Temperature survival mechanisms in animals

Different animal species follow different mechanisms to survive in extremely low or high temperatures. These mechanisms are physiological which aids to rise body temperature in cold environment or to lower body temperature in high temperature environment. When it comes to increasing body temperature in cold atmosphere, the shivering is one of the well known techniques seen in most of the animal species. This is a mechanism which contracts the muscles and hence generates the heat. The second mechanism is decrease in the flow of blood to skin; this hinders the blood from actually cooling down before reaching heart, brain and other muscles and organs. Fluffing out the fur to increase the insulation is the third mechanism which is good for majority of the mammals except humans. (R. C. Tinsley in 2002)

Behavioral regulation mechanism is observed in Antarctic penguins. While the temperature drops to -22F. The one month old penguin chick normally gets insulated against this low temperature hence many other penguin chicks huddle it tightly and act like a large insulated organism. This specific process is so effective that penguin cluster has to move often to stop ice from melting down. The reptiles and amphibians in temperature below zero degrees Celsius burrow themselves underground or sometimes find other locations for shelter.

Some fogs even survive through the lower underground temperature which is up to -40 C. These animals generally stock their blood with antifreeze chemicals and glycerol right at the beginning of the winter. Though wood frogs freeze at this low temperature they reduce the damage by certain mechanisms. These frogs withdraw almost all the fluids from their blood

vessels and organs and store it in extracellular spaces. Hence as a result ice crystals can expand without the need of tearing cells and blood vessels. Moreover these frogs have chemicals which cause formation of ice crystals gradually instead of chunks. The amazing blood clotting attribute of these frogs can instantly repair ruptured blood vessels.

These physiological mechanisms which defend body temperature of the animal depend on brain's hypothalamus in and near area. The anterior hypothalamus regulates the body temperature. Suppose an experimenter/researcher heats this area of animal's brain the animal body will start sweating even in the cooler environment. Suppose the same area is been cooled then the animal will start shivering even at the warmest room.

Mechanisms for Surviving Extreme High Temperature in Animals:

Corrective mechanism for temperature control:

The animals are capable of regulating temperature through negative feedback control. Once again hypothalamus acts like a receptor in temperature regulation by identifying the temperature fluctuation. Skin of the animal plays a primary role in detecting external environment temperature. This information gets conveyed to hypothalamus which in turn transmits the nerve pulses in order to achieve corrective mechanism. There are various survival techniques which enable animals even in the hottest days.

Excessive sweating is one of the corrective responses which are aimed to bring down the animal body temperature. In Vasodilation the blood vessels which are close to animal's skin gradually become highly dilated which

means that the larger surface area is created for heat of the environment to be lost right from blood vessels which carry heated blood. The drop in metabolic rate is another type of mechanism for balancing the body temperature observed in animals.

For example a gemsbok (normally seen in hottest deserts of South Africa) has sparkling coat which can reflect sunlight which in turn aids in reducing the body temperature. The gemsbok has a network of exclusive veins on its face that cools down the blood before it reaches the brain via a process of thermal panting. This process lets the gemsbock’s temperature to move upward. The same process is also followed by ostriches. In addition the features of ostrich insulate it from the rising heat. The ostrich has the capacity to cool itself down by running all around in a sunny day, the fanning out its feathers aids the loss of conventional heat. The body heat gets carried away due to air movement via its features.(Fatik Baran Mandal in 2007)

Some of the animals living in deserts develop the ways which can dissipate the excessive heat of the environment. Some of the well known physiological adaptations are long year or long appendages etc. Some animals are paler in skin color. This feature in fact serves two major functions like absorbing the minimal heat which helps in keeping the animal cooler. Camouflaging according to the desert surrounding helps these from predators. The black vulture excretes urine on its legs which indeed helps in cooling down. The same mechanism is followed by the turkey.

Survival of mechanism in plants at high temperature:

Similar to animals even plants comply various survival methods which help in surviving even at the very high or very low temperature. For example desert plants make use of both behavioral and physical mechanisms in order to adapt to the high heat and the aridity of the desert. Xerophytes are the types of plants which alter the physical structure to adapt to the increasing temperature of the external environment. A cactus is one of the examples of xerophytes. These plants have unique means of conserving water. The limited number of leaves or no leaves in such plants brings down the transpiration level. The plants which grow very long roots in order to acquire moisture near or at the water table are known as Phreatophytes. (David A, 2002)

Some of the behavioral mechanisms followed by desert perennials to survive in extremely high temperature is keeping themselves dormant. These plants spring into life when once more the temperature stabilizes. The cactus adaptation of rose family is known as one of the highly drought resistant plants on earth. The shallow root system, limited leaves, capacity to store water on the stems or on spines for waxy and shade skin in order to steal moisture are some of the traits of these plants to adapt to the enhancing temperature. The other varieties of cactus like beavertail cactus, jumping cholla and more.

The photosynthesis process of cacti is based on the chlorophyll available on the external tissue of the plant skin and its stems. The plant spines in fact shade it from hot sun and aids in collecting the moisture. The extremely shallow root systems of such plants are normally radial. This is because of

the fact that they can store the water on the stems core as well as on roots core. Hence these plants can easily survive dry and high temperature climate and survive just from the water been collected from mere one time rainfall.

Eliminating leaves is one of the best methods followed by trees or shrubs of deserts which replace these leaves with thorns and hence eliminates transpiration. These types of plants generally have green bark and trunks which is capable of producing food and the seal in moisture.

Survival Mechanism in plants at low temperature:

Winter is one of the most difficult seasons for plants which bring number various problems due to low temperature in external environment. In winter season as the number of daylight hours is lesser than that of night hours, the green plants will not be capable to photosynthesize and produce the food. Moreover in winter season when the temperature drops lower than zero the water becomes highly inaccessible to these plants. Hence the survival technique in such environment becomes mandatory. Some plants can survive easily through the winter by entering to a resting stage. (Peter D. Moore, Richard Garratt in 2008)

Indeed the experiments have shown that extremely low temperature slows down the plant growth and also stops the circulation of water in the plant sap. But yet, there are various plants which are accustomed to different mechanism to adapt to the surrounding low temperature environment. In few plants known as annual plants reproduce in summer and die in the last days of summer. The seeds produces will survive through the winter season.

The seeds gradually start germinating and grow into upcoming spring. This type of plant is known as annual plant.

Few plants survive via their underground storage tuber/organs. For example potatoes, carrots, tap roots, onions and more. Autumn and the summer is the season when these plants start storing the food in underground storage organs. At the time of winter, food reserves will be utilized for growing the new leaves and then the shoots over the ground. Such plants are known perennials. Apart from the food storage capacity these plants can also produce huge number of seeds every year.

Some plants add new roots and branches to their body every year as an act of survival mechanism in low temperature. Having their branches and trunks on ground in all the winter exposed to freezing winds and snow these plants will have to survive the entire winter. The carrot plant can produce storage organs in the foremost year of its life and there comes the flower and then the seeds in the second year. Such plants are known as biennial plants, which follow the survival mechanism based on the stage of its life. Thus all in all the plants too have inbuilt survival mechanisms which help them survive even at the lowest temperature and thus survive up to the life span.

Survival of mechanism in Microorganisms at high temperature:

There are various microorganisms in the world, which can survive even in the toughest environment under very low or high temperature. For example few bacteria are adaptable and versatile enough to get accustomed to the varying environment temperature. Some bacteria exist in different sizes and shapes. These shapes may include long like rods, round like cocci and some

in coiled shape. Besides, these shapes mentioned there are various types and shapes of such microorganisms. These creatures can exist even under wacky conditions and such types of organisms are known as extremophiles. The extremophiles microorganisms can survive in extremely low temperature as well as extremely high temperature. These can easily survive in environment with temperature up to 121°C. (A. K. Pavlov, V. N. Shelegedin, in 2003)

These organisms grow in too acidic ph value which is generally less than 3. 0. The Ferroplasma acidiphilum and archaeobacteria are seen in the Iron mountain mines. This type of resilent mine water cells comprise copper, zinc and iron. These microorganisms survive by releasing the hydrogen in the form of a waste and by oxidizing iron. Research has proved that Ferroplasma Acidiphilum not only uses iron just to extract energy but in fact these also use it in the form of an element for cellular proteins. Researchers have also discovered that proteins of these microorganisms comprise iron atoms in almost all of its proteins. These atoms of irons are utilized as anchors in order to hold the protein chains.

Thermophile is a bacteria which normally grows at a very high temperature from 50 degree Celsius to 80 degree Celsius. These bacteria are categorized into facultative and obligate thermophiles. The thermophiles known as hyperthermophiles undergoes the optimal growth only above the temperature of 80 degree Celsius.

One of the highly remarkable discovery was to find the fact that Thermas Aquaticus which is an Archaea microorganism is capable to resist high

temperature. This is due to the survival mechanism found in Thermus Aquaticus which makes it capable enough to duplicate DNA at a very high temperature. The Vibrio vlunificus is one of the curved bacterium which can survive marine environments. These bacterium’s growth rate is very high in warm seawater. The Deinococcus radiodurans are another type of microorganisms which can easily survive in the toughest environment with high level of exposure to radiation. These organisms can survive in thousand times radiation atmosphere than a common person. These organisms have the capacity to put its genome with perfect fidelity. This is one of the highly remarkable features of these microorganisms because despite the radiation shatters the DNA the bacterium proteins can easily repair them. The extra genomes let the bacterium to regain one complete set of genome after it gets exposed to the radiation.

The microorganisms like Archeans incorporate inhabitants of few of the extreme environment on the earth. Some of them can survive right near rift vents inside the deep sea at more than 100°C, some can . live in highly hot springs, or also in highly acid or alkaline waters. Few of the archaeans can also survive desiccating impacts of high temperature. The very sensitive and light pigment bacteriorhodopsin brings the Halobacterium(group of Archaea) chemical energy and the color. Bacteriorhodopsin has purple color and pumps the protons into the membrane. These protons are later used in the ATP synthesis which in fact is the main energy source of each cell. Archeans are those microorganisms which can easily survive in extreme habitats like thermal vents.

Survival of mechanism in Microorganisms at extreme low temperature:

There are several microorganisms which can stand the extreme low temperature of external environment and can go on with its day to day activities without much of impact. For example Psychrophiles are the microorganisms, capable of exhibiting optimum growth even at 15 degree Celsius or lower than that. Some of the other species collected from extremely low temperature environment which include Psychrobacter sp, Arthrobacter sp, members of Genera Halomonas, Sphingomonas and Pseudomonas also exhibit the same properties at low temperature. The Psychrobacter species are the unique microorganisms which can reproduce even at the temperature of -10 degree Celsius to -40 degree Celsius. Bacteria proteins are main source which make these microbes to live as well as reproduce even at the lowest temperature. (Andrew Bell, John Swenson-Wright, Karin Tybjerg in 2008)

The survival and the growth of low temperature is in fact also relevant to storage of food or to food processing, stress responses and normal mechanisms of these bacterial survival. Moreover, these adaptations which Psychrobacter has created to inhabit the permafrost actually enables hypothesis regarding the possible microbial life even in the extraterrestrial environments.

All in all the inbuilt features and traits of these microorganism or plants or animals help in surviving at the extreme temperature easily without hindering its normal activities.