



C. U. SHAH UNIVERSITY
Wadhwan City

FACULTY OF SCIENCES
DEPARTMENT OF LIFE SCIENCES

COURSE: M.Sc.

SEMESTER: II

SUBJECT NAME: Bacterial Diversity

SUBJECT CODE: 5SC02BAD1

Teaching & Evaluation Scheme:-

Teaching hours/week				Credit	Evaluation Scheme/semester								
Th	Tu	Pr	Total		Theory				Practical				Total Marks
					Sessional Exam		University Exam		Internal		University		
					Marks	Hrs	Marks	Hrs	Pr	TW			
4	0	4	8	4	30	1	70	3	-	-		100	

Objectives:- The objective of this course is that the students can learn about basics of bacterial diversity.

Prerequisites:- Basic knowledge of Bacterial diversity.

Course outline:-

Sr. No.	Course Contents	Hours
1	Bacterial Classification- Basis of Bacterial classification; conventional; molecular and recent approaches to polyphasic bacterial taxonomy; evolutionary chronometers; rRNA oligonucleotide sequencing; signature sequences; and protein sequences. Differences between eubacteria and archaeobacteria.	
2	Organization of Bacterial Cell- Structure and function of Cell Wall; Cell Membrane; Cytoplasm; Flagella; Endoflagella; Fimbriae; Glycocalyx; Capsule; Endospore; Growth and Nutrition- Cultivation of aerobic; anaerobic and accessing non-cultureable bacteria. Maintenance and preservation of bacterial cultures; Components of media and different types of culture media. Bacterial nutrition: Transport of nutrients; Salient features of bacterial growth curve.	
3	Important archaeal groups- According to Brock's 2009 and Bergey's Manual of Systematic Bacteriology. Archaeobacteria: General characteristics; phylogenetic overview; genera belonging to Nanoarchaeota (<i>Nanoarchaeum</i>); Crenarchaeota (<i>Sulfolobus</i> ; <i>Thermoproteus</i>) and Euryarchaeota [Methanogens (<i>Methanobacterium</i> ; <i>Methanocaldococcus</i>); thermophiles (<i>Thermococcus</i> ; <i>Pyrococcus</i> ; <i>Thermoplasma</i>); and Halophiles (<i>Halobacterium</i> ; <i>Halococcus</i>)]	



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4	<p>Eubacteria- Non Proteobacteria and Proteobacteria: Morphology; metabolism; ecological significance and economic importance of following groups- Gram Negative- Non proteobacteria (<i>Aquifex</i>, <i>Thermotoga</i>, <i>Deinococcus</i>, <i>Thermus</i>, <i>Chlorobium</i>, <i>Chloroflexus</i>, <i>Chlamydiae</i>, <i>Spirochaete</i>), Alpha proteobacteria (<i>Rickettsia</i>, <i>Coxiella</i>, <i>Caulobacter</i>, <i>Rhizobium</i>, <i>Hyphomicrobium</i>, <i>Agrobacterium</i>), Beta proteobacteria (<i>Neisseria</i>, <i>Burkholderia</i>, <i>Thiobacillus</i>), Gamma proteobacteria (<i>Enterobacteriaceae</i> family, Purple sulphur bacteria, <i>Pseudomonas</i>, <i>Vibrio</i>, <i>Beggiatoa</i>, <i>Methylococcus</i>, <i>Haemophilus</i>), Delta proteobacteria (<i>Bdellovibrio</i>, <i>Myxococcus</i>), Epsilon proteobacteria (<i>Helicobacter</i>, <i>Campylobacter</i>). Gram Positive- Low G+C or Firmicutes (<i>Mycoplasmas</i>, <i>Clostridium</i>, <i>Heliobacterium</i>, <i>Lactobacillus</i>, <i>Lactococcus</i>, <i>Staphylococcus</i>, <i>Streptococcus</i>, <i>Leuconostoc</i>, <i>Bacillus</i>), High G+C or Actinobacteria (<i>Arthrobacter</i>, <i>Bifidobacterium</i>, <i>Corynebacterium</i>, <i>Frankia</i>, <i>Mycobacterium</i>, <i>Nocardia</i>, <i>Streptomyces</i>, <i>Thermomonospora</i>, <i>Propionibacterium</i> <i>Cyanobacteria</i>).</p>	
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Learning Outcomes:- The students are expected to Understand the bacterial diversity.

Books Recommended:

- 1. Salle A.J., Fundamental Principles of Bacteriology.
- 2. Pelczar M.J., Chan E.C.S. & Kreig N.R., Microbiology: Concepts and Application, Tata McGraw Hill.
- 3. Stainier RY, Ingraham JL, Wheelis ML & Painter PR General Microbiology. Publisher: MacMillan.
- 4. Madigan M.T., Martinko J.M. and Parker J., Brock Biology of Microorganisms: Prentice-Hall, Inc USA.
- 5. Atlas R.M., Principles of Microbiology, Wm C. Brown Publishers.
- 6. Vandenmark P.V. and Batzing B.L., The Microbes – An Introduction to their Nature and Importance



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FACULTY OF SCIENCES
DEPARTMENT OF LIFE SCIENCES

COURSE: M.Sc. SEMESTER: II

SUBJECT NAME: Microbial physiology and development

SUBJECT CODE: 5SC02MPD1

Teaching & Evaluation Scheme:-

Teaching hours/week				Credit	Evaluation Scheme/semester							
Th	Tu	Pr	Total		Theory				Practical		Total Marks	
					Sessional Exam		University Exam		Internal			University
					Marks	Hrs	Marks	Hrs	Pr	TW		
4	0	0	4	4	30	1	70	3	-	-	100	

Objectives:- The objective of this course is that the students can learn about basics of Microbial physiology and development.

Prerequisites:- Basic knowledge of microbial physiology and development.

Course outline:-

Sr. No.	Course Contents	Hours
1	Nutritional Categories of microorganisms based on carbon and energy sources, Metabolite Transport- Passive and facilitated, Primary and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron. Microbial Growth- Definition balanced and unbalanced growth, growth curve, the mathematics of growth, Generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxic growth curve..	
2	Brief account of photosynthetic and accessory pigments - chlorophyll, bacteriochlorophyll, rhodopsin, carotenoids, phycobiliproteins; Carbohydrates- anabolism. Autotrophy, oxygenic, anoxygenic photosynthesis –autotrophic generation of ATP; fixation of CO ₂ , Calvin cycle, C ₃ , C ₄ pathway. Chemolithotrophy, sulphur, iron, hydrogen, nitrogen oxidations, methanogenesis, luminescence	



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3	Respiratory metabolism, Embden-Mayer Hoff pathway, Entner Doudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, reverse TCA cycle, gluconeogenesis, Pasteur effect; Fermentation of carbohydrates, homo and heterolactic fermentations.	
4	Assimilation of nitrogen; Molecular biology of biological nitrogen fixation; nitrate and ammonia nitrogen, synthesis of major amino acids, polyamines; Synthesis of polysaccharides, peptidoglycan; Dormancy and germination; Microbial Differentiation, ; sporulation and morphogenesis, hyphae vs. yeast forms and their significance. Multicellular organization of selected microbes. Cell division cycle in <i>E.coli</i> and yeast, Developmental cycle in Myxomycetes.	

Learning Outcomes:- The students are expected to understand the Microbial physiology and development of micro organisms.

Books Recommended:

1. Doelle H.W. 1969. **Bacterial Metabolism. Academic Press.**
2. Gottschalk G. 1979. **Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.**
3. Sokatch JR. 1969. **Bacterial Physiology and Metabolism. Academic Press.**
4. Moat A G., Foster J W., Spector M P. **Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009**



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COURSE: M.Sc.

SEMESTER: II

SUBJECT NAME: Industrial microbiology

SUBJECT CODE:

5SC02IMB1

Teaching & Evaluation Scheme:-

Teaching hours/week				Credit	Evaluation Scheme/semester								
Th	Tu	Pr	Total		Theory				Practical				Total Marks
					Sessional Exam		University Exam		Internal		University		
					Marks	Hrs	Marks	Hrs	Pr	TW			
4	0	0	4	4	30	1	70	3	-	-		100	

Objectives:- The objective of this course is that the students can learn about basics of industrial microbiology.

Prerequisites:- Basic knowledge of industrial microbiology.

Course outline:-

Sr. No.	Course Contents	Hours
1	Introduction and scope of industrial microbiology; Biology of industrially important microbes (metabolic pathways and control mechanisms); Isolation and selection of industrially important microorganisms; Genetic improvement of microbes; Preservation and maintenance of microbial cultures.	
2	Microbial substrate- Media formulation, Optimization of media; Cell growth kinetics: Kinetics of substrate utilization, biomass production and product formation in batch, fed batch and continuous cultivations; Kinetics of death of microorganisms.	
3	Types of fermentation processes; Solid state, Static and submerged fermentations; Design of laboratory bioreactor; Types of Bioreactor: Stirred tank reactor, bubble column reactor, Airlift reactor, Packed bed reactor, Fluidized bed reactors; Scale-up principles; Instrumentation and control of bioprocesses; Downstream process; Fermentation economics.	



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4	Types of microbial products; Production of Biomass: Baker's Yeast, Mushroom, Single cell proteins, Biopesticides and biofertilizers; Production of primary metabolites: Ethanol; organic acids e.g. citric acid and lactic acid; Amino acids: Glutamate; Vitamins; Industrial enzymes. Production of secondary metabolites: Antibiotics (penicillin, cephalosporins, streptomycin, etc), Pigments, enzyme inhibitors; Microbial transformation, Production of metabolites of non-microbial origin eg Insulin, Interlukin, Cytokines etc using rDNA technology. Designer microbes using synthetic genome.	
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Learning Outcomes:- The students are expected to understand the industrial tools and related microbiology.

Books Recommended:

1. Stanbury P. F., A. Whitaker, S. J. Hall. Principles of Fermentation Technology
Publisher: Butterworth-Heinemann
2. Shuler M.L. and F. Kargi: Bioprocess Engineering Basic Concepts by Publisher
Prentice Hall.
3. Vogel H.C., C.L. Todaro, C.C. Todaro: Fermentation and Biochemical
Engineering Handbook: Principles, Process Design, and Equipment by Publisher:
Noyes Data Corporation/ Noyes Publications.
4. W. Crueger and A. Crueger: Biotechnology. A Textbook of Industrial Microbiology,
Publisher : Sinauer Associates.
5. Prescott and Dunn's Industrial Microbiology. Publisher: Gerald Reed: Books.
6. Casida L. E. J. R: Industrial Microbiology by Publisher: New Age (1968)



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FACULTY OF SCIENCES DEPARTMENT OF LIFE SCIENCES

COURSE: M.Sc.

SEMESTER: II

SUBJECT NAME: Microbial Energetics

SUBJECT CODE:

5SC02MIE1

Teaching & Evaluation Scheme:-

Teaching hours/week				Credit	Evaluation Scheme/semester								
Th	Tu	Pr	Total		Theory				Practical				Total Marks
					Sessional Exam		University Exam		Internal		University		
					Marks	Hrs	Marks	Hrs	Pr	TW			
4	0	0	4	4	30	1	70	3	-	-		100	

Objectives:- The objective of this course is that the students can learn about basics of microbial energetics.

Prerequisites:- Basic knowledge of microbial energetics.

Course outline:-

Sr. No.	Course Contents	Hours
1	Biomolecules, Transport and Trafficking – Plasma membrane: Electric properties of membrane, Multi drug resistant efflux forms, Amino acid transport. Mechanism of Vesicular Transport, Trafficking of molecules between nucleus and cytosol, Transport into mitochondria and chloroplast: energy transduction & transformation, ATP synthesis; endocytosis and exocytosis; Protein sorting.	
2	Metabolism of lipids: Lipid composition of microorganisms, biosynthesis and degradation of lipids, lipid accumulation in yeasts. Metabolism of nucleotides: Biosynthesis and regulation of purine and pyrimidine, inhibitors of nucleotide synthesis.	
3	Cell communication: Overview of electrical and chemical signaling, intracellular signaling - Types of receptors involved in cell signaling, various signal transduction pathways; Cell to cell signaling with emphasis on Quorum sensing: A and C signaling system.	
4	Physiological adaptations and Intercellular signaling: Introduction to two component system, regulatory systems during aerobic & anaerobic shifts: Arc, Fnr, Nar, FhlA regulon, response to phosphate supply: The Pho regulon, sporulation in <i>Bacillus subtilis</i> , control of competence in <i>Bacillus subtilis</i> , Heat-Shock responses.	

Learning Outcomes:- The students are expected to understand the Microbial energetics.

Books Recommended:

1. Biochemistry by Geoffrey L. Zubay. Fourth Edition, Addison-Wesley educational publishers Inc., 2008



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2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox. Fifth Edition, W.H. Freeman and Company; 2008.
3. Microbial lipids edited by C. Ratledge and SG Wilkinson, second edition, Academic Press; 1988.
4. Microbial Physiology by Albert G. Moat and John W. Foster. Fourth edition, John Wiley and Sons; 2002.



FACULTY OF SCIENCES
DEPARTMENT OF LIFE SCIENCES

COURSE: M.Sc.

SEMESTER: II

SUBJECT NAME: Microbiology lab-II
5SC02MBL1

SUBJECT CODE:

Teaching & Evaluation Scheme:-

Teaching hours/week				Credit	Evaluation Scheme/semester								
Th	Tu	Pr	Total		Theory				Practical				Total Marks
					Sessional Exam		University Exam		Internal		University		
				Marks	Hrs	Marks	Hrs	Pr	TW				
0	0	20	20	10	-	-	-	-	90	-	210	300	

Objectives:- The objective of this course is that the students can perform various practical's and learn the practical aspects of microbiology.

Prerequisites:- Basic knowledge of Microbiology.

Course outline:-

Experiment
<p>Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food). Staining of bacteria and actinomycetes, Use of selective media, Enrichment culture technique – isolation of asymbiotic nitrogen fixing bacteria; Isolation of symbiotic nitrogen fixing bacteria from nodules, Isolation of antibiotic producing microorganisms. Morphological, physiological and biochemical characterization of isolated bacterial cultures.</p> <p>Use of simple techniques in laboratory (Colorimetry, Centrifugation; Electrophoresis and GLC); Determination of viable and total number of cells, Measurement of cell size, Growth – types of growth (synchronous, diauxic, batch), study factors affecting growth, Sporulation and spore germination in bacteria; Induction and repression of enzymes; Study of bacterial growth under aerobic, micro, aerophilic and anaerobic conditions; Morphological, Physiological and Biochemical tests of selected bacterial cultures. Production of amino acids and vitamins by microorganisms.</p> <p>Isolation of industrially important microorganism from different sources using specific substrates; Design and Preparation of Media for Bioprocesses; Growth curve studies of bacteria/Yeasts in batch culture and calculation of maximum specific growth rate; To study the various methods of biomass measurement; Production of ethanol from sucrose by yeast; Determination of yield coefficient and Monod's constant and metabolic quotient of <i>E.coli</i> culture on glucose.; To study the design of fermenter and its working; Production of citric acid using sucrose and molasses; Production of extracellular enzymes ; Ethanol production using immobilized yeast culture.</p>

Learning Outcomes:- The students are expected to

- Learn various microbial techniques.
- Able to isolate and screen various types of microbes from different sources.
- Learn different types of instrumental handling



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COURSE: M.Sc.

SEMESTER: II

SUBJECT NAME: Microbiology Seminar

SUBJECT CODE:

5SC02MBL1

Teaching & Evaluation Scheme:-

Teaching hours/week				Credit	Evaluation Scheme/semester								
Th	Tu	Pr	Total		Theory				Practical				Total Marks
					Sessional Exam		University Exam		Internal		University		
				Marks	Hrs	Marks	Hrs	Pr	TW				
0	0	4	4	2	-	-	-	-	20	-	30	50	

Learning Outcomes:- The students are expected to developing communication skill.