

Branch Name:	M.Sc. Biotechnology/ Microbiology
Program Code:	SC201/ SC202
Course Name:	Microbiology beyond Earth & Extremophiles
Course Code:	3SC2000204
Pre-requisite Course:	

Course Objectives:

- Understand the scope, aims, and significance of space microbiology, including Martian environment and its analogs (e.g., Antarctica) in astrobiological studies.
- Explain life detection methods and experimental approaches, along with key metabolic indicators of life such as ATP production, phosphate uptake, sulphur metabolism, and photosynthesis.
- Understand the impact of space conditions on microbial life, including changes in astronaut microbial flora and associated health implications.
- Explain the diversity, adaptations, and applications of extremophiles, including alkalophiles, acidophiles, halophiles, barophiles, thermophiles, and methanogens.

Teaching and Examination Scheme:

Teaching Scheme(Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
4	--	--	4	50	50	--	--	100

Subject Contents:

Unit	Content	Lectures	Weightage
1	Space Microbiology Aims and objectives of Space research Life detection methods. Evidence of metabolism (Gulliver) Evidence of photosynthesis (autotrophic and heterotrophic) • ATP production • Phosphate uptake • Sulphur uptake Martian environment (atmosphere, climate and other details): Antarctica as a model for Mars, Search for life on Mars, Viking mission, Viking landers, and Biology box experiment, Gas exchange, Label release and pyrolytic release experiments. Monitoring of astronauts microbial flora: Alterations in the load of medically important microorganisms, changes in mycological autoflora, and changes in bacterial autoflora.	15	25%
2	Biodiversity Introduction to microbial biodiversity: Distribution, Abundance, Ecological Niche, types: Bacterial, Archaeal and Eucarya Alkalophiles and Acidophiles Alkalophiles: Classification, Alkaline environment & Habitats: soda lakes and deserts, calcium, applications Acidophiles: Classification, life at low pH, acid tolerance, applications	15	25%

3	Characteristics and Classification of Archaeobacteria Thermophiles Classification, hyperthermophilic habitats and ecological aspects Extremely Thermophilic Archaeobacteria Mechanism of Thermophily Commercial aspects of Thermophiles Applications of Thermozyms Methanogens Classification, Habitats, Biochemistry of Methanogenesis, Applications	15	25%
4	Halophiles and Barophiles Halophiles Classification Habitats: Dead Sea, Discovery Basin, Salt Lakes Halophilic Cell walls and Cell Membranes – Purple membrane, compatible solutes Osmoadaptation & Halotolerance Applications of Halophiles and their extremozymes Barophiles Classification High-pressure habitats Mechanism of Barophily - Life under extreme hydrostatic pressure	15	25%

Textbooks:

- Microbial Ecology. Fundamentals and Applications by. Ronald M. Atlas and Richard Bartha. 4th Edition. The Benjamin Cummins Publication Co. Inc, 1998.
- Extremophiles by Johri B.N. 2000. Springer Verlag, NewYork.
- Astrobiology: A brief introduction (2nd ed.). Plaxco, K. W., & Gross, M. (2011). Johns Hopkins University Press.
- Life in the universe (4th ed.), Bennett, J. O., & Shostak, S. (2016). Pearson.

Reference Books:

- Microbial life in extreme environments by Kushner, Donn J. 1978.
- Brocks Biology of Microorganisms. 8th Edition. (International Edition - 1997) by Michael T. Madigan, John M. Martinko. Jack Parker. Prentice Hall International Inc.
- Encyclopedia of astrobiology. Gargaud, M., Amils, R., Quintanilla, J. C., Cleaves, H. J., Irvine, W. M., Pinti, D. L., & Viso, M. (Eds.). (2011). Springer.

List of Open-Source Software/learning website:

- <https://astrobiology.nasa.gov/>
- <https://www.esa.int/>
- <https://microbiologysociety.org/>
- <https://microbeonline.com/microbes-in-space-their-survival-and-importance/>
- [https://joyfulmicrobe.com/international-space-station-bacteria/#:~:text=When%20a%20NASA%20mission%20leaves%20Earth%2C%20they,\(yes%2C%20just%20like%20in%20the%20Marvel%20movies\).](https://joyfulmicrobe.com/international-space-station-bacteria/#:~:text=When%20a%20NASA%20mission%20leaves%20Earth%2C%20they,(yes%2C%20just%20like%20in%20the%20Marvel%20movies).)
- <https://www.slideshare.net/slideshow/space-microbiology-food-and-environmental-microbiology/277155039>
- https://onlinecourses.nptel.ac.in/noc25_ae35/preview#:~:text=ABOUT%20THE%20COURSE:,topic%20at%20a%20deeper%20level.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Define and explain the scope, aims, and basic concepts of space microbiology.	1 Remember 2 Understand
CLO2	Explain, apply, analyze, and evaluate life detection methods, metabolic indicators, and findings from Mars missions related to the search for life.	2 Understand 3 Apply 4 Analyse 5 Evaluate
CLO3	Explain, apply, and analyze microbial diversity, including distribution, abundance, ecological niches, and major groups such as Bacteria, Archaea, and Eukarya.	2 Understand 3 Apply 4 Analyse
CLO4	Explain, apply, analyze, and evaluate the diversity and classification of extremophiles including alkalophiles, acidophiles, halophiles, barophiles, thermophiles, and methanogens.	2 Understand 3 Apply 4 Analyse 5 Evaluate
CLO5	Explain, apply, analyze, and evaluate adaptation mechanisms of extremophiles in extreme environments.	2 Understand 3 Apply 4 Analyse 5 Evaluate
CLO6	Apply, analyze, evaluate, and design applications of extremophiles in biotechnology, industry, and astrobiology.	3 Apply 4 Analyse 5 Evaluate 6 Create

Mapping of CLO s with POs & PSOs

Course Learning Outcomes	Programme Outcomes (POs)																Programme Specific Outcome (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	PSO1	PSO2	PSO3
CLO1		2			1	2			2	1								1	
CLO2	3	3	2	2	3	3			3	3							1	1	
CLO3	2	2	2		1	2			2					2				1	
CLO4	2	2	2		1	2			2					2			1	1	
CLO5	2	2	2		1	2			2					2				1	
CLO6	3	3	3		3	3			2	2				2			1	1	

3: High, 2: Medium, 1: Low