GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

REVISED MINUTES

of the 9th Special Meeting of the

X ACADEMIC COUNCIL

Day & Date

Saturday, 30th July, 2022

Time

10.00 a.m.

Council Hall
Goa University

	Francophone Studies meeting held on 22.04.2022 with the suggestions to revise/change the Course Codes for the PG programme. The proposed syllabus/structure for Semester III and Semester IV was deferred by the house. **(Action: Assistant Registrar Academic – PG)**
D 3.22	**Minutes of the Board of Studies in Microbiology meeting held on 19.07.2022.** The Academic Council approved the minutes of the Board of Studies in Microbiology meeting held on 19.07.2022 with the following suggestion: 1. Optional Courses to be indicated separately for each semester. 2. The Course Codes for the PG Programme to be revised/changed. 3. The Chairperson, Board of Studies was requested to resubmit the syllabus incorporating the suggestions. The Vice-Chancellor was authorized to approve the same on behalf of the Academic Council. **(Action: Assistant Registrar Academic – PG)**
D 3.23	**Minutes of the Board of Studies in Electronics meeting held on 21.07.2022.** The Academic Council approved the minutes of the Board of Studies in Electronics meeting held on 21.07.2022 with the suggestion to revise/change the Course Codes for the PG Programme. However, B. Voc. in Electronics, Instrumentation and Computer Networking Course structure and the proposed syllabus/structure for Semester III and Semester IV was deferred by the house. **(Action: Assistant Registrar Academic – PG)**
D 3.24	**Minutes of the Board of Studies in Portuguese meeting held on 01.07.2022 and 22.07.2022.** The Academic Council partly approved the minutes of the Board of Studies in Portuguese meeting held on 21.07.2022 with the following suggestions: 1. Part A of the minutes was deferred. 2. It was informed that the Board of Studies should work within the framework of Goa University Statutes and Ordinances and should not make proposals that do not fall within its ambit. Thus the irrelevant recommendations to be expunged by the Board from its minutes. 3. RSOC semester IV total credits to be corrected. 4. The Chairperson, Board of Studies was requested to resubmit the syllabus incorporating the suggestions. The Vice-Chancellor was authorized to approve the Syllabus on behalf of the Academic Council. The proposed syllabus/structure for Semester III and Semester IV was deferred by the House.

X AC- 9 (Special)
30.07.2022

GOA UNIVERSITY
Taleigao Plateau, Goa 403 206

F I N A L U P D A T E D A G E N D A

For the 9th Special Meeting of the

X ACADEMIC COUNCIL

Day & Date

30th July, 2022

Time

10.00 a.m.

Venue
Conference Hall
Administration Block

	Part C i) Recommendation regarding preparation and publication of selection of reading material in any subject or group of subjects and name of persons recommended for appointment to make the selection. NIL **Part D** i) Recommendation regarding general academic requirements in the Departments of University or affiliated colleges: NIL **Part E** i) **Recommendations of text books for the courses of study at undergraduate level:**NIL ii) **Recommendations of text books for the courses of study at postgraduate level:** As mentioned in the syllabus **Part F** **Important points for consideration/ approval of Academic Council:** Date: 25.04.2022 Sd/- Signature of the Chairperson Part G: Remarks of the Dean, Shenoi Goembab School of Languages and Literature: i) The minutes are in order. ii) The minutes may be placed before the Academic Council. iii) May be recommended for approval by the Academic Council. Date: 20.07.2022 Sd/- Signature Dean, Shenoi Goembab School of Languages and Literature **(Back to Index)**
D 3.22	**Minutes of the Board of Studies in Microbiology meeting held on 19.07.2022.** **Part A** i) Recommendations regarding courses of study in the subject or group of subjects at the under-graduate level. : NA ii) Recommendations regarding courses of study in the subject or group of subjects at the Post-graduate level. **1. Course structure of M.Sc. Microbiology Part 1 for Semester I and Semester II as per 80 credits - Annexure I (refer page no.739)** **2. Course content of M.Sc. Microbiology Part 1 for Semester I and Semester II as per 80 credits - Annexure II (refer page no. 741)** **Part B** i) Scheme of examinations at under-graduate level. **NA** ii) Panel of examiners for different examinations at the under-graduate level. **NA** iii) Scheme of examinations at the post-graduate level. **NA** iv) Panel of Examiners for different examinations at post-graduate level.

Agenda "Board of Examiners for SEA papers (Theory) for Semester 1 M.Sc. Part1 Microbiology" was differed. This agenda will be taken after the start of the Semester I of M.Sc. Part 1 Microbiology.

Part C

i) Recommendations regarding preparation and publication of selection of reading material in the subject or group of subject or group of subjects and names of persons recommended for appointment to make the selection: **NA**

Part D

i) Recommendations regarding general academic requirements in the Departments of University or affiliated colleges. **NA**

ii) Recommendations of the Academic Audit Committee and status thereof: **NA**

Part E

i) Recommendations of the text books for the courses of study at the undergraduate level: **NA**

ii) Recommendations of text books for the courses of study at the post-graduate level: **Recommended text books and reading materials are listed along with the course content of M.Sc. Microbiology Part 1 for Semester I and Semester II as per 80 credits**

Part F

Important points for consideration/approval of Academic Council:

i) The important points/recommendations of BOS that require consideration/ approval of Academic Council (points to be highlighted) are mentioned below:

(a). Course structure of M.Sc. Microbiology Part 1 for Semester I and Semester II as per 80 credits - Annexure I
(b). Course content of M.Sc. Microbiology Part 1 for Semester I and Semester II as per 80 credits - Annexure II
(c). Text books and reading material as listed along with the course content of M.Sc. Microbiology Part 1 for Semester I and Semester II as per 80 credits - Annexure II

ii) The declaration by the Chairman, that the minutes were read out by the Chairman at the meeting itself.

Date: 19.07.2022 Sd/-
Place: Microbiology Classroom 1, Science Block E, SBSB Signature of the Chairperson

Part G The remarks of the Dean of the faculty

i) The minutes are in order.
ii) The minutes may be placed before the Academic Council with remarks if any.
iii) May be recommended for approval of Academic Council.
iv) Special remarks if any.

Date : 21.07.2022 Sd/-

Dean,School of Biological Sciences and Biotechnology

Place: Office of Dean,
School of Biological Sciences and Biotechnology

(Back to Index)

D 3.23

Minutes of the Board of Studies in Electronics meeting held on 21.07.2022.

Part A

i) Recommendations regarding courses of study in the subject or group of subjects at the undergraduate level:

B.Voc in Electronics, Instrumentation and Computer Networking

ii) Recommendations regarding courses or group of subjects at postgraduate level:

Semester I & II Syllabus as per NEP 2020

Part B

i) Scheme of the Examinations at Undergraduate Level: NA
ii) Panel of examiners for different examinations at Undergraduate Level: NA
iii) Scheme of the examinations at post-graduate level: NA
iv) Panel of examiners for different examinations at post-graduate Level: NA

Part C

i) Recommendations regarding preparation and publication and selection of Anthologies in any subject or group of subjects and the names of person recommended for appointment to make the selection : NA

Part D

i) Recommendations regarding general academic requirements in the Departments of University or affiliated colleges: NA
ii) Recommendation of Academic Audit Committee and status thereof: NA

Part E

i) Recommendations of text books for the course for study at the Undergraduate level: NA
ii) Recommendations of text books for the courses of study at the post Graduate level:
List of books required is indicated below each subject in the syllabus.

Part F

Important points for consideration/approval of Academic Council

i) The Important points/recommended of BOS that require consideration/approval of **Academic council (points to be highlighted) as mentioned below.**

- **Approval of M.Sc. Electronics syllabus Semester I and II as per NEP 2020 Annexure I (refer page no. 774)**
- **Approval of B.Voc. in Electronics, Instrumentation and Computer Networking Syllabus Annexure II (refer page no. 794) and Annexure III (refer page no. 800)**

ii) The declaration by the Chairman, that the minutes were read out by the Chairman at the meeting itself.

Sd/-
Signature of Chairman

D 3.22 Minutes of the Board of Studies in Microbiology meeting held on 19.07.2022.

Annexure I

Course structure of M.Sc. Microbiology Part 1 for Semester I and Semester II as per 80 credits

M.Sc. Microbiology - Course structure

M.Sc. MICROBIOLOGY Part 1 (Semester I and Semester II)

COURSE STRUCTURE

CORE COURSES

CODE	COURSE	CREDIT(S) Theory	Practical	Contact Hours
	Semester I			
MIC 101	Microbial Biochemistry [T]	3	-	45
MIC 102	Microbial Biochemistry [P]	-	1	30
MIC 103	Microbial Genetics [T]	3	-	45
MIC 104	Microbial Genetics [P]	-	1	30
MIC 105	Techniques and Instrumentation in Microbiology [T]	3	-	45
MIC 106	Techniques and Instrumentation in Microbiology [P]	-	1	30
MIC 107	Biostatistics [T]	3	-	45
MIC 108	Biostatistics [P]	-	1	30
	Semester II			
MIC 201	Microbial Taxonomy and Systematics [T]	3	-	45
MIC 202	Microbial Taxonomy and Systematics [P]	-	1	30
MIC 203	Industrial Microbiology [T]	3	-	45
MIC 204	Industrial Microbiology [P]	-	1	30
MIC 205	Molecular Biology [T]	3	-	45
MIC 206	Molecular Biology [P]	-	1	30
MIC 207	Archaea – Ecology, Physiology, Biochemistry, and Genetics [T]	3	-	45
MIC 208	Archaea – Ecology, Physiology, Biochemistry, and Genetics [P]	-	1	30

Discipline Specific Optional Courses (Semester I and Semester II)

CODE	COURSE	CREDIT(S)		Contact Hours
		Theory	Practical	
MIO 101	Environmental Microbiology and Bioremediation [T]	3	-	45
MIO 102	Environmental Microbiology and Bioremediation [P]	-	1	30
MIO 103	Immunology [T]	3	-	45
MIO 104	Immunology [P]	-	1	30
MIO 105	Agriculture Microbiology [T]	3	-	45
MIO 106	Agriculture Microbiology [P]	-	1	30
MIO107	Mycology [T]	3	-	45
MIO108	Mycology [P]	-	1	30

Under Discipline specific Optional Courses theory course is a prerequisite for respective practical course.

(Back to Index) (Back to Agenda)

Annexure II

Course content of M.Sc. Microbiology Part 1 for Semester I and Semester II as per 80 credits Course content

M.Sc. MICROBIOLOGY Part 1 (Semester I and Semester II)

CORE COURSES

CODE	COURSE	CREDIT(S) Theory	Practical	Contact Hours
	Semester I			
MIC 101	Microbial Biochemistry [T]	3	-	45
MIC 102	Microbial Biochemistry [P]	-	1	30
MIC 103	Microbial Genetics [T]	3	-	45
MIC 104	Microbial Genetics [P]	-	1	30
MIC 105	Techniques and Instrumentation in Microbiology [T]	3	-	45
MIC 106	Techniques and Instrumentation in Microbiology [P]	-	1	30
MIC 107	Biostatistics [T]	3	-	45
MIC 108	Biostatistics [P]	-	1	30
	Semester II			
MIC 201	Microbial Taxonomy and Systematics [T]	3	-	45
MIC 202	Microbial Taxonomy and Systematics [P]	-	1	30
MIC 203	Industrial Microbiology [T]	3	-	45
MIC 204	Industrial Microbiology [P]	-	1	30
MIC 205	Molecular Biology [T]	3	-	45
MIC 206	Molecular Biology [P]	-	1	30
MIC 207	Archaea – Ecology, Physiology, Biochemistry, and Genetics [T]	3	-	45
MIC 208	Archaea – Ecology, Physiology, Biochemistry, and Genetics [P]	-	1	30

Discipline Specific Optional Courses (Semester I and Semester II)

CODE	COURSE	CREDIT(S) Theory	Practical	Contact Hours
MIO 101	Environmental Microbiology and Bioremediation [T]	3	-	45
MIO 102	Environmental Microbiology and Bioremediation [P]	-	1	30
MIO 103	Immunology [T]	3	-	45
MIO 104	Immunology [P]	-	1	30
MIO 105	Agriculture Microbiology [T]	3	-	45
MIO 106	Agriculture Microbiology [P]	-	1	30
MIO107	Mycology [T]	3	-	45
MIO108	Mycology [P]	-	1	30

Under Discipline specific Optional Courses theory course is a prerequisite for respective practical course.

(Back to Index) (Back to Agenda)

CORE PAPERS

MIC 101 MICROBIAL BIOCHEMISTRY [T]
Theory Course Credit : 3
Contact Hours : 45

Prerequisites	The student should be familiar with the different biomolecules and their metabolism.	
Objective:	This course deals with the characteristics, properties and biological significance of the biomolecules of life. In depth knowledge of the energetics and regulation of different metabolic processes in microorganisms.	
Content:		
1.	**Biological Molecules**	**(15)**
1.1	**Protein**	
A.	Amino acids: features and properties.	
B.	Protein: structure, principles of separation and purification, molecular weight determination; sequencing and chemical synthesis.	
C.	Enzymes: activity, inhibition, mechanism of action; regulatory – allosteric and covalently modulated enzymes and their significance in metabolism.	
1.2	**Carbohydrate**	
A.	Monosaccharides: types, characteristics and properties.	
B.	Disaccharides, oligosaccharides, polysaccharides – biological significance.	
1.3	**Lipid**	
A.	Fatty acids: saturated and unsaturated, structure and properties.	
B.	Lipids: classification, structure (phospholipids, sphingolipids), properties; biological significance; lipid composition of microorganisms.	
2.	**Bioenergetics and Carbohydrate Metabolism**	**(15)**
2.2	**Bioenergetics**	
	Thermodynamics, exergonic and endergonic reactions, redox potential, high energy compounds, ATP structure and significance.	
2.3	**Oxidative Phosphorylation**	
	Redox enzymes, aerobic electron transport and oxidative phosphorylation, Proton Motive Force	
2.1	**Carbohydrate metabolism**	
A.	Carbohydrates: Central pathways of metabolism – regulatory mechanisms, bioenergetics and significance – EMP, TCA cycle (glucose aerobic and anaerobic metabolism, malate metabolism), Homolactic and Heterolactic acids pathway, Glyoxylate cycle. Utilization of sugars such as lactose, galactose, maltose and of polysaccharides such as starch, glycogen, cellulose, pectin.	
B.	Gluconeogenesis from TCA intermediates / amino acids / acetyl-CoA; biosynthesis of polysaccharides (Peptidoglycan, starch and glycogen) and sugar inter-conversions.	

3.	**Lipids, Amino Acids, Nucleotides and other Metabolic Paths**	**(15)**
3.1	**Lipid Metabolism**	
A.	Catabolism: Oxidation of fatty acids and the bioenergetics involved.	
B.	Anabolism: Biosynthesis of fatty acids: saturated and unsaturated, triglycerides, phospholipids, sterol.	
3.2	**Amino Acid and Nucleotide Biosynthesis**	
A.	Amino acid biosynthetic pathways and their regulation.	
B.	Purine and pyrimidine nucleotides, Deoxyribo nucleotides: biosynthesis and regulation.	
C.	Biosynthesis of nucleotide coenzymes.	
3.3	**Photosynthetic Metabolism**	
A.	Microorganisms and photosynthetic pigments, fundamental processes in Photosynthesis.	
B.	Photosynthetic electron transport; Oxygenic and anoxygenic Photosynthesis; photophosphorylation.	
3.4	**Bioenergetics of Chemolithotrophic microorganisms**	
3.5	**Antimetabolites of Microbial Origin**	
	Structure, biosynthesis, types and mechanism of action	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Lehninger, A., Cox, M. and Nelson, D. L., Principles of Biochemistry, W. H. Freeman & Company.	
(Latest Edition)	Moat, A. G., Foster, J. W. and Spector, M. P., Microbial Physiology, A. John Wiley & Sons Inc. Publication.	
	Bull, A. T. and Meadow, P., Companion to Microbiology, Longman Group Limited, New York.	
	Voet, D., Voet, J. G. and Pratt, C. W., Principles of Biochemistry, John Wiley and Sons Inc.	
	Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., Rodwell, V. W. and Weil, P. A., Harper's Illustrated Biochemistry, The McGraw-Hill Companies, Inc.	
	Plummer, D. T., An Introduction to Practical Biochemistry, Tata McGraw Hill Publishing Company.	
	Sadasivam, S., Manickam, A., Biochemical Methods, New Age International (P) Limited.	
	Jayaraman, J., Laboratory Manual in Biochemistry, John Wiley & Sons, Limited, Australia.	
	Berg, J.M., Tymoczko, J.L., Gatto, G.J. and Stryer, L. Biochemistry. W. H. Freeman & Company.	
Learning Outcomes	1. Apply the knowledge to understand the microbial physiology. 2. Understand the regulation of the biochemical pathway and possible process modifications for improved control over microorganisms for microbial product synthesis.	

(Back to Index) (Back to Agenda)

MIC 102 MICROBIAL BIOCHEMISTRY [P]
Practical Course Credit : 1
Contact Hours : 30

Prerequisites	The student should be familiar with the different biomolecules and their metabolism.	
Objective:	This course deals with the characteristics, properties and biological significance of the biomolecules of life. In depth knowledge of the energetics and regulation of different metabolic processes in microorganisms.	
Content:		**(30)**
1.	Standard curve for reducing sugar, total sugar and polysaccharide (starch).	
2.	Standard curve for protein (Folin Ciocalteau method).	
3.	Enzyme assay (Amylase), determination of *Km* and *Vmax*.	
4.	Precipitation of protein from solution by salting out and dialysis	
5.	Size exclusion (Gel filtration) chromatography.	
6.	Specific activity, fold purification, percentage yield of enzyme.	
7.	Molecular weight determination by SDS-PAGE.	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIC 101	
Learning Outcomes	Apply the knowledge for the estimation of various bio-macromolecules. Understand the handling of metabolites of microbial origin.	

MIC 103 MICROBIAL GENETICS [T]
Theory Course Credit : 3
Contact Hours : 45

Prerequisites	It is assumed that students have basic knowledge of Mendelian genetics, structure of DNA and RNA, Prokaryotic and eukaryotic genome organisation, mutation concept, basic knowledge about replication, transcription.	
Objective:	This course develops concept of Classical Mendelian genetics and deviation from Mendelian principles, Microbial genome organization (Prokaryotic and Eukaryotic), Viral Genetics, Mutagenesis and Bacterial plasmids. Understanding the concepts of replication, transcription and their regulation in prokaryotes and microbial eukaryotes.	
Content:		
1.	**Microbial genome organization, gene regulation and genetic transfer**	**(15)**
1.1	Classical Mendelian genetics; deviation from Mendelian principles; Origin of mitochondria and plastids – Endosymbiotic theory, DNA in Mitochondria and plastids, Mitochondrial and plastid genes inherited	

	by Non-Mendelian mechanism; Introduction to epigenetic inheritance.	
1.2	Prokaryotic & Eukaryotic genome size & structure, exceptions in prokaryotic genome (linear chromosome in *Borrelia burgdorferi*); Introduction to synthetic genome (*Mycoplasma genitalium*), pseudogenes and their significance, C-value paradox, polyploidy in prokaryotes. Prokaryotic and Eukaryotic replication, transcription and regulation. Structure of Prokaryotic genes (lac and trp operon) and Eukaryotic Genes (interrupted Genes, intron splicing mechanisms). Microbial gene transfer (Conjugation, transformation, transduction).	
1.3	Genomic organization, replication and regulation of Lytic and Lysogenic Phages - T4 and Lambda Phage	
2.	**Genomic Rearrangements and Mutagenesis**	**(15)**
2.1	Mechanism of General and programmed DNA rearrangements, Antigenic and phase variation in bacteria. Transposons: IS elements – Composite transposons (Tn3, Tn10), Ty, Copia and P type, Mechanism of transposition. Role of transposons in DNA rearrangements, microbial genome evolution and drug resistance. Deletion, duplication, inversion, translocation. Integrons and Genomic islands - pathogenicity islands.	
2.2	**Mutagenesis, mutation and mutants**: Somatic and germinal mutation, spontaneous and induced mutations, site directed mutagenesis using PCR and cassette mutagenesis, and random mutagenesis. Tautomeric shift, transition, transversion; Concept of clustered regularly interspaced short palindromic repeats (CRISPR) - Cas9. **DNA Damage:** Thymine dimer, apyrimidinic site and apurinic site, cross linking, deamination of base, base mismatch. **Types of mutations:** silent mutation, missense mutation, nonsense mutation, Read through mutation, frameshift- insertion and deletion mutation, suppressor mutation, leaky mutation. **Mutagenic chemicals and radiations and their mechanism of action**: Base analogues (5-Bromouracil and 2-amino purines), alkylating agents (EMS, NTG), Intercalating agents (acridines, Acriflavins), Hydroxylamine; mutagenic radiations- UV, X-rays and gamma rays. Ames test; Auxotrophy. Importance of mutations.	
3.	**Fungal Genetics**: Yeast - *Saccharomyces cerevisiae/ Schizosaccharomyces pombe* and *Neurospora* genomes as model genetic systems; Chromosome replication, 2µ plasmid, Yeast Artificial Chromosomes (YAC), tetrad analysis, genetic compatibility and non-compatibility genes, heterokaryosis, Parasexuality, Petite mutants of yeast, Killer yeast.	**(07)**
4.	**Bacterial plasmids**: Types of plasmids, F plasmids and their use in genetic analysis-F^+/Hfr cells/ F'cells, Col plasmids, R plasmids- plasmids with genes encoding metal resistance and antibiotic resistance - efflux pump/MDR bacteria, degradative plasmids, Ti plasmid. Replication in plasmids. Concept of copy number (Col Plasmid) and compatibility; Bacterial plasmids as research tools.	**(08)**

Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Gardner, E. J., Simmons, M. J. and Snustad, D. P., Principles of Genetics, John Wiley & Sons.	
(Latest Editions)	Krebs J. E., Lewin B., Goldstein E. S. and Kilpatrick, S.T., LEWIS Genes XI, Jones and Bartlett Publishers.	
	Maloy, S. R., Cronan, J. E. and Freifelder, D., Microbial Genetics, Jones and Bartlett Publishers.	
	Streips, U. N. and Yasbin, R. E., Modern Microbial Genetics, John Wiley.	
	Synder, L., Peters, J. E., Henkin, T. M. and Champness, W., Molecular Genetics of Bacteria, ASM Press.	
	Dale, J. W. and Park, S. F., Molecular Genetics of Bacteria, John Wiley	
	Trun, N. and Trempy, J., Fundamental Bacterial Genetics, John Wiley & Sons.	
	Peter, J. R., *i*Genetics: A Molecular Approach, Pearson Education.	
	Freifelder, D. Molecular biology, a comprehensive introduction to prokaryotes and eukaryotes. JANE'S PUBLISHING INC., BOSTON, MA(USA).	
	Sambrook, J., Fritsch, E. F. and Maniatis, T., Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory, New York.	
	Green, M. R. and Sambrook, J., Molecular Cloning: A laboratory manual, Cold Spring Harbour Laboratory Press, New York.	
	Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell, Garland Science.	
	Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., Losick, R. Molecular Biology of the Gene, Pearson/Benjamin Cummings	
	Birnboim, H. C. and Doly, J., (1979) A rapid alkaline extraction procedure for screening recombinant plasmid DNA. Nucleic Acid Research, 7: 1513-1523.	
	Holmes, D. S.andQuigley, M., (1981) A rapid boiling method for the preparation of bacterial plasmids. Anal Biochem., 114(1): 193-197.	
Learning Outcomes	1) Explains principles/concept of prokaryotic and eukaryotic genetics, viral genetics and their application. 2) Learn Mutagenesis, mutation and mutants and their significance in evolution. 3) Understanding the concepts of bacterial and eukaryotic plasmids.	

(Back to Index) (Back to Agenda)

Practical Course Credit : 1
Contact Hours : 30

Prerequisites	Students should have basic knowledge of DNA and RNA structure and Prokaryotic and eukaryotic genome.	
Objective:	To learn the basic principles and techniques of microbial genetics.	
Content:		**(30)**
1.	Isolation of genomic DNA from bacteria.	
2.	Isolation of plasmid DNA from bacterial cells by Alkaline Lysis method.	
3.	Spectrophotometric quantification and determination of purity of bacterial plasmid and genomic DNA.	
4.	Agarose gel electrophoresis, visualization and documentation of plasmid and genomic DNA using Gel Doc system.	
5.	UV mutagenesis and screening of pigment deficient mutants of *Serratia marcescens*.	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIC 103	
Learning Outcomes	1. Understanding the principles and concept of Prokaryotic DNA isolation and purification. 2. Exposure to the basic techniques of Mutagenesis.	

MIC 105 TECHNIQUES AND INSTRUMENTATION IN MICROBIOLOGY [T]

Theory Course Credit : 3
Contact Hours : 45

Prerequisites	The student should be familiar with the concepts in chemistry and Microbiology.	
Objective:	This course develops the concepts of methodology and instruments involved in studying the different components of microbial cells and their products.	
Content:		
1.		**(15)**
1.1	**Chromatographic techniques:**	
	Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), detectors, column/s matrix- Ion-exchange, affinity and molecular exclusion. (using examples for separation of microbial lipids, fatty acids, pigments, nucleic acids and proteins/enzymes).	
1.2	**Centrifugation:**	
	Principles, methodology, application, types: low speed, high speed and Ultracentrifugation (preparative and analytical) Density gradient centrifugation; Differential centrifugation	
1.3	**Spectroscopy:**	

	Atomic Absorption Spectrophotometry (AAS), UV-Visible, fluorimetry, Fourier transformation infra-red spectroscopy (FTIR), NMR, MS:MALDI-TOF.	
2.		**(15)**
2.1	**Microscopy:**	
	Phase Contrast, Epifluorescence filter technique (DEFT), SEM, TEM, Confocal and AFM.	
2.2	**Radio-isotope and tracer techniques:**	
	Isotope and types of isotopes, Radio-activity counters, Autoradiography, Radiorespirometry.	
2.3	**Cell and tissue culture techniques:**	
	Biohazards and Biosafety cabinet; Primary and secondary/established cell lines, Monolayer and suspension cultures, Fluorescence activated cell sorting (FACS).	
3.		**(15)**
3.1	**Electrophoretic technique:**	
	PAGE, IEF, Agarose gel electrophoresis, PFGE, DGGE, TGGE, Capillary electrophoresis, Single stranded conformation polymorphism (SSCP), Electroporator, Micro-array technique.	
3.2	**Isolation of cell organelles:**	
	Different methods of cell lysis/ breakage and isolation and purification of various cell organelles - Cell surface structures, cell envelopes, plasma membranes, peptidoglycan, Outer membrane, ribosomes, protoplasts, vesicles, spheroplast, DNA, RNA. Separation of ribosomal subunits of bacteria	
3.3	**Other Bio-Instrumentation Techniques:**	
	X-ray diffraction, Oxygen analyser, Biosensors.	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Wilson, K. and Walker, J., Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, N.Y., USA.	
(Latest Edition)	Goswami, C., Paintal, A. and Narain, R., Handbook of Bioinstrumentation, Wisdom Press, New Delhi.	
	Cooper, T. G., The Tools of Biochemistry, Wiley India Pvt. Ltd.	
	Norris, J. R. and Ribbons, D. W., Methods in Microbiology, Volume 5, Part B, Academic Press.	
	Colowick, S. P. and Kaplan, N. O., Methods in Enzymology, Vol. VI, Academic Press, N.Y.	
	Parakhia, M. V., Tomar, R. S., Patel, S. and Golakiya, B. A., Molecular Biology and Biotechnology: Microbial Methods, New India, Pitampura.	
	Sambrook, J., Fritsch, E. F. and Maniatis, T., Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory Press, USA.	
	Jayaraman, J., Laboratory Manual in Biochemistry, John Wiley & Sons Limited, Australia.	
	Arora MP.Biophysics, Himalaya Publishing House, New Delhi	
	Bajpai P.K. Biological Instrumentation & methodology, 2nd revised edition, S.Chand and Co.	

	Mahesh S. Biotechnology-3. Including Molecular Biology and Biophysics, New Age International Pvt. Ltd Publishers, New Delhi	
Learning Outcomes	Understand the use of various techniques and instruments involved in the study of microorganisms and their products.	

MIC 106 TECHNIQUES AND INSTRUMENTATION IN MICROBIOLOGY [P]
Practical Course Credit : 1
Contact Hours : 30

Prerequisites	The student should be familiar with the concepts of biochemistry and Microbiology.	
Objective:	This course develops the concepts of various techniques, methodology and instruments involved in studying the microbial cells and their products.	
Content:		**(30)**
1.	Analysis of the microbial cell structure using Phase contrast Microscopy.	
2.	Counting of bacterial cells using epifluorescence microscopy.	
3.	Cell disruption by sonicator and efficacy of sonication.	
4.	Density gradient separation of microbial cells.	
5.	Extraction of microbial pigments and profiling using UV-Vis spectroscopy.	
6.	Silica gel based adsorption chromatography for separation of pigments	
7.	Native Polyacrylamide gel electrophoresis (PAGE) for protein separation and Zymogram (Amylase or Protease).	
8	Demonstration of HPLC, FT-IR, GC and spectral analysis.	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIC 105	
Learning Outcomes	To use various instruments for analysis of microbial cell and products. Develop and apply various methods for the processing of microbial cells and their products.	

(Back to Index) (Back to Agenda)

MIC 107 BIOSTATISTICS [T]
Theory Course Credit : 3
Contact Hours : 45

Prerequisites	Basic ability to handle numbers and calculation.	
Objective:	The paper develops concepts about types of data observed in biological experiments, its handling and processing. It develops concepts of hypothesis and formulation of experiments. It gives understanding of various statistical operations needed to carryout and process the biological data.	
Content:		

1.		**(15)**
1.1	**Characteristics of biological data:** Variables and constants, discrete and continuous variables, relationship and prediction, variables in biology (measurement, ranked, attributes), derived variables (ratio, index, rates), types of measurements of biological data (interval scale, ratio scale, ordinal scale, nominal scale, discrete and continuous data).	
1.2	**Elementary theory of errors:** exact and approximate numbers, source and classification of errors, decimal notation and rounding off numbers, absolute and relative errors, valid significant digits, relationship between number of valid digit and error, the error of sum, difference, product, quotient, power and root, rules of calculating digits.	
1.3	**Data handling:** Population and samples, random samples, parameter and statistics, accuracy and precision, accuracy in observations Tabulation and frequency distribution, relative frequency distribution, cumulative frequency distribution. **Graphical representation:** types of graphs, preparation and their applications.	
2.		**(15)**
2.1	**Measures of central tendency:** characteristics of ideal measure, Arithmetic mean – simple, weighted, combined, and corrected mean, limitations of arithmetic mean; Median – calculation for raw data, for grouped data, for continuous series, limitations of median; Mode – computation of mode for individual series, by grouping method, in a continuous frequency distribution, limitations of modes; Relationship between mean, median and mode; mid-range, geometric mean,harmonic mean, partition value, quartiles, deciles, percentiles.	
2.2	**Measure of dispersion:** variability, Range, mean deviation, coefficient of mean deviation, standard deviation (individual observations, grouped data, continuous series), variance, coefficient of variance, limitation. Skewness – definition, positive, negative, purpose, measure, relative measure, Karl Pearson's Coefficient, Bowley's Coefficient, Kelly's Measure, Moments.	
2.3	**Correlation analysis** – Correlation, covariance, correlation coefficient for ungrouped data, Pearson's Rank Correlation coefficient, scatter and dot diagram (graphical method). **Regression analysis -** Linear and exponential function **-** DNSA conversion by reducing sugar, survival/growth of bacteria, regression coefficients, properties, standard error of estimates, prediction, regression analysis for linearequation.	
3.		**(15)**
3.1	Probability: Probability, Combinatorial Techniques, Elementary Genetics, Conditional Probability, Bayes' Rule, Statistical Independence, Binomial, Poisson, Normal Distributions.	
3.2	Hypothesis Testing – parameter and statistics, sampling theory, sampling and non-sampling error, estimation theory, confidence limits testing of hypothesis, test of significance; Students' T-test, t-distribution, computation,paired t-test.	
3.3	Chi-square test, F-test and ANOVA.	

Pedagogy:	Lectures/tutorials/assignments/self-study/MOODLE/Videos	
References/ Readings	Kothari, C. R., Quantitative Techniques, Vikas Publishing House.	
(Latest editions)	Arora, P. N. and Malhan, P. K., Biostatistics, Himalaya Publishing House.	
	Danilina, N.I., Computational Mathematics, Mir Publishers.	
	Surya, R. K., Biostatistics, Himalaya Publishing House.	
	Cochran, WG and Snedecor, GW Statistical Methods. Iowa State University Press.	
Learning outcomes	Able to collect, handle, process, present and analyse the biological data. Apply the principles of statistics to biological experiments.	

(Back to Index) (Back to Agenda)

MIC 108 BIOSTATISTICS [P]
Practical Course Credit: 1
Contact Hours : 30

Prerequisites	Basic ability to handle numbers and calculation.	
Objective:	The paper develops concepts about types of data observed in biological experiments, its handling and processing. It develops concepts of hypothesis and formulation of experiments. It gives understanding of various statistical operations needed to process the biological data.	
Content:		**(30)**
1.	Excel spreadsheet and data analysis	
2.	Linear equation analysis (regression analysis).	
3.	Normal distribution.	
4.	Hypothesis testing (T Test, Z test)	
5.	Application of other software (graphpad / systat) for statistical analysis	
Pedagogy:	Experiments in the laboratory, data collection and processing.	
References/ Readings	As given under respective Theory Course MIC 107	
Learning outcomes	Able to collect, handle, process and present the microbiology-related data. Apply the principles of statistics to biological experiments.	

MIC 201 MICROBIAL TAXONOMY AND SYSTEMATICS [T]
Theory Course Credit : 3
Contact Hours : 45

Prerequisites	It is assumed that students should have a basic understanding of binomial nomenclature, the basis of classification systems and be familiar with the distinguishing features of different groups of microorganisms.	
Objective:	To introduce the concepts, tools and techniques of taxonomy and systematics of the microbial world.	

	To introduce the salient features of various microbial groups and their underlying diversity.	
Content:		
1.		**(30)**
1.1	**Microbial taxonomy and systematics** Concepts of taxonomy (characterization, classification and nomenclature) and systematics; binomial classification and taxonomic hierarchy of microorganisms, three domain, six-kingdom, 8-kingdom systems, Endosymbiotic theory.	
1.2	**Phenotypic characters** - Morphology, Biochemical tests (e.g. API, BIOLOG), Bacteriophage typing, Serotyping.	
1.3	**Chemotaxonomic markers** - Cell wall components, lipid composition, cellular fatty acid (FAME analysis), isoprenoid quinones, protein profiles (e.g. MALDI-TOF), cytochrome composition, polyamines.	
1.4	**Nucleic acid based techniques** – T-RFLP, G+C content (T_m and HPLC); 16S rRNA / 18S rRNA / ITS gene sequencing; phylogenetic analysis; DNA-DNA hybridization; DNA barcoding.	
1.5	Concepts of species, numerical taxonomy and polyphasic taxonomy.	
2.	Salient features of phylum, class and orders with representative examples of the following – Archaea, Eubacteria (bacteria, cyanobacteria, actinomycetes), Mycota, Protista (algae, protozoa, diatoms); and viruses.	**(15)**
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Sneath, A. H. P., Mair, S. N. and Sharpe, E. M., Bergey's Manual of Systematic Bacteriology Vol. 2. Williams & Wilkins Bacteriology Symposium, Series No 2, Academic Press, London/New York.	
	Goodfellow, M., Mordarski, M. and Williams, S. T., The biology of the actinomycetes, Academic Press.	
	Goodfellow, M. and Minnikin, D. E., Chemical Methods in Bacterial Systematics, The Society for Applied Bacteriology. Technical Series No. 20, Academic Press.	
	Barlow, A., The prokaryotes: A Handbook on the Biology of Bacteria: Ecophysiology, Isolation, Identification, Applications, Volume 1, Springer-Verlag.	
	Kurtzman, C. P., Fell, J. W. and Boekhout, T., The Yeasts - A Taxonomic Study, Elsevier.	
	Prescott, L. M., Harley, J. P. and Klein, D.A., Microbiology. McGraw Hill, New York.	
	Norris, J. R. and Ribbons, D. W., Methods in Microbiology, Vol. 18 & 19, Academic Press.	
	Reddy, C. A., Methods for General and Molecular Microbiology, ASM Press.	
Learning Outcomes	1. Apply knowledge of the standard rules of classification systems to categorize microorganisms. 2. Appreciate and explain the dynamic and ever developing nature of	

	the field of microbial taxonomy and systematics.	

MIC 202 MICROBIAL TAXONOMY AND SYSTEMATICS [P]
Practical Course Credit : 1
Contact Hours : 30

Prerequisites	It is assumed that students should have a basic understanding of binomial nomenclature, the basis of classification systems and be familiar with the distinguishing features of different groups of microorganisms.	
Objective:	To understand the tools and techniques of taxonomy and systematics of the microbial world.	
Content:		**(30)**
1.	Morphological, physiological and biochemical characterization of bacteria.	
2.	Chemotaxonomic analysis of cell wall amino acids.	
3.	Characterization of actinomycetes (*Streptomyces* sp.).	
4.	Characterization of yeast (*Saccharomyces cerevisiae*, *Schizosaccharomyces pombe*).	
5.	Characterization of cyanobacteria.	
6.	Phylogenetic analysis of bacterial 16S rRNA sequences – retrieval of sequences from standard databases, BLAST analysis, construction of phylogenetic tree using bioinformatics tools.	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIC 201	
Learning Outcomes	Apply knowledge of the standard techniques of classification systems to categorize and identify microorganisms.	

(Back to Index) (Back to Agenda)

MIC 203 INDUSTRIAL MICROBIOLOGY [T]
Theory Course Credit: 3
Contact Hours: 45

Prerequisites	Basic knowledge about the types of microbes and their products of industrial relevance. Knowledge of microbial biochemistry, physiology, genetics and statistics.	
Objective:	To comprehend concepts of the processes, instruments, management and quality used in the industries to produce the products using microorganisms.	
Content:		
1.		**(15)**

1.1	History of Industrial Microbiology, fermentation processes, descriptive layout and components of fermentation process for extracellular and intracellular microbial products.	
1.2	Microbial growth kinetics: Batch kinetics – Monod's model (single substrate), deviations from Monod's model, dual substrates – sequential utilization, multiple substrates – simultaneous utilization, substrate inhibition, product synthesis (primary and secondary metabolite), toxic inhibition, death constant.	
1.3	Microbial growth kinetics: Fed-batch kinetics – fixed volume, variable volume and cyclic fed-batch, applications and examples of fed-batch systems. Continuous cultivation system – relationship between specific growth rate (μ) and dilution rate, multistage systems, feedback systems (internal and external feedback), applications and examples of continuous cultivation system; comparison between various cultivation systems.	
2.		**(15)**
2.1	Optimization and modeling of fermentation process – single variable design, multivariate screening designs, critical factor analysis, optimization designs for two or more factor, singlet method; Metabolic and flux control analysis.	
2.2	**Bioreactor design and operation:** classification of reactors; Ideal mixed v/s plug flow reactor; designing parameters for reactors (stirred tank reactor, airlift reactor, plug flow reactor), rheology of fermentation broth.	
2.3	**Bioreactor design and operation:** gas-liquid mass transfer, heat transfer, analysis of dimension less parameters and their application (aeration number, power number and Reynold's number; Scale-up of bioprocesses: parameters used in scale-up and problems associated with scale-up.	
3.		**(15)**
3.1	**Solid substrate fermentation (SSF):** Principles and application; Comparison between SSF and Submerged Fermentation (SmF), Bioreactor for SSF. Problems in fermentation process and handling (foam, contamination, strain degeneration, etc), Immobilized enzymes and cell systems.	
3.2	**Fermentation monitoring and control:** Common measurement and control systems (speed, temperature, gas, pH, Dissolved oxygen, foam, redox, air flow, weight, pressure, biomass), On-line and off-line analysis, Digital controllers, control algorithm, flow charting, incubation control, advanced fermentation control and computer-based automation of process.	
3.3	**Industrial scale Down-stream processing and product recovery**: principle and general description of instrumentation, Recovery of particulates (cells and solid particles), recovery of intracellular products, primary isolation (extraction, sorption), precipitation, industrial processes for chromatography and fixed bed adsorption,	

	membrane separations; Type Processes - Antibiotic (Penicillin including semi-synthetic), Ethanol.	
Pedagogy:	Lectures/tutorials/assignments/self-study/Moodle/Videos	
References/ Readings (Latest editions)	1. Demain, A. L., Davies, J. E. and Atlas, R. M. Manual of Industrial Microbiology and Biotechnology, ASM Press. 2. Vogel, H. C. and Tadaro, C. M., Fermentation and Biochemical Engineering Handbook: Principles, Process Design and Equipment, William Andrew Publisher. 3. Atkinson, B. and Mavituna, F., Biochemical Engineering and Biotechnology Handbook, Stockton Press. 4. Flickinger, M. C. and Drew S. W., The Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis and Bioseparation, Volumes 1 - 5, John Wiley Publisher. 5. Stanbury, P. F., Whitaker, A. and Hall, S.J., Principles of Fermentation Technology, Butterworth-Heinemann Publishers.	
Learning Outcomes	1. Apply the principle of management and controls on the microbial processes in industrial settings. 2. Apply the understanding of physiological principles in improvement of the industrial processes.	

MIC 204 INDUSTRIAL MICROBIOLOGY [P]
Practical Course Credit : 1
Contact Hours : 30

Prerequisites	Basic knowledge about the types of microbes and their products of industrial relevance. Knowledge of microbial biochemistry, physiology, genetics and statistics.	
Objective:	Development of concepts in the processes, instruments, management, quality, etc.being used in the industries to produce the products using microorganisms.	
Content:		(30)
1.	Designing of fermentor – stirred tank reactor.	
2.	Fermentation kinetics – growth of *E.coli/S.cerevisiae* and determination of μ_{max}, Ks, Yx/s, m.	
3.	Rheology of substrate solutions.	
4.	Immobilization of microbial cells using alginate.	
5.	Baker's yeast – ISI/BSI quality assurance.	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIC203	
Learning Outcomes	Able to manage the microbial process under industrial settings.	

MIC 205 MOLECULAR BIOLOGY [T]
Theory Course Credit: 3
Contact Hours: 45

Prerequisites	It is assumed that the students have a basic knowledge of DNA (structure and replication), transcription and protein synthesis	
Objective:	To enhance the comprehension of concepts in molecular biology.	
Content:		
1.	**Chromosome architecture and eukaryotic DNA replication**	**(15)**
1.1	**Nucleic acids, types of DNAs and DNA packaging**	
A.	Structure of DNA and RNA.	
B.	Types of DNA (A-DNA, B-DNA, Z-DNA and triplex DNA) and their structural characteristics.	
C.	DNA packaging in bacteria (nucleoid) and viruses.	
1.2	**Chromosomes, genomes and their evolution**	
A.	Fundamental functions of DNA.	
B.	Chromosomal DNA and its packaging in the chromatin fibre, chromatin organization.	
C.	Structural features (telomere, centromere and repetitive sequences) of chromosomes and their functions. Lampbrush and polytene chromosomes.	
D.	Evolution of genomes, paralogous and orthologous evolution of duplicated genes	
1.3	**DNA replication in eukaryotes**	
	DNA replication in the context of the cell cycle; Structure and functions of eukaryotic DNA polymerases, functions of other enzymes (helicase, gyrase, topoisomerase, primase, ligase, telomerase); Steps involved in DNA replication; Similarities and differences between prokaryotic and eukaryotic DNA replication.	
2.	**DNA damage, repair and recombination**	**(15)**
2.1	**DNA damage and repair mechanisms**	
A.	Types of DNA damage: spontaneous and induced DNA damage.	
B.	Mechanisms / pathways to remove damaged DNA: Excision repair, mismatch repair, recombination repair, SOS Repair, photoreactivation repair.	
2.2	**Mechanisms of genetic recombination**	
A.	General and site-specific recombination.	
B.	Homologous recombination, Non-homologous end joining (NHEJ).	
C.	Synaptonemal complex, Bacterial RecBCD system and its stimulation of chi sequences.	
D.	Role of RecA / RAD51 in repair and recombination	

3.	**Gene expression and its regulation in prokaryotes and eukaryotes**	**(15)**
A.	The central dogma concept, DNA to RNA to protein	
B.	The RNA world and the origin of life.	
C.	An overview of gene expression control, DNA binding motifs in gene regulatory proteins, genetic switches and their role in the control of gene expression, combinatorial gene control.	
D.	Structure and function of prokaryotic and eukaryotic RNA: Prokaryotic and eukaryotic mRNA, tRNA, rRNA and ribosomes, processing of eukaryotic hnRNA, snRNA.	
E.	Post-transcriptional controls: Transcriptional attenuation, riboswitches, alternate splicing, RNA editing, RNA interference.	
F.	Synthesis and processing of proteins: The genetic code, aminoacylation of tRNA, mechanism of protein synthesis, translational proof-reading, translational inhibitors.	
G.	Protein folding, post-translational modifications of proteins, leader sequences, protein localization and secretion.	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	*Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell, Garland Science.*	
(Latest editions)	*Darnell, J. E., Lodish, H. F. and Baltimore, D., Molecular Cell Biology, Scientific American Books, Spektrum Akademischer Verlag.*	
	Watson, J. D., Molecular Biology of the Gene, Pearson/Benjamin Cummings.	
	Malacinski, G.M., Freifelder's Essentials of Molecular Biology, Narosa Book Distributors Private Limited.	
	Krebs J. E., Lewin, B., Goldstein, E. S. and Kilpatrick S.T., LEWIS Genes XI., Jones and Bartlett Publishers.	
	E. J., Simmons, M. J. and Snustad, D. P. Principles of Genetics, John Wiley	
	Tamarin, R. H., Principles of Genetics, McGraw-Hill Higher Education.	
	Twyman, R. M. and Wisden, W., Advanced Molecular Biology: A Concise Reference, BIOS Scientific Publishers.	
	Green, M. R. and Sambrook, J., Molecular Cloning: A Laboratory Manual, Cold Spring Harbor Laboratory, New York.	
	Davis, L. G., Dibner, M. D. and Battey, J. F., Basic Methods in Molecular Biology, Elsevier.	

	Gerhardt, P., Methods for General and Molecular Bacteriology, Elsevier.	
Learning Outcomes	*Understanding of gene structure, expression and regulation of gene expression in both prokaryotes and eukaryotes for application in molecular research.*	

(Back to Index) (Back to Agenda)

MIC 206 MOLECULAR BIOLOGY [P]

Practical Course Credit : 1
Contact Hours : 30

Prerequisites	It is assumed that the students have a basic knowledge of DNA (structure and replication), transcription and protein synthesis	
Objective:	This course develops concepts in molecular biology: DNA packaging, DNA damage and repair, gene structure, expression and regulation in both prokaryotes and eukaryotes	
Content:		**(30)**
1.	Isolation of genomic DNA of eukaryotic microorganisms, estimation of quantity and purity of DNA by spectrophotometry, and agarose gel electrophoresis.	
2.	Recovery of genomic DNA from agarose gel.	
3.	Extraction of mRNA / total RNA.	
4.	cDNA synthesis from mRNA.	
5.	PCR amplification of a specific gene using genomic DNA as a template and agarose gel analysis of PCR product to determine amplicon size.	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIC 205	
Learning Outcomes	*Able to handle molecular biology tools for gene expression studies.*	

MIC 207 ARCHAEA - ECOLOGY, PHYSIOLOGY, BIOCHEMISTRY AND GENETICS [T]

Theory Course Credit : 3
Contact Hours : 45

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.	
1.2	**Ecology and Diversity of Archaea**	
	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**	
	Nutrition, growth Characteristics and physiological versatility, Stress response of Major Archaeal Physiological Groups a) Phyla Euryarchaeota : (i) Methanogens (*Methanobacterium thermoautotrophicum*), (ii) Haloarchaea (*Halobacterium halobium*) and (iii) Thermophiles (*Thermoplasma acidophilum*); (iv) Psychrophilic archaea (*Methanogenium frigidum*) b) Phyla Crenarchaeota : (i) *Sulfolobus and* (ii) *Thermoproteus* c) Phyla Thaumarchaeota : Archaeal ammonia oxidizers d) Phyla Korarchaeota e) Phyla Thermoproteota : thermoacidophilic (*Sulfolobus acidocaldarius*), *Ignicoccus hospitalis* f) Phyla Nanoarchaeota: *Nanoarchaeum equitans*	
1.4	**Cell structure and architecture of Archaea:** a) Shape Arrangement and size : *Haloquadratum walsbyi* b) Comparison Between Archaeal and Bacterial Cells c) Cellular organization: cell morphotypes, cell envelopes –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) *Pyrococcus furiosus- Pfu* Polymerase in Molecular studies b) *Halobacterium salinarum* – Bacteriorhodopsin c) *Thermococcus gammatolerans* - To improve DNA repair and reduce cellular aging d) *Methanosarcina* – Methane production	
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 *Methanosarcina* - H_2 dependent and H_2 independent; and *Methanothrix*	

	e) Carbon dioxide reduction pathways: 3-hydroxypropionate pathway, and reverse Kreb cycle f) Bacterioruberin pathway	
2.2	Modified catabolic pathways: a) EMP b) ED: Semiphosphorylative and Nonphosphorylative ED pathway c) Chemolithoautotrophy: S oxidation	
2.3	Bioenergetics: ATP synthesis (i) respiration-driven : Anaerobic a) light-driven:bacteriorhodopsin b) chloride-driven: halorhodopsin c) cation-driven.	
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.	
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.	
3.3	Gene organization in Archaea: Operons (*fdh, his and mcr*). DNA repair in archaea.	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Woese, C. R., Fox, G. E., (1977) Phylogenetic structure of the prokaryotic domain: the primary kingdoms. Proc Natl Acad Sci USA. 74: 5088–5090.	
(Latest editions)	Blum, P., Archaea: New Models for Prokaryotic Biology, Academic Press.	
	Cavicchioli, R., Archaea**:** Molecular and Cellular Biology, ASM Press.	
	Garrett, R. A. and Hans-Peter, K., Archaea: Evolution, Physiology and Molecular Biology, John Wiley and Sons.	
	Howland, J. L., The Surprising Archaea: Discovering Another Domain of Life, Oxford University Press.	
	Barker, D. M.,Archaea: Salt-lovers, Methane-makers, Thermophiles and Other Archaeans, Crabtree Publishing Company.	
	Munn,C.,MarineMicrobiology:EcologyandApplications,GarlandScience,TaylorandFrancisGroup,N.Y.	
	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.	
	Corcelli, A. and Lobasso, S., (2006) Characterization of Lipids of Halophilic Archaea. Methods in Microbiology, 35: 585-613.	
	Rothe, O. and Thomm, M., (2000) A simplified method for the cultivation of extreme anaerobic archaea based on the use of sodium sulfite as reducing agent,Extremophiles. 4: 247-252.	

Learning Outcomes	1. Comprehending the ecology, physiology and biochemistry of the domain Archaea. 2. Understanding of the Principle of Archaeal Genetics. 3. Envisage the application of Archaea and archaeal bioactive compounds in Industry.	

MIC 208 ARCHAEA - ECOLOGY, PHYSIOLOGY, BIOCHEMISTRY AND GENETICS [P]
Course Credit: 1
Contact Hours: 30

Prerequisites	It is assumed that students have basic knowledge of 3 domains of life and basic microbiology techniques.	
Objective:	To introduce the methods in sampling and isolation of archaea from different econiches; identification of archaea and study of archaeal bio-molecules.	
Content:		**(30)**
1.	Isolation and culturing of halophilic archaea.	
2.	Identification of the isolates	
2.1	Biochemical tests for characterization of the halophilic archaea.	
2.2	Extraction of archaeal pigment and characterization using UV-Vis spectroscopy.	
2.3	Cellular lipids - Extraction and chromatographic resolution of lipids.	
3.	Screening for hydrolytic enzymes.	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIC207	
Learning Outcomes	1. Skill development for Isolation, culturing of Archaea and identification of archaea. 2. Screening the archaea for bioactive molecules.	

Discipline Specific Optional Courses

MIO 101 ENVIRONMENTAL MICROBIOLOGY AND BIOREMEDIATION [T]
Theory Course Credit : 3
Contact Hours : 45

Prerequisites	It is assumed that the students have a basic knowledge of ecosystem structure and environmental pollution.	
Objective:	To introduce the concepts of microbial diversity, community structure, role of microorganisms in biogeochemical cycles, sustainable development and bioremediation.	
Content:		
1.	**Microbial Ecology**	**(15)**

	Ecosystems: Concept of ecosystem, habitat, econiche. Components and functioning of ecosystem, Microbial interactions with biotic environment. Ecological pyramids, energy flow, food chain and food web. Concepts of microbial guild, *r* and *k* selection concept, role of microbes in ecological succession. **Microbial diversity in ecosystem and Community structure:** The expanse and estimates/measurement of microbial diversity- Rank-abundance curve (species richness and eveness), indices of diversity (Shannon index, simpson index, Gini-simpson index), Culture based microbial diversity, Newer high throughput approaches (extinction culture, diffusion chamber/ichip, gel micro droplet method, co-culture method, flow cytometry) for exploring microbial diversity from environmental samples. Culture independent molecular methods (DGGE, FISH, phylochips, metagenomic library) for understanding microbial community structure. Metabolic diversity of microbial communities in diverse environments (aquatic and terrestrial). **Microbial biofilms in environment**: Quorum sensing in bacteria; Nature and significance, Microbial mat.	
2.	**Biogeochemical processes, Pollution and sustainable devvelopment**	**(15)**
	Biogeochemical cycles: Physiological, biochemical, microbiological aspects of carbon, nitrogen, phosphorous, sulphur, Fe and Mn cycles.	
	Impacts of pollution on ecosystem and Concepts of sustainable development: Effect of marine pollutants on productivity and sustainability of aquatic and terrestrial econiche. Eutrophication, HABs, biomagnification. Ballast water and significance of invasive microorganisms. Climate change and occurrence of microbial diseases. Environment impact assessment (EIA) studies. Concept of sustainable development and application of microorganisms towards sustainable development; Microorganisms for clean energy.	
3.	**Biomonitoring and microbial bioremediation of pollutants.**	**(15)**
	Application of microorganisms for pollution Biomonitoring-biotracers and biosensors, microbes as Bioindicators. **Bioremediation technologies**: Microorganisms for bioremediation of oil spills (biodegradation, bioaugmentation, biostimulation, biosurfactants) heavy metals, xenobiotics (biotransformation, co-metabolism) and recalcitrant pesticides. **Waste water treatment plants**: Primary, secondary and tertiary treatment of waste water. Concept of microbial consortia and microbial biofilms in waste management and pollution abatement. **Valorization of agro waste**: Containing lignin, cellulose and pectin. Intimate coupling of photocatalysis and microbial biodegradation (ICPB) for advanced treatment of organic pollutants.	
Pedagogy:	Lectures/tutorials/assignments/self-study	

References/ Readings	Scragg, A. H., Environmental Biotechnology, Longman Publishers.	
(Latest editions)	Sharma, P. D., Environmental Microbiology, Alpha Science International.	
	Osborn, A. M. and Smith, C. J., Molecular Microbial Ecology, Taylor and Francis.	
	Liu, W-T. and Jansson, J. K., Environmental Molecular Microbiology, Caister Academic Press.	
	Norris, J. R. and Ribbons, D.W., Methods in Microbiology, Vol. 18 & 19, Academic Press	
	Murugesan, A. G. and Rajakumari, C., Environmental Science and Biotechnology: Theory and Techniques, MUP Publishers.	
	Naik, M. and Dubey, S. K., Marine Pollution and Microbial Remediation, Springer Publications.	
	Munn, C., Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis Group, N.Y.	
	Mitchell, R. and Kirchman, D. L., Microbial Ecology of the Oceans, Wiley Publishers.	
	Satyanarayana, T., Johri, B. and Anil, T., Microorganisms in Environmental Management, Springer Publishers	
	Kennish, M. J. Practical Handbook of Estuarine and Marine Pollution. CRC Press, Francis and Taylor.	
	King, R. B., Sheldon, J. K. and Long, G. M. (1997) Practical Environmental Bioremediation: The Field Guide, Lewis Publishers.	
	Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2017). Reference/ Readings Prescott's Microbiology. McGraw-hill Education. 10th Edition	
	Medigan, M. T., Bender, K. S., Bukley, D. H., Sattley, W. M., & Stahl, D. A. (2019). Brock Biology of Microorganisms. Pearson. 15th Edition.	
	Cavicchioli, R., Ripple, W. J., Timmis, K. N., Azam, F et al. (2019). Scientists' warning to humanity: microorganisms and climate change. Nature reviews microbiology, 17, 569- 586.	
	King, R. B., Sheldon, J. K., & Long, G. M. (2019). Practical Environmental Bioremediation: The Field Guide. CRC Press. second edition.	
Learning Outcomes	Applying the understanding of the microbial diversity, community structure and role of biogeochemical cycling of nutrients, for bioremediation and sustainable development.	

(Back to Index) (Back to Agenda)

MIO 102 ENVIRONMENTAL MICROBIOLOGY AND BIOREMEDIATION [P]
Practical Course Credit : 1
Contact Hours : 30

Prerequisites	It is assumed that the students have a basic knowledge of environmental pollution and microbiology.	
Objective:	To familiarize with the techniques of waste water analysis, biodegradation of aromatic pollutants and bioremediation of metal/metalloid pollutants.	
Content:		**(30)**
1.	Analysis of water samples for COD, BOD and microbial load.	
2.	Isolation of hydrocarbon degrading microorganism (degradation of sodium benzoate/Naphthalene).	
3.	Isolation of biosurfactant producing microorganisms.	
4.	BATH assay for microbial adherence.	
5.	Isolation of selenite/tellurite resistant microorganisms for application in bioremediation.	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIO 102	
Learning Outcomes	1. Able to perform waste water analysis; biodegradation of aromatic pollutants 2. Able to demonstrate the role of microorganisms in bioremediation.	

MIO 103: IMMUNOLOGY [T]
Theory Course Credit : 3
Contact Hours : 45

Prerequisites	Basic knowledge on pathogens, serology, and general principles of immunology.	
Objective:	1. To understand the concepts and mechanisms in the functioning of immunological cells and their interactions. 2. To get acquainted with the regulations of molecule synthesis, signalling, immune responses and allied activities of immune system at the molecular level.	
Content:		
1.		**(15)**
1.1	**Phagocytosis** – Cell surface receptors/markers and their role, killing mechanisms; **NK cells** – Cell to cell recognition for normal and modified cells, receptors, initiation of apoptosis and killing of target cells, malfunctioning of NK cells; role of mast cells in immunity.	
1.2	Classification and concepts of immunoglobulin domain, distribution of immunoglobulin domain, superfamily member, structure and function of TCR and BCR, diversity of antigen binding domain, concept of segmented gene, gene organization of Ig and TCR, rearrangement and generation of gene during differentiation	

	and development of B and T Cells, expression of Ig and TCR Cistrons, class switch and regulation of expression, B and T Cell ontogeny.	
1.3	Major Histocompatibility Cluster – Introduction to MHC I, II and III, structure and function of MHC I and II, distribution and recognition of MHC I and II, gene organisation and concept of polymorphism, expression and its regulation, processing of extracellular antigen by APC, presentation of intracellular antigen by nucleated cells, recognition of MHC I and II by TCR/CD3 complex; Members of MHC III and their roles (in brief).	
2.		**(15)**
2.1	Immunocompetent T and B cells, recognition, signaling and activation of T cells by APC, control and regulation of activated T-Cells, B-cell activation – Type 1 thymus-independent antigen, Type 2 thymus-independent antigen, thymus dependent antigen, co-operation with T-cells and activation of resting B-cells, antigen processing by B-cells, stimulation by cross-linking surface Ig.	
2.2	Cytokine as messengers, receptor for cytokine – gp130 subfamily, beta-c and gamma-c receptor subfamily, signal transduction and effects, network interactions; TH1 and TH2 responses; Cytokine mediated chronic inflammatory response; Killer T Cell and its regulation; effect of antigen dose and maturation of affinity of antibodies; role of memory cells.	
2.3	Antigen as major factor in control, feedback control of antibody production, T cell regulation – T-helper cells, T-cell suppression; Idiotypic networks, influence of genetic factors, immune regulation through hormone; T-cell tolerance.	
3.		**(15)**
3.1	Concept of inflammation (self-study), complement fixation (self-study), defense against intracellular bacterial pathogen, immunity to viral infection, immunity to fungi, immunity to parasitic infections; Passively acquired immunity, vaccination – herd immunity, strategies, killed organisms as vaccines, live attenuated vaccines, subunit vaccine, epitope vaccines, vaccines in use and experimental vaccines, Adjuvant and new approaches in vaccine development.	
3.2	**Immuno-techniques**: Antigen antibody interactions in solution (self study), identification and measurement of antigen (self study), epitope mapping, hybridoma technology and monoclonal antibody revolution, catalytic antibodies, engineering antibodies, antigen-antibody based affinity chromatography (self study), isolation of leukocyte and subpopulations, localization of antigen *in cyto* and *in tissue*, assessment of functional activity, genetic engineering of experimental animal for immune response investigation. **Immuno-assays and their application**: ELISA, SRID RIA, Immuno-fluorescence, Western Blotting.	
3.3	**Clinical immunology (Immunodeficiency)**: phagocytic cell defects, complement system deficiency, primary B-cell deficiency, primary	

	T-cell deficiency, combined immunodeficiency, secondary immunodeficiency, comparison between SCID and AIDS, recognition of immunodeficiency.	
Pedagogy:	Lectures/tutorials/assignments/self-study/Moodle/videos	
References/ Readings (Latest edition)	1. Goldsby, R. A., Kindt, T. J. and Osborne, B. A., Kuby Immunology. W.H. Freeman 2. Bona, C. A. and Bonilla, F. A., Textbook of Immunology, Fine Arts Press 3. Janeway, C. A., Travers, P., Walport, M. and Shlomchik, M. J., Immunobiology, Garland Science. 4. Delves, P., Martin, S., Burton, D. and Roitt, I., Roitt's Essential Immunology. Wiley-Blackwell. 5. Chakraborty, P. and Pal, N. K., Manual of Practical Microbiology and Parasitology, New Central Book Agency (P) Ltd, Delhi, India. 6. Goldsby, R. A., Kindt, T. J. and Osborne, B. A., Kuby Immunology. W.H. Freeman 7. Bona, C. A. and Bonilla, F. A., Textbook of Immunology, Fine Arts Press 8. Janeway, C. A., Travers, P., Walport, M. and Shlomchik, M. J., Immunobiology, Garland Science. 9. Delves, P., Martin, S., Burton, D. and Roitt, I., Roitt's Essential Immunology. Wiley-Blackwell. 10. Chakraborty, P. and Pal, N. K., Manual of Practical Microbiology and Parasitology, New Central Book Agency (P) Ltd, Delhi, India. 11. Abbas, A. K., Lichtman, A. H., & Pillai, S. Cellular and molecular immunology. Elsevier Health Sciences.	
Learning Outcomes	1. Comprehend the mechanisms of immunological responses. 2. Apply the principles of cellular ontogeny and the gene rearrangement to understand the novel and complex immune system.	

(Back to Index) (Back to Agenda)

MIO 104 IMMUNOLOGY [P]
Practical Course Credit : 1
Contact Hours : 30

Prerequisites	Basic knowledge of pathogens, haematology and principles of immunology.	
Objective:	Hands-on practice for various techniques used in immunology.	
Content:		**(30)**
1.	Haemagglutination: Blood grouping - ABO and Rh systems	
2.	Immunodiffusion slide technique	
3.	Agglutination tests for *Salmonella*-antigens	
4.	Complement fixation test	
5.	C-reactive protein determination	
6.	ELISA	
7.	Rapid tests – Malaria antigens Pv/Pf, IgM/IgG antibodies for Dengue, Hepatitis HBsAg	
8.	Rheumatoid Arthritis Factor determination	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIO 103	
Learning Outcomes	Apply techniques in immuno-diagnosis.	

MIO 105 AGRICULTURE MICROBIOLOGY [T]

Theory Course Credit : 3

Contact Hours : 45

Prerequisites	It is assumed that the students have knowledge about microorganisms and their diversity.	
Objective:	The course deal with the information about Inter-relationship of soil and microorganisms, different groups of beneficial microorganisms in agriculture, microbes as biofertilizer, plant pathogen and biocontrol agent.	
Content:		
1.	**Soil Microbiology**	**(15)**
1.1	**Microbial ecology:** Terrestrial Ecosystem, Pyramids and Econiches.	
1.2	**Soil Biogeochemistry**	
A.	Types of soil, soil Profile, Physico-Chemical (abiotic) and biotic characteristics.	
B.	Factors influencing microbial survival and establishment of inoculants.	
C.	Significance of microbial metabolism/enzymes on soil chemistry (nutrient cycling) & humus formation (humic and fulvic acids).	
1.3	**Plant and soil Microbiology:** Microbiology of the above and below ground parts of the plant (Phytosphere; Rhizosphere and Rhizoplane Microflora, phyllosphere, spermosphere)	
2.	**Plant-Microbe interactions (beneficial)**	**(15)**
A.	Plant growth promoting bacteria as biofertilizers	

	Direct Mechanisms: Nutrient acquisition (nitrogen fixation, phosphate, Zinc, Potassium mobilization, siderophores, plant growth promoting hormones-Auxins, ACC Deaminase) Indirect Mechanisms: ISR, disease suppression	
B.	Mycorrhiza – Ectomycorrhiza, Endomycorrhiza, VAM structure & significance.	
C.	Nitrogen Fixing Microbes – Free living nitrogen (*Azotobacter, Azospirillum*), associative (Cyanobacteria, *Anabaena azollae)* and symbiotic (*Frankia*, *Rhizobium)*	
D.	Biochemistry and Genetics of Nitrogen fixation with reference to symbiotic and non symbiotic nitrogen fixers Significance of *nif* H, D, K, A, L, nod, nodulin and fix genes in the process of microbial nitrogen fixation.	
E.	Manure and compost as a soil amendment.	
G.	Microbial Pesticides-Biocontrol agents for agriculturally important crop plants-Development and their significance; Source Organisms: Bacteria-*Bacillus thuringiensis*, Bt based commercial products, other Bacilli producing pesticides; Fungi—*Beauveria bassiana*, *Metarhizium anisopliae*, *Trichoderma,* Viruses- Baculoviruses for insect pest control.	
3.	**Plant-Microbe interactions (Harmful)**	**(15)**
A.	Plant Pathogens and Genetic basis of pathogenesis, symptoms and plant defense response	
	Causative agents, pathogenesis symptoms, control of common bacterial pathogens, fungal, algal, viral, nematodes.	
B.	Plant Defense Response	
(i)	Phytoalexins and their induction.	
(ii)	Plant defense responses or mechanisms of control (anatomical changes and biochemical synthesis of toxins, alkaloids and other biocontrol molecules).	
C.	Other means of pathogen control.	
(i)	Application of Viral proteins in controlling viral diseases.	
(ii)	Antisense RNA technology in disease control.	
(iii)	Mycoviruses acting against fungal plant pathogens.	
(iv)	Integrated pest management, post harvest management, agri-entrepreneurship development(steps for starting small industry)	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Alexander, M., Introduction to Soil Microbiology, Wiley.	
(Latest edition)	Dadarwal, K. R., Biotechnological Approaches in Soil microorganisms for sustainable crop production, Scientific Publishers.	
	Subba Rao, N. S., Advances in Agricultural Microbiology, Oxford & IBH Publishers.	
	Carr, N. G. and Whitton, B. A., The Biology of Blue-green algae, University of California Press.	
	Mahanta, K. C., Fundamentals of Agricultural Microbiology, Oxford & IBH Publishers.	

	Veeresh, G. K. and Rajagopal, D., Applied Soil Biology and Ecology, Oxford & IBH Publishing Company Pvt. Limited.	
	Somani, L. L., Biofertilizers in Indian Agriculture, Concept Publishing Company.	
	Subba Rao, N. S., Biofertilizers in Agriculture and Forestry, International Science Publishers.	
	Bilgrami K. S. (1987) Plant Microbe Interactions, Proceedings of Focal Theme Symposium, Indian Science Congress Association, Narendra Publishing House.	
	Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H. and Stahl, D. A., Brock Biology of Microorganisms, Pearson Education Limited.	
	Kumar, H. D., Modern Concepts of Microbiology, Vikas Publishing House Pvt. Ltd.	
	Agrios G.N. Plant Pathology. Academic Press, San Diego	
Learning Outcomes	1. Apply the knowledge of soil chemistry and significant biochemical processes of microbes to improve agricultural practices. 2. Apply the understanding of role of microorganisms in plant growth promotion and control of disease and pests.	

(Back to Index) (Back to Agenda)

MIO 106 AGRICULTURE MICROBIOLOGY [P]

Practical Course Credit : 1

Contact Hours : 30

Prerequisites	It is assumed that the student have knowledge about the soil properties and microbial interactions with plants.	
Objective:	Assessing the diverse parameters influencing the soil health. Studying the plant growth promoters and plant pathogens.	
Content:		**(30)**
1.	Isolation of plant growth promoting bacteria from rhizosphere and screening for phosphate/zinc solubilisation, IAA production, K mobilisation, siderophore activity and seedling vigour test.	
2.	Detection of microbial enzymes – amylase, phosphatase, lipase, protease, catalase, urease from various soils such as sandy soil and garden soil.	
3.	Isolation of microbial plant pathogen(s)-bacterial/fungal.	
4.	Preparation of biofertilizer using cyanobacteria	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	
References/ Readings	As given under Theory Course MIO 105	

Learning Outcomes	Integrate the knowledge of soil microorganisms for the betterment of agriculture.	

MIO 107 MYCOLOGY [T]

Theory Course Credit : 3

Contact Hours : 45

Prerequisites	The student should be familiar with basic microbiology.	
Objective:	This course deals with classification and identification offungi, fungal diversity, genetics and their applications.	
Content:		
1.	**Fungal diversity and distribution**	**(15)**
1.1	**Origin and phylogeny**; **classification**	
1.2	**Fungi – Terrestrial and Aquatic**	
A.	Terrestrial fungi; Aquatic Fungi: Fresh water fungi; Marine fungi: Coastal and Mangrove, Estuarine, Open Ocean, Polar regions.	
B.	Fungal diversity in Hypersaline waters – Thalassohaline and Athallasohaline: Solar salterns, Salt Lake, Dead Sea.	
1.3	**Extremophilic Fungi**	
	Oligotrophs, Alkaliphiles, Acidophiles, Barophiles, Psychrophiles, Thermophiles, Halophiles, Osmophiles, Xerophiles.	
	Fungal adaptation to extreme environments.	
2.	**Physiology and Genetics**	**(15)**
2.1	**Physiology of fungi**	
A.	Growth and development.	
B.	Fungal hormones- attractants, morphogenesis and differentiation.	
C.	Microbial interactions.	
D.	Secondary metabolites: antimicrobials, mycotoxin, pigments.	
2.2	**Fungal genetics**	
	Neurospora and *Saccharomyces*: Life-cycle; Tetrad analysis, gene conversion; Deuteromycotina: parasexuality, cytoplasmic inheritance; Electrophoretic karyotyping.	
2.3	**Identification of fungi**	
A.	Colonial and morphological characteristics, standard keys for identification of fungi.	
B.	Molecular finger printing.	
3.	**Pathogenesis - Antifungal Therapy**	**(08)**
3.1	**Pathogenesis**	
A.	Mycoses - Systemic, sub-cutaneous, cutaneous and superficial, Opportunistic	
B.	Plant pathogens.	
3.2	**Antifungal Therapy**	
	Drugs acting on cell membrane, protein synthesis inhibitors;fungicides.	
4.	**Applications**	**(07)**

A.	Industrially important enzymes.	
B.	Bioprospecting of secondary metabolites: Antimicrobials, antitumour agents, nutraceuticals, pigments,.	
C.	Biodegradation and bioremediation.	
D.	Biocontrol	
E.	Edible Mushrooms	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	Alexopoulus, C. J., Mims, C. W. and Blackwell, M., Introductory Mycology, John Wiley & Sons (Asia) Pvt. Ltd.	
(Latest editions)	Mehrotra, R. S. and Aneja, K. R., An Introduction to Mycology, Wiley Eastern Limited.	
	Cooke, R. C. and Whipps, J. M., Ecophysiology of fungi, Blackwell Scientific Publications, Oxford.	
	Deacon, J. W., Introduction to Modern Mycology, Volume 7 of Basic Microbiology, Blackwell Scientific Publications.	
	Kendrick, B., The Fifth Kingdom, Focus Publishers.	
	Davis, B. D., Dulbecco, R., Eisen, H. N. and Ginsberg, H. S., Microbiology, Harper and Row.	
	Strickberger, M. W., Genetic, The MacMillan Company, New York.	
	Domsch, K. H., Gams, W. and Anderson, T-H., Compendium of Soil Fungi, IHW-Verlag.	
	Gilman, J. C. and Joseph, C., A Manual of Soil Fungi, Daya Books.	
	Onions, A. H. S., Allsop, D. and Eggins, M. O. W., Smith's Introduction to Industrial Mycology, Edward Arnold, London.	
Learning Outcomes	Apply the knowledge in identification and bioprospecting of fungi.	

(Back to Index) (Back to Agenda)

MIO108 MYCOLOGY[P]

Practical Course Credit : 1

Contact Hours : 30

Prerequisites	It is assumed that students have basic knowledge of microbiology techniques.	
Objective:	To familiarize with techniques related to fungal isolation, identification and application.	
Content:		**(30)**
1.	**Study and Identification of fungi:** Study of standard cultures and identification - Observation of colonial and morphological characteristics, Reference to identification keys	
2.	**Fungal Genetics:** Isolation of fungal DNA	
3.	**Application of fungi for bioremediation:** Fungal degradation of azo dye	
4.	Degradation of plant polymer by fungal enzyme (crude)	
5.	Mushroom cultivation	
Pedagogy:	Hands-on experiments in the laboratory, video, online data	

References/ Readings	As given under Theory Course MIO 107	
Learning Outcomes	To apply the knowledge gained- i. For isolation and identification of fungal isolate ii. For diverse applications in biotechnology	

(Back to Index) (Back to Agenda)