Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce, and Science College, Ahmednagar (Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

National Education Policy (NEP)
Choice Based Credit System (CBCS)

Programme Skeleton and Syllabus of

M.Sc. Microbiology

Implemented from

Academic Year 2023-24

9.2 Distribution of credits

Type of Courses	Total Credits	Credits/ Semester
Discipline-Specific Core Courses (DSC)	54	14 /12
Discipline Specific Elective Courses (DSE)	16	04
Research Methodology (RM)	04	Semester I only
On-Job Training/ Internship (OJT/I	04	Semester II only
Project (PR)	10	Semesters III and IV only
Total	88	22

9.3 Master of Science (M.Sc.) Course Distribution

Class	Semester	Subjects	Courses	DSC		DSE		RM/OJT/ Internship etc.		Project *	Total Credits
				T	P	T	P	T	P		
M. Sc. I	I	01	09	03	03	01	01	01*		00	22
M. Sc. I	II	01	09	03	03	01	01	00	01	00	22
M. Sc. II	III	01	07	02	02	01	01	00	00	01	22
M. Sc. II	IV	01	07	02	02	01	01	00	00	01	22

* RM: Theory and Practical credits in RM paper shall be decided by the Department. The final marks/grade point shall be calculated by considering theory and practical marks.

9.4 Master of Science (M. Sc.) Credit Distribution

Class	Semester	Subjects	Courses	DSC		DSE		RM/OJT/ Internship etc.		Project *	Total Credits
				T	P	T	P	T	P		
M. Sc. I	I	01	09	08	06	02	02	04*		00	22
M. Sc. I	II	01	09	08	06	02	02	00	04	00	22
Exit Option: PG Diploma											
M. Sc. II	III	01	07	08	06	02	02	00	00	04	22
M. Sc. II	IV	01	07	08	04	02	02	00	00	06	22
				32	**20**	**08**	**08**	**02**	**06**	**12**	**88**

9.5 Master of Science (M. Sc.) Distribution of Courses

Class	Semester	Course and their credits in the bracket			
		DSC	DSE	RM/OJT/ Internship etc.	Project *
M. Sc. I	I	DSC -01 (03)	DSE -01 (02)	RM-01(04)	NA
M. Sc. I	I	DSC -02 (03)	DSE -02 (02)		
M. Sc. I	I	DSC -03 (02)			
M. Sc. I	I	DSC -04 (02)			
M. Sc. I	I	DSC -05 (02)			
M. Sc. I	I	DSC -06 (02)			
M. Sc. I	II	DSC -07 (03)	DSE -03 (02)	OJT-01 (04)	NA
M. Sc. I	II	DSC -08 (03)	DSE -04 (02)		
M. Sc. I	II	DSC -09 (02)			
M. Sc. I	II	DSC -10 (02)			
M. Sc. I	II	DSC -11 (02)			
M. Sc. I	II	DSC -12 (02)			
M. Sc. II	III	DSC -13 (04)	DSE -05 (02)	NA	PR-01(04)
M. Sc. II	III	DSC -14 (04)	DSE -06 (02)		
M. Sc. II	III	DSC -15 (03)			
M. Sc. II	III	DSC -16 (03)			
M. Sc. II	IV	DSC -17 (04)	DSE -05 (02)	NA	PR-02(06)
M. Sc. II	IV	DSC -18(04)	DSE -06 (02)		
M. Sc. II	IV	DSC -19 (02)			
M. Sc. II	IV	DSC -20 (02)			

Programme Framework (Courses and Credits): M. Sc. Microbiology

Sr. No.	Year	Sem	Level	Course Type	Course Code	Title	Credits
1.	I	I	6.0	DSC-01	MS-MR111T	Microbial Cell Organization And Biochemistry	03
2.	I	I	6.0	DSC-02	MS-MR112T	Quantitative Biology	03
3.	I	I	6.0	DSC-03	MS-MR113T	Microbial Systematics	02
4.	I	I	6.0	DSC-04	MS-MR114P	Practical Course Based On Biochemical Techniques	02
5.	I	I	6.0	DSC-05	MS-MR115P	Practical Course Based On Biostatistics And Bioinformatics	02
6.	I	I	6.0	DSC-06	MS-MR116P	Practical Course Based On Developmental Biology And Microbial	02

						Diversity	
7.	I	I	6.0	DSE-01	MS-MR117T	Virology	02
8.	I	I	6.0	DSE-02	MS-MR118P	Practical Course Based On Virology	02
9.	I	I	6.0	RM-01	MS-MR119T/P	Research Methodology	04
10.	I	II	6.0	DSC-07	MS-MR121T	Instrumentation And Molecular Biophysics	03
11.	I	II	6.0	DSC-08	MS-MR122T	Molecular Biology I	03
12.	I	II	6.0	DSC-09	MS-MR123T	Microbial Metabolism And Photosynthesis	02
13.	I	II	6.0	DSC-10	MS-MR124P	Practical Course Based On Instrumentation Techniques	02
14.	I	II	6.0	DSC-11	MS-MR125P	Practical Course Based On Molecular Biology I	02
15.	I	II	6.0	DSC-12	MS-MR126P	Practical Course Based On Microbial Metabolism And Photosynthesis	02
16.	I	II	6.0	DSE-05	MS-MR127T	Enzymology And Bioenergetics	02
17.	I	II	6.0	DSE-06	MS-MR128P	Practical Course Based On Enzymology	02
18.	I	II	6.0	OJT-01	MS-MR129P	On Job Training	04
19.	II	III	6.5	DSC-13	MS-MR 231T	Immunology	04
20.	II	III	6.5	DSC-14	MS-MR 232T	Molecular Biology II	04
21.	II	III	6.5	DSC-15	MS-MR 233P	Practical Course Based On Immunology	03
22.	II	III	6.5	DSC-16	MS-MR 234P	Practical Course Based On Molecular Biology II	03
23.	II	III	6.5	DSE-05	MS-MR 235T	Microbiology In Sustainable Development	02
24.	II	III	6.5	DSE-06	MS-MR 236P	Practical Course Based On Microbiology In Sustainable Development	02
25.	II	III	6.5	PR-01	MS-MR 237P	Project 01	04
26.	II	IV	6.5	DSC-17	MS-MR 241T	Drug Discovery And Development	04
27.	II	IV	6.5	DSC-18	MS-MR 242T	Microbial Technology	04
28.	II	IV	6.5	DSC-19	MS-MR 243P	Practical Course Based On Drug Discovery And Development	02
29.	II	IV	6.5	DSC-20	MS-MR 244P	Practical Course Based On Microbial Technology	02
30.	II	IV	6.5	DSE-07	MS-MR 245T	Waste Water Treatment	02
31.	II	IV	6.5	DSE-08	MS-MR 246P	Practical Course Based On Waste Water Treatment	02
32.	II	IV	6.5	PR-02	MS-MR 247P	Project 02	06

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar (Autonomous)

Board of Studies in Microbiology

Sr. No.	**Name**	**Designation**
1.	Ms. Giramkar Dipali D.	Chairman
2.	Mr. Shaikh Sajid H.	Member
3.	Ms. Pansare Ragini P.	Member
4.	Ms. Shinde Ashwini A.	Member
5.	Ms. Mehetre Vidya S.	Member
6.	Ms. Shinde Supriya D.	Member
7.	Dr. Gahile Yogesh R.	Member
8.	Mr.Wani Ashish S.	Member
9.	Dr. Patil Ulhas K	Member (Co-Opt)
10.	Dr. Dixit Prashant P.	Academic Council Nominee
11.	Dr. Naphade Bhushan S.	Academic Council Nominee
12.	Mr.Choure Rajendra G.	Vice-Chancellor Nominee
13.	Mr. Yewatkar Saikiran	Alumni
14.	Mr. Dube Chandrakant G.	Industry Expert

1. Prologue/ Introduction of the program:

The previous syllabus of M.Sc. Microbiology was sufficient to provide the needs of students to develop their careers in industrial and research sectors. However, with the introduction of NEP in the Credit Based Semester and Grading system and also considering the change at the local and global level scenario, we feel that the syllabus orientation should be changed to keep pace with developments in the education and industrial sectors. This syllabus is implemented with effect from 2023-24. The syllabus has been designed such that the theory goes hand in hand with the practical's thus enabling students to develop professional skillsets of a Microbiologist. Theory supplemented with extensive laboratory expertise will help these students, to avail these opportunities. The need to develop research skills and Critical thinking/reasoning in students was also kept in the mind while developing the syllabi. This will aid the students in their specific area of their interest/ specialization in particular. Syllabus covers various topics enlisted for entrance exams i.e. CSIR NET, SET, GATE, PET, ARS, DBT & entrance tests for other Research Institutes. This revised syllabus is aimed at equipping students with theoretical foundations and practical techniques required in R & D, quality control, regulatory function in pharmaceuticals, environmental sciences, Pharmaceutical Microbiology, Advances in Molecular Biology, Applied & Environmental Microbiology and Environmental monitoring and management. Areas covered in Semester I & Semester II will boost employability of students. Thus, college itself will be developing the trained and skilled man-power required in education, industrial and research fields

In line with the NEP 2020, college offers two types of Master's Programmes – A Two-Year Master's Programme for students joining with Three Year Bachelor's Degree and a One-Year Master's Programme for those who completed Four-Year Bachelor's Degree with Honours/Research.

The NEP-2020 offers an opportunity to affect paradigm shift from a teacher-centric to student-centric higher education system in India. It caters skill based education where the graduate attributes are first kept in mind to reverse-design the programs, courses and supplementary activities to attain the graduate attributes and learning attributes. The learning outcomes-based curriculum framework for a degree in M.Sc. (Honours) Microbiology is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. Effort has been made to integrate use of recent technology and use of MOOCs to assist teaching-learning process among students.

The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of knowledge and skills in Microbiology and allied courses, as well develop scientific orientation, spirit of enquiry, problem solving skills, human and professional values which foster rational and critical thinking in the students. This course serves a plethora of opportunities in different field's right from classical to applied aspects in Microbiology.

Program Outcomes (Pos) Students enrolled in the program complete a curriculum that exposes and trains students in a full range of essential skills and abilities. At the time of completion of the program the students will have developed extensive knowledge in various areas of Microbiology. By cultivating talents and promoting all round personality development through multi-dimensional education a spirit of self-confidence and self-reliance will be infused in the students. They will have the opportunity to master the following objectives.

1. Outline steps in development, differentiation
2. Explore and understand the expanse of the Microbial diversity Identify organisms using bioinformatics tools.
3. Explain structure and classification of viruses
4. Describe, evaluate and use different molecular tools in genetics and modern diagnostic tools.
5. Perform procedures as per laboratory standards in the areas of Biochemistry, Bioinformatics, Taxonomy, and Ecology.
6. Use chromatographic and spectroscopic techniques for analysis of biomolecules.
7. Assess results of research for accuracy and precision.
8. Categorize and communicate ecosystems and explain species interactions.
9. Acquire basic Microbiology laboratory skills and expertise in the use of instruments applicable to research, clinical methods and analysis of the observations.
10. Understand prokaryotic and eukaryotic genetic systems & physiology of microorganisms.
11. Understand the role of microorganisms in human health, immune response to infection and antibiotic resistance.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Microbial cell organization and Biochemistry								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-1	MS-MR 111T	03	00	03	45	30	70	100

Learning Objectives: The objectives of this course are to introduce students to an in-depth analysis of protein structure and function as well as to make students aware of the different components of cell biology and to provide a comprehensive understanding of the concepts of developmental biology.

Course Outcomes (Cos):

1. Students will acquire detailed knowledge about structures and features of Proteins.
2. Students will get to know how to apply different techniques of Biochemistry and Molecular Biology in research as well as in different industries
3. Students will understand Developmental Biology of invertebrates and vertebrate.
4. Students will learn about ultra-structure and organization of Eukaryotic Cell

Detailed Syllabus:

Unit No.	**Topics**	**Allotted lectures**
Unit I	**Protein Chemistry** 1. Structural features of amino acids, classification of amino acids 2. Amino acids as buffers, Henderson Hasselbalch equation and its role in buffer formulation Peptide linkage, partial double bond nature of peptide bond 3. Determination of primary structure of polypeptide (N-terminal, C-terminal determination, method of sequencing of peptides) 4. Structural classification of proteins: primary, secondary, tertiary,	**15**

quaternary structures of proteins, Non-covalent interactions, Conformational properties of proteins, Polypeptide chain

5. Geometry, Resonance forms of the peptide group, cis /trans isomers of peptide group,Ramchandran plot
6. Secondary, Super-secondary, Motif & Domain, Tertiary and Quaternary structures of proteins, (Myoglobin & hemoglobin)

Unit II Developmental Biology **15**

1. Introduction to developmental biology. Different model systems used to study developmental biology
2. Conserved nature of development, Concepts of commitment, determination and differentiation,
3. Morphogen gradients in developmental regulation, Hox code, MPF
4. Gastrulation and cellular movements involved in it, Organizer and its importance giving examples of invertebrates (Drosophilla) and vertebrate (Xenopus) model systems, pattern formation in body axis, antero-posterior and dorso-ventral polarity.
5. Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; transition to flowering, floral meristems and floral development in Arabidopsis.

Unit III Cell biology and Molecular Biology Techniques **15**

1. Cytoskeleton and function of Molecular motors.
2. Protein trafficking among various cellular compartments (by secretory and cytosolic pathway: targeting to secretory vesicles, cell membrane, lysosomes, nucleus, mitochondria and peroxisomes)
3. Events in cell cycle, Regulation of cell cycle. Apoptosis
4. Polymerase chain reaction: Principle, variations of PCR (Hot start, Nested, Reverse transcription, real time PCR) and its Applications.
5. Sequencing methods: RNA-sequencing methods and applications, DNA sequencing: Classical and next generation sequencing methods (Pyro-sequencing, Ion torrent, Nano-pore sequencing).

Suggested Readings/Material:

1. Nelson D. L. and Cox M. M., (2002).Lehninger's Principles of Biochemistry, 4thEdition, Mac MillanWorth Pub. Co. New Delhi.
2. Segel I. H., (1997). Biochemical Calculations. 2ndEdition, John Wiley and Sons, NY.
3. Garrett R. H. and Grisham, C. M., (2004). Biochemistry. 3rdEdition, Brooks/Cole, Publishing Company, California.
4. Moat Albert G. and Foster John W., (2002). Microbial Physiology 4thEdition, John Wiley and Sons New York.
5. Berg Jeremy, Tymoczko John, StryerLubert, (2002).*Biochemistry* 5th Edition, W. H. Freeman, New York.
6. Gilbert Scott F., (2010). Developmental Biology. 9th Edition. Sinauer Associates Inc. Mass. USA.
7. Muller W.A., (1997). Developmental Biology, SpringlerVerlag, New York, Inc.
8. Lewis Wolpert, Cheryll Tickle, and Alfonso Martinez Arias, (2015). Principles of Development, 5th Edition, Oxford University press
9. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter., (2002) Molecular Biology of the Cell, 4thEdition, Garland Science; New York
10. H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, M. P. Scott, A. Bretscher, H. Ploegh, and P. Matsudaira, (2007). Molecular Cell Biology, 6th Edition W. H. Freeman and Company, New York.

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New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Quantitative Biology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-2	MS-MR112T	03	00	03	45	30	70	100

Learning Objectives: This course equips microbiology students with skills in statistics in preparation for areas of biology which require quantitative data analysis. Such skills are important for experimental design and for analyzing and interpreting quantitative data sets arising from modern bioinformatics and biological modeling. Topics covered include basic concepts and tests for analyzing different types of data by Descriptive Statistics, Inferential Statistics and Probability.

Course Outcomes (Cos)

1. Students will understand importance of statistics in biology, measure of central tendency, measure of dispersion, Data presentation, Simple Regression and Correlation
2. Students will understand the testing of hypothesis - concept of null and alternative hypothesis, t test, Z test, chi square test and nonparametric test.
3. Students will understand the Probability and Probability Distributions.
4. Students will understand accurate and efficient use of specific Statistical tools in the analysis of biological data.

Detailed Syllabus:

Unit No.	**Topics**	**Allotted lectures**
Unit I	**Descriptive Statistics**	**15**

1. Fundamental concepts –Sample Statistics and Population parameter, data (qualitative and quantitative data, discrete and continuous series data), data sources, variables, measurement

scales (nominal, ordinal, interval and ratio), variability and uncertainty in measurements

2. Measures of central tendency – Mean Mode, median
3. Measures of dispersion – Mean deviation Standard deviation and Variance
4. Data presentation-Tables and Graphs (Scatter Plot, Box plot, Density Plot, Histogram, bar, pie and line)
5. Correlation and linear Regression *(significance testing not necessary)*

(Sr. No. 1:- only theory questions to be asked in exam. Sr. No. 2 – 5:- only problem solving questions to be asked in exam.)

Unit II Inferential Statistics **15**

1. Uncertainty: Variation, Probability and inference
2. Central Limit Theorem, Standard deviation of the means standard error and confidence interval
3. The concepts of null hypothesis, Test statistics, P-value significance level, type I and type II errors, one tailed and two tailed tests, degrees of freedom, Parametric and nonparametric test, Parametric statistical test: Z-test, t-test and F-test
4. Test of Significance: Chi square test
5. Comparison of 3 or more samples – ANOVA

(Sr. No 1 – 3:- only theory questions to be asked in exam except Z-test, T-test and F-test.)

Unit III Probability and Probability Distribution **15**

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

Suggested Readings/Material:

1. Irfan Ali Khan and Atiya Khanum, Fundamentals of Biostatistics. 3rdEd. Ukaaz, Publications, Hyderabad.
2. Bernard Rosner,(2000).Fundamentals of Biostatistics,5thEdition Duxbury Thomson.
3. Wayne Daniel, (2007). Biostatistics A foundation for Analysis in the health sciences,wileyIn.
4. Norman T. J. Bailey Statistical methods in biology (1995), 3rd Edition, Cambridge University Press.
5. Gupta S.P. Statistical methods, Sultan Chand & Sons Publisher, New Delhi
6. Montgomery D.C. Design and analysis of experiments, 8th Edition John Wiley & Sons
7. Stephen Newman, Biostatistical methods in Epidemiology. Wiley Interscience Publication,
8. Aviva Petrie and Carolene Sabin, (2005), Medical Statistics at a glance, 2nd Edition, Blackwell.
9. David Brown & Peter Rothery. Models in biology: Mathematics, statistics, and computing John Wiley & Sons, USA
10. Brian McNeil and Linda M. Harvey,(2008).Practical Fermentation Technology, John Wiley & Sons, Ltd.
11. Pauline M. Doran, (1995). Bioprocess Engineering Principles by, Elsevier Science & Technology Books.
12. Peter J. Diggle, Amanda G. Chetwynd Statistics and Scientific Method: An Introduction for Students and Researchers, Publisher: Oxford University Press

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New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Microbial Systematics								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-3	MS-MR113T	02	00	02	30	15	35	50

Learning Objectives: The objectives of this course are to acquaint students with basic concepts of microbial diversity and to understand the structural similarities and differences among various physiological groups of bacteria/archaea, to know general bacteriology and microbial aspects pertinent to bacteria and to study the concept of unculturable bacteria and different methods to identify them.

Course Outcomes (Cos)

1. Students will develop the capacity to design experiments to assess the total diversity of environmental samples and learn the basics of grouping organisms with respect to their phylogenies.
2. Students will understand Concept of speciation and species evolution- types of species and evolution.
3. Students will understand the concept of unculturable bacterial diversity and strategies for culture unculturable bacteria and describe Culture independent molecular methods for identifying unculturable bacteria.

Detailed Syllabus:

Unit No.	Topics	Allotted lectures
Unit I	**Microbial Systematics & Diversity** 1. Species concept in prokaryotes and eukaryotes 2. Determinative Bacteriology (Phenetic Approach) 3. Systematic Bacteriology (Phylogenetic Approach) 4. Polyphasic Approach	**15**

5. Molecular clocks, phylogeny and molecular distances
6. Species divergence and measurement of microbial diversity
7. Measures and indices of diversity; alpha, beta and gamma diversity

Unit II **Exploration of Un-culturable microbial diversity:** **15**

1. Concept of "unculturable" bacterial diversity
2. Strategies for culture of "unculturable" bacteria
3. Culture independent molecular methods for identifying uncultura bacteria (PCR, RFLP, ARDRA, DGGE, TGGE, RAPD, Microar FISH, RISA)
4. Methods of extracting total bacterial DNA from a habitat metagenome analysis

Suggested Readings/Material:

1. Microbial Diversity: Form and Function in Prokaryotes, Published Online: 30 NOV 2007. DOI: 10.1002/9780470750490.ch1 Copyright © 2005 by Blackwell Science Ltd
2. Brown James. Principles of Microbial Diversity.ASM Press, 2014.
3. Catherine Lozupone and Rob Knight, (2008).Species Divergence and the measurement of microbial diversity, FEMS Microbiol. Rev. 32 557 – 578.
4. Jennifer Kirk et al, (2004).Methods of studying soil microbial diversity, Journal of Microbiological Methods 58, 169 – 188.
5. Keller M. and Zengler K., (2004), Tapping in to Microbial Diversity. Nature Reviews 2, 141- 8. Pace N. 6.
6. Breed and Buchanan,(1974). Bergey"s Manual of Determinative Bacteriology. 8th Edition
7. Breed and Buchanan,(1982). Bergey"s Manual of Determinative Bacteriology. 9th Edition.
8. Breed and Buchanan. (2001-2003)Bergey"s Manual of Systematic Bacteriology. 2nd Edition, (Volumes. 1 – 5).
9. Sykes, G. and F. A. Skinner,(1973). Actinomycetales: Characteristics and Practical Importance. Society for Applied Bacteriology Symposium Series No. 2, Academic Press..

10. Jacquelyn G. Black, (2013) Microbiology: Principles and Explorations, 6th Edition, John Wiley & Sons.
11. Lodder J., (1974). The Yeasts: A Taxonomic Study, North Holland Publishing Co. Amsterdam.
12. Michael S. Rappe and Stephen J. Giovannoni, (2003). The Uncultured Microbial Majority. Annual Review of Microbiology, 57: 369 – 94.
13. Rakesh Sharma, Ravi Ranjan, Raj KishorKapardar and Amit Grover, (2005). "Unculturavble" bacterial diversity: An untapped resource. Current Science, 89 (1)
14. Sonia R. Vartoukian, Richard M. Palmer and William G. Wade, (2010). Strategies for culture of "un-culturable" bacteria. Minireview, FEMS MicrobiolLett 309, 1 – 7.
15. James D. Oliver, (2005). The Viable but Non-culturable State in Bacteria, The Journal of Microbiology, 43, Special Issue, 93 – 100.
16. Lindell Bromham and David Penny (2003). The Modern Molecular Clock.
17. www.nature.com/reviews/genetics. MARCH 2003 | VOLUME 4, Page. 216. Nature Publishing Group.

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Syllabus
M.Sc. Microbiology

Title of the Course: Practical course based on Biochemical Techniques								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-4	MS-MR114P	00	02	02	60	15	35	50

Learning Objectives: This course objective is to teach the good laboratory practice required to execute the learned techniques, make students aware of the safety measures to be followed in the laboratory, to give hands on experience on the preparation of buffers and various solutions,to identify and separate the biomolecules. The knowledge in the analytical techniques will enable the student for isolation, purification and chemical characterization of compounds from microbes which will have medical or commercial importance

Course Outcomes (Cos)

1. Students will learn Good Laboratory Practices and their importance.
2. Students will understand preparations of buffers
3. Students will study methods of extraction of proteins and exopolysaccharide
4. Students will learn the methods for Biomolecular Separation and Detection

Detailed Syllabus

Title of the experiment

1. Safety rules in Laboratory: Laboratory safety, hazard from chemicals, handling of chemicals, disposal of chemicals and cultures, recording of scientific experiments.
2. Standardization of laboratory procedures, calibration and validation instruments, preparing / designing SOP for the same, maintenance of instruments.
3. Preparation of buffers using KH_2PO_4 and K_2HPO_4, acetic acid and sodium acetate
4. Determination of pKa of a monoprotic weak organic acid
5. Extraction of Protein /Exo-polysaccharide from bacterial culture(may use TCA and ethanol method)

6. Colorimetry and spectrophotometry: Estimation of Protein /Exo-polysaccharide: Bradford and UV Spectrophotometry (purity using A_{280} method) and phenol sulphuric acid method
7. Chromatography: Separation of hydrolysed protein /EPS sample using paper and thin layer chromatography.)
8. Electrophoresis: SDS-PAGE of proteins
9. Interpretation of Ramachandran Plot and study of conformations of protein molecule using Molecular Graphics Visualization Tool (e.g. Swiss PDB)

Suggested Readings/Material:

1. Segel I. H., (1997). Biochemical Calculations. 2nd Edition, John Wiley and Sons, NY.
2. David Plummer. An Introduction to Practical Biochemistry (TMH). 3rd Edition McGraw Hill Education Publication
3. Dr. G. Sattanathan, Dr. S.S. Padmapriya, Dr. B. Balamuralikrishnan. .Practical Manual of Biochemistry. Skyfox Publishing Group Skyfox Press
4. Walker & Gastra, Croom Helm. Techniques in Molecular biology 1983.
5. Holt-Sanders. Principles of instrumental analysis, 2nd Ed, 1980.
6. Brown S.N. An introduction to spectroscopy for Biochemistry, Academic press.
7. Holmes and Hazel Peck, Longman. Analytical Biochemistry, 1983.
8. Robert K. (2015), Introductory Experiments on Biomolecules and their Interactions.
9. J. Jayaraman. Laboratory Mannual in Biochemistry. New Age International Publishers. 2nd Edn. 1981.
10. Alan H Gowenlock Varley's Practical Clinical Biochemistry. published by CBS Publishers and distributors, India Sixth Edition, 1988

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New Arts, Commerce and Science College, Ahmednagar
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Syllabus
M.Sc. Microbiology

Title of the Course: Practical course based on Biostatistics and Bioinformatics								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-5	MS-MR 115P	00	02	02	60	15	35	50

Learning Objectives: This course objective is to provide Microbiology students with skills in statistics, bioinformatics and computing in preparation for areas of biology which require quantitative data analysis, to make them able to interpret results of commonly used statistical analyses in written summaries as well as make them understand the use of bioinformatics tools.

Course Outcomes (Cos)

1. Students will be able to sort data using different parameters
2. Students will be able to represent data in different statistical forms
3. Students will understand the use of various hypothesis tests to interpret scientific data

Detailed Syllabus:

Title of the experiment

1. Computer applications: (Using Microsoft Excel)
   Plotting graphs – bar charts, line graphs, pie charts, adding error bars. (Using data sheets, and sorting data with different parameters)
2. Statistical analysis of data using ANOVA, F test (e.g. Using Microsoft Excel)
3. Statistical analysis of data using Students t test and Chi square test (e.g. Using Microsoft Excel)
4. Databases search for homologous sequence using BLAST and FASTA
5. Pair wise sequence alignment - Local and Global alignment
6. Multiple Sequence Alignment – Clustal Omega, Clustal X, T-Coffee, Muscle

7. Drawing phylogenetic tree using related sequences (Using standard software like Phylip, Mega etc.)
8. Demonstration of databases (GENBANK, PDB, OMIM) and software (RASMOL, Ligand Explorer)

Suggested Readings/Material:

1. Jin Xiong, (2006) Essential Bioinformatics Cambridge University Press, New York publication
2. Dr. S. B. Bhise, Dr. R.J. Dias, K.K. Mali and P. H. Ghanwat (2011) Textbook Of Computer Applications and Biostatistics, Trinity Publishing House
3. Descriptive Statistics using Excel and Stata (Excel 2003 and Stata 10.0+) https://www.princeton.edu/~otorres/Excel/excelstata.htm

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Practical course based on Developmental Biology and Microbial Diversity								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-6	MS-MR116P	00	02	02	60	15	35	50

Learning Objectives: The objective of this course to develop strategies for isolation of bacteria depending upon ecological niches and specific properties. Students will also gain the knowledge of developmental biology.

Course Outcomes (Cos):

1. Students will understand developmental phases in detail by using model organisms.
2. Students will be able to use Bergey's manual and create keys for the identification of Bacteria up to genus level.
3. Students will develop logic of media designing for isolation of a particular group of Microorganisms from a particular environment.

Detailed Syllabus:

Title of the experiment

1. Studying the stages of mitosis in growing tip of onion root cells
2. Development of in vitro of Fruit fly culture
3. Study of various developmental stages of fruit fly and of mounting of embryos
4. Isolation and characterization of pigment producing bacteria
5. Enrichment, Isolation and identification of the alkalophiles from natural samples
6. Demonstration of various stages of chick embryo development
7. Isolation and characterization of cellulose degrading bacteria.
8. Calculation of Simpson diversity index

Suggested Readings/Material:

1. Debarati Das. Essential practical handbook of cell biology and genetics, biometry and Microbiology, A Laboratory Manual, First edition.
2. Ulrich Graf, Nancy van Schaik, Friedrich E. Würgler (2012), Drosophila Genetics, A practical course.
3. R.C Dubey and D. K. Maheshwari (2006) Practical Microbiology Revised edition.
4. Bharti Arora, D. R. Arora (2020), Practical Microbiology.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Virology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-1	MS-MR117T	02	00	02	30	15	35	50

Learning Objectives: The objective of this course is to familiarize students about the replication and morphological features of the viruses, to understand the different viral genomic structures and their replication strategies, to impart knowledge about the mode of transmission, multiplication, infection of viruses and to gain knowledge of cultivation techniques, detection and diagnosis of viruses.

Course Outcomes (Cos)

1. Student will learn the basic structure of viruses
2. Student will understand the structure and replication of viruses
3. Student will learn methods for cultivation ,diagnostic and detection methods for viruses

Detailed Syllabus:

Topic No.	Topic	Allotted lectures
Unit I	**A. Structure of Viruses**	**15**

1. Enveloped and Non enveloped viruses
2. Capsid symmetries – Icosahedral, Polyhedral and Helical
3. Structural components of virus –
4. Protein-Envelope proteins, Matrix proteins and Lipoproteins
5. Genome – dsDNA, ssDNA, dsRNA, ssRNA (positive sense, negative sense and ambisense), linear, circular, segmented
6. Virus related structures – Viroids and Prions

B. Replication of viruses

Virus infection and replication in a host cell: recognition of the host cell, strategies of genomic replication and gene expression in DNA and RNA viruses, control of viral replication, virus assembly, release from the host cell and maturation

(with representative life cycle of)

Unit II A. Cultivation of viruses: **15**

1. *In ovo*: using embryonated chicken eggs
2. *In vivo*: using experimental animals
3. *Ex vivo / In vitro:* using various cell cultures - primary and secondary cell lines, suspension cell cultures and monolayer cell culture

B. Diagnostic and detection methods for viruses:

1. Direct methods of detection – Light microscopy (inclusionbodies), Electron microscopy and Fluorescence microscopy
2. Immnuodiagnosis, Hemagglutination and Hemagglutinationinhibitiontests, Complement fixation, Neutralization,Western blot, Radioactive Immuno Precipitation Assay(RIPA)
3. Nucleic acid based diagnosis: Nucleic acid hybridization, Polymerase Chain Reaction (PCR)
4. Infectivity assay for animal and bacterial viruses – Plaque method, Pock counting, End point methods, LD50, ID50,EID50, TCID50

Suggested Readings/Material:

1. Cann A.J, (2005). Principles of Molecular Virology, 4th Editon, Elsevier Academic Press.
2. Dimmock N. J., Easton A. J. and K. N. Leppard, (2007), Introduction to Modern Virology, 6th Edtion, Blackwell Publishing.
3. Edward K. Wagner, Martinez J. Hewlett, (2004). Basic Virology, Blackwell Publishing.
4. Flint S. J., V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A.M. Skalka, (2003). Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses, American Society Microbiology.

5. Haaheim L. R., J. R. Pattison and R. J. Whitley, (2002). A Practical Guide to Clinical Virology. 2nd Edtion, Edited by, John Wiley & Sons, Ltd.
6. Knipe David M., Peter M. Howley, Diane E. Griffin, Robert A. Lamb, Malcolm A. Martin, Bernard Roizman, Stephen E. Straus, (2007). Field's Virology, 5th Edition, Lippincott Williams & Wilkins
7. Luria S. E. et.al., (1978), General virology, 3rd Edition, New York.John Wiley and Sons.
8. Straus J. H. and Straus E.S., (1998). Evolution of RNA Viruses Ann. Rev. Microbiol. 42: 657
9. Baltimore D., (1971). Expression of Animal Virus Genomes,Microbiology and molecular Bioology Reviews, 35(3), 235 –241.
10. Cornelia Buchon-Osmond, (2003). The Universal Virus Database ICTV db Computing in science and Engineering,May/June, pp 2-11.
11. Fenner F, (1976). The Classification and Nomenclature of Viruses Summary of Results of Meetings of the International Committee on Taxonomy of Viruses in Madrid, September 1975, Journal of General Virology, 31, 463-470.
12. http://ictvonline.org/codeOfVirusClassification_2012.asp
13. Mahy B. WJ. And Kangro H.O., (1996). Virology Methods Manual, Academic Press.
14. Shors T. (2011). Understanding Viruses, 2nd Ed., Jones & Bartlett Publishers LLC, Canada.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Practical course based on Virology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-2	MS-MR118P	00	02	02	60	15	35	50

Learning Objectives: The objective of this course is to learn the different techniques for study and observation of plant and animal viruses, to understand the methods of bacteriophages isolation and one step growth curve.

Course Outcomes (Cos):

1. Students will be able to perform the methods for virus cultivation and detection.
2. Students will be able to perform detection and quantification of bacteriophages and understand one step growth curve.
3. Students will be able to perform the infectivity assay of plant viruses and prepare herbaria of plants infected with plant virus.

Detailed Syllabus:

Title of the experiment

1. Egg inoculation technique for virus cultivation by various routes - embryo, yolk sac, allantoic fluid, amniotic cavity, chorioallontoic membrane.
2. Animal virus titration by Hemagglutination technique
3. Confocal Microscopy demonstration / Analysis of confocal images
4. Qualitative and quantitative detection of bacteriophage
5. One step growth curve of bacteriophage
6. Preparation of plantlets from seeds of indicator plant, leaf infection and infectivity assay for plant mosaic viruses
7. Study of plant virus diseases: Collecting data and samples (preparation of herbaria)
8. Study of the structure of important animal viruses using electron micrographs

Suggested Readings/Material:

1. Cristopher Burrell colin Howard Frederick Murphy.fenner and White's Medical Viroloy 5 th Edition.Academic press
2. Pelczar M. chan E.C.S. and Krieg,N.R. Microbiology.Tata Mc Grew Hill publishing co.Ltd.,New Delhi.
3. Stainer R.V.,Ingraham,J.L.,Wheelis,M.L.and Painter P.R. The microbial World.Printice-Hall of India(Pvt.)Ltd.,New Delhi
4. Ellen strauss,James Strauss,Viruses and human Disease 2nd Edition.Academic press.
5. Harbarium - https://herbarium.duke.edu/about/what-is-a-herbarium
6. Prance, G. T. (2001). The importance of herbaria. Journal of the New York Botanical Garden, 52-58.
7. Sillankorva S. Isolation of Bacteriophages for Clinically Relevant Bacteria. Methods Mol Biol. 2018;1693:23-30. doi: 10.1007/978-1-4939-7395-8_3. PMID: 29119429.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Research Methodology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
RM-1	MS-MR119T/P	02	02	04	90	30	70	100

Learning Objectives: The main objective of this course is to introduce the basic concepts in research methodology. This course addresses the issues inherent in selecting a research problem and discusses the techniques and tools to be employed in completing a research project. This will also enable the students to prepare report writing and framing Research proposals, to develop skills in qualitative and quantitative data analysis and presentation.

Course Outcomes (Cos):

1. Students will learn presentation skills, power point presentation and poster preparation.
2. Students will gain the knowledge about formats of scientific reports, copy rights, plagiarism.
3. Students will be able to design research experiment.
4. Student will be able to write literature review, plant experiment, represent data.
5. Students will learn formats of progress reports and synopsis.
6. Students will learn dissertation techniques.

Detailed Syllabus:

Unit No.	**Topic**	**Allotted lectures**
Unit I	**Introduction of Research Methodology:** 1. Meaning of research, objectives of research, types of research, significance of research. 2. Research Design: Meaning, need and features of good	**15**

research design, types of research designs, -, Descriptive Research Design - concept, types and uses. Experimental Design - Concept of Independent & Dependent variables. Biased and unbiased research design Qualitative and Quantitative Research: Qualitative - Quantitative Research - Concept of measurement.

3. Problem Identification & Formulation: definition and formulating the research problem, Necessity of defining the problem, Importance of literature review in defining a problem. Literature survey: primary and secondary; websources; critical literature review.

Unit II Scientific Communication **15**

1. Concept of effective communication: Presentation skills, formal scientific presentation skills; Preparing power point presentation, Presenting the work, Scientific poster preparation & presentation; Participating in group discussions.
2. Technical writing skills: Types, Formats of scientific reports, scientific writing skills, Significance of communicating science, ethical issues, Copy rights and plagiarism, Components of a research paper, publishing scientific papers - peer review process and problems.
3. Use of search engines for scientific data mining, Use of reference management tools, statistical data analysis using software.

Title of the experiments of Scientific communication

1. Literature review (and choosing a suitable topic)
2. Experiment planning
3. Experimentation, with the use of contemporary methods and standard protocols
4. Representation of and calculations for data obtained
5. Interpretation of data with the use of statistical tools (if required)
6. Writing progress reports / synopsis / abstract of the work done (as applicable).
7. Writing a pedagogical (academic) article on a scientific theme (Review).
8. Writing a Masters' thesis/Writing a review article
9. Oral presentation: Critically commenting on a manuscript (Research Paper / Article).
10. Presenting the thesis in an 'Open Defense'
11. Preparation of display material (such as scientific posters)
12. Preparation of Visual Aids: Photomicrography, taking photographs of experimental results and using them in the reports Scanning pictures
13. Making Power Point slide shows
14. Paper Presentation: Presentation of research article published in peer reviewed journal

Suggested Readings/Material:

1. Anthony M. Graziano A. M. And Raulin M. L., 2009. Research Methods: A Process Of Inquiry Allyn And Bacon.
2. Coley S. M., and Scheinberg C.A., 1990, "Proposal Writing", Sage Publications
3. Fink A., 2009. Conduction Research Literature Reviews: From the Internet to Paper. Sage Publications.
4. Garg, B. L.Karadia R. Agrawal, F. and Agrawal U. K., 2002. An Introduction to Research Methodology, RBSA Publishers.
5. Leedy, P. D. and Ormrod J. E., 2004 Practical Research: Planning and Design, Prentice Hall
6. Practical Research Methods-Catherine Dawson.
7. Research Methodology and Scientific Writings- C George Thomas.
8. Research Methodology: A Step By Step Guide for beginners- Ranjeet Kumar.
9. Research Methodology: An Introduction-Stuart Melville and Wayne.

10. Research Methodology: Principle, Methods and Practices-Joshua O.Miluwi and Hina Rashid.
11. Research Methodology-C R Kothari.
12. Research Methods for Science Michael P Marder.
13. Sinha S. C. and Dhiman A. K., 2002. Research Methodology Ess Ess Publications 2 Columns.
14. Trochim W. M. K., 2005. Research Methods: The Concise Knowledge Base Atomic Dog Publishing. 270P.
15. Wadehra B. L., 2000. Law Relating to Patents, Trade Marks, Copyright Design and Geographical Indications, Universal Law Publishing

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar

(Autonomous)

Syllabus

M.Sc. Microbiology

Title of the Course: Instrumentation and Molecular Biophysics								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-7	MS-MR121T	03	00	03	45	30	70	100

Learning Objectives: To introduce the learner to the basic concept of qualitative and quantitative analysis of various biological samples. Students would be taught about the biophysical and biochemical techniques currently available to investigate the structure and function of the biological macromolecules. Learner would be made aware about the various separation techniques and its instrumentation, principles behind each technique, make them familiar with various methods of analyzing the output data and to build a strong foundation in the area of Microbiology.

Course Outcomes (Cos)

1. Student will learn Biomolecular Separation and Detection methods.
2. Student will understand Biophysical Techniques.
3. Student will learn application of radioisotopes in biology.

Detailed Syllabus:

Unit No.	Topics	Allotted lectures
Unit I	**Separation and analysis of biomolecules**	**15**

1. Techniques for sample preparation: Dialysis, ultra-filtration, centrifugal vacuum concentration
2. Chromatography- Partition Coefficient, Selectivity, Resolution, Column Efficiency, Van Deemter equation, Interpretation of chromatograms, Principle, instrumentation and applications of High Performance Liquid Chromatography (HPLC), Fast Protein Liquid Chromatography (FPLC), Supercritical Fluid Chromatography, Reversed Phase Chromatography and Gas chromatography.
3. Electrophoresis Methods: Pulse field gel electrophoresis, capillary electrophoresis, isoelectric focusing, 2-dimensional electrophoresis, immune-electrophoresis

Unit II **Spectroscopy** **15**

1. Introduction: Electromagnetic spectrum, Atomic orbitals, Molecular orbitals, Electronic, Rotational and Vibrational transitions in spectroscopy.
2. UV/Visible spectroscopy-Instrumentation, Molar Absorptivities, Beer and Lamberts Law, Bathochromic and hypochromic shifts.
3. Fluorescence spectroscopy- Instrumentation, Quantum Yield, Quenching, FRET, Binding and Folding studies, Flow cytometry and FACS
4. Infrared spectroscopy- Principle, Instrumentation, Absorption bands, FTIR and its applications
5. Mass spectroscopy- Principles of operation, Ionization, Ion fragmentation, Mass Analysers, MALDI-TOF

Unit III **A. Biophysical Techniques** **15**

1. NMR spectroscopy: Basic Principles of NMR, Chemical shift, Spin -Spin coupling, NMR Applications in Biology
2. X-ray crystallography: purification of proteins, crystallization of proteins, instrumentation, acquisition of the diffraction pattern, basic principles of x-ray diffraction, Phase determination

B. Radioisotopes in Biology:

1. Principles and applications of radio tracers in medicine, agriculture, industry, and fundamental research
2. Radiation and Radioactive isotopes: Types, Quantities and units of estimation, half-life of isotopes
3. Detection and measurement of radioactivity- Autoradiography, Liquid scintillation counting.

Suggested Readings/Material:

1. Clive Dennison, (2002).A guide to protein isolation, Kluwer Academic Publishers.
2. Pattabhi, V. and Gautham, N., (2002).Biophysics. Kluwer Academic Publishers, New Yorkand Narosa Publishing House, Delhi.
3. David J Holme, Hazel Peck, (1998). Analytical Biochemistry, 3rd Edition Prentice Hall, Pearson Education Limited, Harlow England.
4. Rodney F. Boyer, (2000), Modern Experimental Biochemistry 3rd Edition., Benjamin Cummings.
5. Nölting, B., (2006).Methods in modern biophysics. 2nd Edition. Springer, Germany.
6. Wilson Keith and Walker John,(2005). Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed.Cambridge University Press, New York.
7. Rolf Ekman, Jerzy Silberring, Ann Westman-Brinkmalm, AgnieszkaKraj, (2009). Mass spectrometry: instrumentation, interpretation, and applications, John Wiley & Sons,Inc.,Canada.
8. Irwin H. Segel, (1976). Biochemical Calculations: How to SolveMathematical Problems in General Biochemistry, 2nd Edition.John Wiley & Sons.
9. Mount, D. W., (2001). Bioinformatics: sequence and genomeanalysis. Cold Spring Harbor Laboratory Press, New York.

10. David M Webster, (2000). Protein Structure Prediction-Methods and Protocols, Methods In Molecular Biology Vol143 Humana Press.
11. Narayanan, P., (2000). Essentials of Biophysics. New Age International Publication, New Delhi.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Molecular Biology I								
Year: I					**Semester: II**			
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-8	MS-MR122T	03	00	03	45	30	70	100

Learning Objectives: The course has been organized to cover most of the important aspects related to the Molecular Biology field. The course will provide a brief overview of RNA processing & Molecular Techniques, Tools for Genetic engineering, Genome projects and Molecular diagnostics and its applications. The course will emphasize Post Transcriptional Modifications and Processing of Eukaryotic RNA covering the concepts of Introns, Exons, Splicing Mechanisms, mRNA transport, Regulatory RNAs and RNA Editing. The course will also provide the knowledge regarding various advances of molecular biology in the Molecular diagnostics and its applications.

Course Outcomes (Cos)

1. Students will learn the Mechanism of RNA processing like splicing and nuclear export
2. Students will learn different Tools used in molecular biology, genetic engineering and Molecular Diagnostics
3. Students will understand the concept of various genome projects

Detailed Syllabus:

Unit No.	Topics	Allotted lectures
Unit I	**RNA processing & Molecular Techniques**	**15**

A. RNA Processing: Eukaryotic

1. mRNA splicing (Spliceosome and auto splicing by Intron I and Intron II), rRNA processing, tRNA processing, RNA Editing,
2. Nuclear export of mRNA
3. Regulatory RNAs and noncoding RNAs : Si RNA, Micro RNA, RNAi
4. Pi RNA (PIWI interacting RNAs)

B. Molecular Techniques

Knockout mice, phage display, expressed sequence tags, Yeast two and three hybrid assay, Activity gel assay, DNA helicase assay, Chromatin Immuno-precipitation (ChIP), Designing probe, Epitope tagging

Unit II	**Tools for Genetic engineering**	**15**

A.

1. Enzymes: Restriction endonucleases and methylases; DNA ligase, klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase;
2. Cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing;
3. Labeling of DNA: nick translation, random priming, radioactive and non-radioactive probes,
4. Hybridization techniques: northern, southern, south-western and farwestern and colony hybridization, fluorescence *in situ* hybridization.

B. Vectors for cloning and gene expression:

1. Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Blue script vectors, *Baculovirus* and *Pichia*vectors, plant-based vectors (Ti and Ri as vectors). Vectors for

gene expression: types (pMal, GST, pET-based vectors),

2. Protein tagging and purification (His-tag, GST-tag, MBP-tag)

C. Construction of cDNA and genomic libraries

Unit III **A. Genome projects** **15**

1. Concept of Genome projects and its Applications
2. Introduction to Genome projects of *E. coli*, yeast and Mouse and comparative genomics
3. Gene annotation
4. Human Genome project and its applications

B. Molecular diagnostics and applications

1. Protein arrays to detect polygenic diseases,
2. Detection of diseases-associated changes in gene expression using microarray
3. Detection of RNA signatures of Antibiotic Resistance in Bacteria
4. Detection of miRNA signatures of Cancer

Suggested Readings/Material:

1. Benjamin Lewin, (2008). Genes IX, Jones and Bartelett Publishers Inc.
2. S.B Primrose and R M Twyman, (2006). 7th Edition. Blackwell publishing .
3. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Loswick, (2004). Molecular Biology of the Gene, 5th Edition, Pearson Education, Inc.
4. Bruce Albert et. al., Molecular Biology of the Cell, 6th Edition, Garland Sciences.
5. W. H. Freeman, Loddishet. al., (2012). Molecular Biology, 7th Edition.
6. Weaver R., (2007) Molecular Biology, 4th Edition, McGrew Hill Science.
7. B. R. Glick, J.J. Pasterneck, Principles and applications of recombinant DNA, 3rd Edition, ASM press

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Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Microbial Metabolism and Photosynthesis: MSA								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-9	MS-MR123T	02	00	02	30	15	35	50

Learning Objectives:. The objective of this course is to help the students (i) to learn about the biosynthesis of five families of amino acid and purine, pyrimidine. (ii) To familiarize about the anaerobic respiration and Methanogens.(iii) to impart knowledge about the Photosynthesis and regulation of it.

Course Outcomes (Cos):

1. Students will understand process of biological nitrogen fixation at molecular level.
2. Students will acquire detailed information of anaerobic respiration.
3. Students will gain the knowledge of photosynthesis at molecular level.

Detailed Syllabus:

Unit No.	Topics	Allotted lectures
Unit I	**Nitrogen Metabolism**	**15**

1. Biochemistry of biological nitrogen fixation, properties of nitrogenase and its regulation
2. Ammonia assimilation, glutamine synthetase, glutamate dehydrogenase, glutamate synthetase, their properties and regulation,
3. Biosynthesis of five families of amino acids and histidine.

4. Biosynthesis of purine and pyrimidine bases.

Unit II Anaerobic Respiration and Photosynthesis 15

A. Anaerobic Respiration:

Anaerobic Respiration: Concept of anaerobic respiration, oxidized sulfur compounds, and nitrate as electron acceptor with respect to electron transport chain and energy generation, Biochemistry of methanogenes.

B. **Photosynthesis:**

Organization of photosystem I and II, cyclic and non-cyclic flow of electrons, Z scheme, Hill reaction, photolysis of water ,C3, C4, CAM plants, Photorespiration, Regulation of photosynthesis

Suggested Readings/Material:

1. Nelson D. L. and Cox M. M., (2002), Lehninger's Principles of Biochemistry, 4th Edition, Mac MillanWorth Pub. Co. New Delhi.
2. Segel Irvin H., (1997). Biochemical Calculations. 2nd Edition, John Wiley and Sons, NY.
3. Garrett, R. H. and Grisham, C. M., (2004). Biochemistry. 3rd Edition, Brooks/Cole, Publishing Company, California.
4. Moat Albert G. and Foster John W., (2002). Microbial Physiology 4thEdition, John Wiley and Sons New York.
5. Berg Jeremy, Tymoczko John, StryerLubert, (2002). Biochemistry 5th Edition, W. H. Freeman, New York.
6. Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark, (2012). Brock Biology of Microorganisms, 13th Edition, Benjamin Cummings, San Francisco.
7. White David, (2000). Physiology and Biochemistry of Prokaryotes. 2nd Edition Oxford University Press, New York.
8. Mandelstam Joel and McQuillen Kenneth, (1976). Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Practical course based on Instrumentation Techniques								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-10	MS-MR124P	00	02	02	60	15	35	50

Learning Objectives: The objective of this course is to make students understand the basic working principle, handling of different analytical instrument used in Microbiology.

Course Outcomes (Cos)

1. Students will be able to determine molar extinction coefficient of biomolecule

2. Students will how to perform column chromatography.

3. Students will learn the biosynthesis of nanoparticles and their characterization.

4. Students will understand the principle, working and calibration of the bio-analytical instruments**.**

Detailed Syllabus:

Title of the experiment

1. Determination of molar extinction coefficient of biomolecule
2. Calibration of analytical instruments – Colorimeter and Spectrophotometer by estimation of biomolecules and statistical analysis of data generated.
3. Separation of amino acids by thin layer and paper chromatography
4. Separation of sugar by thin layer and paper chromatography
5. Determination of Nature and Capacity of ion exchange resins
6. Column chromatography – Separation of a mixture of proteins and salt using Sephadex column
7. Biological synthesis of nanoparticles using actinomycetes /fungi/yeast and their

characterization by UV-Vis spectroscopy

8. FTIR analysis of biomolecules
9. Virtual lab exercise to understand the instrumentation, experimentation and interpretation of data obtained using HPLC, FACS, FTIR, GC-MS, NMR, X-Ray crystallography MALDI TOF, SEM, TEM, AFM, Confocal Microscope (representative websites)
10. Visit to any lab or institute to understand the principle and working of the bio-analytical instrument studied in theory courses

Suggested Readings/Material:

1. R.C Dubey and D.K.Maheshwari (2006) Practical Microbiology Revised edition.
2. Microorganisms Miroslav Blumenberg ,Mona Shaaban Abdelaziz Elgaml (2020)
3. Yogita Chaudhary ,Pratik Gosavi ,Annika Durv (2020) Isolation and application of siderophore producing bacteria.
4. Handbook of cyanobacterial monitering and cyanotoxin analysis Jussi Meriluoto, Lisa Spoof, Geoffrey A. Codd · 2017
5. Practical Microbiology By Bharti Arora, D. R. Arora · 2020.
6. Methods for general and Molecular biology, 3rd edition. T.J. Beveridge, J.A. Breznak.
7. Laboratory Methods in Microbiology and Molecular biology. Richa Salwan, Vivek Sharma

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Practical course based on Molecular Biology I								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-11	MS-MR125P	00	02	02	60	15	35	50

Learning Objectives: The main objective of this course is that students will follow laboratory protocols to perform different experiments in molecular biology. Students will get theoretical and practical knowledge of important methods and techniques in molecular biology. These include plasmid purification and quantification, restriction mapping, plasmid curing, Diauxic growth curve, bacterial chromosomal DNA purification and quantification and PCR, as well as gel electrophoresis. Furthermore, students will get hands-on experience in the usage of bioinformatics tools for Gene Annotation.

Course Outcomes (Cos)

1. Students will understand plasmid isolation , quantification, curing of bacterial plasmid and restriction mapping of plasmid
2. Students will understand bacterial DNA isolation and its quantification
3. Students will understand concept of Diauxic growth curve
4. Students will be able to perform gene annotation

Detailed Syllabus:

Title of the experiment

1. Isolation of Plasmid DNA from a bacterial sample
2. Quantitation and characterization of plasmid DNA by gel electrophoresis
3. Construction of restriction digestion map of plasmid DNA
4. Curing of bacterial Plasmid
5. Gene annotation

6. Diauxic growth curve of *E. coli.*
7. Isolation of chromosomal DNA of bacteria, purity checking using A260/A280 ratio
8. Agarose gel electrophoresis of isolated chromosomal DNA of bacteria
9. Demonstration of the PCR technique

Suggested Readings/Material:

1. R.C Dubey and D.K.Maheshwari (2006) Practical Microbiology Revised edition.
2. Lincoln Stein (2001) Genome annotation: from sequence to biology, nature reviews,volume 2, 493-503
3. Jin Xiong, (2006) Essential Bioinformatics Cambridge University Press, New York publication

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Microbiology

Title of the Course: Practical Course based on Microbial Metabolism and Photosynthesis								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-12	MS-MR126P	00	02	02	60	15	35	50

Learning Objectives: The objective of the course is to impart the knowledge of isolation and characterization methods of cyanobacteria and ammonia producing bacteria to students and to enable the students to characterize different bacteria. The Students will develop skills in isolation methods and production of siderophore producing bacteria.

Course Outcomes (Cos)

1. Students will acquire practical knowledge of isolation of plant growth promoting bacteria form different samples.
2. Students will be able to handle extraction techniques.
3. Students will be able to isolate and characterize photosynthetic bacteria, Sulphur reducing bacteria, lignin and xylan degrading microorganisms.

Detailed Syllabus:

Title of the experiment

1. Isolation of IAA producing microorganism.
2. Isolation of siderophore producing microorganism.
3. Enrichment, Isolation and characterization of nitrogen fixing bacteria.
4. Enrichment, Isolation and characterization of Sulphur reducing bacteria/Methanogens.
5. Enrichment, Isolation and characterization of Cyanobacteria.
6. Enrichment, Isolation and characterization of ammonia producing bacteria.

Suggested Readings/Material:

1. R.C Dubey and D.K.Maheshwari (2006) Practical Microbiology Revised edition.
2. Microorganisms Miroslav Blumenberg ,Mona Shaaban Abdelaziz Elgaml (2020)
3. Yogita Chaudhary ,Pratik Gosavi ,Annika Durv (2020) Isolation and application of siderophore producing bacteria.
4. Handbook of cyanobacterial monitering and cyanotoxin analysis Jussi Meriluoto, Lisa Spoof, Geoffrey A. Codd · 2017
5. Practical Microbiology By Bharti Arora, D. R. Arora 2020.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
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Syllabus
M.Sc. Microbiology

Title of the Course: Enzymology and Bioenergetics								
Year: I				**Semester: II**				
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-3	MS-MR127T	02	00	02	30	15	35	50

Learning Objectives: The course is designed to enable students understand enzymes, properties, mechanism of action and regulation of their activity and to acquaint students grasp the basic cascades of the energy transfer system and subsequent products in biology. The course will help the students understand fundamental energetics of biochemical processes, their functionalities.

Course Outcomes (Cos)

1. Student will gain detailed information of enzyme structure, purification, kinetics, inhibitors etc.
2. Students will learn the concept of allosteric, models and kinetics of allosteric enzymes.
3. Students will learn the significance of allosteric enzymes in regulation.
4. Student will understand the laws of thermodynamics, Gibbs free energy equation.
5. Student will learn to determine free energy of biological oxidation reduction reactions.
6. Student will learn about high energy compounds, Atkinson's energy charge etc.

Detailed Syllabus:

Unit No.	Topics	Allotted lectures
Unit I	**Enzymology** 1. Purifications of enzyme, purification chart, 2. Kinetics of reversible inhibitions: Competitive, uncompetitive, non-competitive, mixed, substrate. Primary and secondary plots, Determination of Ki using secondary plots. Significance of inhibitors 3. King Altman approach to derive – two substrate enzyme catalysed reactions 4. Concept of allosterism, positive and negative co-operativity, models of allosteric enzymes (Monad, Wyamann and Changuax and Koshland, Nemethy and Filmer model), kinetics of allosteric enzyme, Hill plot, examples of allosteric enzymes and their significance in regulation.	**15**
Unit II	**Bioenergetics** 1. Laws of thermodynamics, entropy, enthalpy, free energy, free energy and equilibrium constant Gibbs free energy equation with reference to biological significance. 2. Determination of free energy of hydrolytic and biological oxidation reduction reactions under standard and non-standard conditions 3. High energy compounds 4. Coupled reactions 5. Determination of feasibility of reactions 6. Problems based on 2 and 4. 7. Atkinson‟s energy charge.	**15**

Suggested Readings/Material:

1. Nelson D. L. and Cox M. M., (2005). Lehninger‟s Principles of Biochemistry, 4th Edition, W.H. Freeman & Co. New York.

2. Palmer Trevor, (2001). Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.
3. Segel Irvin H., (1997). Biochemical Calculations 2nd Edtion., John Wiley and Sons, New York.
4. Garrett, R. H. and Grisham, C. M., (2004). Biochemistry. 3rd Edifion, Brooks/Cole, Publishing Company, California
5. Michael T. Madigan, John M. Martinko, David A. Stahl, David P. Clark, (2012). Brock Biology of Microorganisms,13th Edition, Benjamin Cummings, San Francisco.
6. Moat Albert G. and Foster John W., (1988). Microbial Physiology 2nd Edition. John Wiley.
7. Berg Jeremy, Tymoczko John, StryerLubert,(2001). Biochemistry 4th Ed, W. H. Freeman, NY.
8. White David, (2000). Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York. 2. Mandelstam Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.

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New Arts, Commerce and Science College, Ahmednagar
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Syllabus
M.Sc. Microbiology

Title of the Course: Practical Course based on Enzymology								
Year: I					**Semester: II**			
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-4	MS-MR128P	00	02	02	60	15	35	50

Learning Objectives: This course is designed to obtain a basic knowledge about how enzymes work, to determine the optimum pH, temperature and concentration of an enzyme for a certain reaction and to study the kinetics of enzymes.

Course Outcomes (Cos)

1. Students will be able to purify enzymes using different methods.

2. Students will be able analyze kinetic properties of enzymes.

3. Students will be able to isolate enzyme producing microbes

Detailed Syllabus:

Title of the experiment

1. Isolation of enzyme Producing microorganism , production and quantification of the Enzyme produced : (any two) Protease/Lipase/ Chitinase/ Cellulase
2. Purification of enzymes (Amylase/Invertase): (any one method - ammonium sulphate precipitation, organic solvent precipitation, gel filtration, etc.) and Establishment of enzyme purification chart
3. Effect of temperature/pH/Salt/activators/ inhibitors/ on Enzyme activity (any one factor or parameter on any one enzyme)
4. Determination of Km and Vmax values of enzyme (any two enzymes)

Suggested Readings/Material:

1. Palmer T. Understanding enzymes. Ellis Harwood ltd., 2001.

2. S.P. Colowick and N.O. Kaplan. Methods in Enzymology Vol. I and II. New York: Academia Press, 1955.
3. Wilchek, Meir, and Edward A. Bayer. "Methods in enzymology." (1990).
4. Sawhney, S. K., and Randhir Singh. Introductory practical biochemistry. Alpha Science Int'l Ltd., 2000.
5. A. White, P. Handler, and E. L. Smith. Principles of Biochemistry. 5th edition pp 1296: McGraw-Hill Kogakusha Ltd., 1973,
6. Dr.J.Jayaraman. Manuals in Biochemistry. New Age International Private Limited publication.
7. David Plummer. An Introduction to Practical Biochemistry. 3rd Edition. McGraw Hill EducationFvirology
8. Dr.S.Ramakrishnan. Manuals in Biochemistry. TR Publications 1995.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
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Syllabus
M.Sc. Microbiology

Title of the Course: On Job Training								
Year: I					**Semester: II**			
Course Type	Course Code	Credit Distribution		Credits	Allotted lectures	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
OJT-01	MS-MR129P	00	04	02	60	15	35	50

Learning Objectives: The Objectives are for students 1.to learn how to use particular tools or equipment in a live-work practice, simulated, or training environment, typically under the guidance of a supervisor or mentor 2. To gain experience working in situations very similar to those they'll encounter on a daily basis in the industry.

Course Outcomes (Cos)

1. Students will be able to Expand Training with Real Experience.

2. Students will learn skills like adaptability and flexibility.

3. Students will comprehend the devices and procedures in the company quickly and proficiently