

Title of the Course: **ARCHAEA - ECOLOGY, PHYSIOLOGY, BIOCHEMISTRY AND GENETICS [T]**

Course Code: MIC-514

Number of Credits: 3, Theory

Contact hours: 45

Effective from Academic Year: 2022-23

Prerequisites	Basic knowledge of the three domains of life.	
Objective:	This course gives the understanding of the ecology, diversity, cell structure, physiology and genetics of Archaea.	
Content:		
1.	Ecology, Taxonomy and Significance of the Domain Archaea	(15)
1.1	Evolution of the Domain Archaea: Three domains of life – Archaea, Eubacteria and Eukarya. a) Carl Woese classification of archaea based on 16S rRNA analysis. b) Similarities and dissimilarities - archaea, eubacteria and eukaryotes. c) Uniqueness of archaea versus other extremophilic microorganisms.	2
1.2	Ecology and Diversity of Archaea	3
	a) Ecology and Global econiches: Deep Sea, Hydrothermal vent, Dead Sea, solar salterns, geothermal vents, solfataras, Antarctica, soda lake, alkaline hot springs, marshy land. b) Strategies to cultivate, preserve and maintain Thermophilic and Halophilic Archaea. c) Studies of unculturable archaea by metagenomics.	
1.3	Archaeal Taxonomy	3
	Nutrition, growth Characteristics and physiological versatility, Stress response of Major Archaeal Physiological Groups a) Phyla Euryarchaeota : (i) Methanogens (<i>Methanobacterium thermoautotrophicum</i>), (ii) Haloarchaea (<i>Halobacterium halobium</i>) and (iii) Thermophiles (<i>Thermoplasma acidophilum</i>); (iv) Psychrophilic archaea (<i>Methanogenium frigidum</i>) b) Phyla Crenarchaeota : (i) <i>Sulfolobus</i> and (ii) <i>Thermoproteus</i> c) Phyla Thaumarchaeota : Archaeal ammonia oxidizers d) Phyla Korarchaeota e) Phyla Thermoproteota : thermoacidophilic (<i>Sulfolobus acidocaldarius</i>), <i>Ignicoccus hospitalis</i> f) Phyla Nanoarchaeota: <i>Nanoarchaeum equitans</i>	
1.4	Cell structure and architecture of Archaea: a) Shape Arrangement and size : <i>Haloquadratum walsbyi</i> b) Comparison Between Archaeal and Bacterial Cells c) Cellular organization: cell morphotypes, cell envelopes –	4

	Envelopes; membrane lipids and cell wall, ribosomes, histones-nucleosomes appendages -pili, flagella, cannulae, hami. d) Novel bio-molecules: Glycerol diether moieties and macrocyclic lipid, enzymes, co-enzymes: methanopterin, formaldehyde activation factor, Component B, Coenzyme M, F420, F430, corrinoids.	
1.5	Significance of Archaea in Biotechnology and Biogeochemical cycling a) <i>Pyrococcus furiosus</i> - Pfu Polymerase in Molecular studies b) <i>Halobacterium salinarum</i> – Bacteriorhodopsin c) <i>Thermococcus gammatolerans</i> - To improve DNA repair and reduce cellular aging d) <i>Methanosarcina</i> – Methane production	3
2.	Metabolism and Energetics of Archaea	(15)
2.1	Modified anabolic pathways: a) Gluconeogenesis b) Lipid biosynthesis c) Methanogenesis: from CO ₂ and methanol d) Acetoclastic reactions in <i>Methanosarcina</i> - H ₂ dependent and H ₂ independent; and <i>Methanothrix</i> e) Carbon dioxide reduction pathways: 3-hydroxypropionate pathway, and reverse Krebs cycle f) Bacterioruberin pathway	5
2.2	Modified catabolic pathways: a) EMP b) ED: Semiphosphorylative and Nonphosphorylative ED pathway c) Chemolithoautotrophy: S oxidation	5
2.3	Bioenergetics: ATP synthesis (i) respiration-driven : Anaerobic a) light-driven:bacteriorhodopsin b) chloride-driven: halorhodopsin c) cation-driven.	5
3.	Genome of Archaea	(15)
3.1	Size of genome, G + C content, archaeal histones (Sul7d, MC1), chaperonins and heat shock proteins in archaea, introns in archaea, archaeal RNA polymerases, reverse DNA gyrase.	5
3.2	DNA replication, transcription and translation in archaea. Plasmids, transposons and insertion elements, AT-rich-islands, Modifications in tRNA and rRNA structure. Novel 7S rRNA.	5
3.3	Gene organization in Archaea: Operons (<i>fdh</i> , <i>his</i> and <i>mcr</i>). DNA repair in archaea.	5
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Barker, D. M.,Archaea: Salt-lovers, Methane-makers, Thermophiles and Other Archaeans, Crabtree Publishing Company. (2010)	

	Blum, P., Archaea: New Models for Prokaryotic Biology, Academic Press. (2008)	
	Boone, D. R. and Castenholz, R. W., Bergey's Manual of Systematic Bacteriology: The Archaea and The Deeply Branching and Phototrophic Bacteria, Springer Science and Business Media. (2011)	
	Cavicchioli, R., Archaea: Molecular and Cellular Biology, ASM Press. (2007)	
	Corcelli, A. and Lobasso, S., Characterization of Lipids of Halophilic Archaea. Methods in Microbiology, 35: 585-613. (2006)	
	Garrett, R. A. and Hans-Peter, K., Archaea: Evolution, Physiology and Molecular Biology, John Wiley and Sons. (2008)	
	Howland, J. L., The Surprising Archaea: Discovering Another Domain of Life, Oxford University Press. (2000)	
	Munn, C., Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis Group, N.Y. (2011)	
	Rothe, O. and Thomm, M., A simplified method for the cultivation of extreme anaerobic archaea based on the use of sodium sulfite as reducing agent, Extremophiles. 4: 247-252. (2000)	
	Woese, C. R., Fox, G. E., Phylogenetic structure of the prokaryotic domain: the primary kingdoms. Proc Natl Acad Sci USA. 74: 5088–5090. (1977)	
Course Outcomes	● Describe the ecology, physiology and biochemistry of the domain Archaea. ● Integrate the metabolism and physiology of Archaea. ● Relate the Principle of Archaeal Genetics. ● Appraise the application of Archaea and archaeal bioactive compounds.	