Anekant Education Society's

Tuljaram Chaturchand College, Of Arts, Science & Commerce, Baramati (Autonomous Institute)

Syllabus (CBCS) for M.Sc. Microbiology

w.e.f. June 2019

Preamble:

Overall picture of student trends (before undergraduate studies) in selecting courses is very typical; most of the science students aim at professional courses, particularly leading to studies in Engineering. Comparatively less number of students opts for degrees in Biosciences. For several years now, the first preference of students desiring to enter the field of Life Sciences has been Microbiology, and for last 2 to 3 years it has shifted partly to Biotechnology courses. Both these disciplines viz. Microbiology and Biotechnology deal with overlapping interests. Microbial sciences focus more on study of the microbial world (this limitation needs to be corrected!)While Biotechnology focuses more on application of mammalian systems. The main theme of teaching these courses, however, remains the same i.e. application of basic principles of Life Science to develop into technology. Modern biology combines the principles of chemistry and biological sciences (molecular and cellular biology, genetics, and immunology) with technological disciplines (engineering, computer science) to produce goods and services and for environmental management. Tools of molecular biology play an important role in preparation of an engineered clone, a recombinant or a genetically manipulated organism (GMO). The Board of Studies in Microbiology has identified the following thrust areas and prospective plans for syllabi reforms at postgraduate level:

- **Microbial Technology** – includes application of bacteria, fungi, protozoa and viruses in traditional (food, dairy, wine, antibiotics, fermentation, etc.) and biotechnological industries.
- **Human health** – includes pathogenic micro-organisms (bacterial, viral, protozoan and fungal), therapeutics and pharmaceutical approach towards diseases, diagnostics, vaccine developments, epidemiological characterization of diseases, gene therapy, etc.
- **Agriculture** – includes biofertilizers and biocontrol, ecology and geomicrobiology.
- **Environment** – includes cleaner processes that produce less waste and use less energy and water in such industrial sectors as chemicals, pulp and paper, textiles and dyes, food, energy, and metals and minerals, harnessing microbial utilities avoiding the use of caustic chemicals, bioremediation and bioprospecting
- **Microbial diversity** – includes collecting information of diversity, exploration and utilization of diversity to identify and harvest biomolecules for human health improvisation, micro-organisms from extreme environments, Archeabacteria, etc.

- **Research in life-sciences** – includes research tools like immunology and molecular biology, developmental biology, evolution, stem cell research, etc. To enrich students'

knowledge and train them in the above mentioned areas; we feel certain topics in the present syllabus need to be supplemented and strengthened by inclusion of few additional topics. Areas that need to be introduced in syllabi have been identified as:

- Eukaryotic cellular organization
- Eukaryotic gene expression e.g. yeast genetics
- Determinants of microbial pathogenecity
- Immunopathology, immunopharmacology and cancer biology
- Protein stability, conformation and folding
- Over-expression of recombinant proteins
- Biocontrol
- Bioinformatics
- Molecular tools for characterization, identification of bacteria
- Possible utilization of microbial population from extreme environments

In addition, we feel that the students should be well acquainted with research methodology which includes different skill developments in scientific writing, data handling and processing, development of research ideas and planning / designing of research projects. The skill sets thus evolved will help the students in academic and applied research.

Introduction:

The syllabi till today had been sufficient to cater for the needs of students for building up their careers in industry and research. However, with the changing scenario at local and global level, we feel that the syllabus orientation should be altered to keep pace with developments in the education sector. The need of the hour is proper syllabi that emphasize on teaching of technological as well as the administrative aspects of modern biology. Theory supplemented with extensive laboratory expertise will help these students, to avail these opportunities. Both these aspects i.e. theory and more of practical needs to stressed, such that a post-graduate student can start work directly in applied fields (Industry or institutions), without any additional training. Thus, the university / college itself will be developing the trained and skilled man-power. We even find a lack of trained teachers who

can share their experiences on different aspects in microbiology. And we plan to restructure the syllabus in this viewpoint. The restructured syllabus will combine the principles of chemistry and biological sciences (molecular and cell biology, genetics, immunology and analytical tools) with technological disciplines to produce goods and services and for environmental

management. Microbiology curricula are operated at two levels viz. undergraduate and postgraduate. The undergraduate curricula are prepared to impart basic knowledge of the respective subject from all possible angles. In addition, students are to be trained to apply this knowledge particularly in day- today applications of Microbiology and to get a glimpse of research.

Objectives to be achieved:

- To enrich students' knowledge and train them in the pure microbial sciences
- To introduce the concepts of application and research in Microbiology
- To inculcate sense of scientific responsibilities and social and environment awareness
- To help student's build-up a progressive and successful career

Eligibility

B. Sc. with Principle subject Microbiology. The concerned centers may conduct their own entrance examination, for admission.

Duration of Course – Two years.

External students – There shall be no external students.

Course Structure –

There shall be four semesters, at each semester there will be 4 theory courses and 2 practical courses. In each theory course there shall be 4 core / compulsory credits. Each practical course shall have 4 core / compulsory credit.

Workload:

There shall be 16 contact hours per credit (1 hour / credit / week), out of which classroom teaching hours will be 12 and 4 contact hours for preparation of in-semester continuous assessment.

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Autonomous

Course Structure for M.Sc. - I: Microbiology

Semester	Paper Code	Title of Paper	No. of Credits
I	MICRO4101	Microbial Systematics and Diversity	4
	MICRO4102	Quantitative Biology	4
	MICRO4103	Biochemistry	4
	MICRO4104	Cell Biology	4
	MICRO4105	Practical Course: Microbial Systematics	4
	MICRO4106	Practical Course: Cell biology and Biochemistry	4

SYLLABUS (CBCS) FOR M.Sc. I. Microbiology
(w. e. from June, 2019)
Academic Year 2019-2020

Class : M. Sc. I (Semester- I)
Paper Code : MICRO4101
Paper : I
Title of Paper : Microbial Systematics and Diversity
Credit : 4
No. of lectures : 60

Course Objectives:

1. To enrich students' knowledge and train them in the pure microbial sciences.
2. To introduce the concepts of application and research in Microbiology.
3. To inculcate sense of scientific responsibilities and social and environment awareness.
4. To help student's build-up a progressive and successful career.
5. To acquaint students with basic concepts of microbial diversity.
6. To enrich students' knowledge of how the microbe concept emerged.
7. To develop an understanding of physiological and molecular diversity within a community of microbes.

Course Outcome:

CO1. Students will be able to understand the principles and methods behind studying and identifying cultured and uncultured microorganisms.
CO2. Introduce the concepts of application and research in Microbiology.
CO3. Students will be able to apply knowledge of the standard rules of classification systems to categorise microorganisms.
CO4. Students will be able to understand the basic microbial structure and study the comparative characteristics of prokaryotes and eukaryotes.
CO5. Students will be able to explain the dynamic and ever developing nature of the field of microbial taxonomy and systematic.
CO6. Students will be able to understand the structural similarities and differences among various physiological groups of bacteria, archaea.
CO7. Students will be able to explain general bacteriology and microbial aspects pertinent to bacteria, fungi and algae.

UNIT 1: Taxonomy of Bacteria and Introduction to Bergey's Manuals (15L)

- Introduction to Bacterial Taxonomy
- Science of classification
- The 5-Kingdom classification system
- The 3-Domain classification system
- Bergey's Manuals and the classification of prokaryotes.
- Determinative Bacteriology (Phenetic Approach)
- Systematic Bacteriology (Phylogenetic Approach Polyphasic Approach

UNIT 2: Microbial diversity (15L)

- The expanse of microbial diversity
- Estimates of total number of species
- Species Divergence and the measurement of microbial diversity.

- Measures and indices of diversity.

UNIT 3: Exploration of Un-culturable bacteria (15L)

- Concept of 'unculturable' bacterial diversity.
- Strategies for culture of 'unculturable' bacteria.
- Culture independent molecular methods for identifying unculturable bacteria.
- Methods of extracting total bacterial DNA from a habitat and metagenome analysis.
- Approaches to identify Culture -NGS (Next generation Sequence)

UNIT 4: Concept of speciation and species evolution (15L)

- Differences in concept of 'species' in eukaryotes and prokaryotes.
- Definition of species in prokaryotes.
- Types of 'species'
- Evolution of species and concepts of speciation (in sexual and asexual organisms)
- Types of evolution (neutral, co-evolution);
- Types and levels of selection; r and k selection;
- molecular clocks; phylogeny and molecular distances

Text / Reference Books:

- Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 8th Edition, 1974.
- Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 9th Edition, 1982.
- Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – (2001 – 2003).
- Sykes, G. and F. A. Skinner (Eds). Actinomycetales: Characteristics and Practical Importance. Society for Applied Bacteriology Symposium Series No. 2, Academic Press. 1973.
- Jacquelyn G. Black (2013) Microbiology: Principles and Explorations, 6th Edition, John Wiley & Sons, Inc.,
- Species Divergence and the measurement of microbial diversity. Catherine Lozupone and Rob Knight. FEMS Microbiol. Rev. **32** (2008) 557 – 578
- Methods of studying soil microbial diversity. Jennifer Kirk *et al*, (2004). Journal of Microbiological Methods **58**, 169 – 188.
- Keller M. and Zengler K. (2004) Tapping in to Microbial Diversity. Nature Reviews 2, 141- 150.
- Pace N. (1997) A Molecular View of Microbial Diversity and the Biosphere, Science, 276, 734-740.
- Woese C. (1987), Bacterial Evolution. Microbiological Reviews, 221-271.
- Michael S. Rappe and Stephen J. Giovannoni (2003). The Uncultured Microbial Majority. Annual Review of Microbiology, 57: 369 – 94.
- Rakesh Sharma, Ravi Ranjan, Raj Kishor Kapardar and Amit Grover (2005). 'Unculturavble'
- bacterial diversity: An untapped resource. Current Science, 89 (1).
- Sonia R. Vartoukian, Richard M. Palmer and William G. Wade (2010). Strategies for culture
- of 'unculturable' bacteria. Minireview, FEMS Microbiol Lett 309, 1 – 7.
- James D. Oliver (2005). The Viable but Nonculturable State in Bacteria (2005). The Journal of Microbiology, 43, Special Issue, 93 – 100.

- Jacquelyn G. Black (2013) Microbiology: Principles and Explorations, 6th Edition, John Wiley & Sons, Inc.,

- Microbial Diversity: Form and Function in Prokaryotes, Published Online: 30 NOV 2007. DOI: 10.1002/9780470750490.ch1
- Copyright © 2005 by Blackwell Science Ltd
- Carl R. Woese. The archaeal concept and the world it lives in: a retrospective. Photosynthesis Research 80: 361 – 372, 2004. Kluver Academic Publishers.
- Ridley Mark (2004). Evolution. Blackwell Science Ltd.

Mapping of course outcomes and programme outcomes:

Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

	Programme Outcomes (POs)								
Course outcomes (COs)	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	2		3		2		3	3
CO2	3			2					3
CO3	3	2		3				2	3
CO4	3			3		2			2
CO5	3								2
CO6	3								
CO7	3								2

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO1: The fundamentals of Microbial systematics shall be learned by the students.

CO2: The students shall learn about the basic concepts used in the microbial systematics in research.

CO3: The students shall gain knowledge about standard rules of classification systems to categorise microorganisms

CO4: Students shall learn about the different characteristics of prokaryotes and eukaryotes.

CO5: The students shall learn knowledge about the developing nature of microbial taxonomy and systematic

CO6: The students shall learn structural similarities and differences among bacteria , archaea

CO7: The students shall gain knowledge of general bacteriology and microbial of bacteria , fungi, algae

PO2 **Critical Thinking and Problem Solving:**

CO1: The students shall be aware of the basic technique to isolate culturable and unculturable microorganisms.

CO3: The students will be able to understand classification systems to categorise microorganisms

PO4 **Research-related skills and Scientific temper:**

CO1: Students will be able to learn isolation technique

CO2: It cultivates a scientific temper by encouraging students to approach microbiological concepts with curiosity, skepticism, and a commitment to evidence-based inquiry.

CO3: The students will be able use standard rules of classification systems to categorise microorganisms in research.

CO4: The students shall be able to understand basic microbial structure and compare characteristics of prokaryotes and eukaryotes used for morphological characteristics in research

CO5: field of microbial taxonomy and systematic.

PO6 **Personal and professional competence:**

CO1: It contributes to professional competence by providing essential methods for studying microorganisms, which is valuable in various professional settings

CO4: This knowledge shall grant confidence ensuring a solid understanding of structures essential for professional work in microbiology.

PO8 **Environment and Sustainability:**

CO1: It contribute to environmental awareness in students , as understanding principles and methods may involve considerations for environmental impact.

CO3: The application of classification systems may have environmental and sustainability considerations with ecological roles of microorganisms and their impact on ecosystems..

PO9 **Self-directed and Life-long learning:**

CO1: It encourages students to explore additional resources beyond the course material, stay updated with current research, and develop a habit of continuous learning in microbiology.

CO2: It sets the foundation for lifelong learning by emphasizing the evolving nature of microbiology research

CO3: It encourages students mindset of ongoing learning as taxonomies evolve.

CO4: It prompts students to explore advanced literature on microbial structures beyond the basics presented in the course. It lays the groundwork for lifelong learning in the field.

CO5: It encourages students to stay informed about changes and updates in microbial classification.

CO7: It encourages students to explore specific areas of interest within bacteriology and microbiology, fostering a habit of continuous learning.

SYLLABUS (CBCS) FOR M.Sc. I.
Microbiology (w. e. from June, 2019)
Academic Year 2019-2020

Class : M. Sc. I (Semester- I)
Paper Code : MICRO4102
Paper : II
Title of Paper : Quantitative Biology
Credit : 4
No. of lectures : 60

Course objective:

1. Gain a comprehensive understanding of basic statistical concepts such as probability, hypothesis testing, estimation, sampling, and study design.
2. Learn how to summarize and describe data using measures such as mean, median, mode, variance, standard deviation, and graphical representations.
3. Master inferential methods to make predictions or inferences about a population based on sample data. This includes confidence intervals, hypothesis testing, and regression analysis.
4. Develop skills to critically evaluate and interpret statistical results in the context of biological and health sciences, considering limitations and implications.
5. Effectively communicate statistical findings to non-statistical audiences through clear and concise reporting, visualization, and interpretation of results.

Course outcome:

Knowledge Acquisition:

CO1. Students should able to demonstrate a comprehensive understanding of fundamental statistical concepts and principles applicable to biological and health sciences.

CO2. Students should able to describe and explain various methods of data collection techniques used in biostatistics.

CO3. Students should able to describe and explain various methods of study designs, and sampling techniques used in biostatistics.

Data Analysis and Interpretation:

CO4. Students should able to apply appropriate statistical techniques to analyze biological and health-related data sets effectively.

CO5. Students should able to interpret statistical results, drawing meaningful conclusions and insights relevant to biological and health contexts.

Critical Thinking and Problem-Solving:

CO6. Students should able to critically evaluate the validity and reliability of statistical methods used in research studies within the field of biostatistics.

Communication and Presentation Skills:

Students should able to effectively communicate statistical findings to diverse audiences, including non-statistical professionals, using clear and concise language, visual aids, and appropriate documentation.

UNIT 1: Introductory Biostatistics (15L)

- Importance of statistics in Biology,
- Samples and Population,
- Types of data, Random sampling methods and sampling errors, Scales and Variables

• Collection and organization of data, tabulation, graphical representation (Histogram, frequency polygon and ogive curves, survival curves), diagrammatic representation (Simple bar diagram, percentage bar diagram, multiple bar diagram, sub-divided bar diagram and pie diagram).

UNIT 2: Descriptive Statistics (15L)

(No descriptive questions to be asked in examination; only appropriate problems should be asked in the examination.)

• Measures of central tendency – Mean (arithmetic, geometric, harmonic), median, Percentile and mode;
• Measures of dispersion – Mean deviation Standard deviation and Variance;
• Measures of skewness; Measures of kurtosis;
• Regression and correlation

UNIT 3: Probability and Probability Distributions (15L)

(No descriptive questions to be asked in examination; only appropriate problems should be asked in the examination.)

• Concept of experiment, event (mutually exclusive & non exclusive events, dependent & independent events);
• Laws of probability (addition and multiplication);
• Probability distribution – Normal (x-scale and z- scale), Binomial and Poisson distributions.

UNIT 4: Testing of Hypothesis (15L)

(No descriptive questions to be asked in examination; only appropriate problems should be asked in the examination.)

Equality of two population means: t-tests and z-test χ^2 (chi square) test - test for goodness of fit, independence and homogeneity; Non-parametric tests (Run test, Sign test, Wilcoxon's signed rank test, Mann- Whitney test).

Text / Reference Books:

• Goon, Gupta and Dasgupta Fundamentals of statistics, World Press, Kolkata.
• Gupta S.P. Statistical methods, Sultanchand & Sons Publisher, New Delhi.
• Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rd Ed. Ukaaz, Publications, Hyderabad.
• Lindgren B.W. Statistical Theory, Macmillan Publishing Co. Inc.
• Wayne Daniel (2007) Biostatistics A foundation for Analysis in the health sciences, Edition 7,
• Wiley- India edition.
• Bernard Rosner Fundamentals of Biostatistics,5th Ed. Duxbury Thomson
• Norman T.J.Bailey Statistical methods in biology, 3rd Ed. Cambridge University Press

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)								
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO 1	3	3							2
CO 2	2	2			2				3
CO 3	2	2							3
CO 4	3	3		3					2
CO 5	3	3							2
CO 6	2	3		2		2	2		2
CO 7	3	2	2						3

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Grasping statistical concepts in biological and health sciences significantly contributes to disciplinary knowledge, laying the foundational understanding of statistics within these fields.

CO2: Introducing techniques in data collection partially enhances disciplinary knowledge, specifically within biostatistics, broadening comprehension within the discipline.

CO3: Introducing study design methods and sampling techniques partially contributes to disciplinary knowledge by familiarizing students with methodologies commonly used in biostatistics in biological and health sciences.

CO4: Proficiently applying statistical techniques to analyze biological and health-related datasets significantly enriches disciplinary knowledge by adeptly employing statistical tools within these fields.

CO5: Aptly interpreting statistical outcomes and drawing meaningful conclusions directly advances disciplinary knowledge by using statistical results to gain insights within biological and health contexts.

CO6: Exercising critical evaluation skills partially contributes to disciplinary knowledge by assessing the reliability of statistical methodologies in biostatistics research studies within these fields.

CO7: Effectively communicating statistical findings enhances disciplinary knowledge by disseminating statistical insights and conclusions comprehensibly to non-statistical professionals in biological and health sciences.

PO2: Critical Thinking and Problem Solving

All Course Objectives involve critical thinking and problem-solving skills, aligning directly with the program outcome.

PO3: Social Competence

CO7: Communicating statistical findings to diverse audiences involves social competence by effectively conveying complex statistical information to various stakeholders in a comprehensible manner.

PO4: Research-related Skills and Scientific Temper

CO4: Proficiently applying statistical techniques significantly contributes to research-related skills by effectively utilizing statistical tools in analyzing biological and health-related datasets.
CO6: Exercising critical evaluation skills partially enhances research-related skills by evaluating the reliability of statistical methodologies in biostatistics research studies.

PO5: Trans-disciplinary Knowledge
CO2: Describing techniques in data collection partially contributes to trans-disciplinary knowledge by introducing methods used specifically in biostatistics, expanding comprehension across disciplines.

PO6: Personal and Professional Competence
CO6: Developing critical evaluation skills partially contributes to personal and professional competence by enabling students to assess statistical methodologies used in biostatistics research studies.

PO7: Effective Citizenship and Ethics
CO6: Exercising critical evaluation skills partially contributes to effective citizenship and ethics by evaluating the credibility of statistical methodologies in biostatistics research studies.

PO9: Self-directed and Life-long Learning
All Course Objectives necessitate continuous learning and skill development in utilizing statistical tools, aligning directly with the program outcome of self-directed and life-long learning.

SYLLABUS (CBCS) FOR M.Sc. I.
Microbiology (w. e. from June, 2019)
Academic Year 2019-2020

Class : M. Sc. I (Semester- I)
Paper Code : MICRO4103
Paper : III
Title of Paper : Biochemistry
Credit : 4
No. of lectures : 60

Course Objective:

1. To apply basic principles of chemistry to biological systems and molecular biology
2. Know about the composition of living matter and importance of water and buffer in life
3. To provide students with a solid foundation in the fundamental principles of biochemistry, including the structure, function, and metabolism of biological molecules.
4. To introduce students to the techniques and methodologies used in biochemical research and analysis.
5. To explore the relationship between structure and function of biomolecules and their role in cellular processes.
6. To foster critical thinking and problem-solving skills in the context of biochemical processes and pathways.
7. To promote an awareness of the applications of biochemistry in various fields, such as medicine, biotechnology, and agriculture.

Course Outcome:

CO1. Demonstrate a comprehensive understanding of the structure, function, and properties of biomolecules, including proteins, carbohydrates, lipids, and nucleic acids.
CO2. Apply knowledge of biochemical principles to analyze and interpret experimental data related to biological molecules and processes.
CO3. Evaluate the applications of biochemistry in various fields, such as drug discovery, biotechnology, and genetic engineering.
CO4. Students will be able to demonstrate an understanding of fundamental biochemical principles.
CO5. Students will be able to develop in- depth understanding of the area of biochemistry to choose for the research purpose.
CO6. Inculcate a healthy attitude to be a lifelong learner.

UNIT 1: Bioorganic Chemistry (15L)

• Chemical reactivity: Concept and factors affecting reactivity (Inductive effect, Resonance / Mesomeric effect, Conjugation and Hyper-conjugation, Tautomerism, etc.)

• Bonding other than covalent – H-bonds, Van der Wall's interaction, charge transfer complexes, ionic bonding, Iondipole, Host-guest interactions

• Reactions of organic molecules: A brief overview of Important reactions in organic chemistry e.g. Substitution, Addition, Elimination, Rearrangement, Oxidation, Reduction, etc.

• Bioorganic mechanism of enzyme catalyzed reactions: Acid – base, covalent catalysis and metal ion catalysis with examples of respective enzymes
• Stereochemistry: Three-dimensional shape of molecules, conformation and configuration, structure and biological activity
• Concept of pH of weak acids and weak bases, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, buffer value, important biological buffers

UNIT 2: Nucleic acid chemistry (15L)

Structure of bases, nucleosides, nucleotides, phosphodiester linkages, 5' phosphate, 3'hydroxyl polarity of nucleic acids, tautomeric forms of bases and their implication in pairing of bases, structure of DNA (A, B and Z forms), Tm value Cot curves, structure of t-RNA, r-RNA, and m- RNA and other RNAs

UNIT 3: Protein Chemistry (15L)

Physical and chemical properties of amino acids, classification of amino acids, amino acids as buffers, non-covalent interactions, Conformational properties of proteins, Polypeptide chain geometry, Resonance forms of the peptide group, *cis/trans* isomers of peptide group, Ramachandran plot, Secondary, Super-secondary, Motif & Domain, Tertiary and Quaternary structures of proteins, (Myoglobin & hemoglobin)

UNIT 4: Carbohydrate and lipid biochemistry (15L)

a. Carbohydrate Chemistry:
Mono, di, oligosaccharides and polysaccharides, with examples, asymmetric centre in sugars, D- series, L- series, dextro, leavo-rotatory, reducing and non- reducing sugars, sugar anomers, sugar epimers, sugar derivatives such as sugar alcohols, amino sugars, sugar acids, deoxy sugars, Methods of estimation of carbohydrates
b. Lipid Chemistry:
Classification of lipids according to chemical structure, fatty acids, saturated, unsaturated, branched, nomenclature system, structure and function of triglycerides, phospholipids, sphingolipids, terpenes, prostaglandins, waxes, and steroids, methods of estimation and characterization of lipids

Text / Reference Books:

• Clayden, Greeves, Warren and Wothers, *Organic Chemistry*, Oxford Press
• Jerry March, *Advanced Organic Chemistry*, John Wiley
• Voet Donald and Voet Judith G. (1995) *Biochemistry*, 2nd Ed.. John Wiley and sons, New York.
• Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) *Outlines of Biochemistry* 5th Ed, John Wiley and Sons, New Delhi.
• Nelson D. L. and Cox M. M. (2002) *Lehninger's Principles of Biochemistry*, Mac Millan Worth Pub. Co. New Delhi
• Segel Irvin H. (1997). *Biochemical Calculations*. 2nd Ed. John Wiley and Sons, New York.
• Campbell M. K.(1999)Biochemistry. 3rd edition Harcourt Brace College Publishers
• Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry*. 3rd Ed. Brooks/Cole, Publishing Company, California.
• David J Holme, Hazel Peck (1998) *Analytical Biochemistry* , 3rd Ed., Prentice Hall, Pearson Education Limited, Harlow England.
• Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) *Biochemistry*. 6th Edition. Freeman, New York.

• Garrett, R. H. and Grisham, C. M. (2004) *Biochemistry.* 3rd Ed. Brooks/ Cole, Publishing Company, California
• Cotterill, R. M. J. (2002) *Biophysics: An Introduction.* John Wiley & Sons, England.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2									
CO 2		2								
CO 3			3		2		2			
CO 4				2						
CO 5				2						
CO 6						2				2

Justification for the mapping

PO1.Disciplinary Knowledge:

CO1 demonstrates a comprehensive understanding of biomolecules, showcasing disciplinary knowledge in biochemistry.

PO2.Critical Thinking and Problem Solving:

CO2 involves applying knowledge of biochemical principles to analyze and interpret experimental data, reflecting critical thinking and problem-solving skills.

PO3.Social Competence:

While not explicitly mentioned in the provided sentences, the applications of biochemistry in drug discovery, biotechnology, and genetic engineering (CO3) can have social implications and may involve collaboration and communication skills.

PO4.Research-related Skill:

CO4 and CO5 involve demonstrating an understanding of fundamental biochemical principles and developing an in-depth understanding of biochemistry for research purposes, emphasizing research-related skills.

PO5.Transdisciplinary Knowledge:

CO3, which involves evaluating the applications of biochemistry in various fields, touches upon transdisciplinary knowledge as it connects biochemistry with other disciplines like drug discovery, biotechnology, and genetic engineering.

PO6.Personal and Professional Competence:

CO6 aims to instill a healthy attitude as a lifelong learner, reflecting personal and professional competence.

PO7.Effective Citizenship and Ethics:

Ethics is implicit in CO3 when evaluating the applications of biochemistry, especially in drug discovery and genetic engineering, and is aligned with effective citizenship and ethical considerations.

PO8.Environment and Sustainability:

The provided sentences do not explicitly address environmental aspects or sustainability.

PO9.Self-directed and Lifelong Learning:

CO6 explicitly mentions the goal of inculcating a healthy attitude to be a lifelong learner, emphasizing self-directed learning.

SYLLABUS (CBCS) FOR M.Sc. I.
Microbiology (w. e. from June, 2019)
Academic Year 2019-2020

Class : M. Sc. I (Semester- I)
Paper Code : MICRO4104
Paper : IV
Title of Paper : Cell Biology
Credit : 4
No. of lectures : 60

Course objectives

1. Recognize and describe the structure and function of major cellular organelles.
2. Understand the processes of diffusion, osmosis, and active transport across the cell membrane.
3. Describe the phases of the cell cycle, including interphase, mitosis, and meiosis. and understand the significance and regulation of cell division.
4. Explain cellular communication and signaling pathways.
5. Explore the role of receptors, second messengers, and signal transduction.
6. Explore different cell types and their specialized functions. And understand the organization of cells into tissues and organs.
7. Understand the interdisciplinary nature of cell biology, connecting concepts with genetics, biochemistry, and physiology.

Course outcome

CO1. Student able to identify and describe the structure of eukaryotic and prokaryotic cells.
CO2. Student able to understand the functions of different cellular organelles.
CO3. Understand the cell cycle and its regulation.
CO4. Understand how cells respond to external signals and environmental cues.
CO5. Explore the diversity of cell types and their specialized functions in different tissues and organisms.
CO6. Apply knowledge to solve problems related to cellular processes and functions.
CO7. Understand how cell biology intersects with other fields, such as genetics, biochemistry, and physiology.

UNIT 1: Ultrastructure and Organization of Eukaryotic Cell (30L)

Structural organization of: Cytoskeleton, Endoplasmic Reticulum, Golgi apparatus, Nucleus, Mitochondria, Chloroplast, Protein trafficking among various cellular compartments; Events in cell cycle, Regulation of cell cycle, apoptosis.

UNIT 2: Communication And Coordination among microorganisms (15L)

Life cycle of *Dyctiostellium discoidum,* Molecular mechanism of quorum sensing in slime moulds, Life cycle of myxobacteria, Molecular mechanism of quorum sensing in myxobacteria.

Quorum sensing in Gram positive and Gram negative bacteria, Biofilms, their organization, signals involved in their formation and dispersal, applications of study on biofilms in pathogenic and non-pathogenic environments

UNIT 3: Cell signaling in prokaryotic and eukaryotic systems (15L)

Secretory systems in bacteria, competence development, sporulation

Signaling in eukaryotes: autocrine, paracrine, endocrine, neurotransmitters
Pathways in cell signaling: GPCRs a) ion channels b) rhodopsin c) adenylate cyclase pathway d) regulation of cytosolic Ca2+

Text / Reference Books:

- Alberts Bruce (1985) *Molecular Biology of Cell.* Garland Pub
- Metzler David E. (2001) *Biochemistry: The chemical Reactions of Living Cells*, Volume 1&2, Academic Press California.
- Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell (2000) Molecular Cell Biology, 4th edition, W. H. Freeman & co., New York
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- Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.
- Munehiko Asayama and Yasuo Kobayashi (1993) Signal transduction and sporulation in Bacillus subtilis: autophosphorylation of SpoOA, a sporulation initiation

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	1			2					
CO 2	2	2	1	1	2	2	1	1	2	
CO 3										
CO 4										
CO 5										
CO 6										

Justification for the mapping

PO1: Disciplinary Knowledge:
CO 1: "Student able to identify and describe the structure of eukaryotic and prokaryotic cells."
CO2: This aligns with the concept of disciplinary knowledge as it involves understanding the structures and functions of cells, which is a fundamental aspect of biology.

PO2.Critical Thinking and Problem Solving:
CO1: Apply knowledge to solve problems related to cellular processes and functions."
CO2: Critical thinking and problem-solving are represented in the second set as essential skills, implying the ability to use knowledge in practical scenarios.

PO3.Social Competence:
CO2: Social competence is not explicitly addressed in the first set, which focuses more on cellular and biological concepts.

PO4.Research-Related Skill:
CO2: Research-related skills are not explicitly mentioned in the first set, but the application of knowledge to solve problems implies a practical and research-oriented approach.

PO5.Transdisciplinary Knowledge:
CO1 "Understand how cell biology intersects with other fields, such as genetics, biochemistry, and physiology."
CO2: Transdisciplinary knowledge is also represented in the second set as it emphasizes understanding the connections between cell biology and other disciplines.

PO6. Personal and Professional Competence:
CO2: This category in the second set is broader and encompasses a wide range of skills, including those related to personal and professional development, beyond the scope of cell biology.

PO7. Effective Citizenship and Ethics:
CO2: This category in the second set addresses aspects beyond the scope of cell biology, such as ethical considerations and effective citizenship.

PO8. Environment and Sustainability:
CO2: Environment and sustainability are not explicitly addressed in the first set but are included in the second set as essential considerations in a broader context.

PO9. Self-Directed and Lifelong Learning:
CO2 This category in the second set aligns with the idea of continuous learning and personal development, which goes beyond the specific knowledge of cell biology

SYLLABUS (CBCS) FOR M.Sc. I.
Microbiology (w. e. from June, 2019)
Academic Year 2019-2020

Class : M. Sc. I (Semester- I)
Paper Code : MICRO4105
Paper : V
Title of Paper : Practical Course: Microbial Systematics
Credit : 4
No. of lectures : 60

Course Objectives:

1. To enrich students' knowledge and train them in the pure microbial sciences.
2. To introduce the concepts of application and research in Microbiology.
3. To inculcate sense of scientific responsibilities and social and environment awareness.
4. Explore taxonomic strategies and approaches used to name microorganisms.
5. To study relationships and phylogeny of microbes, particularly Bacteria and Archaea, and develop an understanding of the current classification of microbe groups.
6. To develop a detailed understanding of a species, and the classification and naming of microorganisms.
7. To help student's build-up a progressive and successful career.

Course Outcome:

CO1. Enrich students' knowledge and train them in the pure microbialsciences
CO2. Introduce the concepts of application and research in Microbiology
CO3. Students will be able to demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures
CO4. Students will be able learn microbial techniques for isolation of pure cultures of bacteria, fungi and algae
CO5. Students will be able to learn aseptic techniques and be able to perform routine culture handling tasks safely and effectively
CO6. Students will comprehend the various methods for identification of unknown microorganisms
CO7. Students will recognise the scope of microbiology in all spheres of life and industrial sector ways to classify the living system.

A. Isolation of the following types of bacteria from natural samples. Identification of the bacteria to at least the Genus level using the Bergey's Manuals:
Mesophilic bacteria
Actinomycetes
The identification key must be designed for each isolated and identified bacterium. Students are expected to isolate at least one Genus from each group.

B. Isolation of the following types of fungi from natural samples.
Morphological Identification of the fungi.
Molds (Saprophytic)
Yeasts

The identification key must be designed for each isolated and identified fungus. Students are expected to isolate at least one Genus from Mold and Yeast each.

C. Isolation and identification of any one type of cyanobacterium from a natural sample.
The identification key must be designed for each isolated and identified cyanobacterium. Students are expected to isolate at least one Genus of cyanobacteria.

D. Isolation of the following types of bacteria from natural samples. Identification of the bacteria to at least the Genus level using the Bergey's Manuals:
Halophilic bacteria
Acidophilic Bacteria
Thermophiles
The identification key must be designed for each isolated and identified bacterium. Students are expected to isolate at least one Genus from each group.

Text / Reference Books:

- Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 8th Edition, 1974.
- Breed and Buchanan. Bergey's Manual of Determinative Bacteriology. 9th Edition, 1982.
- Breed and Buchanan. Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) (2001 – 2003).
- Sykes, G. and F. A. Skinner (Eds). Actinomycetales: Characteristics and Practical Importance. Society for Applied Bacteriology Symposium Series No. 2, Academic Press. 1973.
- Barnett, H. L. and Hunter, B. B. 1960. Illustrated Genera of Imperfect Fungi. Burgess Publishing Co., Minnesota.
- Lodder J. (1974). The Yeasts: A Taxonomic Study, North Holland Publishing Co. Amsterdam.
- Bergey's Manual of Systematic Bacteriology (2nd Edition) Volume One: The Archaea and the Deeply Branching and Phototrophic Bacteria.
- Boone, David R.; Castenholz, Richard W. (Eds.). Originally published by Williams & Wilkins,

Mapping of course outcomes and programme outcomes:

Weightage: 1= weak or low relation, 2= Moderate or partial relation, 3= Strong or direct relation

	Programme Outcomes (POs)								
Course outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3							3
CO2	3	2		3	3		3	3	
CO3	3					3		2	
CO4	3	3			2				
CO5	3					3			2
CO6	3			3			2		

CO7	3				3			3	3

Justification for the mapping

PO1 **Disciplinary Knowledge:**

CO1: The enrichment of students' knowledge in pure microbial sciences, will have core of disciplinary expertise.

CO3: It focuses on both theoretical and practical skills related to microscopy and staining techniques, which are essential components of microbiological studies.

CO4: It focuses on the practical aspects of microbial techniques for isolating pure cultures, a fundamental skill in microbiology.

CO5: It emphasize aseptic techniques and routine culture handling tasks, which are foundational practices in microbiology..

CO6: The diverse methods used in the identification of microorganisms, adding to the students' comprehensive understanding of microbiological practices.

CO7: Broadening students' understanding of the scope of microbiology across various sectors, including its classification system in living organisms..

PO2 **Critical Thinking and Problem Solving:**

CO1: It involve in understanding complex microbial concepts..

CO2: It encourage students to apply theoretical knowledge in practical scenarios and engage in research, fostering problem-solving skills.

CO4: The students shall use various techniques for microbial isolation, involving decision-making and problem-solving in experimental procedures..

PO4 **Research-related skills and Scientific temper:**

CO2: It introduce students to the concepts of research in microbiology, preparing them for future research endeavors.

CO6: It involve the comprehension of various identification methods, a critical aspect of microbial research.

PO5 **Trans-disciplinary knowledge:**

CO2: It emphasizes how microbiological concepts apply to diverse areas such as environmental science, medicine, and biotechnology

CO4: It connects microbial isolation techniques to applications in various fields, such as biotechnology, environmental science, or industrial processes..

CO7: It expandes students' awareness of microbiology's impact on various sectors, including healthcare, agriculture, and industry.

PO6 **Personal and professional competence:**

CO2: It bridge theoretical knowledge with practical applications, preparing students for research and real-world applications in their professional journey.

CO4: Develops personal competence by allowing students to master techniques fundamental to their field.

PO7 **Effective Citizenship and Ethics:**

CO1: Enriching students' knowledge in microbial sciences contributes to effective citizenship by providing a foundation for responsible decision-making in scientific research and applications, aligning with ethical considerations..

CO6: Comprehending methods for the identification of unknown microorganisms aligns with effective citizenship by emphasizing responsible and ethical practices in microbial identification, especially in the context of unknown or potentially harmful species

PO8 **Environment and Sustainability:**

CO2: It contribute to environmental protection, such as bioremediation or sustainable agricultural practices by studing beneficial microorganisms

CO4: It emphasizes sustainable practices in microbial cultivation, such as using environmentally friendly media or optimizing resource usage.

CO7: It explores microbiological applications in sustainable agriculture, environmental monitoring, or biotechnological practices that promote eco-friendly solutions.

PO9 **Self-directed and Life-long learning:**

CO2: It introduces students to the concept of research and application, encouraging them to explore specific areas of interest independently and stay updated with ongoing research.

CO5: Encourages lifelong learning by emphasizing the importance of maintaining and updating skills for routine tasks throughout their careers.

CO7: Supports lifelong learning by emphasizing the continuous evolution of microbiology and the need to stay informed about new developments.

SYLLABUS (CBCS) FOR M.Sc. I.
Microbiology (w. e. from June, 2019)
Academic Year 2019-2020

Class : M. Sc. I (Semester- I)
Paper Code : MICRO4106
Paper : VI
Title of Paper : Practical Course: Cell biology and Biochemistry
Credit : 4
No. of lectures : 60

Course Objectives:

1. Demonstrate proficiency in using common laboratory techniques for the quantitative analysis of biomolecules, including spectrophotometry, chromatography, and electrophoresis.
2. Perform protein estimation using methods such as the Bradford assay, Lowry assay, or BCA assay.
3. Understand the principles behind protein estimation techniques and factors influencing accuracy.
4. Construct standard curves for biomolecule quantification to convert experimental data into meaningful concentrations.
5. Emphasize the importance of precision and accuracy in biomolecule estimation.
6. Perform quality control measures to ensure reliable and reproducible results.

Course Outcome:

CO1. Understand and apply ethical considerations related to the use of biomolecules in research and analysis
CO2. Differentiate between various chromatographic techniques and their applications.
CO3. Proficiency in TLC Techniques:
CO4. Understand the selection of appropriate stationary and mobile phases for biomolecule separation.
CO5. Apply appropriate methods for estimating the concentration of specific biomolecules in a given sample.
CO6. Understand the validation processes for biomolecule estimation methods.

A. Good laboratory practices: Laboratory safety, hazard from chemicals, handling of chemicals, disposal of chemicals and cultures, recording of scientific experiments. Standardization of laboratory procedures, calibration and validation instruments, preparing / designing SOP for the same, maintenance of instruments
B. Buffer: Determination of pKa of a monoprotic weak organic acid; Preparation of buffers using KH2PO4 and K2HPO4, acetic acid and sodium acetate, K2HPO4 and H3PO4
C. Chromatography: Separation of sugar and amino acids by paper and thin layer chromatography
D. Colorimetry and spectrophotometry: Estimation of sugar and total carbohydrate, estimation of protein by Lowry, Bradford and UV Spectrophotometry
E. Isolation and characterization of bacterial pigment
F. Studying the stages mitosis in growing tip of onion root cells
G. Computer applications: Using data sheets, and sorting data with different parameters Plotting graphs – bar charts, line graphs, pie charts, adding error bars

H. Statistical analysis of data – Students t test, ANOVA, Chi square test , F test using computer softwares (e.g. Microsoft Excel,Minitab)

Text / Reference Books:

- Alberts Bruce (1985) *Molecular Biology of Cell.*Garland Pub
- Metzler David E. (2001) *Biochemistry: The chemical Reactions of Living Cells*, Volume 1&2, Academic Press California.
- Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell (2000) Molecular Cell Biology, 4th edition, W. H. Freeman & co., New York
- Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2						1			
CO 2		2								
CO 3			1							
CO 4				3						
CO 5					2					
CO 6						6			2	

Justification for the mapping

PO1: Disciplinary Knowledge:
CO1: falls under disciplinary knowledge as it requires a deep understanding of the ethical principles and guidelines specific to the field of bimolecular research.

PO2: Critical Thinking and Problem Solving:
CO2: involves critical thinking and problem-solving skills. It requires the ability to analyze different techniques and determine their suitability for specific research objectives.

PO3. Social Competence:
CO:3 Proficiency in TLC techniques (CO3) may involve social competence as it could be applied in collaborative research settings where effective communication and teamwork are essential for successful implementation.

PO4. Research-Related Skill:
CO4: Understanding the selection of appropriate stationary and mobile phases for biomolecule separation (CO4) is a research-related skill. It involves the application of knowledge to make informed decisions in the design and execution of experiments.

PO5. Transdisciplinary Knowledge:

CO5: Applying appropriate methods for estimating the concentration of specific biomolecules in a given sample (CO5) may require transdisciplinary knowledge, as it involves integrating techniques and methods from various scientific disciplines to achieve accurate results.

PO6. Personal and Professional Competence:
CO6: Understanding the validation processes for biomolecule estimation methods (CO6) contributes to personal and professional competence. It involves ensuring the accuracy and reliability of data, which is crucial for professional credibility.

PO7. Effective Citizenship and Ethics:
CO1: Understanding and applying ethical considerations (CO1) directly align with effective citizenship and ethics. It involves a commitment to responsible and ethical conduct in the use of biomolecules in research.

PO8. Environment and Sustainability:
While not explicitly stated, biomolecular research often has implications for the environment and sustainability, especially if it involves the use of resources or materials with environmental impact.

PO9. Self-Directed and Lifelong Learning:
CO6: The entire set of learning outcomes emphasizes the need for continuous learning. This is particularly evident in understanding validation processes (CO6) as it requires staying current with evolving methodologies and standards in biomolecular research