Name of the Programme: M.Sc. Biotechnology

Course Code: GBT-524

Title of the Course: BIOLOGY OF THE EXTREMOPHILIC ORGANISMS

Number of Credits: 2

Effective from AY: 2022-23

Pre-requisites for the Course:	No prerequisites required	
Course Objectives:	1) To obtain knowledge regarding the existence of extreme habitats. 2) To understand how the strategies are adopted to overcome extreme conditions.	
Content:	**MODULE I** • Thermophiles: Tree of life • Types of Extreme habitats based on environmental variables/sources: • Low Temperatures: Polar regions (Antarctica and Arctic). • High temperatures: Deserts, Hot springs, hydrothermal vents, Deserts. • Pressure: Deep-sea environments, Subsurface rocks, Mariana Trench. • Vacuum: Space station, space habitation. • Desiccation: extreme hypersaline environments, deserts. • Hypersaline: coastal lagoons, salt and soda lakes, salterns, deep-sea brine pools, brine channels in sea ice, and fermented foods and pickling brines. • pH: Acidic [Solfataric fields (sulfuric volcanic fields), geysers, sulfuric acid pools, acid minedrainages from coal and metal mining waste] or Alkaline (Soda lakes and soda deserts). • Low oxygen: Low or depleted oxygen level in water bodies (anthropogenic activities, pollution, eutrophication, algal growth) • Methane: Natural wetlands, freshwater lakes, streams, rivers, estuarine and coastal areas, termite, and wild	**No of hours** 15

	ruminant guts, terrestrial and marine seeps, volcanoes, geothermal vents, gas hydrates, and methane produced from biomass combustion (i.e., wildfires). Anthropogenic sources agriculture, with cattle and rice cultivation as the largest contributors, fossil fuels, waste (ex. landfills, sewage), and biomass/biofuel burning. • Categories of extremophiles: Thermophile, Halophile, Psychrophile, Alkaliphile, Acidophile, Piezophile or barophile, Xerophiles, Anaerobic, methanogenic, metal resistant, radiation resistant, endoliths.	
	MODULE II • Homeostasis, enantiosis (physiological/biochemical) • Thermogenesis, exothermic, endothermy molecular mechanisms (stability of proteins, catalytic rates) Stress proteins: heat shock, chaperonins, SAPKs • Freeze avoidance/tolerance: antifreeze proteins, ice nucleation, frost (cold) hardiness, Membrane structures, and temperature. • Life under pressure: barophilic bacteria, metazoan, Deep diving penguins, mammals • Energy metabolism – the role of oxygen (normoxia, hypoxia, anoxia) physiological adaptations (hibernation, torpor, estivation) • Photosynthesis - physiological and biochemical adaptations to extreme light and temperature • Ionizing radiation - mechanism of radiation resistance • Life with limited water - arthropods, reptiles • Hot, dry environments - mammalian physiological adaptations • Mechanisms to avoid osmotic stress acid and alkaline environments • Overcoming heavy metal and toxin tolerances, • Biotechnological application of extremophiles	15
Pedagogy:	Lectures, tutorials, assignments	

References/ Readings:	1. R.P. Anitori, Extremophiles: Microbiology and Biotechnology. Caister Academic Press, 2012. 2. R.V. Durvasula, and D.V. Subba Rao, Extremophiles: From Biology to Biotechnology. CRC Press, 2018. 3. J. Elster, G. Prisco, A.H.L Huiskes, H.G.M. Edwards, Life in Extreme Environments., Insights in Biological Capability. Cambridge University Press, 2020. 4. N. Gunde-Cimerman, A. Oren, A. Plemenitaš (Ed) Adaptation to Life at High Salt Concentrations in Archaea, Bacteria, and Eukarya. Springer Publisher, 2005. 5. S. Richa and S. Vivek, Physiological and Biotechnological Aspects of Extremophiles. Academic Press, 2020. 6. V. Singh Om, Extremophiles: Sustainable Blackwell, 2012. 7. D.A. Wharton. Life at the Limits: Organisms in Extreme Environments Cambridge Press, 2002.
Course Outcomes:	1. Students will be able to understand and distinguish between various types of extreme environments. 2. Students shall gain knowledge about specialised features exhibited by extremophilic organisms. 3. Students shall be able to understand the mechanisms of adaptation adopted by different organisms in extreme habitats. 4. Students shall be able to understand the bioprospecting of the extremophiles for biotechnological applications.

(Back to top)