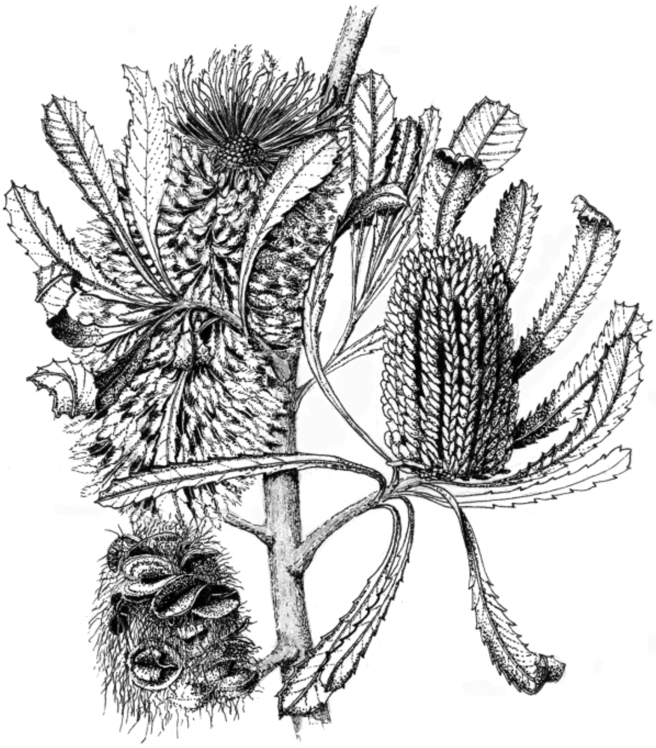
Australian Curriculum
Biological Science 9.1.2

Ecology



2013 Edition

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Ecology

FIELDWORK

Terms used in Ecology

Abiotic factor	A non-living component of the environment e.g. soil type.
Adaptation	Any feature of an organism that helps it to survive.
Biological control	Using a natural predator to control an introduced pest species.
Biomagnification	The progressive accumulation of pesticides and heavy metals in the organisms forming a food chain.
Biosphere	The part of the Earth where life is found.
Biotic factor	A living component of the environment e.g. food, disease.
Carnivore	An organism that eats only other (living) animals.
Community	Interacting populations of different species in a particular place at a particular time**.**
Consumer	An organism that cannot make its own food, and therefore relies on pre-existing sources of food (also known as a <u>heterotroph</u>).
Decomposer	An organism that feeds on decaying matter (e.g., bacterium, fungus).
Ecology	The science which studies the interactions between organisms and their surroundings.
Ecosystem	A community together with the abiotic (non-living) factors which affect the members of the community.
Environment	All the factors in the surroundings that affect the survival of an organism.
Habitat	An organism's living place (its "address")**.**
Herbivore	An organism that eats only plants.
Niche	An organism's role in the community (its "profession"), usually described in terms of its trophic level e.g. carnivore.
Omnivore	An organism that eats both plant and animal matter.
Population	Interacting individuals of one species in a particular place at a particular time.
Producer	An organism that can make its own food, also known as an <u>autotroph</u>.
Scavenger	An organism that feeds on dead animals (e.g., vulture, Tasmanian Devil).
Species	Individuals of a species interbreed under natural conditions and produce offspring that can themselves interbreed.
Succession	Changes made to an environment by one community of organisms enable a new community to establish and replace the first community.
Trophic Level	The position of an organism in a food web, e.g., producer, herbivore.

Ecology

> ***Ecology is the study of the interactions that occur between different plants, animals and their non-living surroundings.***

Why Study Ecology?

The study of our environment and an awareness of the relationships between living organisms and their surroundings are important for a number of reasons.

- We need a society to be environmentally aware. You are the decision-makers of the future and should understand how decisions made could affect our environment for many years to come.

- Our Earth is what is known as a 'closed system' in that energy can enter and leave, but there is very little exchange of matter with systems beyond Earth. This means that we have limited supplies of resources such as water and minerals. As the population continues to grow, humans throughout the World need or want more land to develop. We need to be able to develop and use our resources in such a way that they last for many generations to come.

- By identifying changes in our environment, particularly those brought about by humans, we can predict, and possibly prevent, problems that may occur in the future.

- By identifying increased levels of pollution we may be able to find the source and stop, or at least reduce, the problems associated with pollution.

- We may be able to correct mistakes made in the past, e.g., by cleaning up a badly polluted area or by replanting cleared areas with native bushland.

QUESTIONS

1. Consider the definition for ecology given at the beginning of this page. What do you think is meant by the "ecology triangle"?

2. Summarize the importance of having an understanding of ecology.

THE AUSTRALIAN ENVIRONMENT

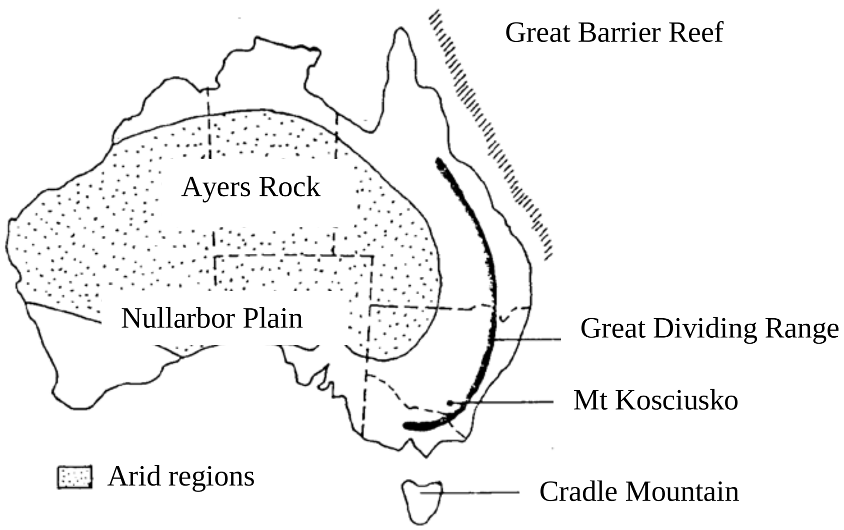
Introduction

For the student of ecology, Australia provides unique plants and animals and many fascinating environments for study. Visitors to Australia have long marvelled at animals such as the kangaroo, koala, echidna and platypus. Our enormous range of eucalypts and wattles are interspersed with a great variety of smaller plant species, including banksias, bottlebrushes and kangaroo paws.

Much of the variety of plant and animal life in Australia is due to the wide range of environments. The spectacular scenery around Uluru (Ayers Rock) in central Australia contrasts with the landscape of alpine parks in Tasmania and New South Wales. Coastal areas provide heathland, sandy beaches, mangroves and rocky shore communities. With Australia's enormous coastline, marine communities, including the Great Barrier Reef, provide unique opportunities for research.

Today, much of Australia is arid or semi-arid, and many types of Australian animals and plants have special features (adaptations) for coping with lack of water. For example, some marsupial mice do not need to drink at all, and many eucalypts have leaves with a thick waterproof covering on their surface to reduce water loss.

Australia is largely a flat area of land with the mountains of the Great Dividing Range running down the east coast. Most rain falls on this range, especially on the eastern side. Parts of Tasmania and south-east Australia contain temperate rainforests, whilst northern Australia contains tropical rainforests and the flora of Western Australia ranges from plants of the karri forests of the southwest to those of the wattle scrub, mulga and spinifex of the desert regions.

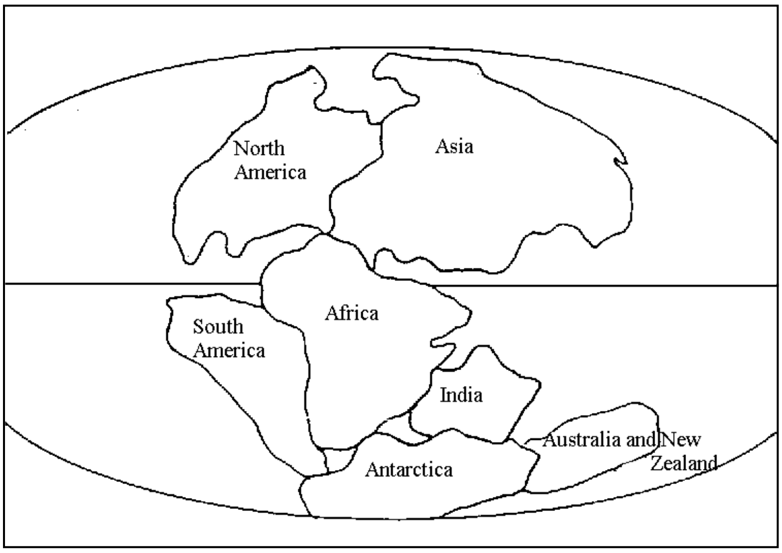


Australia in the past

In order to explain the uniqueness of Australian flora and fauna, it is necessary to look at the geological history of Australia. While the exact history of continents is not fully understood, certain ideas are accepted by many geologists. It appears from fossil evidence and patterns of rock distribution, that the Australian continent was once linked with Antarctica, India, Africa and South America some 100 million years ago to form a 'super continent' called Gondwanaland. Groups of organisms spread out over the huge landmass. Various dinosaur species roamed this landmass. Then the continents began to drift apart, and Australia was isolated 15 to 40 million years ago.

Except for some organisms that could have colonised Australia by air or sea from Asia, particularly in periods when a land bridge joined Australia and Asia (during ice ages, for example), most of the Australian flora and fauna developed in isolation from other groups of plants and animals.
In recent geological time, Australia has undergone quite sudden changes in climate. Because of Continental Drift, the climate has changed from cool and moist to cool and dry, then to warm and dry. Parts of Australia have turned from tropical rainforest to areas of extreme dryness. This would have led to the extinction of many plants and animals.

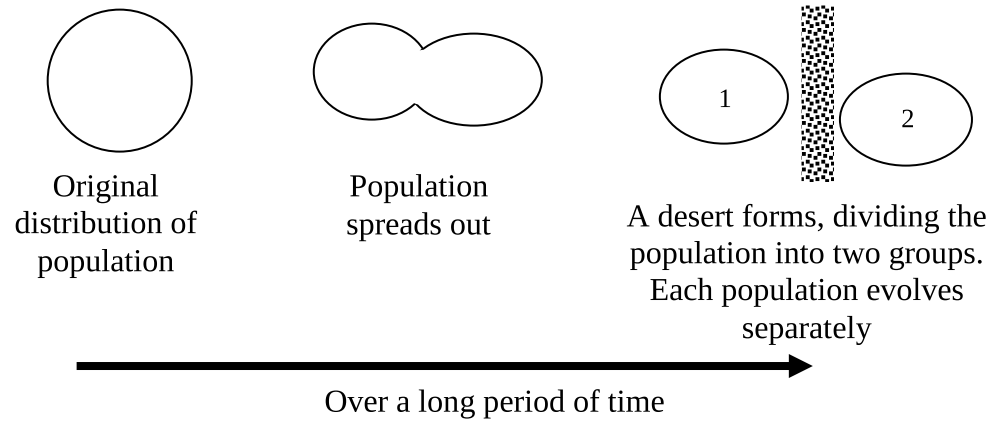
Until about 3500 years ago, very large marsupial mammals such as 'giant' kangaroos and wombats were widespread, but these animals are now extinct. There is a lack of early mammal fossils, and therefore many questions remain unanswered, but it is fairly clear that, as Australia became separated from Gondwanaland, some of the animals on it were able to survive climatic changes and develop separately, forming a unique set of species.



The position of the continents 200 million years ago

Fossil evidence, in the form of pollen grains, supports the Gondwanaland origins of Australian flora. For example, members of the *Proteaceae*, a family of flowering plants which includes banksias and grevilleas also exist in South America, New Zealand and southern Asia, but plants of this family are not found in the northern hemisphere.

Many plants found in eastern parts of Australia are also found in western parts, but there are many species which are not common to both areas. This is probably because related plants were separated by the formation of the Nullarbor Plain. This plain came into existence about 20 million years ago. Such geographic isolation has resulted in the gradual evolution of separate species in eastern and western parts of Australia.



QUESTIONS

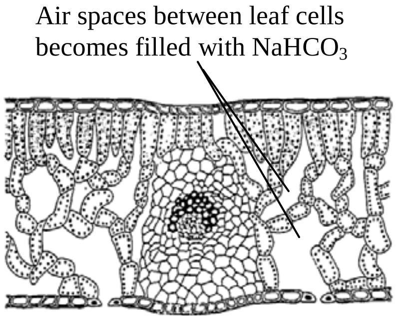
1. List five different kinds of natural environment found in Australia.
2. Much of Australia is classified as arid. What does this mean? Use the map of Australia's arid zone to estimate the percentage of arid land in the continent.
3. Give three examples of Australia's unique flora and fauna, other than those mentioned in the passage.
4. What evidence is there to suggest that Australia was once part of the continent called Gondwanaland?
5. How did Australia become separated from the rest of Gondwanaland?
6. What kinds of organisms might be able to cross
   a) a land bridge?
   b) a sea barrier between neighbouring continents?
7. A group of organisms can be separated into two or more groups when the sea divides the group. In what other ways can a group of organisms be separated from each other?
8. Explain why some plant species that are found in Western Australia are not found in eastern Australia.

ENERGY RELATIONSHIPS IN PLANTS AND ANIMALS

ll living organisms require energy throughout their lives. This energy may be used for a variety of purposes including body movement, growth and repair, heartbeat, digestion of food and for nerve impulses. All of the energy in your body was originally energy in plants, because all of the food you eat can be traced back to plants, whether you eat plants directly (e.g., fruit and vegetables) or eat animals that have eaten plants (e.g., when you eat steak or chicken).
Plants don't make their own energy, but they do make their own food, using the energy in Sunlight. The process by which plants make their own food is called **photosynthesis.**

Photosynthesis is a process in which plants convert light energy (sunlight) into usable chemical energy in the form of carbohydrates. Last year you carried out an experiment in which you tested a green leaf for the presence of starch. Starch is a means of storing the sugar made during photosynthesis, but this sugar is not the only product of photosynthesis. In this experiment you will look for evidence of a gas being produced during photosynthesis.

ACTIVITY 1: PHOTOSYNTHESIS IN LEAF DISKS



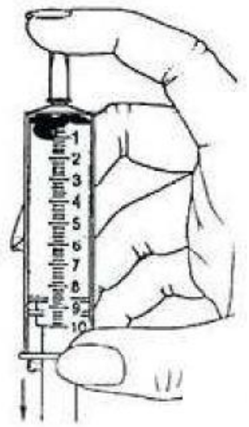
In this experiment, the spaces between the cells of leaf disks are filled with a sodium bicarbonate solution, which causes them to sink in the solution. The leaf disks are then exposed to light and observations are made as the cells undergo photosynthesis.

MATERIALS:

- 0.2% sodium bicarbonate ($NaHCO_3$)
- Liquid dish soap
- Eyedropper
- Plastic syringe (20-65 mL)
- Plastic spoon or straw (for stirring)
- Leaf material e.g. spinach
- Hole punch
- 250mL beaker
- 2 small beakers (150mL)
- Stop watch
- Light source e.g. fluorescent tube
- Paper towels

PROCEDURE:

1. Using a one-hole punch, cut 20 leaf disks from young actively growing leaves.
2. Add 150 mL of the $NaHCO_3$ solution to the 250mL beaker.
3. Use an eyedropper to add about 2 drops of dish detergent to the solution and stir gently. There should be no bubbles afterward.
4. Remove the plunger from a large clean syringe. Place 20 leaf disks into the body of the syringe. Be sure the leaf disks are near the tip of the syringe as you re-insert the plunger so as not to damage the disks.
5. Insert the tip of the syringe into a beaker of 0.2% $NaHCO_3$ solution and draw 15-20mL into the syringe. The leaf disks should be floating at this time. If your syringe is smaller than 60ml fill it about one third full.
6. Hold the syringe tip upward and expel the air by depressing the plunger carefully. Stop before solution comes out the tip.



7. Seal the tip of the syringe using the index finger of your left hand and hold tightly. Pull back on the plunger creating a partial vacuum within the syringe. If you have a good seal it should be hard to pull on the plunger and you should see bubbles coming from the edge of the leaf disks. Hold for a count of ten.
8. Simultaneously, release your index finger and the plunger. Some of the leaf disks should start to sink. Tap the side of the tube or shake gently to break any bubbles on the edges of the disks.
9. Repeat steps 6 and 7 until all the disks sink. Do not overdo these steps!! You have been successful if the disks sink to the bottom. Don't repeat "just to be sure" as it is possible to damage the cells of the leaves.
10. Remove the plunger from the syringe and pour the solution containing the disks into the 150 mL beakers and add the remainder of your solution equally to both beakers. There should be 10 disks per beaker. Make sure they sink to the bottom.
11. Cover ONE of the beakers to block light from the leaf disks. Place the second beaker under a light source, approximately 10 cm below the light. Begin timing the experiment as soon as the light is turned on. Record your observations in a suitable table in your notebook.
12. Notice what is happening to the leaf disks as photosynthesis proceeds. Continue to record your observations in a table similar to the one below for 15 minutes. After each time check, tap the side of the beaker to make sure the disks are not "sticking" to the container walls. Note: Check the covered beaker quickly to avoid light exposure. When instructed, clean the lab equipment and dispose of solutions in the sink drains.

Time (Minutes)	Number of Disks Floating (Light)	Number of Disks Floating (Dark)
0		
1		
2		
3		
4		

(After 15 minutes consider the experiment over and that no more disks will rise.)

QUESTIONS:

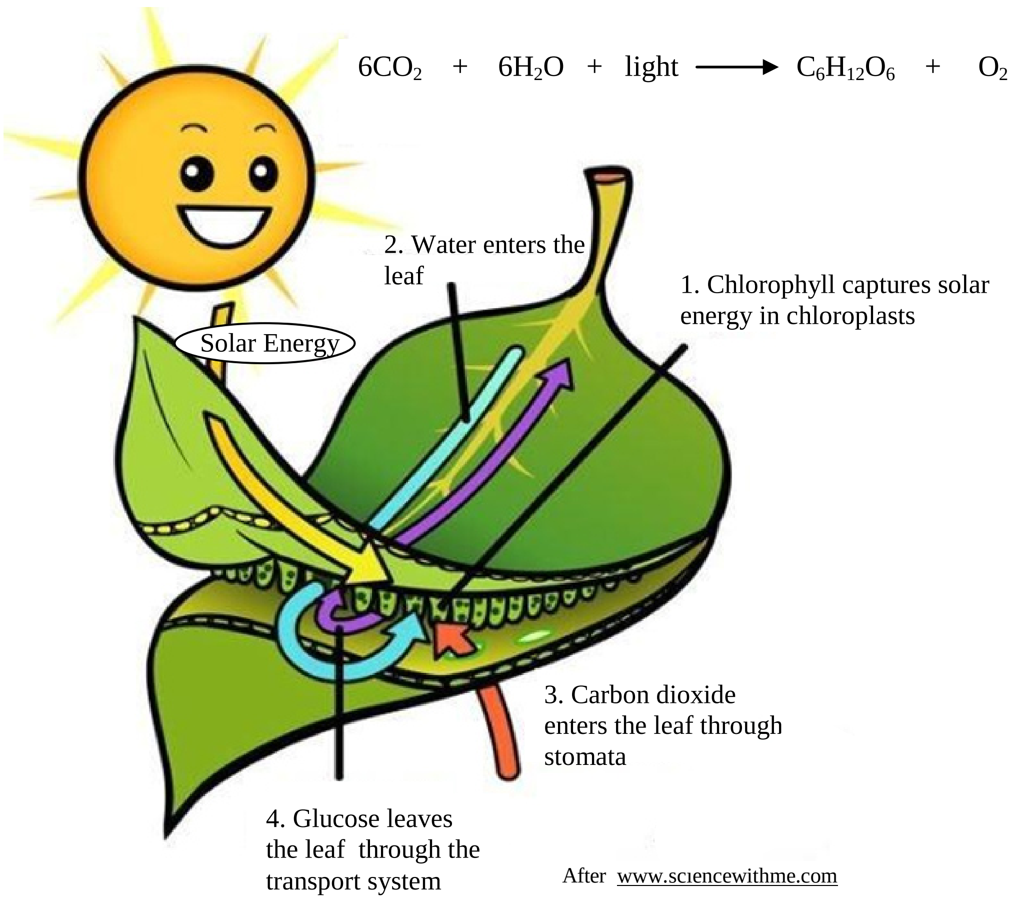
1. What is the independent variable in the experiment?
2. What is the dependent variable?
3. Graph the results from the light and dark treatments.
4. What problem/question did you answer in this experiment?
5. Why was detergent added to the solution
6. Why was sodium bicarbonate ($NaHCO_3$) added to the solution?

7. Explain why it was important to keep one beaker covered during the experiment.
8. Describe and explain the relationship between the number of disks floating and time, as shown on the graph.
9. Did any leaf disks float in the dark treatment? If so, what may explain this result?
10. What process cannot occur in the dark treatment?
11. Explain the changes that occurred within the leaf tissue that allowed the leaf disks to rise to the surface.

CHALLENGE

Think about another variable that you could test to determine its affect on photosynthesis. Plan an experiment to test how the variable affects photosynthesis, listing your hypothesis, materials, procedures, data charts and results that might support your hypothesis. Your teacher may let you carry out your experiment if time permits.

Based on an activity posted by the Arkansas Department of Education
http://www.biologyjunction.com/5b-photoinleafdiskslesson.pdf

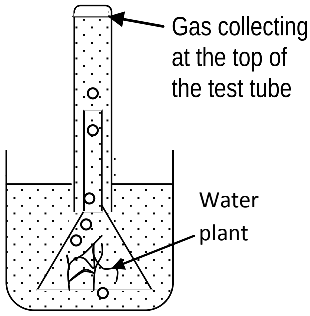


After www.sciencewithme.com

ACTIVITY 2: BLOWING BUBBLES

Have you ever sat on a bright Sunny day and watched plants in a fish tank or algae on the surface of a pond? If so, you may have noticed bubbles of gas around the plants. This gas is a product of the process of photosynthesis. How could the type of gas produced by the leaf during photosynthesis be tested to see if it really was oxygen?

The apparatus shown was set up and then placed in bright light for several days. The plant material used was Canadian Pondweed, a declared pest species in Australia because of its tendency to choke ponds and lakes by its very rapid growth. It is well known to produce lots of bubbles from its leaves during a period of light. Over several days it filled the test tube, displacing the water from it. What is this gas?



Testing the gas (Day 3)

When a glowing splint was inserted into the unknown gas it glows more brightly then burst into flame. What was the gas?

Testing the rate of photosynthesis

The number of bubbles produced in a given time can be used to compare the rate of photosynthesis under different conditions. A student set up apparatus similar to that shown and counted the number of bubbles produced in a minute with the light at various distances from the beaker. The experiment was repeated three times, and averaged results are shown in the table below:

Distance of light source from beaker (cm)	Number of bubbles produced per minute
10	82
20	22
30	5
40	2
50	1

Plot these data on a piece of graph paper, joining points with a straight line.

QUESTIONS

1. Why did the student repeat the experiment three times?
2. What is the relationship between distance of light source and rate of photosynthesis as shown by the line on your graph?
3. Would any factor other than light intensity vary as the lamp was moved further from the beaker? If so, do you think the student should be concerned about this?

APPLICATIONS AND ISSUES

1. The atmosphere of Earth soon after it was formed contained no oxygen. The present atmosphere of Earth contains approximately 21% oxygen.
   (a) Suggest where the oxygen came from.
   (b) If the amount of oxygen in Earth's atmosphere is more or less constant, what does this suggest?
2. In what ways does animal life on Earth depend on plant life, and on the products of photosynthesis in particular?
3. The energy you use to write down answers to these questions was not long ago energy in the Sun. Explain this statement.
4. Many scientists believe that the Earth's atmosphere is gradually becoming warmer because we are releasing increasing amounts of carbon dioxide into the atmosphere by burning fossil fuels such as oil and coal. Global rates of photosynthesis are expected to rise as a result of this. Explain why this could be so.
5. Write a word equation to summarise the process of photosynthesis.

ACTIVITY 3: ENERGY RELEASE FROM FOOD

The solar energy trapped by green plants during photosynthesis is converted to chemical energy. The process of **cellular respiration**, which occurs in all living organisms 'unlocks' this energy and makes it available for such essential processes as growth, repair and movement. When plants respire, they use the food they have produced during photosynthesis; when animals, fungi and other non-photosynthesising organisms respire, they use the food they have gained by eating other organisms.

AIM: To investigate the production of carbon dioxide by humans.

MATERIALS: (per group)

- two wide bore test tubes
- one set of 'breathing apparatus'
- lime water

METHOD:

Half fill each of the two test tubes with limewater.
Place the rubber bungs of the breathing apparatus into the mouths of the test tubes. Check that the openings of the longer capillary tubes are immersed in the limewater; if they are not, and then add sufficient limewater to ensure that they are immersed. Record the colour of the limewater in each test tube.
One volunteer from each group should now use the plastic tube to **VERY GENTLY** breathe in and out through the apparatus for about 30 seconds. Notice that when the person breathes out, the air appears to pass through a different boiling tube from that when he/she breathes in.

QUESTIONS:

1. Make a sketch of the apparatus, using arrows to indicate the direction of airflow through the apparatus.
2. Record the appearance of the limewater at the end of the experiment, compared to that at the beginning of the experiment. Remember that lime water tests for the presence of carbon dioxide.
3. How did the amount of carbon dioxide in the air breathed in compare with the amount in the air breathed out?
4. Where must this additional carbon dioxide have come from?
5. If the carbon dioxide was the product of cellular respiration, how did it get to the air in the lungs?
6. The percentage of carbon dioxide in the air we breathe has increased from 0.03% to 0.035% in the last century. What is the most likely origin of this additional carbon dioxide?
7. It has been suggested that we should plant more trees in order to reduce global levels of carbon dioxide. Explain why planting trees would have this effect.

FOOD CHAINS

While green plants act as producers by trapping the energy of Sunlight in food molecules during photosynthesis, animals have to get their energy either by eating plants directly or by eating other animals. A simple model that shows a single feeding relationship is called a food chain.

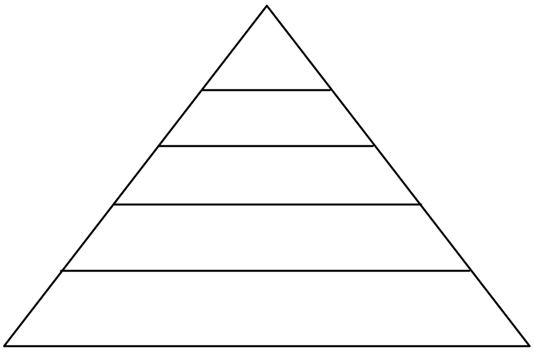
Plant nectar → moths → lizard

In the food chain shown, some of the energy taken in by the moths during their lives and built into their bodies as proteins and fats will pass to the lizard. The arrows show the direction in which the energy passes.

The moth in this chain is acting as a **1st order consumer** or **herbivore** when it eats plant matter directly.
The lizard is acting as a **2nd order consumer** or **carnivore** when it eats the moth.
Other food chains might show higher order consumers.

ACTIVITY 4: A FOOD PYRAMID

Another way of representing a food chain is by using a food pyramid. In a food pyramid living organisms which make their own food, the **producers,** are at the bottom of the pyramid and the animals which eat them and each other, the **consumers,** are on the higher levels of the pyramid.



The diagram shows a blank food pyramid. The pyramid represents a food chain, which contains fish, ducks, algae, mosquitoes and dragonfly larvae.

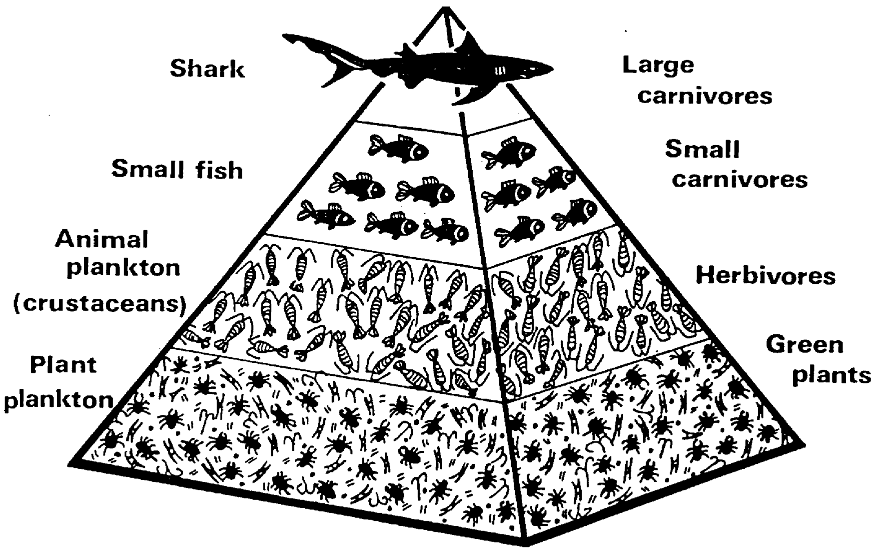
Copy the pyramid into your book and label each section with the living organism it represents.

1. Explain briefly what the pyramid tells us.
2. What are producers and consumers?
3. Which of the living organisms in this pyramid are producers and which are consumers?
4. Because a food pyramid is a food diagram rather than an energy diagram, the Sun is not shown. However, if we were to draw an energy pyramid, where would the Sun be?
5. Draw another food pyramid to represent a different food chain.

ACTIVITY 5: A FOOD CHAIN MOBILE

Find diagrams of various living organisms in magazines and books and copy them or cut them out (ONLY if the magazine is yours and you don't mind it being damaged!) or redraw them on paper. Stick them on to cardboard and then use them to make a mobile to represent a food chain. Start the mobile with producers at the bottom. Organisms at the same level in the food chain should be at the same level in the mobile. Your completed food chain mobile should be as colourful as you can make it and might make a good educational present for a small relative or the child of a friend.

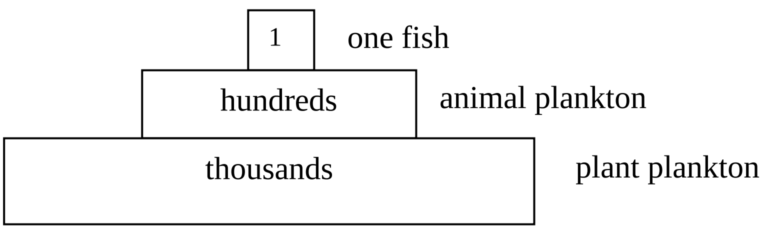
MORE ON FOOD PYRAMIDS



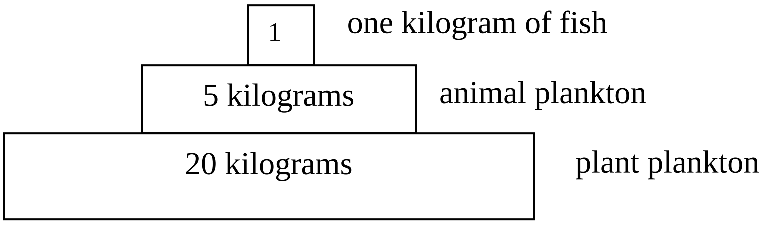
Pyramids show the importance of each level of organisms in the ecosystem.
The producer organisms form the base of the pyramid, and the rest is made up of successive consumer levels.
There are three types of pyramids:

- A pyramid of numbers.
- A pyramid of biomass.
- A pyramid of energy.

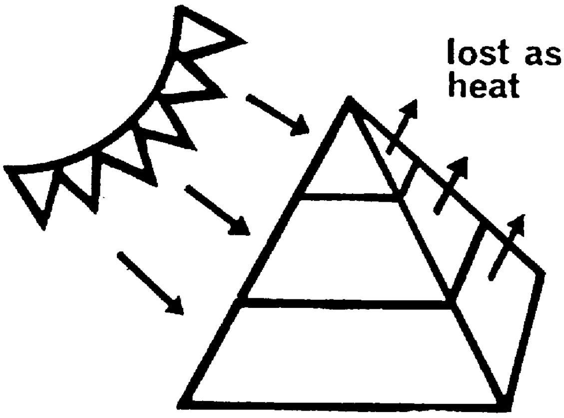
A **Pyramid of Numbers** shows the number of organisms at each level at any one time. There are lots of producers and progressively fewer consumers up the pyramid.



A **Pyramid of Biomass** refers to the total amount of dry mass accumulated by living organisms over an area at each level at any one time.



A **Pyramid of Energy** shows the transfer of energy through the ecosystem. About 1 per cent of the Sun's energy that reaches Earth is used by green plants, which make active use of most of it. Only a small part remains to be stored in the plant.
The stored energy is passed on as food to the next level. At each level, most of the energy is **used** by the organisms at that level and lost as heat, leaving little to be passed on. As a result, each level has less energy available to it than the previous level. Therefore, there are fewer organisms at the top of the pyramid - there is less energy available for life.

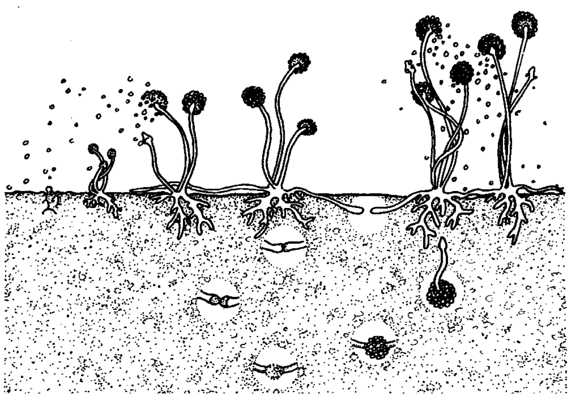


Energy pyramids are always shown in units of mass, e.g. kilograms. This reflects the amount of new material produced at each level in a unit of time, or productivity. The amount that can be produced relates to the amount of energy available at each level.

THINK!

Decomposer organisms like bacteria and the mould fungus illustrated, are not often shown on pyramids, despite them having an extremely important part in food chains – they are at the end of **EVERY** food chain.

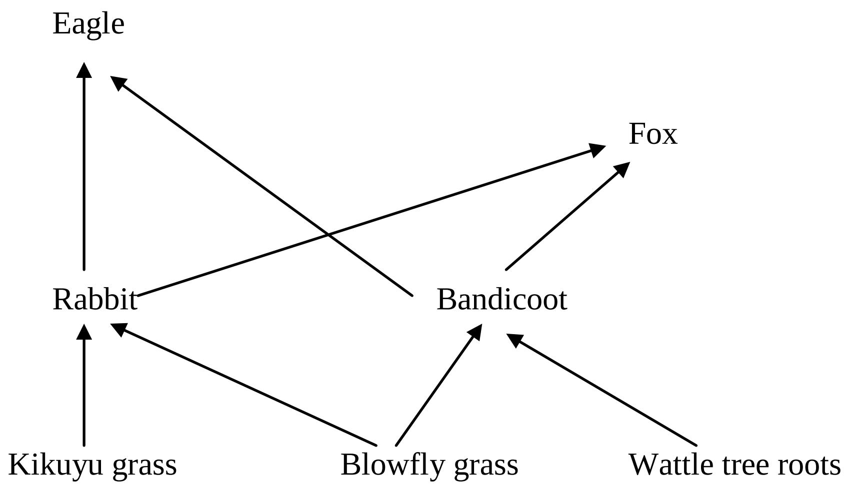
Why do they end every food chain?



FOOD WEBS

If you think about the foods that you eat, you will realize that you are part of a number of interlocking food chains. When all the food chains for a community are shown linked together a **food web** is formed.
The various levels in the food web are called **trophic** levels- plants capture the Sun's energy and this energy passes to herbivores and then to carnivores.
Decomposers complete the flow of energy through the community.

This exercise refers to the food web drawn below.



Blowfly grass:
Briza maxima

QUESTIONS

1. What two things do the arrows show?
2. List the prey species of the eagle?
3. What are the predators of the rabbits?
4. If the disease myxomatosis killed all the rabbits, what effect would this have on the population of the following animals? Give a reason in each case.

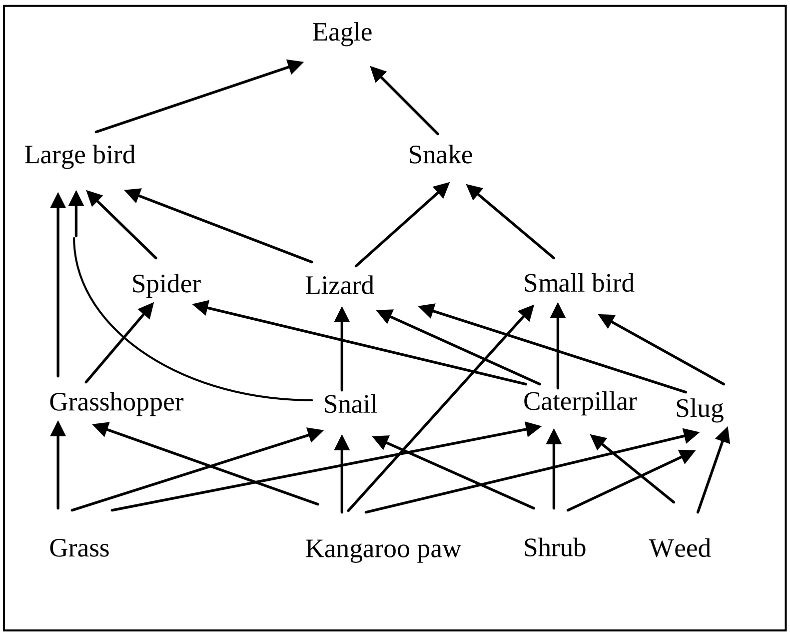
   a. Eagles
   b. Grass
   c. Bandicoots

5. Why would there be more bandicoots than foxes in this community?
6. Draw a food pyramid of one food chain in the food web.

Western barred bandicoot
Parameles bougainville

FOOD WEBS (continued)

Study this diagram of a food web then answer the questions, which follow.



1. List the producers in this food web.
2. List the herbivores.
3. What are the carnivores?
4. What is the only omnivore?
5. What is the top predator?
6. What are the predators of the lizard?
7. Which animals fall prey to spiders?
8. If all the grasshoppers and snails were poisoned, what would happen to the population of large birds?
9. If all the herbivores died, what would happen to the numbers of carnivores? Give a reason.
10. Name the species that are predators of the spider?
11. What is the food source of the caterpillar?
12. Are any decomposers shown on this food web?
13. Which organisms would best take the place of the small bird: frog, flower or fox.
14. In this community, are there likely to be more snakes or more lizards?

ACTIVITY 6: DECOMPOSERS

Detritus is the term commonly given to the dead organic matter found in an ecosystem. On land it consists of fallen leaves, twigs, dead animals and the wastes of animals. Detritus is a mass of food waiting to be eaten.

Decomposers are an important group of organisms found in the living environment. These are the organisms that get rid of all the detritus, returning the nutrients it contains back to the non-living surroundings and releasing heat in the process.

There are many different types of decomposers. They include tiny micro-organisms called bacteria, as well as fungi, such as mushrooms and moulds.

In this activity you are going to grow and study a type of fungus.

MATERIALS:

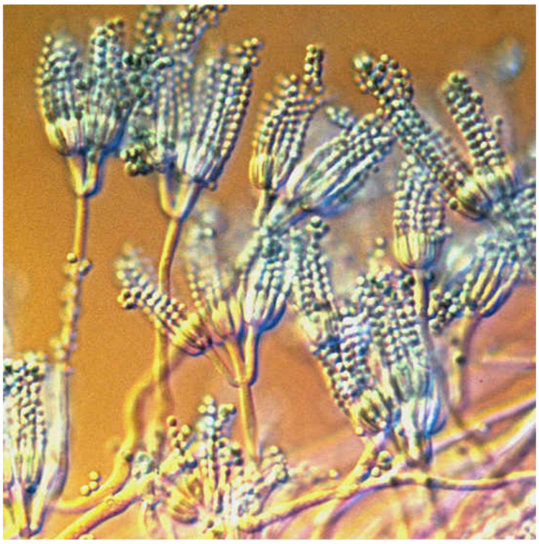
- two Petri dishes
- 4 rings of carrot
- 1 piece of bread

METHOD:

1. Boil the carrot pieces until they are soft then place them in one of the Petri dishes.
2. In the other dish place the bread, and then moisten.
3. After a few minutes put the lids on the dishes.
4. Study the dishes each day for a week. At the end of the week describe what has happened. Record your observations in a table.

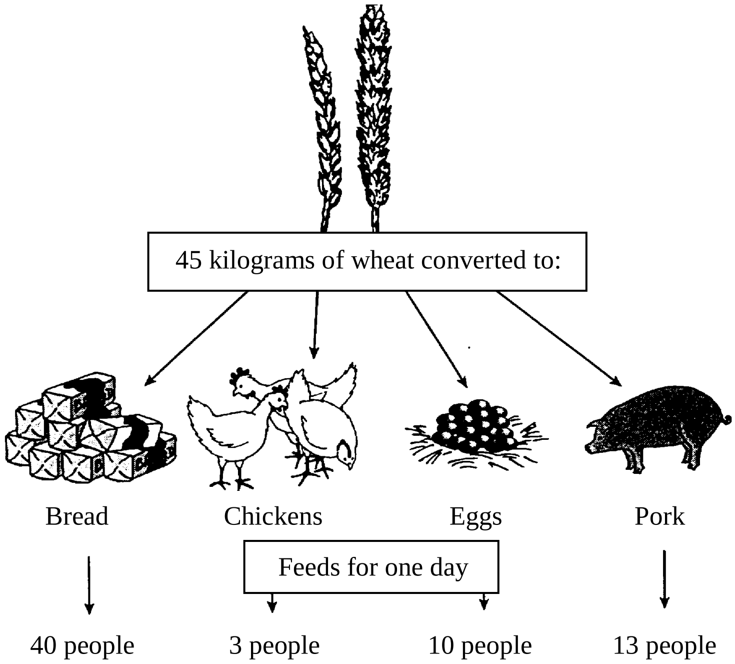
QUESTIONS:

1. Why do you think decomposers such as the fungi you have grown are important?
2. Where do you think these decomposers come from?



Penicillium notatum

ECONOMICS OF FOOD



QUESTIONS:

1. a. What does the diagram above tell us about diet and energy value from food?

   b. What would be a good title for this diagram?

   c. When the 45 kg of wheat is made into bread it will feed 40 people for one day, but eaten by a chicken and then by people will feed only three people for a day. But the original wheat contained the same amount of chemical energy in each case. Why is there enough energy for only three people in the chicken? Where has all the energy gone?

   d. Give reasons for the differences in the number of people the original 45 kg of wheat could feed through eggs and pork.

2. Getting energy **second** hand is very wasteful. Green plants capture only about one-thousandth of the energy reaching Earth from the Sun. Only about one-tenth of this energy is available to herbivores and only one-tenth of this is eventually passed on to carnivores.

   a. Draw a diagram, which contains the same information.

   b. What fraction of the amount of the Sun's energy absorbed by plants is available to a person who eats fruit?

   c. What fraction of the amount of the Sun's energy absorbed by plants is available to a person who eats meat?

   d. Why is there this difference?

   e. What is the difference between a herbivore and a carnivore?

   f. Are humans, herbivores, carnivores or something else? Explain.

ACTIVITY 7: FEEDING PATTERNS

You are going to use the results of an experiment done by someone else. We call such results second-hand data. This data can be analysed, and the results interpreted by you. Your interpretations can then be compared with those of others, or those of the original experimenters.

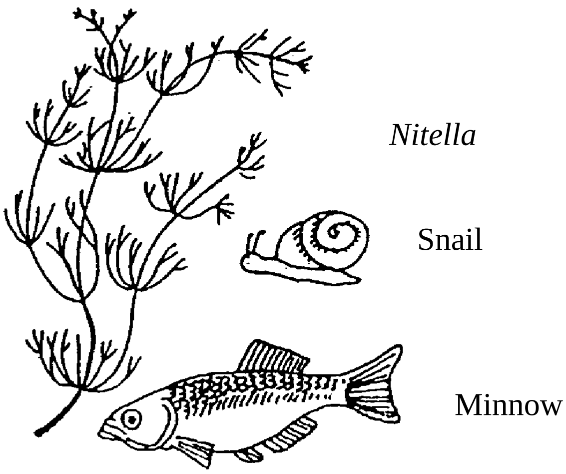
AIM: To interpret some second hand data for a community.

MATERIALS:

- A sheet of graph paper
- A pencil

WHAT TO DO: *Read this paragraph then analyse the results as directed.*

A freshwater pool was studied over two years by a group of biologists. They wanted to find out how the organisms in a simple food chain affected one another. The biologists found that the water snails ate the water plant, *Nitella*. The water snails were in turn eaten by the freshwater fish called minnows.



The biologists set about counting whole plants, snails, and fish at two monthly intervals. The results obtained are tabulated below.

Time in months	**N° of *Nitella* plants**	**N° of snails**	**N° of minnows**
0	340	150	170
2	320	180	130
4	200	250	80
6	150	230	60
8	200	170	160
10	270	150	230
12	320	130	100
14	350	150	50
16	280	200	50
18	220	310	100
20	200	210	200
22	230	150	210
24	320	130	200

ANALYSING THE RESULTS:

1. Plot a graph for each population. Put all three graphs on the same graph grid. Plot time, in months, on the horizontal axis, and number of organisms on the vertical axis.
2. What food chain relationship exists between the three organisms?
3. Which organisms are producers, and which are consumers?
4. Why did the snail population reach a peak after the *Nitella*?
5. What would happen to the graph if long-necked tortoises were introduced to the pond? (Long-necked tortoises eat plants only).

INTERACTIONS BETWEEN ORGANSIMS

In Activities 3 - 6 we have been examining some interactions that exist between living organisms, namely

- producer-consumer
- competition
- predator-prey
- decomposer - all living things

There are some other interactions that are interesting because they show more of the sometimes very close links that exist between living things, sometimes being **positive** in that the organisms concerned benefit from the relationship while other are **negative** because the relationship harms at least one of the organisms.

A. Pollination

Let's begin with a positive interaction, that between animals and plants that lead to the pollination of the flowers so that a new generation of plants, representing food for the pollinators can result.

Discuss the following questions in your group then record answers:

1. What is meant by pollination?
2. Name three different ways by which flowers can be pollinated.
3. List some of the different groups of animals that act as pollinators.
4. What features do some animals have that make them good pollinators?
5. What are some of the 'costs' to plants of relying upon animals pollinators?
6. What features of flower shape might affect pollinators?
7. How do plants attract pollinators?

Useful Websites:

http://australianmuseum.net.au/Pollination
http://australianmuseum.net.au/Bee-Scene1
http://australianmuseum.net.au/movie/Buzz-pollination

B. Parasitism and disease

Both of these interactions between organisms are always negative. The parasite or disease organism benefits at the expense of the host organism upon which it feeds.

Not all diseases (e.g., cancer or arthritis) are caused by parasites, but all parasites cause disease. Some parasites and disease causing organisms are listed below. Research one of these as directed by your teacher or another of your own choice that is not listed below and make notes about it so that you might report back to the members of you group or class. Scientific names are written in italics.

1. Guinea worm	A. Rust (*Puccinia*)
2. *Giardia*	B. *Phytophthora cinnamomi*
3. Malaria	C. Mistletoe (*Amyena*)
4. Tick	D. *Rafflesia*
5. Athlete's foot (Tinea)	E. *Orobanche minor*
6. Liver fluke	F. *Nuytsia floribunda*
7. Tapeworm	G. *Cassytha*
8. *Clonorchis sinensis*	H. Human papilloma virus
9. *Ascaris*	I. *Herpes simplex*
10. *Schistosoma*	J. *Influenza*
11. Flea	K. Lyme Disease
12. *Wucheria bancrofti*	L. Ross River Virus
13. Taxoplasmosis	M. Sleeping sickness
14. Amoebic meningitis	N. Dysentery
15. Plague	O. Marri canker disease
16. Legionnaire's disease	P. Listeriosis

You must include in your notes at least the following points:

- What kind of an organism is the parasite or causes the disease.
- What is the impact of the parasite or disease on its host?
- How is it dispersed to new hosts?
- An image might be interesting to assist you in making your report.

POPULATIONS

Animals and plants do not live alone. They live with other members of their kind together with different kinds of organisms to form a **community**. You might think of your own community and the different plants and animals that form it - humans, cats, dogs, birds, insects, trees, shrubs and grasses. The kinds of organisms present and the numbers of these organisms will differ from one place to another.

The number of organisms of the same kind found living and interacting in an area at a given time is called a **POPULATION**.

A typical garden in the middle of the day, for example, might support populations of snails, slugs, slaters, butterflies, moths, lizards, New Holland honeyeaters, bees and so on. On a larger scale, we might refer to the population quokkas on Rottnest Island or the population of people in the World.

ACTIVITY 8: A POPULATION OF BRINE SHRIMP

Artemia salinas (brine shrimp) or their cousins are available, usually as eggs, from some pet shops**.** They often live in salt lakes, including those on Rottnest Island. In some parts of the World these salt lakes tend to dry out during droughts or they freeze in winter. The shrimp are useful for population studies.

AIM: To estimate daily changes in the population of a culture of brine shrimp.

MATERIALS:

- brine shrimp eggs
- non-iodized salt
- wide-necked glass jar or large Petri dish
- distilled water
- 250mL beaker
- hand lens

METHOD:

- To hatch the eggs, tip half a tablespoon of non-iodized salt, and the eggs, into a wide-necked glass jar.
- Add 250mL of distilled water and stir. Leave for 40 hours in a warm place (about $25^{O}C$). Leave the top off the jar so oxygen can diffuse into the water.
- Use a hand lens to watch the eggs hatch (have the light behind the jar). Alternatively, you could use a Petri dish and observe the hatching with a stereomicroscope.
- Tip your newly hatched *Artemia* into another jar of the same size, leaving the wastes behind, and repeat this every few days. Make sure you periodically add distilled water up to the original level to maintain the salt concentration.

- To feed *Artemia*, place 1 square cm of a lettuce or cabbage leaf into the jar. This will feed the tiny organisms on which *Artemia* in turn feed. Replace the leaf when it is used.

- Do not add too much food or the solution will become cloudy. Aeration by mixing may clear the cloudy solution because oxygen slows the growth of some of the cloud-causing bacteria on which *Artemia* feed.

- Each day count the number of brine shrimp. There may be too many to count so your group may have to take a sample and estimate the population in your sample. From this your group will need to work out a way of estimating the whole population of brine shrimp.

- Record all your results in a table in your book. Plot the data as a suitable graph.

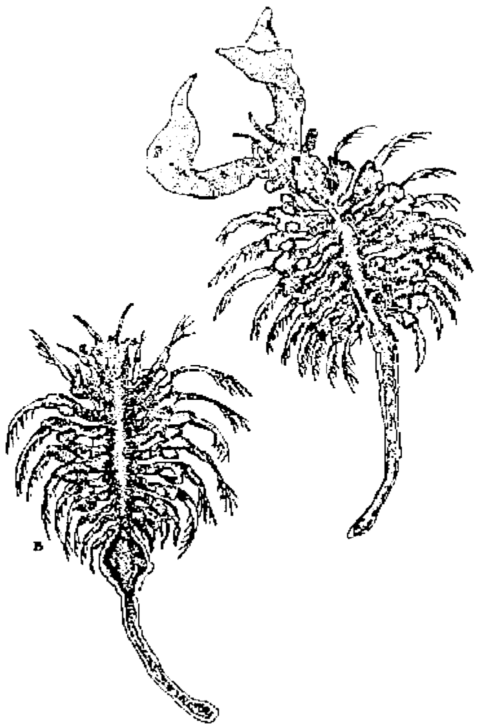
QUESTIONS:

1. How might the shrimp survive drought or freezing conditions?

2. Why do you not have to add food till after the hatching?

3. Write a paragraph to describe the changes that took place in the brine shrimp population over the period of a week.

4. Explain the changes in the population size over this time period.



POPULATION SIZE AND DENSITY

Sometimes it is easy to measure the size of a population. You might count five cabbage moths in a garden for example. At other times, it can be quite difficult to do. For example, the huge size of the population (e.g., the number of a certain single celled alga in a swimming pool); or the size of the area under consideration being very large (e.g., the population of quokkas on Rottnest Island).

If you did the activity using brine shrimp you might already appreciate the problem. Rather than measure total population size we often make use of **population density**.

DENSITY

Generally, abundance is expressed as number per square or cubic metre, or per square kilometre etc., that is, as a unit of density. The use of population density gives us an idea of whether the population is large or small.

QUESTIONS

1 If you have estimated that there are 5000 weeds in a lawn of 100 square metres, what is the density per square metre?

2 What is the density of students in your classroom?

3 If you counted 5 daisies in a square metre area, how many would you find in an area of 10 metres by 10 metres that seemed to be evenly covered in daisies?

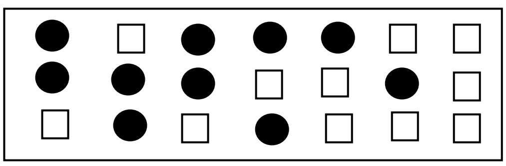
4 If you counted 18 daisies in four separate square-metre areas on the school oval, what is your estimate of the density in number per square metre?

5 If there are 20 tadpoles in 5 cubic metres of pond water, what is the density per cubic metre?

6 If you count 1000 single-cell Paramecium in a cubic centimetre of pond water, how many would there be in a cubic metre?

7 What is the density per square metre of organism ● and organism □ in the following plot?

2 metres



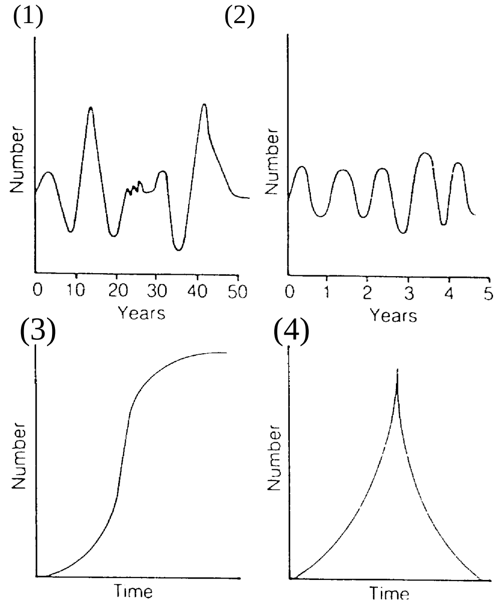
5 metres

GRAPHING CHANGES IN POPULATION SIZE

Populations do not remain constant in size. The size changes due to births, deaths as well as individuals migrating to or from an area. The factors that affect these determiners of density vary from time to time. These may be environmental factors such as light, temperature and water availability or they may be characteristic of the organism such as reproductive activity.
In many organisms, reproductive activity is seasonal. If you look at the graphs of population size against time you can identify different patterns. Before reading on, see if you can think of conditions and situations that would lead to the different patterns shown in the graphs.

Graph 1: Fluctuations

Fluctuations are irregular up and down movements. The graph (1) shows major and minor fluctuations that occur due to changes in conditions and organism activity. Fluctuations generally appear to be random and the causes may be difficult to determine. They can be caused by changes in predation, competition, climate, and food supply, for example.



Representational examples of changing populations: (1) fluctuation, (2) cycles, (3) S curve and (4) J curve.

Graph 2: Cycles

Changes may recur regularly. This may be caused by regular changes in the environment. For instance, the old and weak may tend to die in winter due to cold and because they find it hard to compete for limited food; on the other hand, births may occur in spring when water and food are abundant, and when temperatures are suitable. Such cycles may be affected by behaviour.

Graph 3: 'S' curve

The 'S' curve is typical of the introduction of one or a few individuals into a new suitable area. At first, with few organisms, reproduction leads to a slow but accelerating increase in population. Births exceed deaths. In the next phase, food and space are still plentiful and the large number of reproducing organisms leads to rapid population increase. Many more are born than die. This may be termed a **POPULATION EXPLOSION**.

In the last phase, food, space or a build up of wastes slows or limits the population size as it approaches the carrying capacity of the area. When deaths equal births, the carrying capacity has been reached and the curve is a straight line parallel to the X-axis.

Graph 4:'J' curve

The 'J' curve is actually a double J curve, where the second J is back to front. It starts as an S curve but the population explosion is so rapid that an essential resource is used up, leading to a rapid decline in population size or die off completely. Alternatively, a disease might strike a densely packed population, spreading easily, and so decimate the population; or the build-up of toxic wastes may poison the whole population.

Overpopulation and plagues

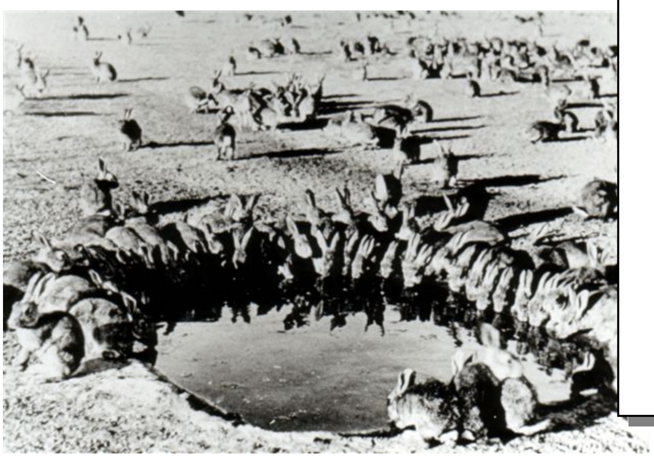
Sometimes populations grow at an explosive rate and the numbers of an animal reach plague proportions. Locust plagues are well known. These insects, under the right conditions, reproduce rapidly, eat most of the vegetation in their area, and then migrate to new places.

QUESTIONS

1. Match the these population changes to one of the graphs
   - Human population growth over the last 10 000 years.
   - Changes in blowfly population in Perth during a 10-year period.
   - Population of bacteria growing in a culture dish under ideal conditions.
   - Population of seagulls on the waterfront at Fremantle over a year.
   - Population of blue-green algae in the Canning River over a 5 year period

2. The human population is said to be undergoing an 'explosion'.

   a. List some factors that might eventually cause it to be limited.
   b. Name a country where at least one of these limits is already at work.



ACTIVITY 9: KANGAROO POPULATION

Before population densities can be taken and growth curves constructed and studied ecologists must first count the various members of a population. More often than not this means going into an area, identifying the various species of plants and animals present, and individually counting each one. Sometimes, however, this method of individually counting organisms is not possible. For example, how would you like to try counting all the ants in an anthill, bees in a hive, or kangaroos in the Kimberley?

Let's see how an ecologist would tackle a problem like counting the number of kangaroos in the Kimberley.

Firstly, the ecologist would establish the boundaries of the area to be studied and randomly choose a number of smaller areas within those boundaries. Let's assume the area of the Kimberley is 1 million hectares and that ecologists have divided it into 10 000 plots, each of 100 ha (hectares).

Secondly, the ecologist would go into some of the 100 ha plots and catch as many kangaroos as possible. Each kangaroo would be tagged and released.

Thirdly, at a later date the ecologist would go back to the same plot and again catch as many kangaroos as possible. By counting the number of tagged kangaroos in this catch the ecologists can calculate the total number of kangaroos in the area. Study the sample data below.

Number of kangaroos originally caught and tagged in the plot	Number of kangaroos caught in same plot 1 month later	Number of tagged kangaroos in second catch
110	120	30

Ratio of kangaroos caught to those tagged in the second catch:

120 caught : 30 tagged = 4:1 also written $\frac{4}{1}$

The Estimated Total number of Kangaroos in the plot would be:

(number originally caught and tagged) x (ratio of total to tagged)

$$110 \times \frac{4}{1}$$

= <u>440 per 100 ha.</u>

Fourthly, the total number of kangaroos in each of the sample plots would be combined and an average would be calculated. This will give the ecologists the average number of kangaroos per area of land (e.g. 4.4 per hectare).

The Total Number of Kangaroos	=	440 kangaroos per 100 ha.
Density of kangaroos	=	<u>4.4 kangaroos per ha</u>

Finally, the area of the study area, 1 million hectares, would be used with the number of kangaroos per area of land to calculate the total number of kangaroos in the Kimberley

Total Number of Kangaroos in the Kimberley	=	area of Kimberley	x	density of kangaroos
	=	1 000 000 ha.	x	4.4 per ha.
	=	<u>4 400 000 kangaroos</u>		

QUESTIONS

An ecologist wanted to estimate the population of rabbits on a 2000 hectare area of land. She first trapped, marked and released 25 rabbits in a 100 ha. plot. A week later she made a second capture of 36 rabbits in the same plot, which included 6 rabbits that were marked in the first capture.

a) What is the estimated population density for the area?

b) What is the estimated total population for the area?

Western Grey Kangaroo
Macropus fuliginosus

CYCLES IN NATURE

It may surprise you to know that some of the molecules in the food you eat and making up your own body were once part of a gum tree, a mouse or even a dinosaur. Matter on our Earth is cycled between the non-living surroundings and living things. Plants use carbon dioxide, water and minerals to produce complex molecules of carbohydrates, fats and proteins. These are passed on to consumers when they eat the producers. Eventually, the elements are returned to the producers by the decomposition of the consumers and their wastes. Elements that are recycled include carbon, oxygen, hydrogen, nitrogen and sulfur. Water is also recycled.

ACTIVITY 10: A MODEL WATER CYCLE

AIM: To model the cycling of water.

MATERIALS needed (per group)

- beaker
- Bunsen burner
- tripod
- gauze mat
- retort stand
- 250 mL beaker
- round bottom flask
- ice cubes

METHOD

Half fill the beaker with water. Place the beaker on the tripod and heat the water until it is steaming. Clamp the round bottom flask to the retort stand and add ice to the flask. Place the flask directly over the beaker so that the bottom of the flask is almost touching the beaker. Look at the water, the ice cubes and the bottom of the flask and record your observations.

QUESTIONS

1. Which parts of your experiment represented:

    (a) clouds
    (b) rain
    (c) lakes and oceans?

2. Explain the terms

    (a) evaporation
    (b) condensation
    (c) precipitation

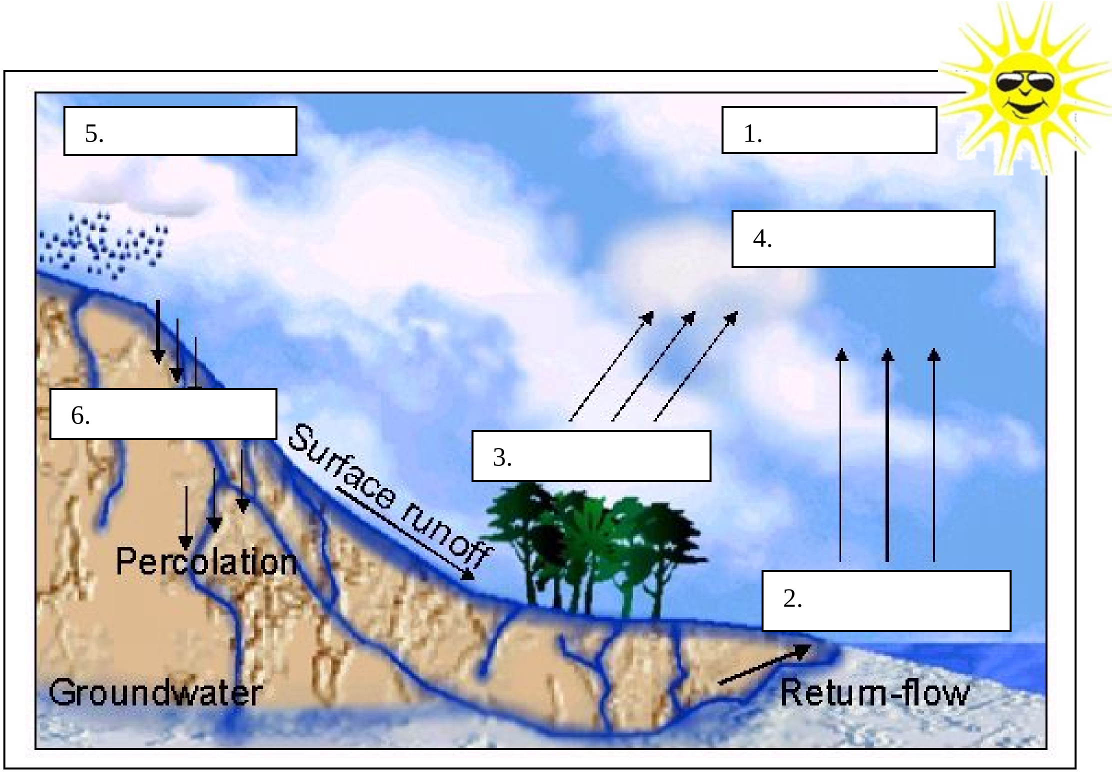
3. In nature, what heats the rivers, lakes and oceans?

4. Under what conditions will the water evaporate most rapidly?

5. Not all precipitation runs off the soil surface into rivers, lakes or dams. What else happens to rainfall?

6. It is possible that some of the water in your body was once in the leaves of a plant in the Brazilian rainforest. Explain why this may be so.

7. We can never run out of water on Earth, but already some countries have water shortages, and it is predicted that this problem will become worse next century. Explain this statement.



8. In your notebooks under the heading "Water Cycle" write a paragraph to describe the water cycle shown above. Match the numbers and the following information to help you.

   - Heat of the Sun
   - Evaporation
   - Transpiration loss from plants
   - Condensation (water in clouds, dew)
   - Precipitation (rain, hail and snow)
   - Run-off into rivers
   - Infiltration into soil

9. What other connections do plants and animals have with this cycle, that have not been represented in this diagram?

ACTIVITY 11: THE CARBON CYCLE

Plants use carbon dioxide from the air to make sugars and other compounds in the process called **photosynthesis**. These become food for consumers. Both plants and animals release energy from food in the process of **respiration**. **Carbon dioxide** is a waste of this process. Wastes of both plants and animals are food for **decomposers**. They also carry out respiration.

Other processes in nature also release carbon dioxide. The burning of wood and fossil fuels (**combustion**) for example releases large quantities of carbon dioxide into the atmosphere. In this way carbon is kept cycling between producers, consumers and the surroundings.

QUESTIONS

1. Using the preceding information, draw a diagram to represent a carbon cycle.

2. What would happen in this cycle if huge amounts of forest were

   a. Removed

   b. Removed and burned

3. WEBQUEST: Many scientists are concerned that levels of carbon dioxide in the atmosphere are gradually rising.

   a. What is the suggested cause of this rise?

   b. What is the predicted long-term consequence of this rise in carbon dioxide level?

   c. What is the link between global warming and

4. Sea level changes

   i. Loss of sea ice

   ii. Permafrost

   iii. Coral bleaching

   iv. Gulf Stream

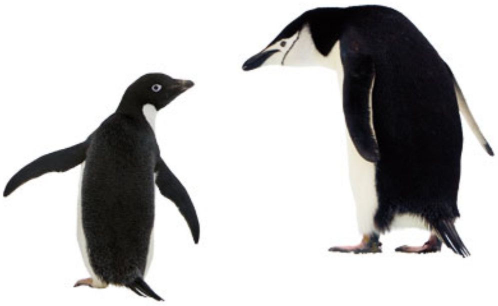
   v. Climate change

   vi. Biodiversity

5. Construct a flow chart to show the causes and consequences of the Enhanced Greenhouse Effect.

Useful Websites:

https://www.youtube.com/watch?v=nQ0It_n3bNI
https://www.youtube.com/watch?v=03xB9JbVgLE
http://www.bbc.co.uk/climate/impact/gulf_stream.shtml
http://www.wunderground.com/climate/SeaIce.asp



CHANGES IN A COMMUNITY: SUCCESSION

If we could watch a bare rock outcrop for a very long period of time, we would see a process of **succession** taking place. At first, there would be no living things to be seen on the rock, but over time, pioneer plants called lichen would colonize it. The lichen would change the chemical composition of the rock's surface until moss could grow on it. Moisture and soil particles trapped by the mosses over many years would allow other plants to grow and insects as well as microorganisms of various kinds would be able to find a home on the rock. After many more years, large areas of the rock would have been transformed by the activity of these living things, and one day a tree seed would be able to take root and grow in the newly created soil. By this time, many of the early inhabitants of the rock would have been displaced: "**pioneer**" species create conditions favourable for other types of organisms and are replaced by them. During the tree's growth, it would further transform the rock, perhaps splitting it into smaller fragments and so speeding the process of changing a large, hard mass of rock into life-supporting soil through a combination of physical and biological processes.

Stages in succession

1. An abiotic environment is colonized, and an extremely simple ecosystem typical of a young or pioneer stage of succession is created.
2. Gradually the first colonisers transform the environment, until a slightly more complex pioneer ecosystem is established.
3. This in turn creates conditions suitable for more complex ecosystems, until the most complex ecosystem the local climate and physical environment are able to sustain comes into being. Since this is the temporary end of development, this final stage is called the **climax**. It will last, largely unchanged as long as it is undisturbed by fire, human intervention, or other unusual stresses or until major geological or climatic changes cause the process of succession to continue.

QUESTIONS

1. What is an abiotic environment?

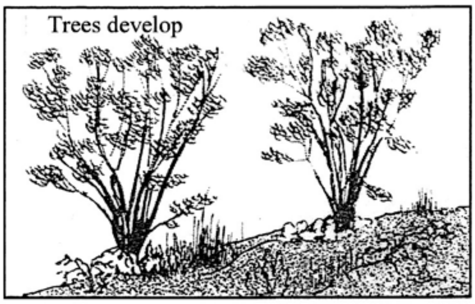
2. In the description above, which organisms were the pioneers?

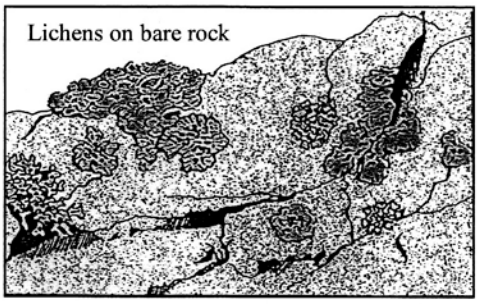
3. Living things do not merely adjust to their environment, they change it. Explain how the moss changed the local environment in the rock surface?

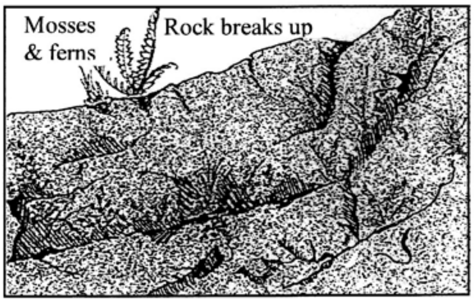
4. What is meant by a 'climax community'?

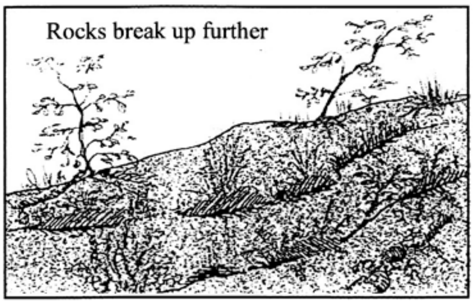
Collect a copy of this page from your teacher.

Look at the five diagrams. Cut them out and arrange them in order showing the changes that are likely to occur in the succession from bare rock to climax community. Paste them into your notebook. Explain why you selected this order of diagrams.









CHANGES IN HABITAT

Whenever a population of animals or plants becomes established in an area it affects the surroundings in some way. Burrows, wastes, leaf litter, shade and the use of soil nutrients are some examples of the way change can be brought about. These changes may mean that another population can no longer survive in the area. On the other hand the changes may allow other populations to establish. They in turn will change the habitat. Over time, one set of organisms will be replaced by another, as the conditions change to allow their survival. This process is called **SUCCESSION**.

ACTIVITY 12: INVESTIGATING CHANGES IN HABITAT

Colonisers are organisms that are the first to live in a habitat. The activities of colonisers in a habitat can alter the environment to such an extent that it is no longer a suitable place for them to live.

AIM:

To study changes made by colonisers in a habitat.

MATERIALS (per group)

Part 1

- two Petri dishes containing starch agar.
- iodine solution
- forceps
- bread mould
- labels
- Sellotape

Part 2

scalpel
Benedict's solution
Bunsen burner, tripod
gauze mat
100mL beaker

METHOD (Part 1)

- Label the Petri dishes containing the agar "Control" and "Experiment".
- Flood each Petri dish with iodine solution and then record the colour of the agar in each dish.
- Gently rinse the excess iodine from the agar surface with the sterile water.
- Using the forceps, add about lcm^2 of bread mould to the central part of the dish labelled "Experiment"; do not add any mould to the other Petri dish.
- Put lids on each of the Petri dishes, secure the lid of the Petri dish to its base with the Sellotape and store them in a safe place.

RESULTS (Part 2)

1. After about three weeks, examine each Petri dish and, by means of labelled diagrams and/or a written account, describe the appearance of each dish.
   - Is the blue-black colour still present throughout the agar in each dish?
   - If not, where has there been a colour change?

2. Use a scalpel to cut a small piece of agar from close to the mould and place this in a test tube. Label the test tube 'experiment'

3. Cut a piece of agar from the control dish and place this in another test tube. Label this tube 'control'.

4. Test both pieces of agar for sugar by adding 2cm of Benedict's solution to each test tube and placing the test tubes in a 100cm^3 beaker half-full of water and then bringing this water to the boil over a Bunsen flame.
   A change in colour to green or orange indicates that sugar is present.

5. Record your results in terms of the amount of sugar present in the agar.

CONCLUSIONS:

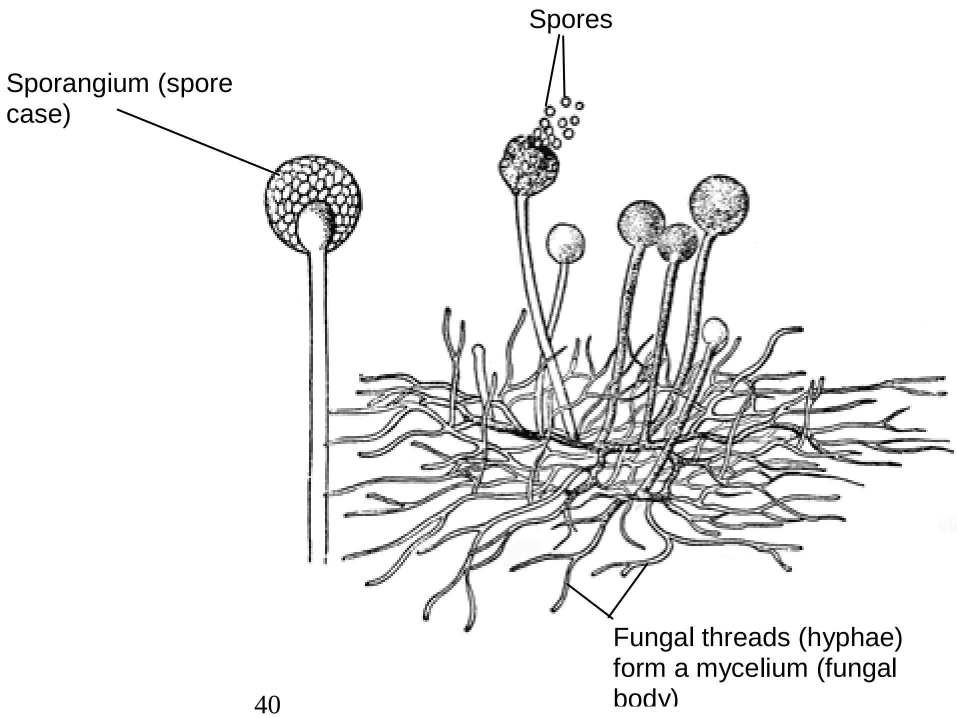
Consider the following when making your conclusions:

a) What changes took place in the starch agar containing the bread mould?

b) What caused these changes?

c) How do the results in the 'control' dish help tell you what caused these changes?

d) If the changes in the agar continue, will the agar still be suitable for the growth of bread mould? Why, or why not?



ACTIVITY 13: SUCCESSION IN A HAY INFUSION

This activity is an alternative to the previous one.

Use your textbook to research and write definitions for the following terms:

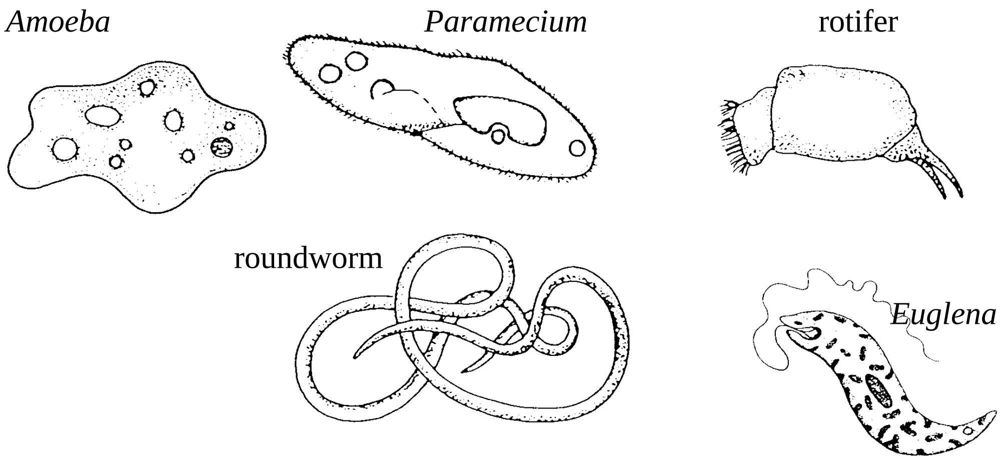
- Population
- Succession
- Climax community

You will now try to observe ecological succession and make population estimates using a hay infusion culture.

Observing Ecological Succession

Covering dead grass with some cooled boiled water makes a culture called a 'hay infusion'. The culture medium will be prepared for you. What you have to do is to try and work out how you can observe succession. You can use the naked eye, hand lens, binocular microscope or monocular microscope. Your teacher may give you some help with this or just ask you to try out some of your ideas.

Some of the organisms you may see are drawn below.



Estimating Populations

Each time you observe a sample of the hay infusion in your investigation of succession you will also need to estimate the numbers of each organism and then work out the changes in population over time. To do this you could:

1. Observe the culture under a monocular microscope and count the number of individuals that you see in your field of view for each type of organism.

2. Move the slide to look at a different part. Repeat the counting. Do this three times and work out an average.

3. Record your data in a table.

4. Once you have collected all your data, draw a graph to show the population changes in each of your organisms.

Discussion

1. Sketch the different kinds of organisms you observe daily.
   Do certain groups of organisms outnumber others on Day 1?
2. Do the proportions and kinds of organisms alter after Day 1?
3. Do the same organisms remain from day to day or do certain new populations appear as some populations die off and disappear?
4. Compare changes detected with the hand lens and those detected with the microscope
5. What changes would be evident if succession was indeed taking place in the hay infusion? How can you tell when a climax community is established?

ACTIVITY 14: NUTRIENTS IN THE WATER

AIM: To investigate the effect of fertilizer on the growth of algae in river water.

MATERIALS:

- two 250ml glass beakers
- river water
- liquid garden fertilizer
- a lamp or torch (for part B)
- a light meter (optional).

METHOD (Part A)

- Label the two beakers:

  Beaker 1 - water only; and
  Beaker 2 - water and fertilizer.

- Put 250mL of water into each of the beakers.
- Add 1mL of water to Beaker 1 and 1mL liquid fertilizer to Beaker 2.
- Place the beakers on a window-sill where they will get some light.
- Observe the beakers over the next 2 -3 weeks (or more in cooler weather) - recording your observations in a chart similar to the one drawn below:

Day	Date	Beaker 1	Beaker 2
1			
2			
3			
4			
5			
6			
7			

QUESTIONS

1. Describe what happened over the period of the week.
2. The fertilizer contains nitrogen and phosphorus – the two nutrients contained in sewage – so the changes you observed in the beakers were comparable to what happens in the river when nutrient levels rise.
3. What effects do you think this could have on the river environment?
4. Find out what is meant by **eutrophication**. Write a paragraph to describe the impact of eutrophication on aquatic plants and animals.

Research Assignment:

Introduced Species

Many plant and animal species have been introduced into Australia during the past two hundred years. They have established populations that have in some cases threatened the natural populations of Australian animals and plants. Most species were introduced deliberately, but some were accidentally introduced.
Some examples of introduced species are:

Ragwort, Mimosa, Pampas Grass, Starling, Fox, Rabbit, Cane Toad, Blackberry, Rat, Mouse, Boneseed, House Sparrow, European Wasp, Prickly Pear, Water Hyacinth, Feral Cats and Dogs.

TASK

Select ONE species that has been introduced into Australia (or specifically Western Australia if you wish) and research the following questions:

1. Why was the species introduced? (1)

2. Why did the species thrive and increase in numbers in the Australian environment? (1)

3. What problems has the introduction of the species caused in Australia? (2)

4. Are there methods of controlling the introduced species? If so, how successful have these methods been? (1)

Limit your account to **TWO** pages of writing, but include illustrations where appropriate.

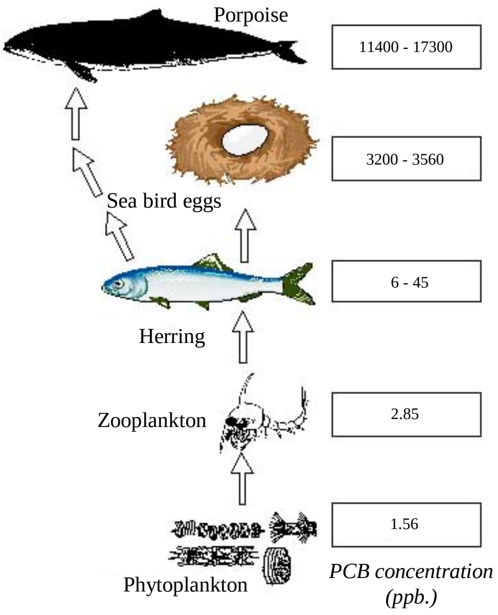
MARKS WILL BE AWARDED AS FOLLOWS: -

❑ Research	5
❑ Illustrations	1
❑ Presentation	2
❑ Originality	2
TOTAL:	**10 marks**

POLLUTION OF FOOD CHAINS

Many chemicals enter our environment because of our daily activities. Some of these are excretory wastes while others result from industrial, transport and household processes. Some pollutants are harmful because they promote excessive growth of water plants. Atmospheric pollutants can directly damage sensitive tissues of plants and animals.
Some pollutants are especially dangerous because they enter living things and then accumulate in fat and other tissues. This can continue up food chains, from one trophic level to the next, until the top predator has very high, often lethal, amounts in its body. This process is called **biomagnification.**

The diagram opposite shows how a chemical known as PCB (Poly Chlorinated Biphenol) can enter water and **biomagnify**. The same can happen to heavy metals and some long life pesticides. Microscopic plants absorb these pollutants directly from the water. The pollutants pass from one consumer to the next, mainly in the food they eat. When the small crustaceans eat microscopic plants, they take in only tiny amounts of pollutants. But all of it is retained and builds up in their fatty tissues and cannot be excreted, so that when small fish eat the crustaceans they take in larger amounts of pollutants. Again, all the pollutants are retained and **accumulate** in the small fish, so that larger fish get a bigger dose.
Fish eating birds (and of course humans) get the biggest dose of all.



ppb = parts per billion

Heavy metals

Humans are in great danger from the biomagnification of heavy metals such as lead and mercury. Lead accumulates in the liver and kidneys, and damages the nervous system.
Mercury severely damages the nervous system and causes birth abnormalities.

QUESTIONS

Around 1960, the sparrowhawk population decreased dramatically because pesticide in their bodies caused females to lay eggs with **shells** so thin, they broke before hatching.

1. How could pesticide have got into their bodies?
2. Why are consumers at the top of a food chain, such as sparrowhawks, in more danger from pollutants?

BIOLOGICAL CONTROL: DUNG IN AUSTRALIA

Chemical pesticides have a major disadvantage of killing animals that were not the intended targets. **Biological control** is an alternative to using pesticides. It involves introducing an organism from the country of the pest species in order to control the pest. A good example of how this process can be used can be seen in the introduction of dung beetles to Australia.
Dung beetles feed on cattle faeces (also known as dung) and, in doing so, are responsible for the decomposition of very large amounts of dung. Dung beetles are particularly common in parts of India and Africa. They are capable of burying large amounts of dung in a short period of time. Not only do the dung beetles feed on the dung but they also feed it to their larvae (young). The dung beetles play an essential role in recycling the nutrients present in the dung (e.g. nitrogen compounds).Australia does not have the kinds of dung beetles that can efficiently bury dung.

In 1788, cattle were introduced into Australia. The accumulation of cowpats has caused serious problems. By 1966, 1214 km^2 of grassland had been lost because of the accumulation of cowpats. The cowpats also supply the nutrients for the growth of very poor quality grasses that are of no real use to the farmer.

A more serious problem in Australia is the presence of the buffalo fly. This fly was introduced into Australia accidentally when buffalo were introduced into this country in 1825. The buffalo fly irritates and bites the buffalo so much that the cattle lose mass and produce less milk. They are also a considerable pest to humans. Buffalo flies lay their eggs in dung pats. The dung beetles interfere with the pats and therefore reduce the numbers of buffalo flies. Also some species of dung beetles carry small spiders called mites. These mites prey upon the larvae of the buffalo flies.

Australian biologists are deliberately introducing many kinds of dung beetles into Australia. Many of these species are now successfully reducing the numbers of cowpats. Up to 40% of dung pats can be buried by the dung beetles within 24 hours.

Watch:
https://www.youtube.com/watch?v=q703ArSTDE0

Answer the following questions.

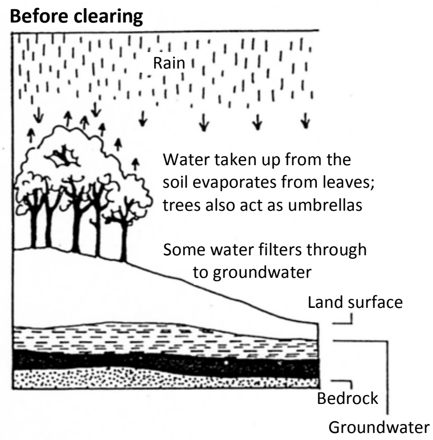
1. Why is dung a useful source of food to animals that feed on it?
2. What essential role do dung beetles play in the environment?
3. Give two reasons why the buffalo fly should be controlled in Australia.
4. How do dung beetles control the population of buffalo flies?
5. Draw a food web for Australian dung
6. This article is really about the biological control of a serious pest.
   What is meant by the term 'biological control?

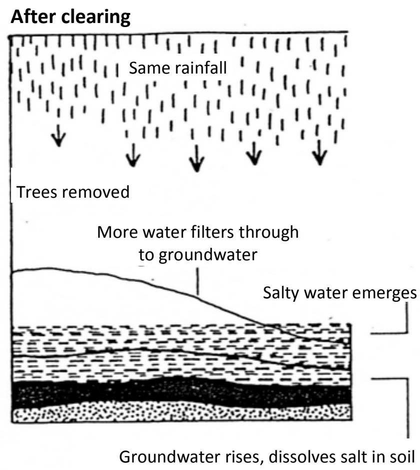
Rubbing salt in nature's wound

SALINISATION has become a big problem because the crops we plant today use much less water than the deep-rooted native trees and shrubs they have replaced.
A century ago, the W.A. landscape was a botanical wonderland and one of the World's most diverse eco-logical systems.

The complex but fragile system had adapted to cope with the salt carried inland from the Indian Ocean by the prevailing winds over hundreds of thousands of years to be and deposited on the soil.
Rain washed the salt down into the water table.
Deep- rooted native trees and shrubs used a phenomenal amount of ground water. For example, the jarrah tree is a magnificent water pump, with a large tree taking 200 litres of water per day out of the ground and transpiring it into the air.
This kept the water table, and the damaging salt, far enough underground to be out of harm's way.
Extensive land clearing for farming stripped the land of the deep rooted plants and the water table rose, bringing the salt with it.

Now the excess salt is killing off the surviving plants which bind the surface together and the topsoil is washing into streams and rivers.





Read the newspaper clipping and then answer these questions about the salinity problem:

1. How do salts get to the agricultural land?
2. Why does the salt not harm the trees and shrubs when it is deposited?
3. How do trees keep the water table low?
4. What happens to the height of the water table when trees are removed?
5. If there is a depression in the land which is lower than the water table, what landscape feature might form as the water table rises?
6. What process is responsible for making surface water saltier than the groundwater?
7. If salt affected land was replanted with the original vegetation found in the area do you think this would solve the problem of soil salinity? Give reasons for your answer.

INVESTIGATION: SEED GERMINATION AND SALT

BACKGROUND INFORMATION

In many areas of the wheat-belt of Western Australia, salting has occurred due to mineral accumulation at the soil surface. This has prevented the growth of crops like clover, oats, wheat and barley, making the land less productive.

How is the germination of different types of crop seeds affected by different concentrations of salt?

On a clean piece of paper, design an experiment that will help you to investigate this question. Use the following headings to guide you:

HYPOTHESIS:

MATERIALS MY GROUP WILL NEED:

MY GROUP'S EXPERIMENTAL DESIGN:

- ❑ The independent variable for our experiment:
- ❑ The dependent variable for our experiment:
- ❑ How we plan to set up our experiment:

- ***How we will control other variables that might otherwise influence our results?***
- ***How we will present our data (show any table format you plan to use)?***
- ***Results we would expect to support our hypothesis?***

Present your detailed plans to your teacher for assessment and then set up your experiment.

Hint:

Suitable concentrations of salt solution to try might range from 0.01M to 0.1M

ADAPTATIONS

Animals and plants need to have special features to be able to survive in their environment. These special features are called ADAPTATIONS.

Adaptations of organisms are of many types, and vary from species to species. They can be classified into 3 main groups.

1. **STRUCTURAL** adaptations are features of an organism's construction that help it to survive.

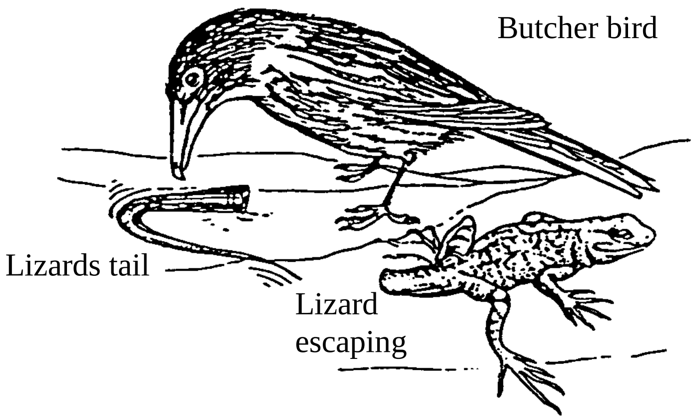
   Some examples are:

   - the long neck of a giraffe enables it to eat the leaves of tall trees.
   - the webbed feet of· a duck help it to swim quickly.
   - shiny leaves of some gum trees reflect heat to prevent water evaporation.

2. **BEHAVIOURAL** adaptations are <u>actions</u> of an organism which help it to survive.

   Some examples are:

   - desert animals sleep during the heat of the day and feed when it is cooler.
   - lizards shed their tails to fool predatory birds.



3. **PHYSIOLOGICAL** adaptations are ways <u>in which the organism's body works</u> to help it survive.

   Some examples are:

   - dogs panting to cool down their body temperature.
   - desert frogs recycling all the water from their urine.

Obtain a copy of this worksheet from your teacher

Worksheet: ADAPTATIONS Name:_________________

For each of the following adaptations state i) what type of adaptation is described and ii) explain how it helps the organism to survive.

1. Some Australian plants have very shiny leaves.

   i. ____________________
   ii.____
   ____

2. Possums are nocturnal.

   i. ____________________
   ii.____
   ____

3. Native cats have spots on their coats

   i. ____________________
   ii.____
   ____

4. Flounder and herring are dark coloured on the dorsal (upper) surface and light coloured on the ventral (under) surface.

   i. ____________________
   ii.____
   ____

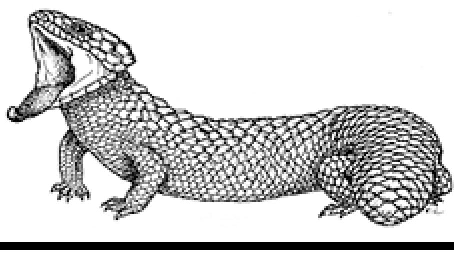
5. A bobtail skink opens its mouth and hisses at its enemies.
   i. ____________________
   ii.____
   ____

6. Pig-face is a succulent plant - it stores water in its leaves.

   i. ____________________
   ii.____
   ____

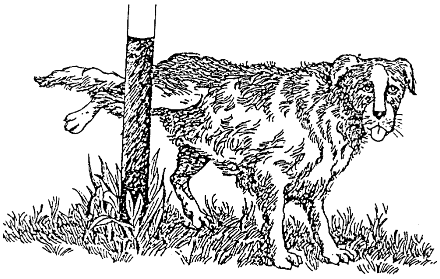
7. The lower half of a pelican's beak supports a baggy sack.

   i. ____________________
   ii.____
   ____



8. Explain what is meant by a 'behavioural' adaptation.

9. Look at the diagram of the dog below. What is the dog doing? What kind of adaptation is this and why would the dog do it?



10. Frilled-neck lizards have a frill around their neck that they can puff up and fan out. This ability serves two adaptive purposes for the frill neck lizard. Explain what the two adaptations are and what type of adaptation they are.

a.

b.

11. Dung beetles lay their eggs in cow dung and then bury the dung. This means that the larvae have something to feed on when they hatch. What type of adaptation is this?

12. Some flowers also exhibit behavioural adaptations. Look at the diagram below of one type of flower at two different times of the day. At what time of the day is the flower open and what time of the day closed**?** Why do you think they do this?

BULL CREEK WETLANDS RESERVE

The earliest use of the area was by indigenous Beeliar people. Early settlement of the area by Europeans began in 1834.
Prior to the suburbs of Rossmoyne and Willetton being established, the land beyond Karel Avenue was largely farmland.

In the early years of Rossmoyne Senior High School the area to the south of the new Science buildings was bushland as far as Parry Avenue. In time new estates including the Brockman Estate were established and the bushland area diminished to what it is today.

Bull Creek Reserve is one of many reserves in the Perth Metropolitan Area. It was proclaimed a Reserve in 1974.

1. ***Suggest some reasons for setting this area aside as a reserve.***
2. There are three significantly different parts to the Reserve; Bull Creek itself, a **perennial** stream that drains a region that probably extends well beyond the suburbs of Willetton and Bullcreek; the banks of the creek; and the sandhills on either side of the creek. Each has very different physical conditions that provide for the very different life forms that exist in each area.
3. Although it represents a small sample of what might once have grown in the area, because it is surrounded by housing, roads and the school itself it is very vulnerable to damage from a number of sources. ***Can you suggest some?***
4. Kangaroos, emus and bandicoots might once have been common in the area. ***Why do we not find them here now?***
5. For an area like this to function as it was intended by those who thought it valuable enough to set aside as a Reserve, if you look around it you will quickly see that the area has become degraded. ***Make a list of as many of these as you can think of.***
6. Without care and attention the area will quickly become less and less what it once was; less attractive a place and a loss to us all. The area comes within the boundaries of the Canning and Melville City Councils and they have contributed to its maintenance through a series of Management Plans. Each of these Plans identified problems that needed to be addressed, resulting in the funding of weed control and the maintenance of firebreaks. The W.A. Government would also have an interest through its Department of Parks and Wildlife (DPaW). Unfortunately, the care of this Reserve and the many other isolated reserves is beyond both local and State Governments.
7. Sadly through disturbance the area has been rated as being in Poor to Very Poor condition in the 2004 - 2007 Plan. ***Make a list of the disturbances that might have led to this rating.***
8. The **Friends of Bull Creek Wetlands** is a group of dedicated local residents who give freely of their time to assist. They focus on weeding and re-vegetating. Rossmoyne Senior High School is linked to this group through its Year 9 Ecology module. Together, with a coordinated approach, we might be able to reverse some of the damage and re-establish the Reserve as a conservation and recreation area to be proud of.

MANAGING BULL CREEK WETLANDS RESERVE

ACTIVITY 15: INTRODUCTORY VISIT

1. Look around the Bull Creek Reserve beside the school grounds and write a description of the area, including:

    - Your own impressions of its appearance.
    - Your feelings about the environment.
    - Any major variations in vegetation and soil type (e.g., compare an area close to the creek with one away from the creek)
    - Any signs of animal life.
    - Any evidence of fire.
    - Any evidence of pollution that you see.
    - Any plants or animals that you think are not native to the area.

2. Look beyond the Reserve and

    - Describe the ways in which land is used away from the Reserve. A simple map showing the major land uses will add much to your description.

    - Identify and record any land-use activities that you think will have a direct affect on the quality of water in the creek, explaining the link between these activities and water quality.

3. Form into small groups. What does your group think are **five (5) major issues** facing the long-term survival of plants and animals in the Reserve? ***Record these in a list to be submitted to your teacher.*** Ensure the names of your group members on your list.

4. On the same sheet of paper list ways that the movement and activity of your class group might in itself be damaging to the area. How could this impact be minimised? ***Record some key rules students working in the Reserve.***

5. Back in class following feedback from each group establish a set of **Class Rules for Working in Bull Creek Reserve.**

6. Review the Major Issues to be addressed in managing the Bull Creek Reserve. ***On which of these issues can students of this school make a contribution to the long-term care of the Reserve?***

The integrated management of any reserve needs some basic understandings:

1. What is the physical (abiotic) environment - this will include
    a. soil type and characteristics
        - colour
        - texture
        - wettability
        - water holding capacity
        - soil pH
        - water availability
        - soil temperature
        - macro-invertebrates present

    b. air temperature and humidity - this will change throughout the day and year.
    c. water quality
        - pH of water
        - dissolved solids
        - turbidity
        - flow rate
        - NPK concentrations

2. What is the living (biotic) environment - this will include a catalogue of
    a. Plants, both native and introduced.
    b. Animals, both native and introduced.
        - mammals
        - birds
        - reptiles
        - fish
        - amphibians
        - insects
        - macro-invertebrates

    c. Fungi
    d. The abundance and distribution of these organisms within the Reserve.
    e. Identify distinct communities/associations of plants in the reserve e.g.,

       Bull Creek Reserve (1987 Plan):

        - Agonis-Acacia
        - *Eucalyptus rudis* woodlands
        - *Eucalyptus rudis* -Melaleuca swamp complex
        - Banksia-Allocasuarina woodlands
        - Bracken fern

3. Record keeping:
    - photographs
    - database of living and non-living factors

ACTIVITY 16: THE PHYSICAL ENVIRONMENT

AIM:

To measure a number of aspects of the physical environment of the Bull Creek Reserve.

MATERIALS

- ruler
- trowel
- two 500ml beakers for soil samples for testing back in class
- light meter
- thermometer
- anemometer
- wet and dry bulb thermometer (hygrometer)
- copy of 'Physical Environment Data sheet'
- The Bull Creek Wetlands map

STEP 1: LOCATING PLOT 1 (creek)

1. Under the direction of your teacher, select a small area of bush near the creek. Work out the size of the area and how the boundaries will be marked.

2. On a copy of the map of the whole area given on the next page, show the location of your class's study plot, recording GPS coordinates.

STEP 2: MEASURING

Using the correct instruments, measure the physical factors of the environment listed in the table on the next page. Your teacher will give you a copy of this record sheet and give you instructions on how to take each measurement.

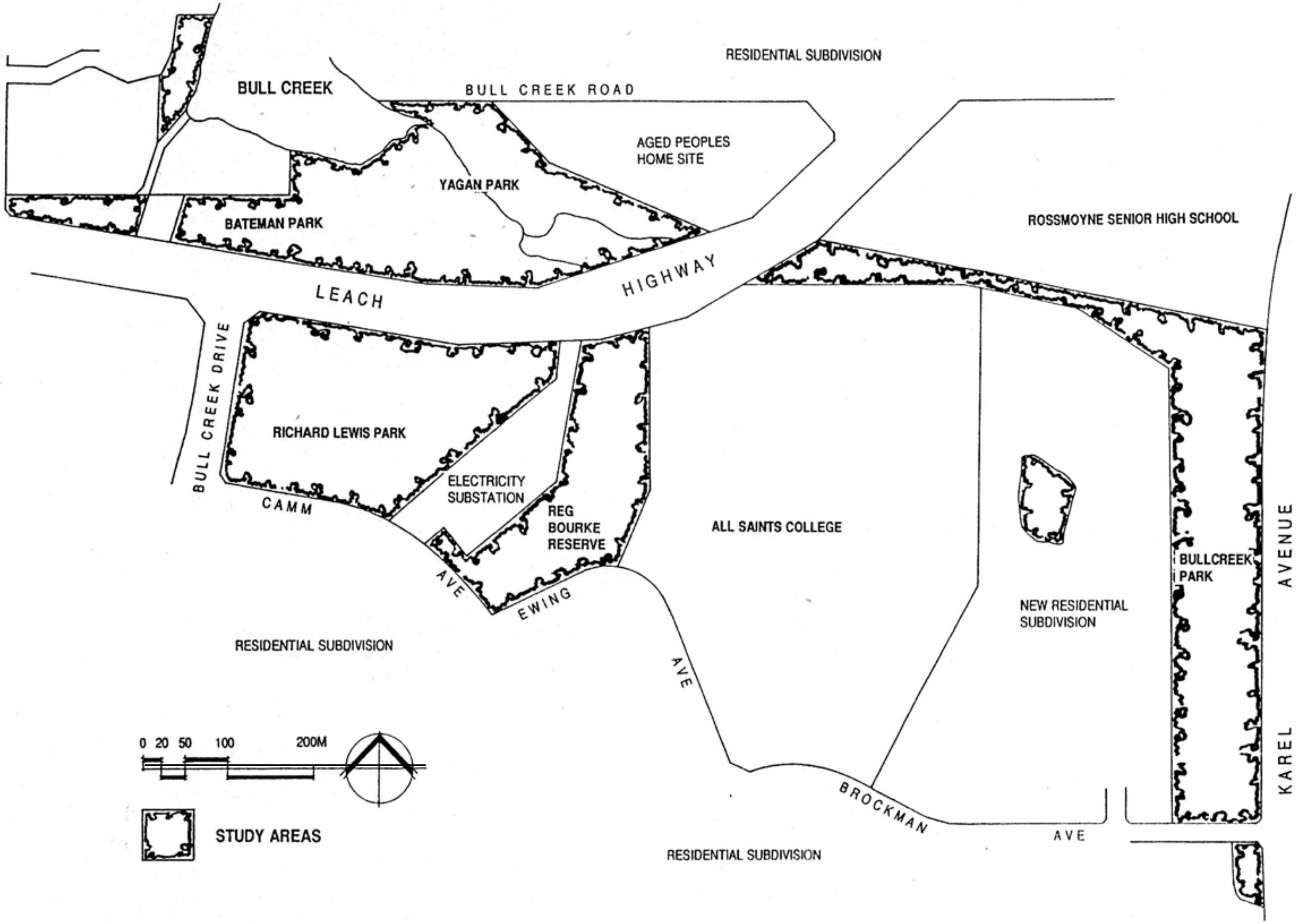
If you do this study over an extended period you might like to add more measurements over time. If so make columns on the table for each new measurement. Head each column with the date on which the measurement is made. Time of day might also be an important record.

3. Record the abiotic (physical) factors for the area of ground (a plot or quadrat) near the creek. Use the 'Physical Environment Data Sheet' to record your measurements.

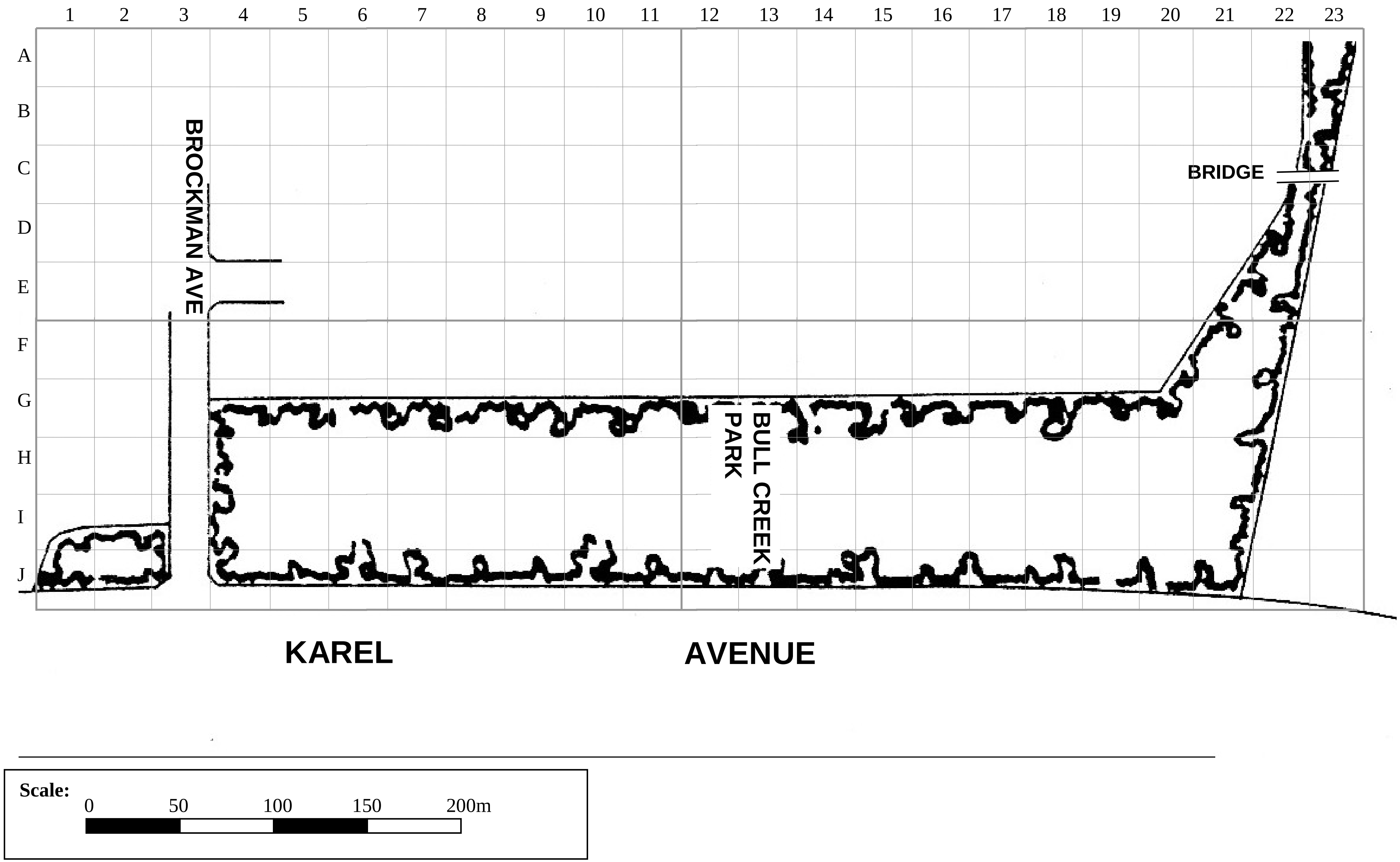
STEP 3: LOCATING PLOT 2 (Away from the creek)

4. Next, your class has to record the abiotic factors for a similarly sized plot away from the creek. Locate your new plot on the map you have drawn.
5. Complete the Physical Environment Data Sheet for this new plot.
6. Complete the 'Discussion and Comparison of Environments' section of this data sheet.

THE BULL CREEK WETLANDS



THE BULL CREEK WETLANDS



PHYSICAL ENVIRONMENT DATA SHEET

NAME:______________________

PHYSICAL FEATURE	DESCRIPTION/FACTOR MEASURED		DIFFERENT OR SIMILAR BETWEEN ENVIRONMENTS
	Alongside creek	Away from creek	
Soil factor: 1. pH: 2. water content: 3. texture:			
Light:			
Temperature: Air: Soil surface:			
Wind speed:			
Humidity:			

DISCUSSION AND COMPARISON OF ENVIRONMENTS

List the features that had the greater differences. Give a possible reason for the differences. Give a possible effect on the living environment.

FEATURE	REASON	EFFECT ON LIVING ORGANISMS	

INVESTIGATING SOIL

To study ecosystems, scientists often first study the soil and water on which they are based. Soil investigations test both the physical and the chemical properties of the soil.

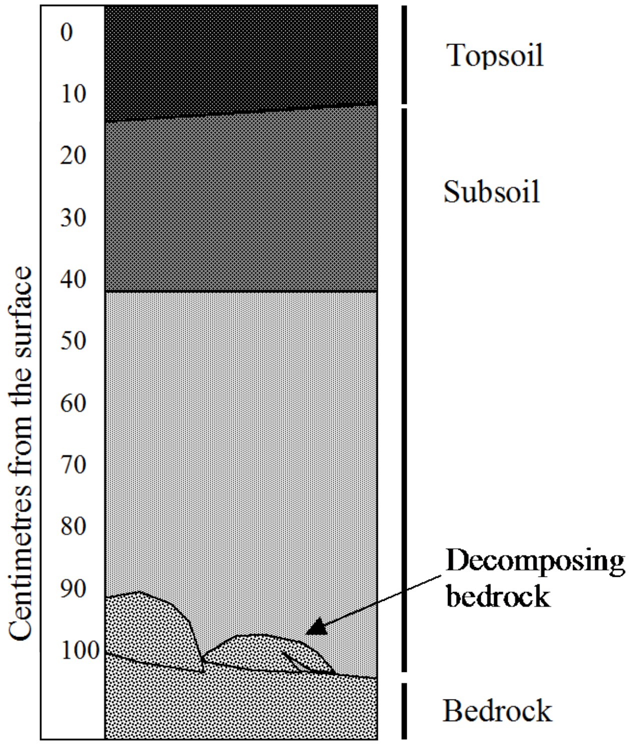
PHYSICAL PROPERTIES

A soil profile is a vertical section through the soil, often showing distinct layers of topsoil, subsoil and decomposed rock. On the Perth coastal plain the decomposed rock layer is thousands of metres beneath the surface. In the hills around Perth, the soil layer might be very thin in places.

The ***texture of the soil*** is determined by the amount of gravel, sand, silt and clay it contains. It describes how loosely or tightly packed the soil particles are, it tells you how well the soil drains and how well it holds water and nutrients. If the soil particles are very loosely packed, water can drain away from the roots of plants before it is absorbed.

The ***colour of the soil*** is related to the minerals and other matter in the soil.

Soil structure tells you how the particles are clumped together to form soil crumbs (aggregates). Well-structured soil is crumbly and has many pores, small and large, which enable the roots of plants and water to enter the soil easily.



A soil profile

ACTIVITY 17: SOIL TEXTURE

AIM: To compare the texture of soils from different parts of a profile and from two different sites.

MATERIALS:

- 250mL beaker of water
- about 500 millilitres of soil from two very different sites (also for use in later studies).

METHOD:

- Moisten some of each sample of soil with water, forming a ball around 4 cm in diameter. Roll it in your hand for a few minutes.
- Does it feel silky, gritty or like Plasticine?
- Press the soil between your thumb and forefinger to make a ribbon. Observe the length of the ribbon that can hang down without breaking.
- Refer to the chart below to classify your soil sample by its texture.

RESULTS:

1. Use the table to identify the soil. Compare soils from different sites.
2. Explain how you think the differences in texture that you have noticed might affect plant growth.

Classification	**Behaviour of ball of soil**	**Ribbon test**
Sand	Does not stick together, single grains	Will not form a ribbon
Silt	Can form into a ball, smooth and silky feel	Ribbon 2.5 mm
Clay	Smooth ball that is easily moulded	Forms a ribbon 50-75 mm

INVESTIGATION: Soil Permeability

Permeability refers to how easily water can pass through a soil sample.

Design a way of testing the permeability of the different soil samples from the previous activity. Make your test a ***quantitative*** one if possible.

Carry out your test.

THINK!

Which of the soil samples would be best at retaining water for plant growth?

INVESTIGATION: Soil Wet-ability

Many soils of the Perth region become very hard to wet during summer. Water simply runs off the surface without penetrating.

1. **Research** the cause of this problem.
2. **Investigate** how effective some of the products available on the market are at wetting reducing this problem. (e.g., Wettasoil). Do these products really work?

ACTIVITY 18: SOIL ACIDITY

The pH or acidity of the soil affects whether nutrients are available to plants.

AIM: To test the pH of the soil samples collected in the field

MATERIALS

- small amounts of three or four different soil samples
- a Universal Indicator solution and colour chart
- some barium sulfate powder
- a spoon or spatula
- a dropper
- three or four small dishes or white tiles.

METHOD

1. Place half a teaspoon of soil onto the dish or tile.
2. Add a few drops of indicator solution, enough to make a thick paste.
3. Sprinkle the barium sulfate powder onto the soil and leave for 3 minutes to allow the colour to develop. Do the same for the other soil sample. The pH value can be read off the colour chart according to the colour of each sample.
4. Record the pH of both samples and comment on your results.

RESULTS:

1. Was the pH different for each soil sample?
2. Account for any differences.

ACTIVITY 19: THE LIVING or BIOTIC ENVIRONMENT

AIM: To explain any differences between the kinds and numbers of plant and animals found in the two study plots.

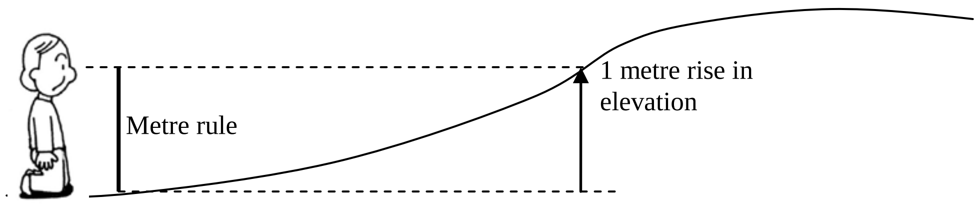
MATERIALS:

- Living Environment Data Sheet
- Reference books

METHOD:

1. Return to the first plot you studied near the creek. Record the types and numbers of living things present in this plot on the 'Living Environment Data Sheet'

2. Draw a profile diagram of your plot and a scale diagram of your plot showing the main types of vegetation. Use symbols or diagrams to represent each type of plant present.



3. Similarly, record the types and numbers of living things present in the second plot on the 'Living Environment Data Sheet'.

4. Draw profile diagram and a scale diagram of your new plot showing the main types of vegetation.

5. Explain any differences you have observed in the types and numbers of living things present between the two plots.

Remember:

Try to leave the bush as you found it. E.g., return logs or stones that have been overturned, do not pick wild flowers and do not willfully destroy anything.
Watch where you are walking to avoid trampling
Keep to the paths

THE LIVING ENVIRONMENT DATA SHEET

AREA 1

Living things present		Profile diagram showing vegetation	Plan view of plot showing scale
Plants	Animals		

AREA 2

Living things present		Profile diagram showing vegetation	Plan view of plot showing scale
Plants	Animals		

FURTHER STUDIES……………

A booklet produced by the Swan River Trust, Ribbons of Blue, Field Activities Workbook is available to teachers on the S-Drive. It details activities that could be conducted in the Bullcreek Reserve including:

- Site Survey
- Water Quality Testing
- Macroinvertebrates – a look at life beneath the water surface.
- Birds of our wetlands and waterways.
- Planning for Action

If time permits any of these would be well worth completing.