video after each stage and let students discuss in small groups what has happened to Sammy and how his life has changed. Students add information to their ***Notebook*** tables. Remind students to look back at the characteristics of life and pose the question - Is Sammy alive?

Step 5: A spokesperson from each group then reports to the class. Give a short time for comments/discussion after each report. Encourage open-mindedness to differing points of view that are backed up with reasons.

Suggested questions:

- What happened to Sammy?
- How will this affect his life?
- Is he still alive?
- What are the essential part(s) of the body that must work for us to be alive?
- Can you relate this to the characteristics of life?