

# Cold on Earth - *the biological response*

## Cold is a fierce enemy of life on earth

The lowest temperature ever recorded on the earth was  $-89.2^{\circ}\text{C}$ , at Vostok Ice Station in Antarctica, on 21 July 1989. At this temperature water poured from a kettle freezes before it hits the ground.



**Freeze tolerance** is achieved by allowing ice to form between the cells, just below  $0^{\circ}\text{C}$ , using active ice nucleators such as bacteria or special proteins. Freeze tolerant arctic woolly bear caterpillars may spend 10 months each year frozen at  $-50^{\circ}\text{C}$ .



Arctic woolly bear caterpillar



Freeze tolerance is also well developed in several North American frogs, salamanders, snakes and turtles.

## Penguins huddle together for warmth

in the coldest climate on earth at temperatures down to  $-60^{\circ}\text{C}$  on the Antarctic ice. They have thick layers of feathers, down and blubber under their outer feathers. The down traps air to retain body heat and maintain a stable body core temperature.



The penguins continuously shuffle around and take turns to be on the outside of the huddle, where the temperature can be  $20^{\circ}\text{C}$  lower than in the middle.

## Animals with antifreeze

**Ice** is lethal to all living cells. When crystals form they penetrate the cell membrane. Plants and cold-blooded animals have adapted to extreme cold by either preventing freezing (**freeze avoidance**) or by only letting ice form where it does not cause damage (**freeze tolerance**).

## Freeze avoidance

Antarctic springtails, mites, fly larvae and other invertebrates prevent their cells from freezing, down to  $-40^{\circ}\text{C}$ , by producing antifreeze compounds like glycerol, by using antifreeze proteins which inhibit the growth of small ice crystals and by avoiding bacteria or other ice nucleators which seed the formation of ice.



Antarctic springtail greatly magnified. It's really about the size of a grain of rice.