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كلية العلوم
قسم علوم الحياة/ المرحلة الثالثة
مادة بيئة الاحياء المجهرية/الدراسة المسائية والصباحية

Extreme Environments

There are two definitions of extreme Environments, The first characterizes an environments as extreme if the environmental conditions are at one or two extreme (high or low).these environmental conditions can include pH, temperature, salinity, pressure and nutrients. The second definition refers to Environments in which conditions select for extremely low microbial diversity.

Extremophile: The organisms that have successfully adapted to environments where it is difficult or impossible for other organisms to survive. Extreme environments are important to environmental microbiologists because there is much speculation that such environments harbor unique microorganisms with activities that are not only of scientific interest but also that have commercial potential.

Microbial communities in extreme environments have adapted to amazing levels of stress. These adaptations are of interest for development of

- Remediation approaches for some contaminated sites including acid mine drainage sites and radioactive waste sites.
- They also are of interest for applications of novel enzymes adapted to temperature or pH extremes.
- Finally, they are of interest for understanding evolutionary history and possible impacts of future climate change.

Types of Extreme Environments

1. Low Temperature Environments

The McMurdo Dry Valleys in Antarctica represent one of the driest and coldest ecosystems known. The average mean annual surface air temperature is -27.6°C and the average surface soil temperature is -26.1°C. This ecosystem has the only permanently ice-covered lakes on Earth, varying in ice-cover thickness from 3 to 5 m .Researchers studying the site found a diverse community of phototrophic purple bacteria, sulfur chemoautotrophs, and heterotrophic sulfate-reducers.

For example, cell numbers of sulfur-oxidizing bacteria were found to peak at 200 cells per ml at a depth of 9.5 m, this is where both dissolved oxygen and sulfide coexist in the water column. Three sulfur-oxidizers were cultured from lake water samples, all most closely related to Thiobacillus thioparus .Sulfate-reducing bacteria were also found in addition methanotrophic microorganisms .

Cold-adapted microorganisms: Their ability to survive and grow in the cold requires specialized adaptations For example, these microorganisms synthesize cold-adapted enzymes which have had to evolve specific structural features that make them highly flexible in comparison to their warm temperature equivalents . the enzyme can operate efficiently at low temperatures. This also means that at high temperatures the enzyme becomes unstable.

In fact, it is these two properties of cold active enzymes that makes them suitable for biotechnological application: their high activity at low temperature and their low stability at elevated temperatures. Low temperature enzymes that have been examined or used in industry include α- amylase, cellulase, β- galactosidase, lipase proteases, xylanase.

2. Desiccation and UV Stress Environments

The deserts of the world represent both hot and semi- cold and hyperarid environments where extreme conditions severely limit primary productivity and thus the diversity of life. Factors limiting microbial life in the arid deserts include water availability, temperature, and the intensity of UV radiation.

Commonly studied feature in arid environments is the **lithic microbial communities**, those that inhabit rock surfaces and subsurface rock pores. These communities are dominated by photoautotrophic nitrogen-fixing cyanobacteria and are capable of colonizing a diverse group of minerals including, granite, gypsum, halite, quartz, and sandstone.

These communities have been found in a range of hot and cold deserts. These **hypolithic** (inhabit rock surfaces) and **endolithic** (inhabit pore spaces within the rocks) communities are believed to exploit the protection offered by rock surfaces that scatter UV radiation and presumably trap limited water supplies. The dominant photoautotroph found in the majority of these communities is the desiccation and radiation tolerant *cyanobacterium chroococcidiopsis*.

Adaptation to desiccation is unique among the extremes experienced by bacteria induce survival strategies for the cells rather than the ability to function under extreme conditions.

The survival strategies identified include the following:

- The ability to protect and repair DNA exposed to UV radiation
- Maintenance of protein stability in the dehydrated state
- Maintenance of membrane integrity

3- Air-Water Interface Environments

The air –water interface is a unique habitat that is often considered an extreme environment for many reasons, including

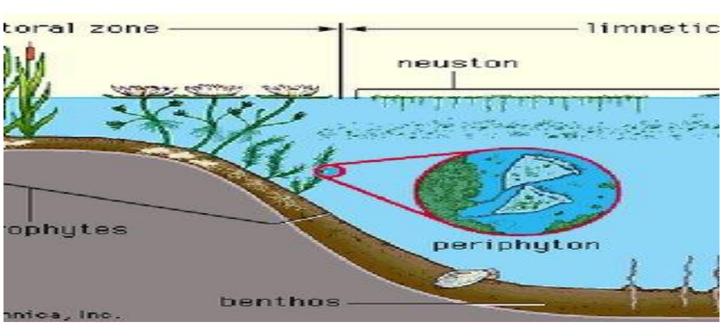
- high levels of solar radiation
- Accumulation of toxic substances (e.g. heavy metals, pesticides).
- Large temperature
- pH
- Salinity fluctuations
- Competition

The air–water interface, also referred to as the neuston layer, contains higher concentrations of organisms than other layers of the water column.

The neuston accumulates nutrients and especially attracts nonpolar organic and inorganic molecules, in addition to the nutrients accumulation the neuston tends to accumulate toxins .Among these toxins are nonpolar organic molecules, including pesticides such as DDT and petroleum hydrocarbons, as well as metals such as Cd,Cu,Mn,Hg,Pb,Se and Cr .The microorganisms that inhabit the neuston have developed unique metabolic, genetic and functional strategies that allow them to survive the extreme environments.

These strategies include:

- Use of pathways that catabolize toxic compounds and provide resistance to metals that accumulate at the interface.
- Some microbes have developed efficient DNA repair mechanisms to repair DNA damage caused by exposure to ultraviolet radiation.



Figur1: Neuston layer