Thermophiles their extreme environment and biological adaptations

The boiling point for water is 100°C. As with humans, the highest temperature at which most animals and plants can live is about 40°C. Above 50°C the only organisms that can survive the heat are some groups of bacteria and archaea.

A **thermophile** is an organism that thrives at relatively high temperatures, between 45 and 80 °C. Many thermophiles are archaea. It has been suggested that thermophilic eubacteria are among the earliest bacteria on the planet Earth.

As a prerequisite for their survival, thermophiles contain enzymes that can function at high temperatures and so they can live in a harsh environment and photosynthesise.

The environment for thermophiles

Thermophiles are found in various geothermally heated regions of the Earth such as hot springs like those in Rotorua and deep sea hydrothermal vents.

Volcanic areas in many places of the world are associated with hot springs. The temperature of these hot springs can go up to 100^0C. Hydrothermal vents are exceptionally hot as the water is under pressure and can be heated above 100oC. They are generally acidic and corrosive as well as being very hot. The cause of the hot spring areas is magma being close to the surface of the Earth and open to rain water which seeps into the ground. Under the Taupo Volcanic Zone the magma chamber lies about 8km below the surface so is in easy reach of rain and other ground water. The temperature of many of the hot pools is over 50^0C yet supports life. One group of organism is the cyanobacteria which live and thrive in these hot pools. The water coming out of these volcanic areas is high in sulfur. (1)

Adaptations of Cyanobacteria and microbial mats:

One group common in hot springs are cyanobacteria. They derive energy from the sun through photosynthesis, and produce oxygen much like plants. They will not grow in highly acidic waters. Their upper temperature limit is about 70°C; above this, photosynthesis cannot occur.

Cyanobacteria are usually green, and are found in most thermal areas throughout the world. Some cyanobacteria can be other colours because of pigments that mask the green chlorophyll. These pigments protect the bacteria from the sun's ultraviolet radiation.

Cyanobacteria growing in near darkness use a previously unknown process for harvesting energy and producing oxygen from sunlight, a research team led by a Penn State University scientist has discovered. The discovery lays the foundation for further research aimed at improving plant growth, harvesting energy from the Sun.

We now have clearly established that photosynthesis can occur in far-red light, in a wavelength range where people previously did not think that oxygenic photosynthesis could take place. Cyanobacteria also reproduce asexually.

Thermophiles, meaning heat-loving organisms, are organisms with an optimum growth temperature of 50 °C or more, a maximum of up to 70 °C or more, and a minimum of about 40 degrees C, but these are only approximate. Some extreme thermophiles (hyperthermophiles) require a very high temperature (80 °C to 105 °C) for growth.

Many of the hyperthermophiles Archea require elemental sulfur for growth. Some are anaerobes that use the sulfur instead of oxygen as an electron acceptor during cellular respiration. In these places, especially in the Taupo Volcanic Zone, we find a zonation of microorganisms according to their temperature optima. Often these organisms are coloured, due to the presence of photosynthetic pigments. (2)