



Science Project Plans

POLE TO POLE

These project plans are designed to be used alongside the accompanying resource sheets.
(please note: a CD resource does not accompany this resource pack, all resources are provided below)

Science Project 1: Amazing Arctic animals (Key Stages 1 and 2)

Aims of the lesson: To learn about Arctic animals.

Activity: The Arctic is home to a vast range of animals. Polar bear, caribou, musk ox, wolf, arctic fox, ermine, lemming, arctic hare, arctic ground squirrel, a range of birds, whales, harp seal and the walrus all live in the Arctic and all have adapted to suit their extreme environments. The **Science Project 1 folder** on the accompanying CD offers Information Sheets on some of these animals, and includes some brief details on how these animals have adapted to live in the Arctic. The page opposite offers a photo of an arctic whale (copy can be found in the **Science Project 1 folder**).

Ask the pupils to research a range of Arctic animals. To help with their research, the **Science**

Project 1 folder on the CD offers a range of black and white sheets for the pupils to colour in. The sheets are also labelled with some basic information about the animals. Once the pupils have investigated a range of Arctic animals, ask them to carry out an experiment to find out what it is like to have a layer of 'blubber' to keep warm. The information needed to carry out this experiment can be found in the **Science Project 1 folder** on the CD.

Other ideas: As an extension to this activity, ask the pupils to list what characteristics (such as fur) these animals have that allows them to live in the Arctic. The **Science Project 1 folder** on the CD includes an experiment asking the pupils why tundra animals have shorter ears, tails, noses and toes.

Science Project 2: Amazing Antarctic animals (Key Stages 1 and 2)

Aims of the lesson: To learn about Antarctic animals.

Activity: Antarctica is home to many animals. In particular, the Antarctic seas are full of life, ranging from microscopic plankton to the biggest animal on Earth, the Blue whale. Seventy per cent of the world's fresh water is frozen in the region of the South Pole – so sea life is amazing.

Similar to their Arctic counterparts, all of the Antarctic animals have adapted to life in extremely cold conditions. Some, like the whales, seals, and birds, have an insulating layer of fat to protect them from the cold. Others, like many fish and insects, have special chemicals in their blood (natural antifreeze) that keep them from freezing. Many animals (like penguins and seals) have a compact body form and thick skin to help retain body heat. Birds also have waterproof plumage (feathers) and downy insulating feathers. The **Science Project 2**

folder on the CD includes a sheet that lists some of the animals that can be found on or around the Antarctic. Leading on from Science Project 1 above, ask the pupils to research Antarctic animals and find out how they have adapted to their difficult surroundings. To help with their research, the **Science Project 2 folder** on the CD offers a range of black and white sheets for the pupils to colour in. The sheets are also labelled with some basic information about the animals.

Other ideas: As a fun extension to this activity, ask the pupils to complete the Antarctica wordsearch puzzle found in the **Project 2 folder** on the CD.



The National Geographic website has a fantastic bank of Arctic and Antarctic animal images



Science Project 3: Arctic medical kit (Key Stage 2)

Aims of the lesson: To develop an understanding of how polar areas affect humans physically by looking at an Arctic medical kit.

Activity: An Arctic expedition physician must be prepared for any medical emergency from polar bear attack to frost-bitten toes. He or she must also be on guard to ensure that stress does not cloud individual or team judgement. Arctic and/or Antarctic conditions can have a serious (even fatal) effect on humans – so it is absolutely essential for explorers or scientists travelling across these extreme regions to be prepared.

Begin this activity by asking the pupils what they think it would be like to go the North or South Pole. How do they think it would effect them? Then ask them to list items they think they would need in their expedition medical kit. The **Science Project 3 folder** on the accompanying CD includes a list of potential

items. How many did the pupils think of?

Next explain to the class that stress is a big problem for explorers when travelling to the North and South Poles. The environment is very, very demanding and explorers have to overcome fear on a regular basis. After all, they are risking their lives! To help monitor stress, scientists and doctors have devised a simple test and the **Science Project 3 folder** on the CD includes a description of this test for the pupils to try themselves.

Other ideas: One of the biggest dangers that explorers and scientists at the North and South Poles have to face is frostbite. Frostbite is, literally, frozen body tissue – usually skin but sometimes deeper – and must be handled carefully to prevent permanent tissue damage or loss. Ask the pupils to find out how explorers and scientists prevent frostbite.

Science Project 4: There may be trouble ahead (Key Stages 2+)

Aims of the lesson: To research and find out about the ozone and the effect that humans are having on the ozone layer. To find out about global warming and decide how we can all help save the planet.

Activity: Scientists working in the Arctic and Antarctic have found that large areas of the ozone are thinning due to the amount of CFCs and other chemicals that we use. Covering an area of around 22 million square kilometres, this year's hole in the Antarctic ozone is a little smaller than in 2003. Measurements made during August and September at BAS Halley and Rothera Research Stations reveal a 50 per cent reduction on normal ozone levels over the base of the Antarctic Peninsula and the Weddell Sea, and a 20 per cent reduction over the tip of South America and the Falkland Islands. This is good news. But, we need to make sure that we carry on being aware of how we affect the ozone layer, and education is key to this.

Begin this activity by explaining to the pupils what the ozone is. The **Science Project 4 folder** on the accompanying CD includes an Information Sheet on ozone and the ozone layer. Explain to the pupils that all the harmful chemicals we use have an effect on our planet and it is important for us to stop using them as soon as possible (or limit their use). Next ask

the pupils if they have heard of the phrase 'global warming'. Ask the pupils to find out what causes global warming and what we can do about it. Some of the easiest ways to help reduce global warming is walking (car fumes contribute dramatically to global warming); turning the heating down and lights off (the consumption of energy is a big factor); and creating less rubbish (the incineration of waste is another big factor; as is the gas created by massive landfills full of rubbish). The **Science Project 4 folder** on the accompanying CD includes Information Sheets on global warming and the ozone.

Other ideas: Conservation is a big issue at the Arctic and the Antarctic. Over the years since the Antarctic Treaty came into force, ever greater environmental awareness has led to increasing regulation by the Antarctic Treaty System. All plants and animals in Antarctica are now protected and there are measures in place to prevent pollution of this – the world's most pristine environment. Ask the pupils to find out about polar conservation). The **Science Project 4 folder** on the accompanying CD includes an Information Sheet on Antarctic conservation. The page opposite offers a picture of a seal – an animal that was brought dangerously close to extinction in the Antarctic. In parts of northern Canada, seals are still being killed in vast numbers.



Watch a video explaining the effects of global warming: <http://video.nationalgeographic.com/video/environment/global-warming-environment/global-warming-101/>



Science Project 5: How do penguins keep warm? (Key Stages 1 and 2)

Aims of the lesson: To learn about penguins and find out how they keep warm.

Activity: Antarctic birds and mammals are warm-blooded animals and they maintain internal body temperatures similar to warm-blooded animals in any other climate zone – that is about 35–42°C (95–107°F). They have to keep high body temperatures to remain active. A large (bigger than a small insect) Antarctic animal could never get enough energy from the surroundings to become active if it allows itself to cool – they have to stay warm to be active. So how do penguins keep warm? The **Science Project 5 folder** on the accompanying CD includes an Information Sheet on how penguins keep themselves warm. From cuddling together to having a layer of blubber; from standing in the right position to having an amazing blood supply – penguins have adapted perfectly to suit their extreme environment.

Thermal insulation

Moving on from how penguins keep warm, ask the pupils to investigate how we keep warm. Answers might range from wearing warm clothes to keeping moving. But, do the pupils realise that some materials make good thermal insulators (to keep us warm – such as wood and plastic) whilst other don't (such as metals).

Begin this activity by showing the children a cup of hot coffee or tea. Ask them to guess the temperature of the liquid. Measure the temperature accurately with a thermometer. What would happen to the drink if we left it in a room for an hour? What would happen to the temperature? Ask the pupils to think of a way of keeping the drink warm or at least stopping it cooling down so quickly? Tell the pupils that a material that stops heat loss is called a thermal insulator.

Can they think of some good thermal insulators? What happens when the cup of coffee or tea is placed in a plastic bag? What happens when it is placed under a cardboard box? What happens when it is placed in a paper bag etc. Ask the pupils to devise an experiment (and carry it out) to find out which material was the best thermal insulator? Which was the worst? Finally, ask the pupils to plot the results from the table in the online activity as a line graph.

Penguins aren't the only animals that have developed special characteristics to keep warm. In

the Arctic, polar bears have to keep warm – and the **Science Project 5 folder** on the accompanying CD also includes an experiment sheet to help pupils investigate how polar bears keep warm.

Igloos

As a further extension to this activity, ask the pupils to find out about igloos. An Inuit or Eskimo dwelling, called an igloo, is a permanent home made of snow and ice. The **Science Project 5 folder** on the CD includes an Information Sheet on how igloos are built and two igloo-related colouring-in sheets. The pupils could also make their own little igloo, using sugar cubes.

Start by laying a base row of sugar cubes around a 7-inch-diameter cardboard circle, leaving space for the entrance. Using a mortar of two egg whites mixed with three cups confectioners' sugar, add subsequent layers of cubes, one row at a time, decreasing the circumference gradually as you go. Apply the mortar to the top cubes, not to those already in place. Be sure to work alternately left and right from the entrance toward the back of the igloo and stagger the cubes the way a builder lays bricks. Build a total of 10 layers, stopping halfway through the construction to let the igloo dry. Make the arch and roof separately, working on a flat surface. When they are dry, glue them in place. Allow the igloo to dry completely, then sprinkle with a blizzard of sugar.

Visit YouTube to watch videos on how to build an igloo!



Other ideas: Ask children to find materials in their houses that work as insulators, either stopping something losing heat or stopping something warming up. Ask the pupils to find out about the different kinds of penguins found at the South Pole. The **Science Project 5 folder** on the accompanying CD includes some data sheets on three different types of penguins – chinstrap, gentoo and emperor penguins. The page opposite offer a photo of an Emperor penguin (copy can be found in the **Science Project 5 folder** on the CD.)



Pole to Pole

Science Project 1:
Amazing Arctic
animals

Key Stages 1 & 2





Arctic animals

Polar bears

Polar bears spend most of their time on the pack ice or in the water, where they can hunt their favourite food – the ringed seal. The white fur helps the bear sneak up on seals that are laying on the ice packs. If the bear sees a seal's breathing hole, it waits by the hole and drags the seal out as soon as its head appears. In the summer it is harder to catch seals, so before summer comes, the bears eat as much as they can to get fat, then live off the fat in their bodies. Females dig dens in the snow where they hibernate during the worst part of the winter. The cubs are born in the den.

Caribou

Caribou are members of the deer family. They move across the Arctic in large herds. Caribou eat moss, lichen and green plants. For the winter they go to the forests of the south where trees give them protection from the wind and the snow. In the spring the caribou leave the forests and go to the tundra to have their calves. A baby caribou is able to stand and walk an hour after it is born. It can run when it is a day old. The baby has enemies like wolves, bears and eagles.

Wolves

Tundra wolves live on the mainland. Arctic wolves live farther north on the islands. Tundra wolves are often brown or grey. Arctic wolves are usually smaller and white. Wolves on the mainland and Baffin Island hunt caribou. Arctic wolves hunt musk oxen and arctic hares. Wolves also eat fish, lemmings, birds, foxes and ground squirrels.



The Arctic fox

The Arctic fox is hard to see in the snow. It has a thick white coat of fur for the winter. In the summer the coat is brownish-gray. The arctic fox eats a lot of lemmings. They also eat hares, birds' eggs and the chicks. If there is a lot of food, the female has twelve or more pups, but if there is not much food she may have only five or six pups.

Lemmings

Lemmings look like furry hamsters. The brown lemming and the collared lemming live in the Arctic. The brown lemming prefers wetter areas, while the collared lemming is usually seen in rocky places. The collared lemming turns white in winter. In the winter lemmings stay warm in tunnels under the snow. When summer comes the lemmings leave their dens to feed on new leaves, grasses, roots and berries. If there is plenty of food a female lemming has as many as six sets of babies. Many arctic animals hunt lemmings.

The Arctic hare

The Arctic hare lives farther north than any other hare. They live among the rocks on hillsides where they can hide from foxes, wolves, owls and other enemies. Hares eat grasses, willows and other plants. Their favorite meal is the arctic willow. Hundreds of them gather together in herds, to stay warm, and for protection from their many enemies. When a noise is heard they hop away in all directions. The fur of the hares that live farther south may change to gray or brown for the summer.



Arctic ground squirrel

Arctic ground squirrels make underground dens with lots of tunnels and rooms. They live in colonies. During the spring and summer they eat and eat (tundra plants, seeds, fruits) to prepare for a long sleep. In late summer they store food in their burrows. When they wake up in the spring there is stored food to eat until the new plants begin to grow. Ground squirrels are the only Arctic animals that hibernate. They line the burrows with lichens, leaves and musk ox hair, then roll up into a ball and sleep for seven months. The body temperature drops to just above freezing and the heartbeat slows down during hibernation.

Whales

Whales are able to live in the cold waters of the Arctic. Only three whales make Nunavut their home – belugas, bowheads and narwhals. Bowheads can reach 18 metres in length. They almost became extinct due to overhunting in the 18th, 19th and 20th centuries. Whalers wanted the whales' oil and baleen. They are still considered endangered in Nunavut. Narwhals have long ivory tusks. They are threatened by overhunting for their tusks and meat. The white belugas seem to be smiling all the time. They make noises that sound like chirps, trills, whistles and clicks. Belugas use their foreheads to smash the ice so they can get to the surface to breathe.

The walrus

The walrus has to eat thousands of krill and shellfish each day. With its thick whiskers, the walrus feels around in the water for krill. Layers of blubber protect the walruses when they lie out on the ice in the cold wind. Walruses are very noisy animals. They are often seen crowded together on ice floes or on the shore.



Why do tundra animals have shorter ears, tails, noses and toes?

Objective:

Students will identify what adaptations arctic animals have that makes them suite to live in the cold.

Materials:

A pair of latex gloves, rubber bands, two thermometers, warm water, a measuring cups, two containers, refrigerator, and goggles.

Directions:

- Think about what will keep your hands warmer; a mitten or a glove?
- Close off each finger of one glove with rubber bands, this must be very tight. This will be the mitten.
- Leave the other glove intact.
- Pour an equal amount of warm water in each glove.
- Measure and record the water temperature making sure it is the same for each glove.
- Close the top with rubber bands. Make sure they will not leak.
- Place both gloves in a cool place; nest to one another but not touching.
- Wait 30 minutes.
- Pour the water from each glove into separate container.
- Measure and record the temperature.
- Which had the greatest decrease in temperature? (It should have been the glove).
- Apply what you have learned to the size of tundra animals ears, tails, noses and toes compared to their temperate counterparts.



Blubber experiment

The aim of this simple experiment is to find out what it's like to have a layer of blubber to keep warm.

You will need:

1. Fat or lard
2. Two closable sandwich bags
3. A bowl of ice water with ice cubes

Procedure:

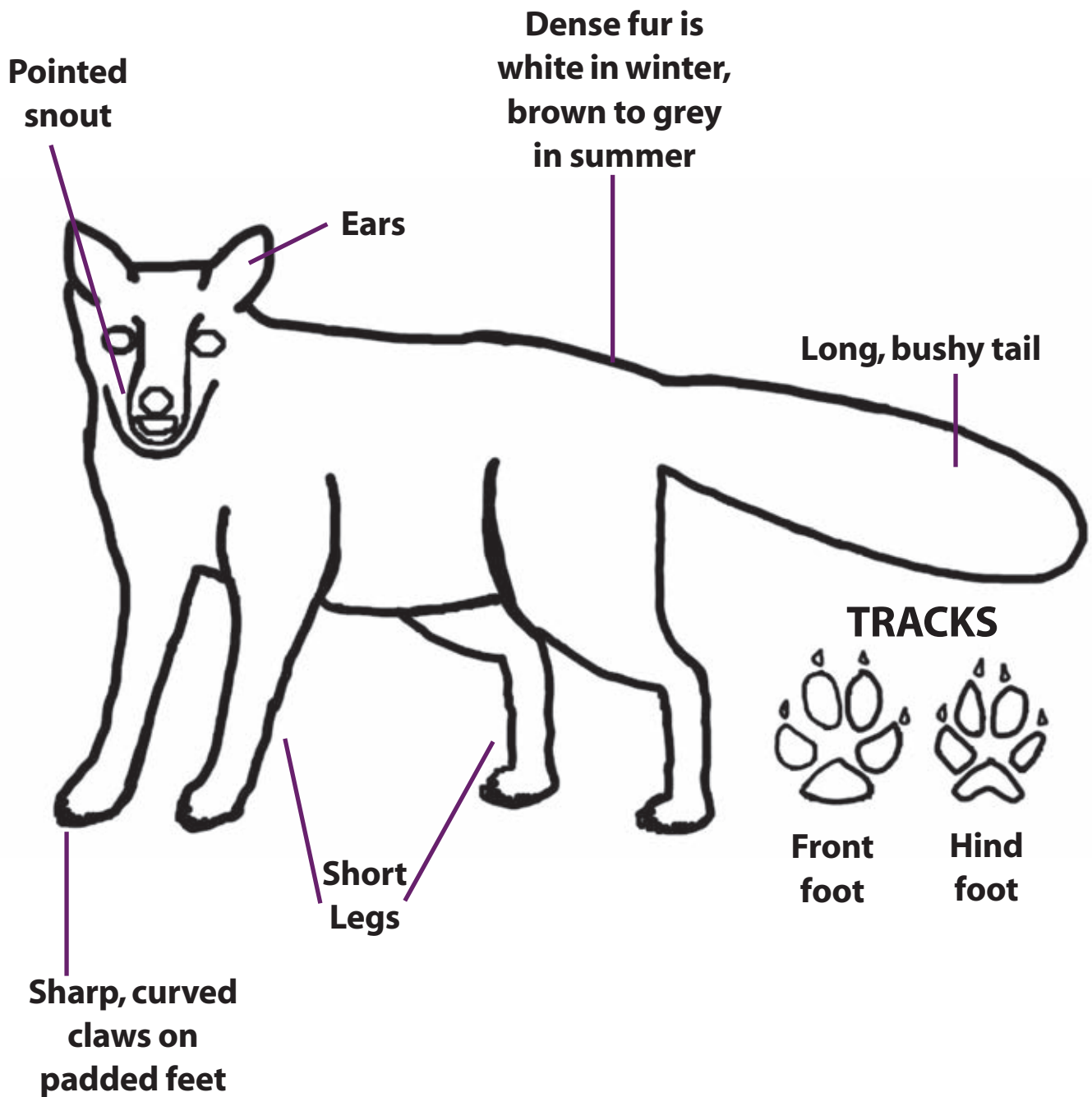
- Fill one of the sandwich bags about one-third full of fat or lard, then turn the remaining sandwich bag inside out. Place it carefully inside the bag with the fat or lard so that you are able to close the one bag to the other. This creates a 'blubber mitten' for you to put your hand in.
- Put your bare hand in the bowl of cold water and see just how cold it is.
- Next, place your hand in the 'blubber mitten' and now place your mittened hand in the ice water. How cold does the water seem with the 'blubber mitten' on? Do you think a nice layer of blubber would be great protection against cold? Walrus, whales, and seals all have layers of blubber which help to keep them warm.

Arctic Whale



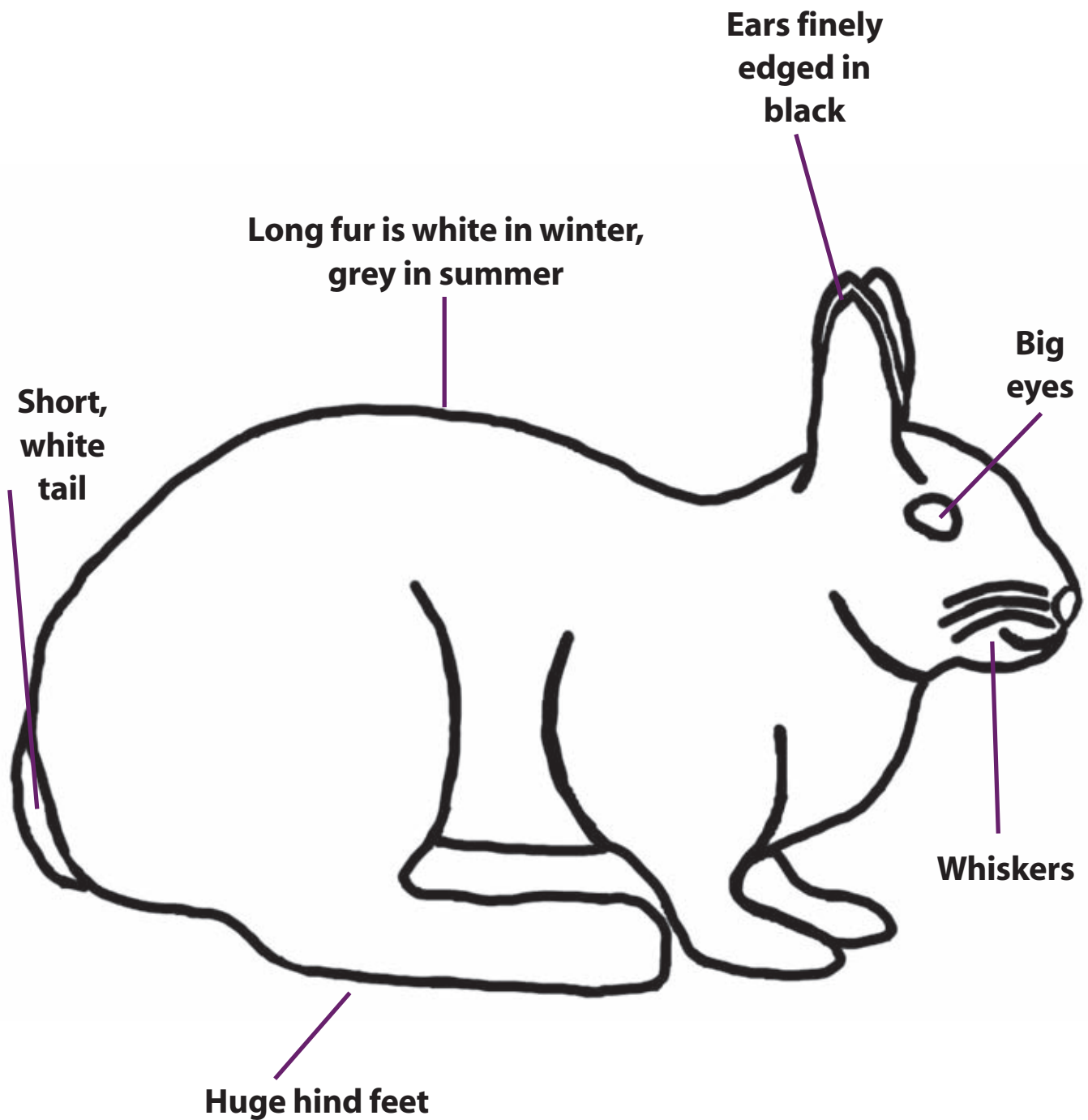


Arctic fox



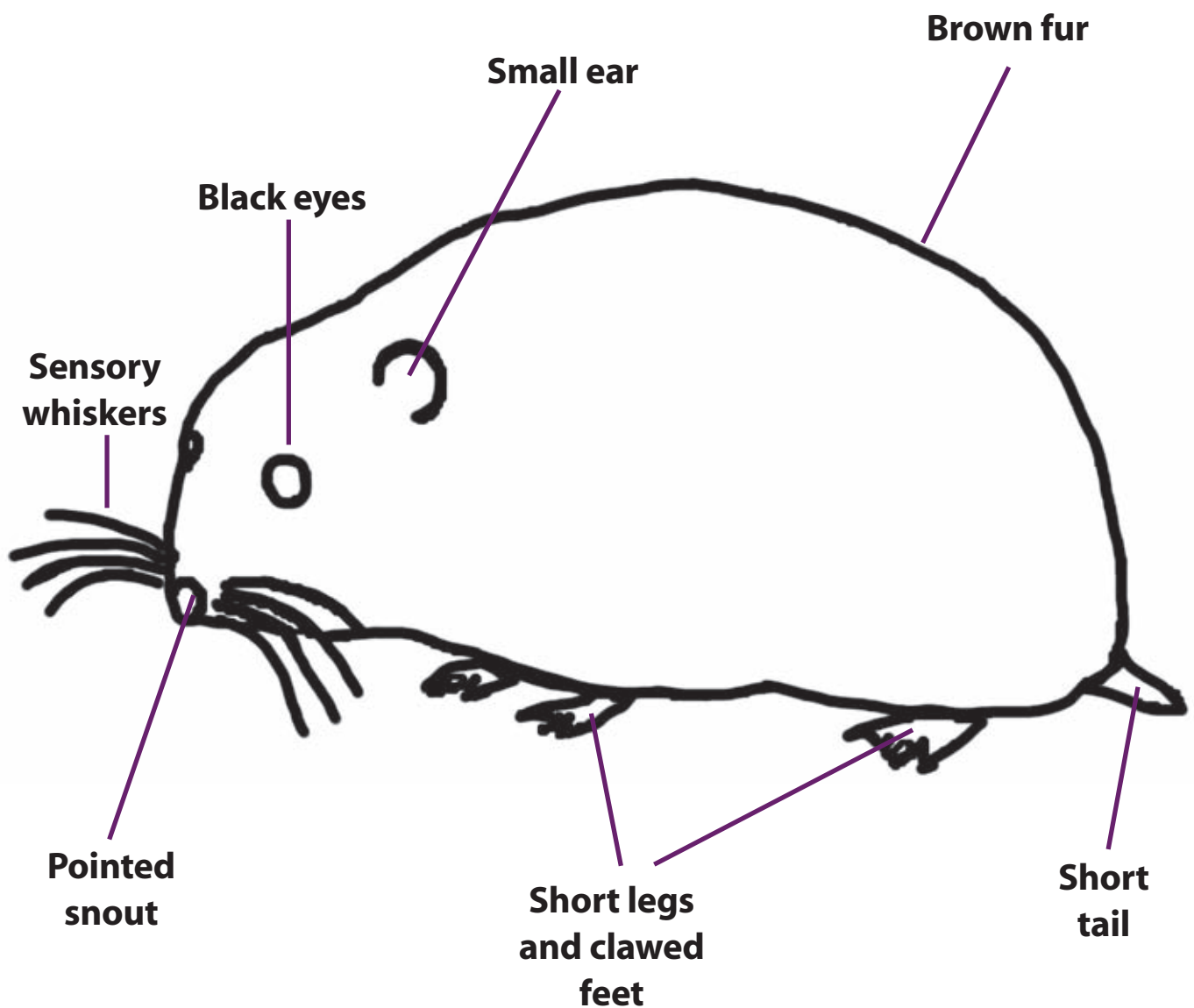


Arctic hare



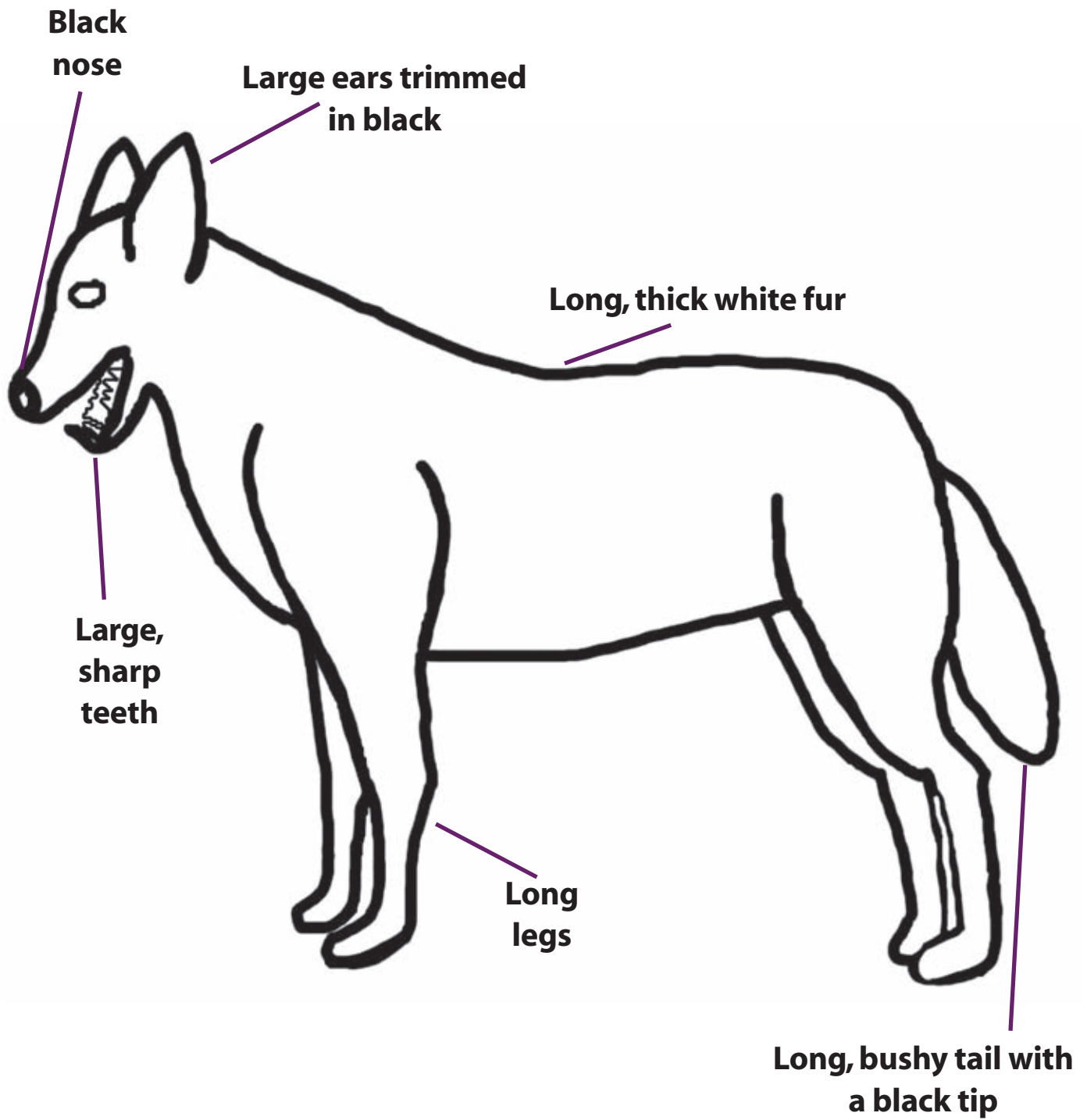


Arctic lemming



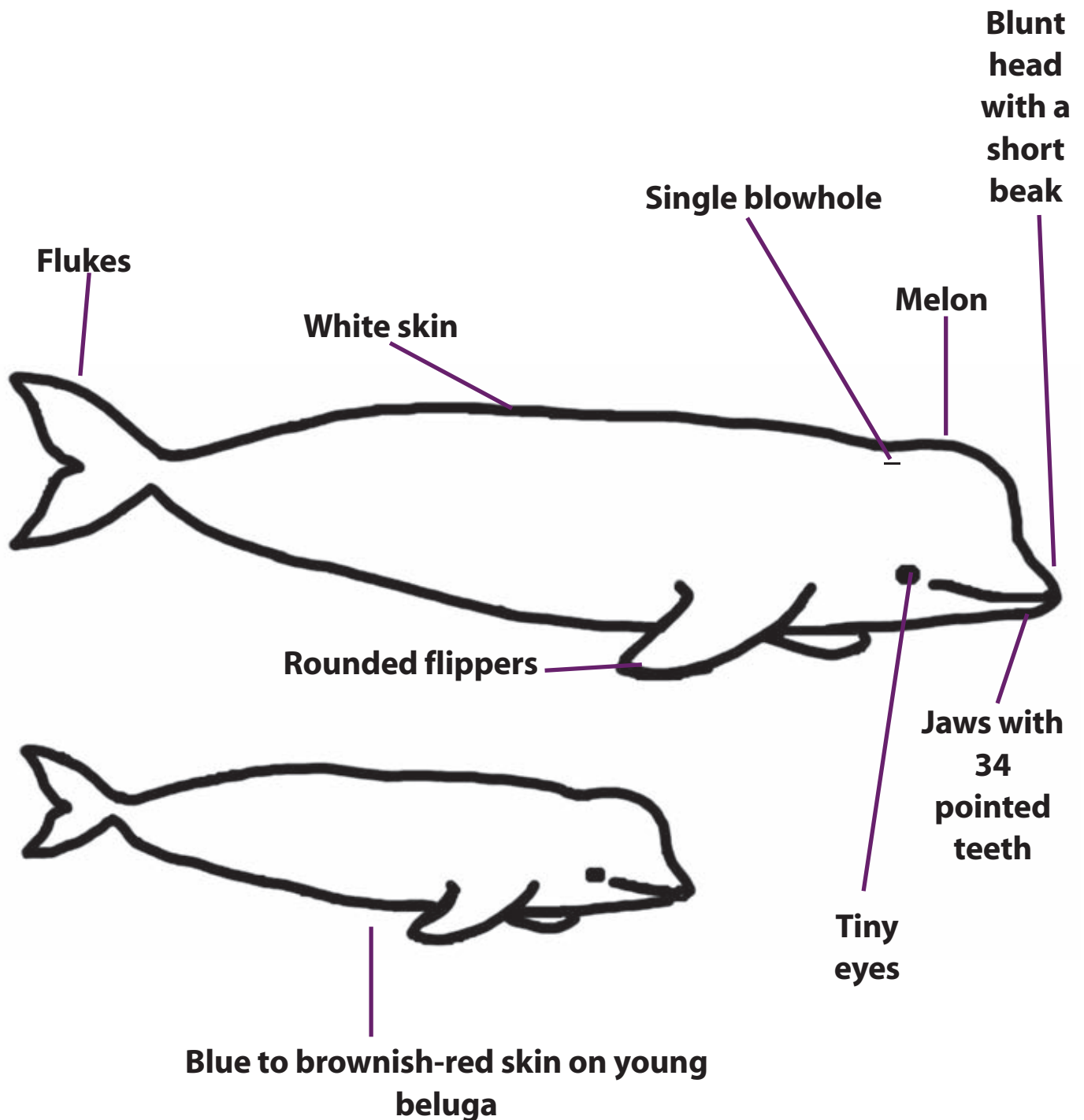


Arctic wolf



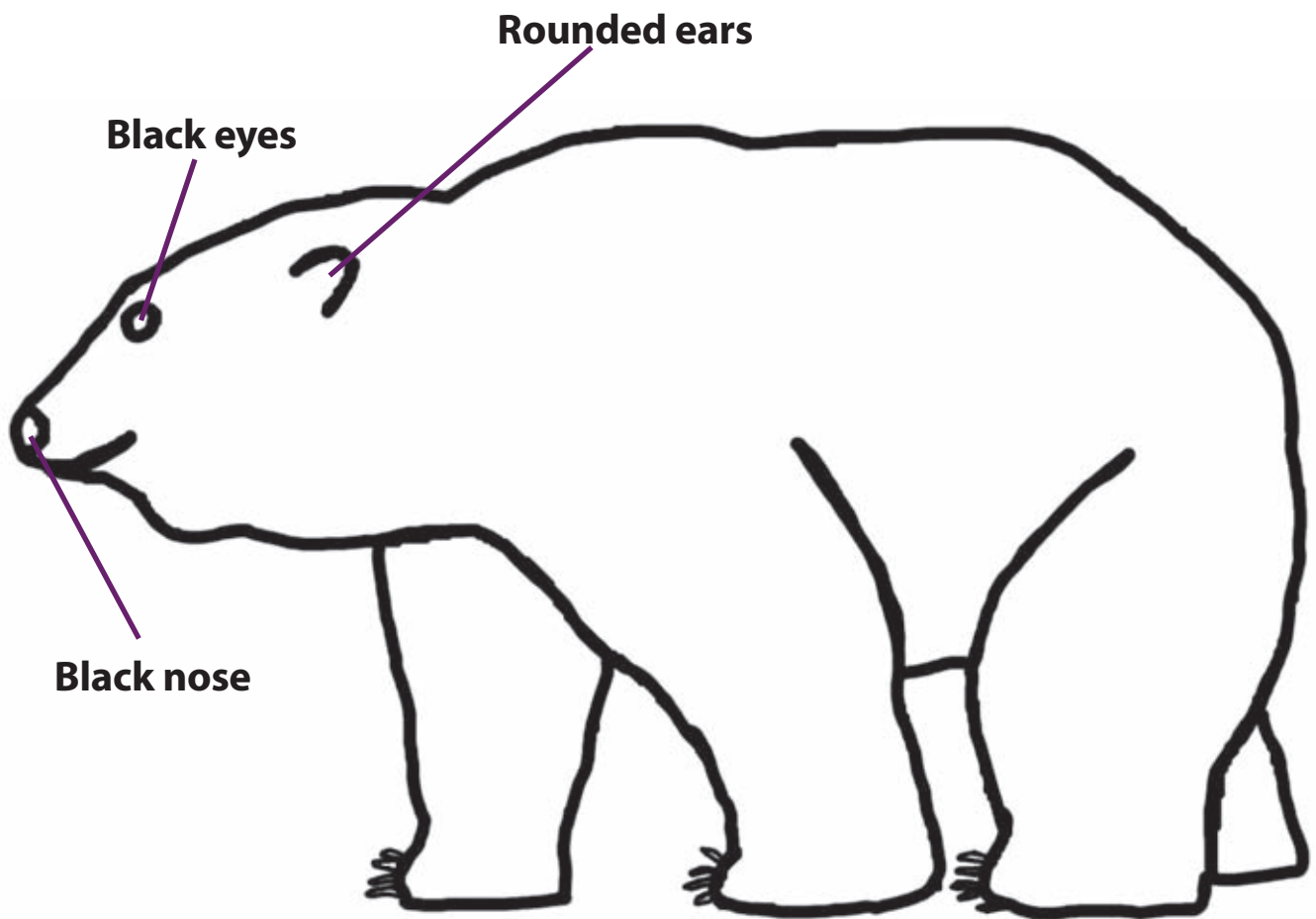


Arctic Beluga whale





Arctic polar bear



**Front
track**

**Hind
track**



Pole to Pole

Science Project 2: Amazing Antarctic animals

Key Stages 1 & 2





Antarctic animals

Some animals leave Antarctica during its horrendous coldest months, from June until August. Animals like the Humpback whale migrate to warmer waters to reproduce after eating huge amount of krill in Antarctic waters. Many other animals (like the Emperor penguin) remain at the South Pole.

Land and sea animals from Antarctica include:

- Crustaceans – krill (euphausiids), copepods, amphipods, isopods, crabs, shrimp, sea spiders and many others
- Other marine invertebrates – squid, cuttle-fish, octopus, marine snails, limpets, sponges, sea stars, sea squirts, nudibranchs, sea anemones, comb jellies, corals, hydroids, sea urchins and many others
- Insects and arachnids – springtails, mites, midges (the only winged insect native to the Antarctic) and others
- Fish – Antarctic cod, ice fish, crocodile fish, dragon fish, robber fish, rat-tailed fish, skates, eel-pouts, sea snails, and others
- Mammals – Fur seals (including the Elephant seal, Leopard seal, Weddell seal, Crabeater seal, Ross seal, and Fur seal), Whales (including the Blue whale, Fin whale, Sei whale, Southern right whale, Humpback whale, Minke whale, Sperm whale, Killer whale or Orca, Southern bottlenose whale, Blackfish, Dusky dolphin, Cruciger dolphin, and Spectacled porpoise)
- Birds – many penguins (including Emperor, King, Macaroni, Rockhopper, Chinstrap, Adélie, and Gentoo), many albatrosses (including the Lightly-maned sooty, Wandering, Gray-headed and Black-browed), many petrels (including the Blue, Kerguelen, Gray, Great-winged, White-headed, White-chinned, Snow, Southern giant, Wilson's storm, Black-bellied storm, Gray-backed storm, and pintado), many prions (including the dove, fulmar, and thin-billed), Antarctic fulmar, Antarctic cormorant Kerguelen cormorant, Dominican gull, Brown skua, McCormick's skua, Arctic tern, Kerguelen tern, Wattled sheathbill, Lesser sheathbill, South Georgia pintail, Kerguelen pintail, and South Georgia pipit (the only Antarctic songbird).



Whales and dolphins – fascinating facts

Whales and dolphins come in all shapes and sizes. This Information Sheet offers you some amazing facts and figures about these incredible animals.

- The blue whale is the heaviest and longest animal on Earth. The average adult length is 25 metres (82 feet) in males and 26.2 metres (86 feet) in females, with body weights of 90–120 tonnes.
- Hector's dolphin is the world's smallest cetacean. They may be only 1.2 metres (3 feet 11 inches) long when fully grown.
- A 'blow' or 'spout' is the cloud of water droplets produced above a whale's head when it blows out. The tallest blow belongs to the blue whale where blows of up to 12 metres (39 feet 5 inches) have been reported.
- A blue whale eats up to 4 tonnes of krill everyday. This is equivalent to eating a fully grown African elephant every day.
- The sperm whale is believed to dive deeper than any other cetacean. They have been known to dive as deep as 2000 metres (6560 feet)
- The sperm whale has the world's heaviest brain which can weigh up to 9.2 kg (20 lb 5 oz). This compares with the average 1.4 kg (3 lb 1 oz) for the brain of an adult human.
- Male humpback whales sing the longest and most complex songs in the animal kingdom. Each song lasts for half an hour or more and consists of several main components. The aim of the singing is probably to woo females and to frighten off rival males. The songs can be heard underwater hundreds, or even thousands, of miles away!
- Whales and dolphins do not sleep like we do, but they rest on the surface of the sea or catnap for a few moments while they are swimming. Each side of the brain takes it in turns to 'switch off' while the other half stays vigilant and keeps the animal breathing (which is a voluntary action in cetaceans).
- When whales and dolphins open their eyes underwater, special greasy tears protect them from the stinging salt.



Antarctic animals – Whales

Whales are amongst the most enigmatic and fascinating of all creatures. The blue whale is the largest animal ever to have lived on earth, at up to 100 tonnes, easily out-weighting the heaviest dinosaurs, even an 'ordinary' sized whale is a vast and impressive creature. Whales belong to the group of mammals called *cetaceans*, they are a part of this group along with dolphins and porpoises. Whales are mammals as are humans, dogs, cats, elephants and kangaroos amongst others. This means that they are not fish. They breathe air and so must return to the surface at regular intervals to get a breath.

Whales are warm blooded and have a skeleton similar to our own (though greatly modified) the fore limbs are their front flippers and have similar bones in them to our arms and hands. The hind-limbs are generally not present at all. The rear flippers of a whale are called the flukes, these have no bone in them at all, being made of tough fibrous material. It is the flukes that provide the propulsive power in all cetaceans with the forelimbs controlling direction and being used for communicative and social functions.

Toothed whales or Baleen whales

Cetaceans are split into two groups, depending on whether they have teeth or not.



Toothed whales – Odontoceti

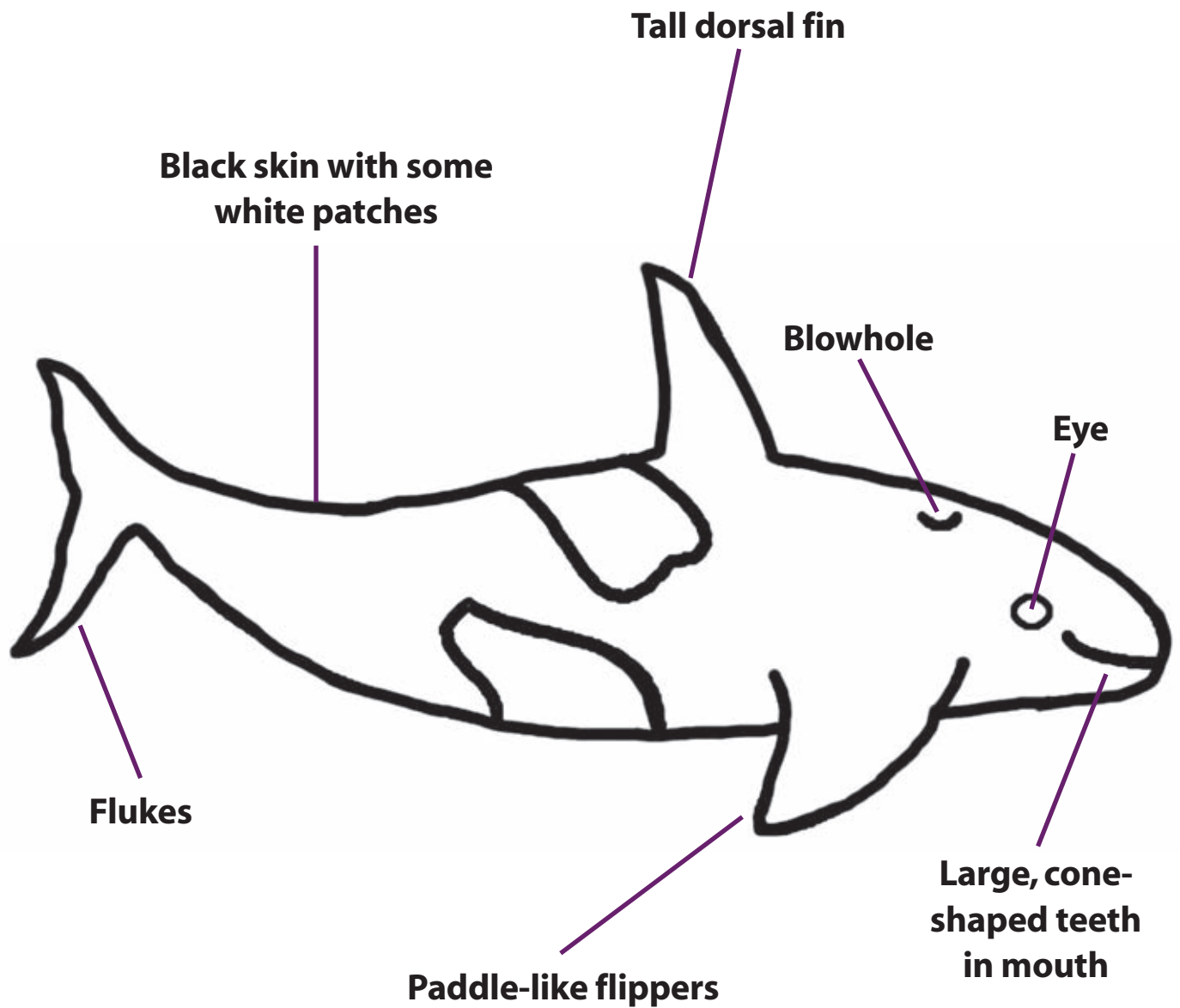
This group includes dolphins, porpoises, killer whales (orcas) and sperm whales. They have teeth in the usual manner, usually consisting of lots of identical peg-like (but often very sharp!) teeth to catch their slippery prey. Odontocetes are predators on fish or other fast swimming and fairly large prey such as squid. Toothed whales differ from baleen whales (and every other mammal) in that they only have one nostril instead of two.

Baleen Whales – Mysticeti

The members of this group don't have teeth as we know them, but baleen plates or 'whalebone'. The whole skull of such whales is highly modified. There is a large strong bony projection from the front of the 'brain case' from which baleen plates hang on either side. This makes a triangular tent-like structure that is a large and elaborate sieve. The lower jaw is the 'floor' of this tent and baleen whales have a huge tongue that sits in the middle of it all. Mysticetes take in a mouth full of sea water and huge numbers of planktonic food such as krill or even shoaling fish. They then close their mouths and use the tongue to push out all of the water through the baleen filters which keep the small prey inside, these are then swallowed.



Killer whale





Antarctic animals – seals

Elephant seals?

Elephant seals are the largest of all seals. Males can grow to 4.5 m long (15 ft) and weigh up to 4 tonnes (8800 lb). They are called elephant seals partly because of their size and also partly because of the males snout or trunk that he inflates to impress and intimidate rivals when competing with other males.

When ashore and not competing with each other and when they don't have pups, elephant seals gather in groups called 'pods'. Pods are extremely smelly places! A diet largely consisting of squid that is caught during feeding dives usually of 200– 400 m but sometimes up to 1500 m doesn't do anything for the digestive system or your breath!

Elephant seal pups are born in the Antarctic spring. Like many Antarctic seal pups, they stay with their mother increasing rapidly in weight while the mother gets progressively thinner. Eventually the mother has to feed and teach the pup, by which time the pup is quite large and well developed.

Crabeater seals

Crabeater seals are probably the most numerous large mammals on Earth after humans. They live almost their entire lives on and amongst floating ice. For this reason also, it is difficult to estimate their numbers, but by 2000 there were thought to be about 50 million.



Crabeaters are large seals of about 220 kg (484 lb). They are frequently scarred, sometimes quite badly by predatory leopard seals or killer whales. Crabeaters are fairly solitary. Crabeater seals probably got their name because of a mistake by the early sealers who went down to the Antarctic. They actually eat krill, the staple diet of much of Antarctica's bird and mammal population. In fact there are no crabs at all in Antarctic waters.

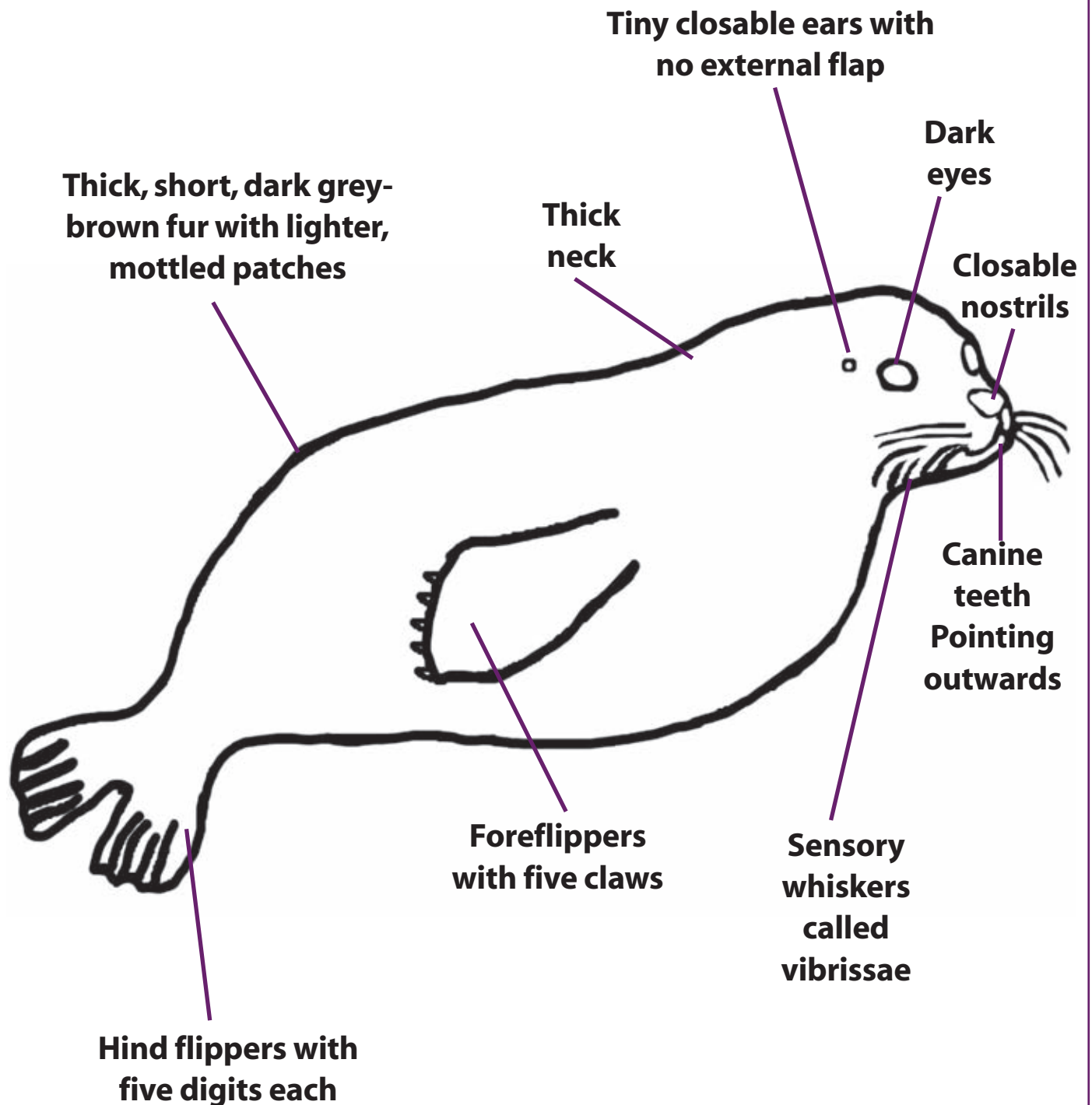
Leopard seals

Named for the spotting on its underside, the leopard seal is one of the largest predators in Antarctica, smaller only than the killer whale. Females are larger than males and average about 3 m (10 ft) long and around 350 kg (770 lb).

Leopard seals are built for speed, they have a large powerful head, a huge gape and a massive lower jaw. They frequent the edge of the pack ice and in particular areas around penguin rookeries all around Antarctica. They are fairly opportunistic as predators and will eat a wide variety of prey from krill to penguins to young crabeater seals – their main prey. Their teeth are very much those of a carnivore, though they are also partly adapted with three large cusps on the pre-molars and molars that interlock and are also able to act as a strainer when feeding on krill.

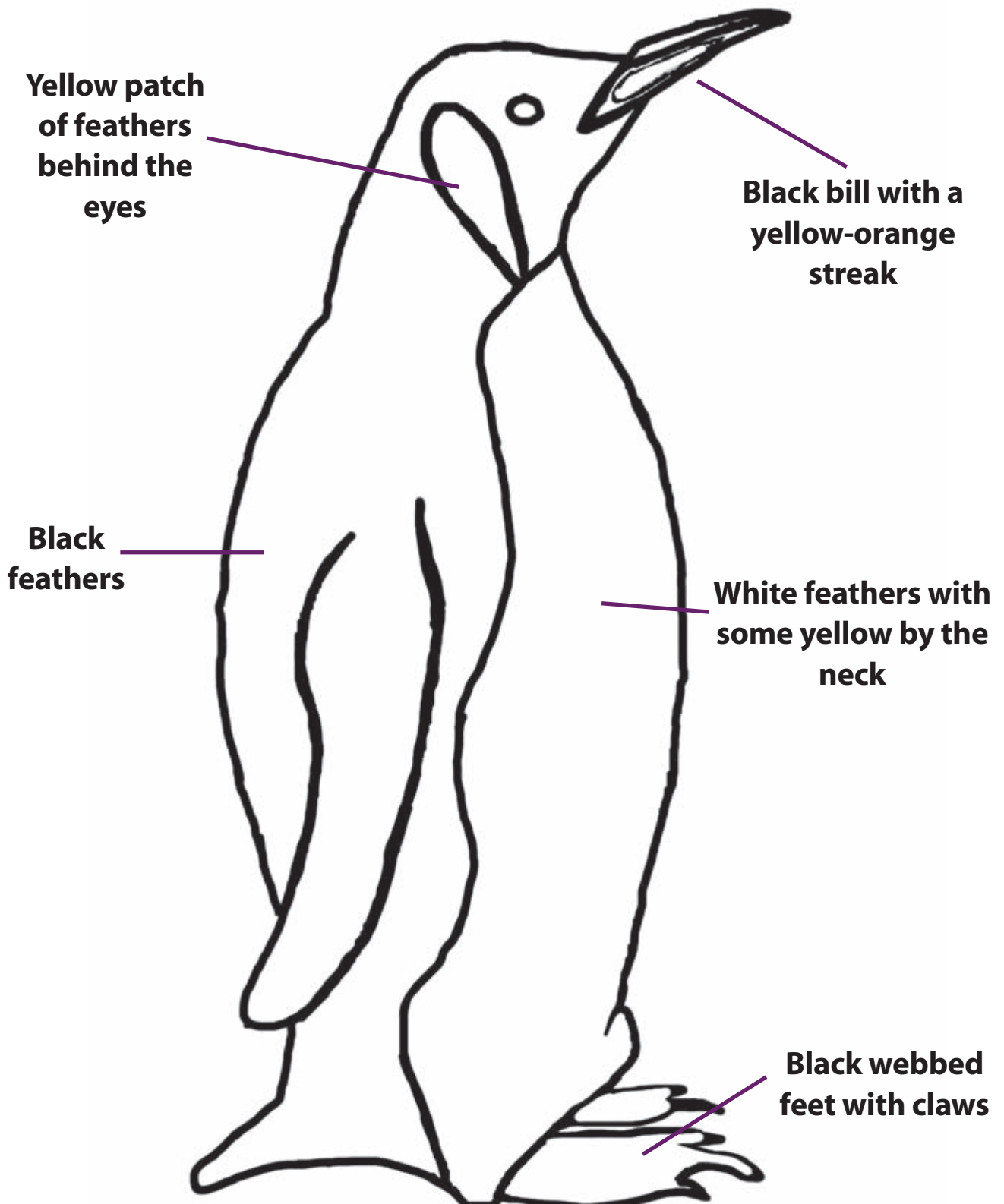


Weddell seal





Emperor penguin





Antarctica Wordsearch

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

AMUNDSEN
CLIMATE
FROZEN
ICEBERG

SCOTT
WHALES
ANTARCTICA
COLD

GLACIER
LAND
SEAL
BYRD

DISCOVERY
ICE
PENGUINS
SHACKLETON



Pole to Pole

Science Project 3: Arctic medical kit

Key Stage 2





Arctic medical kit

Potential List of Items

- Examination table
- Anesthetic
- Syringe
- Cotton and alcohol
- Oxygen
- Tape and dressings
- Ice bag
- Scalpel
- Painkillers
- Antibiotics
- Scissors
- Hot-water bottle
- Ointment for damaged skin
- X-ray machine
- Stretcher
- Stethoscope
- Bandages
- Sutures and needle
- Crutches
- Plasters
- Antiseptic cream



Arctic stress test

Student 'A' selects a number between 500 and 1000.

Student 'B' mentally subtracts 9 from this number and tells 'A', who writes it down where 'B' cannot see it.

Student 'B' then subtracts 8 from this answer and 'A' again records the response.

This is continued, with 'B' subtracting 7, then 6, etc. down to 1, then starting again at 9 (or different starting number on second 4 minutes).

'Relaxed' results:

Number of correct responses/minute: _____

'After exercise' results:

Number of correct responses/minute: _____



Pole to Pole

Science Project 4:
There may be trouble
ahead

Key Stage 2+





The ozone

What is ozone?

Ozone is a gas made of oxygen atoms. Usually oxygen atoms hang around in pairs – this is the sort of oxygen that we breathe and that helps things to burn. However, oxygen sometimes forms a molecule with three oxygen atoms, this is what we call ozone.

Where is the ozone?

Most of the ozone on Earth isn't on Earth at all, but in the layer of the Earth's atmosphere called the stratosphere. This is the upper layer of the atmosphere and starts between 12.9 to 19.3 km (8 to 12 miles) above our heads and goes upwards to almost 50 km (30 miles). The stratosphere has virtually no clouds or other form of weather, it's thinnest at the equator and thickest at the poles.

Why is a ozone hole a problem?

Ozone in the stratosphere is nicely out of the way and has the wonderful benefit to life on Earth that it specifically absorbs the harmful ultra-violet light from the sun while letting other light wavelengths through. Though we talk about a 'hole' in the ozone layer, it's not really a hole at all, just a thin bit. Ozone is spread thinly throughout the stratosphere – and in low quantities too – if all the ozone above your head was collected together in a continuous layer, it would only be about 3–5mm (1/8 of an inch) thick. If there is a hole in the ozone layer then this means that more harmful ultra-violet rays get through than are good for us or many other life forms, plant or animal. Too much ultra-violet light can result in:

- Skin cancer
- Eye damage such as cataracts
- Immune system damage



- Reduction in phytoplankton in the oceans that forms the basis of all marine food chains including those in Antarctica.
- Damage to the DNA in various life-forms So far this has been as observed in Antarctic ice-fish that lack pigments to shield them from the ultra-violet light

Why does a ozone hole form over Antarctica?

The ozone hole is caused by the effect of pollutants in the atmosphere destroying stratospheric ozone. During the Antarctic winter something special happens to the Antarctic weather.

- Firstly, strong winds blowing around the continent form, this is known as the 'polar vortex' – this isolates the air over Antarctica from the rest of the world.
- Secondly, special clouds form called Polar Stratospheric Clouds. Clouds don't normally form in the stratosphere and these turn out to have the effect of concentrating the pollutants that break down the ozone, so speeding the process up. Polar stratospheric clouds at about 80,000 feet altitude. These are the highest flying of all clouds and only occur in polar regions where the temperature in the upper atmosphere dips below minus 100F.
- By the time spring arrives and the sun comes back after the long polar night, the ozone levels are severely depleted around the Antarctic continent causing the 'ozone hole'. Unfortunately, there then follows a particularly long period of high sunshine and long days, just to make the effect of the ozone hole worse.

What causes the ozone depletion?

Ozone is mainly broken down by chemicals called Chlorofluorocarbons CFC's and also by nitrogen oxides. CFC's ironically were first used in large quantities because they were thought to be safe and inert (unreactive) chemicals. They are a group of chemically similar gases used in refrigeration systems, air conditioners, aerosols, solvents and in the production of some types of



packaging. Nitrogen oxides are a by-product of fuel burning, e.g. aircraft exhausts. CFC's don't occur naturally, they are man-made chemicals. They are very useful when they are where they are supposed to be, and doing what they are supposed to be doing. But once released into the atmosphere they are a serious pollutant.

Can the ozone hole recover?

The way to stop the formation, growth and spread of ozone thinning is to reduce the production of those chemicals that cause the destruction of ozone, namely CFC's and nitrogen oxides. In 1987, the Montreal Protocol was signed by many nations whereby those nations that signed agreed to reduce their emissions of CFC's to a half (of the 1987 levels) by 2000. Potential problems come from nations that do not see the reduction of CFC's to be a priority, and also from the huge quantity of refrigeration and air conditioning systems in the world that still contain CFC's. If they are not disposed of correctly, then the CFC's will escape into the atmosphere and continue to destroy ozone. The problem is far from settled and is under investigation by research teams all over the world. The latest estimates are that as long as production and release of CFC's is regulated properly, global ozone levels should recover by 2050.



What is global warming?

What is the global warming?

The term global warming describes the observed and projected increase in globally averaged temperatures over time. Because the global climate is a dynamic system, global warming has occurred in the past and will occur in the future. Using surface station temperature measurements and satellite-based measurements, researchers have identified an increasing trend in the global average surface air temperatures. The Intergovernmental Panel on Climate Change has determined that this increase can be attributed to a combination of natural climate variations and human factors. One of the leading causes under investigation is the greenhouse effect of gasses in the atmosphere.

What is the greenhouse effect?

The greenhouse effect obtained its name from the behavior of a greenhouse. A greenhouse's glass allows shortwave radiation to enter but then prohibits outgoing longwave radiation from exiting, thus warming the air in the greenhouse. Although the behaviour of the atmosphere is different from that of a greenhouse, the result is similar and thus the warming effect was termed the greenhouse effect. If it wasn't for the natural greenhouse effect, almost all radiation would be returned to space and the average surface temperature would be around 0°C. Atmospheric gasses that cause this effect include water vapor (H₂O), carbon dioxide (CO₂) and methane (CH₄). If the amount of these gasses in the atmosphere increases, then the greenhouse effect will be magnified and warmer global temperatures will result.

Some of the impacts of global warming may include stronger storms, migration of agricultural zones, spreading of tropical diseases, melting of glaciers and ice caps and increases in pollution levels.



Antarctic conservation

Until the 1960s, some species of whales and seals were taken to the brink of extinction by human activities in Antarctica. Waste and garbage was left where it fell, burnt in great open fires or was deposited in the ocean. Fisheries were non-existent or on a very small scale, but either way were completely unregulated.

Over the years since the Antarctic Treaty came into force, ever greater environmental awareness has led to increasing regulation by the Antarctic Treaty System. All plants and animals in Antarctica are now protected and there are measures in place to prevent pollution of this – the world's most pristine environment.

There are many resolutions and measures for the protection of Antarctica and its fauna (animals) and flora (plants). In brief they state that:

- No Antarctic bird or mammal can be killed or captured without a permit – granted only for scientific reasons
- Measures must be taken to minimize harmful interference with wildlife and control the introduction of non-native species - animal or plant, even to the point of not taking soil or growing compost to Antarctica as it may contain plant seeds, fungal spores and adults or eggs of any number of soil-dwelling invertebrates.
- The establishment of specially protected areas to protect sites of outstanding scientific interest and designate specially protected species.
- Seals in particular are covered by a 1972 convention designed to prevent the resumption of sealing. Killing of both Ross and Antarctic fur seals is totally prohibited and catch limits are set deliberately at low levels. All six seal species that breed in the Antarctic are covered.



- Commercial fisheries in the Southern Ocean are controlled by the CCAMLR – Convention on the Conservation of Antarctic Marine Living Resources. The aim of the Convention is to conserve marine life of the Southern Ocean – this does not exclude harvesting carried out in a rational manner.
- The discharge into the sea within the Antarctic Treaty Area of all toxic and noxious chemicals, oil and oily wastes, plastics and other forms of non-biodegradable rubbish, is prohibited. The discharge of other wastes (such as sewage from ships and bases) is strictly regulated.
- Mining has been prohibited.

Permits for travelling to Antarctica

The Environmental Protocol of the Antarctic Treaty became law in 1998 after legislation in each of the member countries. One of the ways in which this protects Antarctica is by only allowing visitors to Antarctica by member nations as long as they are given a permit to do so. The granting of a permit is dependent on the visitors agreeing to adhere to certain rules and guidelines. Each nation's rules are not the same in the detail, though they are similar in the general principles. In Britain for example, the following activities require a permit from the Secretary of State for Foreign & Commonwealth Affairs:

- British expeditions travelling to Antarctica.
- British stations in Antarctica.
- British registered vessels and aircraft going to Antarctica.
- Mineral resource activities for scientific research or for certain construction purposes.
- The taking of, or harmful interference with, fauna or flora.
- The introduction of non-native animals or plants.
- Entry into areas protected under the Protocol (Antarctic Specially Protected Areas – ASPA) or under the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) (CEMP Monitoring Sites)



Examples of how these regulations are put into practice

Waste from Ships

- The discharge of any oil or oily mixture, bulk chemicals or garbage from a ship is prohibited in Antarctica and must be discharged at port reception facilities outside the region.
- Sewage from ships is usually passed through a biological treatment plant that meets the requirements of the IMO before discharge.
- Food waste is passed through a waste disposal unit that shreds the waste so that it will pass through a mesh size of less than 25 mm, discharge is then at least 12 nautical miles from shore.
- Other waste generated on ships is stored on board until it can be disposed of outside Antarctica. Shredders are used to process glass and small metal waste. Compactors are used to bale plastic. Paper and cardboard are burnt in high temperature marine incinerators. Waste food wrappings are frozen for later disposal in port.

Arctic seal





Pole to Pole

Science Project 5:
How do penguins
keep warm?

Key Stages 1 & 2





How do penguins keep warm?

Be big

Warm blooded animals in cold climates are pretty large, even the smallest Antarctic birds are large and the smallest Antarctic penguin, the Rockhopper is a fairly hefty 2.5 kg (5.5 lb). The Adelie and Emperor penguins are larger still. Adult weights are 5kg (11 lb) for the Adelie and 30 kg (66 lb) for the Emperor. The larger the animal, the smaller the surface-area: volume ratio and so the less relative area there is to lose heat. This means that for identically shaped animals of different sizes, the large one will keep its temperature more easily.

Don't touch unless necessary

Ice and snow are cold. Lying on snow, you would be really cold as there would be a large area of contact to lose body heat through conduction. Stand up and immediately your area of contact reduces enormously, stand on tip-toes and your area of contact is reduced to a minimum. This is what penguins do, except they don't stand on tip-toes when it's really cold, they rock backwards on their heels, holding their toes up. They support themselves by their stiff tail feathers that have no blood flow and so lose no heat. So in the coldest conditions, penguins sit there supported on a tripod of two feet (heels) with reduced blood flow and a stiff tail that they lose no heat through anyway.

Hang around in gangs

Emperor penguins live in probably the most extreme conditions endured by any warm-blooded animal on earth. They even breed in the depths of the



Antarctic winter at temperatures of -30°C (-22°F) and below while putting up with winds of 200 km per hour (125 mph) and more. Even worse, the emperors breed and overwinter on permanent ice shelf far from open sea where there isn't any chance of being able to feed so the penguins not only endure horrendously cold conditions, but do so with little or no shelter, without feeding – fasting for months – and in the darkness of the long Antarctic winter night.

Let's cuddle

One of the Emperor penguins' secrets to keeping warm is huddling. Emperor penguins have developed a social behaviour that when it gets cold, they huddle together in groups that may comprise several thousand penguins.

Blubberly warm

Penguins also have feathers to keep them warm right? – Well partly right, feathers work on land, but in the water where penguins spend much of their lives, they're not so valuable. What really keeps penguins warm in the sea is a sub-cutaneous (under-the-skin) layer of fat or blubber. This blubber layer is the best form of internal insulation yet devised by mother nature (external fur and feathers are better and thinner, but can be ruffled by wind and of course are useless when wet) and it keeps all warm-blooded cold water animals operational down to -1.9°C (25.8°F). Why this temperature? Because that's when sea-water freezes, you can't get sea water colder than that without it being solid and then it would be difficult for anything to swim in it!

It's penguins blubber layer that protects them against the cold more than anything while in the sea. On the land however their feathers have a very valuable function in keeping them warm. Penguin feathers aren't like the



large flat feathers that flying birds have, they are short with an under-layer of fine woolly down. When it gets very cold, penguins can puff their feathers out to trap more air for even better insulation. When it gets too warm they fluff their feathers out even more so that the trapped warm air can escape and allow the penguin to cool down.

Warm toes?

Penguins have two areas where their body is very poorly insulated and where they can lose a lot of heat, these are their flippers and their feet. These regions give penguins a problem and a solution at the same time. A problem because of the heat loss, and a solution because they can be used for cooling down. It's all well and good being brilliantly insulated, but when you use a lot of energy and so generate heat, or the temperature rises, not being able to lose that heat becomes a big disadvantage in itself. The solution is really quite elegant. The muscles that operate feet and flippers are not located in the feet and flippers, but deeper in the warmer regions of the penguins body. The feet and flippers are moved by tendons that pass through them and attach to toes etc. like a sort of remote operation by wire or string. This means that it doesn't matter if the feet and flippers get really cold as they can still be operated normally by regions that are fully functional and at normal body temperature.

Penguins feet are never allowed to get below freezing point, blood flow is finely adjusted so that they are kept just above freezing point. When it gets very cold, the feet are covered by the feathers and fat layer of the body so they are not exposed to cooling winds. So while a man standing barefoot on ice would quickly get frostbitten, penguins can do so all their lives with no damage at all.



Emperor penguins

Emperor penguins are one of the 'classic' penguin species that people imagine when they hear the name. Along with king penguins and adelia penguins, they are representative of the whole group.

Emperor penguins are the largest of penguin species with an average weight of around 30 kg (66 lb, but can be up to 40 kg (88 lb)) and a height of approx. 1.15 metres (3.8 feet). They have colourful feathers around their necks and heads, though are not quite as bright as king penguins. There is little or no possibility of confusing the two species however as their distribution around Antarctica is very different. While king penguins are a sub-Antarctic species, being based on islands dotted around the continent, emperor penguins are animals of the deep south.

Emperor penguins have yellow ear patches that are 'open' fading into the white of the breast feathers, whereas king penguins have orange ear patches that are 'closed' by a band of black feathers. Emperor penguin chicks have distinctive plumage with a large white face patch.

All but 2 of about 40 known emperor penguin colonies are on winter fast ice that is frozen solid and attached to the land from autumn until it begins to break up in the spring (though some years it doesn't break up at all). They are found all around the coasts of the Antarctic

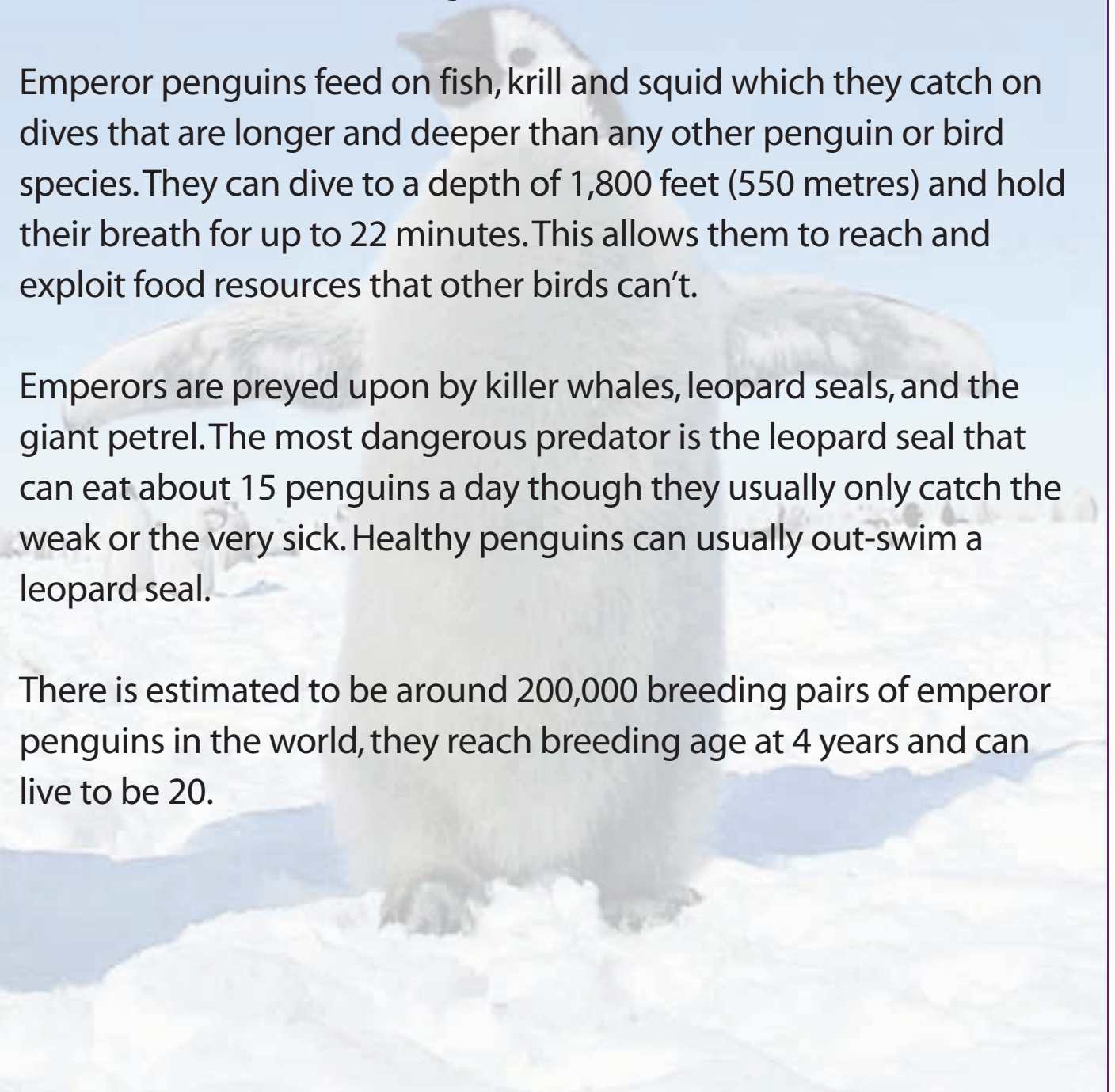


continent. They breed during the depths of the Antarctic winter and in some of the most desolate, coldest, windiest and downright grim places on the planet during the season of 24-hour darkness. Some emperor penguins are therefore the only birds that never set foot on land. They were completely unknown until the first sighting in 1902 by Lt. Reginald Skelton on Scott's 1901–04 Discovery Expedition and new colonies were still being discovered as late as 1986.

Emperor penguins feed on fish, krill and squid which they catch on dives that are longer and deeper than any other penguin or bird species. They can dive to a depth of 1,800 feet (550 metres) and hold their breath for up to 22 minutes. This allows them to reach and exploit food resources that other birds can't.

Emperors are preyed upon by killer whales, leopard seals, and the giant petrel. The most dangerous predator is the leopard seal that can eat about 15 penguins a day though they usually only catch the weak or the very sick. Healthy penguins can usually out-swim a leopard seal.

There is estimated to be around 200,000 breeding pairs of emperor penguins in the world, they reach breeding age at 4 years and can live to be 20.



Emperor Penguin





Chinstrap penguins

Chinstrap penguins are the most numerous penguins in the world. It is estimated there are 12 to 13 million located on the barren islands of the sub-Antarctic Region and the Antarctic Peninsula. These penguins live and breed in large colonies. They often live on large icebergs on the open ocean. They dive off to catch fish and krill. They are the boldest penguin and are most likely to fight other penguins.

Called 'chinstrap' penguins because of their characteristic band of dark feathers under the chin that appears to be keeping their dark hats on, these are the smallest of three species of *Pygoscelis* penguins. They average about 4.5 kg and 68 cm tall.

Chinstraps along with many other species of penguins return to the same colony each year and often settle within a very short distance of the same nest site. The nest is a very simple affair of a pile of small stones, the main purpose being to separate it from other nests and to raise it above the surrounding ground so that melt-water from snow doesn't wet the eggs or chicks.

Chinstrap penguins make a round nest out of stones and pebbles. The female lays two eggs and the eggs are kept warm by both male and female. They do this by taking turns for 5 to 10 days, while the other mate is feeding. The eggs hatch after about 33 to 15 days. The chicks stay in the nest until they are 20 to 30 days old. At this time they have feathers to keep them warm. They join the crèches, which are groups of young penguins huddling together for warmth and protection.

Chinstrap chicks get fed about once a day on average, with the returning parent bringing back about 300 g of krill. Fishing trips take the adults around 20–30 kilometres from the colony, though distances of well over 200 kilometres have been recorded. The young remain on the nest, looked after in turns by each parent until they are large enough to maintain their own body temperature and can wander around freely.



Gentoo penguins

Gentoo penguins are the largest of the *Pygoscelis* penguins, though not by much they average about 5.5 kg and 71 cm tall for the southern gentoo and about 0.7 kg heavier and 10 cm taller for the northern gentoo. The northern subspecies nests on and around the sub-Antarctic island of South Georgia, while the southern subspecies nests as far south as the Antarctic peninsula to 65 degrees south.

They have a wide white stripe that goes across the tops of their heads from one eye to the other. They have a very bright orange beak. They are the largest members of the stiff-tailed family. They live on many of the islands of the Antarctic region but the main colony is on the Falklands. There are about 300,000 breeding pairs on the islands. They live in large and noisy breeding colonies

Their nests are made on the rocky shores. They prefer the inland grasslands for nest building. They carry and pile stones, pebbles, grass, sticks, and anything they can find to make a circle. Gentoos can be very aggressive and will fight over stones or take stones and nest building material away from other birds' nests. Two eggs are laid inside this circle. Both parents tend to the eggs. The eggs hatch after 34 to 36 days. If there is lots of food, both chicks will survive. The chicks stay in the rock nest for 30 days. Then it forms groups with other chicks called 'crèches'. They stay here while the parents hunt for food. After about 80 to 100 days the chicks grow their adult feathers and they go on their own.

Gentoo nests are spaced out in a way that nearly all penguin nests are spaced out, at just over two 'attack lengths' apart. If a penguin sitting on its nest can get a peck at a nearby or passing penguin, then it will usually do so. The resulting spacing is that penguins sitting on adjacent nests are just that bit too far away to reach each other, so neither feels immediately threatened and peace ensues. The down side of this arrangement is that when a penguin wants to leave the nest to go fishing, or if it's coming back from fishing, it becomes in range of both beaks from the adjacent nests when walking through the colony.

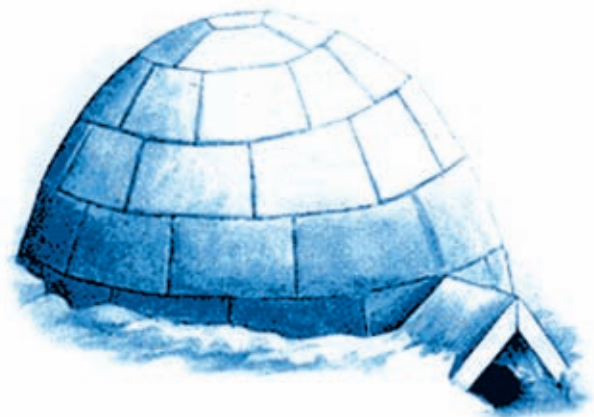


How to build an igloo

1. Cut blocks from dry, hard, hard snow, using a snow saw or large knife. Each block should be about 3 feet (1 metre) long, 15 inches (40 cm) high, and 8 inches (20 cm) deep.
2. Form a circle with blocks around the hole created where you cut the blocks. Cut the circle in a spiral from the top of the last block to the ground ahead of the first block. This will make it easy to construct a dome.
3. Build up walls, overlapping the blocks and shaping them so that they lean inward. Cut a hole under the wall for the cold sink and entrance. Put several blocks along one wall as a sleeping platform.
4. The last block must initially be larger than the hole. Place the block on top of the igloo, then, from inside, shape and wiggle it to slot exactly into the hole.
5. Hot air from your body and stove rises and is trapped inside the dome. Cold air falls into the sink and flows away to the outside. It is essential to cut ventilation holes in the walls with an ice ax.



Finished igloo. With warmth inside the igloo, the surface of the walls will melt and freeze over, to form a smooth, airtight ice surface. The roof over entrance tunnel prevents snow from blowing into igloo.



WARNING! It is vital to make at least one airhole in the roof to avoid suffocation. The igloo will get very warm inside with heat from your body, even if it is cold and windy outside. Without ventilation, lethal carbon dioxide will build up. Also, the use of stoves in an enclosed shelter is not recommended due to dangerous build-up of carbon monoxide.



Colouring-in – igloo 1





Colouring-in – igloo 2

