GREEN ADELAIDE

Frogs

teacher information pack

About this pack

This pack can be used as a resource for students and/or a teaching aid in developing lesson plans and units of work. This pack provides you with background information about frogs and information some of the amazing things frogs do.

The pack also contains a number of fun activities that you can run with your students and other learning ideas that you can tailor for you and your students' specific needs.

We have attempted to use language that is easily understood by most readers and to explain complicated concepts in plain English. Due to the scientific nature of the topic, some more advanced terms have been used. For the most part, these words have been highlighted in **blue** and have been listed and defined in the glossary at the back of this document.

Frog monitoring

FrogWatch SA allows you to learn about some of Australia's frogs, while helping to build an interactive map of frog distributions. It uses new technologies to build upon the previous long-term Frog Census program that ran in South Australia in the 1990s and early 2000s.

Frog calls vary between species and provide a simple means for gaining information about where frogs are found. By learning to identify frog calls and contributing them to a central, mappable site, together we can build up a picture of what is happening to our neighbours, the frogs.

Register on-line at www.frogwatchsa.com.au to begin contributing. You can make recordings at anytime of the year. Full instructions and assistance are available through the website.

Contents

What is a frog?

Frogs are amphibians. The word amphibian comes from the Greek words 'amphi' and 'bios', which loosely translates to 'living a double life' or 'living on two sides'. This is because most amphibians lay eggs in water. The eggs hatch into larvae (tadpoles), then grow and change into little frogs which live on land. This growth and change is called **metamorphosis**. In other words, at one point in their lives they live in an aquatic habitat (water) and at another point they live in a terrestrial habitat (land). However, there are many amphibians that have very different life cycles; some don't even have tadpoles living in water!

Amphibians are 'cold-blooded' **vertebrates**. They have a back bone and control their body temperature by moving between hot and cold areas in the external environment. They usually have smooth, moist, **semipermeable** skin. This means that they don't have hair, scales or feathers to protect them and water is able to pass in and out of their bodies straight through their skin.

There are three different groups of amphibians living on the planet today. These are the tailless amphibians (frogs and toads), the tailed amphibians (newts and salamanders) and the legless amphibians (caecilians). In Australia, the only native amphibians we have are the tailless amphibians, although many people have pet axolotls, which are the tadpoles of a Mexican salamander.

Green Tree Frog: a tailless amphibian

Spotted Salamander: a tailed amphibian

Caecilian: a legless amphibian

The largest and the smallest

The smallest frog in the world was believed to be the Monte Iberia Eleuth from Cuba, but a frog discovered in 2009 near the village of Amau in Papua New Guinea that only grows to 7.7 mm now holds the record. It was formally named *Paedophryne amauensis* in January 2012; and later the common name New Guinea Amau Frog.

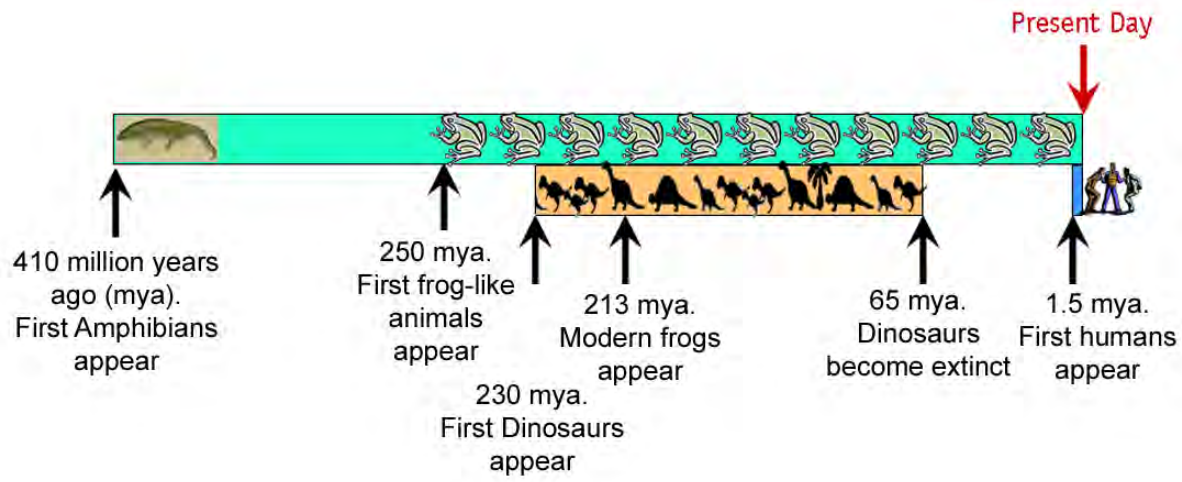
The largest is the Goliath Frog, *Conraua goliath*, from Western Africa, which reaches a length of over 30 cm and may weigh more than 3 kg.

Paedophryne amauensis; the smallest frog in the world!

A life-size model of the Goliath Frog, the largest frog in the world.

Prehistoric frogs

Amphibians have been on Earth for about 410 million years, so they have lived through all of the different environmental changes that have occurred during this time; including ice ages and other **extinction** events, like those that resulted in the extinction of the dinosaurs. The frogs alive today are very similar to those that first appeared about 250 million years ago.



Amphibians have been on the planet for over 400 million years. The modern frogs appeared about 213 million years ago.

Is it a frog or a toad?

This is actually a tricky question to answer without a detailed discussion of how scientists classify plants and animals. The words frog and toad have been used for many hundreds of years. The word frog was originally used for the European Common Frog, a wet-skinned (slimy) animal living in or near water. The word toad applied to the European Common Toad, a more dry-skinned animal usually living away from water.

The European Common Frog, Rana temporaria.

In the 1700s, Carl Linnaeus, a Swedish botanist, developed a system for giving names to plants and animals. In this system, the European Common Frogs were given the scientific name *Rana temporaria* and the European Common Toads were given the name *Bufo bufo*. The common frogs and their close relatives were put into the family Ranidae and the toads and their relatives into the family Bufonidae.

For example, the Asiatic Grass Frog from China and Mongolia is closely related to the European Common Frog and has been classified as *Rana chensinensis*.

The Common Toad, Bufo bufo.

Therefore, the word frog only applied to the animals in family Ranidae and the word toad only for the animals in family Bufonidae.

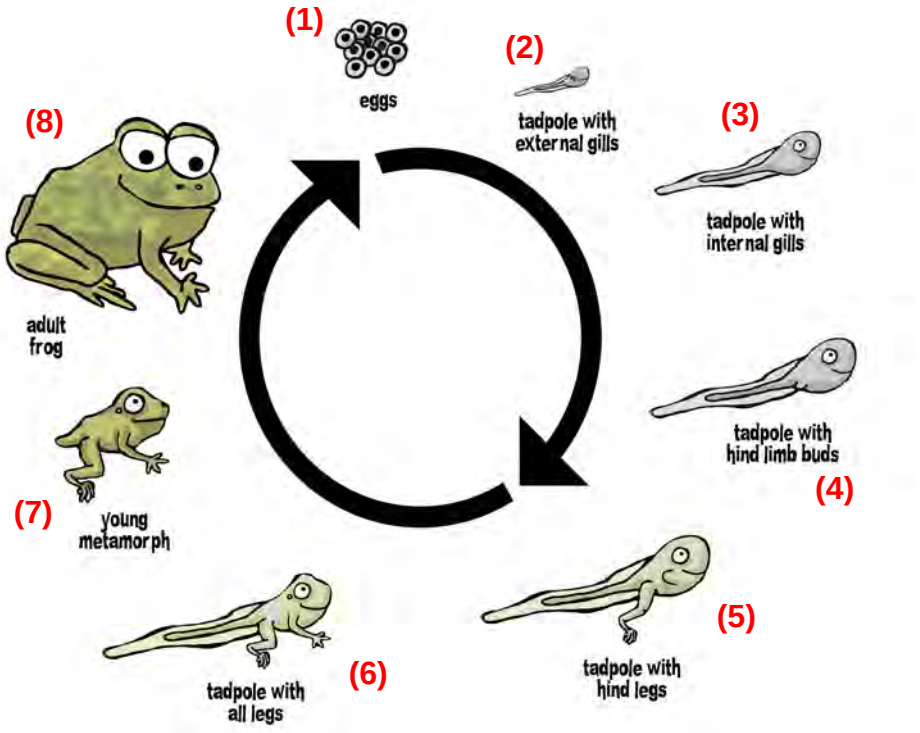
However, in the years that have passed since those early classifications, many more species of tailless amphibians have been found, including some that are not closely related to animals in either of the families Ranidae or Bufonidae. For example, the common Australian Green Tree Frog, *Pelodryas caerulea*, is not closely related to the European Common Frog or Toad and is placed in the family Pelodryadidae. For that reason, the Green Tree Frog should not strictly be called a frog.

Like the Australian Green Tree Frog, there are many other tailless amphibians around the world that have features similar to both Ranidae and Bufonidae but which are not closely related to either. Most scientists now agree that the word frog can be used to apply to all tailless amphibians including those in family Bufonidae. Similarly, the word toad is often applied to tailless amphibians that have dry warty skin, but which are unrelated to the Bufonidae. What this means is that the words 'frog' and 'toad' are not used as true classification tools and you can use either to describe a tailless amphibian.

However, if you hear the term 'true frog' it only applies to the family Ranidae. 'True toad' only applies to the family Bufonidae.

Frog life cycles

There are huge numbers of ways in which frogs **breed** and develop, but the typical life cycle of the frog is shown below. Please note that the growth and development of a frog is a gradual process and is not really made up of just a few separate stages. The description and diagram of the life cycle is only presented to give you an idea of how a tadpole changes throughout **metamorphosis**. Many scientists recognise over 40 stages in the development of a frog, with half of these occurring before the tadpole even hatches out of the egg!



1) Huge numbers of eggs are laid in the water by the female and then **fertilised** by the male. The eggs contain yolk which provides energy to the developing **embryo**.

2) Tadpoles hatch out of the eggs and, for the first few days, the tadpoles feed off the remainder of the yolk inside them. The young tadpoles breathe through their skin and also with external gills (not all species).

3) The external gills are replaced by internal gills after a few days. Water is pumped in through the mouth, passes over the gills and then exits through a small hole called a spiracle (there may be a spiracle on each side of the body or, more commonly, just on the left side). The tadpoles eat plants and decomposing material in the water and begin to grow. Tadpoles have a horny beak for cutting large or tough material and rows of teeth for scraping algae from the surface of stones and plants.

4) The hind legs slowly develop on the outside of the body, whilst the front legs (arms) grow internally. If you look closely at a young tadpole you can see small bumps called limb buds where the back legs develop.

5) The lungs develop as the tadpoles grow – with tadpoles often rising to the surface to gasp air – and these gradually replace the internal gills. If you look at a tadpole at this stage of development, you can see that the body changes shape where the front legs are pressing out.

6) When the hind legs have developed fully, the arms emerge from inside – the left one via the spiracle, the right (if no spiracle exists on the right side) through a weakened area in the skin surrounding the gill chamber.

7) The young frog stops eating whilst the 'frog' head shape forms, during which time the tadpole mouth parts are shed, the lower jaw develops and the intestines shorten. When the young frog is not eating, it receives energy from its tail, which has stored nutrients during the growth of the tadpole. As the tail begins to shorten, the young frog moves onto land. This young frog is often called a metamorph.

8) After a few days, the tail is completely absorbed (it does not drop off) and the young frog begins to grow into a larger adult feeding on live animals.

The length of time taken for metamorphosis varies from species to species. Some desert frogs can go from egg to young frog in as little as 16 days. In other species, it may take one or two years!

When a tadpole turns into a frog its tail does not drop off. Instead, the tail is absorbed back into the body, providing energy at a time when the young frog doesn't eat.

Breeding

Frogs usually **breed** in a special embrace called **amplexus** and, in almost all cases, frogs reproduce using external **fertilisation**. As the female releases eggs from her body, the male frog releases sperm over the eggs to fertilise them. This external fertilisation is called spawning and the fertilised eggs are commonly known as frog spawn.

To help the male frog maintain his hold on a female, some species develop special structures called nuptial pads. These pads are found on the thumb and sometimes on the adjacent fingers, but only during breeding season. After breeding season, the nuptial pads are shed off during a frog's normal skin shedding.

The Tailed Frog, *Ascaphus montanus*, from Canada and the USA is a frog that reproduces with internal fertilisation. The Tailed Frog doesn't really have a tail, but the male has a special organ which is used to fertilise the eggs inside the female.

Amplexus in the Cane Toad. In this species, the male frog holds the female under her armpits. Other species hold the female around the waist.

A male Tailed Frog showing the 'tail' – not really a tail but a reproductive organ for internal fertilisation.

Breeding in water

Frogs have been described as the 'highest form of life to lay a naked egg in water'. In other words, they are the most advanced animals to lay eggs that do not have a hard, protective coating, like the shell surrounding a bird's egg. Instead, a frog's egg is surrounded by layers of jelly and soft **membranes**. These membranes allow water and oxygen to flow freely through the egg (they are **semipermeable**). When the egg is **fertilised**, water flows through the membranes and causes the jelly to swell many times its original size. Unfortunately, being semipermeable also means that pollutants in the water, such as chemicals and heavy metals, can pass through the membranes into the developing embryo. These pollutants can have a devastating effect; they can kill the **embryo**, weaken it and make it more at risk of catching life-threatening diseases or they can even cause the embryo to grow into a mutated frog that may have extra or missing arms, legs or other body parts!

The jelly layer serves to protect the eggs from physical damage and also keep dirt, bacteria, fungi and small predators away from the developing embryo. It has also been suggested that the jelly may also help maintain the temperature of the egg.

Frogs spawn in many different ways. Some lay eggs in small clumps attached to submerged plants, some lay long strands or chains of eggs, some lay eggs in large floating rafts that slowly sink to the bottom of the water. Others, like the Spotted Grass Frog, a common inhabitant of South Australian swamps and wetlands, lay eggs in big foam nests floating on the surface of the water.

A typical clump of frog spawn attached to vegetation in the water.

Many frogs like the Cane Toad lay their eggs in long chains.

Frogs like the Spotted Grass Frog attach a foam nest to plants on the surface of the water.

Tadpoles that come from large eggs will have fat little tummies with more yolk than those from small eggs. They can take longer and grow larger before hatching.

Some frogs lay a small number of large eggs with lots of yolk, others lay hundreds or thousands of small eggs with only small amounts of yolk. As a general rule of thumb, the size of an egg will give a good indication of how quickly they will hatch into tadpoles and how long it will take for the tadpoles to start feeding. A small egg has only a small amount of yolk, meaning that a tadpole will have to hatch quickly and start looking for food so that it can grow. A large egg usually means a lot of yolk; therefore a tadpole has plenty of food reserves and can take its time hatching and growing before having to find additional food.

Many predators, such as the introduced gambusia, eat frog spawn and tadpoles. Frogs lay lots of eggs to make sure that some survive to become adult frogs.

Frogs lay lots of eggs because eggs and tadpoles are a very popular food source for fish and other aquatic creatures and young frogs are readily consumed by land-based predators such as birds, snakes, lizards and mammals – most will get eaten, so frogs need to have lots of babies to ensure that a few survive to reach adulthood and have babies of their own.

Breeding on land

Despite the very successful method of aquatic reproduction, about 20% of frogs and toads around the world do not lay their eggs in water (this includes approximately 25% of the more than 200 species of Australian frogs). In these cases, there is often some component of parental care and, generally, fewer and larger eggs are laid by these species.

Some species have delayed emergence, whereby eggs are laid out of water, tadpoles develop to an advanced stage inside the egg, hatch out into the water, then grow and **metamorphose** into a young frog. For example, in Australia, frogs like Bibron's Toadlet, the Corroboree Frog and the Red-backed Toadlet lay up to 200 large eggs in a nest in a depression or in moist leaf litter during autumn or winter. Tadpoles develop inside the eggs, feeding off the large amount of yolk, until they are about ready to develop limbs. Following winter rains and the flooding of the site, the tadpoles break out of the egg and complete their development in the water.

Bibron's Toadlets lay their eggs on the ground in moist leaf litter.

Unfortunately, many of the Australian toadlets are starting to disappear because habitat has been removed and flooding prevented. Without a suitable habitat that floods after rains, these frogs are not able to breed and will eventually die out.

Some other species of frogs have direct development, in which tadpoles develop completely inside eggs laid on land; a fully formed frog hatches out of the egg without ever having a swimming tadpole phase.

Parental care

Most frogs do not care for their young. However, there are some frogs that do protect either their eggs or their tadpoles. In fact, some frogs take this parental care to extremes with specially developed pouches for holding their babies or even giving birth to live young. Listed below are some of the more unusual frogs that care for their young.

Gastric Brooding Frogs

In 1973, the Gastric Brooding Frog, *Rheobatrachus silus*, was discovered in Queensland. A year later, scientists watched a captive female do something amazing.

The frog, which had been acting strangely, suddenly spat up several young through her mouth. Later observations showed that the female frog had actually turned her stomach into a breeding chamber. The fertilised eggs, which were rich in yolk, were swallowed by the female and allowed to develop in her stomach.

A female Gastric Brooding Frog giving birth through her mouth!

Hormones secreted from the eggs and developing tadpoles prevented acid production. As a result, the female frog did not eat during the six or seven week development of the tadpoles. When development was completed, the metamorphosed froglets were passed out through her mouth. Truly a frog in the throat! Unfortunately this species and another closely related species discovered in 1983, *Rheobatrachus vitellinus*, are now believed to be extinct. They have not been seen in the wild since the early 1980s.

Vocal Sac Brooding Frogs

There are two species of frog in Chile and Argentina that use the males' vocal sacs to care for the young. Eggs are laid and **fertilised** on land. The male frog guards the eggs until the tadpoles hatch. He then collects them in his mouth, without swallowing them, and passes them into his vocal sac.

In the Chile Darwin's Frog, *Rhinoderma rufum*, about 12-25 eggs are laid, which hatch after 7 days. The male simply collects and carries the tadpoles to a water body where he releases them after about 2 weeks. The tadpoles then develop in the water, after about 120 days **metamorphosis** occurs. This species has not been seen since the early 1980s and may be **extinct**.

These three little Darwin's Frogs have just come out of their father's mouth!

In Darwin's Frog, *Rhinoderma darwinii*, 5-15 eggs are laid which hatch after 20 days. The remaining development and metamorphosis of the tadpoles occurs completely in his vocal sac. After 34-60 days, the froglets come out through his mouth, still with a small tail.

Surinam Toad

Surinam Toads, *Pipa pipa*, are found in South America and, during mating, the male and female swim in somersaults. At the top of the somersault, the female releases the eggs, which are fertilised by the male who then uses his large feet and belly to press the eggs into the soft, spongy skin on the female's back. After 24 hours the skin starts to swell around the eggs, which become embedded in little pouches after about 10 days.

The tadpoles develop inside the pouches, feeding off the large amount of yolk in the egg.

After about 15 weeks, the skin above each egg breaks, allowing a fully developed toad to struggle free.

Reproduction in the amazing Surinam Toad. The eggs are first attached to the female's back and the tadpoles grow up inside little pockets in her skin. They then dig their way out as a fully developed frog!

Australian Marsupial Frog

The female Marsupial Frog, *Assa darlingtoni*, lays small clutches of eggs (8-13) on damp soil.

The male guards these eggs until they hatch about two weeks later. Then the tadpoles climb up his sides into special pouches (hip-pockets) on either side of his **groin**. Here the tadpoles develop into frogs, only feeding off their yolk, until they come out as little frogs about 10 weeks later.

Amazingly, this behaviour was not known until 33 years after the frog was originally discovered!

The Australian Marsupial Frog with tadpoles.

Midwife Toads

The males of some species of European midwife toads attach the string of eggs to their legs and back and carry them around, keeping them moist and safe from predators, until they are ready to hatch.

Once the tadpoles are ready to hatch, the males carry the eggs to water where the tadpoles are released.

They finish growing into frogs in the water.

The male Midwife Toad carrying the eggs on his back.

Poison Dart Frogs

Strawberry Poison Dart Frogs, *Oophaga pumilio*, lay their eggs on land.

When the tadpoles hatch, the mother carries the tadpoles on her back to water-filled plants called bromeliads that grow on trees. The tadpoles complete their growth in these tiny, predator-free pools, where the mother regularly feeds them with **unfertilised eggs**.

In some other species of poison dart frog, such as the Golden Dart Frog, the father carries the tadpoles to the bromeliads.

Other species of poison dart frogs lay a single egg in a water-filled plant and return every five days to lay another **fertilised** egg. New eggs will be eaten by a surviving tadpole or will hatch if no tadpole has survived from a previous spawning. If the parents do not return to feed a tadpole at least five times, the tadpole will die.

The Strawberry Poison Dart Frog carries a tadpole to a water-filled plant where it will grow into a little frog.

African Live-Bearing toads

Some African toads give birth to live young.

In two of these, Tornier's Tree Toad, *Nectophrynoides tornieri*, and Morogoro Tree Toad, *Nectophrynoides viviparus*, the developing **embryos** are fed from the large amount of yolk in the egg; they do not receive any other food from the mother.

The Nimba Toad, *Nimbaphrynoides occidentalis, on the other hand,* actually provides food for the developing embryos.

In these toads, the tube that carries the eggs inside the mother, the oviduct, is converted into a womb that produces a fluid the embryos are able to feed upon.

Fully formed toads are born after about 8 months.

One of the African live-bearing toads with a little baby on its back.

South American Egg-Brooding frogs

For frogs in the family Hemiphractidae, the eggs are **fertilised** and then deposited on the back of the female, either in enclosed dorsal pouches or externally in a frothy sac that the male makes out of a fluid from the female's cloaca. The sac hardens in two to three days, giving protection to the eggs.

The developing **embryos** feed off the large amount of yolk inside the egg.

After about three weeks, some species deposit the eggs in a water-filled plant, where the tadpoles hatch out and finish growing, after feeding on the remains of the egg sac.

In other species, the embryos develop completely inside the egg sac or pouch with no free-swimming stage, instead hatching out as small frogs which are then carried around by the female.

Some of the marsupial frogs from South America carry their developing young around within pockets under their skin. Can you see the bumps on its back? These are its babies inside the pockets.

How do frogs and tadpoles breathe?

Frogs

Adult frogs obtain oxygen and release carbon dioxide (**respiration**) in a number of different ways. Frog lungs are not as good as those found in birds, reptiles and mammals, so they need to help this breathing by using two other types of respiration. Gas exchange can occur across the roof of the mouth (this is called '**buccal**' or '**buccopharyngeal**' respiration) and directly across the skin (this is called '**cutaneous**' respiration). The three different methods of respiration are used in different amounts depending on what type of frog it is, what it is doing and what time of year it is.

Using their mouth

The roof of the mouth is richly lined with blood vessels that are able to extract oxygen from the air. The constant movements of the frog's throat are used to bring air in through the nose and across the roof of the mouth, where oxygen is absorbed and carbon dioxide is removed. The air is then released through the nose. During this process, the passage to the lungs is kept closed. This type of respiration may account for up to 10% of a frog's gas exchange.

Using their lungs

Frogs do not have ribs or a **diaphragm** and, unlike mammals, they are not able to use them to change the internal pressure and ventilate the lungs. To get past this problem, frogs inflate their lungs in stages by closing them off and bringing air into their throat via their nose. They then block off their nose, pass the air from the throat into their lungs, close their lungs off and bring in more air through their nose. This process is repeated a few times until the lungs are inflated. Once the lungs are fully inflated, gas exchange occurs across the lungs and the used-up air is then released through the nose (in a stream over the top of some more fresh air that is brought into the throat). Some frogs will also lift their eyes to increase the space available inside the throat to allow more air in! This is why you can usually see a frog's throat moving in and out.

Using their skin

Frog skin has a number of special features that help it to function as a respiratory surface. Frog skin is very loose and thin and it has lots of blood vessels. By keeping the skin moist, frogs allow gases to pass directly between the blood vessels and the outside. If the skin is dry, this method of breathing does not function very well, so most frogs have special **glands** in their skin that produce a mucous to keep them moist. Frogs are able to breathe on land or underwater using cutaneous respiration! Unfortunately, this sort of breathing is only effective in small animals, which probably explains why most frogs are relatively small.

Tadpoles

Tadpoles have similar adaptations for breathing. Initially breathing is undertaken using external gills (in some species) and then with internal gills and their skin. Amazingly, some species use their skin to obtain up to 60% of their oxygen and remove up to 50% of their waste carbon dioxide. As the tadpoles develop, they will also start to use lungs to breathe – this can be observed when tadpoles swim up to the surface and gasp for air.

Frog communication

How do frogs communicate with each other? Most frogs communicate using calls; the most common one we hear is the mating call. Frogs also communicate using other calls and signals.

Mating calls

How do the male and female frogs find each other to **breed**? Generally, the males are the first frogs to arrive at a breeding site at the beginning of their breeding season. Breeding season varies from species to species, but it often happens with the onset of winter or spring rains – in South Australia, most frogs are actively breeding in the warm spring months, especially September.

When a male frog has arrived at the breeding site, he will try to find a suitable calling site to attract a female frog. A male frog needs to impress a female frog with a loud, resonant call with lots of energy, so he will look for a site that will help make his call louder. For example, Eastern Banjo Frogs can often be heard calling in hollow spaces at the edge of a stream, especially under overhanging tree roots or rocks. For most frog species, only the male frogs are responsible for calling and attracting mates. Males do the attracting and females do the selecting!

During breeding season, a male will continue to call for a female and may go without eating. It is not unusual for a calling male to lose weight and get very thin during this time.

How does a frog make its call?

In order to be able to produce a call, the male frog continuously gulps air, until he has filled up his lungs, and then closes his mouth and nostrils. A call is made by forcing the air from his lungs across his larynx (vocal chords) to his mouth and then into his vocal sac. Pushing air across his vocal chords makes them vibrate and produce a sound; the vocal sac is used to transmit this call. The vocal sac does not act as an amplifier of the sound; instead it helps the call to resonate or boom. In other words, it radiates and prolongs the call and acts as a **frequency-specific filter**.

Vocal sacs are spherical in shape because this helps to transmit the call evenly in all directions, regardless of where females may be located. In most species of frog, males have a single external vocal sac under the throat. Vocal sacs may be paired or singular, internal or external, under the throat or at the sides of the mouth. There are even some frogs that do not have any sort of vocal sac; these frogs may produce very quiet calls that may not be heard more than a few metres away!

This Brown Tree Frog from Australia has a single external vocal sac.

This frog has paired external vocal sacs.

Not all frogs go ribbit

The mating call made by a male frog is species-specific. This means that all frogs of a particular species will make a call that sounds the same as the calls made by other members of his species and that is different to the call made by frogs of another species. No two species of frogs make a call that is exactly the same – a very useful tool for scientists who want to know which species are present at a waterway. They can listen to, or record, frog calls and accurately identify the species present!

A male frog does not learn his call from the other frogs around him. Instead, his call comes naturally to him and he can only make the call specific to his species. In addition, hearing in female frogs is finely tuned to the call structure – females are able to filter out and ignore the calls of other species. This is a very important aspect of frog calling behaviour because it helps a female find a mate when there may be hundreds or thousands of frogs calling at a site, often with many different species present. It is also important because it helps the mating call to act as a pre-mating isolating mechanism. This means that the call will prevent frogs of two different species being attracted to each other and they should not accidentally interbreed and produce unhealthy or **sterile hybrid** offspring.

Females attracted to the area do not mate with just any male frog. Instead, they select the male that they think is going to give them the strongest, healthiest babies. This may mean that a female picks the biggest frog with the loudest, deepest, most repeated call. A big frog has demonstrated his survival skills, meaning that any offspring will probably also grow to be big healthy frogs. A young, weakling frog is not likely to be selected when a bigger frog is present.

How loud can a frog call?

Frog calls can be extremely loud. The Puerto Rican Coqui Frog, *Eleutherodactylus coqui*, has had its call recorded at an astonishing 120 dB; the sound made by a jackhammer is about 100dB and close to the threshold of human pain!

So that the frog does not damage its own eardrum and become deaf, the frog has a direct air link between its lungs and its eardrum. When a frog calls, the change in air pressure in the lung also changes the air pressure in the eardrum. Therefore, when the frog makes a note, sound travelling from the mouth and lungs pushes the eardrum out at the same time as the sound radiated outside the body by the vocal sac causes the eardrum to be pushed in. In effect, the two sounds cancel each other out and the ear is momentarily turned off or has its sensitivity reduced.

There are even some frogs that communicate via seismic vibrations (like the rumbles made during an earthquake) by thumping their vocal sacs on the ground during their normal calling behaviour!

Recent research has shown that the American Bullfrog, *Lithobates catesbeianus*, can also broadcast calls through its ears! This now explains why males in this species have eardrums about twice as large as those in females.

The Puerto Rican Coqui Frog has a call >100 decibels!

The American Bullfrog is able to broadcast its mating call using its large ear drums!

Other types of frog calls.

The calls made by frogs are not just used to attract a mate. Other type of calls made by frogs include territorial calls, distress calls, warning calls and release calls.

- **Territorial calls** are calls made by male frogs to inform others that this is their patch and that intruders should 'back off'! Often these calls are a low groan or are slightly different to the mating call. Territorial calls and mating calls are often termed **advertisement calls** because they are made to let other frogs know that they are present.
- **Distress calls** are very dramatic calls made by a frog that is being attacked by a predator. These calls are usually a high-pitched scream or wail that startles a predator causing it to release the frog, allowing it to escape. These calls are a clear sign of panic and can be quite distressing to hear.
- A **warning call** is a noise that is made by a frog that has been startled or disturbed. The frog may make a short grunt or squawk as it jumps away; probably letting other frogs know that there may be some danger. These calls are very much like the exclamation noises humans make when they have been surprised.
- **Release calls** are made by frogs that have been grabbed by another frog that is searching for a mate. If a male frog is unsuccessfully trying to attract a mate, he may grab hold of any frog that moves past him. If he grabs a male frog, a female frog that has already bred or a frog of a different species, the grabbed frog will make a release call to let him know that he is wasting his time and should let go. In Green Tree Frogs, these calls sound like the soft clucking of a chicken and they are sometimes made by the frog if it is being held too tightly in your hands!

Some people report that some frogs will also make a rain call at the onset of light rains. These may be a call of joy that the rains are on their way, but they are more likely a sign that the changing weather has jogged the frog into activity.

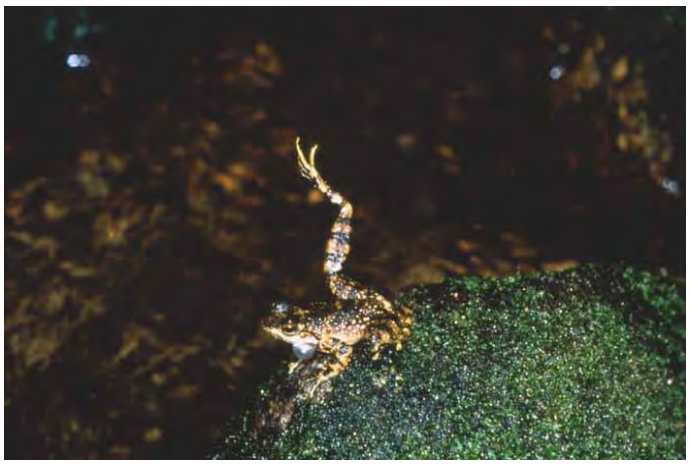
Other signalling systems

Not all frogs use calls to communicate. A number of species that live in or near fast-flowing, mountain streams are not able to produce a call that is easily heard over the continuous noise of the water.

In fact, the only sort of call that can be heard is a high-pitched squeak, which can only be heard over a very short distance.

Instead, these frogs communicate through the use of **semaphore**-like signalling! Semaphoring is used by frogs to attract mates and also to defend a territory.

It is not uncommon for two frogs to engage each other in display when ownership of a territory is not agreed upon. In these cases, the frogs will signal at each other, with the territory holder attempting to warn an intruder away. If the intruder does not leave, a territory holder may leap onto him and try to chase him off!



Some frogs communicate using semaphore!

These frogs are mainly active during the day and the males wave their legs in an irregular pattern one after the other, or sometimes waving both legs together. When the legs are extended, the frog tilts his feet forward so that bright markings on and between his toes are visible. Only a small number of species use their arms to semaphore.

Food for frogs

Frogs and tadpoles are important parts of the food web and they usually eat different things.

What do frogs eat?

Most frogs are carnivores, feeding on a range of prey. They are also not very fussy, basically eating anything that moves and is smaller than them.

Frogs are mainly insect eaters, but they also eat a wide range of animals such as spiders, scorpions, worms, snails, slugs, slaters and centipedes.

Some large frogs will also eat such unusual prey as small fish, snakes, lizards, birds, mice, rats, bats, land crabs and other frogs.

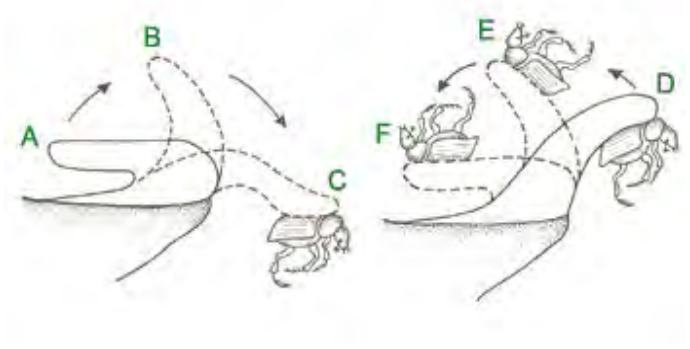
Nearly all frogs require their food to be alive and moving – they will not eat a freshly killed insect lying beside them. In fact, frogs will often carefully watch their food moving around for a long time before attempting to eat it. This behaviour probably gives the frog a chance to identify the prey to ensure that it doesn't eat something that is unsuitable or which the frog has previously disliked.

A small Sudell's Frog eating a worm.

How does a frog catch food?

Despite what most people think, most frogs do not have really long tongues that they can shoot out to catch insects flying around or crawling on land. In fact, most frogs have tongues that take up the same area of their mouths as humans do. The difference is that a frog usually has its tongue attached at the front of its mouth, not at the rear like most other **vertebrates**. At most, some species of frog may have a tongue up to a third of their body length when flicked out.

The tongue is not coiled up in the frog's mouth; it is folded back so that the underside of the tongue faces the roof of the mouth.



How a frog moves its tongue to catch prey.

When a frog wants to catch some prey, it normally has to leap towards it, open its mouth and then flick out its tongue at lightning-fast speed. When a frog flicks its tongue, it rubs it across a **gland** on the roof of its mouth, which coats the bottom of the tongue with a sticky **secretion**. The tongue hits the prey, which sticks to it like glue, before it is moved into the frog's mouth.

Sight is the most important sense a frog uses in hunting. Once the prey is selected the frog will leap forward to get closer and flick out its tongue with lightning speed.

Not all frogs have tongues. African tongueless frogs eat underwater by opening up their mouth and using suction to pull in prey. They also use their fingers to help stuff larger prey into their mouths.

Can a frog chew its food?

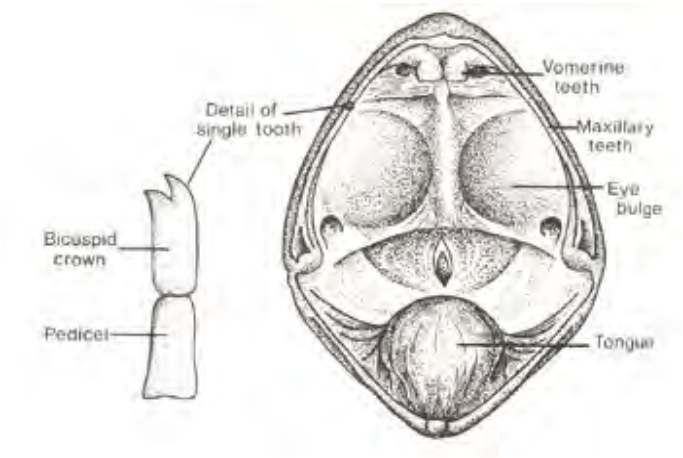
Some frogs have teeth, but they are very different to the teeth in other **vertebrates**.

There are two sorts of teeth in frogs, a set of small maxillary teeth (usually at least 100) around the edge of the upper jaw (these are often difficult or impossible to see) and a set of 'pseudo teeth' or vomerine teeth - extensions of the bones that surround the nostrils on the inside of the mouth (frogs don't have a bone or palate separating the mouth from the nose).

Frogs' teeth are not used for chewing or biting off pieces of their meal, instead they are used only to help hold onto the prey.

Some people think that the pseudo teeth in some frogs may also crush or puncture the prey, helping the frog's tastebuds by releasing some of the prey's juices into the frog's mouth. If the prey is poisonous or tastes bad, the frog will be able to 'spit it out' before swallowing.

Frogs do not have teeth on their lower jaw, but some species have 'tusks'. The function of the tusks is unknown, but in the Australian Tusked Frog, *Adelotus brevis*, the male has larger tusks than the female.



Inside a frog's mouth - note the different teeth, eye bulges and position of the tongue.

The male Australian Tusked Frog has large tusks on its lower jaw.

Watching what you eat!

As a frog is not able to chew or bite off small pieces of food, it must swallow its food whole. This means that a frog can only eat what fits in its mouth – small frogs can only eat small animals, big frogs can eat bigger animals.

Many frogs also use their hands to help push food into their mouths, but the most unusual feature of a frog's feeding habits is the use of its eyes!

Unlike birds and mammals, frog eyes are not enclosed in a bony socket. Instead, they only have a thin sheet of tissue or **membrane** separating the eyes from the mouth cavity. When a frog attempts to swallow food, it is able to press the back of its eyes down into its mouth and push the food between the eye bulges and the tongue down its throat into the stomach.

Better out than in!

When a frog eats something that is poisonous or painful, they can vomit it up and learn to avoid eating something similar in the future.

Some frogs are even able to push their entire stomach out of their mouth. Australian frog expert, Professor Mike Tyler, reports that if a frog is exposed to or force fed poisons the stomach may be expelled out of its mouth, inside-out, and then swallowed back in. However, he said that he had never seen a frog expel a stomach with food in it and that reports of a frog being able to clean out its stomach by wiping it with its hands are probably false.

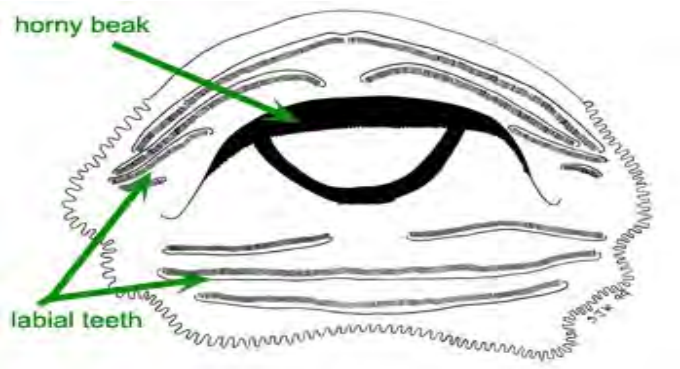
What do tadpoles eat?

Tadpoles normally feed on algae and other plant matter in the water, but they will sometimes eat decomposing matter, including dead fish, tadpoles and other animals. As they are mostly vegetarians, tadpoles have a long, coiled gut that aids in digestion – as the tadpole grows into a frog, the intestine shortens and straightens.

When population sizes are high and food is scarce, it is common for tadpoles to become cannibals, feeding on smaller, weaker tadpoles! This is very common in desert-dwelling species.

Tadpoles have a 'horny beak' that is surrounded by several rows of '**labial teeth**'. The beak is made from a substance called keratin, which is the same hard protein that is found in hair, horns, hooves and fingernails of mammals.

The labial teeth consist of rows of tiny black spikes on ridges of thick, stringy tissue. Tadpoles use their beak to cut up large pieces of plant material, while the rows of labial teeth can scrape off algae and small pieces of plant (or dead animal) material.



A tadpole's mouth showing the horny beak and rows of labial teeth.

Frogs as food

Frogs are a source of food for a large number of different predators, including fish, spiders, beetles, praying mantis, snakes, lizards, crocodiles, birds, frogs and a huge range of mammals such as dogs, cats, wild boars, bats, otters, rats, bears and weasels. To avoid being eaten, many frogs have developed **camouflage** as a way of blending into the background so that they escape and are not seen by predators. Most species blend into the background just using colours and patterns that match their surroundings (e.g. using brown stripes and patches to match leaf litter or having the appearance of bird droppings), but some species have also developed ridges, flaps, crests or lumps that make them virtually invisible in their natural surroundings.

The Green-eyed Tree Frog from Northern Australia is an expert at camouflage

Where is the Marbled Narrow-mouthed Frog?

Many species of frog are also able to change their colour as they move to new locations or if their habitat changes colour. While most frogs cannot change colour as much as animals like chameleons, many are able to change between light and dark shades. For example, the Mount Lofty Ranges Tree Frog, *Rawlinsonia calliscelis*, can change between pale cream and chocolate brown and the Southern Bell Frog, *Raniodea raniformis*, may change between bright emerald green and dull, dirty brown or bronze.

A pale Mount Lofty Ranges Tree Frog.

A dark Mount Lofty Ranges Tree Frog.

Although unrelated to camouflage, male Moor Frogs, *Rana arvalis*, change colour during their **breeding** season. In fact, the colour change may put the male Moor Frogs in even greater danger of predation. These frogs are usually a dull brown, but slowly change to a bright blue for breeding. Females do not change colour during breeding season.

Even though many species use **camouflage**, there are still times when predators discover and attack frogs. In most cases, frogs jump away from predators when attacked but may also use other defences.

Jumping

Jumping in frogs evolved for two reasons. One reason is that the ability to leap quickly and powerfully helps frogs to catch moving prey but, perhaps more importantly, leaping is a very effective way to get away from predators and avoid being eaten.

Some frogs are able to leap amazing distances. The record for the triple jump is held by a South African Sharp-nosed Ridged Frog, *Ptychadena oxyrhyncus*, which was able to cover over 10m in three hops (one of these was almost 5.5m). This species grows to approximately 6cm – if a human was able to cover the same distance in relation to body size, it would be like jumping over 100m!

The long jumping Sharp-nosed Ridged Frog from South Africa.

The high jump record is held by a Southern Cricket Frog, *Acris gryllus*, from America which leapt a height 62 times its body length – that would be like an adult human jumping as high as a 38 storey building!

Jumping has produced many changes in the body of the frog, the most obvious being the huge muscles and great length of the hind legs. The lower leg bones have also been joined together to help the frog take the force required for 'pushing off' during leaping. Their is also an extra joint in the foot that is not present in most vertebrates. Frogs' hands point inwards and two bones of the forearm have been joined into one, which acts like a shock-absorber when the frog lands.

Unfortunately for many frogs, the large leg muscles that help them leap long distances has resulted in them being considered a delicacy in many restaurants all around the world – not just those in France!

There are even a few species of tree frog in Southeastern Asia that have developed the ability to glide through the air to escape predators. These frogs have huge amounts of webbing between their fingers and toes which are spread out during jumping, acting as parachutes to enable the frog to cover large distances in their escape. Some of these frogs also have flaps of skin on their forearms and feet to improve their gliding ability.

The Edible Frog is considered a tasty treat in many parts of the world!

A gliding frog from South-East Asia.

Flash colouration

Many frogs, especially tree frogs that are capable of jumping long distances, make use of brightly coloured markings on their legs or sides to escape from predators if they are disturbed.

These markings, called flash colours, are designed to confuse the predator as the frog leaps away from it. When the frog lands, the flash colours are hidden and the frog once again **camouflages** with its surroundings.

In the hope of eating a frog, the predator may briefly continue searching for the bright colours before giving up. Once the predator has left, the frog can find a safer place to hide.

A South American Red-eyed Tree Frog showing the flash colours on its sides.

Defence postures

Some frogs use colours but do not jump away from predators. Instead they sit or stand in such a way that they show off bright colours on their bodies. The way they position their body to avoid being eaten or attacked is called a defence posture. The bright colours may have the appearance of large eyes to scare off predators or they may simply be bright stripes or bands suggesting that the frog is poisonous or tastes bad.

The Cuyaba Dwarf Frog, *Physalaemus nattereri*, has bright spots on its **groin** that look like large eyes. When at rest, the eyespots are concealed but when attacked the frog puts its head down and lifts its bottom revealing the eyespots. This makes the frog look like an animal with a big, scary head.

Many frogs will also use defence postures without the use of bright colours. For example, the Painted Frog, *Neobatrachus pictus*, will lift itself up on all fours and inflate its lungs so that it appears larger. It may also make a loud piercing scream to try scare off the predator.

A Cuyaba Dwarf Frog and its misleading eyespots. Is it facing you or looking away?

Painted Frogs in Australia will also puff up when alarmed.

Bibron's Toadlet, *Pseudophryne bibroni*, will pretend to be dead when attacked. These small frogs will flip over onto their backs and go limp, staying in this pose until the predator has gone.

Many predators only eat fresh, live prey, so playing dead will make the frog appear bad to eat.

Bibron's Toadlet also has black and white stripes on its belly – a combination that often indicates poison in the animal world.

Bibron's Toadlet pretending to be dead.

Poisons

Many frogs make chemicals that taste bad to predators; stopping them from attacking the frog or spitting it out.

For most species, these chemicals are produced all over their skin, but some species, such as the Cane Toad, *Rhinella marina*, have special **glands** on their head called parotoid glands that are able to shoot poison a distance of about one metre.

As well as frightening off predators, some of these chemicals can cause death.

Some frogs also make smelly chemicals that may help them in escaping predators. These chemicals may act by stopping predators or warning other frogs of danger. For example, when the Australian White-Lipped Tree Frog, *Sandyrana infrafrenata*, feels threatened, it releases a chemical that smells like curry powder!

The Cane Toad has large poison glands behind its ear drums that are able to spray poison 1m.

Approximately 170 species of small South and Central American frogs are able to avoid most predators because they produce some of the deadliest poisons known in nature.

These frogs are active only during the day and many have amazing colours and markings. The bright markings act as a warning to predators, telling them that they are poisonous.

Three of these species are known to have been used by the Colombian Chocó Indians in hunting. The poisons were collected from the frogs and used to coat darts used in blowguns.

Different methods were used to obtain the poison from the frogs – the southern Chocó Indians simply wiped the darts across the backs of the frogs, the northern Chocó Indians stabbed frogs with sticks, causing them to release large amounts of poison as they died. The frog can produce enough poison to coat 50 darts and the poison can remain active on a dart for over a year!

Some of the poisons in these frogs (batrachotoxins) act upon the nervous system and cause spasms, paralysis, heart attacks and eventually death.

The most poisonous of these frogs, the Golden Dart Frog, *Phyllobates terribilis*, is so toxic that only 0.00001 gram (10 micro grams, 10µg) of poison can kill an adult human. An adult frog may contain as much as 1900 µg – enough to kill about 190 humans or over 20,000 mice!

Although only four species are believed to have been used by the Chocó Indians for poison darts, this family of frogs is collectively known as Poison Dart or Dart Poison Frogs.

Some people incorrectly call them Poison Arrow Frogs, but they have never been used on arrows, only blow darts.

Predators learn not to attack these frogs because of their bright colouration. The different species can be found in a wide range of colours. Many have striped patterns, but you can also find poison dart frogs that are one colour or have bright spots, bands or mottling. They come in most colours, including orange, blue, red, green yellow, grey, brown and black.

The Golden Dart Frog - the most poisonous animal on the planet!

Frogs of the same species may even come in different colours and patterns and look completely different to each other!

Not all Poison Dart Frogs are deadly, but even some of the less toxic ones can cause numbness or temporary paralysis. Most taste nasty, so predators avoid eating them.

Interestingly, if these frogs are kept in **captivity**, they gradually become less poisonous. Any frogs born or reared in captivity are completely safe to touch. It appears that these frogs are only poisonous because of the poisonous ants and beetles they eat in the wild. If they don't have access to these food items, they cannot make their own poison! Lots of people in America like to keep these amazing frogs as pets.

Poison Dart Frogs come in a large range of colours and patterns.

To make things even more confusing, there are many species of frog that copy the colours and patterns of the poisonous frogs but are not themselves poisonous. These frogs mimic the poisonous frogs so that they will not get eaten by predators!

Frog habitats

Frogs are found throughout the world, occurring on all continents except Antarctica, as well as living on many offshore islands. As a result, frogs live in a huge range of habitats including swamps and rivers, cool woodlands, wet forests, tropical rainforests and alpine regions.

Living in deserts

Large numbers of frogs can also be found in arid deserts and coastal sand dunes. Whilst most species rely on plenty of fresh water or moist conditions during their life, some species have adapted to the most extreme habitats on earth.

For example, many desert dwelling frogs burrow underground during hot, dry periods and only become active after rainfall. Some of these species, such as the Australian Water-holding Frog, *Cyclorana platycephala*, can burrow a few metres underground, shed skin to form a protective cocoon and stay there in a kind of suspended animation (**aestivation**) until the rains fall.

These frogs may stay burrowed in this cocoon many years waiting for rain. They are able to store large amounts of water in their bladder or in sacs under the skin and they have often been used by desert nomads, including Aboriginals, as a source of water in the desert.

By stamping on the ground, the people are able to trick the frogs into thinking it is raining so that they climb to the surface where they can be collected. When the frogs are gently squeezed, they release water which can then be drunk!

Most species of burrowing frog burrow backwards, using either an angled sliding technique or a corkscrew-like twisting motion. These frogs have a special structure called a '**metatarsal tubercle**' or '**scaphoid**' on their feet that helps them to dig. In Western Australia, three species, the Northern Sandhill Frog, *Arenophryne rotunda*, the Southern Sandhill Frog, *Arenophryne xiphorhyncha*, and the Turtle Frog, *Myobatrachus gouldii*, burrow head first.

A Painted Frog twisting and turning as it burrows underground.

This black ridge on the bottom of a burrowing frog's foot is used for digging.

Living in the cold

As well as living in some of the hottest places on Earth, frogs also live in some of the coldest.

One particular frog, the Wood Frog, *Rana sylvatica*, lives in Alaska, Canada and other parts of North America near the Arctic Circle. Over winter, this region gets incredibly cold and the ponds and other waterways freeze, so the frogs are not able to enter or leave the water. Instead, the Wood Frogs find a shelter spot, in a burrow, under leaf litter or in the mud, and they also freeze solid.

The Wood Frog from North America is able to freeze over winter!

Once warmer spring temperatures cause the ice to melt, the frogs also thaw out. These frogs are able to survive freezing because they release large amounts of glucose (a type of sugar) into their cells. The glucose binds to the water inside the frog's body so that when their body freezes, they do not dehydrate and damage their internal organs. However, these frogs are only able to survive freezing between -1 and -6°C. If the temperature gets any colder the frogs will die.

These frogs are being closely studied by scientists who have been trying to develop methods for freezing human organs. They want to be able to freeze human organs so that they can be stored and used in transplant surgery at a later time. Currently, organs cannot be stored and must be transplanted very quickly. If doctors are able to freeze organs and later revive them, they will be able to help many more people who need heart, liver, kidney or other organ transplants.

Living in trees

Many species of frogs can be found living in the trees. Most tree frogs have evolved special finger and toe pads that enable them to grip on branches and leaves. These frogs are also able to climb on rocks and walls and even very smooth surfaces like glass windows. The toe pads are not just acting like a suction cup; they are made up of millions of interlocking cells that can be squeezed together using surface tension to hold on. Underneath the skin between the interlocking cells are special **glands** that produce a sticky material. Therefore, the frogs use both increased surface tension and glue to help them hold on and climb. Unfortunately, the pads don't work very well if they are wet – the frog will not be able to grip onto smooth surfaces and will slip or slide down!

A White-lipped Tree Frog climbing a branch.

A Peron's Tree Frog climbing on glass. Look at the large toe pads that help it stick on.

Frogs as bio-indicators

In the late 1970s scientists all around the world began noticing declines in the number of amphibians. Various causes have been suggested for this global decline; including disease, global warming, ultraviolet radiation, habitat degradation and pollution, including acid rain. The current feeling is that a combination of these different problems could be responsible.

Regardless of the cause of the amphibian declines, we now know that frogs are able to tell us about the health of our environment. If we have a healthy environment, we will expect to find lots of frogs of different species. If the environment is unhealthy, there will be very few frogs present.

Humans have impacted upon frogs in many different ways:

Disease

A number of diseases have been spreading through frog populations. For example, the gallbladder protozoan, *Myxidium immersum*, was introduced into Australia with the Cane Toad, *Rhinella marina*; and it has since infected native frogs. The chytrid fungus, *Batrachochytrium dendrobatidis*, which has been detected in wild frogs from various parts of Australia and Central America and also in **captive** specimens in Australia and the USA, has killed large numbers of frogs. The spread of this disease will result in the decline of many frogs and it is also possible that many species that are only found in very small areas may be lost altogether.

Habitat loss

Some frogs, particularly tree frogs, are able to live with humans. Farm dams, shallow quarries and backyard ponds are all commonly used by frogs as **breeding** sites, but a large number of species suffer because of human population growth and habitat loss. Land clearance for housing and farming is directly responsible for removing a large amount of habitat and the decrease in native scrubland and particularly the modification of natural waterways into concrete-lined stormwater drains removes breeding and sheltering sites. This action also highly modifies the natural water flows which may reduce flooding of the floodplains, common breeding sites for many species.

Farming and building has resulted in a large loss of habitat for frogs and other animals.

Unfortunately, many streams and creeks have been turned into concrete drains.

Ultraviolet radiation

Associated with global warming, the partial loss of the ozone layer may have significant effects on the amount of ultraviolet radiation (UV) reaching the earth's surface. UV damage is potentially a major problem to frogs because, unlike higher vertebrates, they lack hair or feathers to act as a UV filter. Absorption of UV energy by proteins and DNA can result in genetic errors leading to mutations and possibly death.

Pollution

Pollution is the most likely cause of frog declines and the one that has attracted the most attention. Pollutants, which include a wide range of items such as chemical waste, oils, organic material, heavy metals, radioactive waste, thermal pollutants and household refuse, may enter the aquatic environment from industrial activities, agricultural runoff, stormwater runoff and direct dumping. These contaminants can have a number of different impacts on frogs and may result in death or they may cause frogs to be more at risk to other problems like diseases and habitat loss.

Pollution in our waterways. Yuck!

More water pollution. Can you see the family of ducks trying to swim through the filth?

High levels of nutrients, for example fertiliser runoff and leaf litter, in water promote the growth and reproduction of blue-green algae which are responsible for algal blooms. These algal blooms reduce light penetration into the water meaning that aquatic plants are not able to photosynthesise. This reduces the amount of oxygen in the water and the amount of food available for plant eating animals, such as tadpoles. There is also a large drop in oxygen levels in the water when blue-green algae and other algae die and decompose, which may lead to the death of frogs and other aquatic organisms.

Torrens Lake, closed due to water pollution causing an algal bloom.

More algal problems in the River Torrens.

Large amounts of agricultural chemicals can enter waterways and many herbicides contain surfactants. Surfactants are spreading (wetting) agents that are used to spread the chemical across the surface of the weed. Frogs have a very loose skin that is used in breathing and when they are exposed to surfactants their entire skin is also covered with the chemicals. This causes them to suffocate and die. In some cases the surfactant may be more toxic than the herbicide.

Large quantities of oils and petroleum products enter the system from stormwater runoff, especially from roads. Oil slicks on the surface of the water also prevent oxygen getting into the water and, because they are also toxic, they can kill frogs and tadpoles.

Frogs can tell us quite a lot about the health of our environment and warn us if we are making mistakes in the way we live within our catchment.

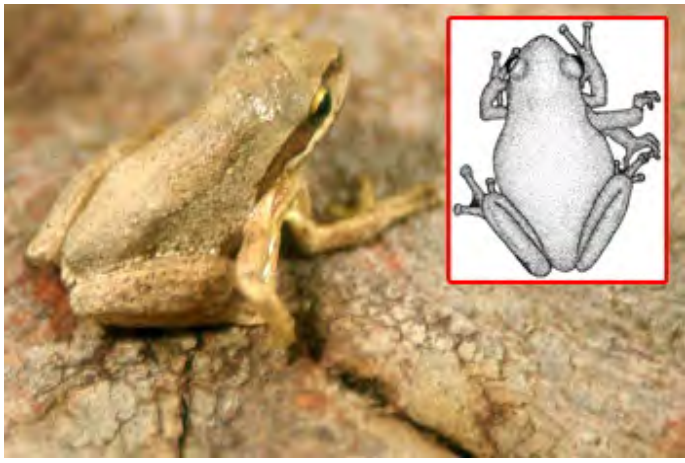
Abnormal frogs

An investigation of natural levels of abnormalities in South Australian frogs from locations in and around the Mt Lofty Ranges showed that abnormal frogs were more common in areas where chemical use is high. Agricultural fertilizers, pesticides and household and industrial chemicals all increase the rate of abnormality in frogs.

Abnormalities may include major deformities such as missing or extra legs, but even very minor deformities like a reduction in the length of the toes can have a huge impact on the survival of a frog.

Mistakes can happen in nature. Even in perfectly clean water we can expect to find some abnormal frogs. Recordings of frogs from near-pristine sites around the world show that the rate of abnormality can be as high as 3%, but it is generally less than 2%. Therefore if we find abnormal frogs at a rate much higher than three in every 100 frogs collected, we can assume there are major pollution problems.

Abnormal frogs - result of water pollution.



This six-legged Mount Lofty Ranges Tree Frog was found in clean water. Not all abnormalities are the result of pollution!

Frogs of Adelaide and the Mount Lofty Ranges

There are currently six species of native frogs listed as being found in the Adelaide and Mount Lofty Ranges. In addition, Peron's Tree Frog has also become established in the region. The Southern Bell Frog was introduced into in the 1960s but it has not been recorded here since the mid-1980s (it is still found in the Murray Valley, South East South Australia, Tasmania, Victoria and New South Wales).

There have also been some species of frogs that have been released into the region over the years, including those that have been accidentally transported from Northern Australia in fruit, vegetable and plant shipments and those that have been released into ornamental ponds or as pets. It is unknown how many of these translocated species, if any, have established **breeding** populations or what serious impact they may prove to have on our local native frogs.

As yet, the introduced Cane Toad has not made inroads into South Australia; two individuals were discovered and removed, one each near Paradise and Victor Harbor, in the 1990s. It is thought that these were probably stowaways in vehicles that had travelled from New South Wales or Queensland. Further searches failed to find any other individuals.

In the mid-2000s a couple were also found near a train depot in Salisbury. These also seemed to be rare stowaways that did not become established.

The six endemic (true locally native) frogs in Adelaide and the Mount Lofty Ranges represent three families of frogs, the Pelodryadidae (tree frogs), the Myobatrachidae (ground frogs) and the Limnodynastidae; which are also ground frogs.

Family Pelodryadidae

Mount Lofty Ranges Tree Frog (Rawlinsonia calliscelis)

The Mount Lofty Ranges Tree Frog is the only tree frog naturally found in Adelaide, the Mount Lofty Ranges and surrounding areas. It is often found clinging to windows and is a common visitor to bathrooms.

It is slender and medium sized with a broad head and rounded snout. A wide and undivided band runs along its back.

It is generally pale to dark brown with a narrow, black or brown stripe from the snout to the shoulder and a pale stripe beneath the eye.

The thighs are orange and may have black spots. The fingers are unwebbed and the toes are half webbed. The ear is distinct.

Size: Males 22-40 mm; Females 32-46 mm.

Habitat: It can be found on the ground, in vegetation, or under rocks near permanent streams or pools.

Mount Lofty Ranges Tree Frog (Rawlinsonia calliscelis)

Breeding: Occurs any time during the year. Eggs are deposited in small clumps attached to submerged vegetation.

Mating call: A loud, distinctive, high pitched 'weep-eep-eep' of 10 to 20 notes.

Peron's Tree Frog (Pengilleyia peronii)

Peron's Tree Frog is naturally found throughout the swamps of the Murray Valley and the South East but it has now become established in the Mount Lofty Ranges, possibly as a result of the pet trade.

It is characterised by a cross-shaped pupil, emerald spots and bright yellow and black markings in the groin and arm pits.

It has a black along the edge of the ear drum.

It has large pads on the fingers and toes. The fingers are not webbed, but the toes are almost fully webbed.

Peron's Tree Frog (Pengilleyia peronii)

Size: Males 44-53 mm; Females 46-65 mm.

Habitat: In the Mount Lofty Ranges it has been found around ponds, dams and wetlands, and in well-vegetated garden areas.

Breeding: Male frogs commonly call from the ground or in vegetation which may be two metres or more above the water. The tadpoles are yellow with dark brown lateral stripes.

Mating call: A series of separated rattling notes resembling laughter. Commonly described as a 'maniacal cackle'.

Family Myobatrachidae

Common Froglet (Crinia signifera)

The Common Froglet is the most commonly found frog in South Australia.

It has highly variable skin colour and texture, even within populations. The skin may be plain, striped or spotted, smooth, warty or ridged. The belly is usually white with black splotches.

Common Froglet (Crinia signifera).

Size: Males 18-25 mm; Females 19-28 mm.

Habitat: Found beneath rocks, vegetation and debris at the edge of creeks, ponds, wetlands and areas of seepage. During dry periods the frog may be found away from water sources.

Breeding: Breeds throughout the year except in mid summer. Eggs are laid in small bunches of 100-150 in shallow water.

Mating call: Rapidly repeated 'crick...crick...crick'.

Bibron's Toadlet (Pseudophryne bibroni)

Bibron's Toadlet (Pseudophryne bibroni)

Although the most abundant and widespread of its genus, Bibron's Toadlet is believed to have become less abundant in recent times.

It is generally found singularly or in small numbers under rocks and logs.

Bibron's Toadlet is grey or brown to almost black above with a scattering of darker flecks and red or orange spots and it may have a yellow area around the region of the anus. Its skin can be smooth or granular and is usually scattered with a few warts.

The belly is marbled black and white, sometimes appearing almost blue.

Size: Males 22-30 mm; Females 25-32 mm.

Habitat: Found in damp areas with some cover such as logs and stones.

Breeding: Calling begins in February and continues until August. Eggs are deposited in damp leaf litter under logs and stones. Hatching of well developed tadpoles occurs after rains flood the area.

Mating call: A short, grating, upwardly inflected 'ark'.

Family Limnodynastidae

Eastern Banjo Frog (Limnodynastes dumerilii)

Eastern Banjo Frog (Limnodynastes dumerilii)

The Eastern Banjo Frog is a common inhabitant of dams, wetlands and rivers.

It is a medium to large burrowing frog with a broad, rounded head and short, thick limbs. A tibial **gland** is present on each thigh, and labial glands at the corners of the mouth.

The body is rough and warty, varying from a pale grey to dark brown or black. The sides are commonly marked with bronze, purple or black.

Size: Males 52-70 mm; Females 52-83 mm.

Habitat: Burrows in loamy soils and emerges to feed and breed after rains. Commonly seen crossing roads on rainy nights.

Breeding: A large foam nest containing up to 4000 eggs is laid in water, attached to vegetation. Females have flanges on their fingers that are used during mating to carry air bubbles from the surface of the water into the foam nest to oxygenate the eggs.

Mating call: A single musical 'bonk'.

Spotted Marsh Frog (Limnodynastes tasmaniensis)

The Spotted Marsh Frog is found throughout most of eastern Australia.

It has olive, green or brown spots on a pale background which may change over the course of the day. The ventral (lower) surface of the body is smooth and white. Breeding males have a dark yellow/green throat. Many specimens have a stripe running down the middle of the back that may be white, yellow or red.

Females have flanges (flaps of skin) on the first two fingers.

Spotted Grass Frog
(Limnodynastes tasmaniensis)

Size: Males 31-42 mm; Females 32-47 mm.

Habitat: A widespread species, habitat includes marshy country, creek edges and wetlands.

Breeding: Males call from the edge of shallow water, often hidden in vegetation. A foam nest of 90-1300 eggs is laid floating in water attached to vegetation

Mating call: A rapid, soft 'uk..uk..uk..uk', like a toy machine gun.

Painted Frog (Neobatrachus pictus)

Living in woodland, mallee, open and disturbed areas, the burrowing Painted Frog has no obvious site preferences.

It is moderately sized, stockily built with short limbs and is generally deep olive with darker markings on the head and body. The skin is smooth, except during the mating season when the male will develop tiny black thorns.

The eye is prominent and has a vertical pupil. The **tympanum** (ear drum) is not visible.

The fingers are cylindrical and lack webbing. The toes are extensively webbed. It also has a black horn-like 'shovel' on the foot.

Painted Frog
(Neobatrachus pictus)

Size: Males 46-58 mm; Females 48-55 mm.

Habitat: Mostly open grassland and woodland.

Breeding: About 1000 yellow eggs are laid in a chain entwined with submerged vegetation.

Mating call: A long, rapidly pulsed, musical trill.

Frog ID Key

Fingers and toes without pads

Large gland on hind leg

No gland on hind leg

Hard, black shovel on sole of foot. Vertical (cat-like) pupil

No shovel on foot. Horizontal or diamond pupil

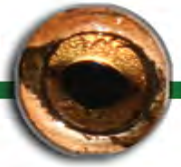
Belly has black & white spots or stripes

Smooth belly with black & white stripes (marbling)

Rough belly with black & white spots (stippling)

Belly mostly white; throat may be green or yellow

Fingers and toes with pads



Horizontal pupil

Line forms cross-shaped pupil

Eastern Banjo Frog

Painted Frog

Bibron's Toadlet

Common Froglet

Spotted Marsh Frog

MLR Tree Frog

Peron's Tree Frog

Introduced into the Adelaide region

Photos (c) Steve Walker, except Painted Frog foot (c) Peter Robertson (Museum Victoria)

Other learning opportunities and activities

Engaging with nature is designed to enhance learning programs and encourage a holistic approach to sustainability education. Although lessons may primarily have a Science and Society & Environment focus, other learning opportunities are recommended that can be integrated across the learning areas.

The following pages include a number of activities and ideas to help you develop frog-related lessons to run with your students:

- Construct a food web diagram or poster for a species of frog.
- Compare two frog species found in different habitats and describe how each has adapted to their environment.
- Read an Aboriginal dreaming story relating to frogs or water. What messages are conveyed about the relationship between humans and the environment?

- Design a frog friendly pond for your school, to provide a suitable habitat for a local species. Cost the materials and develop a plan for managing the pond.
- Research the current threats to frog populations and consider how these can be prevented or reduced in the future.
- Read 'Lester and Clyde' (Reece, J.H. 1975) then write a follow-up story for the 21st century.
- Draw a consequences wheel with the question "What if all frogs species became extinct?".

- Identify what it is that makes frogs good bio-indicators. What environment would you need to create to encourage frogs to return?
- Create a labelled illustration of an imaginary 'Super Frog' that could survive in polluted waters. What special features would it need?
- Investigate an Australian frog, or other amphibian, and present your findings in project book or poster form.
- "Wanted - Pet Frog Owners." Write a job description or application letter to demonstrate the knowledge and skills needed to care for frogs.
- Play celebrity frog using the six frogs of the Adelaide and Mount Lofty Ranges region, or add your favourite frogs from around the world.

- Imagine you are a tadpole turning into a frog. Describe the changes and how it might feel, through a song, interpretive dance or piece of visual art.
- Develop an argument for prosecuting people whose actions threaten frog life. Debate whether imposing fines would solve the problems of stormwater pollution.
- Design and produce a board game to teach younger students about the impacts that people have on a frog's life.
- Run a debate on whether we should try to save a threatened species or not.

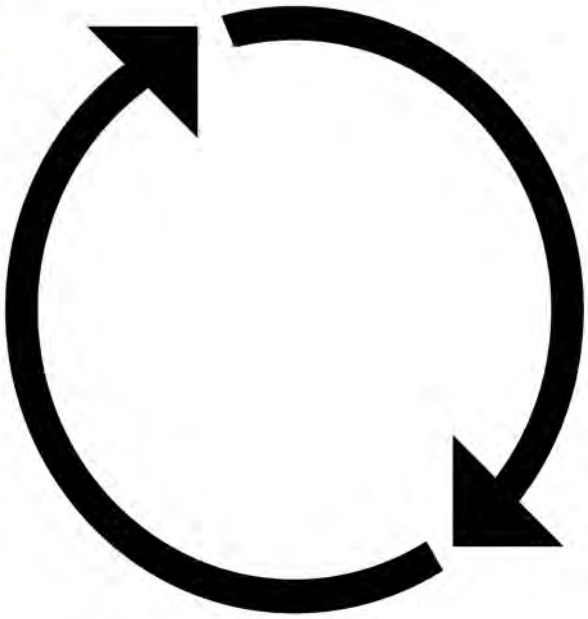
- Visit your local waterway and record frog calls to determine your local species.
- Imagine you are a frog, write a "day in the life" story about your environment and the hazards of pollutants.
- Imagine you could talk to frogs. What would you ask them and what might they tell you? Script a conversation.

Draw your own frog life cycle

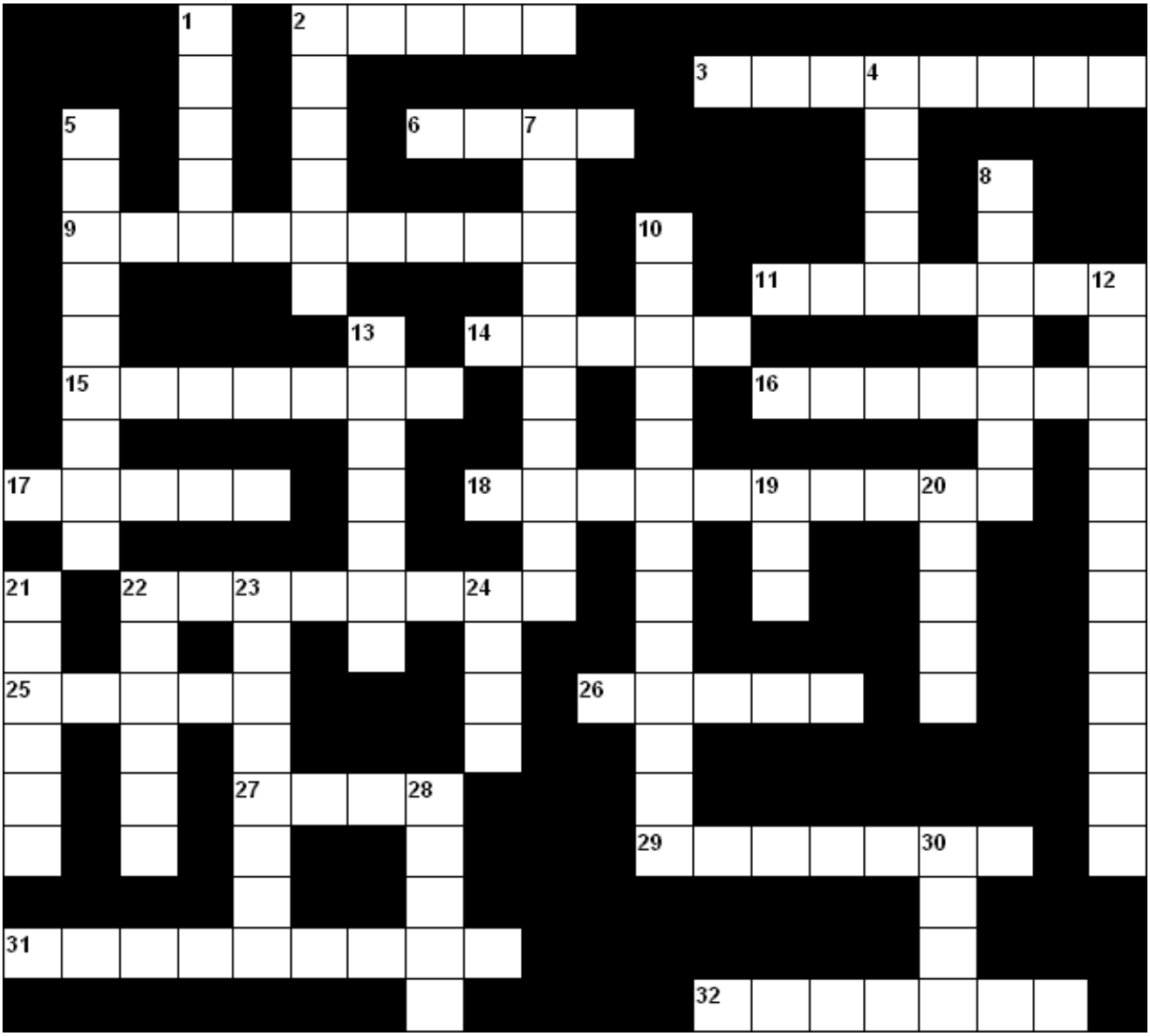
Imagine you are frog spawn beginning your life cycle, and you go from spawn to frog.

Draw the stages of your lifecycle.

Describe the changes you go through and how they might feel.



Frog crossword



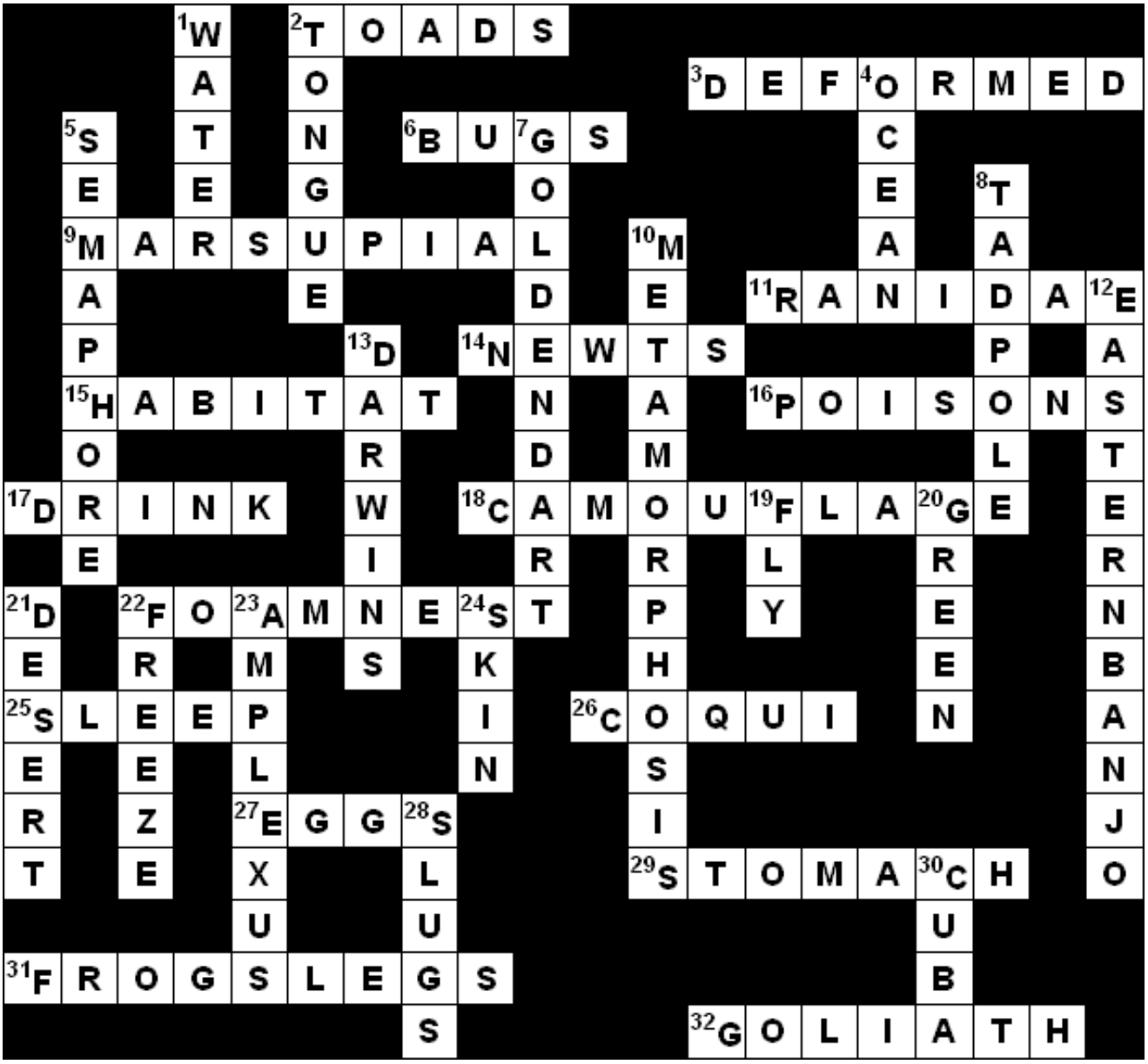
Across:

2. Some people think that these amphibians are different to frogs, but they aren't.
3. Chemicals in the water can cause frogs to become___
6. Most frogs like to eat these.
9. This frog raises its babies in hip-pockets.
11. This is the family name for 'True Frogs'
14. These tailed amphibians can be found in Europe.
15. If this is removed, the frogs will all disappear.
16. Many bright coloured frogs produce these in their skin.
17. Aboriginals can get one of these from a burrowing frog.
18. Most frogs use this to avoid being eaten.
22. Spotted Grass Frogs make one of these when they breed in the water.
25. Many frogs do this during the day.
26. This frog has a call louder than a jackhammer.
27. Most frogs lay these in water.
29. The Gastric Brooding Frog used to keep its babies in this.
31. Many French people like to eat these.
32. The largest frog in the world.

Down:

1. Most frogs lay their eggs in this.
2. A frog uses this to help it catch food.
4. You won't find frogs living here.
5. Some frogs don't use sound to communicate, they use this special signalling system.
7. This frog is the most poisonous animal in the world.
8. This fishlike animal will grow into a frog.
10. The development of a frog from an egg to an adult.
12. This South Australian frog has a call like a loud 'bonk'.
13. This frog rears its babies in its vocal sac.
19. Many frogs like to eat this animal, but they eat lots of other things as well.
20. Not all frogs are this colour.
21. Not all frogs live in wet areas. Some even live here.
22. This is what the Wood Frog will do during winter.
23. This is the special embrace used by frogs during breeding.
24. Frogs use this part of their body to breath with. Frogs also eat it as it gets old.
28. Many frogs like to eat these slimy creatures.
30. The tiny Monte Iberia Eleuth comes from this country.

Frog crossword answers



Create your own frog and star it in a cartoon

Use your favourite frog as the main character to create a cartoon illustrating its thoughts about some of the following:

- Where frogs live
- What it eats and who eats it
- What frogs do
- What happens in its environment
- What frogs look like
- How frogs move
- What its life is like today compared to the life of its ancestors living before Europeans arrived in Australia.

Remember to include features such as toes and eyes and use the correct colours.

Thinking frogs

Compare the diet of a frog with the food you eat.	Draw two places where you would never find a frog.
List five differences between frogs and humans. List five similarities.	For or Against? Should threatened frog species be protected? Write four reasons to support your argument.
You are a frog living in a creek near a national park. A child takes you to live in their backyard pond. Describe your feelings about this change.	Experts believe that global warming will bring less rain, higher temperatures and more frequent extreme weather events in Australia. Design a frog to cope with the conditions in this new environment.

Discussing frogs

Here are some good opening questions to get your students discussing and debating about frogs.

- What is a frog?
- What special features do frogs have?
- How do frogs' features help them to survive?
- How are frogs different to other animals? How are frogs similar to other animals?
- How many fingers and toes do frogs have?

- Are there differences between frogs and toads?

- Why do frogs have long hind legs?
- How do frogs catch their food?
- What do frogs like to eat?
- Do frogs drink water? How does water get inside their bodies?

- Compare the way frogs breathe with that of humans.
- Frogs cannot take a deep breath. Why is this?

- What do baby frogs look like?
- Where do baby frogs come from?
- What are the stages of a frog's life cycle?
- Frogs undergo metamorphosis. Can you name other animals that do the same?

- What sound does a frog make?
- Do all kinds of frog make the same sound?
- What do frogs from Adelaide and the Mount Lofty Ranges sound like?
- Why do frogs call?
- Do both male and female frogs call?

- Where can frogs be found? Where have you heard them? Are they living near your home?
- Compare a good and a poor frog habitat.
- What problems do humans cause for frogs?
- What can you do to care for frogs in your area?

- What do you think the main problem will be for frogs in the future?
- Imagine a world without frogs. How would this make you feel?
- Imagine a bright future for frogs? How would it look? What changes would people have to make?
- Were frogs around at the time of the dinosaurs?

- What happens if you illegally park a frog? It gets toad away!!!!!

Frogs on the internet

There is a huge number of frog websites on the internet. You may find some of the following useful when preparing lesson plans or if you are just looking for information about frogs. As they are external websites, we are not responsible for their content:

FrogWatch SA

www.frogwatchsa.com.au

By assuming that healthy habitats provide suitable conditions for diverse and abundant frog populations, we can make a simple assessment of the health of our waterways. Unhealthy or degraded habitats have few or no frogs present. FrogWatch SA provides information on which waterways have frogs, which may be used by land managers to determine areas that need protection or rehabilitation.

Amphibian Species Of The World: An Online Reference

research.amnh.org/vz/herpetology/amphibia/index.php#child

This site is really geared towards scientists, but it has links to information on just about every known amphibian species on the planet.

Amphibian Research Centre

frogs.org.au

This excellent site has information about conserving threatened frogs and links to a whole range of programmes including frog interest groups around Australia, community frog surveys, and keeping frogs in captivity. There is also lots of information about the many frogs in Australia.

Calphotos

calphotos.berkeley.edu

CalPhotos is an excellent collection of many thousands of photos of plants, animals, fossils, people, and landscapes from around the world. Please be aware that these various contributors maintain copyright and you need to follow the usage guidelines provided with each image. We sourced many of the photos in this teacher information pack from this website.

The Somewhat Amusing World Of Frogs

latham.dropbear.id.au/frogs/

This is a site with some fun and interesting fact about frogs from around the world. It is a few years old now and doesn't seem to have been updated much, so some of the material has been superseded, but it's still a fun place to visit.

Because the internet is quite a transitory place, many websites come and go or change their address.

Therefore, it is sometimes quite hard to find the information you are looking for. Many search engines help you find information just by typing in your question, others require much more specific key words. Here are just a few suggested hints, key words or phrases to type into your favourite search engine. Enter some or all of the key words for the given topic:

TOPIC	HINT / KEYWORDS / PHRASE
Frog declines and effects of pollution	frog amphibian deformity frog decline frog human impact
Photographs of frogs	search a frog's name on images.google.com
Life cycles	frog life cycle metamorphosis how long do frogs live
Frogs in Australia	Australian frog
What do frogs eat?	frog diet
Frogs and human culture	frog culture religion myth heritage
A specific frog	try its scientific as well as its common name
Frog conservation & ecology	frog habitat needs frog ecology
Prehistoric frogs	frog amphibian evolution frog amphibian dinosaurs Jurassic frog amphibian amphibian Devonian

Glossary

Aestivation:

The slowing down of the body's metabolism during a hot or dry period. Many frogs burrow underground during this period.

Amplexus:

A special embrace during breeding. Male frogs hold onto the female either around the waist or in the armpits and fertilise the eggs as the female lays them.

Breed or Breeding:

To produce offspring by mating. Also called reproduction. If plants and animals breed at a specific time or season, this is known as breeding season.

Buccal or buccopharyngeal respiration:

A special sort of breathing used by frogs. Gas exchange occurs directly across the roof of the mouth which is lined with many blood vessels. These blood vessels are able to take up oxygen from the fresh air and get rid of the waste carbon dioxide.

Camouflage:

The means by which animals escape the notice of predators, usually because of a resemblance to their surroundings.

Captive or Captivity:

Kept as a pet or held in a zoo, aquarium or other enclosure rather than in the wild.

Classification or Classify:

Naming and grouping plants and animals into categories based on how closely they are related to each other. Plants and animals can be grouped according to their families, appearance or habits.

Cloaca:

Frogs do not have separate outlets for faeces, urine or reproductive material (eggs or sperm). Instead, they have a common cavity (the cloaca) through which all waste and eggs or sperm are released.

Cutaneous respiration:

A special sort of breathing where frogs are able to exchange gases (oxygen and carbon dioxide) between their blood and the atmosphere directly across their skin.

Debris:

A collection of loose material derived from rocks, or an accumulation of animal or vegetable matter.

Diaphragm:

A muscle in the chest that is used in breathing in many animals. Together with the ribs, it is used to adjust the volume of the chest cavity and control the amount of air in the lungs.

Embryo:

The developmental stage of a plant or animal that comes after fertilisation and before birth or hatching.

Extinct or Extinction:

No longer in existence; that has ended or died out

Fertilise or Fertilisation:

Combining the genetic material of the male (sperm) with that of the female (egg) to produce an embryo.

Frequency-specific filter:

The mating call of a male frog is used to attract females for breeding. As a male frog only wants to breed with a female of his own species, his mating call needs to be different to that of other species so that he only attracts his own kind. His vocal sac is designed to help broadcast his call but it also controls the sounds being made so that they are different to those made by other types of frog.

Gland:

A cell or group of cells that produces chemicals for use elsewhere in or outside of the body. e.g. sweat glands, salivary glands, poison glands.

Groin:

The fold or depression where the lower abdomen meets the inner part of the thigh.

Hybrid:

The offspring resulting from the mating of two different species of animals or plants. e.g. a mule is a hybrid between a donkey and a horse. Hybrid animals are usually sterile.

Labial teeth:

Rows of rasping teeth in tadpoles that are used to scrape off algae and other materials from rocks and other structures in the water.

Membrane:

A thin, flexible layer of tissue that covers, lines, separates, or connects cells or parts of an organism. Membranes are usually made of layers of fatty acids and proteins which are permeable to water and other substances.

Metabolism:

The chemical interactions taking place in living organisms that provide the energy and nutrients needed to sustain life.

Metamorph:

A name commonly used to describe a young frog that has just completed, or is close to completing, metamorphosis.

Metamorphosis or metamorphosed:

The process of growth and development of a frog (or other animal) from an egg through larval stages (tadpoles) to become an adult. A frog that has completed metamorphosis is said to have metamorphosed.

Metatarsal tubercle:

A special hardened plate on the foot of burrowing frogs that is used like a shovel to help them dig a burrow.

Oviduct:

The tube that carries the eggs from where they are produced in the female's ovaries to the cloaca and outside.

Photosynthesis:

Plants are able to make their own food by using sunlight to change water and carbon dioxide (a type of gas in the air) into sugar. This process is called photosynthesis and one of the waste products in the process is oxygen. Animals use this oxygen for breathing.

Reproduction:

See Breed or Breeding.

Respiratory surface:

All plants and animals need to breathe. To help them take in oxygen and release carbon dioxide (a waste product from breathing), they have special body parts called respiratory surfaces that allow the exchange of gases between the inside and outside of the body. For example, most mammals and birds have lungs and most fish have gills.

Secretion:

A chemical that is produced in the body for use elsewhere inside or outside on the body. e.g. saliva, sweat, poison.

Semaphore:

Semaphore is a type of long-distance communication that is used by people who can see but cannot hear each other. These people use arm movements (often with flags) to 'talk' to each other.

Semipermeable:

Frog skin allows small particles like oxygen and water to pass into and out of the body but it acts as a barrier to other larger particles.

Spiracle:

A small tube or opening on the side of a tadpole's body that allows the water to pass out of the gills after oxygen has been removed from it.

Species:

The basic category of biological classification, composed of related individuals that resemble one another, are able to breed among themselves, but are not able to breed with members of another species.

Sterile:

Not capable of producing eggs or sperm and therefore unable to have offspring of its own.

Tympanum:

The thin oval membrane that transmits vibrations produced by sound to the inner ear. Also known as the ear drum.

Unfertilised egg:

An egg that has not been fertilised and is therefore only made up of the genetic material of the mother. It will not hatch and grow into another frog.

Vertebrate:

An animal with an internal skeleton of bone or cartilage, a nervous system divided into brain and spinal cord, and not more than two pairs of limbs.

Acknowledgements

The photographs and illustrations in this teaching pack come from a number of sources and we would like to give a special thanks to all of them for giving us permission to use their images. The original photographers/ illustrators retain copyright; their images and photographs should not be reproduced without their permission.

p3 Spotted Salamander - Brad Moon
Caecilian - Dr Peter Welsh

p4 New Guinea Amau Frog - Eric Rittmeyer

p7 Tailed Frog - Brad Moon

p8 clump of frog spawn - William Leonard

p9 Gastric Brooding Frog - Mike Tyler

p10 Surinam Toad - Honolulu Zoo (www.honoluluzoo.org)
Australian Marsupial Frog - Dr Michael Mahony

p11 Midwife Toad - Michael Frede
Strawberry Poison Dart Frog - Patrick Nabors (www.saurian.net)
African Live-bearing Toad - Dennis Demello

p12 South American Marsupial Frog - J Koehler

p14 Paired vocal sacs - Dr Peter Janzen

p15 Coqui Frog - William Flaxington
American Bullfrog - Joyce Gross

p16 Semaphore - Celio Haddad

p17 Frog tongue - Mike Tyler

p18 Frog mouth - Mike Tyler
Australian Tusked Frog - Jean-Marc Hero

p20 Green-eyed Tree Frog - Jean-Marc Hero
Marbled Narrow-mouthed Frog - Franco Andreone

p21 Sharp-nosed Ridged Frog - Miguel Vences and Frank Glaw
Edible Frog - Arie van der Meijden
Gliding Frog - Nikolai Orlov

p22 South American Red-eyed Tree Frog - Dr Peter Welsh
Cuyaba Dwarf Frog - Celio Haddad

p25 Burrowing Frog foot - Peter Robertson (Museum Victoria)

p26 Wood Frog - Joyce Gross

p27/8 Habitat loss & pollution photos - KESAB