

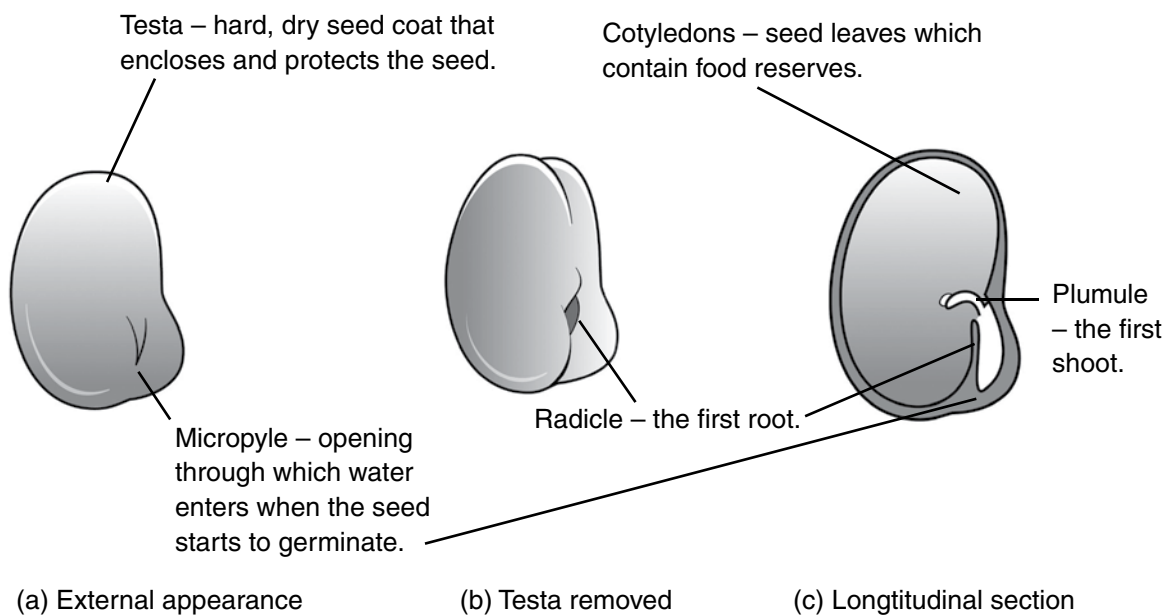
Unit 1

Teaching ideas

Background knowledge

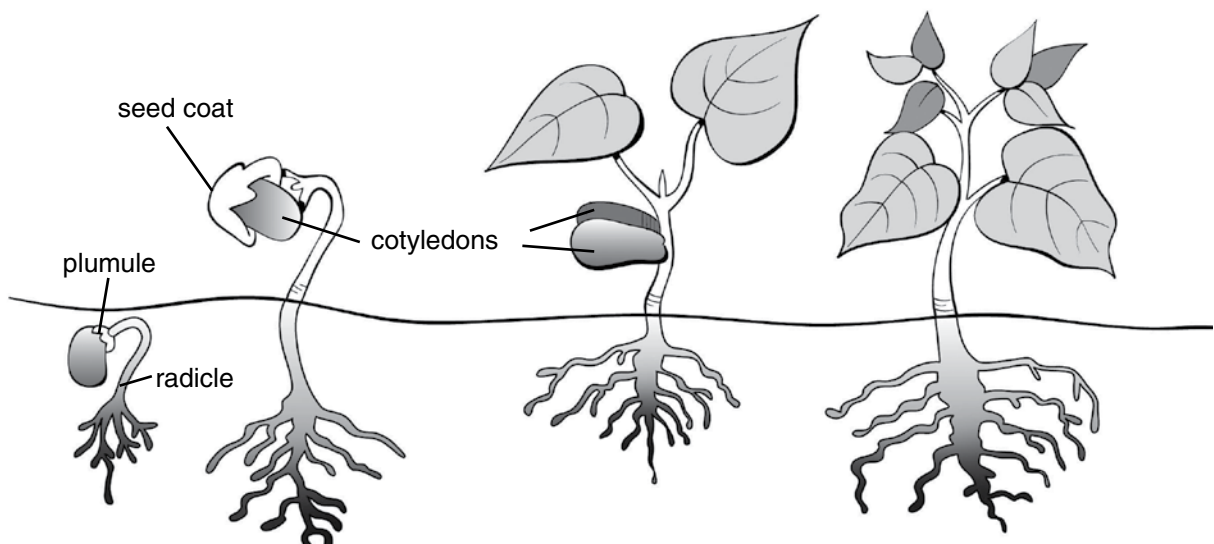
Seeds and germination

A seed is the product of sexual reproduction in flowering plants. In dicotyledonous plants, such as beans, the seed consists of a miniature plant (the embryo) and two modified leaves (the cotyledons) which contain the seed's food reserves.



Germination

Germination is the process by which the embryo grows and develops into new plant. The new plant eventually becomes a fully mature plant. The energy and raw materials required for growth come from the food stored in the cotyledon.



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Seeds need water and warmth to start germinating. When conditions become suitable for germination, the seed takes in water through the micropyle. The tissues absorb water and swell, and the seed coat becomes soft. The radicle grows first. It pushes through the testa and enters the soil. Next, the plumule pushes upwards through the soil.

The embryo grows between the cotyledons, and up through the soil. It leaves the cotyledons below the ground. As the plumule grows, it brings the cotyledons for most plants above ground. Note that in broad beans, the cotyledons stay below the ground.

It is easiest to observe and understand seed structure and germination if large seeds, such as peas and beans, are used.

Factors needed for seed germination

Some seeds need light for germination, but most seeds germinate in the absence of light.

The essential factors for seed germination are:

- water
- oxygen
- temperature.

Water

A dormant seed contains 10–15% of its mass as water and is generally dry. A dormant seed is one which is inactive and has not yet germinated. The dormant seed has to absorb water to become active and start germination. Water makes the seed coat soft, which causes it to split. The seed absorbs water and swells. Cell processes are activated and germination starts. Water is also needed to bring in the dissolved oxygen for use by the growing embryo.

Oxygen

Dormant seeds use very little oxygen. When seeds germinate, they need large quantities of oxygen to allow respiration, and other metabolic processes associated with growth, such as hydrolysis of starch to glucose, to occur. The seeds obtain this oxygen from the air contained in the soil. Seeds sown deeply in soil often fail to germinate because they do not have enough oxygen. Seeds are likely to germinate better in ploughed soil because ploughing aerates the soil (adds air, and therefore oxygen to the soil).

Temperature

Germination can take place over a wide temperature range (from about 5–40 °C), but the optimum temperature (best temperature) for most seeds is between 25–30 °C.

Plant growth

Like animals, plants require air, water and food for survival. They also need light. Light is essential for plant growth because it is used in the process of photosynthesis. In photosynthesis, plants make food substances such as glucose and starch. Chlorophyll, the green pigment in plants, absorbs the light in order for photosynthesis to take place. Light is also needed for the formation of chlorophyll. This is why plants kept without light are yellow and not green.

Plants require both oxygen and carbon dioxide gas. They use oxygen for the process of respiration. They use carbon dioxide during photosynthesis as a source of carbon for the manufacture of food molecules, for example, starch.

Water is needed for photosynthesis. Without water, the stems and leaves of plants would not be strong and firm. Water transports dissolved food, oxygen and minerals around the body of the plant, much as blood does in the human body.

Unit overview

| Topic | Number of lessons | Outline of lesson content | Resources in Learner's Book | Resources in Activity Book | Resources in Teacher's Resource |
|----------------------------------|--|--|--|----------------------------|--|
| 1.1 Seeds | 1 | A seed contains an embryo that grows into a plant. | Activity 1.1 SE Questions 1, 2, 3 Ex | Exercise 1.1 Su | Worksheet 1.1a SE Su Worksheet 1.1b SE Worksheet 1.1c SE Ex |
| 1.2 How seeds grow | 1 | Under the right conditions, seeds germinate and grow a first root and first shoot. | Activity 1.2 SE Questions 1, 2, 3, 4, 5 Ex | Exercise 1.2 Su | |
| 1.3 Investigating germination | 2 (over a period of one week) | Seeds need water, warmth and air to germinate. | Activity 1.3a SE Activity 1.3b SE Questions 1, 2, 3, 4, 5 SE | Exercise 1.3 SE | Worksheet 1.3 SE Ex |
| 1.4 What do plants need to grow? | 2 Note: Cover an area of grass two or three days before the lesson. | What do plants need to grow? | Activity 1.4 SE Questions 1, 2, 3, 4, 5, 6 SE | Exercise 1.4 | Worksheet 1.4 SE Su |
| 1.5 Plants and light | 2 (over a period of three weeks) | Investigating plant growth. | Activity 1.5 SE Questions 1, 2, 3 SE Challenge activity SE Ex | Exercise 1.5 Su SE | Worksheet 1.5 SE Ex |
| Check your progress | 1 | | Questions 1,2 L , 3,4, 5 | Language review L | |

Ex Extension **L** Language **SE** Scientific enquiry **Su** Support

Resources

- fruits with seeds, such as cucumber, tomato and pumpkin
- large fresh seeds, such as broad beans
- a hand lens
- water
- a container for soaking seeds in
- a selection of different seeds
- a saucer
- a plant for making cuttings from, such as geranium, impatiens (Busy Lizzie), basil or African violet
- a knife, scissors or secateurs
- an onion
- glass jars
- soil, sawdust, paper towel or cotton wool
- a measuring cup or cylinder
- some small seeds such as mung (moong) beans or lentils
- small plastic bags and bag ties
- drinking straws
- a candle
- a bell jar or large glass jar
- a brick
- two similar pot plants
- a dark cupboard
- a ruler

Topic 1.1 Seeds

Learners will have explored how seeds develop into plants in Stage 1. This topic builds on that knowledge. Learners will discover that seeds develop inside fruits and grow into new plants. Each seed contains an embryo, which develops into the new plant.

Learning objectives

- Know that plants reproduce.
- Discuss the need for repeated observations and measurements.
- Recognise and make predictions from patterns in data, and suggest explanations using scientific knowledge and understanding.
- Interpret data and think about whether it is enough to draw conclusions.
- Present results in bar charts and line graphs.

Curriculum links

- You can link this lesson with Art. Learners can make coloured drawings of different fruits and their seeds. They could also make seed pictures from dried beans, lentils and sunflower seeds.

Ideas for the lesson

- Find out what learners already know by asking them where seeds come from and what seeds do. Learners will know that we plant seeds to grow new plants, but they may not know that seeds are found in fruits.
- Show learners examples of different fruits, including some that they would not instinctively classify as fruits, such as a pumpkin, cucumber or tomato. Explain that seeds form inside fruits.
- Talk about the numbers of seeds and the sizes of seeds that different fruits have. Get learners to think about patterns in these features.
- Get learners to do Worksheet 1.1b, which can be completed at home if there is not enough time in class. Learners have to recognise a pattern in the number and sizes of seeds and make predictions based on this pattern.
- Ask the class why a seed is able to grow into a new plant. Discuss the structure of seeds. It will be helpful if learners can observe real seeds during this discussion.
- Get learners to do Activity 1.1, in which they examine and make observations of seed structure. They should answer Questions 1–3 about the functions of different parts of a seed.
- Exercise 1.1 in the Activity Book consolidates the learning from this topic.
- Worksheet 1.1c gives learners an opportunity to practise data handling skills.

Notes on practical activities

Activity 1.1

Each group will need:

- a large fresh seed
- a hand lens.

Learners should work in groups of 4 or 5.

Large seeds are best. Try broad bean seeds or other large bean seeds. Chick peas are also suitable. Maize seeds are not suitable because they cannot be split in two to see the internal structure.

Seeds should be soaked for an hour or two to soften the seed coat and make it easier to peel away. The seed coat should be wrinkled but the seed should not have absorbed much water and swelled yet.

Demonstrate the use of a hand lens if the learners have not used them before.

Some learners may struggle with their drawings of seeds. Support them by giving clear guidelines:

Look very carefully at the object you are drawing. Notice the shape and size of the parts, how many parts there are and how they are arranged.

Press lightly with your pencil in case you make a mistake and have to erase it.

Make sure your drawing is big enough to see all the parts clearly. You may have to draw them bigger than they really are. Always label the parts of a drawing. Draw pencil lines with a ruler to the parts you want to label. Write the labels with a pen.

Write the labels in line with one another down the page. Leave enough space between the label lines so the labels are clear.

You can extend the activity by letting learners observe different seeds. Ask these questions: *Do all seeds look alike inside? Are the food storage areas alike? What and where is the embryo? What does the embryo look like? Where are the future leaves?*

Internet and ICT

The website: <http://www.easyfunschool.com/article1941.html> has ideas for exploring fruits and seeds further.

Assessment

- Can learners label the parts of a seed correctly? Ask learners to check each others labelled drawing of a seed made in Activity 1.1 and suggest any corrections that need to be made.
- Get learners to look at their diagrams of the seed from Activity 1.1 and the fruit from Worksheet 1.1a. Are they happy with them? How can the diagrams be improved?

Differentiation

- Lower achieving learners can use Worksheet 1.1a to practise their drawing and observation skills.
- Higher achieving learners could research why some fruits, such as bananas and some varieties of grapes, are seedless. How do the new plants grow? (Note: seedless fruits actually do contain seeds at some point. However, a genetic mistake prevents the seeds from forming hard outer coats like normal seeds do, and the seeds do not develop. Because seeds don't form, new plants cannot grow from seeds. They come from cuttings instead. For example, a piece of the grape vine is cut off, dipped in rooting hormone and then placed in moist soil so that roots and leaves form. With bananas, new shoots grow from the base of the plant and produce flowers and fruits.)

Talk about it!

Ask the class what they think the answer is. Do big plants produce big seeds? You could ask them to do some research to find out. The largest seed is the Coco de mer, the seed of a palm tree. It can reach about 30 cm long, measure 3 m in diameter and weigh up to 18 kg. The palm tree grows to about 30 m tall. But other trees like redwoods found in the USA grow to about 100 m tall and have much smaller seeds than the Coco de mer seed.

Common misunderstandings and misconceptions

Many learners at this level think that all fruits are sweet and edible. In this topic, you will be introducing the biological concept of a fruit that will address this misconception. You should also explain that not all fruits are edible and some may be poisonous. Learners should never eat any unknown fruit, no matter how colourful or tasty it looks.

Homework ideas

- Exercise 1.1 in the Activity Book could be completed by lower achieving learners.
- Worksheet 1.1c can be completed by higher achieving learners. The worksheet asks learners to identify a pattern in results, think about using repeated measurements to draw a conclusion and present the results in a bar chart.

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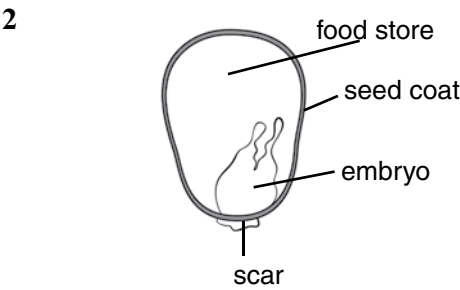
- Discuss answers to homework in class.
Allow learners to check their own answers for self-assessment.

Answers to Learner’s Book questions

- 1 So that the embryo can get energy to grow into a new plant.
- 2 To protect the inside of the seed.
- 3 Learners may suggest water, warmth, soil, air.

Answers to Activity Book exercise

- 1 Maria (girl 1) is right. A pumpkin is a fruit because it has seeds.



- 3 embryo – grows into new plant
seed coat – protects the seed
scar – joins the seed to the fruit
food store – gives the seed energy to grow

Answers to Worksheets

Worksheet 1.1a

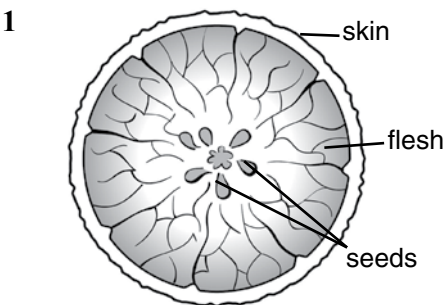
Learners’ drawings will depend on the fruit they choose.

If there are no fruits available, they can draw and label the orange from the Worksheet.

Drawings must be:

- At least 5 cm high and 5 cm wide.
- Neatly drawn with a sharp pencil.
- Clearly labelled with label lines drawn with a ruler.

Answers and drawing are based on an orange.



- 2 orange
- 3 The flesh is soft.
- 4 The flesh is juicy.
- 5 The seeds are white.
- 6 a eight seeds
b The seeds are small.

Worksheet 1.1b

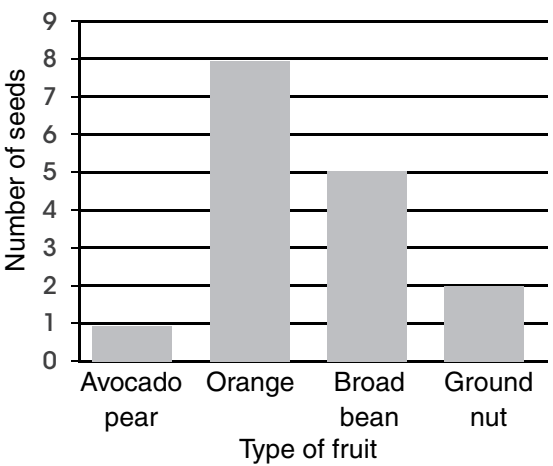
- 1 The plum has the largest seed.
- 2 The kiwi fruit has the smallest seeds.
- 3 The kiwi fruit has the most seeds.
- 4 The plum has the fewest seeds.
- 5 Fruits with small seeds have lots of seeds.
Fruits with large seeds have few seeds.
- 6 No. Only four fruits were investigated. To be able to form a conclusion you would have to look at lots of different fruits.
- 7 The seeds would be quite big.

Worksheet 1.1c

1

| Fruit | Number of seeds |
|--------------|-----------------|
| avocado pear | 1 |
| orange | 8 |
| broad bean | 5 |
| groundnut | 2 |

2



- 3 a The avocado pear will. The number of seeds will be different in the others.
b Cut open lots of each type of fruit and count the seeds.

Topic 1.2 How seeds grow

In this topic, learners learn about the stages in the process of germination. Knowing the stages of germination is not required by the

curriculum, but this additional material is important for understanding the life cycle of the plant. Learners observe the changes in seeds as the seeds prepare for germination.

Learning objectives

- Investigate how seeds need water for germination.
- Make relevant observations.
- Make predictions based on scientific knowledge.
- Decide whether results support predictions.

Ideas for the lesson

- Begin the lesson by revising the structure of a seed. Ask the class what happens when the seed starts to grow. What makes the seed start growing? Which part of the seed grows? You can record learners' ideas on the board in a mind map.
- If possible, show the class a video clip of seed germination so they can see all the stages (see *Internet and ICT*). Discuss the stages that take place.
- Learners can then start doing Activity 1.2. At the start of the activity, they must predict the changes they expect to take place in the seed overnight. The activity should be completed the next day. Learners observe the changes that have taken place and decide whether their observations support their predictions.
- You can add to the discussion of the 'Talk about it!' question by demonstrating how to make a leaf or stem cutting. Learners could make their own cuttings and observe the growth of their cuttings. Most soft-stemmed plants are suitable to make cuttings from. If possible, also show the class examples of bulbs or corms. These are underground stems which develop shoots that grow into new plants.
- Exercise 1.2 in the Activity Book consolidates the learning from this topic.

Notes on practical activities

Activity 1.2

Each group will need:

- a bean seed
- a saucer of water.

Learners should work in groups of 4 or 5.

Learners can prepare their beans and make a prediction about what will happen to the seed in the water at the end of one lesson. They should note their prediction.

In the next lesson, let learners observe how their beans have swollen. They can also feel the seed and observe that it is quite soft. They should compare their observations to their prediction.

Learners may give a range of predictions at the start of Activity 1.2, which could include:

- It will start growing.
- It will get bigger.
- It will get softer.
- It will split open.

The bean seed swells up and becomes softer.

This happens because water enters the seed and makes it swell and get softer.

Learners may give range of answers. The best answer is at the scar. It is the only opening on the outside of the seed coat.

Internet and ICT

- The website: <http://videos.howstuffworks.com/discovery/30704-assignment-discovery-germination-of-a-seed-video.htm> has a good quality time lapse video on germination.
- The website: <http://www.kidsgrowingstrong.org/germination> gives a simple explanation for learners about germination.
- The website: <http://urbanext.illinois.edu/gpe/case3/c3facts3.html> has an interactive game and text about seeds and germination featuring Detective Leplant and his partners Bud and Sprout.

Assessment

- Can learners correctly sequence the different stages in the process of germination? Get them to peer assess the answers to Exercise 1.2.

Differentiation

- Lower achieving learners can be supported if you read through the instructions for Activity 1.2 with the class to ensure that they understand the task. Lower achieving

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learners can also do Exercise 1.2 in the Activity Book, which will help them consolidate their understanding of the different stages in germination.

- Higher achieving learners could find the information to answer these questions: *What is seed dormancy? How can it be ended? Can seeds start growing into new plants while they are inside the fruit?*

Talk about it!

Bring an onion to class. Ask learners how they can grow a new onion. Do they need onion seeds? Many of them will have seen an onion sprout roots and shoots. New onions grow from the onion bulb that we eat. You could also make a leaf cutting a few days in advance from a plant such as a begonia. New roots will start to grow from the leaf as the leaf begins to grow into a new plant. Explain that we can grow plants from other parts of the plant, such as stem and leaf cuttings and from bulbs and corns.

Common misunderstandings and misconceptions

- A common misunderstanding is that seeds are not living things because they do not actively show any characteristics of living things. Seeds are living. They contain an embryo that is capable of germinating to produce a new plant. Seeds use small amounts of stored energy to stay alive and are ‘waiting’ for good conditions to begin to grow. Most seeds need water and certain temperatures to begin to grow.

Homework ideas

- Questions 1–5 in the Learner’s Book. Discuss answers in class at the start of the next lesson. Allow learners to check their own answers for self-assessment.

Answers to Learner’s Book questions

- 1 Seeds need to absorb water to start the growth process/germination.
- 2
 - a The first root is the first part to grow.
 - b The first root grows downwards to get water and to anchor the new plant in the ground.
- 3 The first shoot grows upwards. It needs to break through the soil to get light.

- 4 The new leaves start to grow above the ground because they need light so they can make food for the plant.
- 5 The seed shrivels and becomes small after germination because the food store gets used up during germination.

Answers to Activity Book exercise

- 1 Correct order of pictures is:
 - i Seed coat splits.
 - ii The first root grows.
 - iii The first shoot grows.
 - iv The first leaves grow.
 - v Leaves get bigger and seeds shrivel.
- 2 Yes. The seed absorbs water and swells.

Topic 1.3 Investigating germination

In this topic, learners conduct investigations to determine the conditions needed for seed germination.

Learning objectives

- Investigate how seeds need water, warmth and air for germination but not light.
- Use knowledge and understanding to plan to carry out a fair test.
- Discuss the need for repeated observations and measurements.
- Make predictions of what will happen based on scientific knowledge.
- Collect sufficient evidence to test an idea.
- Interpret data and think about whether it is sufficient to draw conclusions.

Ideas for the lesson

- Start the lesson with a discussion about what people and pets need for growth. Explain that plants also have needs for growth. Ask learners for ideas about what seeds need to make them start to grow.
- Use Worksheet 1.3. Discuss the statements made by the learners in the picture on the worksheet. Record your learners’ ideas and suggestions in a mind map.
- In Activity 1.3a, learners make observations and suggest a reason for them based on deduction.

- Next, start Activity 1.3b. Learners can set up their jars of seeds and draw their observation tables.
- After eight days, learners should answer the questions relating to the activities on page 11 of the Learner’s Book. The questions address learners’ understanding of a fair test and get them thinking about the need for repeated observations and measurements. They also make predictions and use these predictions to plan their work.
- Exercise 1.3 in the Activity Book consolidates the learning from this topic.

Notes on practical activities

Activity 1.3a

Each group will need:

- ten small seeds such as mung (moong) beans or lentils
- paper towel
- water
- two small plastic bags
- two bag ties
- a drinking straw.

Learners should work in groups of 4 or 5.

Use smaller seeds as they will germinate quickly. Radish and cress seeds germinate very quickly, so you could use them as alternatives if they are available. The plastic bags must be big enough for a saucer to fit into. You could use Petri dishes instead of saucers, if they are available. Demonstrate how to suck the air out the plastic bag with the straw. Learners should hold the bag closed around the straw while they suck out the air. They must quickly pull out the straw and tie the bag without getting any air into it.

The results for Activity 1.3a should be as follows. After two days the seeds in the bag containing air germinated. No seeds germinated in the bag without air. The reason is that seeds need air to germinate.

Activity 1.3b

Each group will need:

- twenty seeds
- four glass jars
- soil or sawdust
- water
- a measuring cup or cylinder.

Learners should work in groups of 4 or 5.

Before the lesson, set out the materials so that learners can collect them from a central point. Fill the jars with sand or sawdust in advance. Use seeds that germinate fairly quickly and are large enough to be observed easily. Kidney beans, peas or seeds of similar size are suitable. The seeds will take a few days to germinate. Carry on with the next topic during this time. Demonstrate how to place the seeds against the sides of the jar. The seeds must be visible so that their growth can be observed. You can use paper towel or cotton wool on saucers instead of soil or sawdust in jars. As these materials dry out quickly, learners must keep the relevant seeds moist at all times. You could extend the activity by getting learners to draw bar charts of the results they obtain.

Possible results for Activity 1.3b are given here, but the learners may come up with different numbers of germinated seeds.

| Days | Number of seeds germinated | | | |
|------|----------------------------|------------------------|--------------------------|------------------------|
| | Moist soil in warm place | Dry soil in warm place | Moist soil in cold place | Dry soil in cold place |
| 2 | 2 | 0 | 0 | 0 |
| 4 | 4 | 0 | 1 | 0 |
| 6 | 5 | 0 | 2 | 0 |
| 8 | 5 | 0 | 3 | 0 |

- 1 Give jars the same amount of water, use the same number of seeds, use same amount of soil in each jar
- 2
 - a More seeds germinated in the jar with moist soil in a warm place. No seeds germinated in the jars without water. The germinating seeds in the jar with moist soil in a warm place grew best. The seeds in moist soil in a cold place did not grow as well. The seeds in the other jars did not grow.
 - b Reasons could include: seeds need water and warmth to germinate and grow.
 - c Using more seeds would give better results because it would show that the growth patterns of the seeds observed under different conditions can be repeated.
- 3 No. There is air all around us and in soil. None of the seeds had any air.
- 4 Seeds need water, warmth and air to germinate.

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- 5 a No – light is not needed for germination.
- b Use two jars, each with the same number of seeds, in moist soil. Place one jar in the dark, inside a cupboard. Place the other one in the light in the same room, but not in a warmer place. Observe the differences between the seeds in the two jars every two days for eight days.

Worksheet 1.3

Each pair or group will need:

- big and small seeds
- glass jars
- soil
- water
- saucers
- paper towel
- water.

Learners should work in pairs or small groups.

Get learners to plan the investigation. Set out the materials they will need and allow them to choose how to set up the experiment. This can be done in one lesson. To make the test fair, they should give the big and the small seeds the same amount of water and put them in the same place so they get the same amount of warmth and air.

Learners will need to leave the seeds for about two days before the small seeds start to germinate.

Get learners to check their seeds every day until all seeds have germinated. During this time the seeds must be kept moist. Learners should discover that larger seeds take longer to germinate. Once the seeds have germinated, learners can decide if their prediction was correct or not and form a conclusion.

Alternative activity or demonstration

This is an alternative to show that seeds need air for germination. You can use this demonstration to introduce the idea that oxygen in air is necessary for living organisms to stay alive and grow.



Do not allow learners to work with the lighted candle.

- Place seeds on a damp paper towel on two saucers as in Activity 1.3a.

- Light a candle and place it next to one of the saucers.
- Place a bell jar or large glass jar over each saucer.
- Let learners observe that the candle goes out in the one jar. Explain that this is because the candle uses up the oxygen gas in the air inside the jar. The air in the other jar still contains oxygen gas.
- Leave the jars in a warm place for two days and then observe how many seeds germinated in each jar.
- Discuss the observations. You could explain that living things need the oxygen in air. Seeds therefore need the oxygen to germinate and grow. When there is no oxygen in the air, seeds cannot germinate.

Internet and ICT

The website: <http://www.buzzle.com/articles/steps-of-seed-germination.html> gives a good overview of factors and processes involved in germination.

Assessment

- Can learners identify the conditions (factors) that seeds need for germination? Have a quick question-and-answer session in class to find out. Name each factor, and ask the class to say if it is needed for germination or not. You can include some other factors that have no effect such as day length, type of soil, and how deep the seed is planted.

Differentiation

- Lower achieving learners will benefit if you sit down with them on a one-on-one basis to make sure they understand the lesson. After answering their questions and helping them to get started, check back occasionally to make sure their progress is on track. They can also work in mixed ability groups with more able learners who can provide peer support.
- Higher achieving learners could do Worksheet 1.3 in which they plan an investigation. This activity addresses learners' understanding of fair tests, their ability to use existing knowledge to make predictions and collect sufficient evidence.