

## Extremophile bacteria

### Why in news?

The recent research studies shows that extremophile bacteria can survive not only in extreme environments but also in microwaves.

### What are extremophile microbes?

- **Microbes** - They are microorganisms, tiny living organisms , that are *too small to be seen with the naked eye*.
- **Microbes Type** - Protozoa, bacteria, fungi and microscopic animal and plant viruses, viroids and also prions that are proteinacious infectious agents.
- **Single or Multi cell** - Microorganisms may be single-celled like bacteria, some algae and protozoa, or multicellular, such as many algae and fungi.
- **Global Initiatives** - Many global initiatives are currently trying to map, organise, and understand this diversity.
- **Earth Microbiome Project** - It was founded in 2010 to sequence 200,000 genetic samples and assemble 500,000 microbial genomes.
- **Earth Biogenome Project** - To sequence the genomes of all of the planet's eukaryotic organisms to create one of the largest and most comprehensive maps of organisms
- **Habitats** - They live in all types of environment, ranging from ice cold climate to hot springs; and deserts to marshy lands.
- They are also found inside the bodies of animals including humans.
- Some microorganisms grow on other organisms while others exist freely.
- **Extremophiles** - Microbes that live in extreme natural conditions are called extremophiles.
- They have been found in
  - Hydrothermal and volcanic vents
  - Permafrost
  - Dark lakes buried kilometres under polar ice caps
  - Acid mines
  - Around nuclear waste storage sites.
  - Exteriors of spacecraft

*Deinococcus radiodurans, an earth-born bacteria, could survive in outer space for more than three years, stuck to the outside of the International Space Station*

- There are different types of extremophiles adapted to live in different extreme conditions.

Extremophiles Types	Description	Examples
<b>Thermophiles</b>	These organisms live in extremely hot environments, such as hot springs or deep-sea hydrothermal vents.	Thermus aquaticus and Pyrococcus furiosus.
<b>Psychrophiles</b>	These microbes thrive in extremely cold environments, such as polar ice caps and deep oceans.	Psychrobacter cryohalolentis.
<b>Acidophiles</b>	Acid-loving microorganisms that grow in highly acidic environments with pH levels below 3.	Ferroplasma acidarmanus and Acidithiobacillus ferrooxidans.
<b>Alkaliphiles</b>	These organisms prefer basic or alkaline environments with a pH above 9. They are often found in soda lakes.	Alkalimonas universalis and Bacillus alcalophilus.
<b>Halophiles</b>	Salt-loving microbes that thrive in high-salt environments, such as salt mines and salt flats.	Halobacterium salinarum and Halococcus salinaris.
<b>Barophiles</b>	These organisms live under extreme pressure, such as in the deep sea.	Halomonas salaria and Deepleogaster formosus.
<b>Xerophiles</b>	These microbes can survive in extremely dry conditions, such as deserts. They have adaptations to conserve water and manage desiccation.	Bacillus spores and Clostridium species.

- **Radiation Resistant Extremophiles** - Microbes that are resistant to radiation, desiccation, and high temperatures have been found in domestic microwaves and research facilities.

### What are the adaptations of extremophiles microbes?

- Microbes adapt to extreme environments by incorporating unique *biological and biochemical processes*.
- **Proteins and Enzymes**- Their proteins and enzymes are often *more stable and functional under extreme conditions*, such as high temperatures or acidic pH.
- **Extremozymes** - These organisms use unique enzymes, called extremozymes, which allow them to survive and function in harsh conditions.
- For example, thermophiles have heat-stable enzymes that are useful in industrial processes (e.g., PCR).
- **Cell Membranes**- They have *unique membrane lipids that maintain fluidity and integrity* under extreme temperatures or pressures.

- **DNA Repair Mechanisms-** Extremophiles have *specialized mechanisms to repair DNA damage* caused by extreme conditions, such as high radiation or desiccation.

### What are their significance in science and industry?

- Understanding extremophiles could lead to advances in synthetic biology, disease resistance, and bioremediation.
- They offer potential for new medications and industrial applications.
- **Enzyme development** - Extremophiles produce enzymes and proteins that remain stable and active under extreme conditions.
- These enzymes are used in industries like *detergents, biofuels, and pharmaceuticals*.
- **Example** - Heat-resistant enzymes like Taq DNA polymerase from *Thermus aquaticus* bacteria from a hot spring at Yellowstone National Park, is used in Polymerase Chain Reaction( PCR).
- **Bioremediation** - Radiation Extremophiles are useful in bioremediation of toxic waste.
- **Exoplanet search** - Helps in understanding life in extreme environments, both on Earth and potentially on other planets.
- **Medicine-** Extremophiles' unique proteins and metabolic pathways aid in creating new treatments and drugs, including antibiotics and other therapeutics.
- **Genetic Research-** Extremophiles' unique genetic adaptations offer insights into *gene regulation and stress responses, advancing genetic engineering*.
- Understanding them can help in creating synthetic biological systems that can augment the immune system.
- **Agriculture-** Extremophiles can be used to develop crops that are more resistant to extreme conditions, helping *improve food security in challenging environments*.

### References

1. [The Hindu | Extremophile bacteria](#)
2. [Biolablest | Extremophiles](#)
3. [Britannica | Extremophile](#)



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