Progressive Education Society's

Modern College of Arts, Science and Commerce,

Shivajinagar, Pune 5

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Framework of Syllabus

For M.Sc. Microbiology

(2019-20 Course)

(with effect from 2019-20)

Semester 1 (Part 1)

Course Type	Course Code	Course / Paper Title	Hours / Week	Credit	CIA	End Sem Exam	Total
CCT-1	19ScMicP101	Microbial Taxonomy and Diversity	04	04	50	50	100
CCT-2	19ScMicP102	Instrumentation & Molecular biophysics	04	04	50	50	100
DSET-1	19ScMicP103	Biochemistry & Cell Biology (Elective)	04	04	50	50	100
DSET-1	19ScMicP104	Evolution, Ecology and Communication Biology (Elective)	04	04	50	50	100
CCP-4	19ScMicP105	Practical course I: Based on Microbial Taxonomy and Diversity	04	02	50	50	100
CCP-5	19ScMicP106	Practical course II: Cell Biology, Biochemistry & Biophysics	04	02	50	50	100
AECCT-1	19CpCysP101	Cyber Security-I	1	1	-	-	25
AECCT-2	19CpHrtP102	Human Rights-I	1	1	-	-	25
		Total Credits	-	**22**			

Semester 2 (Part 1)

Course Type	Course Code	Course / Paper Title	Hours / Week	Credit	CIA	End Sem Exam	Total
CCT-6	19ScMicP201	Industrial wastewater treatment and management	04	04	50	50	100
CCT-7	19ScMicP202	Quantitative Biology	04	04	50	50	100
DSET-2	19ScMicP203	Metabolism (Elective course)	04	04	50	50	100
DSET-2	19ScMicP204	Microbial and Plant Physiology (Elective course)	04	04	50	50	100
CCP-8	19ScMicP205	Practical course I: Industrial Wastewater Treatment &Biostatistics	04	02	50	50	100
CCP-9	19ScMicP206	Practical course II: Enzymology & Metabolism	04	02	50	50	100
AECCT-3	19CpCysP201	Cyber Security-II	1	1	-	-	25
AECCT-4	19CpHrtP202	Human Rights-II	1	1	-	-	25
		Total Credits	-	**22**			

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP101
Course Name: Microbial Taxonomy and Diversity

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

PrerequisiteCourses: B.Sc.Microbiology

Course Objectives:

- To study the taxonomy and classification of differentmicroorganisms
- To study different isolation and cultivation method for culturablemicroorganisms.
- To understand and learn different methods for the study of VBNCmicroorganisms.
- To study the importance of phylogenetic tree construction.

Course Outcomes:

1. Acquire principles and science of microbial taxonomy, diversity andsystematics.
2. Understand the properties of VBNC state in microorganisms and learn methods to analyzethem.
3. Understanding the principles and procedures of classical and next-generation sequencing, define challenges involved in these techniques, comment on the quality ofsequences.
4. Learning the basics of grouping organisms with respect to theirphylogenies.
5. Develop the capacity to design experiments to assess the total diversity of environmentalsamples.

Course Contents

Unit 1	Microbial species concept and molecular evolution	No. of lectures	References
	• Differences in the concept of 'species' in eukaryotes and prokaryotes. • Definition of species in prokaryotes. • Neutral evolution,molecular	15	• Catherine Lozupone and Rob Knight. (2008). Species Divergence and the measurement of microbial diversity. FEMS Microbiol. Rev. **32**

	clocks, phylogeny, and molecular distances **Microbial diversity** • The expanse of microbial Diversity • Estimates of the total numberof Species • Concept of SpeciesDivergence • Measures and indices of Diversity • Application of taxonomyand diversity principles in the characterization of the Microbiome		557 – 578 • Keller M. and Zengler K. (2004) Tapping into 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. • Jacquelyn G. Black (2015). Microbiology: Principles andExplorations, 9th Edition, John Wiley & Sons,Inc., • Microbial Diversity: Form and Function in Prokaryotes, Published Online: 30 NOV2007. DOI: 10.1002/9780470750490. ch1 • Carl R. Woese (2004). The archaeal concept and the world it lives in: aretrospective. Photosynthesis Research 80: 361 – 372, . Kluver Academic Publishers. • Ridley Mark (2004). Evolution. 3rd edition.Blackwell Science Ltd.
Unit 2	**Taxonomy of Bacteria and Introduction to Bergey'sManuals**	**No. of lectures**	**References**
	Taxonomy of Bacteria • Introduction to Bacterial Taxonomy • Science ofclassification • The 5-Kingdom classification system • The 3-Domain classification system **Introduction toBergey's manuals** • Bergey's Manuals and the classification ofprokaryotes. • Determinative Bacteriology (PheneticApproach) • Systematic Bacteriology (PhylogeneticApproach) • Polyphasic Approach	15	• Breed and Buchanan (1982). Bergey's Manual of Determinative Bacteriology. 9th edition. • Breed and Buchanan (2001 – 2003). Bergey's Manual of Systematic Bacteriology. 2ndEdition, (Volumes.1– 5). • Sykes, G. and F. A. Skinner (Eds) (1973). Actinomycetales: Characteristics and Practical Importance. Society for Applied Bacteriology Symposium Series No. 2, Academic Press. • Jacquelyn G. Black (2015). Microbiology: Principles and • Explorations, 9thedition, John Wiley & Sons,Inc.,
Unit 3	**Exploration of Un-culturablebacteria**	**No. of lectures**	**References**
	• Concept of 'unculturable' bacterialdiversity. • Strategies for the culture of 'unculturable'bacteria. • Culture-independent molecular methods for identifying unculturablebacteria.	**15**	• Michael S. Rappe and Stephen J. Giovannoni(2003). The Uncultured Microbial Majority. Annual Review of Microbiology, **57**: 369 –94. • Rakesh Sharma, Ravi Ranjan, Raj KishorKapardarandAmitGrover

	• Methods of extracting total bacterial DNA from a habitat and metagenomeanalysis.		(2005). 'Unculturable' bacterial diversity: An untapped resource. Current Science, **89(1).** • Sonia R. Vartoukian, Richard M. Palmer and William G. Wade (2010). Strategies for the culture of 'unculturable' bacteria. Minireview, FEMS Microbiol. Lett. **309**, 1 – 7. • James D. Oliver (2005). The Viable but NonculturableStatein Bacteria (2005). The Journal of Microbiology, **43**, Special Issue, 93 –100.
Unit 4	**Gene sequencing and bioinformatics**	**No. of lectures**	**References**
	Gene sequencing • Vectors used in genesequencing • Outline of gene sequencing procedures and automated sequencing: Sangermethod • Next-generation sequencing: Ion Torrent, Nanopore,and other upcomingmethods. • Whole Genome Shotgun Sequencing • Gene sequencing and identification ofmicroorganisms **Bioinformatics** • Introduction to Sequences, Sequence alignment, Local and global alignment, pairwise sequence alignment, Multiple sequence Alignment • Introduction todatabases • BLAST analysis • Concept of phylogenetictrees	**14**	• Sandy Primrose, Richard Twyman, Bob Old (2001). Principles of Gene Manipulation 6th Edition, Blackwell ScienceLtd • Molecular Cloning: A Laboratory Manual *4th Edition)*, Michael R. Green, Joseph Sambrook, (2012). Cold Spring Harbor Laboratory Press • Ausubel F. M. AndBrent R. (1994). Current Protocols in Molecular Biology, John Wiley & Sons Inc, New York • URLs: ***National Center for Biotechnology Information*** *www.**ncbi**.nlm.nih.gov/**Ribosomal Database*** **Project - Release 10** *rdp.cme.msu.edu/* ***rdp.cme.msu.edu/*** *seqmatch/* **Building *phylogenetic trees* www.itu.dk/~sestoft/bsa /dinaws/**phylogeny**.html Reading a *Phylogenetic Tree* - Nature** *www.nature.com/ /reading-a-**phyloge***
Unit 5	Industrial visit/ Experiential learning/ Internship	**01**	

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP102

Course Name: Instrumentation and Molecular Biophysics

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course Objectives:

- To study the importance of Instruments used in differentexperiments
- To know how to apply different techniques in research as well as in differentindustries

Course Outcomes:

- Acquire principles and science behind different instruments, their role, and importance in research as well as in differentapplications
- Students will be skilled in using different instruments with detailed knowledge of each instrument used in research as well asindustries

Unit 1	Biomolecular separation and detection (numerical and conceptual problems included)	No. of lectures	References
	• **Chromatography-** Partition Coefficient, Selectivity, Resolution, Column Efficiency, Van Deemter equation, Interpretation of chromatograms, principle, components of the instrument, operation and application of: Gel filtration chromatography, Ion-exchange Chromatography, Affinity chromatography, Gas chromatography, High-Performance Liquid Chromatography, • **Electrophoresis** - PAGE, NATIVE PAGE, SDS-PAGE, Isoelectric focusing, Use of Phosphor imaging • **Ultracentrifugation**- Differential centrifugation, Isopycnic, and Rate-zonal centrifugation.	**15**	• Clive Dennison (2002). A guide to protein isolation, Kluwer AcademicPublishers • Pattabhi, V. and Gautham, N. (2002). Biophysics. Kluwer Academic Publishers, New York, and Narosa Publishing House,Delhi. • David J Holme, Hazel Peck (1998)Analytical Biochemistry,3rd edition., Prentice Hall, Pearson Education Limited, Harlow England. • Rodney F. Boyer (2000). Modern Experimental Biochemistry 3rd edition.,BenjaminCummings. • Nölting, B. (2006). Methods in modern biophysics.2nd edition. Springer,Germany.

Unit 2	Spectroscopies of Biomolecules (conceptual and numerical problems)	No. of lectures	References
	• The electromagnetic spectrum, Atomic orbitals, Molecular orbitals, Electronic, Rotational and Vibrational transitions in spectroscopy, Interpretation of spectra. • **UV/Visible spectroscopy-** Instrumentation, Molar absorptivities, Beer and Lamberts Law, Bathochromic and hypsochromic shift. • **Fluorescence spectroscopy-** Instrumentation, Quantum yield, Quenching, FRET, Binding and Foldingstudies, • **Infrared spectroscopy-** Principle, Instrumentation, Absorption bands, FTIR and its advantages, • **Circular Dichroism (CD) –** Instrumentation, Circular polarization, Delta absorbance, cotton effect. • **Mass spectroscopy-** Principles of operation, Ionization, Ion fragmentation, Mass Analyzers, GC-MS,MALDI-TOF.	**15**	• Wilson Keith and Walker John (2010).*Principlesand Techniques of Biochemistry and Molecular Biology*, 7th edition. Cambridge University Press, NewYork. • Pattabhi, V. and Gautham, N. (2002).*Biophysics.* Kluwer Academic Publishers, New York, and Narosa Publishing House,Delhi. • Rolf Ekman, Jerzy Silberring, Ann Westman-Brinkmalm, AgnieszkaKraj (2009).*Mass spectrometry:instrumentation,interpretation, and applications*, John Wiley & Sons,Inc.,Canada. • Irwin H. Segel (1976) *Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry*, 2nd Edition. John Wiley &Sons. • Nölting, B. (2006).*Methods in modern biophysics.* Second Edition. Springer,Germany.
Unit 3	**Biophysical technique**	**No. of lectures**	**References**
	• **X-ray crystallography:** Purification of proteins, Crystallization of proteins, Instrumentation, Acquisition of the diffraction pattern, basic principles of x-ray diffraction, Crystal Structures (BravaisLattices), • Crystal planes and Miller Indices, Fourier Transform and Inverse Fourier, Direct Lattice and Reciprocallattice, Ewaldsphere, Electron density Maps, Phase problem, determination &Refinement. • **NMR spectroscopy:** Basic Principles ofNMR,	15	• Pattabhi, V. Gautham, N. (2002).*Biophysics.* Kluwer Academic Publishers, New York, and Narosa Publishing House, Delhi. • Cavanagh John *et.al.* (1995).*Proteins NMR Spectroscopy: Principles and Practice*, AcademicPress. • Keeler, J. (2002) *Understanding NMR Spectroscopy.* John Wiley & Sons, England. • Drenth, J. (2007). *Principles of protein X-ray crystallography.*3rdedition. Springer, Germany.

	Chemical shift, Intensity, Line width, Relaxation parameters, Spin coupling, Nuclear Overhauser Effect Spectroscopy, Correlation Spectroscopy, Approach to structure determination by 2D-NMR.Difference between H^1 and C^{13}NMR.		• Nölting, B. (2006).*Methods in modern biophysics.* Second Edition. Springer,Germany. • Cotterill, R. M. J. (2002).*Biophysics: An Introduction.* John Wiley & Sons,England.
Unit 4	**Synthesis and characterization of Bio-nanoparticles**	**No. of lectures**	**References**
	• **Biogenic nanoparticles** – Synthesis and applications. Magnetotactic bacteria for the natural synthesis of magnetic nanoparticles • Role of plants in nanoparticle synthesis, Significance of the physical properties of nanoparticles • Characterization of nanoparticles, Imaging techniques like TEM (Transmission Electron Microscope) , SEM (Scanning Electron Microscope), AFM (Atomic Force Microscopy), Dynamic Light Scattering (DLS), Scanning Probe Microscopy (SPM), EDAXAnalysis, Meta-analysis	**14**	• Christof M. Niemeyer and Chad A. Mirkin (2006). Nanobiotechnology, John Wiley &Sons. • Daniel L. Feldheim and Colby A. Foss, Jr. (2002). Metal nanoparticles synthesis and characterization and applications Marcel Dekker, Inc. • MahendraRai and Nelson Duran (2011). Metal nanoparticles in Microbiology, Springer VerlagBerlinHeidelberg.
Unit 5	**Industrial visit/ Experiential learning/ Internship**	**01**	

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP103
Course Name: Biochemistry and Cell Biology

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course Objectives:

- To inculcate the basic concepts of biochemistry and cell biology in thestudents.
- To enlighten students about the concepts of developmentalbiology.
- To nourish the students with the knowledge of cell communications and hormones functioning.

Course Outcomes:

- Detailed knowledge about structures and features ofbiomolecules.
- Know the advantages and disadvantages confocal scanning laser,transmission electron, and scanning electron microscopy for a givensituation
- Distinguish between cell envelope structures, cell junctions, organelles,etc.
- Comprehensive knowledge about the developmental processes based on modelsystems.

Unit 1	Chemistry of biomolecules	No. of lectures	References
	• **Proteins:** Henderson Hasselbalch equation and its role in buffer formulation, determination of the primary structure of polypeptide (N-terminal, C- terminal determination, method of the sequencing of peptides), structural classification of proteins, primary, secondary, tertiary, quaternary, Complex proteins (Glycoprotein,lipoprotein) • **Nucleic acid:** Structure of other forms of DNA (Triplex and quadruple), an overview of the structure of t-RNA, r-RNA, and m-RNA. • Other forms of RNAs: miRNA,snRNA, snoRNA (indetail)	**15**	• Campbell M. K. (2011). Biochemistry, 6th editionHarcourt Brace College Publishers, New York • Garrett, R. H., andGrisham, C. M. (2012). Biochemistry. 5thedition. Brooks/Cole, Publishing Company, California. • Nelson D. L. and CoxM. M. (2005). Lehninger's Principles of Biochemistry, 6th edition, McMillan Worth Pub. Co. New Delhi • Segel Irvin H. (1997). Biochemical Calculations. 2nd edition. John Wiley and Sons, New York.

Unit 2	Cell Cytology	No. oflectures	References
	• Structural organization of eukaryotic cell: Cytoskeleton, Cell junctions, Endoplasmic Reticulum, Golgi apparatus, Chloroplast • Protein trafficking among various cellular compartments; • Events in the cell cycle, Regulation of cell cycle, apoptosis. • Localization of macromolecules using electron microscopy,Immunoelectron microscopy, and Confocal Microscopy	**15**	• Alberts Bruce (2017). Molecular Biology of Cell.6th edition,GarlandPublishing Inc, US • Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell (2003). Molecular Cell Biology, 5thedition, W. H. Freeman &co.,NewYork. • Metzler David E. (2003). Biochemistry: The Chemical Reactions of Living Cells, 2nd edition, Volume 1&2, Academic PressCalifornia.
Unit 3	**Developmental Biology:**	**No. of lectures**	**References**
	• Introduction to Developmental Biology- • Conserved nature of development, Concepts of commitment,determination and differentiation, Morphogen gradients in developmental regulation, Hox code, MPF, gastrulation and cellular movements involved in it, pattern formation in body axis, anteroposterior and dorsoventral polarity • *Drosophila* as a model system • *Arabidopsis* as a model system	**15**	• Gilbert Scott F. (2003). Developmental Biology. 7th Edition, Sinauer Associates Inc. Mass. The USA. • Muller W.A. (2011). Developmental Biology, 2nd edition, Springer-Verlag, New York, Inc. • Wolpert Lewis (2002). Principles of Development, 2nd edition,Oxford University Press Oxford.
Unit 4	**Hormones**	**No. of lectures**	**References**
	• Signaling ineukaryotes: • autocrine, paracrine, endocrine, neurotransmitters • Pathways in cellsignaling		• Nelson D. L. and CoxM. M. (2005).*Lehninger's Principles of Biochemistry*, 6th edition, Mac Millan Worth Pub. Co. New Delhi

	• Chemical structure and functions of each hormone in connection with the gland responsible for its production: ○ Thethyroid ○ Theparathyroid ○ Thepancreas ○ Theadrenals ○ The pituitary gland ○ Sexhormones	**15**	• Harper Biochemistry, (2009). 17th edition, Lange medical publication, New York • Robert Murray, Daryl Granner (2009). Harper's Biochemistry. 25th edition
Unit 5	**Industrial visit/ExperientialLearning / Internship**	**01**	

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP104

Course Name: Biochemistry and Communication Biology

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course Objectives:

- To inculcate the basic concepts of biochemistry and cell biology in the students.
- To enlighten students about the concepts communication biology
- To nourish the students with the knowledge of cell communications and functioning

Course Outcomes:

- Students will have detailed knowledge about the features of various biomolecules with their role.
- Comprehensive knowledge about communication biology in microorganisms

Unit 1	Bioorganic Chemistry	No. of lectures	References
	a.Chemical reactivity: Concept and factors affecting reactivity (Inductive effect, Resonance / Mesomeric effect, Conjugation and Hyperconjugation, Tautomerism, etc.) b. Bonding other than covalent: • H-bonds, • Van der Wall's interaction, • Charge transfer complexes, • Ionic bonding, Ion-dipole, • Host-guest interactions c. Reactions of organic molecules: A brief overview of important reactions organic chemistry: • Substitution, • Addition, • Elimination, • Rearrangement, • Oxidation, • Reduction, etc. d. Bioorganic mechanism of enzyme-catalyzed reactions: • Acid-base • Covalent catalysis • Metal ion catalysis with examples of respective enzymes **e.** Stereochemistry: • The three-dimensional shape of molecules, • Conformation and configuration, • Structure and biological activity **f.** Concept of pH of weak acids and weak bases • Henderson- Hasselbalch equation, • Concept of the buffer, • Strength of buffer, • Buffer value, • Important biological buffer g. Properties of water h. Polar, non- polar compounds and their classification • Problems based on credit	15	• Clayden, Greeves, Warren, and Wothers, (2012).Organic Chemistry, 2nd edition, Oxford University Press • Jerry March(2006). Advanced Organic Chemistry, 6th edition, John Wiley Publications • Voet Donald and Voet Judith G. (2011). Biochemistry, 4thedition. John Wiley and Sons, New York. • Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H.,(2006). Outlines of Biochemistry 5th ed, John Wiley and Sons, New Delhi • Nelson D. L. and CoxM.M. (2005). Lehninger's Principles of Biochemistry, 6th edition, McMillanWorth Pub. Co. New Delhi • Segel Irvin H. (1997). Biochemical Calculations. 2nd edition. John Wiley and Sons, New York.
Unit 2	**Carbohydrate and Lipid chemistry**	**No. of lectures**	
	a. Carbohydrate Chemistry: Mono, di, oligosaccharides, and polysaccharides, with examples, asymmetric center in sugars, D-series, L-series, Dextro, Leave-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, Metabolic engineering b. Lipid Chemistry: Classification of lipids according to chemical structure, fatty acids, saturated, unsaturated, branched, nomenclature system, structure, and function of triglycerides,	15	• Campbell M. K.(2011). Biochemistry, 6th edition HarcourtBrace College Publishers, New York • Garrett, R. H., and Grisham, C. M. (2012). Biochemistry.5thedition. Brooks/Cole, Publishing Company, California. • Nelson D. L. and CoxM.M. (2005). Lehninger's Principles of

	phospholipids, sphingolipids, terpenes, prostaglandins, waxes, and steroids, methods of estimation and characterization of lipids Lipidomics: Lipid profiling with respect to the identification of pathogens		Biochemistry, 6th edition, McMillanWorth Pub. Co. New Delhi • Segel Irvin H. (1997). Biochemical Calculations. 2nd edition. John Wiley and Sons, New York
Unit 3	**Biochemical role of Micronutrients**	**No. of lectures**	
	• Structure, function, and biochemical mechanism offollowing micronutrients in metabolism • Water-soluble vitamins and their coenzyme forms (Niacin, • Riboflavin, Pantothenic acid, Thiamine, Pyridoxal, VitaminB12, Folic acid, Glutathione) • Fat-soluble vitamins (A, D, E, and K) • Minerals as vitamins (Iron, Manganese, Magnesium, Cobalt, Molybdenum, Copper, Zinc, Nickel)	15	• Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H.,(2006). Outlines of Biochemistry 5thedition, John Wiley and Sons, New Delhi • Nelson D. L. and CoxM.M. (2005). Lehninger's Principles of Biochemistry, 6th edition, Mac MillanWorth Pub. Co. New Delhi
Unit4	**Communication Biology**	**No. of lectures**	
	• Communication in microbes: • The life cycle of *Dictyosteliumdiscoidum,* • Molecular mechanism of quorum sensing in slime molds • The life cycle of myxobacteria, Molecular mechanism of quorum sensing in myxobacteria. • Quorum sensing in Gram-positive (*Staphylococcus aureus*virulence factors) and Gram-negative bacteria (*Vibrio fischeri*lux operon) • Biofilms: • Their organizationSignals involved in biofilm formationand dispersal of biofilms • Applications of study on biofilms in pathogenic (*Pseudomonas aeruginosa*) and non-pathogenic environments (dental plaque)	14	• Hamilton W. Allan, (1987). Biofilms: Microbial Interactionsand Metabolic activities, in Ecology of MicrobialCommunities, (Eds. M. Fletcher, T. R. G. Gray, and J. G.Jones) Cambridge University Press, Cambridge. • Peterson J. E. (1969). Isolation, cultivation and maintenance of Myxobacteria, Methods in Microbiology (Eds. Norris J. R.and W. Ribbons) Vol. 3B, Academic Press London, 185-210. • Toole 'O' George, H. B. Kaplan, R. Kolter, (2000).Biofilm formation as microbial development Annual Review of Microbiology, Vol. 54, 49-79 • Melissa B. Miller and Bonnie L. Bassler (2001). Quorumsensing in bacteria**.** Annu. Rev. Microbiol. Vol. 55, 165–199. • Christopher M. Waters and Bonnie L. Bassler (2005).Quorumsensing:cell-to-cell communication in bacteria. Annu. Rev.Cell Dev. Biol. Vol. 21, 319–46.
Unit 5	**Industrial visit/ Experiential learning / Internship**	**01**	

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP105

Course Name: Practical course on Microbial Taxonomy and Diversity

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course objective: To improve their practical skills and concepts

Expected outcomes:

1. Using Bergey's manual to create keys for the identification of pure culturesof bacteria. Constructing identification keys for yeasts andmolds.
2. Develop logic of media designing for isolation of a particular group of microorganismsfrom a particularenvironment
3. Become competent in various molecular techniques for isolation and purificationof chromosomal DNA, use of software in microbialsystematics.
4. Learn the art of scientific communication ofdata.
5. Develop the basic skills required to work in research laboratories working in the field of moleculartaxonomy.

Unit 1	Isolation and identification of Eubacteria and Fungi	No. of Practicals	References
	• Isolation of bacteria from natural samples and Identification to at least the Genus level using the Bergey'sManual • Actinomycetes • Thermophiles • Isolation and identification of the following types of fungi from naturalsamples. • Molds • Yeasts	**8**	• Breed and Buchanan (1982). Bergey'sManual of Determinative Bacteriology. 9th Edition, • Breed and Buchanan (2001 –2003). Bergey's Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5) • Sykes, G. and F. A. Skinner (Eds) (1973).*Actinomycetales*: Characteristics and Practical Importance. Society for Applied Bacteriology Symposium Series Academic Press. • 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.

Unit 2	Isolation and identification of Cyanobacteria	No. of Practicals	References
	• Isolation and identification of any one type of cyanobacterium from a natural sample. The identification key must be designed for each isolated and identifiedcyanobacterium.	2	• Breed and Buchanan (1982). Bergey'sManual of Determinative Bacteriology. 9th Edition • Boone, David R.; Castenholz, Richard W. (Eds.) (1984). Bergey's Manual of Systematic Bacteriology. 2nd Edition Volume One: The Archaea and the Deeply Branching and Phototrophic Bacteria. Originally published by Williams & Wilkins,
Unit 3	**Molecular Taxonomy**	**No. of Practicals**	**References**
	• Isolation, purification and checking purity of isolated chromosomal DNA ofbacteria • Isolation, purification and checking the purity of total DNA isolated fromenvironmental sample (soil/water) • Demonstration of the following steps, if not possible to perform in yourlab: ○ PCR ○ Purification of the PCRproduct ○ Sequencing using the automated machine(demonstration) ○ Use of nucleotidedatabases ○ Sequence matching by BLAST analysis. • Drawing a phylogenetic tree using related sequences (Using standard software like Philip, Mega,etc.)	6	• Sandy Primrose, Richard Twyman, Bob Old (2001).Principles of Gene Manipulation 6thEdition, Blackwell ScienceLtd. • Sambrook, J., Fritsch, E. F., and • Maniatis, T. (1989). Molecular Cloning: A Laboratory Manual, 2ndedition. Cold Spring Harbor: Cold Spring Harbour LaboratoryPress • Ausubel F. M. And Brent R. (1994). Current Protocols in Molecular Biology, John Wiley & Sons Inc, New York • URLs: **National Center for Biotechnology Information** www.**ncbi**.nlm.nih.gov/**Ribosomal Database Project- Release 10** rdp.cme.msu.edu/ **rdp.cme.msu.edu/** seqmatch/**Building phylogenetic trees www.itu.dk/~sestoft/bsa /dinaws/**phylogeny**.html Reading a Phylogenetic Tree - Nature** www.nature.com//reading-a-**phyloge**
Unit 4	**Scientific Communication I**	**No. of Practicals**	**References**
	• Scientific PowerPoint presentations orientation (activity), reviewwriting. • Analysis of published review, Publication ethics, impact factor, plagiarism check software.	4	• Alley, M. (1996). The craft of scientific writing, 3rd edition. Prentice Hall, NJ. [and accompanying web site: http://filebox.vt.edu/eng/mech/writing/] • Day, R. (1998). How to write and publish a scientific paper, 5thedition. OrynxPress. • Day, R. (1995). Scientific English: A guide for scientists and other professionals, 2nd edition. OrynxPress.

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP106

Course Name: Practical course on Cell Biology, Biochemistry and Biophysics

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course objectives: To improve their practical skills and concepts

Expected outcomes:

1. Must be aware of good laboratory practices and theirimportance
2. Students will understand communication and developmental biology indetail
3. Develop basic skills required to work in research laboratories working in the fieldof biochemistry andbiophysics

Unit1	**Good laboratory practices:**	**No. of Practicals**	**References**
	• **Laboratory safety**, hazard from chemicals, handling of chemicals, disposal of chemicals and cultures, recording of scientific experiments. Standardization of laboratory procedures, calibration, and validation of instruments, preparing/designing SOP for the same, maintenance of instruments • **Buffer**: Determination of pKa of a monoprotic weak organic acid; Preparation of buffers using KH2PO4 and K2HPO4, acetic acid and sodium acetate, K_2HPO_4 and H_3PO_4	**1** **2**	• David T. Plummer (2001). An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi • Segel Irvin H. (1997). Biochemical Calculations. 2nd Edition John Wiley and Sons, New York.
Unit 2	**Cell biology**	**No. of Practicals**	**References**
	• **Cell biology 1**: Studying the stages mitosis in the growing tip of onion rootcells • **Cell biology 2:** Isolation and characterization of bacterial pigment and the determination of molar extinctioncoefficient	**1** **3**	• Alberts Bruce (2017). Molecular Biology of Cell.6th edition,Garland Publishing Inc, US • Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell (2003). Molecular Cell Biology, 5th edition, W. H. Freeman &co.,NewYork.
Unit 3	**Biophysics I: Planar Chromatography**	**No. of Practicals**	**References**

	• Separation of sugar and amino acids by thin layer chromatography • **Column chromatography**: To determine the ion-exchange capacity and nature ofgiven resin using anion exchange chromatography.	**3**	• Rodney F. Boyer (2000). Modern Experimental Biochemistry, 3d edition, BenjaminCummings. • Nölting, B. (2006). Methods in modern biophysics. 2nd edition. Springer,Germany.
Unit 4	**Biophysics II**	**No. of Practicals**	**References**
	• Biological synthesis of nanoparticles(actinomycetes /fungi /yeast) and their characterization by UV-Vis spectroscopy. • Interpretation of Ramachandran Plot and study of conformations of a protein molecule using Molecular Graphics Visualization Tool.	**2** **1**	• Daniel L. Feldheim and Colby A. Foss, Jr. (2002). Metal nanoparticles synthesis and characterization and applications Marcel Dekker, Inc. • MahendraRai and Nelson Duran (2011). Metal nanoparticles in Microbiology, Springer-VerlagBerlin Heidelberg.
Unit 5	**Developmental biology:**	**No. of Practicals**	**References**
	1. Observation of mutant strains of *Drosophila* **Communication biology:** 1. Observation and isolation of organisms from biofilm 2. Formation /Disruption of biofilms 3. Isolation of Myxobacteriaandobservation of fruitingbodies	**1** **6**	• Gilbert Scott F. (2003). Developmental Biology. 7th Edition, Sinauer Associates Inc. Mass. The USA. • Muller W.A. (2011). Developmental Biology, 2ndedition, Springer-Verlag, New York, Inc. • Wolpert Lewis (2002). Principles of Development, 2nd edition,Oxford University Press Oxford.

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP201

Course Name: Industrial Waste Water Treatment

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course objectives:

- To study different sources of pollution and how to removethem
- To study how to give treatment to wastewater and get knowledge about differentprocesses for thesame
- To study how to choose an appropriate method for the treatment of different typesof wastewater

Course outcomes:

- Understand the sources of pollution of water, its control and how water quality can be maintained.
- Comprehensive knowledge about wastewater treatment methods and stages which will be helpful in designing an outline of a new process based on pollution load ofwastewater.
- Basic knowledge of parameters involved in designing a wastewater treatment unit process, calculation and interpretation of values of these parameters. Develop the capacity to design a basic unit process based on theseparameters.
- How current treatment of wastewater from major industries is done based on the components of waste, develop logic to understand the combination of methods used in industrial wastewater treatment. Principles of e-waste management, treatment, and role of microbiology in thesame.

Unit 1	Principles of Industrial Wastewater Treatment	No. of lectures	References
	• The need for Wastewater Treatment • Measuring Pollution Load of wastewaters, Methods for estimating parameters used for determining treatmentefficacy • Water pollution control, Regulation, and the limit for disposals in the lakes, rivers, oceans, andland • Water quality standards: Desirable limits, permissiblelimits • The layout of typical industrial wastewater treatmentplants	15	• Satya (2009) Biotechnology for Water and Wastewater Treatment. Prakash. Navyug Publishers & Distributors, New Delhi. • W. Wesley, (2000) Industrial Water Pollution Control. 3rd Edition. Eckenfelder Jr. McGraw Hill. • APHA(2005).Standard Methods for the Examination of Water & Wastewater. 21stEdition.APHA.AWWA.WEF
Unit 2	**Pretreatment & Primary treatment operation (Unit Processes)**	**No. of lectures**	**References**
	• Flow equalization • Screening • Flocculation • Flotation • Granular medium filtration	15	• Tchobanoglous G. and F. L. Burton. (2002). Wastewater Engineering, Treatment, Disposal and Reuse. 4thEdition, Metcalf, and Eddy (Eds). Tata Mac Graw Hill Publishing Co. Ltd. New Delhi
Unit 3	**Secondary and Tertiary Treatment process (UnitProcesses)**	**No. of lectures**	**References**
	• Secondary treatment processes(withproblem-solving) • Biological: (aerobic, anaerobic and combined processes.) Working treatment systems and their analysis, reactor types, critical operating parameters like DO, mixed liquor suspended solids, mixed liquor volatile suspended solids, hydraulic retention time, mean cell residence time, F/M ratio • Tertiarytreatment • Sedimentation andclarification	15	• Tchobanoglous G. and F. L. Burton. (2002). Wastewater Engineering, Treatment, Disposal and Reuse. 4th Edition, Metcalf, and Eddy (Eds). Tata Mac Graw Hill Publishing Co. Ltd. New Delhi

	• Disinfection • Adsorption • Sludge treatment anddisposal • Bioremediation andbiosorption • Composting		
Unit 4	**Current industrial wastewater treatmentprocesses**	**No. of lectures**	**References**
	• Dairyindustry • Food processingindustry • Dyeing industry / Dye-house effluents • Paper manufactureindustry • Electronicindustry • Municipal waste management in India	**14**	• A. D. Patwardhan, (2008). Industrial Wastewater Treatment. © Prentice – Hall of India Pvt. Ltd., New Delhi. ISBN 978-81-203-3350-5. • http://mpcb.gov.in/ • Sharholy et al. (2008). Municipal solid waste management in Indian cities – A review. Waste Management 28 459–467 • Joshi & Ahmed (2016). Status and challenges of municipal solid waste management in India: A review. Cogent Environmental Science, 2: 1139434
Unit 5	**Industrial visit/ Experiential learning / Internship**	**01**	

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP202
Course Name: Quantitive Biology

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course objective:

- To study statistical analysis with different methods and significance of thesemethods

Expected outcomes:

- Students will learn the significance of different statisticalmethods
- They will learn which method is appropriate to find out the significance of research aswell as experiments
- Students will learn how to use the graph and excel to show the statisticaldifferences

Unit 1	**Testing of Hypothesis-I (Theory +Problems)**	**No. of lectures**	**References**
	• The concepts of the null hypothesis, alternate hypothesis, significance level, type I and type II errors, p-value, one-tailed, and two-tailedtests • Distribution of sample means, standard error and confidence interval, Degrees offreedom • Equality of two population means, proportions: t-tests and z- test. • Comparison of 3 or more samples – F-test,ANOVA	**15**	• Irfan Ali Khan and AtiyaKhanum (2009), Fundamentals of Biostatistics. 3rdEditionUkaaz, Publications,Hyderabad • Gupta S.P. (2018). Statistical methods, Sultan Chand & Sons Publisher, New Delhi • NormanT.J. Bailey (2012).Statistical methods in biology, 3rdEdition Cambridge UniversityPress
Unit 2	**Testing of Hypothesis 2 (nonparametric test) (Theory +Problems)**	**No. of lectures**	**References**

	• Measurement of scales (Nominal, Ordinal, interval, andratio) • $\chi 2$ (chi-square) test – test for goodness of fit, independence, and homogeneity; • Non-parametric tests (Kruskal Wallis test, Sign test, Wilcoxon's signed rank test, Mann-Whitney test).	**15**	• Irfan Ali Khan and AtiyaKhanum (2009), Fundamentals of Biostatistics. 3rdEditionUkaaz, Publications,Hyderabad • Gupta S.P. (2018). Statistical methods, Sultan Chand & Sons Publisher, New Delhi • Norman T.J.Bailey(2012). Statistical methods in biology, 3rdEdition Cambridge UniversityPress
Unit 3	**Probability and probability distributions (with Problems)**	**No. oflectures**	**References**
	• Concept of experiment, event (mutually exclusive &nonexclusive events, dependent &independent events); Laws of probability (addition and multiplication); • Probability distribution – Normal (x-scale and z- scale), Binomial and Poisson distributions.	**15**	• Irfan Ali Khan and AtiyaKhanum, (2009). Fundamentals of Biostatistics. 3rdEditionUkaaz, Publications,Hyderabad • Gupta S.P. (2018). Statistical methods, Sultan Chand & Sons Publisher, New Delhi • NormanT.J.Bailey(2012). Statistical methods in biology, 3rdEdition Cambridge UniversityPress
Unit 4	**Design of Experiment**	**No. of lectures**	**References**
	• Basic prerequisites for DOE, the significance of DOE, types ofDOE • Surveydesign • Factorial design (Plackett-Burman), • Completely randomized design(CRD) • Random block design (RBD) For all the designs, conceptual problems must be studied. • Introduction to Modeling in Biology, significance using the SIR model, the difference between logistic and exponential model. Classic Hardy Weinberg modelconcept.	14	• Irfan Ali Khan and AtiyaKhanum (2009), Fundamentals of Biostatistics. 3rdEditionUkaaz, Publications, Hyderabad • Norman T. J. Bailey (2018).Statistical methods in biology, 3rdEdition Cambridge UniversityPress • Gupta S.P. (2012). Statistical methods, Sultan Chand &Sons Publisher, NewDelhi • Montgomery D.C. Design and analysis of experiments, John Wiley &SonsBernard Rosner (2016).Fundamentals of Biostatistics, 8thEditionDuxbury • Thomson Learning USA Stephen Newman (2002), Biostatistical Methods in Epidemiology. WileyInterscience publication, USA. • Aviva Petrie and Carolene Sabin, (2005), MedicalStatistics at aglance, 2ndEdition, Blackwell
Unit 5	**Industrial visit/ Experiential learning / Internship**	**01**	

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP203
Course Name: Metabolism

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course Objectives:

- To study energy conversion processes in livingorganisms
- To study anaerobicrespiration.

Course Outcomes:

- Knowledge about general principles of energy conversion processes in livingorganisms.
- Skills to analyze, compare and critically evaluate the bioenergetics relatedinformation.
- Given energy demands and available substrates, predict and comment on the feasibility of reactions.
- Understandingtheprocessofanaerobicrespirationintermsofelectrontransport andenergy generation.
- Acquisition of comprehensive knowledge of enzymes and theirkinetics.
- Mastery of bioenergetics and enzymology by applying this knowledge in a variety of qualitative and quantitative problem-solvingsituations.

Unit 1	Enzyme Kinetics	No. of lectures	References
	• Enzymes:Introduction • Kinetics of single substrate enzyme-catalyzedreaction. • Kinetics of reversible inhibitions enzyme-catalyzed reactions • Types of two substrate enzyme-catalyzed reactions King Altman approach to derive two-substrate enzyme-catalyzed reactions • Concept of allosterism, positive and negative cooperativity, models ofallosteric enzymes (Monod, Wyman, and Changeux model, Koshland, NemethyandFilmermodel), • Kinetics of allosteric enzyme, Hill plot, examples of allosteric enzymes and their significance in allosteric regulation	**15**	• Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry, 6th edition, McMillan Worth Pub. Co. New Delhi • Palmer T. (2001). Enzymes: Biochemistry, Biotechnology, and Clinical chemistry,2nd edition Horwood Pub. Co. Chinchester,England. • Segel I. H. (1997). Biochemical Calculations 2nd edition, John Wiley and Sons, New York

Unit 2	Bioenergetics	No. of lectures	References
	• Laws of thermodynamics, entropy, enthalpy, free energy, free energy and equilibrium constant Gibbs free energy equation • Determination of free energy of hydrolytic and biological oxidation-reduction reactions under standard and non- standard conditions(Problem-solving) • High energycompounds • Coupledreactions • Determination of feasibility of reactions (Problem-solving)	**15**	• Garrett, R. H., & Grisham, C. M. (2010). Biochemistry. 4th edition, Belmont, CA: Brooks/Cole, Cengage Learning. • Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, 6th edition, Mac Millan Worth Pub. Co. New Delhi • Segel I. H. (1997). Biochemical Calculations 2nd edition., John Wiley and Sons, New York
Unit 3	**Membrane transport and signal transduction**	**No. of lectures**	**References**
	• The composition and architecture of membranes, Membranedynamics • Solute transport across membranes: Passive diffusion, facilitated transport, primary and secondary active transport using P, V and F type ATPases, Ionophores, Ion mediated transport, transport of ions across membranes (ion pumps), ligand and voltage-gated ionchannels, • Liposomes and model membranes, Signal transduction pathways in bacteria, secondmessengers, regulation of signaling pathways, bacterial two-component systems, chemotaxis.	15	• Berg, J. M., Tymoczko, J. L., Stryer, L., &Stryer, L. (2015). Biochemistry. 8th edition,New York: W.H. Freeman. • Garrett, R. H. Grisham, C. M. (2004). Biochemistry. 3rd. edition. Brooks/Cole, Publishing Company, California. • Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry, 6th edition, Mac MillanWorth Pub. Co. New Delhi
Unit 4	**Respiration and photosynthesis**	**No. of lectures**	**References**
	• Mitochondrial electron transport chain, structure and function of ATPase (bacterial and mitochondrial), generation and maintenance of proton motive force, oxidative phosphorylation, inhibitors, and un-couplers of the electron transport chain and oxidative phosphorylation, Atkinson's energy charge, phosphorylation potential, and its significance • Anaerobic Respiration: Concept of anaerobic respiration, oxidized sulfur compounds, and nitrate as an electron acceptor with respect to electron transport chain and energygeneration, Biochemistry ofmethanogenesis. **Photosynthesis:**	**14**	• Madigan M.T., Martinko J.M., Stahl D.A., Clark D.P (2012). Brock Biology of Microorganisms, 13thedition, Benjamin Cummings, San Francisco. • Moat, A. G., Foster, J. W., & Spector, M. P. (2002). Microbial physiology. 4th edition New York: Wiley-Liss.

	• Structure of chloroplast, energy consideration in photosynthesis, light and darkreaction, electron carriers in photosynthesis • Organization of photosystem I and II, the cyclic and non- cyclic flow of electrons, Z scheme, Hill reaction, photolysis ofwater • C3, C4 CAM plants, Photorespiration, Regulation of photosynthesis • Photosynthesis in bacteria	**15**	• Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, 6th edition, Mac Millan Worth Pub. Co. New Delhi
Unit 5	**Industrial visit/ Experiential learning / Internship**	**01**	

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP204

Course Name: Microbial and Plant Physiology

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course Objectives:

- To study the photosynthesis inplants.
- To study about the biosynthesis of carbohydrates and aminoacids
- To understand and learn the processes involved in nitrogen fixation.
- Understand the mechanisms of various metabolic and physiological processes in plants andbacteria.

Course Outcomes:

- Acquire basic knowledge about growth and development inplants
- Well equipped with skills and techniques related to plant physiology so that they can design their ownexperiments
- Ability to construct explanations of the mechanisms and structural features of cells that allow organisms to capture, store, utilize and invest freeenergy.
- The student is able to evaluate data to show the relationship between photosynthesis and respiration in the flow of energy through asystem.

Unit 1	Nitrogen metabolism	No. of practicals	References
	• Biochemistry of biological nitrogen fixation, properties of nitrogenase and its regulation, ammonia assimilation with respect to glutaminesynthetase, glutamate dehydrogenase, glutamate synthetase, their properties andregulation, • Biosynthesis of five families of amino acids andhistidine, • Biosynthesis of purine and pyrimidinebases	15	• White D. (2000). Physiology and Biochemistry of Prokaryotes. 2nd edition. Oxford University Press, New York. • Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry, 6thedition, Mac Millan Worth Pub. Co. New Delhi • Moat, A. G., Foster, J. W., & Spector, M. P. (2002). Microbial physiology.4th Edition New York: Wiley-Liss.

Unit 2	Biosynthesis of carbohydrates in plants and bacteria	No. of practicals	References
	• **Calvin cycle and its regulation**, • Transport ofsoluteacross chloroplast membrane, Synthesis of starch and sucrose, • Photorespiration, C4 and CAM pathways, synthesis of celluloseand peptidoglycan, integration of carbohydrate metabolisminplantcell.	15	• Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry, 6th edition, Mac Millan Worth Pub. Co. New Delhi • Berg, J. M., Tymoczko, J. L., Stryer, L., &Stryer, L. (2015). Biochemistry. 8th edition,New York: W.H. Freeman. • Garrett, R. H., and Grisham,C. M. (2004). Biochemistry. 3rd edition. Brooks/Cole,Publishing Company, California
Unit 3	**Lipid biosynthesis**	**No. of practicals**	**References**
	• **Synthesis of storage lipids**: Fatty acids and triacylglycerols, • Synthesis of membranelipids: Glycerophospholipids, sphingolipids, sterols, Lipids as signal molecules suchas phosphatidylinositol,	15	• Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry, 6th edition, Mac Millan Worth Pub. Co. New Delhi • Berg, J. M., Tymoczko, J. L., Stryer, L., &Stryer, L. (2015). Biochemistry. 8th edition,New York: W.H. Freeman.

	eicosanoids, Vitamins, A, D, K, and E,Dolichols.		• Garrett, R. H., and Grisham,C. M. (2004). Biochemistry. 3rd Edition Brooks/Cole, Publishing Company, California
Unit 4	**Plant Physiology**	**No. of practicals**	**References**
	• **Photosynthesis** - Light-harvestingcomplexes; mechanisms of electron transport; photoprotectivemechanisms; CO_2 fixation-C3, C4 and CAMpathway. • **Respiration and photorespiration** – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratorypathway. • **Plant hormones** – Biosynthesis, storage, breakdown, and transport; physiological effects and mechanisms of action. • **Sensory photobiology** - Structure, function, and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatalmovement; photoperiodismandbiological clocks. • **Plant-Microbes Interactions** Plant growth-promoting rhizobacteria	14	• Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry, 6th edition, Mac Millan Worth Pub. Co. New Delhi • Madigan M.T.,Martinko J.M., Stahl D.A., Clark D.P (2012). Brock Biology of Microorganisms, 13thedition, Benjamin Cummings, San Francisco. • Taiz L., Zeiger E, Møller I.M., and Murphy A.(2015), Plant Physiology and Development, 6th edition Sunderland, Massachusetts: Sinauer Associates, Inc., Publishers , • Moat, A. G., Foster, J. W., & Spector, M. P. (2002). Microbial physiology. 4th edition New York: Wiley-Liss.
Unit 5	**Industrial visit/ Experiential learning / Internship**	**01**	

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP205

Course Name: Practical Course in Waste Water Treatment and Biostatistics

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course objectives:

- To learn basic techniques required for analysis of wastewater and wastewater treatment efficiency.

Expected outcomes:

- Understand the principles of techniques used in the calculation of pollution load of wastewater, hand-on these methods, and interpretation ofresults
- Develop the capacity to comment about the quality ofwater
- Students will understand the use of different statistical test such as ANOVA, t-test,etc.
- Students will know the scientificwriting

Unit1	**Wastewater treatment I**	**No. of Practicals**	**References**
	• Estimation of pollution load of a natural sample and its interpretation using the followingparameters ○ BOD:CODratio ○ TS ○ TSS • Simulated waste decomposition using aerobic microorganisms and analysis for the following parameters: sludge volume index (SVI), Mixed liquor suspended solids (MLSS), Mixed liquor volatile suspended solids (MLVSS), F/M ratio.	**5**	• A. K. Shrivastava. (2003) Environmental Impact Assessment. APH Publishing, • R. R. Barthwal, (2002) Environmental Impact Assessment, New Age International. • John Glasson, RikiTherivel, Andrew Chadwick. Routledge. (2012). Introduction to Environmental Impact Assessment. 4th Edition. • APHA(2005).Standard Methods for the Examination of Water &Wastewater. 21st Edition. APHA.AWWA.WEF
Unit 2	**Wastewatertreatment II**	**No. of practicals**	**References**

	• Biosorption of dyes using biomass and study of factors affecting biosorption such as temperature, pH, biomassconcentration. • Demonstration of the analysis of SOx, NOx, Chloride content of watersample	**5**	• APHA(2005) Standard Methods for the Examination of Water &Wastewater.21st Edition. APHA.AWWA.WEF
Unit 3	**Computer applications**	**No. of practicals**	**References**
	• Using data sheets, and sorting data with differentparameters • Plotting graphs – bar charts, line graphs, pie charts, adding error bars	**2**	
Unit 4	**Statistical analysis of data**	**No. of practicals**	**References**
	• Standardization of analytical method, statistical analysis and preparing a scientific report (Students t-test), ANOVA, Chi-square test, F test using computer software (e.g. Microsoft Excel)	**2**	
Unit 5	**Design of Experiment**	**No. of practicals**	**References**
	Design of Experiment - problem solving Scientific Writing (Research article, Project proposal writing as per guidelines of different funding agencies, the procedure for a patent application, clinical ethics, accreditation process (NABL)	**2** **4**	

Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous), Shivajinagar, Pune - 5

First Year of B.Sc. (Mathematics) (2019 Course)

Course Code: 19ScMicP206
Course Name: Enzymology and Metaboolism

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**
Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Course objectives:

- To perform the various techniques in enzymology forpurification.
- To enlighten students' kinetic properties ofenzymes.
- To nourish the students with the knowledge of plantphysiology.

Expected Outcomes:

- Hands-on training in the purification of enzymes andcharacterization.
- Expertise in the purification of a plantchloroplast.
- Expertise in PGPR activity ofmicroorganisms.

Unit 1	**Purification of enzyme**	**No. of Practicals**	**References**
	• Purification of the enzyme from natural sources like an animal,plant,bacterial/fungal by ammonium sulfate precipitation, organicsolvent precipitation, Dialysis, gel filtration, etc. • Establishment of enzyme purification chart	**5**	• Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry, FourthEdition, W. H. Freeman & Co. New York. • Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology, and Clinical chemistry, Horwood Pub. Co. Chinchester,England. • Segel Irvin H. (1997) Biochemical Calculations 2nd Edition, John Wiley and Sons, New York
Unit 2	**Characterization of enzymes**	**No. of Practical's**	• **References**
	• Determination of Km and Vm values of anyhydrolyticenzyme • Determination of molecular weight of enzyme:Protein electrophoresis by PAGE and SDS PAGE • Enzyme inhibition study	**3**	• Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, FourthEdition,W. H. Freeman & Co. NewYork. • Palmer Trevor (2001) Enzymes: Biochemistry,Biotechnology, and Clinical chemistry, Horwood Pub. Co. Chinchester,England. • Segel Irvin H. (1997) Biochemical

			Calculations 2nd Edition, John Wiley and Sons, New York Wilson Keith and Walker John (2005) PrinciplesandTechniques of Biochemistry and Molecular Biology, 6thEditionCambridge University Press, New York.
Unit 3	**PGPR from rhizosphere**	**No. of Practical's**	**References**
	• Isolation of plant growth promoting rhizobacteria and characterization with respect to IAA/Siderophore • Plantphotosynthesis • Chloroplast isolation • Spectrophotometric assay of Hill reaction and estimation of chloroplast	**4**	• David T. Plummer (1993) An Introduction to Practical Biochemistry, 3rdEdition, Tata McGraw-Hill Publishing Company Limited, NewDelhi • Mandelstam Joel and McQuillan Kenneth (1976). Biochemistry of Bacterial Growth, Blackwell Scientific Publication London. • Nelson D. L. and Cox M. M. (2005). Lehninger's Principles of Biochemistry, 4thedition, W. H.Freeman & Co. New York. • White David (2000).Physiology and Biochemistry of Prokaryotes. 2nd EditionOxford University Press, New York
Unit 4	**Degradation of different compounds bybacteria**	**No. of Practicals**	**References**
	• Isolation and characterizationof ○ Cellulose degradingbacteria ○ Lipase producingbacteria ○ Facultative anaerobicbacteria ○ Pesticide degrading bacteria	**6**	• Moat Albert G. and Foster John W. (1988). Microbial Physiology 2nd Edition John Wileyand Sons New York. • Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark (2012). Brock Biology of Microorganisms,13thedition, Benjamin Cummings, San Francisco. • Nelson D. L. and CoxM. M. (2005). Lehninger's Principles of Biochemistry, 4thedition, W. H. Freeman &Co. New York.