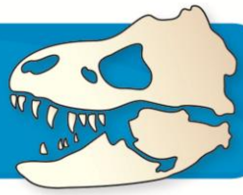
Fossil Kit Spice up your science! Teacher Guide

Contents

fossils



Dinosaurs, data and dimensions

Fossil fun and fabrication

These activities are designed for use in classrooms in Western Australia

For more information and support please contact:

ESWA web site at **www.earthsciencewa.com.au/**

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Fossil Kit Spice up your science!

This kit has been provided by ESWA and Scitech through generous funding by Bhp. It is primarily designed for schools in regional and remote Western Australia. We hope that these schools will share this resource. Earth Science content and Working Scientifically practise covered is useful for both primary and secondary students.

The package consist of:

1. A box of fossil specimens
2. A teacher's guide
3. A student's workbook

The box contains:

Shark teeth 10 Often only teeth remain after death and burial as the "bones" of a shark are actually made of cartilage. Cartilage stiffens our noses, forms our breast bone and rots easily rots. Shark teeth are not often not very useful as index fossils (fossils that tell the geological age of the organism) because they did not change much over time. Odotus came from the ancient genus Cretolamna. The largest Odotus teeth are from Late Palaeocene and Early Eocene times (50 – 60my ago). The shark grew to about 12 metres long. It ranged from 60 to 37.5 million years ago and fossils have been found in North America, Europe and North Africa. Our fossils have been soaked in resin to make them somewhat stronger. Shark teeth have been found embedded in ammonites.	
Trilobites 12 replica & 1 real Trilobites, (meaning three lobes or bumps) are extinct marine arthropods which scuttled about scavenging on the bottom of ancient seas. They died out about 250 my ago. They were found in most oceans and their body shape changed often making them good indicators of time (index fossils). Usually only the hard exoskeleton remains to be fossilised. The replicas are Phacops rana (rana relating to their frog like eyes). The fossil soaked in resin on the left is of the order Phacopida, is about 400 my old and is from Morocco. The replicas are also Phacops.	

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Ammonites 6 replica & 1 real Ammonites were marine cephalopods (similar to modern octopus and squid though they had shells like the nautiliods). Like trilobites they were found in most oceans, varied over time and are therefore good index fossils. Like the dinosaurs, ammonites became extinct 65 my ago. These replicas are of Pleuroceras from Europe and are about 165 my old. The resin soaked real fossil is Perisphinctes from Madagascar. The Greeks thought they were the horns of the Egyptian god Ammon. Some had snakes heads carved into them and were sold as snakes drowned in Noah's flood!	
Heteromorph Ammonites 6 replica These unusual ammonite replicas are of uncurled specimens from the Walsh River in Queensland. They are good markers for the Cretaceous period 120 to 140my ago. Unfortunately unscrupulous fossil hunters have damaged the rocky outcrops they were originally gathered from and fossils are now difficult to find..	
Coprolites 2 real Coprolites are fossil faeces. Their extruded shapes are indicative of their origin. Students might like to compare faeces shape and size from an herbivore such as a cow or emu with those from a carnivore, dog or cat. It is often difficult to state precisely the species source or the size of the individual. A general indication is that a larger, poorly shaped coprolite is more likely to come from an herbivore. These are from Morocco. The study of fossil faeces is termed coprology.	

Hand lenses 2 Your box also contains two hand lenses and cases. Students need to place the lens close to the eye and then move the object up towards the lens to bring the fossil into focus. Wetting rocks and fossils often results in a clearer image.	
A specimen of fossiliferous limestone is included in the box. This demonstrates how rarely good samples are found and how difficult it is to extract a specimen.	
20 cardboard geological time scales are also included. These can be obtained from the Department of Mines and Petroleum, publications section	

If you wish further information, please contact Julia Ferguson Julia.ferguson@scitech.org.au or the ESWA site http://www.earthsciencewa.com.au/

fossils

INTRODUCTION
TEACHER BACKGROUND

Fossils are the naturally preserved remains or traces of ancient life that lived in the geologic past

Fossils represent the remains or traces of once-living organisms found in sedimentary rocks.

Rocks and fossils tell us about past events in Earth's history.

Most fossils are the remains of extinct organisms; that is, they belong to plants or animals that are no longer living anywhere on Earth.

Fossil crinoids or "stone sea lilies" near Geraldton WA. Photograph courtesy of Enza.

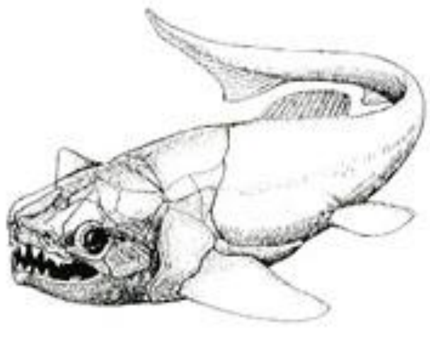
The kinds of fossils found in rocks of different ages differ because life on Earth has changed through time. These changes can be used to estimate the age of fossils and the strata that contain them.

Without fossil fuels formed from once living plants (coal) and animals (oil and gas), our energy expensive modern lifestyle could not be sustained.

Fossils also figure richly in folklore. In medieval times fossil ammonites were believed to be snakes which drowned in Noah's flood. Gryphaea, an ancient oyster, was believed to be the Devil's toenails and belemnites were thought to be thunderbolts! Fossils have been ground up to add to medicine and strung on leather thongs to make jewelry.

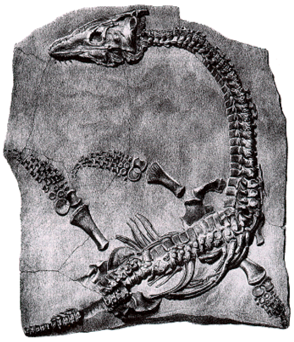
True paleontology, the study of life in Earth's geological past, started in Florence with Steno (Niels Stensen 1638-1687). He realised that the fossils called "tongue stones" were the same as shark teeth. Fossils are used as clues to indicate the type of organism, the environment which that organism inhabited and possible evolutionary trends Index fossils can be used correlate coeval rocks.

Western Australia has its own state fossil emblem, the Gogo fish (*Mcnamaraspis kaprios*). This was a voracious predator with a bony head shield and trunk shield unlike modern fishes. It swam in quiet inter-reef bays in seas that existed 375 million years ago



Fossils can be preserved in sediments, tar, oil and amber. The two main types of fossil are body fossils (the petrified organism) and trace fossils (moulds, casts and faeces). Even petrified Earth processes such as water ripple marks and raindrop patterns are fossils.

fossils

			
Dinosaur bone	Dinosaur footprint	Mud cracks	Ripple marks
Body fossil	Trace fossil	Body fossil	Trace fossil
The remains or traces of prehistoric plants or animals e.g. dinosaur bones or dinosaur footprints.		Signs of Earth processes e.g. mud cracks filled with sand.	

It is rare for an organism to be fossilised. Usually predators, scavengers and decomposers break down the remains. Often only hard parts of the organism will survive this process e.g. shells, carapaces, skulls and teeth. A dead sheep in Perth's summer heat will be reduced to a scattered skull, broken long bones and patches of indigestible wool in less than a week. Dogs, cats, crows and flies are the main agents of its breakdown. Rapid burial excludes oxygen and can reduce decomposition and stop scavenging. The organism must then survive the pressures of burial, compaction, mineralisation, folding and faulting. Lastly the rocks must be exposed at the surface to reveal their contents. Often a mould of the fossil, an imprint of the organism or its cast, a mineral infill of the cavity in which it lay, is all that remains.

The major constituent of West Australian coal is fossilised fragments of the Permian plant, Glossopteris, which grew across the super continent of Gondwanna before Australia broke free. This extinct order of deciduous woody trees grew to 30 m in cold wet swampy conditions. Its name derives from its "tongue" like leaves. The acidic bog water limited bacterial decomposition and preserved the wood.

The picture of Glossopteris above is reproduced courtesy of the E de C Clarke Museum at the University of Western Australia. The museum is a great place to take students to see fossils, rocks and to find out more about Earth Sciences. Admission is free. http://www.collectionsaustralia.net/org

fossils

Representatives of some organisms appear throughout geological time and are termed “living fossils”. They show changes through geological time however. Rocks at Marble Bar contain fossil stromatolites (cyanobacteria) over 3.4 billion years old which are the ancestors of those stromatolites presently growing at Shark Bay, Rottnest Island, Pink Lake near Esperance and many other locations in WA. The word stromatolite literally means “layered rock”. Layers of sediment build up round the growing bacterial mats.

The specimens in the pictures above are stromatolites. The fossil on the left is over 3,200 million years old from near Marble Bar, whereas the one on the right is only 70-90.000 years old. The recent fossils can be easily picked up on Myalup Beach WA. They probably come from an offshore undersea outcrop which is being broken by wave action. Similar fossils are washed up on other beaches south of Mandurah.

Australia drifted apart from the other Gondwannaland continents (Africa, South America, India and Antarctica) about 45 million years ago. Many fossils of organisms which evolved here since then are unique. Although the giant marsupial Diprotodon once roamed Australia 50 million years ago, it and other megafauna are now extinct. Modern marsupials evolved from these in response to changing conditions as the Australian continent moved northwards and the environment changed.

It is postulated that humans, rather than climate change, were responsible for the extinction of giant marsupials whose fossils are found in the south west of WA. Fossil finds from caves south of Margaret River and on the Nullarbor suggest that fire was the major factor which caused the extinction of 3m tall kangaroos and giant goannas about 40,000 to 50,000 years ago within 20,000 years of humans arriving from the north. Researchers from Flinders University suggest that the Tasmanian tiger, Tasmanian devil, marsupial lion and short faced kangaroo populations had successfully survived earlier climate fluctuations. Extinction coincided with the arrival of early aboriginal groups.

Mankind has arrived very recently on the geological scene. 3.6 million year old fossils of Australopithecines, our ape like precursors, have been found in East Africa. From these and later finds, our changing theories of evolution of man have developed. Although in the past differing species of human coexisted, only Homo sapiens remain.

fossils

Rhizoliths (root rocks), form around and replace the roots of living plants. They are common in Tamala Limestone, common along most of our coast, which was used to build the older parts of Fremantle. These should not be confused with the rock forms at "The Pinnacles" and occurring within the local Bassendean sands. Although there the source of the lime was ancient beach shells, present structures are the result of chemical solution and deposition of waters moving within the sands. The Pinnacles are therefore not fossils.

Many sea dwelling organisms such as bivalves (mussels, oysters etc) have a wide geographic range and change the structure of their hard parts frequently. This makes them particularly suitable as INDEX FOSSILS. Fossils showing the same structure must be of the same age. We can correlate sedimentary beds across large distances using these fossils. Geologists logging samples from drill sludge from oil wells use the fossil pollen spores to age the sediments. They are called palynologists.

Rhyzoliths forming round dune vegetation roots at Myalup Beach WA

Vocabulary

Fossils	Fossils are the naturally preserved remains or traces of ancient life that lived in the geologic past. The remains have been altered by earth processes.
Cast	Mineral infill of the cavity in which the organism lay.
Mould	The imprint of a fossil.
Paleontologist	A paleontologist studies fossils.
Petrified	Changed into rock. (petra Latin rock)

More information can be found at:

The Australian Museum online has lots of fossil information at:
http://www.amonline.net.au/palaeontology/faqs/fossil.htm#clean

View several fossils online at: http://3dmuseum.geology.ucdavis.edu/frame.html

A source for obtaining 3D colour cut-out fossils of dinosaurs, a trilobite and an ammonite is:
http://www.ga.gov.au/education/teachers/resources.jsp

Information about Australian dinosaurs at Lark quarry in Queensland with animations and quizzes:
http://www.heritage.gov.au/dinosaur/teachers.html

Why are fossils rare?
TEACHER BACKGROUND

3,500 million year old fossil stromatolite,

Western Australia

This photograph is reproduced courtesy of Cath. Grey of GSWA

It is rare for an organism to become fossilised, particularly those without bony parts. Predators, scavengers and decomposers will break down the remains. Earth processes of weathering and erosion may scatter, mix and destroy some of the evidence. The material of the fossil may also be mineralised by calcium carbonate, silica or even pyrites which can remove details of original structures. Preservation only occurs rarely and under specific conditions:

- Rapid burial to provide protection from scavengers, weathering and erosion.
- Anoxic (low oxygen) conditions to prevent bacterial decomposition.
- Acidic conditions to preserve flesh.
- Alkaline conditions to preserve bone.
- Relatively undisturbed conditions during the processes of deposition, compaction and cementation.
- Uplift and subsequent exposure at the surface.

Petri dishes (right) are named after Julius Richard Petri a bacteriologist.

Since microorganisms reproduce at the rate of 2^{n-1}, growth is rapid. Furry colonies are usually fungi (most commonly black furry penicillium mould) and slimy ones are bacteria. It is not unusual in classrooms for colonies of staphylococcus aureus (golden staph.) to form. Opening used Petri dishes and releasing the high concentrations of spores is dangerous. If the school has an autoclave or pressure cooker, the containers can be sterilized and recycled. If not **… USE, SEAL, OBSERVE and DISPOSE.**	 *Biohazard symbol*

Why are fossils rare?
STUDENT ACTIVITY

Predators, scavengers and decomposers

The class can discuss what usually happens to the bodies of creatures when they die e.g. a sheep dies in a field. If it has been killed by a predator (dog or dingo) part of the carcass will be eaten and the remains broken and scattered. The larger scavengers will move in (cats, magpies, crows) and further breakdown and deplete the remains. In quite a short period of time, all that may remain is the larger bones (skull and pelvis) and indigestible wool. Teachers may wish to show a short You Tube presentation on now extinct trilobite scavengers (37 sec.). http://www.youtube.com/watch?v=CDymcLsB69c

Materials provided in the kit

- Student worksheet “Predators, scavengers and decomposers”
- Student worksheet “The dreadful and disgusting decomposition of Denis the dinosaur”

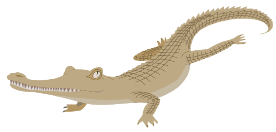
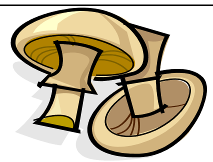
Materials provided by teacher

- Access to internet if required
- Coloured pens/pencils, scissors etc.

TEACHERS ANSWERS

When things die, their remains are broken up by:

Living things

	Your example	Hint
PREDATORS	**Wedge tail eagles, dingos, mankind, sharks, dogs, cats.**	
SCAVENGERS	**As above and, magpies, rats, mice, blowfish, lizards.**	
DECOMPOSERS	**Flies, cockroaches, fungi, bacteria.**	

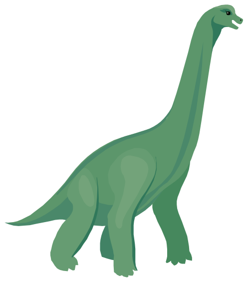
In your own words

A predator is an animal which hunts living animals for food
A scavenger is an animal which feeds on dead organic (plant and animal) material/living things
A decomposer is an organism that breaks down organic matter/living things

The remains of a kangaroo carcass after three months lying in the open.

Why are fossils rare?
STUDENT WORKSHEET

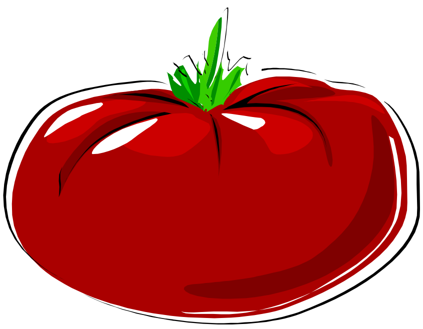
The dreadful and disgusting decomposition of Denis the dinosaur.



Students create a cartoon strip to explain why all that remained of Denis the dinosaur after a year was two leg bones and his skull.

http://www.youtube.com/watch?v=C6sFP_7Vezg&feature=related has many short videos demonstrating decomposition.

Extension



Tomato Bodies

Tomatoes are reasonably cheap and can be used to represent bodies, having a skin which seals softer moist internal parts. Ripe Roma tomatoes can be inexpensive. Students can choose where to place their tomato bodies in the school yard to minimize breakdown (covered/exposed/under water/in bushes/ in sunlight/on ant's nest, whole/skin pierced). They measure decomposition rate resulting from differing conditions. The results can be tabulated against predictions.

Apples can also be used but are often slower to break down.

Location	Reason	Predicted Survival	Actual survival	Comment
In pond	*Less oxygen and cold*	*12 days*	*6 days*	*Fish ate them*
On roof	*High and dry*	*3 weeks*	*More than 3 weeks*	*Too hot and dry for bacteria and fungi*

Microorganisms and water

Petri dishes

Dead plants and animals rarely survive to become fossilised because they are broken down by Nature's recyclers. Decomposing microorganisms such as tiny bacteria and fungi in the air are so small that individuals cannot be seen by the naked eye. Luckily, under the right conditions, they multiply and grow into large colonies that are easier to see.

Bread, being made from a living plant, is a good food source for microorganisms. Compare what happens to the two pieces of bread, one moist and one dry, over two weeks to see the effect that moisture has on decomposition.

HINT Commercial bread has strong preservatives and may take quite some time to break down. Home-made bread or scones are preferable.

Washed plastic take-away food containers can replace Petri dishes.

You will need

- Two samples of bread, one of which has been dried (Same size, same thickness, etc for fair test)
- Two Petri dishes or clear plastic food containers
- Marking pen
- Sticky tape for sealing the dishes

What will we have to do to make this a "FAIR TEST"?

Same bread, same size bread sample, same size Petri dish, same time same ambient conditions etc.

The results of your experiment will be colonies of bacteria and fungi. They can be dangerous to your health. Do not open the Petri dishes after they have been sealed!

Biohazard symbols can be found in "clip art", printed and stuck on the equipment.

fossils

Students will

1. Place the moist sample of bread in the Petri dish, mark the dish "MOIST", add the biohazard symbol and seal it properly with sticky tape.
2. Repeat with dry bread, marking the dish "DRY", adding the biohazard symbol and sealing it. This is the CONTROL against which any change in the moist sample will be measured.
3. Leave the dishes somewhere warm for two weeks observing any changes regularly. For this to be a "**FAIR TEST**" the ***same*** materials should be in the ***same*** place for the ***same*** time. The only variable being tested is the presence or absence of moisture.

   For students from Year 7 onward:

   Moisture is the ***independent variable***, the ***one*** change we deliberately made.

   The change which occurs as a result of the experiment and which is measured is the ***dependent variable***
4. Write down your observations.
5. Return your unopened dishes for the teacher to dispose of.

Used Petri dishes can be decontaminated by cooking in a pressure cooker. They may then be safely re-used.

Prediction (from the Latin meaning to prophesy)

What do you think will happen to the two pieces of bread? Students should be encouraged to use their experience to make reasonable predictions. These may be written on the board and discussed.

Observations on the effect of moisture on the decomposition of bread

Day	Moist bread	Dry bread
1	***No change***	***No change***
5	***Coloured dots and blobs***	***No change***
12	***Black and green clumps***	***No change***

HINT Fungal colonies tend to be furry and bacterial colonies tend to be slimy.

Use the information you have learned

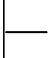
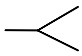
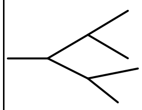
What conditions would help a dead plant or animal to be fossilized?

Dry conditions help the fossilization process – relate to preserved mummies, jams and dried fruit.

Interesting fact for teachers Some Aboriginal people in the north would place dead bodies in trees to be away from predators and to be dried by the wind. They would return later and have a formal burial.

Extension

The number of bacterial on a student's body is ten times greater than the number of their body cells. Cells multiply by division. In 5 divisions, one bacterium can create 32 bacteria in five periods of cell division (n).

		1^{st} div.	2^{nd} div.	3^{rd} div.	4^{th} div	5^{th} div.
Number of bacteria	1	2	4	8	16	32
Diagram				etc	etc	etc

Since some bacteria can reproduce every 20 minutes, one bacterium which is microscopic can produce a bacterial blob the size of a sugar cube in a day.

Visit http://www.youtube.com/watch?v=gEwzDydciWc&feature=related and find out how many bacteria that would be. Students can estimate bacterial growth numerically (2^{n-1}) or pictorially (see above).

Interesting fact for teachers

It can be interesting watching "real estate wars" as colonies competes for resources and space in the Petri dishes.

Microorganisms and temperature

Early settlers in the tropics died from simple bacterial infections which would not have been so virulent in more temperate regions. Warm conditions allowed bacteria to multiply at a greater rate than the bodies' defense system could combat. Plants and animals decay at a much faster rate. Chemical reactions in living things are controlled by enzymes whose metabolic rate is temperature dependant. Up to a certain point enzyme activity increases with heat. Thereafter it decreases. This is why cooking and freezing adversely affects the rate of decomposition.

Materials provided in the kit

- Student worksheet "Microorganisms and temperature"

Materials provided by teacher

- 10 Petri dishes, clean jam jars with lids or clean take-away containers
- 1 marking pen
- Fresh bread slices cut to fit flat in Petri dish
- Access to fridge
- Sticky tape to seal dishes

This activity follows the same process as the first activity except using temperature as the dependant/experimental variable. Using a permanent marker label the dishes experiment (warm area) and control (fridge) and leave for a week. Students observe and comment on change. A light spray or sprinkle of water on both specimens will increase the speed of colonization and multiplication.

This experiment follows similar procedure to the previous one, "Microorganisms and water"

You will need

1. Two samples of bread (same size/type/age etc)
2. Two Petri dishes
3. Marking pen
4. Sticky tape for sealing the dishes
5. A warm place to put one specimen and a cool place to put the other

The results of your experiment will be colonies of bacteria and fungi. They can be dangerous to your health. Do not open the Petri dishes after they have been sealed!

Students will:

- Place same sized samples of fresh bread in both Petri dishes and seal them.
- Mark both with the biohazard symbol.
- Place one dish on a warm place and the other in a cool place. This is the ***CONTROL***
- Leave the dishes observing any changes regularly.
- Write down your observations.
- Return your unopened dishes for the teacher to dispose of.

Which variable will they be measuring? (The dependent variable) ***Rate of decomposition***

Rate of colonization by bacterial and fungal colonies can be estimated by percentage of bread surface affected over time. Transparent grids are provided in the kit.

Observations on the effect of moisture on the decomposition of bread

Day	Cool bread	Warm bread
1	***No change***	***No change***
5	***No change***	***Coloured dots appear***
12	***Some dots appear***	***Large colonies present***

Hint Fungal colonies tend to be furry and bacterial colonies tend to be slimy.

Use the results of your experiments and your own experience

What conditions would help a dead plant or animal to be fossilized. Add your knowledge from the previous experiment "Microorganisms and water" to make a more complete answer.

Both moisture and warm conditions speed up the rate of decomposition of bread. Rapid burial in dry hot conditions would protect the organism from scavengers, bacteria and fungi.

Where in Australia would you find conditions which would aid the fossilisation process?

Southern cooler parts of Western Australia, especially where it is dry. In the very dry inland where hot wind will aid mummification. Not in the warm moist tropics during the "wet" season.

Why are fossils rare?
TEACHER DEMONSTRATION AND STUDENT HOMEWORK

Groundwater A

In ancient peat bogs and marshes of Europe, bodies (and part of bodies) up to 6,000 years old have been found in varying states of preservation. Visit http://www.tollundman.dk/ and view Tollund Man, one of the best preserved examples. Tollund man had been strangled, hit on the head and thrown into water, perhaps in a Celtic ritual associated with the end of winter. Since the soft internal organs are well preserved his recent meals could be interpreted. This form of fossilization is neither a mould nor a cast as parts of the original organism are retained. It is a “body” fossil.

Bog water contains humic acid and tannin both of which are produced from rotting vegetation. Humic acid is weak and is not a single acid but a mix of varying components depending on varying vegetation types. Humic acid preserves flesh but dissolves calcium carbonate in bone. Tannin is the chemical which is released by our tea trees in the south west of Western Australia and this colours stream water brown. Tannin is also the agent in tea which gives it its brown colour and refreshingly astringent flavour. People have used tannin for colour and for tanning (preserving) leather since ancient times.

Another mild acid, vinegar or acetic acid, is used for preserving fruits and vegetables as pickles. Bog water is cold and low in oxygen and this also restricts bacterial decomposition. Although flesh is well preserved bones are not. Bones contain the mineral calcium carbonate which will dissolve in acid.

$$CaCO_3 + 2CH_3COOH = (CH3COO)_2Ca + CO_2 + H_2O$$

Calcium carbonate + vinegar (acetic acid) = calcium acetate + carbon dioxide + water

Materials provided in the kit

- Student homework worksheet “Groundwater A”

Materials provided by teacher

- 2 cleaned chicken wing bones.
- 2 beakers, large cool drink bottles or jam jars
- Vinegar or weak hydrochloric acid

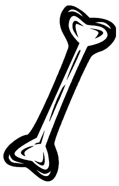
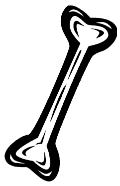
Chicken bones can also be collected from a supermarket, from home or from the school canteen and cleaned. Thick leg bones take longer to dissolve than the thinner wing ones provide. Cooked bones are fine. Place one chicken bone in plain water in one beaker and another in vinegar (acetic acid) or weak hydrochloric acid. The acidulated bones become soft and flexible in about three days. Left in the air they will harden again. Students may soften the bones, tie them in knots and leave them in the air to harden. The knotted bones can make an interesting neck or wrist adornment. Spare rib bones and chop bones will also work well but take much longer and require more acid. This explains why wine marinade is used to soften tough meat, why herring are prepared in vinegar as roll mops and onions are preserved in pickle).

Hint *Schools with Science laboratories may choose to use hydrochloric acid and refresh the acid marinade frequently as the results are faster.*

Wobbly eggs

A fairly disgusting but fun activity which also demonstrates how egg shell (calcium carbonate) is dissolved in acidic solutions but flesh (protein rich yolk and white) remains, involves placing raw eggs in vinegar. In a couple of days the eggshell is dissolved leaving the liquid egg only contained by a pair of very thin outer membranes. Trying to lift these eggs from the liquid is messy but memorable. The eggs can be boiled first to reduce the mess (and the fun!). A worksheet is supplied for student homework.

Observations of chicken bones over one week.

Acidic water	Plain water
The chicken bone becomes flexible 	No change 

Acid groundwater tends to form in cold wet places like swamps and wetlands.

Use the results of your experiment

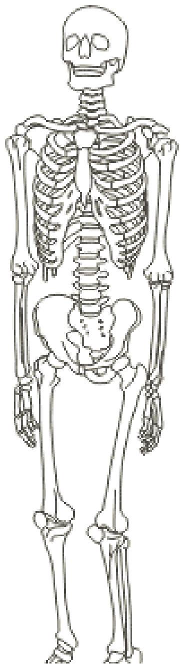
Where in Western Australia would such conditions be found?

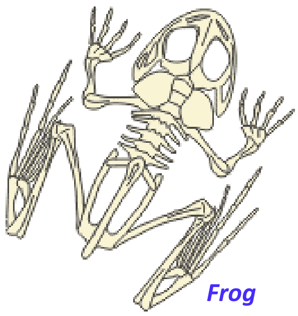
The South West of the state where boggy acidic conditions occur.

fossils

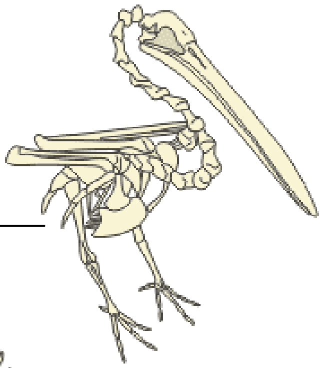
Usually only large strong bones survive natural burial. Name the animals below and colour in which bones you think might survive burial.

Names of skeletons are provided. Usually only the skull or cranium, lower mandible or jaw bone and some of the long bones are dense enough to survive. Most of the smaller complex bones in the ribs, hands and feet are easily dissolved. Cartilage in the nose, breast bone etc dissolves quickly. A shark has no "bones" only cartilage. Teeth are made of hard enamel and dentine, the two hardest materials in the body. Usually only shark teeth, like the ones in the kit, survive to be fossilized. Ancient sharks are classified by their teeth.

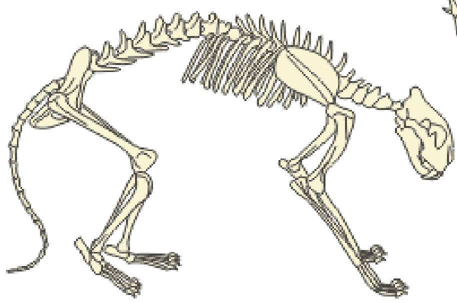




Frog



Pelican



Human- Homo sapiens

Cat

You may wish to try another experiment at home

Place a hardboiled egg in a glass of vinegar over-night and observe.

What did happen? *The shell dissolved leaving the rest of the egg.*

Brave students may wish to repeat the experiment with a raw (un-boiled egg).

Rollmops ***Vinegar dissolves the annoying bones but preserves the flesh. The acid discourages bacterial multiplication.***

Extension

BODIES IN BOGS

Submerged in peat bogs and marshes of Europe, bodies (and part of bodies) up to 6,000 years old have been found in varying states of preservation. Visit http://www.tollundman.dk/ and view Tollund Man, one of the best preserved examples. Bog water contains humic acid and tannin which is produced from rotting vegetation. Humic acid is weak and is not a single acid but a mix of varying components depending on varying vegetation types. Tannin is the chemical which is released by our tea trees in the south west of Western Australia and this colours stream water brown. Tannin is also the agent in tea which gives it its brown colour and refreshingly astringent flavour. People have used tannin for staining and for tanning leather since ancient times. Bog water is cold and low in oxygen and this also restricts bacterial decomposition.

Students tan eggs using tea bags. Tanning preserves proteins. Boot leather was preserved by tanning in urine. The wool in tweeds was preserved by tanning in male urine.

Why do the bodies in the bogs have well preserved skin and internal organs but their bones are damaged?

Humic acid dissolves bones but preserves the protein rich skin.

Interesting Fact for teachers

The volcanic island of Iceland in the North Atlantic has an interesting delicacy. Fresh Greenland shark flesh is poisonous. Sharks are hunted and their bodies gutted and laid in volcanic sand and pebbles for about three months to ferment. The low ambient temperature discourages most bacterial and fungal growth and fluids drain away. After about three months the shark is cut into strips and left to dry. The result is a very smelly strong tasting gelatinous dish called Hákarl. It is usually eaten with local spirits and is said to give strength to the consumer. The smell of ammonia is so strong that most people can only eat it if they hold their noses otherwise the “gag reflex” kicks in.

Chef Anthony Bourdain (Kitchen Confidential) described this dish as ***“The single worst, most disgusting and terrible tasting thing I have ever eaten”***

Groundwater B

Alkaline water, such as is found in deserts, dissolves flesh but preserves bone. The mineralized water can fill cavities in the fossil and **permineralise** it or if they replace the original structures the fossil becomes **petrified.** (Petros = rock). Water with dissolved salts will penetrate porous organic substances and deposit the salts as water evaporates. Wool, cotton or paper will draw in the solutions and become hardened by the deposited salt. Water is attracted to narrow tubes in the process of capillarity. Water molecules are polarized and act like small magnets to the walls of fibers. You may have noticed how a piece of kitchen towel draws liquid. Manmade fibers are usually less efficient at drawing water as the fibers are not hollow. Proud parents used to hang their children's' first shoes under carbonate rich drips "fossilize" them and turn them to "stone" as mementos.

Empty tea bags can be dipped into super saturated solutions of salt or Epsom salts to copy this process. Artistic students can cut the tea bag material or cotton to create fossil shapes first.

Materials provided in the kit

- Student worksheet "Groundwater B"

Materials provided by teacher

- 2 plastic beakers or clean jam jars
- Bag of Epsom salts (found in the medicine section of the store as "Health Salts", " Eno's Fruit Salts" or "Lemon Salin"e can be substituted)
- Empty tea bags
- Option – salt

Students will

1. Make a super saturated solution of Epsom salts (Magnesium sulphate) by one third filling the container with hot water. Keep stirring in Epsom salts until no more will dissolve. Add food colouring if desired.
2. Hang the tea bag over the pencil and into the container until it just sits into the solution. The tea bag tie can be wrapped round to adjust the height.
3. Leave the equipment for some days adjusting the tie to continue the tea bag to dip into the solution.

Interesting fact for teachers

In different climatic conditions, silica will dissolve in ground water and permeate plant and animal bodies replacing them cell by cell to form opal fossils. At lightning Ridge opalised snails, pine cones, crocodile teeth and more have been uncovered.   Visit: http://www.australianopalcentre.com/fossils.php

Why are fossils rare?

TEACHER DEMONSTRATION

Compression and compaction (Option).

In the process of burial, the weight of overlying sediment causes the materials to become compacted and cemented. An inverted bell jar or large food jar can be filled with alternating layers of sand, moist fresh leaves and ripe tomatoes or small inflated balloons (make sure they are against the glass). The jar should then be sealed and placed upright. Over time the leaf and tomato layers collapse. Balloons can take two weeks to compress. Plastic animals, being hard, do not compress.

TEACHERS NOTES

Fossils also have to survive compaction and cementation processes which turn sediments into rock. Rock must be uplifted and eroded to expose the fossil. Even drilling into strata known to contain fossils does not mean you will necessarily intersect any. Students create sedimentary sandwiches containing replica fossils, compact them and then drill into them to try and intersect a fossil.

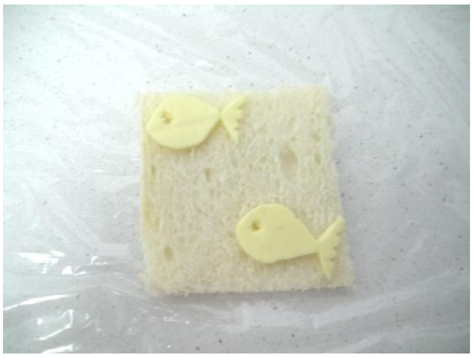
Materials provided in the kit

- Student worksheet "Sedimentary sandwiches"

Materials provided by teacher

- Board and knife to cut shapes and remove bread crusts
- Sliced bread – different types make interesting rock strata. Remove crusts first
- Processed cheese slices
- Optional margarine or butter
- Jelly lollies (thinly sliced snakes are good)
- Cling wrap
- Drinking straws

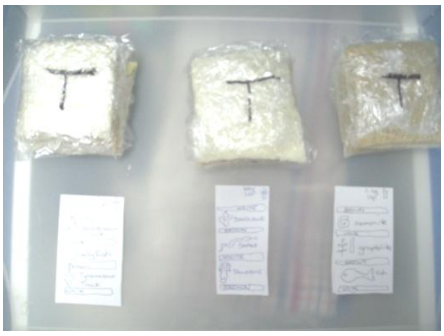
1. Students wash their hands and lay down cling wrap.
2. Students place the first slice of bread on cling wrap to represent the first layer of sediment deposited on the sea bottom.
3. Students cut cheese into small fossil like shapes and randomly place three of these on the first slice of bread. These are the bodies of dead animals which fell to the bottom of the sea and despite scavengers and microorganisms, survived. Fossils are not evenly distributed in rocks, so there will be zones with fossils and zones without.



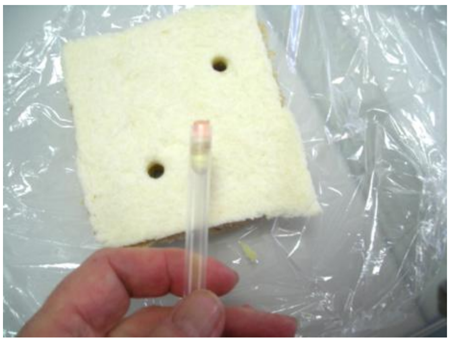
Fossil fish

Descriptions of the rock columns

4. Students create a visual representation of which fossils were placed in each layer. (Above right)
5. This layer is covered with another slice of bread and more fossils (or not). Repeat until a stack of sediments with some fossils is created. At least one fossil free layer should be included.
6. When stack is complete, students wrap with the cling wrap and mark the top of the sandwich/sedimentary rock column.
7. The height of the stack or sedimentary column is measured.
8. Place these columns on a flat surface and cover and compress with a heavy weight (books?) to represent compaction (crushing) under the weight of overlying sediment within the Earth. If you wish, students can sit on their stack for 10 minutes to compact it. If you intend eating the sandwiches they can be "drilled" immediately. The impressions or "moulds" of fossils and the seepage of oils from the cheese can be observed. This seepage from animal fossils is the source of oil which migrates to traps and collects there to form oil fields such as those offshore from Barrow Island.



9. Re-measure height. (See note below).
10. Students can estimate the degree of compaction. Compacted height ÷ original height X 100
11. Use the plastic straw to drill down into the sediment and see if you intersect (cut through) a fossil. When you withdraw the straw you will see a sedimentary sequence similar to the rock sequence seen in diamond drill core. Students should be encouraged to squeeze out the drill section rather than blowing it out!



12. Open compacted sandwich, observe the effects of compaction and count the numbers of fossils intersected.

13. Students may discuss how many holes have to be drilled before we can discover the sedimentary and fossil history of the rock column. The cost of drilling is great. The hire of a rig to drill an oil well is over one million dollars a day. Traditional strategies involved drawing a square grid centered on the first find and moving outwards to find any patterns which could indicate future drilling directions. Recently a spiral pattern centered on the original find has been employed.

Since the formation of fossils requires materials to be buried deeply, it is only when uplift due to folding or faulting brings rocks to the surface that fossils are commonly found. This explains how fossil beaches can be found at the top of Mt Everest.

If you intend eating the sandwiches they can be "drilled" after 2.5 hours of book pressing or 5 minutes of under-bottom compaction. Students should be able to observe the impressions or "moulds" of fossils and the seepage of oils from the cheese. Seepage from animal fossils is the source of oil which migrates to traps and collects there to form oil fields such as those offshore from Barrow Island.

How had your fossils changed because of the forces of compaction applied to them?

Deformed, thinner, broken

Drill core

Extension

As materials are buried deeper and deeper within the Earth they become increasingly hot and compacted. This is called regional metamorphism. When however rocks are locally "cooked" by an igneous intrusion of a volcano, dyke or sill with minimum pressure, this is known as contact metamorphism.

Students can use a heated sandwich press to mimic regional metamorphism and a simple grill to mimic contact metamorphism .

Regional

One sandwich is left un-pressed and un-heated as the ***control.*** A second identical sandwich is heated and pressed and the results compared with the control.

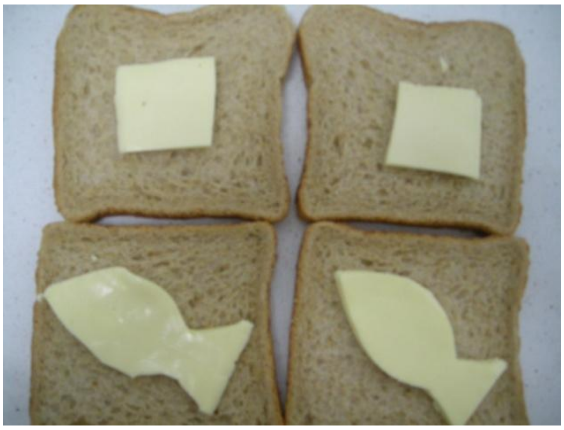
Contact

One sandwich is grilled and the other left untouched as the Control.

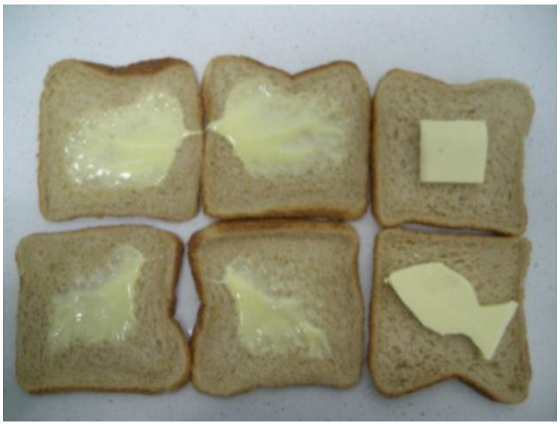
All data should be:

Observable, Measurable, Repeatable and Reportable

Measuring deformation caused by heat and pressure is difficult. If the initial material has a regular geometric shape such as a square or cube, a simple ruler is sufficient. If however the original shape is irregular, measurement is more difficult. If graph paper is printed on transparent film (e.g. an overhead sheet) the percentage change can be measured by overlaying the material with a transparent grid and counting squares.



Control and experimental models (before)



Comparison Of heated (left) & Control (right)

Students may be encouraged to ***compare*** (similarities) and ***contrast*** (differences) for the experimental sandwich and the control.

fossils

Revision and wordsleuth

What is a fossil?

Fossils represent the remains or traces of ancient life that lived in the geologic past

1. What are the three things which attack and destroy plants and animal bodies at the surface of the Earth? Name an example of each.

   Predators *example dingo/dog/cat*

   Scavengers *example magpies/rats*

   Decomposers *example bacteria & fungi*

2. Under which conditions would a dead body last longer? Circle the correct answer.
   a. Warm and wet
   b. Warm and dry
   c. Cold and wet
   d. Cold and dry

3. Once the bodies have been buried in sediment, what else can attack them?

   Groundwater and the force of compaction

Fossil crinoid or sea lily from near Geraldton W. Photograph courtesy of Enza

fossils

Fossilisation Word Sleuth

E	L	B	A	T	A	E	P	E	R	L	D	P	S	M
R	K	G	R	O	U	N	D	W	A	T	E	R	C	E
O	C	A	S	T	X	H	S	I	D	T	C	A	A	A
S	O	D	E	E	M	Y	R	U	R	C	O	L	V	S
I	M	E	D	M	M	U	G	I	H	O	M	K	E	U
O	P	P	I	P	B	E	F	E	G	M	P	A	N	R
N	R	O	M	E	U	I	Y	T	N	P	O	L	G	A
F	E	S	A	R	C	Q	N	M	I	A	S	I	E	B
M	S	I	N	A	G	R	O	O	R	C	I	M	R	L
F	S	T	T	T	K	D	L	I	E	T	T	L	S	E
B	I	I	A	U	C	I	O	S	H	I	I	I	T	I
K	O	O	R	R	O	C	C	T	T	O	O	S	R	G
N	N	N	Y	E	R	A	R	U	A	N	N	S	A	N
R	N	C	E	L	B	A	V	R	E	S	B	O	T	U
S	T	E	R	I	L	I	S	E	W	K	E	F	A	F

ACID
ALKALI
BONE
BURIAL
CAST
COLONY
COMPACTION
COMPRESSION
DECOMPOSITION
DEPOSITION
DISH
EROSION
FOSSIL
FUNGI
GROUNDWATER
MEASURABLE
MICROORGANISM
MOISTURE
OBSERVABLE
OXYGEN
PETRI
PETRIFICATION
RARE
REPEATABLE
ROCK
SCAVENGERS
SEDIMANTARY
STERILISE
STRATA
TEMPERATURE
WEATHERING

Finding Fossils
TEACHERS NOTES

Searching through geological time

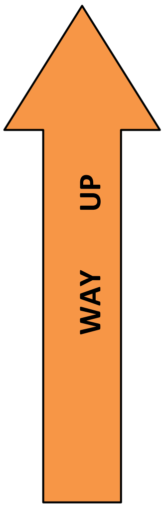
The fossil on the left is faeces (poo) from an Australian land dwelling dinosaur and the one on the right is from a Scottish sea dwelling dinosaur. Faeces rolling about on the bottom of the sea become coated in a mud layer. The core of this mud ball is a mass of fossilized fish bones. Both are from the Crectaceous period

Our planet was without life for a very long time. The Earth formed about 4.5 billion years ago. Evidence suggests life only appeared about 3.8 billion years ago. As more data is uncovered and as new technologies and techniques are developed, these dates may change. Scientists change their interpretations when new data becomes available. Dinosaur skeletons were reassembled when more information became available from present day lizards and birds. Bones which were thought to be nose horns were found to be more likely hooks on thumbs for grabbing prey.

Early life consisted of simple soft organisms that would be unlikely to form fossils. The first fossil evidence of life in Australia is from Ediacarian times 680 million years ago in what is now the Flinders Ranges in South Australia. The shapes of soft bodied jellyfish were preserved in sandstones. Complex life forms suddenly appeared in the early "Cambrian Explosion" perhaps as a response to higher levels of oxygen in the atmosphere.

A general outline of progression of life forms follows. Dates will change as more fossils become available and dating techniques improve.

200,000 years	modern man appeared
200 million years	mammals evolved
300 million years	reptiles evolved
400 million years	insects and seed evolved
475 million years	land plants evolved
600 million years	simple animals evolved in the sea
1 billion years	simple multi-cellular plants and animals evolved
3.8 billion years	simple cells
3.9 billion years	remelt of crust due to planetary bombardment
4.5 billion years	Earth formed



Geologists place the oldest rocks at the bottom of a key and the youngest at the top as this is how rock sections appear in cliffs and cuttings (unless overturned). Geologists have broken the scale into smaller units because of geological events such as mountain building or other major tectonic events and also because of changes in dominant life forms. We shall be looking at the geological history of Australia from Cambrian times up to the Present.

Students are asked to visit the Mining Council of Australia web site http://www.minerals.org.au/primary/secondary/secondary_resources/index.html

and download "Down to Earth" and open "Paleotraveller".

There are activities explaining "deep time" in the development of the Australian continent. The worksheet asks them to progress through time and answer questions on fossils.

Extension

There are many more activities already present in this site which can be used for extension allowing students to track climate through time and follow the movement of the continent of Australia around the globe.

Materials provided in the kit

- Student worksheet "Finding fossils through time"
- Copies of the Geological Time Scale.

Materials to be provided by the teacher

- Access to a laptop and the internet

Answers

Sketch	Two facts	Where you would look in Western Australia
Sea Scorpion	***Lived on sea floor, hunting and scavenging. Largest 1m. Ancestor of modern scorpions. Could breathe in water and on land – one of first amphibious creatures.***	***Seas NW to SE of Broome and off the Kimberly coast.***

When did the Cambrian period begin?

545 my.

Which fossil can be found in Western Australia Brachiopod in both Cambrian and Ordovician times?

Brachiopod

fossils

What happened to Ordovician seas in northern Western Australia during Ordovician times?
(Hint –landscapes)

The seas grew larger and then retreated.

The eastern coast of what is now Queensland would not be a good place to collect Devonian fossils. Explain why?

Volcanoes would kill life. The volcanic gasses and lava flows would incinerate living and dead organisms.

Glossopteris was a tree. Its fossilised remains form some of Western Australia's economic coal deposits. Would you expect to find its fossilised remains in Permian rocks in the south of Western Australia? Explain your answer.

No. This area was near the South Pole and was covered by a glacier in those times.

Why would it not be a good idea to look for glossopteris fossils in rocks laid down near Geraldton 251 to 245.1 million years ago?

Trees do not grow under the sea.

In what age rocks would you look for fossils of Rhoetosaurus, the dinosaur, and where in Western Australia might you find them?

Jurassic age (205-146my) near the coast south west of Broome.

Interesting facts for teachers
William Smith (1769-1839) the father of modern geology, used fossils to correlate different sequences of rocks in widely separated areas of the United Kingdom and draw the first national geological map. This is the subject of the book "The map that changed the world".
Smith came from humble background and did not move easily in society. His work was plagiarised and he became bankrupt and landed in debtor's prison. It was only later in life that he gained true recognition for this massive work.

Ethical fossil collection rules

In 1996 rock bearing fossil dinosaur footprints was stolen from the beach near Broome in northern West Australia. http://www.dinosauria.com/jdp/stolen/stegfoot.htm.

Not only were these fossils rare but they were also part of the local aboriginal Dreamtime and their loss was sorely felt. During wars, fossil collections are pillaged and taken away from their source country. The skull of Peking Man (a possible precursor to modern man) disappeared from a museum in China during WW2. Illegal collections are hidden and become unavailable for study. Illegal fossil collectors may use explosives and jack hammers to break up the rock and thus destroy important evidence. “Fossil Fairs” in the USA are now being examined by Customs officers for illegal imports.

Fossil legislation around the world is patchy. Dinosaur fossils are routinely cut from the earth by poor people in undeveloped countries and sold to rich collectors in “the west”. Fossils are seen by these people as an economic resource and not as national treasures. In Europe and the USA, damage by casual collectors has resulted in many classic areas of geological significance declared as National Parks. Western Australia attempted to legislate for fossil collection a few years ago but was stymied by the fact that major commercial groups develop fossil deposits of coal and oil. How can we differentiate between economic and esoteric interests? There are few existing laws which restrict fossil collection. Most are concerned with the export of fossils. Fossil collection is not allowed in National Parks, on private land without the owner’s consent and at some designated fossil sites.

ETHICAL FOSSIL COLLECTION RULES ACTIVITY

The ethical collection of fossil (and mineral) specimens could be discussed with students and a set of rules created. Although some fossils are easy to find and have little significance or monetary value, for example the fossil root concretions or rhyzoliths in the coastal Tamala limestone, others like the stromatolites at Marble Bar and the crinoids in the first picture in this book, are very rare and consequently precious.

Materials provided with the kit

- Student worksheet
- Replicas of two different ammonites collected from Morocco and Queensland a real ammonite, real shark teeth collected from Algeria, replica trilobite,s a real trilobite and fossiliferous rock.

Materials provided by the teacher

- Internet access if students wish to view information about the stolen dinosaur footprints at Broome WA
- Scrap paper for rough copy, A3 paper for final poster

fossils

Concerns and suggestions which may arise

- ***Fossilisation is a rare event, so unique specimens may be lost.***
- ***If a fossil is casually removed, the information gained from it in comparison with others is lost to Science.***
- ***Casual hacking can damage specimens.***
- ***Fossils may have ethnical or religious significance.***
- ***The casual collector may take more specimens than they need.***
- ***In some countries, illegal fossil collection is extremely lucrative, so people are exploited and localities stripped.***
- ***Although scientific techniques improve, (DNA, electron spin resonance) the specimen if removed or in a private collection, is no longer available for testing.***
- ***How can we differentiate between commercial development of fossils e.g. coal mining and other less commercial exploitation of less common fossils?***

Some suggestions for ethical collection would be:

- ***Do not collect in National Parks, reserves or designated areas.***
- ***On private land ask the landowner first – do not disturb animals or damage crops.***
- ***Use a camera not a hammer.***
- ***Collect from debris or river beds rather than "the rock face".***
- ***If it looks interesting take a photograph and send it to a palaeontologist (Geological Survey of WA, West Australian Museum, E. De C. Clarke Museum).***
- ***Students may visit this New South Wales site for information. http://www.austmus.gov.au/factsheets/collecting_fossils.htm .***

The poster displayed represents ***"Beware of falling rocks/avalanches".***

Interesting Facts for teachers

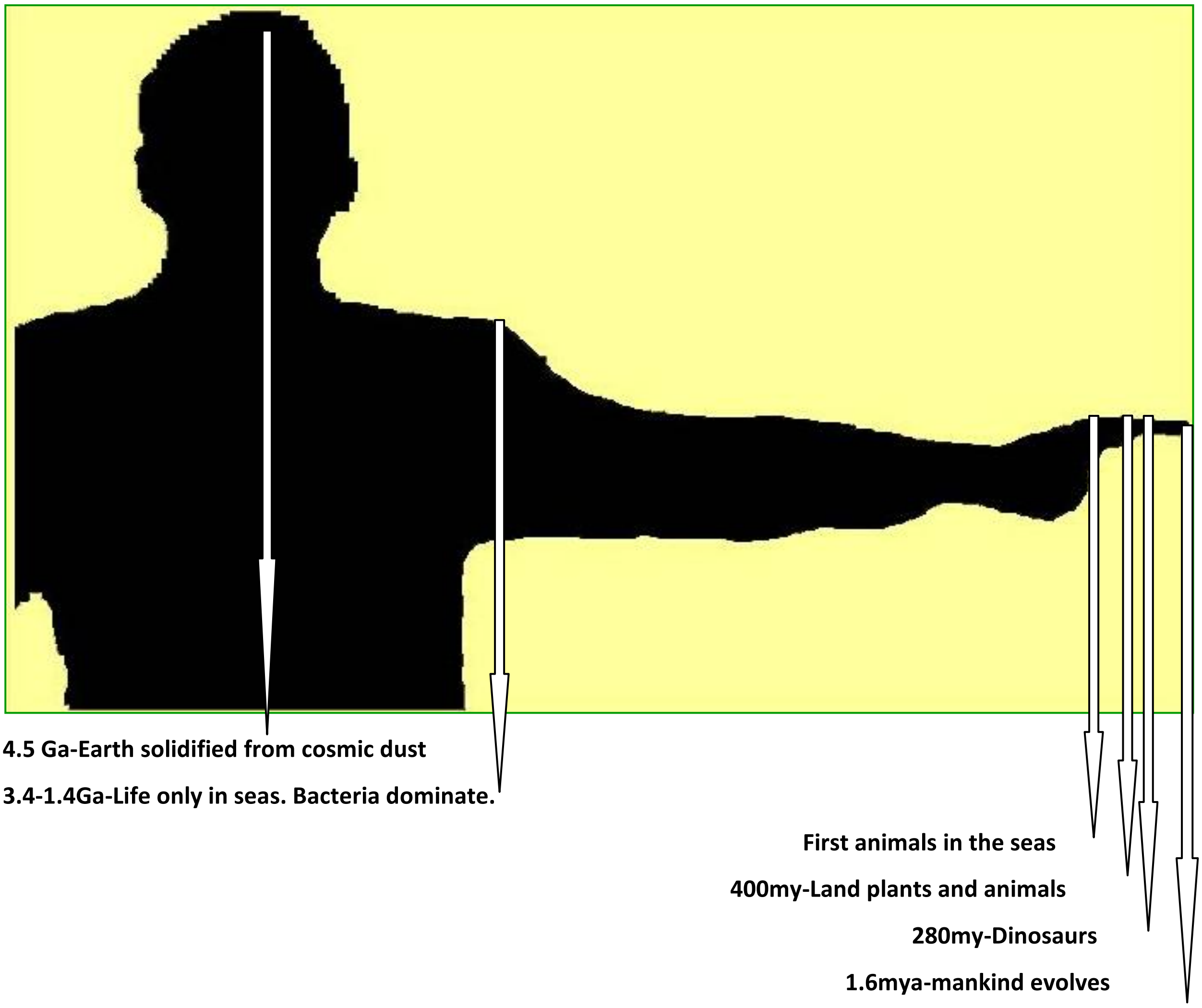
Good collections of fossils may be found in Museum of Western Australia, E. de C. Clarke Museum at UWA and in most regional museums.

Students may wish to visit any of the virtual fossil collections from museums around the world on the internet.

The time of dinosaurs

You can give students an impression of the scale and sequence of evolution of life on Earth using their own bodies as a reference. See below. The entire history of mankind and its Australopithecine forebears can be obliterated by one sweep of a nail file! The precise times on this diagram, like everything else in Science, are subject to adjustment as new fossils and new aging techniques become available.

After McPhee. Basin and Range 1980 (Ga = billion years ago, my = million years ago)



4.5 Ga-Earth solidified from cosmic dust

3.4-1.4Ga-Life only in seas. Bacteria dominate.

First animals in the seas

400my-Land plants and animals

280my-Dinosaurs

1.6mya-mankind evolves

Fossils of Australian dinosaurs are rare as the conditions for fossil preservation, gentle undisturbed deposition in swampy ground, were rarer on this drier continent. Australian dinosaurs appeared during the Triassic (280mya) and most died at the end of Cretaceous times (65mya). They appear to have lasted slightly longer in Australia.

fossils

Hollywood often portrays humans and dinosaurs coexisting. Although mammals evolved about the same time as dinosaurs, they were small nocturnal insectivorous shrew like creatures. The conditions which wiped out dinosaurs allowed other creatures, including mammals, to take their place and thrive.
Some animals, such as cockroaches and sharks developed a simple effective form very early on and have only been modified slightly over the ages. Cockroaches appeared as soon as the first land plants, ferns and cycads and thrived in the same damp boggy conditions.

Materials provided in the kit

- Geological Map of Western Australia
- Geological timescale bookmarks

Materials provided by teacher

- Access to internet
- Rulers
- Paper
- Coloured pencils

Timeline

It is easiest if students orient the page “landscape”. They need to estimate the longest period of time to be measured and find a suitable scale to encompass this. (50mm=1 my)

Marking Key for Timeline	
Title	1 mark
Correct choice of scale to fit page	1 mark
Scale stated	1 mark
Clear time markings on line	1 mark
Labels correctly positioned	1 mark
Neat Presentation	1 mark

Timeline questions (1 mark each)

1. Could early humans have fought dinosaurs?

   No.

2. Explain your answer.

   They lived at different times.

3. Why might dinosaurs have survived longer in Australia than elsewhere?

   Conditions were different, an asteroid struck other side of Earth so less impact,continental dinosaurs were more able to stand drier conditions

4. Could sharks have eaten marine dinosaurs?

   Yes

5. Explain your answer.

   They lived at the same time. (Some older definitions insist that the word "dinosaur" only relates to land dwelling creatures. This has been superseded).

6. Why would dinosaurs not have evolved earlier than land plants?

   Herbivorous (plant eating) dinosaurs need plants as food. Carnivorous (meat eating) dinosaurs needed herbivorous dinosaurs for food (though they ate other animals as well).

EXTENSION

Did mammoths and dinosaurs live at the same time?

Mammoths and dinosaurs did not coexist. The most recent Ice Age started 2.8 mya long after dinosaurs were extinct (about 66 mya).

DINOSAUR FACTS

- Tyrannosaurus rex (favourite of many students) did not live on the Australian continent.
- Some dinosaurs had three (small) brains, one in their head, another in their back and yet another in their tail**.**
- Dinosaurs lived on Earth for about 165 million years
- Dinosaurs remained longer in Australia than in the northern hemisphere.
- The longest dinosaur trackway in the world lies along the Pilbara coast

Extension

A great fun activity, "The toilet roll time line" can be found at: http://www.worsleyschool.net/science/files/toiletpaper/history.html . It is best carried out inside or when there is little wind or rain.

Finding Fossils
TEACHERS NOTES

Dig them out

Fossils are usually found in rocks which reflect the type of environment organism would have lived in. Fossil oysters are found in sandstone and limestone from near shore sediments, scorpions are found in sandstones from sands rounded by desert winds and ferns which lived in moist muddy environments are found in dark mudstones.

1. Use different sands, gravel and soil to form layered "beds" in a plastic cup, yoghurt container or the bottom of a plastic bottle. In the case above, the grey sand is beach sand containing broken fragments of shell, the orange sand is from dunes and does not contain obvious fossils and the brown layers are of garden soil or potting mix. Sand from creek beds is often different from the soils in clay pans and school gardens.
2. Select "fossils" such as beach shells, cool drink bottle tops, beads, small bones or plastic toys. Place these in appropriate beds. In the example above, I placed beach shells in one of the grey beach sand and little metal flowers in the soil layer. I left one of the beach sand layers free of macro-fossils to support the fact that you don't always find fossils.
3. Add a dissolved cementing agent. Using a super-saturated solution of Epsom salts (Magnesium sulphate) was suggested by Jan Ganfield of Dongara DHS. She reflected that it most closely reflected natural groundwater processes. It takes quite some time (1 month or so in cold weather) to solidify however. Weak solutions of PVA glue are good. I have tried using powdered cement mixed through the sediments. Piercing small holes near the base of the container aids drainage through the layers and speeds percolation. Placing on a warm breezy window sill or heating with a hair dryer also speeds the process.
4. Split the cup with a Stanley Knife and ask the students to first guess (or form an hypothesis) as to which beds might contain fossils and write this on the attached worksheet.
5. Students cut open the container to expose the rock. Using the nail and paint brush they gently expose any fossils and discover if their hypothesis has been supported.

I recommend that students view any episode of Time Team (UK) on the ABC. It reminds them that hypotheses change as more data becomes available. Short downloads are also available on "You tube".

Finding Fossils
TEACHERS NOTES

Finding fossils using a grid

Once one interesting fossil has been found in an area palaeontologists will search for more. Where rock strata outcrop at the surface, this can merely mean following along the exposed rock beds. However often there is little to be seen at the surface due to many million years of weathering. In Western Australia some of our weathering profile can be over a hundred meters deep. Weathered rock can also be moved down hill by gravity and general soil creep. Scientists then have to "best guess" where to look as excavation can be difficult and expensive.

A grid is laid over the find area and clues such as colour change in soils, geomorphology or direction of drainage flow are mapped. These might suggest a change in underlying rock type. A map is drawn with these features and the location of the original find. If there are clues in the landscape e.g. the first fossil was found along a ridge face in dark grey soil, these will be used to guess the next location to excavate. Once a second find is made the lie of the underlying land can be roughly guessed. The greater number of fossils located the more accurately the underlying geology may be mapped. Sometimes remote sensing such as magnetic surveys or geochemical soil sampling may be used but these are very expensive.

Of course, since fossils are rare, just finding the right geology does not guarantee a fossil!

Materials supplied in the kit

- Student worksheet

Materials supplied by the teacher

- Measuring tape
- Phys. Ed. long jump sand pit or sandy area (Good excuse for an outing to the dry creek bed!)
- 3 different kinds of objects to be buried in the sand to represent fossils (empty cool drink bottles, pencils, erasers, straws etc)
- Ruler for drawing grids or graph paper

First hide the pseudo-fossils in bands across the sandpit or sand filled tray. Mark the location of **one** of each of the different kinds of "fossils" on the surface. Students start their worksheet and extrapolate from known locations where fossils might be found to where they might be found. Move to the sandpit and with the measuring tape mark an alpha-numeric grid over the location where the pseudo fossils were hidden. The lines of the grid can be marked by dragging an object over the sand or student footprints. They draw the grid and location of known finds on their worksheets.

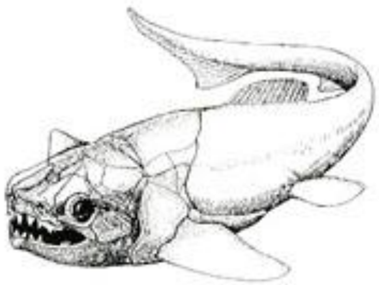
Students then take turns to "best guess" where to find more fossils. Once fossils have been found at a second location, it will take another good guess to suggest bed orientation and a third to confirm this. Since often beds are parallel in strata, the orientation of other fossil bearing beds can be inferred.

It is assumed that the large fossilised shell of the ammonites pictured came from a creature similar to the smaller central white *Spirula shell* or ram's horn shell of a present day squid which lives in ocean deeps. Palaeontologists assume that similar structures develop as adaptations to similar habitats. The structures are sufficiently different to suggest that they are not the same species. The concept was first described by James Hutton (1726-1797). He called it "The Principle of Uniformitarianism" but is more commonly known as **"The present is the key to the past".**

What modern creatures resemble dinosaurs? *Lizards & birds.*

Revision and wordsleuth

Gogo Fish Guessing Game



Western Australia's fossil emblem is the Gogo fish (Mcnamaraspis kaprios). They are found at Gogo Station south east of Fitzroy Crossing in shale which was deposited in quiet inter-reef bays 375 million years ago. They had a shark like body with a single dorsal fin and gave birth to live young. They are the best preserved early fishes in the world

From the information above and what you have discovered about fossils. Choose the answer you think is most correct.

If you were looking for a Gogo fish elsewhere, you would look:

A. For rocks of the same age.
B. For rocks of the same type.
C. For rocks which outcrop at the surface.
D. All of the above.

You can find and collect fossils like the Gogo fish:

A. Anywhere in outback Western Australia.
B. Only on open country where there are no houses.
C. Anywhere except National Parks and Reserves (with permission of any farmers etc).
D. In mines and quarries.

The Gogo fish was fossilised because:

A. It lived in a reef environment and had sharp teeth to defend itself against scavengers.
B. It lived on Gogo Station up in the Kimberley.
C. Its body was deposited in gentle waters and rapidly covered with sediment.
D. It died out before modern fish evolved.

We usually find only the head parts of the Gogo fish because

A. These were the hard bony parts.
B. Mineralising waters would have hardened bone.
C. Bacteria and scavengers would have eaten the soft parts.
D. All of the above.

The Gogo fish is extinct. This means

A. It smells.
B. It died a long time ago.
C. It can no longer be found on Earth.
D. It was fossilized.

TEACHERS ANSWERS

Finding fossils word sleuth

AGE	GLOSSOPTERIS	PARK
CAMBRIAN	GOGO	PERIOD
CARBONIFEROUS	GRID	RESERVE
DEVONIAN	JURASSIC	ROCKS
DINOSAUR	LANDSCAPE	SEDIMENTS
EXTINCT	NATIONAL	SILURIAN
FINDING	ORDOVICIAN	TIME
FOSSIL	OUTCROP	
GEOLOGICAL	PALEONTOLOGIST	

Interesting Idea
Recent finds have demonstrated that the Gogo fish would have been able to gulp air from the surface. This might have been in response to a change in climate and a decrease in the amount of oxygen in the atmosphere in Devonian times.

Dinosaurs, Data and Dimension
TEACHER BACKGROUND

Inference plays a large part of our understanding about fossils. We have to infer the size of an animal from its footprint or the environment of a plant from its vascular system.

True (body) fossils of dinosaurs are rare in Australia however dinosaur tracks (trace fossils) are more plentiful. Dinosaurs have created "track ways", records of their passing when they walked across soft mud and clay which subsequently hardened. Australia has two famous dinosaur track ways, one at Lark Quarry near Winton in Queensland and another about 80km long just south of Broome in Western Australia. Whereas carnivorous dinosaurs (Theropods and Ornithopods) had three toes with claws, herbivorous (Sauropods) dinosaur feet impressions are more varied and lack claws.

By examining these trace fossils we can estimate:

1. Whether the animal was biped or quadruped.
2. The height of the dinosaur. (footprint length X4 will give the hip height of the dinosaur)
3. The length of the dinosaur. (footprint length X10 will give the length of the dinosaur)
4. Whether the dinosaur was an herbivore or a carnivore. (presence or absence of claws)
5. Speed of travel. (ratio between pace and stride)
6. Whether they were solitary or travelled in packs or families.

Extension

Students can also cut out dinosaur feet from potatoes/carrots and print track ways in clay or damp sand. These tracks can be interpreted. "Tracks Tell Tall Tales" e.g. herbivorous dinosaurs travelled in herds with their young. They were attacked by carnivorous dinosaurs. If the model feet are pressed hard into soft white bread and the bread toasted, then a dinosaur footprint will appear as a less brown area. Toasted track ways can also appear in biscuit dough.

Younger students may wish to start with human, dog or bird feet dipped in paint to make familiar tracks on paper.

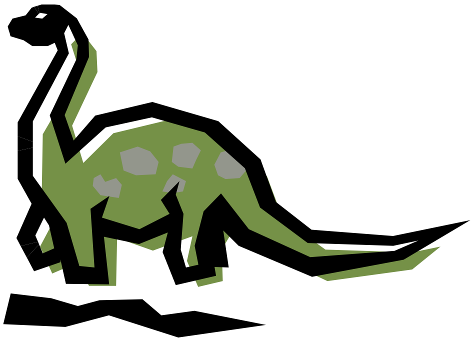
HINT *If the paint is squeezed onto a piece of kitchen sponge to be used like an ink pad, the prints are clearer.*

Some indigenous students know how to use their fingers to make tracks in sand and tell stories..

Dinosaur track ways worksheet

A track way is created when animals move across soft ground. When the ground hardens within the Earth, it becomes a fossil track way.

Australia has two particularly famous dinosaur track ways, one near Winton in Queensland and another about 80km long just south of Broome in Western Australia. Students may use the model dinosaur feet provided and stamp pads to familiarise themselves with the shape of carnivores and herbivores footprints first. MYA or mya = millions of years ago.



Materials provided in the kit

- Wooden board or bench protector
- Potato or carrot and knife
- Student worksheet

Materials provided by teacher

- Access to internet or printed download.
- Stamp pad
- Scrap paper or a student tray filled with damp sand

Hint *If you don't have stamp pads, cut a kitchen sponge in quarters and soak with PVA paint.*

Safety hint *Children should be dissuaded from putting the model feet in their mouths.*

Students may visit the web site http://www.abc.net.au/dinosaurs/meet_the_dinos/ozdino2.htm or be given printed/downloaded copies and answer the following questions.

1. How long ago did these dinosaurs live? ***115 to 120 mya***
2. What three things made these footprints exceptional (very special) according to Dr Guiseppe Leonardi? ***Largest number of footprints, greatest diversity of types, best preservation***
3. When was this track way first scientifically studied? ***1991***
4. Using the internet or a dictionary find the definition of

   Herbivorous ***plant eating***

   Carnivorous ***meat eating***

5. What is the difference between the tracks of herbivorous and carnivorous dinosaurs? ***There are more herbivores (also carnivores have claws and three toes)***
6. Was this footprint from an herbivorous or a carnivorous dinosaur? Explain your answer. ***Carnivore – three toes and claws.***
7. How can we infer that herbivorous dinosaurs are more common that carnivorous ones? ***More footprints – one carnivore needs several herbivores for food.***
8. Name the five groups of dinosaurs which roamed south of Broome. ***Theropods, Sauropods, Ankylosaurs, Ornithopods and Stegosaurs.***

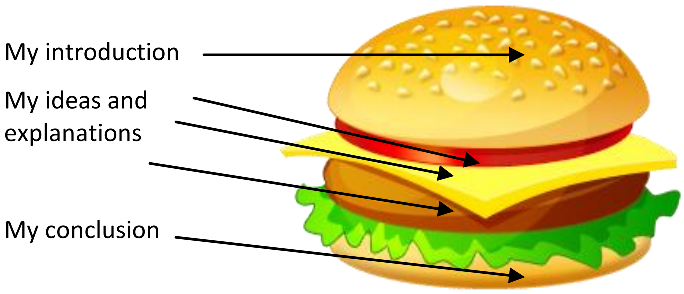
Using books or the internet, draw a dinosaur from one of these four groups and fill in the questions below.

Sketch	Information
	Name ___________________________________ Geological Era ___***Mezozoic***___________________ Size _____________________________________ Diet _____________________________________

What else was discovered during the expedition? ***Prehistoric shark teeth and jaws, bits of marine reptile backbone and first Australian evidence of stegosaurus.***

9. Would you like to go on an expedition like this? Explain your answer.
10. Why should we be upset to find out that the stegosaur footprints were stolen?
    Surely they are just bits of rock. ***Scientific, cultural and tourism reasons***.

Describe your feelings on this subject in a short essay. Students are provided with the hamburger model of essay writing in their worksheets**.**

	DRAFT IDEAS

This should provide a draft outline for checking.

Dinosaurs, Data and Dimensions

TEACHER'S ANSWERS

Dinosaur Dimensions

By studying places where there are dinosaur track ways and skeletons, scientists have been able to use the tracks to tell us about the dinosaurs which left the tracks even if no bones are left. Students will test to see if the same is true for humans. They may wish to reflect on two major concepts first.

A. **"The present is the key to the past".** This idea was proposed by the Scottish father of Earth Sciences James Hutton (1726 – 1793). He suggested we can better interpret past events by relating them to present day processes and data.

B. Scientific data is only acceptable if it is observable (senses), measurable and repeatable.

Hint - The effect of increasing measurement accuracy by increasing sample number can be demonstrated by asking the class "How many people like fish?" or a similar question. Place the apparent percentages of response on the board after asking one student, three students, ten students and finally after asking the whole class. The larger the statistical sample – the more accurate the estimation.

Materials provided by the kit

- Student worksheet

Materials provided by teacher

- Tape measure
- Calculators
- Rulers
- Sand pit – long jump pit or play pit
- Rake to flatten sand

1. The hip height of the animal (dinosaur).

The hip height of a dinosaur can be estimated by multiplying its foot length by four.

A B C D

Scale 1:100

Which of these dinosaurs is the tallest (at hip)?

D

What is the hip height of the tallest dinosaur?

720cm or 7.2m (1.8X4X100).

Why can there be problems if we only measure ONE footprint from each group?

The one measured might not be typical of the group (juvenile, injured, male/female etc). Averaging provides a better representative measurement for the group.

2. The hip height of the animal (human)

Students are asked to create an experiment which will find if there is a direct relationship between a human's height and their hip height. To help them organize their thoughts there are some hints

Which variable/s will they measure?

Length of foot and height of hip.

How can they be sure we are all measuring the same things?

Agree on precisely what to measure (highest part of hip and left feet of males etc).

What measuring instrument will they use?

Ruler, tape measure, whatever is available with small gradations.

Which units should they use for measurement?

Precision and accuracy suggests mm but the result may be converted to cm or m. Results are usually given to two decimal places.

Which variable/s will we control?

Age, sex, medical history, shoes or not, same instruments.

How many humans should they test?

Several (Minimum 3 to be able to produce an average and reduce the effect of rare "outriders " – whole class results can be boarded and compared with groups of three).

How will you display your results?

Table with averaged results.

3. **The length of the dinosaur.**

The foot length is usually one tenth of the length of the dinosaur.

What is the length of these three dinosaurs?

Dinosaur	Foot length	Length in metres
A A Sauropod from Texas	91.44cm	*9.15m*
B Tyrannosaurus rex	114cm	*11.40m*
C Scutellosaurus	12cm	*1.20m*

Can we estimate the height of a human from length of their feet? Explain your answer. ***We can estimate (but not with great accuracy) because there is a direct relationship for adults (Police CSI agents use this). With children/students, rate of development and maturity make this estimation much more difficult.***

4. **How fast were the dinosaurs travelling?**

Visit the school sand pit or long jump pit. Rake the sand flat. Measure the distance of imprint between strides when a student walks, ambles and runs across the sand. Is there a direct relationship between the speed and the length of pace? ***Yes***

fossils

Wordsleuth Dinosaurs data and dimensions

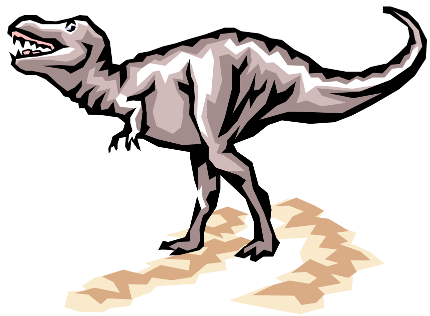
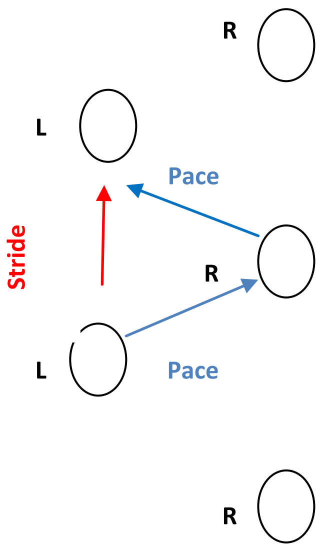
T	Y	P	E	A	B	B	F	M	T
R	H	A	B	R	O	O	M	E	R
A	E	L	F	U	N	N	Y	S	A
C	R	E	F	N	E	S	S	O	C
E	B	O	O	K	S	A	T	Z	K
D	I	N	O	S	A	U	R	O	W
E	V	T	T	E	A	R	I	I	A
P	O	O	P	A	I	I	D	C	Y
A	R	L	R	R	R	A	E	A	S
C	E	O	I	C	E	N	A	S	E
E	G	G	N	H	M	U	D	T	A
S	P	Y	T	B	I	P	E	D	C
P	R	E	S	E	R	V	E	D	L
H	I	P	F	O	S	S	I	L	A
L	A	R	K	Q	U	A	R	R	Y
S	T	A	M	P	E	D	E	N	T

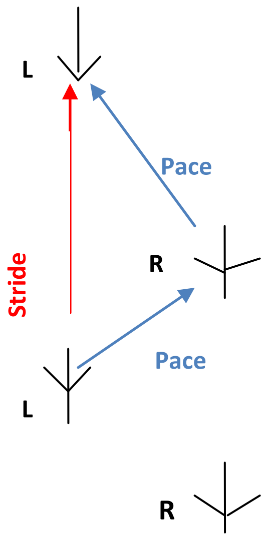
Air	Egg	Broome	Biped	Books
Dinosaur	Foot print Fossil	Hip	Herbivore	Lark Quarry
Pace	Palaeontology	Preserved	Type	Clay
Run	Saurian	Stampede Stride	Trace	Track ways
Mesozoic Mud	Cast	Bones		

Quadrupedal and bipedal tracks

Dinosaurs travelled on two feet (biped) or four feet (quadruped). The earliest dinosaurs were bipedal and had three toes. Students select a biped and a quadrupedal dinosaur and paste or draw them into the table. They are then informed of the difference in shape the tracks left by these different methods of locomotion. Students collect data to support this by comparing the geometry of their footprints with that of a quadruped (cat/dog/cow). Measurements can be done at home or in the school sand pit.

A ***stride*** measures the advance from left foot to left foot, whereas ***a pace*** measures the advance from left foot to right foot and vice versa. A stride is usually slightly more than twice the length of a pace.

<table>
<tr>
<td>
Quadrupedal locomotion
From Triceratops</td>
<td>
Bipedal locomotion
From Tyrannosaurus</td>
</tr>
<tr>
<td>

The triangular space created between pace and stride is wide for quardrupedal animals.</td>
<td>

The triangular space between pace and stride is narrow for bipedal animals.</td>
</tr>
</table>

Scientists will only accept ideas if they are backed up by data that is:

Observable, Measurable and Repeatable.

Bipedal Animal

Walk across soft ground, the school sand pit or clay and make three measurements of stride and pace. The average of these readings will represent a bipedal animal – YOU! (Homo sapiens).

Quadrupedal animal

Cows and horses leave deep imprints which are easy to measure. Dogs and cats don't seem to mind water on their paws and they leave obvious wet tracks across concrete and sand. Rats and mice would prefer if their paws are gently dipped in dry flour.

Dinosaur data and dimensions **Revision and wordsleuth**

What five things can footprints tell us about dinosaurs?

Herbivore or carnivore , biped or quadruped, length of dinosaur, height of dinosaur, speed of travel,

solitary or pack animal, direction of travel

James Hutton, the "Father of Earth Science" said that the present is the key to the past. Can we use information about the dimensions of present human beings to understand more about dinosaurs?

Not really, humans are not reptiles. We can get an impression of number and direction of travel but our body structure is quite different.

How would the tracks from a quadrupedal dinosaur differ from the tracks of a bipedal dinosaur?

Bipedal dinosaurs have three toes and prominent claws

Puzzle for sneaky Scientists Does your ability to ride a bicycle increase with your shoe size?

When we are very young we cannot ride a bicycle and have small shoe sizes. Later our size might increase

but unless a bicycle is available we will not ride. In adulthood our shoe size remains constant but our

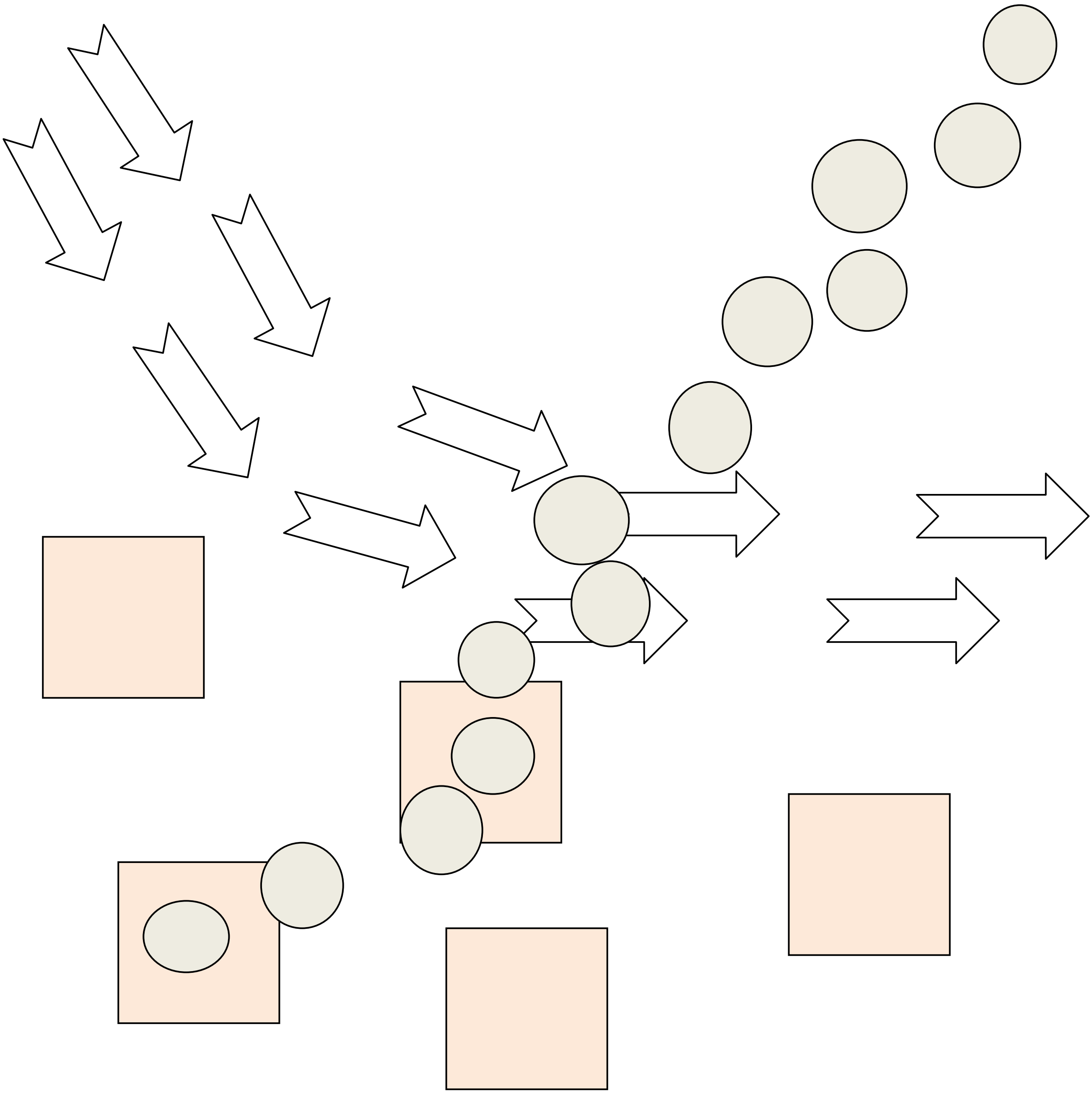
ability may increase or decrease depending on interest or need.

Extension

These marks represent footprints on a Cretaceous (Time of the dinosaurs) track way.

Which of these tracks is bipedal ___________ and which quadrupedal? ______________________________

Which animal was the first to walk on the track way? ____



FOSSIL FUN AND FABRICATION

TEACHER NOTES

Moulds and Casts

A PALEONTOLOGIST STUDIES FOSSILS. Fossils can be preserved organisms, moulds or casts of the organism or tracks left by the organism. A mould is formed from the material enclosing the fossil. A cast is formed when something else fills the void left by the organism.

In this activity students learn the difference between moulds and casts. In both cases trace fossils are produced.

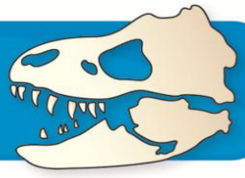
Paper clay casts from silicone moulds

Materials provided in the kit:

- Student worksheet
- Fossils and replica fossils from the accompanying box

Materials provided by the teacher:

- Plaster of Paris PoP. If possible use ***CASTING*** Plaster of Paris as it dries mush faster than standard. It can be bought in bulk or in 2 or 3kg packets from hardware stores).
- Plasticine or modelling clay. Old clay from the Art room is excellent!
- Kitchen non-stick spray
- Ice cream container and a spoon for stirring
- Water in jug
- Option – teacher may use paper clay available from art suppliers. This enables smaller children to produce more colourful casts (see above). These can take days to dry however.
- Transparent squared sheet for estimating scale (photocopy graph paper on printable transparency)
- Old newspaper to protect desks from plasticine smears.
- Paint and brushes for decoration
- Access to the internet



Hints

- *In cold weather leave plasticine somewhere sunny to soften before use.*
- *Do not prepare your Plaster of Paris (PoP) mix until immediately before use. It sets quickly.*
- *A small ball or column of plasticine or a small piece of drinking straw placed in the mould before plaster is poured will provide a hole for stringing the cast as a necklace. If you have little magnets, place these on last and the cast will make a lovely fridge decoration if painted.*
- *Tell students to gently tap the mould for two minutes to bring bubbles of air in the PoP to the surface. This also allows sufficient time for the teacher to move round the classroom and all the students' moulds to be filled. Leave excess PoP in the ice cream container. When it is dried it can be easily cracked out and put in the bin.*
- *Do not pour PoP down the sink as it may cause an expensive blockage.*

Plaster of Paris is calcium sulphate CaSO4 $0.5H_2O$. It is used to plaster walls and ceilings, to create plasterboard and to align and set broken limbs. It is made from gypsum, a natural salt found in our salt lakes. Gypsum is heated and water driven off to create Plaster of Paris.

$$2\ CaSO_4{\cdot}2H_2O \rightarrow 2\ CaSO_4{\cdot}0.5H_2O + 3\ H_2O$$

When the PoP is mixed with water it becomes a solid again and releases a little heat. It hardens from the outside inwards. Students should not play with their mould as the cast can still be weak and liquid inside. Its name originates from a deposit found near Montmartre in the city of Paris. The rate of hardening depends on the thickness of the cast and on the ambient temperature and humidity.

To make a fossil mould

1. Make a flat disc of plasticine about the size of the palm of your hand. Old plasticine or clay is fine. If neither is available, fine wet sand pressed into a soup plate or tray produces tolerable results. Student worksheets have pictures of the process.
2. Spray the object to be copied with kitchen spray (fossil, leaf, shell or small plastic toy).
3. Mould the plasticine firmly around the object to form a cup-like shape. Take care not to puncture the mould. Leaves need to be pressed gently into the plasticine.
4. Ease the object free from the mould without deforming it. The mould should now be a cup like-shape. Sketch your mould into the left side of the table below.
5. *Visit* http://en.wikipedia.org/wiki/Ediacaran_biota and copy the photograph of *Dickinsonia costata* into the second box. This is a mould of one of the earliest complex living things on Earth – and - of course - it is Australian!
6. Save the mould for the next activity.

Student's mould	Sketch of D. constata
Mould of	Mould of *Dickinsonia costata*
Age Scale 1:	Age Scale 1: ***will vary***

HINT: Younger students may need to use the transparent squared sheet to estimate scale.

1. Not all features of an organism survive the moulding process. List features of your original fossil which no longer appear in the mould and are therefore subject to interpretation. **Internal structures, information from the other side of the fossil, some fine detail.**

Ask another student if they can guess what you used to make the shape of your mould.

2. I think the object used was ____

What sort of organism/s could the mould of *Dickinsonia costata* be interpreted as? ***Unknown – we don't have sufficient data preserved or similar living things today to compare them with. Science ideas changewith new data..***

To make a fossil cast

Most creatures which die and fall into the mud and other soft sediments at the bottom of the sea are eaten by scavengers or decay due to the action of fungi and bacteria. All that remains is the mould or imprint where they lay. This shape is filled with later sediments which petrify and form fossil casts.

Plaster of Paris should be mixed with water to form a thick custard-like consistency. If you have a large class it might be easier to make two quantities, one after the other.

1. Use the mould you created in the last activity or one of the blue dinosaur silicone moulds.
2. Fill this mould with Plaster of Paris. It is less messy if the teacher does this.
3. Students should place the mould on the table, hold it with one hand and gently tap the plasticine with two fingers for two minutes. This will move any air bubbles from the PoP and also enable teachers to finish filling all moulds whilst students are busy.
4. After five minutes the plaster will be hard enough on the outside to allow students to inscribe their initials in the top of the cast with a pencil or thin stick.
5. Any movement of the cast will disrupt the still wet PoP inside the cast. It must be left undisturbed until completely dry. This can vary from 20 minutes in summer to one hour on a cold rain day.
6. Students gently ease the cast from the plasticine mould.
7. Examine the cast. Has any detail been lost forming the cast? ***Yes, even more detail is lost. Any spherical voids are air bubbles still trapped in the plaster.***

Students may wish to paint their casts to more closely resemble the original.

Extension

Modelling deformation due to compression and compaction.

When sediments are buried they become compressed (squashed) and compacted (stuck together). This is due to pressure from overlying sediments, heat from the Earth and materials dissolved in ground water. Sediments become rock. During these processes and subsequent uplift rocks become deformed.

1. Students create another mould of the original object.
2. They gently deform this to model Earth forces during compression and compaction.
3. Fill the mould with Plaster of Paris as you did in the previous activity and leave it to harden.
4. Compare this cast with the original object. Sketch both below.

Original	Deformed cast

FOSSIL FUN AND FABRICATION
TEACHER NOTES

Make a replica fossil

James Hutton suggested that "The present is the key to the past". By copying present day Earth processes we can create a replica fossil within in an hour. This activity follows the same steps as "Moulds and casts"

Materials provided in the kit:

- Student worksheet
- Plaster of Paris (casting)
- Iron oxide colouring agent - option
- 10 ammonites, 10 shark teeth and 3 trilobites.
- Kitchen spray (non-allergenic)

Materials provided by the teacher:

- Jug of water
- Plastic bowl (ice cream container is perfect) and stirring spoon

Follow the directions to make a mould in and cast in the previous activity. In this case a real fossil is used.

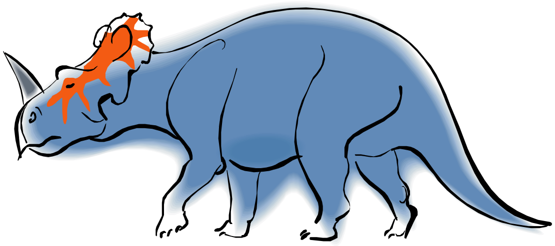
In many parts of the world people make replica fossils and sell them over the internet. They make their replicas more realistic by using different textures and colours for the fossil and for the rock it sits in.

Who wrote "The present is the key to the past"? ***James Hutton, the father of Earth Science***
What does this statement mean? ***We can use our knowledge of present Earth processes to explain things which have happened in the past.***
Having made your replica fossil, do you agree that "The present is the key to the past"? Please explain your answer. Yes. ***We can make fossils using present day processes. We can understand the past by using our knowledge of the present.***
Can you think of any ways that you could tell if you were being offered a fake or replica fossil?

- ***Hardness***
- ***Density***
- ***Colour***
- ***Spheres caused by air bubbles***
- ***Cost***
- ***Source areas may not have the right rocks of the right age to contain these fossils***

NAME YOUR DINOSAUR

Dinosaur names come from:



- Locations where they were found
- The names of their finders
- The names of the sponsors of their finders
- The characteristics of the creature
- Names of apparently similar creatures
- Heroes of the finders
- Living creatures are given names according to their genus and species. This places them amongst similar organisms. Since fossils are often found piece by piece over many years their names do not always give us understandings of the organism. Often fossils are given descriptive names.

Stegosaurus	Stego = roof tile Saurus = lizard	A dinosaur with large bony plates which looked like roof tiles
Scotosaurus	Scot = thorn Saurus = lizard	A dinosaur with distinctive spiky skin
Tyrannosaurus	Tyranno = tyrant or king Saurus = lizard	A powerful and frightening dinosaur
Triceratops	Tri = three Ceratops = horns	A three horned dinosaur
Archaeopterix	Archaeo = ancient Opterix = wing	A dinosaur with birdlike “wings”

Students are asked to design and name a dinosaur.

Students of Year 7 on should be able to give the dinosaur both its genus and species names. The genus name starting conventionally with a capital letter, E.g., we humans are Homo sapiens (Homo = genus and sapiens = species) and Tyrannosaurus rex.

EXTRA RESOURCES

More resource for teachers

Geoscience Australia has a beautiful coloured trilobite to cut out and has downloadable posters of geological time

http://www.csiro.au/helix/sciencemail/activities/Trilobite.htm cut out trilobite

More useful sites:

https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=68903

Maps and posters “History of the Earth” & “Australia through time”

http://www.fossils-facts-and-finds.com/index.html

Lots of activities, pictures, colour-ins and ideas. Particularly useful for the home schooler.

http://www.abc.net.au/dinosaurs/meet_the_dinos/ozdino1.htm

Walking with dinosaurs info – very general but pretty. Lots of worldwide info and pictures

http://www.environment.gov.au/heritage/places/national/dinosaur-stampede/lark-quarry/environment.html Australian dino info - environment

Lark quarry dinosaur stampede – classify dinosaurs into two groups – more needed

http://www.bbc.co.uk/schools/scienceclips/ages/8_9/science_8_9.shtml

BBC Sites Lots of fun for students

Revision & animations

Some parts only work in UK but most work here

Starchild NASA scavenger hunt

Students Http://starchild.gsfc.nasa.gov

Teachers: http://starchild.gsfc.nasa.gov/docs/StarChild/teachers/scavl1_2.html

If you wish any further information, please contact Julia Ferguson of Earth Science Western Australia at:

Julia.ferguson@scitech.org.au

or visit the Earth Science Western Australia web site:

http://www.earthsciencewa.com.au/

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Links to the Australian Curriculum

Overarching Ideas **Patterns, order and organisation & Scale and measurement**

Science Understandings

	1	2	3	4	5	6	7	8
Biological Science			Living things can be grouped on the basis of observable features.	Living things, including plants & animals depend on each other and the environment to survive	Living things have structural features	Differences between groups of organisms.	Grouping a variety of organisms on the basis of similarities and Interactions in food chains.	Cells reproduce via cell division.
Chemical Sciences		Different materials can be combined for a particular purpose.						Elements & simple compounds can be represented by symbols and formulae.
Earth & Space Science		Earth's resources are used in a variety of ways.		Earth's surface changes over time. (Rocks and fossils).				Sedimentary, igneous & metamorphic rocks contain minerals that are formed by processes that occur within Earth over a variety of timescales.

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Science as Human Endeavour

	1	2	3	4	5	6	7	8
Nature & development of science	Asking questions about and describing changes in objects & events		Describing patterns & relationships. Making predictions.		Science involves testing predictions by gathering data and using evidence.		Scientific knowledge changes as new evidence becomes available.	Scientific knowledge can develop through collaboration and connecting ideas across science.
Use & influence of science		Earth's resources are used in a variety of ways.	Science contributes to discussion (Evolution).		Important contributions to the advancement of Science have been made by people from a range of cultures		Science understandings influence the development of practices in areas of human activity – resource management. People use understandings and skills from across the disciplines of science in their occupations	

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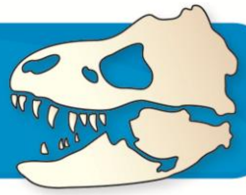

Science Inquiry Skills

	1	2	3	4	5	6	7	8
Questioning & Predicting			Working in groups to discuss things that might happen during an investigation.		Applying experience from similar situations in the past to predict what might happen.		Recognise that the solution of some questions requires consideration of other social aspects.	Identify problems and make predictions.
Planning & Conducting	Explore & answer questions.		Safely use tools to make observations. Discuss safety rules.		Accurately observe, measure and record data. Use equipment and materials safely.		In fair tests, measure & control variables and select equipment.	Identifying ethical considerations.
Processing & Analysing data	Sort information, including drawings.		Identify patterns & trends.		Patterns & relationships in data. Compare data with predictions and use evidence.		Construct a range of representations. Summarise data.	Draw conclusions based on a range of evidence.

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	1	2	3	4	5	6	7	8
Evaluating	Compare observations with those of others.		Reflect on investigations.		Suggest improvements.		Evaluate the quality of data collected.	Decide whether or not to accept claims based on scientific evidence.
Communicating	Represent & communicate observations in a variety of ways.				Discuss how models represent scientific ideas.		Communicate using scientific language & representations.	Select & use appropriate language and representations to communicate science ideas.

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Achievement standards

	F	1	2	3	4	5	6	7	8
	Describe properties of objects. Share observations.	Follow directions & record observations.	Use informal measurements to collect and present observations	Use formal measurements & compare observations.	Discuss how natural processes can change the surface of the Earth's surface. Safely use equipment.	Compare & classify substances. Gather data & use evidence. Use patterns in data to suggest explanations.	Students follow procedures to design investigations. They identify variables to be changed and measured and describe potential safety risks. They collect, organise & interpret data.	Describe situations where scientific knowledge from different science disciplines has been used. They use scientific language.	Explain how evidence has led to an improved understanding of a scientific idea. They consider safety and ethics. They analyse data & justify conclusions.