**Life in the Extreme Environment of Antarctica Level 5**

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| https://farm6.staticflickr.com/5133/5536987424_e684c38e92_o_d.gif | **Dry Valley Life**  Explorer Robert Scott, who discovered the Dry Valleys in 1903, looked over one of them and called it “a valley of death.” This was, of course, before scientists arrived. Today, we know that Scott was wrong.  Researchers have discovered that the Dry Valleys are home to a variety of extremophiles (organisms that live in extreme environments). Among them are lichen and mosses, communities of microbes (including cyanobacteria), and nematodes (microscopic worms). Researchers continue to find and study these and other organisms and their adaptations, which allow them to survive in one of the most punishing environments on the planet. Some of these animal and plants have evolved ways to survive the extreme cold and lack of water.  **http://2.bp.blogspot.com/-8Vvgphe794U/UJ5e8g5UhDI/AAAAAAAAD90/43eT6xWaykg/s1600/Unknown.jpegSolutions to survival by invertebrates**  **1. Dehydration** This can be partial or “complete” (also called anhydrobiosis)  Anhydrobiosis removes enough water that the animal will not freeze. It is obviously inactive, but is effectively “instant life” when water is added. **Tardigrades** (water bears) are able to do this.They areperhaps the toughest animal on the planet    *Mudfooted.com*  https://qph.is.quoracdn.net/main-qimg-21b68f831beba8dcb59fe1817b2a1bb1?convert_to_webp=true [*www.quora.com*](http://www.quora.com)  http://www.amentsoc.org/images/tree-weta.jpg  **2. Freezing**  Many New Zealand insects do this for example the **Alpine weta** andthe **Alpine cockroach** freeze readily at around -30˚C. The ability to freeze is associated with a reduction in body water content.  Pictured left; New Zealand Tree Weta    *www.amentsoc.org*  Isotoma_Habitus.jpg (659×445)**3. Super cooling**  The Antarctic’s largest animal, the **springtail**, is only just visible to the naked eye and can supercool. The springtail can slow down their metabolism to save energy. In winter it is as low as –38˚C. This insect like creature uses sugars as colligative antifreezes, in the form of a sugar called glycerol, which lower their freezing point. They live under rocks feeding on fungus and bacteria and have been found as far south as 86˚ latitude in Antarctica.  *Photo;Wikipedia*    antarctic animals, antarctica's wildlife, antarctic wildlife, animals, nematodes, tardigrades, rotifers, springtails, extreme animals, plectus Tiny **nematode worms** are also able to cope with the extreme cold by lowering their freezing point. They are able to protect themselves from the crystals that develop as water freezes inside their cells by producing proteins that pack around the sharp-edged crystals. Nematodes are able to dehydrate when conditions get too dry. The worms blow around in the wind and when moisture is available; perhaps when melt from glaciers provides freshwater streams they revive. No one is sure how long nematodes can survive this state, but these worms have rehydrated into a living worm after 60 years in a freeze-dried mode.  *Credit: Byron Adams*  **Fish in the freezer**  Sea water is colder than fresh water and freezes at a lower temperature of -1.9˚C, rather than at 0˚C, because of the salinity of the sea. So that their blood and tissues do not freeze at this lower temperature polar fish in the Arctic and in the Antarctic have developed an anti-freeze. Fish in both areas have evolved this adaptation separately. Arctic fish have added a protein and Antarctic fish, a sugar plus a protein. This anti-freeze prevents ice crystals forming and interrupts the freezing process that would freeze their blood and tissues.    **Seals and Penguins**  Seal and penguins are both endotherms; warm blooded vertebrates.  *Right;* King penguins walk amongst Elephant seals  poster-king-penguins-walk-among-elephant-seals-resting-on-beach-on-coastline-of-south-georgia-island-atlant-1488495.jpg (500×333)**Size and surface area**  Warm blooded animals in cold climates are pretty large, even the smallest Antarctic birds are on the large side and the smallest Antarctic penguin, the Rockhopper is a fairly hefty 2.5kg. The Adelie and Emperor penguins of the deep-south are larger still. Adult weights are 5kg (for the Adelie and 30kg for the Emperor and King; a similar size to an overweight 10 year old child, but with a man-sized chest measurement. The larger the animal, the smaller the surface-area: volume ratio and so the less relative area there is to lose heat. *Photo; Image.posterlounge*  **Seals**  Seals have **fur** which is a good insulator on land, and **blubber** which is a good insulator in the water. The illustration below shows a seal with a thick layer of blubber. Of the total area 58% is blubber and 42% is muscle, bone and visceral organs.  **Penguins**  **Penguin feathers**  Penguin feathers keep penguins warm on land. Penguin feathers aren't the large flat feathers that flying birds have, they are short with an under-layer of fine woolly down. Penguin feathers are also very good at shedding water when the bird emerges from the sea. They overlap and give a good streamlined effect in the water and have excellent wind-shedding abilities when on the land. When it gets very cold, penguins can puff their feathers out to trap more air for even better insulation. When it gets too hot, they fluff their feathers out even more so that the trapped warm air can escape and enable the penguin to cool down. Penguins have the highest density of feathers per unit of surface area than any birds.  **Under the skin, a layer of fat**  External fur and feathers are the most efficient insulators on a weight for weight basis, but can be ruffled by wind and are much less useful when wet. In the water penguins have a sub-cutaneous layer of fat to keep them warm. This fat layer also serves as a valuable energy store. This fat layer keeps all warm blooded cold water animals operational down to minus 1.9°C. Sea water freezes at this temperature and so cannot be colder than this without being solid. A penguin can have up to 30% of its body weight as blubber (fat).  penguins-10a.jpg (350×295)**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 at the same time a problem and a solution. A problem because of the heat loss, and a solution because they can be used for cooling down. Its good being brilliantly insulated when it's very cold, but when you use a lot of energy and so generate heat, or the temperature rises, not being able to lose that heat is a problem. *www.reddit.com*  The solution is that the muscles that operate feet and flippers are not located in the feet and flippers, but deeper in the warmer regions of the penguin’s body. The feet and flippers are moved by tendons that pass through them and attach to the bones of the toes, ankle, and wrist. This means that if the feet and flippers get really cold as they can still be operated normally by muscles in regions that are at normal body temperature and so are still fully functional. Penguins have a heat-exchange blood-flow to these regions. The warm blood entering the feet flows past cold blood leaving so warming it up in the process and cooling the blood entering at the same time, the same sort of thing happens in the flippers. Blood in the feet and flippers is kept significantly colder than in the rest of the body much of the time. By the time the blood re-enters the rest of the body it has been warmed up and so does not cool the core body temperature. |
| http://www.thebestcareerforme.com/wp-content/uploads/Orange-Question-Mark.png | **Questions / think pair share / discuss**   1. Why do you think Scott and the early explorers missed seeing life in the Dry Valleys? 2. Do you think there are any similarities to life in the extreme environment of Antarctica and the possibility of life on Mars? 3. Make a “T” diagram comparing early explorers clothes and shelter with modern scientists and explorers. 4. Explain to your friend how fish manage to survive in waters colder than 0˚C. |
| consent-clipart-pen_and_paper_legal_document_with_pen_signing_the_paper_0515-0909-2116-0233_SMU.jpg (300×257) | **Activities**   1. Watch these You tube clips to see tardigrades in action   <https://www.youtube.com/watch?v=ZuxwisK-8f8>  <https://www.youtube.com/watch?v=u2lkPq3Cil0>   1. Research one of the animals that survives the cold in Antarctica. Present your findings to the class by a poster or slide show presentation. 2. Check out these websites for further information   <http://www.livescience.com/30991-weird-wildlife-real-animals-antarctica-penguins.html>  <http://www.coolantarctica.com/Antarctica%20fact%20file/science/cold_penguins.php> |
| https://pixabay.com/static/uploads/photo/2014/04/02/16/20/chemistry-306977_960_720.png | **Practical work**   1. Look for water bears in mosses and lichens. Rehydrate and then use a microscope. 2. Plan an investigation to discover the effect on the freezing temperature of water if salt or sugar is added to make a solution. What is the salinity of sea water? Pure water freezes at 0˚C and sea water at – 1.9˚C. 3. Calculate the surface area to volume ratio of a 1cm cube and a 3cm cube   **1cm cube**  Volume = 1 x 1 x 1 = 1cm3  Surface Area ( 6 faces ) = 6 x (1 x 1) = 6cm2  For 1cm3 of volume there are 6cm2 of surface area to lose heat from; 6 / 1 = 6cm2per 1cm3  **Surface-area : volume ratio is 6:1**  **3cm cube** Volume = 3 x 3 x 3 = 27cm3  Surface Area ( 6 faces ) = 6 x (3 x 3) = 54cm2  For 27cm3 of volume there are 54cm2 of surface area to lose heat from; 54 / 27 = 2cm2per 1cm3  **Surface-area : volume ratio is 2:1**  **If you imagine these are simple cubic warm-blooded animals, the small cube has 3 times the surface area per unit of volume compared to the large cube.** |