Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022
'B^{++}' Grade (CGPA 2.96)

Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

Syllabus: Biotechnology

Name of the Course: M.Sc. I (Sem. I &II)

(Syllabus to be implemented from June 2024)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science & TechnologyNep 2020 Compliant Curriculum

M.Sc. (Biotechnology)

Program Preamble

Master of Science (M.Sc.) in Biotechnology is a comprehensive program that provides a broad overview of biotechnology and can produce expert hands with knowledge and expertise to deal with the several issues, problems, opportunities and challenges in life sciences and their numerous applications. The course structure is technology-centric where students learn about the advances in Biotechnology along with the necessary fundamental knowledge of subjects in life sciences. Aligned with the vision of the National Education Policy (NEP) 2020, the program offers a flexible, multidisciplinary, and learner-centric curriculum that encourages critical thinking, innovation, and holistic development. This programme allows the opportunity to the students to experience holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per their choices. Each year of the curriculum offers progressively advanced learning and is designed to build a strong foundation in Biotechnology. The curriculum is structured around several key components:

1. **Major Courses:**These core courses form the backbone of the program, providing in-depth knowledge and understanding of essential Biotechnology concepts, theories, andmethodologies.
2. **Minor Courses:** Students have the opportunity to choose minor courses from related or distinct disciplines, promoting an interdisciplinary approach to learning.
3. **Open Electives/General Electives:** The program encourages intellectual exploration beyond the core discipline by offering a wide range of elective courses. These electives enable studentsto pursue their interests in diverse subjects, fostering creativity, critical thinking, and a well-rounded educational experience.
4. **Vocational and Skill Enhancement Courses:** Practical skills and technical proficiency are integral to the program, with vocational and skill enhancement courses providing hands-on experience in Biotechnology areas. These courses are designed to prepare students for immediate employment and equip them with the tools necessary for career advancement in various scientific and technological fields.
5. **Ability Enhancement Courses (AEC), Indian Knowledge System (IKS), and Value Education Courses (VEC):** In alignment with NEP 2020, the program integrates courses that emphasize the Indian Knowledge System, ethical values, and life skills. These courses foster a deep appreciation for India's rich cultural heritage, while also developing essential communication and ethical decision-making skills that are vital for personal and professional growth.
6. **Field Projects/Internships/Apprenticeships/Community Engagement Projects/On-Job Training:** To bridge the gap between theoretical knowledge and real-world applications, the program includes opportunities for field projects, internships, apprenticeships, and community engagement. These experiences provide students with practical insights, problem-solving abilities, and exposure to professional environments, enhancing their readiness for careers in Biotechnology and related fields.

7. **Research Methodology and Research Projects:** Research is a critical component of the M.Sc Biotechnology program, with students acquiring skills in research methodology, data collection, analysis, and scientific inquiry. By engaging in independent research projects, students are encouraged to develop innovative solutions to complex scientific problems, preparing them for advanced studies and research-oriented careers.

Multiple Entry and Multiple Exit Options:

In accordance with the NEP 2020, the M.Sc Biotechnology program incorporates a Multiple Entry and Multiple Exit framework, offering students the flexibility to enter or exit the program at various stages. This approach ensures that students can tailor their educational journey according to their personal and professional goals, with options to earn certificates, diplomas, or degrees based on the duration of study completed.

- Post-Graduation: First Year : PG Diploma (44 Credits)
- Post-Graduation: Second Year: Masters Degree (44 Credits)

Eligibility for <u>M.Sc. I Biotechnology</u>:

- A Candidate possessing Bachelor Degree with Biotechnology/Biochemistry/Chemistry/ Microbiology/Botany/Zoology/B. Pharm/MBBS/BAMS/BHMS/BUMS/BDS/B. E./B. Sc. Agri. OR Concerned subjects to life sciences from recognized university, and **who have passed the entrance examination conducted by the PAH Solapur University** shall be eligible for admission to the M. Sc. Programme in Biotechnology.
- **Admission:** Merit list based on average of B. Sc. aggregate and an Entrance Exam conducted by PAH Solapur University.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।
NAAC Accredited-2022 'B++' Grade (CGPA-2.96)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science & Technology

NEP 2020 Compliant Curriculum

M. Sc. (Biotechnology)
Program Outcomes (PO)

Students with post graduation from the Master of Science in Biotechnology program will be able to:

Major Courses:

- PO1: Have an intensive and in-depth learning and are acquainted with fundamental and advanced knowledge of science in their specialization area.
- PO2: Have a scientific temperament and a basic research aptitude to address the underlying recurring issues and new opportunities.
- PO3: Have an awareness about professional and ethical responsibilities required for their work field.
- PO4: Have developed an awareness, skill & knowledge as per the requirements of career opportunities in the field of specialization to take up a wide variety of roles.

Minor Courses:

- PO5: Acquire complementary knowledge and skills from a related or distinct discipline, enhancing interdisciplinary understanding and versatility.

Open Electives/General Electives:

- PO6 Explore diverse subjects beyond the core discipline, fostering a broad-based education and cultivating critical thinking and creativity.

Field Projects/Internship/Apprenticeship/Community Engagement Projects/ On Job Training/ Internship/Apprenticeship:

- PO7: Apply theoretical knowledge to real-world situations through field projects, internships, community engagement and On job Training for gaining practical experience and problem-solving skills.

Research Methodology and Research Project:

- PO8: Acquire research skills, including data collection, analysis, and interpretation, fostering a scientific approach to problem-solving to develop independent research projects handling capabilities.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science & Technology
Nep 2020 Compliant Curriculum

M.Sc. (Biotechnology)
Program Specific Outcomes (PO)

PO 01 Students have a basic as well as in depth understanding about the fundamentals and advances in the core subjects of biotechnology.

PO 02 Students have acquired practical and theoretical knowledge in subjects of biotechnology.

PO 03 Students become skilled with techniques in biotechnology and are able to critically think about application of these skills as per requirement.

PO 04 Students have developed a research and logical aptitude and are able to interpret and communicate the biological data.

PO 05 Students can identify the contemporary technical and professional requirements in Biotechnology and are competent to take up a wide variety of roles.

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY,SOLAPUR

M. Sc. Biotechnology

Syllabus for M. Sc. I - Biotechnology - Sem.-I

Semester	Code	Title of the Paper	Semester Examination			Hrs/ Week	Credits
		Mandatory (Major)	**UA**	**CA**	**Total**		
Sem-I	**2311101**	Biochemistry and Enzymology	60	40	100	4	4
	2311102	Cell and Molecular Biology	60	40	100	4	4
		Mandatory (Minor)					
	2311103	Research methodology	60	40	100	4	4
		ELECTIVE (Any one)					
	2311107	Biostatistics and Bioinformatics	60	40	100	4	4
	2311108	Nanomaterials and Fabrication					
	2311109	Plant breeding and Tissue Culture					
		PRACTICALS					
	2311104	Practical Course Biochemistry and Enzymology	30	20	50	4	2
	2311105	Practical Course Cell and Molecular Biology	30	20	50	4	2
	2311106	Practical Course (Elective subject)	30	20	50	4	2
		Total for Semester-I	**440**	**110**	**550**		**22**

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY,SOLAPUR

M. Sc. Biotechnology

Syllabus for M. Sc. I - Biotechnology - Sem.-II

Semester	Code	Title of the Paper	Semester Examination			Hrs/ Week	Credits
		Mandatory (Major)	**UA**	**IA**	**Total**		
Sem-II	**2311201**	Microbiology and Microbial Techniques	60	40	100	4	4
	2311202	Immunology and Immunotechniques	60	40	100	4	4
		Mandatory (Minor)					
	2311203	On Job Training/ Field Project	60	40	100	4	4
		ELECTIVE (Any one)					
	2311207	Inheritance Biology	60	40	100	4	4
	2311208	Molecular Medicine					
	2311209	Cancer Genetics and Animal Tissue Culture					
		PRACTICALS					
	2311204	Practical Course Microbiology and Microbial Techniques	30	20	50	4	2
	2311205	Practical Course Immunology and Immunotechniques	30	20	50	4	2
	2311206	Practical Course (Elective subject)	30	20	50	4	2
		Total for Semester-II	**440**	**110**	**550**		**22**

M. Sc. I - Biotechnology - Sem.-I

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I
Vertical : DSC
Course Code: 2311101
Course Name: BIOCHEMISTRY AND ENZYMOLOGY

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:
The course aims to introduce the theories and concepts of biomolecules, provide an advanced understanding of the core principles and topics of biomolecule metabolism and their experimental basis and to enable students to acquire a specialized knowledge and understanding of energetics , photosynthesis, oxidative phosphorylation and nutritional importance of minerals. This course also emphasizes the concept of enzyme catalysis and fundamentals about the kinetic study of enzyme catalyzed reactions.

Course Objectives:
During this course, the student is expected to:

- Get an introduction to the components of the biochemical basis of the living system.
- Understand the structure, organization and role of important biomolecules and bioactive components.
- Understand the biochemical processes and metabolic pathways in the living cells.
- Get knowledge about the mechanism and kinetic aspects of enzyme catalyzed reactions and their biological regulation.

Course Outcomes:
At the end of this course:

- Students get acquainted with the components of the biochemical basis of the living system.
- Students can understand the structure, organization and role of important biomolecules and bioactive components.
- Students can understand the biochemical processes and metabolic pathways in the living cells.
- Students have knowledge about the mechanism and kinetic aspects of enzyme catalyzed reactions and their biological regulation.

BIOCHEMISTRY AND ENZYMOLOGY (4 Credits - 60L)

Unit I	Biomolecules and metabolism	No. of Lectures: 20	Weightage (UA):20-28 Marks

Properties of biomolecules favoring living conditions-directionality, information, 3D architecture,Structural complementarity

Structure, function biological role and important biochemical pathways of:

Carbohydrates: Glycolysis, Gluconeogenesis, TCA, Pentose Phosphate Pathway, Glycogen metabolism

Amino acids and Proteins: Conformation of proteins (Primary, secondary, Ramachandran plot, tertiary and quaternary structure; domains; motif and folds),

Amino acid metabolism-Decarboxylation, transamination, deamination, Urea cycle

Lipids: biosynthesis and beta oxidation of fatty acids

Nucleic acids: Nucleotide metabolism-De-novo and Salvage pathway

Vitamins: Source, biochemical role and deficiency disorders

Hormones: Classification and role of human hormones

Unit II	Oxidative phosphorylation and photosynthesis	No. of Lectures: 10	Weightage (UA):10-18 Marks

Oxidative phosphorylation - Location, components and their arrangement, mechanism of working, theories and evidence for it, inhibitors and uncouplers.

Photosynthesis – Location, light harvesting in green plants, photosystem I & II, Z scheme of noncyclic photophosphorylation, Cyclic photophosphorylation, dark reactions – C3 and C4 pathway, rubisco enzyme, synthesis of sucrose and starch.

Unit III	Enzymes	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Nomenclature and Classification, Characteristics, Activation energy. Transition state theory. Effect of temperature, pH and substrate concentration on reaction rate.

Mechanism of Enzyme Catalysis: Factors affecting catalytic efficiency - proximity and orientation effects, distortion or strain,

Types of catalysis with example: acid - base and nucleophilic catalysis.

(Lysozyme, ribonuclease, trypsin, carboxypeptidase, phosphorylase, aspartate transcarbamylase and Na - K ATPase), Ribozymes, Abzymes. Multienzyme complex. Clinical significance of enzymes.

Unit IV	Enzyme Kinetics	No. of Lectures: 15	Weightage (UA): 15-23 Marks

Enzyme activity, international units, specific activity, turnover number

Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Graphical procedures in enzymology.

Enzyme inhibition - Types of inhibitors- competitive, non- competitive and uncompetitive (with respect to Lineweaver Burk Plot), Allosteric sites, Modulators, Protein ligand binding, cooperativity, Hill's and Scatchard plot, Enzyme Regulation: Product inhibition, feedback control, enzyme induction Immobilization of enzymes, Enzymes as biosensors.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Vertical : DSC

Course Code: 2311104

Course Name: Practical Course-BIOCHEMISTRY AND ENZYMOLOGY

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

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Practical Course- BIOCHEMISTRY AND ENZYMOLOGY (2 Credits)
1. Qualitative and Quantitative analysis of carbohydrates. 2. Qualitative and Quantitative analysis of proteins. 3. Qualitative and Quantitative analysis of amino acids. 4. Quantitative analysis of nucleic acids – Diphenylamine and Orcinol Method 5. Estimation of Vitamin C. 6. Qualitative analysis of lipid detection and estimation of acid value, saponification value 7. Isolation of chloroplast and spectrophotometric assay of Hill's oxidation. 8. Isolation and quantification of activity of – amylase / invertase / alkaline phosphatase (salivary / plant source) 9. Determination of specific activity of enzyme. 10. Determination of Km and Vmax of enzyme (Amylase/ Invertase/ Alkaline Phosphatase). 11. Determination of optimum parameter of enzyme – pH and temperature/ activator and inhibitor. 12. Perform the immobilization of enzyme/Cell.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Course Name: BIOCHEMISTRY AND ENZYMOLOGY

REFERENCE BOOKS:

1. Biochemistry by Stryer Lubert. (1988). New York: Freeman
2. Biochemistry by Mathew VanHolde
3. Lehninger A. L. (1982), Principles of Biochemistry. 5th Edition (2008), David Nelson &Michael Cox, W.H. Freeman and company, NY.
4. Voet, D., & Voet, J. G. (2004). Biochemistry (4th ed.). Hoboken, NJ: J. Wiley &Sons.
5. Hormones by Norman Litwack
6. Fundamentals of Enzymology- Price and Stevens
7. Enzymes -Dixon and Webb
8. Isoenzymes By D. W. Moss
9. Immobilized Biocatalysts- W. Hartneir
10. Selected papers Allosteric Regulation -M. Tokushige
11. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Trevor Palmer, (2004)
12. Principles and Applications in Engineering Series: Biotechnology for Biomedical Engineers - MartinL.Yarmush, CRC Press, Boca Raton London New York Washington,D.C.
13. Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988
14. Laboratory Manual in Biochemistry J. Jayaraman
15. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande: Dreamtech Press (2020)
16. An introduction to practical biochemistry by David Plummer (3rd Ed.)
17. Biochemical Methods S.Sadasivam and A. Manickam (4th Ed.) 2022.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I
Vertical : DSC
Course Code: 2311102
Course Name: CELL AND MOLECULAR BIOLOGY

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:
The new field of modern biology called molecular biology has enormous potential for use in a wide range of contexts, including the biological sciences, the basic sciences, and other related applied fields. The Molecular Biology Course is conducive to a multidisciplinary approach because it aims to equip blended learners with the necessary skills to conduct research in any area of interest in modern biology. This course is designed for young people with strong academic credentials from a variety of subjects and gives them more chances to get ready for competitive exams (CSIR/UGC, GATE, etc.) for those who want to work as instructors or researchers.Students conduct a molecular biology research project during the course's fourth semester.

Course Objectives:
During this course, the student is expected to:

- It deals with understanding the molecular aspects of biology.
- It majorly emphasizes the concepts of central dogma of molecular biology spanning from DNA Replication till Protein Synthesis and Reverse transcription.
- It also helps in understanding the concepts of cellular functionStudents will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.

Course Outcomes:
At the end of this course:

- Students will understand how these cellular components are used to generate and utilize energy in cells.
- Students will understand the cellular components underlying mitotic cell division.
- Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function.
- These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.

CELL AND MOLECULAR BIOLOGY - (4 Credits - 60L)			
Unit I	**Cell Theory and Genome organization**	**No. of Lectures: 16**	**Weightage (UA):16-24 Marks**
Cell Theory, Cell structure, Ultrastructure and function of Cell organelles, Cell cycle ; Gene structure of Prokaryote and eukaryote DNA as a genetic material (Avery MacLeod and McCarty; Hershey and Chase experiments), Heterochromatin and Euchromatin, Organization of prokaryotic and eukaryotic genome; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; DNA Denaturation (Tm), DNA Renaturation kinetics (Cot curve analysis): - Repetitive DNA and unique sequences; Satellite DNA; and buoyant density.			
Unit II	**Cytoskeleton and Cell Signaling**	**No. of Lectures: 14**	**Weightage (UA): 14-22 Marks**
Structure & function of cytoplasmic membrane, models of cell membrane, membrane permeability, Structure and function of cytoskeletal. Cell adhesion, types of cell junctions, Cell adhesion receptors. Extracellular & Intracellular Messengers, types of receptors, Signal transduction pathway- G-Protein coupled receptors, Receptor tyrosine kinase (RTK), activation of downstream signaling pathway, Light induced signal transduction, general types of Ras Pathway.			
Unit III	**DNA Replication & DNA Damage Repair**	**No. of Lectures: 14**	**Weightage (UA):14-22 Marks**
Unit of Replication: Enzymes involved in replication, Mechanism of DNA replication in Prokaryotic & Eukaryotic. DNA Damage**:** -Mutagens, Types of mutation; DNA Repair: **-** Photoreactivation, Nucleotide and base Excision, Mismatch, SOS, Recombination repair, Role of recA, recBCD pathwayin E. coli, Eukaryotic repair Mechanisms Recombination: Proteins involved in Recombination, Recombination between heteroduplex, Holliday intermediate.			
Unit IV	**Transcription & Translation**	**No. of Lectures: 16**	**Weightage (UA):16-24 Marks**
Regulatory regions and Regulatory proteins, Enzymes involved in Prokaryotic & eukaryotic Transcription; Mechanism of Transcription in Prokaryote & Eukaryote: - initiation, Elongation and Termination (Rho dependent, Rho independent), RNA modification, Transcription regulation in prokaryote & eukaryote, Reverse transcription. Genetic code, Components of translation, Mechanism of Translation in Prokaryote & Eukaryote; translational proofreading, PTM (Post translational modification, Regulation of translation.			

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Vertical : DSC

Course Code: 2311105

Course Name: Practical Course-CELL AND MOLECULAR BIOLOGY

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

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Practical Course- CELL AND MOLECULAR BIOLOGY (2 Credits)

1. Perform the Isolation of organelle DNA Chloroplast.
2. Perform the Isolation of mitochondria and assay of a marker enzyme.
3. Study of flow cytometer (FACS).
4. Perform the Isolation of genomic DNA from bacteria.
5. Perform the Isolation plasmid DNA from bacteria.
6. Perform the Isolation of genomic DNA from Plant/Yeast
7. Perform the Isolation of RNA from Plant cell / Yeast.
8. Quantification of DNA by DPA Diphenylamine assay/Fluorescent.
9. Perform and study the photoreactivation in bacteria.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Course Name: CELL AND MOLECULAR BIOLOGY

REFERENCE BOOKS:

1. Molecular Cell Biology, Lodish et al.Scientific American Books (1995)
2. The World of the Cell Becker, W.M. et al.Benjamin Cummings (2004)
3. Cell and Molecular Biology, Karp G,John Wiley and Sons. (1999).
4. Molecular Biology of Cell, Alberts B et al.Garland Publishers, (2001)
5. Lehninger Principle of Biochemistry, Nelson DL and Cox MM, Worth Publishers, (2000)
6. Principles of cell and Molecular Biology, Kleinsmith LJ & Kish VM,Harper Collins CollegePublishers (1995). 1. Benjamin Lewin -Gene VI, Gene VII, Gene IX, Gene X Oxford University press2 David Friefieder -Essentials of Molecular Biology, Jones &Barlett publications
7. J. Kendrew Encyclopedia of MolecularBiology Blackwell Scientific publications.4 Weaver Molecular Biology
8. J.D.Watson, N.H.Hopkins ,J.W Roberts,et alMolecular Biology of the Gene,Benjamin Cummings publ.co.inc.,California
9. J.Darnell. *et. al.*, molecular biology of the cell (2nd edition) Garland Publishing Inc.7 Meyers R.A (ed)., Molecular biology and biotechnology.VCH publishers NY Inc.
10. Alberts B *et. al.*, Molecular biology of the cell. Garland Publishing Inc.9 Watson J.D., Recombinant DNA.
11. Malacimski; Essentials of Molecular Biology.11 Stansfield; Molecular and cell biology.

12 Walker Molecular biology and Biotechnology.

13 Brown T.A Essential of Molecular biology Vol 1 and 2 each. 14 Dale Molecular Genetics of Bacteria

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I
Vertical : DSC
Course Code: 2311103
Course Name: RESEARCH METHODOLOGY

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:
Research is important in many areas of life which is of great importance. Research Methodology is the primary principle that will guide the students for research. Students learn the fundamentals of research methodology, including data collection, analysis, quantitative methods, and report writing. Students will learn about research methods, problem solving, and analytical techniques. Students will also be able to utilize theoretical knowledge and calculation for proving certain hypotheses put forth during research. Students will learn research skills, including how to apply research design and statistics, and how to use computers for data analysis and report writing.

Course Objectives:
During this course, the student is expected to:

- Identify an appropriate research problem in their interesting domain.
- Understand the Preparation of a research project report
- Understand the law of patent and copyrights.
- Understand the Adequate knowledge on IPR

Course Outcomes:
At the end of this course:

- Students will get useful information about Steps in Research and Sampling Techniques
- Students will be able to learn about Thesis and Manuscript writing.
- Students will know the importance of patents and IPR in processing their innovations.

RESEARCH METHODOLOGY - (4 Credits - 60L)			
Unit I	**Research**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Definition, Importance and Meaning of Research, Objectives, Characteristics, Types of Research. Steps in Research; Identification, Selection and Formulation of Research Problem, Research Design, Formulation of Hypothesis.			
Unit II	**Sampling Techniques & Parametric Tests**	**No. of Lectures: 15**	**Weightage (UA): 15-23 Marks**
Sampling theory, Types of Sampling, Steps in Sampling, Sample Size, Advantages and limitations. Collection of Data: Primary Data, Data Collection Methods, Secondary Data, Relevance, Limitations and Cautions, Testing of significance Mean, Proportion, Variance and Correlation, Testing for Significance of Difference between Means, Proportions, Variances and Correlation Coefficient. Chi- square tests, ANOVA.			
Unit III	**Thesis and Manuscript writing**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Report Writing : Structure and components of scientific reports, types of report, Significance,Different steps in the preparation, layout: Abstract, Introduction, Materials and Methods,Results and Discussion, Summary and Conclusion, References (IMRAD). structure and language of typical reports, illustrations and tables, bibliography, Webliography, referencing, Appendices, plagiarism Preparation of Manuscript; Author instructions, modes of paper communication, Use of Audio-Visual aids in Presentation. citation index, h-index, i10-index, ISSN and ISBN. Scientific proposal writing for funding agencies (UGC, CSIR, DBT, DST, ICMR and DRDO).			
Unit IV	**Introduction to IPR and Patents**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Intellectual property, Protection of Intellectual property, WIPO, forms of protection- patent, copyright, trademark, geographical indications, trade secrets. Criteria and procedure of patenting,patenting biological material. Patent procedure in India and PCT-Patent cooperation treaty. Types of patenting, Patenting of biological materials with examples and case studies,IP Infringement. Plant breeder's right, Farmer's right, advantages and disadvantages of PBR**.**			

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Course Name: RESEARCH METHODOLOGY

REFERENCE BOOKS:

1. Statistical Methods by S.P. Gupta.
2. Research Methodology, Method and Techniques by C.R. Kothari or by Santosh Gupta.
3. Research Methodology by Gurumani.
4. Textbook of Biotechnology, P K Gupta
5. Textbook of Biotechnology, B D Singh.
6. Research Methodology: Methods and Techniques ,Kothari C.R., 1990.. New Age International.
7. Research Methodology; Sinha S.C. and Dhiman, A.K., 2002. Ess Publications. 2 volumes.
8. Research Methodology ; Panneerselvam R., PHI, Learning Pvt. Ltd., New Delhi - 2009
9. Research Methods: A Process of Inquiry Anthony, M., Graziano, A.M. and Raulin, M.L., 2009.,
10. Proposal Writing ; Coley, S.M. and Scheinberg, C. A., 1990, Sage Publications.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I
Vertical : DSE
Course Code: 2311107
Course Name: BIOSTATISTICS AND BIOINFORMATICS

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:

Bioinformatics is a newly emerging branch of life sciences. This course is designed to give the basic knowledge of bioinformatics tools and softwares. Students will get the basic knowledge of bioinformatics. The course covers the important points like methods to retrieve the gene and protein sequences, prediction of structures, knowledge of different types of databases. This course also develops practical knowledge about the use of databases, retrieval of sequences etc. The Biostatistics course will cover the basic knowledge about the data collection, analysis techniques and interpretation of results. Biostatistics covers the application in almost all fields of life sciences.

Course Objectives:
During this course, the student is expected to:

- Understand the relevance of statistics in biology, concept of hypothesis testing.
- Learn about tools and techniques of bioinformatics and their use for analysis and interpretation of biological data.
- Gain knowledge about the in-silico tools and techniques used in molecular biology.

Course Outcomes:
At the end of this course:

- Students can understand the relevance of statistics in biology, concept of hypothesis testing.
- Students learnt about tools and techniques of bioinformatics and their use for analysis and interpretation of biological data.
- Students got knowledge about the in-silico tools and techniques used in molecular biology.

BIOSTATISTICS AND BIOINFORMATICS (4 CREDITS - 60L)			
Unit I	**Measures of central tendency**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Population, Sample, sampling methods, classification of data, Frequency Distribution, tabulation, graphic and diagrammatic representation. Mean, mode & median (with merits and demerits), measures of dispersion: range, variance, standard deviation, coefficient of variation, Probability, Conditional probability. Correlation, Scatter plot, correlation coefficient, regression- linear, Hypothesis testing: Hypothesis, critical region, and error probabilities. Z-test,'t'-test, Chi-square test for independence, P- value of the statistic, Confidence limits.			
Unit II	**Introduction to Bioinformatics**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Search engines, searching Medline, PubMed, Introduction to bioinformatics, genomics and proteomics; introduction to NCBI, Biological Databases: Nucleic acid sequence databases- Gen Bank, EMBL & DDBJ,Sequence submission using Ban Kit & Sequin; Primary Protein sequence databases. genome databases (Bacteria, Human, Viral and Plant).			
Unit III	**Sequence analysis methods**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Methods, Algorithms, pairwise sequence analysis using BLAST and FASTA; Multiple sequence analysis Clustal W, Muscle. Phylogenetic analysis: Elements of molecular phylogeny, methods of phylogenetic analysis, Types of phylogenetic trees, phylogenetic analysis tools- Phylip and MEGA.			
Unit IV	**Structure prediction**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Nucleic acid structure prediction, Protein structure prediction-primary (ExPasy server), secondary (GOR & SOPMA) and tertiary (Homology based modeling), Validation of 3-D structure (Ramachandran plot), 3D structure visualization tools (RasMol and PyMol). Applications of Bioinformatics- Introduction, ORF Prediction, gene prediction methods and tools, Analyzing Genomes and Genome Annotation. In silico restriction digestion, In silico primer designing.			

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Vertical : DSC

Course Code: 2311106

Course Name:

Practical Course- BIOSTATISTICS AND BIOINFORMATICS

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

Practical Course- BIOSTATISTICS AND BIOINFORMATICS (2 Credits)

1. Measures of Central Tendency and Dispersion on Excel
2. Statistical Analysis using EXCEL (Diagrammatic and graphical presentation)
3. Problems on Z test, t-test & chi square test
4. Accessing virtual library- current content, science citation index and current awareness services, electronic journals, grants and funding information.
5. Retrieval of literatures using PubMed and PMC.
6. Retrieval of an amino acid sequence, nucleotide sequence and performing FASTA and BLAST.
7. Multiple sequence alignment by CLUSTAL X/ CLUSTAL W.
8. Predication of secondary structure of proteins.
9. Homology modeling for prediction of 3D structure & its visualization.
10. Structure analysis: secondary, tertiary and quaternary structure, bond angle, bond length, different interactions by RasMol.
11. Phylogenetic tree construction & analysis.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Course Name: BIOSTATISTICS AND BIOINFORMATICS

REFERENCE BOOKS:

1. Biostatistics: A foundation for Analysis in the Health Sciences 7/E /Wayne W. Daniel, Wiley Series in Probability and Statistics.
2. Introductory Statistics. Fifth Edition. (2004) Prem S. Mann John Wiley and Sons (ASIA) Pte Ltd.
3. Basic Statistics- A Primer for Biomedical Sciences-(Olive Jean Dunn).
4. Biostatistics-An introductory text – (Auram Gold Stein).
5. Statistics : An Introductory Analysis (Taro Yamane) Harper and Row Publisher 1964,67,73
6. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
7. An introduction to Computational Biochemistry. (C. Stain Tsai, A JohnWiley and Sons, Inc., publications).
8. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck). Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S.C. Mendiratta, and Rastogi P.)
9. NCBI Web site: http://www.ncbi.nlm.nih.gov

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I
Vertical : DSE
Course Code: 2311108
Course Name: NANOMATERIALS AND FABRICATION

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:
This course describes the foundational knowledge of Nanoscience and related fields. It provides the understanding about the synthesis of nanomaterials and their application and the impact of nanomaterials on the environment. This course includes a basic introduction to chemical and physical principles in the synthesis of inorganic nanostructured materials. In addition, basic principles of finite size effects will be covered. The course will also cover different methods for synthesis and characterization of different nanostructures and nanostructured bulk materials.

Course Objectives:
During this course, the student is expected to:

- Understand the principles and methods of fabrications, classification nano-structured materials.
- Get knowledge about how the nanoparticle size can affect the morphology, crystal structure, reactivity, and electrical properties.
- Get introduced with the synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nanorods, nanowires), thin films, nanoporous materials, and nanostructured bulk materials.

Course Outcomes:
At the end of this course:

- Students can understand the principles and methods of fabrications, classification of nano-structured materials.
- Students get knowledge about how the nanoparticle size can affect the morphology, crystal structure, reactivity, and electrical properties.
- Students get introduced with the synthesis methods for fabrication of inorganic nanoparticles, one-dimensional nanostructures (nanotubes, nanorods, nanowires), thin films, nanoporous materials, and nanostructured bulk materials.

NANOMATERIALS AND FABRICATION (4 CREDITS - 60L)

Unit I	**Physical Methods of Synthesis of Nanomaterials**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
	Synthesis of Nano-structured materials : Principle and relative merits of each techniques for production of Nano-structures including ultra-thin films and multilayer by: (a) Laser Ablation technique, (b) Arc Discharge technique and (c) Mechanical Milling.		
Unit II	**Chemical Methods of Synthesis of Nanomaterials**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
	Fundamentals and need of identification of pertinent parameters amenable to synthesis of nanoparticles by chemical methods such as CVD (Chemical Vapor Deposition), Plasma/Sputtering method, Self assembly technique. Synthesis of metallic, semiconducting and oxide nanoparticles homo- and hetero- nucleation growth methods, Gas hase Synthesis of Nano powders, Sol-gelmethod and Spray pyrolysis.		
Unit III	**Biogenic Methods of Synthesis of Nanomaterials**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
	Properties of living organisms such as to combat deleterious effect of heavy metals in high concentrations; resistance against metals by Modulation of their transport, Active efflux, Redox changes and Sequestration and intracellular compartmentation into detoxified complexes; Biogenic synthesis by (i) bacteria, (ii) fungi, (iii) algae and (iv) plants.		
Unit IV	**Fabrication of Nanocomposite Materials**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
	Introduction to nanocomposites, recent advances in nanocomposites, different types of nanocomposites fabrication, different property of nanocomposites, Fabrication and Evaluation of Bio-Based Nanocomposite, Applications of Nanocomposite.		

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Vertical : DSC

Course Code: 2311106

Course Name: Practical Course- NANO-MATERIALS FABRICATION

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

Practical Course- NANO-MATERIALS FABRICATION (2 Credits)

1. Synthesis of micelles and inverse micelles.
2. Synthesis of dendrimers.
3. Preparation of thiolated silver nanoparticles
4. Synthesis of Gold Nanoparticles by chemical and biogenic methods
5. Zinc selenide quantum dot preparation.
6. Synthesis of Iron Oxide Nanoparticle
7. Thin film preparation by spin coating technique.
8. Synthesis of Nickel metal nanoparticle by urea decomposition method
9. Synthesis of Zinc Oxide nanoparticle
10. Preparation of nanoparticles by using Ball milling

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Course Name: NANOMATERIALS AND FABRICATION

REFERENCE BOOKS:

1. Edelestein A.S and Cammarata RC, Nano materials synthesis, properties and applications:
2. Michael Kohler, Wolfgang Fritzsche, Michael Kohler, Wolfgang Fritzsche, Nanotechnology-An Introduction to Nanostructuring Techniques Wiley (Practical)
3. Brian Robinson, Self-Assembly,IOS Press
4. Tai Ran – Hsu, MEMS and Microsystems, Design, Manufacture and Nanoscale Engineering, John Wiley & Sons, 2008.
5. M. Gentili, C. Giovannella, S. Selci, Nanolithography: A Borderland between STM, EB, IB and X-Ray Lithographies (NATO ASI Series), Kluwer Academic Publishers, 1994.
6. Nicholas A. Kotov, Nanoparticle Assemblies and Superstructures, CRC, (2006).
7. Guozhong Cao, Nanostructures & Nanomaterials Synthesis, Properties G; Z, Applications, World Scientific Publishing Pvy. Ltd., Singapore 2004

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I
Vertical : DSE
Course Code: 2311109
Course Name: PLANT BREEDING AND TISSUE CULTURE

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:
The purpose of this course is to educate students about the fundamental concepts of plant breeding and technology, plant tissue culture and their related applications, thus preparing them to meet the challenges of the new and emerging areas of the agricultural industry. Plant tissue culture enhances skills for large scale and quality plant production. Tissue culture techniques and breeding technology in plants ignites new ideas for development of novel plants of desired characters.

Course Objectives:
During this course, the student is expected to:

- To gain a basic knowledge of plant breeding and apprise students with its relevance to production of quality plant varieties.
- To get acquainted with the basic principles, methods of plant breeding and tissue culture.

Course Outcomes:
At the end of this course:

- Students gain knowledge of plant breeding and apprise students with its relevance to production of quality plant varieties.
- Students learn about basic principles, methods of plant breeding and tissue culture.

PLANT BREEDING AND TISSUE CULTURE - (4 Credits - 60L)

Unit I	**Resources and Components of Plant Breeding**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
	History; Genetic resources- centers of diversity and origin of crop plants, Law of Homologous variation, genetic resources. Breeding methods for self-pollinated, cross pollinated and clonally propagated crops. Component, recombinational and transgressive breeding. Single seed descent. Populations, their improvement methods and maintenance, Hybrid breeding and genetic basis of heterosis.Ideotype breeding.Mutation breeding.		
Unit II	**Plant Breeding Technology**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
	Plant Breeding for Stress Resistance and Nutritional Quality: Genetic basis and breeding for resistance to diseases and insect-pests. Breeding for vertical and horizontal resistance to diseases. Genetic and physiological basis of abiotic stress tolerance. Breeding for resistance to heat, frost, flood, drought and soil stresses. Important quality parameters in various crops, their genetic basis and breeding for these traits. Role of molecular markers in stress resistance breeding: MAS, MARS and MABB.		
Unit III	**Plant Tissue Culture Technology**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
	Plant regeneration pathways - Organogenesis and Somatic embryogenesis; Endosperm culture and triploid production; Anther and pollen culture, and production of haploid and doubled haploid plants; Protoplast culture and fusion, Somatic hybrids; Organelle transfer and cybrids; Micropropagation, artificial seed and bioreactor technology, Virus-free plants by meristem culture; Use of somaclonal and gametoclonal variation for crop improvement; In vitro mutagenesis and mutant selection; Preservation of plant germplasm *in-vitro*.		
Unit IV	**Advances in plant breeding and tissue culture.**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
	Cryopreservation -Principle and types. Biosynthesis- batch, continuous cultures, immobilized plant cell, Biotransformation of precursors by cell culturing, metabolic engineering for production of secondary metabolites, Hairy root culture, elicitation. Transgenic crops for resistance against biotic and abiotic stresses.		

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Vertical : DSC

Course Code: 2311106

Course Name:

Practical Course- PLANT BREEDING AND TISSUE CULTURE

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

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Practical Course- PLANT BREEDING AND TISSUE CULTURE (2 Credits)

1. Induction of polyploidy using colchicines. (Root Tip)
2. Cytological analysis of polyploidy plants. (Root Tip)
3. Study of Pollen fertility.
4. Isolation of genomic DNA from Plants.
5. Isolation of Ti Plasmid from Agrobacterium.
6. Media preparation, sterilization and callus culture.
7. Somatic embryogenesis and somaclonal variation, micro-propagation.
8. Cell suspension culture.
9. Isolation of protoplast by chemical and mechanical methods.
10. Synthetic seeds preparation.
11. Visit to commercial R & D green houses, agro based industries.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-I

Course Name: PLANT BREEDING AND TISSUE CULTURE

REFERENCE BOOKS:

1. Principles of Plant Breeding, Allard RW – Wiley
2. Plant Breeding Theory and Practice, Stoskopf NC, Tomes DT and Christie BR –Westview Press
3. Quantitative Genetics, Genomics and Plant Breeding, Kang MS – CABI Publishing
4. Plant Molecular Breeding, Newbury HJ – CRC Press
5. Plant Cells in liquid culture (1991), Payne Shuler Hanser Publishers.
6. Introduction to plant tissue culture- M.K. Razdan
7. Plant tissue culture-Theory & practice-S.S.Bhojwani& M.K. Razdan
8. Plant tissue culture-KalyankumarDey
9. Biotechnology- H.S. Chawla

M. Sc. I - Biotechnology - Sem.-II

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II
Vertical : DSC
Course Code: 2311201
Course Name: MICROBIOLOGY AND MICROBIAL TECHNIQUES

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:
The scientific discipline of "Microbiology" is one of the most critical components of basic and applied life science studies. It also constitutes an important section of study at various levels of graduate and post-graduate education. A high quality education in microbiology offers tremendous employability in academia as well as industries

Course Objectives:
During this course, the student is expected to:

- To get knowledge about the history and scope of microbiology.
- To understand the concept of microbial taxonomy and distribution of microbial diversity.
- To get introduced with basic and advanced microbial techniques

Course Outcomes:
At the end of this course:

- Students get knowledge about the history and scope of microbiology.
- Students can understand the concept of microbial taxonomy and distribution of microbial diversity.
- Students introduced with basic and advanced microbial techniques

MICROBIOLOGY AND MICROBIAL TECHNIQUES - 4CREDITS- (60L)

Unit I	Microbial Taxonomy	No. of Lectures: 15	Weightage (UA):15-23 Marks

Introduction to microbiology and microbes, history & scope of microbiology.
History of Bergey's Manual,Prokaryotic Domain, Taxonomic ranks, Traditional and Modern methods of prokaryote identification. General outline of Numerical and Polyphasic Taxonomy.
Bacterial Nomenclature, Type Strain. Major Bacterial Culture Collection units (ATCC, MTCC and NCIM).

Unit II	Microbial Diversity	No. of Lectures: 15	Weightage (UA):15-23 Marks

Distribution of microorganisms in soil, water and air.
General characters of oxygenic and anoxygenic, Photosynthetic microbes, Magnetotactic bacteria, Methanogenic archaebacteria. Human microflora (niche with example)
Extremophiles: General characters (origin,habitat, molecular adaptations) and examples of Extremophiles: Acidophiles, Alkaliphiles, Thermophiles, Psychrophiles, Halophiles, Barophiles (Piezophiles), Xerophiles, Radiophiles, Metallophilic, Endoliths, and Osmophiles. Application of Extremophiles and unculturable microbes.

Unit III	Phycology, Mycology, Protozoology & Virology	No. of Lectures: 15	Weightage (UA):15-23 Marks

Brief introduction to- History, Classification, Characteristics,
Morphology- Microscopic structure and macroscopic structures,
Diversity and Reproduction of algae, fungi, slime molds and protozoans.
Symbiosis- algae, fungi, slime molds and protozoans; Pathogenesis And Industrial applications of algae, fungi, slime molds and protozoans.
Virus and bacteriophages, general properties of viruses, viral structures, Classification,
Isolation, Cultivation and Enumeration (Bacteriophages, Plant viruses and Animal viruses). Reproduction of Viruses: Lytic cycle (T phage and phage θ-X174), Lysogenic cycle (λ, and Mu1 phages)

Unit IV	Microbial Techniques	No. of Lectures: 15	Weightage (UA):15-23 Marks

Staining techniques: Nature and types of stains.
Principle & mechanism- Simple and differential, AFB staining, fluorescent, negative. Structural Staining- capsule, spore, cell wall, flagella and reserve food material.
Fungal staining. Wet mounting methods.
Sterilization and Disinfection: Principle & technique- Physical, chemical & mechanical methods.
Cultivation of microorganisms-culture media and types of culture media.
Isolation of Microorganism: serial dilutions, streak plate, pour plate & spread plate.
Characterization & identification of colonies.
Maintenance & Preservation of cultures- slant, stab, soil, glycerol & lyophilization.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Vertical : DSC

Course Code: 2311204

Course Name:

Practical Course - MICROBIOLOGY AND MICROBIAL TECHNIQUES

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

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Practical Course - MICROBIOLOGY AND MICROBIAL TECHNIQUES (2 Credits)

1. Studies of aseptic techniques- Disinfection, cotton plug making, cleaning and sterilization of used and new glassware, Good laboratory practices.
2. Perform the isolation of bacteria from different sources (Soil, water and air) by spread, pour and streak plate method.
3. Perform & study of colony characters of *E. coli*, *P. aeruginosa*, *B. subtilis* & *Klebsiella pneumoniae* on Nutrient agar and specific media.
4. Perform the Microscopic examination-Simple, Gram's staining, Motility, Acid-fast stain and Lactophenol Cotton blue staining (Fungi). Algae And Protozoa
5. Perform the structural Staining: capsule, endospore, cell wall, flagella and reserve food material.
6. Perform & study of growth curve of *E.coli.*
7. Perform & study biochemical characters *E. coli* and *Bacillus sp.*
8. Perform & study the morphological and biochemical characters of Acidophilic/ Alkalophilic/ Thermophilic/ Halophilic Bacteria.
9. Perform the isolation of Bacteriophages (Plaque Formation).

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Course Name: MICROBIOLOGY AND MICROBIAL TECHNIQUES

REFERENCE BOOKS:

1. Bergey's Manual of Determinative Bacteriology- Gibbons,Baltimore:Williams & Wilkins,1974.
2. Brock Biology of Microorganisms (11th edn) by MichaelT.Madigan,JohnM.Martinko(eds).
3. General Microbiology (5th edn)–by RogerY.Stanieretal.
4. Microbiology –PelczarJR.
5. Prescott's Microbiology(10th edn)-ByJoanneWilleyandLindaSherwood andChristopherJ.Woolverton
6. MicrobialGenetics–DavidFreifelder
7. GeneralVirology-byS.E.Luria andJamesE.Darnell.
8. Fungi Bacteria And viruses-by.Cube
9. IntroductiontoPlantVirology–byBosL
10. AnimalVirology –Fenner,FandWhite,D.O.
11. Laboratory Manual in Microbiology by P. Gunasekaran
12. Practical Microbiology by Vinita Kale, Kishor Bhusari
13. Practical Microbiology by R. Vasanthakumari

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Vertical : DSC

Course Code: 2311202

Course Name: IMMUNOLOGY AND IMMUNOTECHNIQUES

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:

The course introduces students to a wide range of topics in immunology starting from cells of immune system, innate and adaptive immune systems, humoral immunity, antibody structure and function, basic immunological techniques, autoimmunity, hypersensitivity and vaccine production. The course is well balanced with the basics of immunology as well as advanced topics delivered easily for students.

Course Objectives:
During this course, the student is expected to:

- Has a basic knowledge about immune system and immunological processes;
- Have an understanding about the mechanisms of immunological reactions.
- Be able to clearly state the role of the immune system
- Be able to compare and contrast the innate versus adaptive immune systems

Course Outcomes:
At the end of this course:

- Students are having a basic knowledge about immune system and immunological processes;
- Students have an understanding about the mechanisms of immunological reactions.
- Students are able to clearly state the role of the immune system
- Students are able to compare and contrast the innate versus adaptive immune systems

IMMUNOLOGY AND IMMUNOTECHNIQUES - (4 Credits - 60L)

Unit I	Immunity and Components of Immune System	No. of Lectures: 20	Weightage (UA): 20-28 Marks

Native or Innate immunity: Introduction, First line of Defense – Physical and Chemical barriers at the portal of entry. Second line of Defense – Cellular Processes in nonspecific defense mechanism.Structure and functions of primary lymphoid organs, secondary lymphoid organ Cells of immune system. Third lineof Defense: Humoral Immunity and cell mediated Immunity. Primary and secondary immune response.

Antigen: immunogenicity, antigenicity, properties of immunogen, Major Histocompatibility Complex: Introduction, classes – structure and function, Processing and presentation of exogenous and endogenous antigens. Cytokines: Introduction, properties, function, Cytokine receptors.

Complement system: Introduction, functions, components, general account on complement activation – classical and alternative pathways.

Cell-mediated effector functions: Cytotoxic T cells, Natural Killer Cells, ADCC, NK cell receptors,inverse correlation with target MHC expression, missing self hypothesis, cytotoxicity reaction

Unit II	Antibody	No. of Lectures: 10	Weightage (UA):10-18 Marks

Antibody: Antibody structure and function (classification of immunoglobulins, immunoglobulin domains, concept of variability, isotypes, allotypes and idiotypic markers). Immunoglobulin genes, VJ/VDJ rearrangements and genetic mechanisms responsible for antibody diversity, affinity maturation, allelic exclusion.

Class switching, receptor and soluble forms of immunoglobulin

Unit III	Antigen – antibody interactions	No. of Lectures: 15	Weightage (UA):15-23 Marks

Antigen antibody interactions: Principles of interaction, strength of interactions, cross reactivity, features of interactions. In vivo reactions of antigen-antibody complex – precipitation, flocculation,agglutination, complement fixation, neutralization.

Principles and applications of techniques based on antigen-antibody interactions– Immunodiffusion, Immunoelectrophoresis, ComplementFixation Test, Immunofluorescence Test, Radioimmunoassay, ELISA, Western blot.

Unit IV	Applications of immunological principles (vaccines, and diagnostics)	No. of Lectures: 15	Weightage (UA):15-23 Marks

Tumor and transplantation Immunology: Immune tolerance to allograft, mechanism of allograft rejection, Immunosuppressive Therapy, Tumor antigens and tumor evasion of immune system. Autoimmunity: Introduction, general mechanism, classification of autoimmune diseases Hemolytic, organ specific (Type I diabetes) and non-organ specific (SLE and RA).

Immunodeficiency: Primary immuno-deficiencies (SCID), Secondary immune-deficiencies (AIDS) Hypersensitivity: Introduction, classification, general mechanisms in Hypersensitivity Monoclonal antibodies: Hybridoma Technology for monoclonal antibody production and applications of monoclonal antibodies.

Vaccines: Introduction active and passive immunization, Traditional vaccines Live- attenuated, killed, New Trend vaccines: subunit, conjugate, DNA, recombinant vector vaccines.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Vertical : DSC

Course Code: 2311205

Course Name:

Practical Course - IMMUNOLOGY AND IMMUNOTECHNIQUES

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

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Practical Course - IMMUNOLOGY AND IMMUNOTECHNIQUES(2 Credits)

1. Study of Immunodiffusion (Ouchterlony method, Mancini method)
2. Study of Immunoelectrophoresis (CCIEP, Rocket Immunoelectrophoresis)
3. Study of slide agglutination test by colony emulsion method for the diagnosis of *Salmonella typhi*.
4. Preparation of *Salmonella typhi* antigens.
5. Diagnosis of *Salmonella typhi* by Widal test (Qualitative and Quantitative test)
6. To study the Dot-blot ELISA.
7. Demonstration of carcinoma slides of different organs of human.
8. Live and Dead cell counting by Trypan blue
9. Demonstration of Immunohistochemistry (IHC) slides.
10. Case study of organ transplantation in India

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Course Name: IMMUNOLOGY AND IMMUNOTECHNIQUES

REFERENCE BOOKS:

1. Immunology - Kuby
2. Essential Immunology- Roitt
3. Cellular and Molecular Immunology- Abbas
4. Immunology and Serology- Philip Carpenter
5. Textbook of Immunology- Barrette J.T.
6. Basic and Clinical Immunology- Fundenberg H.
7. Biology of Immune response- Abramoff and Lavice
8. Fundamental Immunology 5th edition (August 2003): by William E., Md. Paul
9. Immunology an Introduction- Tizard
10. Medical Microbiology- Fritz H. Kayse
11. Laboratory Manual on Biotechnology by Dr. P.M. Swamy; Rastogi Publications
12. Practical Microbiology by R.C. Dubey and D.K. Maheshwari; S. Chand & Company Ltd.
13. Textbook of Practical Microbiology by Dr. Subhash Chandra Parija; Ahuja Publishing House
14. Practical Immunology by Lesle Hudson and Frank C. Hay; Blackwell Scientific Publications
15. LIFE SCIENCES PROTOCOL MANUAL (DBT Star College Scheme) 2018 Compiled by
16. Dr. P. Hemalatha Reddy and Dr. Suman Govil

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II
Vertical : DSC
Course Code: 2311203
Course Name: On Job Training (OJT)/ Internship/ Field Project (FP)

***Teaching Scheme:** **Practical Hands On - 04 Credits**	***Examination Scheme** **UA:60 Marks** **CA: 40 Marks**

Course Objectives:
During this course, the student is expected to:

- Perform and design individual research/ laboratory/ practical/ project work.
- Get hands on training about the skills essential for practical work in a concerned subject.

Course Outcomes:
At the end of this course:

- Students can Perform and design individual research/ laboratory/ practical/ project work.
- Students get hands-on learning about the skills essential for practical work in a concerned subject.

On Job Training (OJT)/ Internship/ Field Project (FP)

Under the One-year PG Diploma program/two-year Master's Degree program, the students must complete on-the-job training/internship of 04 credits **during the second semester of the first year in the respective Major Subject.**

An internal assessment of the OJT/Internship/ Field Project will be of **40 Marks**.
A progress report showing the proof of ongoing OJT/Internship/FP, certified by respective Major Subject Teacher must be presented for the internal assessment.

A university assessment of the OJT/internship/ field project will be of **60 Marks**.
A completion report certified by Major Subject Teacher and Concerned Trainer/Authority must be presented for the University assessment.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II
Vertical : DSE
Course Code: 2311207
Course Name: INHERITANCE BIOLOGY

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:
This course is designed to introduce the basic concepts in genetics and inheritance biology. The objective is to help the students get acquainted with classical, modern and quantitative genetics. Deep study of this course would generate curiosity in students as to how inheritance of traits occurs, reasons and causes of variations among individuals and occurrences of unavoidable syndromes. One can determine how likely members of the population may inherit a disease and to help people manage their risks accordingly.

Course Objectives:
During this course, the student is expected to:

- To learn the mechanism of gene transfer in organisms from one generation to another.
- To understand the concept of inheritance and its pattern.
- To learn the role of genes in evolution and the effect of genes on variation among the population.

Course Outcomes:
At the end of this course:

- Students have knowledge of how genes are transmitted in organisms from one generation to another. Along with this, Inheritance patterns will highlight the role of genetics in gene mapping.
- Students can understand the concept of inheritance and its pattern.
- Students are having knowledge about the role of genes in evolution and the effect of genes on variation among the population.

DSE 2A INHERITANCE BIOLOGY (4 Credits - 60L)

Unit I	Mendelian Genetics and Cytogenetics	No. of Lectures: 15	Weightage (UA):15-23 Marks
Test cross, Back cross, Allelic interactions, gene interactions, Linkage and crossing over. Extra chromosomal inheritance- chloroplast, mitochondria, and plasmid.Concept of Chromosomes, Numerical changes- Aneuploidy, Euploidy, polyploidy with examples. Chromosomal aberrations: Deletion, duplication, inversion, translocation. Structure of sex chromosomes, Sex linked inheritance,			
Unit II	**Drosophila genetics**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Drosophila as an eukaryotic model, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphic, genetic mosaics,genetic epistasis in the context of developmental mechanisms.			
Unit III	**Bacterial and Yeast Genetics**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Methods of genetic transfers –Transformation, Discovery, competency, artificial methods of transformationCaCl2 method, electroporation, gene gun and microinjection. Conjugation-discovery, nature of donor strain and compatibility, Hfr, F, map of F plasmid. Transduction-discovery, structure of bacteriophages lambda and T4, generalized and specialized. Yeast Genetics life cycle of saccharomyces cerevisiae.			
Unit IV	**Evolutionary genetics and Population genetics**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Theories of evolution- Lamarckism, Darwinism, mutation theory and Neo-Darwinism , genetic basis of evolution, Genetic polymorphism, Hardy-Weinberg genetic equilibrium, causes of changes in allele frequency, gene frequency, factors affecting gene frequency. Significance of population genetics. Gene mapping in Prokaryotes and Eukaryotes, QTL mapping strategies, Genome mapping (Physical maps), C Value paradox			

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Vertical : DSC

Course Code: 2311206

Course Name: Practical Course - INHERITANCE BIOLOGY

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

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Practical Course - INHERITANCE BIOLOGY (2 Credits)
1. Demonstration of Mendelian principles using Drosophila / plant system. 2. Numerical exercises related to Mendelian principles, gene interactions, linkage and gene mapping. 3. Study and calculate gene frequency in population by Hardy-Weinberg equilibrium. 4. Study of Karyotype 5. Preparation of salivary gland chromosome from Drosophila/Chironomus larvae. 6. Studies on mutagenic treatment to root, seeds, pollen grains and its mitotic and meiotic analysis. 7. Study of mutation analysis by Replica plate Technique. 8. Study of genetic transfer-Conjugation and transduction 9. Cloning- 1. Preparation of competent cell; 2. Transformation of competent cell 10. Study of genetic transfer- Transduction.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Course Name: INHERITANCE BIOLOGY

REFERENCE BOOKS:

1. Principles of Genetics 8th edition, Eldon J. Gardner, Michael J. Simmons, and D. Peter Snustad,
2. Wiley India Edition (Indian edition).
3. Molecular Genetics: An introductory Narrative (2nd Edition) Gunther S. Stent and Richard
4. Calendar, CBS Publishers and Distributors (Indian Edition) –Reprint 2004.
5. Principles of Genetics, 7th Edition, Robert H Tamarin, Tata McGraw Hill Edition (Indian Edition) Reprint 2004
6. Genetics 5th edition –Strickberger, Pearsons publisher –Low Price Edition (Indian Edition).
7. Modern Microbial Genetics –Editors Uldis N Streips and Ronald E. Yasbin Wiley –Liss publications, 1991

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II
Vertical : DSE
Course Code: 2311208
Course Name: MOLECULAR MEDICINE

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:

The course covers the use of molecular understanding in discovery research in disease prevention, drug development, diagnosis and therapy. It provides the students with the knowledge about molecular and cellular phenomena in biological systems and their relevance to learn molecular aspects of human diseases.Molecular diagnostics is an important field dealing with application of molecular techniques to address issues pertaining to biotechnology development.

Course Objectives:
During this course, the student is expected to:

- Develop a sound molecular understanding about the different diseases we encounter and how atmolecular level
- Understand the importance of molecular diagnostics in healthcare and therapeutics.

Course Outcomes:
At the end of this course:

- Students have a sound molecular understanding about the different diseases we encounter andhow at molecular level.
- Students can understand the importance of molecular diagnostics in healthcare and therapeutics.

DSE 2B - MOLECULAR MEDICINE (4 Credits - 60L)

Unit I	Human Molecular Genetics	No. of Lectures: 15	Weightage (UA):15-23 Marks
Human genome project; Sequence Architecture of human genome; Blood and Blood group Antigens; MHC Antigen – HLA; Identification and isolation of disease genes – Positional cloning, Functional cloning, Microarray technology; Pre-natal diagnosis - Chorionic villus sampling, Amniocentesis; Forensic testing - DNA fingerprinting, DNA footprinting, Paternity testing.			
Unit II	**Genetic Diseases in Human**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Classification of genetic disorder: single gene disorder and examples: Cystic fibrosis, Duchenne muscular dystrophy, Haemoglobinopathies, Agammaglobulinemia, Marfan syndrome, Huntington's disease and Phenylketonuria. Chromosomal disorders and examples: Trisomy 18, Trisomy 13, Klinefelter syndrome, XYY syndrome, Turner syndrome and Down syndrome. Multifactor/ Polygene disorders and examples: Parkinson's disease, Alzheimer's disease.			
Unit III	**Stem Cell as Regenerative medicine**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Introduction; Stem cell sources; unique properties of stem cells; Classification - Embryonic stem cells, Adult stem cells; Similarities and differences between adult and embryonic stem cells; Applications of Embryonic stem cells and ethical issues associated with it; Adult stem cell Differentiation, plasticity, types of adult stem cells; Stem cell specific transcriptionfactors - Induced pluripotent stem cells (iPSC); Therapeutic applications as regenerativemedicine. Stem cell preservation. Organoid Culture and its Applications in Medicine.			
Unit IV	**Gene Therapies**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Introduction; Types of Gene therapy: Somatic and Germ line gene therapy, *In- vivo* and *Ex-vivo* gene therapy; Virus based vehicle for gene therapy, Non Viral Methods of Gene transfer. **Pharmacogenetics:** Steps involved in Drug Discovery/Design - Insilco method, Structure based method, Nature and Sources of drugs; Route of drug administration; Absorption and Bioavailability of drugs in system; Excretion of drugs from system; Pharmacogenetic study of drug.			

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Vertical : DSE

Course Code: 2311206

Course Name: Practical Course - MOLECULAR MEDICINE

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

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Practical Course - MOLECULAR MEDICINE (2 Credits)
1. Study of Sickled RBCs. 2. Demonstration of Flow cytometer. 3. Estimation of hemoglobin from blood 4. Separation of serum and plasma. 5. Estimation of alkaline phosphatase activity in blood serum 6. Estimation of acid phosphatase activity in blood serum 7. Serum Protein Electrophoresis and its clinical significance 8. Study of Gene therapy for SCID by ICT 9. Study of Stem cell in Bone marrow Regeneration by ICT 10. Study of 3D Bioprinting by ICT.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Course Name: MOLECULAR MEDICINE

REFERENCE BOOKS:

1. Peter Sudbery, Ian Sudbery, 2009, Human Molecular Genetics, 3rd edition, Pearson education limited.
2. Leaf Huang, Mien-Chie Hung, Ernst Wagner, 1999, Non viral vectors for gene therapy,Academic press.Max Levitan, Ashley Montagu, 1977, textbook of Human Genetics, 2nd Ed. Oxford University press, N.Y.
3. Tom Strachan & Andrew P. Read. 2004, Human Molecular Genetics, 2nd Ed. John Wiley & Sons. (Asia) PTE Ltd.
4. Ricki Lewis. Human Genetics- Concepts and Applications, 3rd Ed.WCB, McGraw-Hill.
5. Amita Sarkar.2001, Human Genetics, Dominant Publishers, VOL No-1&2 New Delhi.
6. Nagy A, Gertenstein M,VinterstenK, Behringer R(2003). Manipulating the Mouse Embryo NewYork:Cold Spring Harbor Press.
7. Gilbert SF (2000) Developmental biology, 6th edition Sunderland,MA:SinauerAssociates,Inc.
8. Jamie Davies and Melanie Lawrence, Organoids and Mini Organs, Academic Press, 2018

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II
Vertical : DSE
Course Code: 2311209
Course Name: CANCER GENETICS AND ANIMAL TISSUE CULTURE

*Teaching Scheme:	*Examination Scheme
Lectures - 04 Hrs/Week, 04 Credits	UA:60 Marks CA: 40 Marks

Course Preamble:
A complete cure for this dreadful disease cancer has remained elusive. Advances in treatment regimens and surgical interventions have undoubtedly helped better management of the disease. This course enlightens Hallmarks of cancer biology, its diagnosis and applications of animal cell culture including cancer eradication.

Course Objectives:
During this course, the student is expected to:

- Get knowledge about the stem cells and its use as regenerative medicine.
- Understand the molecular level mechanism of cancer development and progression.
- To get introduced to the methods of diagnosis and treatment for cancer.

Course Outcomes:
At the end of this course:

- Students have knowledge about the stem cells and its use as regenerative medicine.
- Students can understand the molecular level mechanism of cancer development and progression.
- Students get introduced to the methods of diagnosis and treatment for cancer.

DSE 2C - CANCER GENETICS AND ANIMAL TISSUE CULTURE (4 Credits - 60L)

Unit I	**Introduction to Cancer Biology:**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Cancer cell vs. Normal cell; Hallmarks of cancer cell; Cell cycle - Regulation of Cell cycle and Tumor suppressor genes (pRb, P53, BRCA, Gene encoding CDK inhibitors); Oncogenes and Proto-Oncogenes; Factors activating proto-oncogene to oncogene (Tumor Virus; Physical and Chemical Carcinogene); Introduction to Epigenetics, Epigenetics in cancer			
Unit II	**Cancer Progressions:**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Apoptosis mechanism, Apoptotic Pathways; Metastasis (Clinical significances of invasion, Metastatic cascade, Basement membrane disruption); Theory of invasion (Proteinases and tumor cell invasion; Angiogenesis and its sequence of events in detail			
Unit III	**Diagnostic and Treatment:**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Methods of diagnosis - Chemotherapy, Radiation Therapy, Immunotherapy use of immunotoxins in cancer therapy, retroviral drugs, Anti- angiogenic Drug; Drugs based on Epigenetics (Acetylation of Histones and Methylation of DNA)			
Unit IV	**Animal Cell culture:**	**No. of Lectures: 15**	**Weightage (UA):15-23 Marks**
Introduction to animal cell and tissue culture, its advantages and limitations, Applications of animal cell and tissue culture. Basic techniques in animal cell culture: Disaggregation of tissue andsetting up of primary culture, established cell line cultures, maintenance of cell culture, culture media and role of serum in cell culture, organ culture.			

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Vertical : DSE

Course Code: 2311206

Course Name:

Practical Course - CANCER GENETICS AND ANIMAL CELL CULTURE

*Teaching Scheme:	*Examination Scheme
Practical - 04 Hrs/Week, 02 Credits	UA:30 Marks CA: 20 Marks

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Practical Course - CANCER GENETICS AND ANIMAL CELL CULTURE (2 Credits)

1. DNA amplification by PCR
2. Reporter gene assay (b- Gal)
3. DNA Fingerprinting: Using RAPD techniques
4. Aseptic Transfer technique in animal Cell Culture
5. Preparation of Balanced Salt Solution and pH standards for animal cell culture.
6. Trypsinization methods in animal cell culture -

A. Warm Trypsinization

B. Cold Trypsinization

7. Chick Embryo Culture/Lymphocyte Culture.
8. Any suitable practicals conducted by the department with respect to the concerned course. (maximum two practicals)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

First Year M.Sc. (Biotechnology) Semester-II

Course Name: CANCER GENETICS AND ANIMAL TISSUE CULTURE

REFERENCE BOOKS:

1. The Biology of Cancer, Robert Weinberg, Garland Science; 2 edition;2010
2. King R.J.B., Cancer Biology, Addision Wesley Longmann Ltd, U.K., 1996.
3. Ruddon.R.W., Cancer Biology, Oxford University Press, Oxford, 1995.
4. Bishob J. A. 1982, Retrovirus, Cancer genes, Advances in Cancer Research.
5. Vogel F. Chemical mutagenesis Spinger and Verlag.
6. Sanberg A. A. 1980, The Chromosome in Human Cancer And Leukemia
7. Stich H. F. Carcinogens and Mutagens in EnvironmentCRC press.
8. R. Lanza, J. Gearhartet al (Eds), Essential of StemCell Biology. (2009), Elsevier Academic press.
9. R. Lanza and I. Klimanskaya, Essential Stem Cells Methods. (2009)
10. J. J. Mao, G. Vunjak-Novakovic et al (Ed): Translational Approaches in Tissue
11. Engineering & Regenerative Medicine 2008, Artech House, INC Publications.

पुण्यश्लोक अहिल्यादेवी होळकर सोलापूर विद्यापीठ ।। विद्यया संपन्नता ।। NAAC Accredited-2022 'B++' Grade (CGPA-2.96)	**Punyashlok Ahilyadevi Holkar Solapur University, Solapur** **NATURE OF QUESTION PAPER** **Course Name: M. Sc. / M.C.A. (Part- I & II) w.e.f. AY 2023-24**

External Evaluation (UA)

Time: **Total Marks: 60**

Instructions 1. All Questions are compulsory 2. Figure to right indicate full marks.	
Q.1 A) Choose correct alternative. (MCQ)	**08 Marks**
B) Fill in the blanks OR Write true/false	**04 Marks**
Q.2. Answer the following. (Any Six) A) B) C) D) E) F) G) H)	**12 Marks** **(2+2+2+2+2+2)**
Q.3. Answer the following (Any three). A) B) C) D)	**12 Marks** **(4+4+4)**
Q.4. Answer the following (Any two). A) B) C)	**12 Marks** **(6+6)**
Q.5. Answer the following (Any two). A) B) C)	**12 Marks** **(6+6)**

Internal Evaluation (CA)

Time: **Total Marks: 40**

Internal Evaluation System for 40 Marks
Choose any two of the following: ➢ **Home Assignment/ Unit Test/ Tutorial/ Seminar**

Pattern of Examination:

External Evaluation + Internal Evaluation 60 Marks + 40 Marks =100 Marks

Passing Criteria:

1. Written Exam – 24 out of 60
2. Continuous Assessment (CA) – 16 out of 40