Curriculum for M. Sc Biotechnology

MASTER OF SCIENCE

M. Sc SYLLABUS

[*For the Candidates admitted under Autonomous, CBCS & OBE pattern*]

(ODD SEMESTER)

DEPARTMENT OF BIOTECHNOLOGY

VIVEKANANDHA

COLLEGE OF ARTS AND SCIENCES FOR WOMEN

[AUTONOMOUS]

An ISO 9001:2015 Certified Institution | Affiliated to Periyar University Approved by AICTE | Re-accredited with "A" Grade by NAAC|
Recognized Under 2(f) and 12 (b) of UGC Act, 1956.
Elayampalayam, Tiruchengode-637 205, Namakkal Dt., Tamil Nadu, India

M.Sc BIOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

GRADE	OBJECTIVE
PEO: 1	Biotechnology graduate students shall attain professional/industrial expertise by developing competent, creative and ever ready personality to accept recent, innovative and challenging roles in Industry and Academic and Research sectors
PEO: 2	Students shall inculcate in the development of entrepreneurial traits in order to cuddle innovative opportunities by adapting emerging biotechnological concepts in terms of techniques with subsequent development of leadership in the course of start-up of small-medium scale biotech based industry
PEO: 3	Students shall progressively adapt, follow and learn the concepts of biotechnology continuously by aiding modern teaching tools
PEO: 4	Imparting the basic and outstanding knowledge in all terms of biotechnology
PEO: 5	Students shall acquire the concepts to disseminate the advanced biotechnological aspects and its cutting edge developments in specific and developing area in the field of Biotechnology

PROGRAMME OUTCOMES (POs)

GRADE	OUTCOME
PO: 1	To train and develop students with the much needed biotechnological education, so that they develop added competitive skill metrics (CSM) for industrial employment higher education and employment upon graduation
PO: 2	To comprehend the assorted knowledge of biotechnical concepts domains and their applicability in the development of value added products for the welfare of the society
PO: 3	To develop a broad range of biotechnological skills and knowledge, development of general and specific competences to meet-out current expectations and requirements of medical, pharmaceutical, bio-molecular and agricultural sectors
PO: 4	To understand and merge the knowledge and concepts of biochemical, biophysical and bio statistical domains
PO: 5	To clarify various challenges in health care by integrating different biological domains including clinical, immunological, pharmaceutical and cancer genomics

PROGRAMME SPECIFIC OUTCOMES (PSOs)

GRADE	SPECIFIC OUTCOME
PSO: 1	To provide solutions for the challenges faced by pharmaceutical and molecular diagnostic Sectors
PSO: 2	To provide technical products with high frequency of reproducibility to the society
PSO: 3	To gain vertical mobility in career that will make students more competent to face national/international qualifying exams with practical knowledge acquaintance and in modern biotechnology field
PSO: 4	To solve complex problems in the field of Biotechnology with an understanding of social, ethical, legal and cultural aspects of the society
PSO: 5	To understand the over-all theme/concepts of each specialization in biotechnology and analysing the frequency of its applicability in industry, research and for the goodness of Society

DEPARTMENT OF BIOTECHNOLOGY

M.Sc. DEGREE COURSE IN BIOTECHNOLOGY
Choice-Based Credit System

REVISED REGULATIONS AND SYLLABUS (w.e.f.2023-2024)

(in compliance with TANSCHE)

The recent development in the field of biotechnology as rapid growth and the establishment of biotechnological industries. This has resulted in great demand for trained manpower in this field and has opened new career opportunities for the young generation of students to acquire skills, training and knowledge to enhance their thinking, comprehension and application abilities and prepare them to compete, succeed and excel globally. Sustained initiatives are required to reform the present higher education system for improving and upgrading the academic resources and learning environments by raising the quality of teaching and standards of achievements in learning outcomes. The academic research into innovations for practical use in society and economy, promoting efficient and transparent governance and management of the higher education system, enhancing the capacity of the higher education system to govern itself through coordinated regulatory reform and increasing both public and private sector investment in higher education, with special emphasis on targeted and effective equity-related initiatives.

Learning Outcomes based approach to Curriculum Planning:

The Learning Outcomes based approach to Curriculum planning aims to factor in on the aptitude, interests and strengths of the students during their progress through the coursework and at the same time focus on overall student attainment. The main objective of the learning outcomes based framework is to better equip the students in their pursuit of knowledge, with the required employability skills, innovation in research and entrepreneurship skills. The course is so designed with practical work that will help students to apply their theoretical knowledge in experimenting and exploring. The curriculum envisions that the student, once graduates as specialists in a discipline, have an important role to play in the newer developments and innovations in the future in the subject for the advancement of the discipline.

Graduate Attributes in Biotechnology:

Graduate attributes are the high-level qualities, skills and understandings that a student should gain as a result ofthe learning and experiences. They equip students and graduates for lifelongpersonal development, learning andto be successful in society. Students will be equipped to be active citizens both nationally and globally. The students graduating in biotechnology should also develop excellent communication skills both in the written as well as spoken language which are a must for them to pursue higher studies from some of the best and internationally acclaimed universities and research institutions spread across the globe. The graduate attributes reflect both disciplinary knowledge and understanding, generic skills, including global competitiveness all students in different academic fields of study should acquire/attain and demonstrate. Some of the characteristic attributes that a graduate should

demonstrate are as follows

- Leadership Readiness
- Moral and ethical awareness/reasoning.
- Multicultural Competence.
- Life–long Learning.
- Communication Skills.
- Critical thinking.
- Problem-solvingng.
- Research-related skills.
- Scientific reasoning.
- Self-directed learning.
- Disciplinary knowledge.

Qualification Descriptors:

Upon successful completion of the course, the students receive an M.Sc. degree in Biotechnology. Biotechnology postgraduates of this department are expected to branch out into different paths of seeking advanced research-based knowledge, professional employment, or entrepreneurship that they find fulfilling. They will be able to demonstrate knowledge as well as skills in diverse fields of Biotechnology. This will provide a foundation, whichshall help them to embark on research careers by attaining doctoral positions in coveted institutions, as well as securing employment in research projects in industry or institutes. Besides research, they can get suitable teaching positions in Colleges and Universities as Assistant professors after qualifying National Eligibility Test (NET). It is expected that besides the skills specific to the discipline, the wider life skills of analysis, logical reasoning, scientific aptitude, communication skills, research and life ethics, and moral values will be inculcated in the students. The list below provides a synoptic overview of possible career paths provided by postgraduate training in Biotechnology:

- Biotechnology entrepreneurship
- Patents and Law
- Scientific Writing and Editing
- Document preparation and publication
- Research
- Industry
- Teaching
- Administration and Policy Making
- Scientific Communication

Teaching-learning process

The Learning Outcomes-Based Approach to curriculum planning and transaction requires that the teaching- learning processes are oriented towards enabling students to attain the defined learning outcomes relating to the courses within a programme. The outcome-based approach, particularly in the context of undergraduate studies, requires a significant shift from teacher-centric to learner-centric pedagogies, and from passive to active/participatory pedagogies. Planning for teaching therein becomes critical. Every programme of study lends itself to a well-structured and sequenced acquisition of knowledge and skills. Practical skills, including an appreciation of the link between theory and experiment, will constitute an important aspect of the teaching- learning process. Teaching methods, guided by such a framework, may include:

- ✓ **Classroom Teaching** for intensely information-based topics. This is a very regular feature of all thecourses in Biotechnology.
- ✓ **PowerPoint slides** for topics that involve information and use of PowerPoint presentationsare alsomade whenever the lectures are to be summarized in a crisp and point-wise mannerto highlight salient/importantconclusions from the topics.
- ✓ **Classroom Discussions** are a regular feature while teaching. The students are drawn into impromptudiscussions by the teacher during the process of teaching.
- ✓ **Video Displaying**, both real-time and animations, are used for topics that require 3D dimensional viewing of the biological mechanisms to drive the point home. These have proved to be very helpful while teaching concepts of molecular biology like DNA replication, transcription and translation.
- ✓ **Model Making** is also used especially for understanding and building a perception of the students.
- ✓ **Laboratory Practical** are an integral part of every course included in the PG programme in Biotechnology. The is also a daily affair for PG students of Biotechnology.
- ✓ **Problem Solving** is encouraged during the laboratory work.
- ✓ **Group Activity** as well as discussions with the laboratory supervisor/ among the students themselves/ Mentor is also encouraged during laboratory work.
- ✓ **Project Work** is included in the programme where students work individually or in groups to design experiments to solve/answer a problem suggested by the Mentor or identified by the students in consultation with the Mentor. The students are mentored regularly during the duration of the project.
- ✓ **Presentations by the Students** are regularly done. The students are mentored in the presentation ofdata, interpretation of data and articulation with the students/teachers/ResearchScholars during their presentation.
- ✓ **Presentations by Experts** in different specialties of Biotechnology are arranged to broaden the horizons of the students.
- ✓ **Interaction with Experts** is also encouraged during/after presentations to satisfy/ignite the curiosities of the students related to developments in the different areas of Biotechnology.
- ✓ **Visit to Industries/Laboratories** related to Biotechnology like fermentation, food, pharmaceuticals; diagnostics etc. are organized to acquaint the students with real-life

working environments of the professional biotechnologist with a view to broadening their perspective on the subject of Biotechnology.

Assessment methods

The students of PG Biotechnology program must achieve the desired results in terms of the learning outcomes to be professionally sound and competitive in a global society. Achieving the desired learning outcomes is also imperative in terms of job employment leading to a happy and prosperous individual further leading to a happy and prosperous family and thereby a happy and prosperous society or nation. The assessment tasks are pivotal to getting authentic feedback for the teaching- learning process and mid-course corrections and further improvements in the future. The assessment tasks are carried out at various stages of the duration of the PG Biotechnology programme like Mid-term assessments, End-term assessments, Semester examinations, Regular assessments, viva-voce, etc. The assessment tasks are listed below:-

✓ **Short-Answer Questions** during term and semester examinations are used to assess the ability of the student to convey his thoughts in a coherent way where prioritization of the information interms of their significance is tested.

✓ **Problem Solving questions** are generally given during the laboratory work.

✓ **Surprise Quizzes** are regularly used during continuous assessment while the teaching- learning process is continuing which prepares the student to quickly recall information or quickly analyze a problem and come upwith proper solutions.

✓ **Impromptu Opinions** on biotechnological problems are sought from student during regular teaching- learning which help them to think quickly in a given context. This help build their ability to come up with solutionsto problems that the students might not have confronted previously.

✓ **Data Interpretation** is also another assessment task that is used to develop the analytical skills of the students. This assessment is used during laboratory work as well as during project work.

✓ **Analytical Skills** are assessed during work related to several experiments like enzyme kinetics, growth of bacteria and Bacteriophages, and mutation frequencies.

✓ **Paper/ Project presentations** are used to assess the articulation skills of the student. These are carried out both during the duration of the teaching-learning processes as well as during end- Semester examinations.

✓ **Report Writing** is used to assess the keenness of the students for details related to Biotechnology while visiting laboratories/industries as students invariably are required to submit a report after such visits.

✓ **Assignment Writing** is used to assess the writing abilities of the students during midterm vacations.

✓ **Viva-voce** during the laboratory working hours and during laboratory, examinations are used to assessthe overall knowledge and intelligence of the students.

Key Words:

Biotechnology, Teaching, Learning outcomes, Curriculum, Curriculum Framework, Programme outcomes, Course outcomes, PG Programme, Postgraduate programme,

Teaching-learning processes, Assessment Tasks, Evaluation Tasks, Online Courses, MOOCS, SWAYAM, UGC, India, Higher Education Institutions.

****

1. CONDITIONS FOR ADMISSION:

A Candidate with a Bachelor's Degree in Science in the disciplines of Biotechnology, Biology, Botany, Zoology, Microbiology, Genetics, Chemistry, Biochemistry, Physics, Agriculture from this University or B.E/ B.TECH (Biotech), B.V.Sc, MBBS, BDS or any area of Biological Sciences / Agriculture and allied sciences; Veterinary and allied sciences or an examination of some other University accepted by the Syndicate as equivalent there to shallbe for the M.Sc Degree Examination of this University after a course of two academic years in an Affiliated Colleges of this University.

2 DURATION OF THE COURSE:

The duration of the course is for two academic years consisting of four semesters.

3. STRUCTURE OF THE COURSE

The course is organized on semester basis with a total off our semesters. In the first, second and third semesters, there arethree (core) theory papers (9 hrs per week), one Core Practical (15hrs per week) and Two elective/ optional papers(4hrs per week), per semester and in the fourth semester, there are only one core theory paper(Research Methodology) (4hrs per week), a core project/ dissertation work constituting a total of 20 hrs per week, two electives (4hrs per week), and a Soft skill program (2hrs perweek).

Elective paper: Each student shall opt for a comprehensive, interactive course with one of the faculty member. The topic of specialization and course content will be determined by the department/ course advisor.

Core Practical Laboratory: Independent practical shall be held under each component. It is recommended that the practical training be organized as an exercise rather than simple demonstration. The students must actually perform theexperiments.

4. ELIGIBILITY FOR THE AWARD OF DEGREE:

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed course of study in a college affiliated to the University for a period of not less than two academic years, passed the examination of all the four semesters prescribed earning minimum of 91 credits and fulfilled such conditions as have been prescribed therefore.

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed courses on Soft Skills and internship in addition to the courses prescribed by the respective Board of Studies for the subject of the Masters Degree. For two years Master's Degree Programme, a candidate shall undergo a minimum of 4 courses (4 x 2=8 credits) from the courses on Soft skills.

A two year Master's Degree student shall undergo 4-6 weeks (2 credits internship during the summer vacation of the First year and submit a report in the beginning of third semester. The

report will be evaluated in third semester and the marks forwarded to the University along with third semester internal assessment (CIA) marks.

5. EXAMINATIONS:

There shall be four semester examinations: first semester examination sat the middle of the first academic year and the secondsemester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be heldat the middle and the end of the second academic year, respectively. Practical examination shall be conducted independently at the end of even semesters. For practical examination, a single comprehensive) (covering different courses offered during that semester) practical examination (6hrsperday) beheld for each component of the core practicalat the end of even semesters.

Examinations for the courses on soft skills will be held along with the semester examinations of the core an delective courses. There is no written examination for internship. A student shall submit a report after completing the summer internship. The report will be evaluated by two examiners within the Department of the college/ institution.

VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN (AUTONOMOUS)

DEPARTMENT OF BIOTECHNOLOGY

M.Sc., Biotechnology Curriculum

(Autonomous, CBCS & OBE pattern)

(For the Candidates admitted during the academic year **2024-2025** onwards)

SCHEME OF EXAMINATION

S.No	Course Componentt	Course Code	Course	Credits	Hours		Maximum Marks		
					T	P	Int	Ext	Total
SEMESTER - I									
1	Core -1	23P1BTC01	Biochemistry	4	4	-	25	75	100
2	Core -2	23P1BTC02	Molecular Genetics	4	4	-	25	75	100
3	Core -3	23P1BTC03	Molecular Cell Biology	4	4	-	25	75	100
4	Core Practical-I	24P1BTCP01	Lab in Biochemistry	2	-	3	40	60	100
5	Core Practical-II	24P1BTCP02	Lab in Molecular Geneticsand Molecular Cell biology	2	-	6	40	60	100
6	DSE -I	23P1BTDE01	Bioinstrumentation	3	3	-	25	75	100
		24P1BTDE02	Tools in Biotechnology						
7	DSE-II	23P1BTDE03	Biostatistics	3	3	-	25	75	100
		24P1BTDE04	Enzyme Technology						
8	Soft Skill -I	23P1BTSP01	Lab in Statistics using R Program	2	-	3	40	60	100
Total				**24**	**18**	**12**	**245**	**555**	**800**

Theory	05
Practical	03

24P1BTCP01	Lab in Biochemistry	3 Hrs
24P1BTCP02	Lab in Molecular Genetics and Molecular Cell biology	6 Hrs
23P1BTSP01	Lab in Statistics using R Program	3 Hrs

Year	I	Program	M.Sc., Biotechnology	Code	23P1BTC01
Sem	I	Core – I : BIOCHEMISTRY		Credits	4
Hrs	60			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

The paper imparts a thorough knowledge on the basics of all the Biochemical concepts, Metabolic reactions and its regulation. The student will get to understand the core concepts of metabolism and physiological processes of the body in both healthy and disease state.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	To understand the basics of pH and related principles and carbohydrate Metabolism.	K1
CO2	To provide basic knowledge about lipid metabolism and related significance.	K1,K2 & K3
CO3	To enlighten the students on Bio-energetics and Biological oxidation pathways.	K1,K2 & K3
CO4	To update the knowledge on Amino acids and Protein.	K1,K2 & K3
CO5	To assess and appraise the role of Nucleic acids.	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	pH, Buffers, Carbohydrates, and Metabolisms	12 Hrs

pH, pK . acid, base .Buffers- Henderson- Haselbach equation, biological buffer system – Phosphate buffer system, protein buffer system, bicarbonate buffer system, amino acid buffer system and Hb buffer system. Water, Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms: glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway.

Unit – II	Lipids and Their Metabolisms	12 Hrs

Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycol lipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroid hormones.

Unit – III	Bioenergetics	12 Hrs

Bioenergetics explores energy concepts, thermodynamics, and the relationship between standard free energy and equilibrium constants. ATP functions as the universal energy currency in biology. Biological oxidation includes vital pathways such as the electron transport chain, oxidative phosphorylation, glycolysis and citric acid cycle. It also encompasses fatty acid oxidation, ketone body metabolism, photosynthesis, urea cycle.

Unit– IV	**Amino Acids and Proteins**	**12 Hrs**
Amino acids and Protein: Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids. Degradation of proteins, nitrogen metabolisms and carbon skeleton of amino acids. Over all in born error metabolisms.		
Unit – V	**Nucleic Acids**	**12 Hrs**
Nucleic acids: Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. In de novo and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolisms of purines and pyrimidines bases. Synthetic analogues of nitrogenous bases.		

References

1. Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Jacqui M. Matthews. (2011). Schaum's Outline of Biochemistry, Third Edition. McGraw-Hill.
2. U. Satyanarayana, U. Chakrapani. (2011). Biochemistry. Books and Allied Private Limited, Kolkata.
3. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer. (2010). Biochemistry, Seventh Edition. W. H. Freeman.
4. Albert Lehninger, David L. Nelson, Michael M. Cox. (2008). Principles of Biochemistry. John Wiley & Sons, Inc.
5. Donald Voet, Judith G. Voet, Charlotte W. Pratt. (2008). Fundamentals of Biochemistry: Life at the Molecular Level, Third Edition. John Wiley & Sons, Inc.
6. David L. Nelson, Michael M. Cox. (2017). Lehninger Principles of Biochemistry, Seventh Edition. W. H. Freeman.
7. Lubert Stryer, Jeremy M. Berg, John L. Tymoczko. (2015). Biochemistry, Eighth Edition. W. H. Freeman.
8. U. Satyanarayana. (2020). Biochemistry, Sixth Edition. Elsevier.
9. Reginald H. Garrett, Charles M. Grisham. (2016). Biochemistry, Sixth Edition. Cengage Learning.
10. Bruce Alberts, Alexander Johnson, Julian Lewis, et al. (2002). Molecular Biology of the Cell, Fourth Edition. Garland Science.

Year	I	Program	M.Sc., Biotechnology	Code	23P1BTC02
Sem	I	Core – I : MOLECULAR GENETICS		Credits	4
Hrs	60			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. To provide a comprehensive understanding of the fundamental principles of molecular genetics, including the structure and function of genes and chromosomes, mechanisms of DNAreplication and repair, and genetic variation.
2. To explore the applications of molecular genetics in various fields such as medicine, forensic science, environmental science, and conservation, emphasizing practical techniques and ethical considerations.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand the structure and function of genes and chromosomes, including the genetic code and complexity of the eukaryotic genome.	K1
CO2	Gain insights into DNA replication, gene expression regulation, mutation dynamics, and chromosomal abnormalities.	K2
CO3	Students will comprehend the various types of DNA damage and the corresponding cellular repair mechanisms.	K3
CO4	To analyze allele and genotype frequencies, understand the Hardy-Weinberg principle, and apply chromosome mapping techniques.	K4
CO5	Explore the applications of molecular genetics in medicine, environmental science, conservation, and forensic analysis, including ethical considerations.	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	Introduction to Genes and Chromosomes	12 Hrs

Genes and chromosomes, Genetic code, Identification of DNA as the genetic material. The complexity of eukaryotic genome (introns, exons, repetitive DNA sequence, gene duplication and pseudogenes). DNA markers -VNTR, STR, microsatellite, SNP and their detection Techniques.

Unit – II	Exploring DNA replication and MutationDynamics	12 Hrs

Replication of DNA, Gene expression and regulation in prokaryotes and eukaryotes. Mutation: Spontaneous and virus induced mutation, Radiation and UV induced mutation. Chromosomal Abnormalities and associated genetic diseases, Techniques in the study of chromosomes and their applications, Recombination – models.

Unit – III	DNA Damage and Repair	12 Hrs

DNA Damage and Repair-Internal and external agents causing DNA damages. DNA damages (Oxidative damages, Depurinations, Depyrimidinations, single and double strand breaks). Mechanisms of DNA damage (transition, transversion, frameshift, nonsense mutations). Repair mechanisms (Photo reactivation, excision repair, mismatch repair, post replication repair, SOS repair).

Unit– IV	**Understanding Genetic Frequencies and Chromosome Mapping**	**12 Hrs**
Allele frequencies and genotype frequencies, Random mating population, Hardy Weinberg principle, complications of dominance, special cases of random mating – multiple alleles, different frequencies between sexes (autosomal and X-linked) inbreeding, genetics and evolution, random genetic drift, Karyotyping and usefulness of chromosomes in understanding Genetic variation, Genetics of eukaryotes gene linkage and chromosome mapping.		
Unit – V	**Applications of Molecular Genetics**	**12 Hrs**
Genetic basis of disease: monogenic and complex disorders. Bioremediation: using microorganisms to clean up pollutants. Conservation genetics: preserving biodiversity through genetics. DNA fingerprinting and forensic DNA analysis. Techniques for analyzing genetic evidence: STR analysis and Y-STRs. Legal and ethical issues in forensic genetics.		

REFERENCES

1. Alberts, B., Johnson, A., Lewis, J., et al. (2015). Molecular Biology of the Cell. 6th edition. Garland Science.
2. Strachan, T., & Read, A. (2018). Human Molecular Genetics. 5th edition. Garland Science.
3. Lodish, H., Berk, A., Kaiser, C.A., et al. (2016). Molecular Cell Biology. 8th edition. W.H. Freeman.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., et al. (2015). Introduction to Genetic Analysis. 11th edition. W.H. Freeman.
5. Friedberg, E.C., Walker, G.C., & Siede, W. (2006). DNA Repair and Mutagenesis. 2nd edition. ASM Press.
6. Jackson, S.P., Bartek, J. (2009). "The DNA-damage response in human biology and disease". Nature, 461(7267), 1071-1078.
7. Strachan, T., & Read, A. (2018). Human Molecular Genetics. 5th edition. Garland Science.
8. Brown, T.A. (2016). Genomes 4. 4th edition. Garland Science.
9. Nussbaum, R.L., McInnes, R.R., & Willard, H.F. (2016). Thompson & Thompson Genetics in Medicine. 8th edition. Elsevier.
10. Primrose, S.B., & Twyman, R.M. (2013). Principles of Gene Manipulation and Genomics. 8th edition. Wiley-Blackwell.

Year	I	Program	M.Sc., Biotechnology	Code	23P1BTC03
Sem	I	Core - 3 : MOLECULAR CELL BIOLOGY		Credits	4
Hrs	75			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. Concentrates on the study of applied technologies in Life Sciences.
2. Trains students to research reliable, viable and good quality bioprocess solutions for social use.
3. The student will get to understand the core concepts of molecules and cell biology.
4. Encourage entrepreneurship.
5. Trains students to take on jobs in industries and academia.
6. Helps contribute to manpower in biopharmaceutical industries.
7. Offers a research-based program for the development of new concepts in Biotherapeutics.
8. Offers an updated curriculum, excellent infrastructure and highly experienced and Knowledgeable faculty members.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	To understanding of the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.	K1,K2 &K3
CO-2	Identify the structures and purposes of basic components in prokaryotic and eukaryotic cells and their molecular mechanism	K1,K2 &K3
CO-3	Demonstrate knowledge and understanding of the principles and basic mechanisms ofnuclear envelope and its functions.	K1,K2 &K3
CO-4	Understand the metabolic pathways and the process of transmission of Extra cellular signals	K1,K2 &K3
CO-5	Demonstrate the operation of various microscopes and microtomy in the laboratory	K1,K2 &K3

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I Exploring the foundations of Cell Biology: From Structure to Function 15Hrs

Introduction to cell Biology- Basic properties of cells- Cellular dimension-Size of cells and their composition- Cell origin and Evolution (Endosymbiotic theory)– Microscopy- Light Microscopy, Electron Microscopy, Application of Electron Microscopy in cell biology, Phase Contrast Microscopy, Fluorescence Microscopy, Flow Cytometry and FRET .Organelles of the eukaryotic cell and its functions; Biomembranes - structural organization, transport across membrane (Passive, Active and Bulk transport); Cell-Cell adhesion- Cell junctions (Tight junctions, gap junctions, desmosomes, adherens); Extra cellular matrix (ECM)- components and role of ECM in growth.

Unit – II	**Comprehensive insights into Molecular Biology: From Nucleic acids to Protein Synthesis and Cellular trafficking**	**15Hrs**
Structure of Nucleic acids, Genome organization in Eukaryotes, DNA Replication, Transcription, Translation and post translational Modification. Synthesis, sorting and trafficking of proteins: site of synthesis of organelle and membrane proteins – transport of secretary and membrane proteins across ER – post-translational modification in RER – transport to mitochondria, nucleus, chloroplast and peroxisome - protein glycosylation – mechanism and regulation of vesicular transport – golgi and post-golgisorting and processing – receptor mediated endocytosis; Synthesis of membrane lipids.		
Unit–III	**Unveiling The Intricacies Of The Nucleus: Structure, Chromatin Organization and Chromosome Dynamics**	**15Hrs**
Nucleus: Nuclear envelope – Nuclear pore complexes- nuclear matrix – organization of chromatin – supercoiling, linking number, twist - nucleosome and high order of folding and organization of chromosome (Solenoid and Zigzag model) - Global structure of chromosome–(Lamp brush and polytene chromosomes).		
Unit–IV	**Exploring cell dynamics: From Cycle regulation to Signaling pathways**	**15Hrs**
Molecular basis of eukaryotic cell cycle, Regulation and cell cycle check points; Programmed cell death (Apoptosis); Cell-Cell signaling-signaling molecules, types of signaling, signal transduction pathways (GPCR- cAMP, IP3, RTK, MAP Kinase, JAK-STAT, Wnt Pathway).		
Unit – V	**Decoding Cancer Biology: From Genetic Mechanisms to Therapeutic Innovations**	**15Hrs**
Cancer Biology: Multistage cancer development Mitogens, carcinogens, oncogenes and proto-oncogenes, tumor suppressor genes-Rb, p 53, Apoptosis and significance of apoptosis, Genome Editing – CRISPR/Cas 9.		

References:

1. Karp, G., 2009, Cell and Molecular Biology, Sixth edition, John Wiley & Sons, New York.
2. David E.Sadva., 2009. Cell biology organelles structure and function, CBS publishers and distributors, New Delhi.
3. Prakash S. Lohar , 2009. Cell and Molecular Biology.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, 2007.,Molecular Biology of the Cell, Fifth edition.Garland Science.
5. Luiz Carlos Uchoa, Janqueira, Jose, Carneiro. 2005. Basic HistologyText and Atlas. McGraw- Hill Professional.
6. Paul A, 2001, Text Book of Cell and Molecular Biology 2edition Niyogi Books
7. T.Fleming. 2002. Cell interactions: A practical approach Second edition.
8. Alberts B, Molecular Cell Biology. 8. Casimeris et al., Lewin's cells. Jones and Bartlett.

****

Year	**I**	**Program**	**M.Sc., Biotechnology**	**Code**	**24P1BTCP01**
Sem	**I**	**Core Practical – I : LAB IN BIOCHEMISTRY**		**Credits**	**2**
Hrs	**30**			**Effect from**	**2024-2025**

Course Objectives:

The main objectives of this course are:

1. Develop practical skills in using laboratory instruments and conducting biochemical experiments.
2. Gain proficiency in the qualitative and quantitative analysis of biological molecules.
3. Acquire the ability to perform and interpret chromatographic techniques and pH measurements.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Mastery of essential laboratory instruments and adherence to safety protocols.	K1
CO2	Proficiency in preparing and measuring pH of standard and biological buffers.	K3
CO3	Competence in qualitative and quantitative analysis of sugars, amino acids, proteins, and nucleic acids.	K3
CO4	Skills in performing and interpreting chromatographic techniques for amino acid separation.	K4
CO5	Ability to conduct accurate cholesterol estimation using biochemical methods.	K2

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

S.No	**Experiments**	**Hours**
1	**Introduction to commonly used instruments and laboratory safety.** **Exp. No.: 1 -** Stoichiometric Calculations.	3
2	**Preparation and measurement of pH of standard buffers.** **Exp. No.: 2** - Measurement of pH using pH meter. **Exp. No.: 3** - Preparation of Biological Buffers.	3
3	**Qualitative analysis of Monosaccharide in samples.** **Exp. No.: 4** – Aldose - Reducing hexose sugar (Glucose). **Exp. No.: 5** – Ketose – Reducing hexose sugar (Fructose). **Exp. No.: 6** - Reducing pentose sugar (Aldose – Ribose/Ketose – Ribulose)	3
4	**Qualitative analysis of Disaccharides in samples.** **Exp. No.: 7** – Reducing disaccharide (Maltose/Lactose). **Exp. No.: 8** – Non-Reducing disaccharide (Sucrose).	3
5	**Qualitative analysis of amino acids in samples.** **Exp. No.: 9** – α-amino acids (aromatic amino acids and sulphur containg amino acids)	3
6	**Quantitative analysis of proteins.** **Exp. No.: 10**- Estimation of proteins by Lowry's method	3

7	**Quantitative analysis of nucleic acids.** **Exp. No.: 11-** Estimation of DNA by Diphenylamine method. **Exp. No.: 12-** Estimation of RNA by orcinal method	3
8	**Quantitative estimation of cholesterol.** **Exp. No.: 13** – Estimation of Cholesterol by Zak's method	3
9	**Separation of amino acids on Paper Chromatography.** **Exp. No.: 14** – Separation of amino acids by Paper Chromatography.	3
10	**Separation of amino acids on Thin Layer Chromatography** **Exp. No.: 15** – Separation of amino acids by Thin Layer Chromatography.	3

References

1. Principles of Biochemistry" by Albert L. Lehninger, David L. Nelson, and Michael M. Cox, published by W.H. Freeman, 2017.
2. "Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Gregory J. Gatto Jr., published by W.H. Freeman, 2015.
3. "Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry" by Irwin H. Segel, published by John Wiley & Sons, 2004.
4. "Practical Biochemistry: Principles and Techniques" by Keith Wilson and John Walker, published by Cambridge University Press, 2010.
5. "Chromatography: Concepts and Contrasts" by James M. Miller, published by John Wiley & Sons, 2013.

Year	I	Program	M.Sc., Biotechnology	Code	24P1BTCP02
Sem	I	Core Practical – 3: LAB IN MOLECULAR GENETICS AND MOLECULAR CELL BIOLOGY		Credits	2
Hrs	45			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. The practical will establish a basic study skill on the subject and will improve the student stability to calculate and improve their practical skill and knowledge.
2. Explore cellular mechanisms through experimentation.
3. Separation analysis of DNA and Proteins using different practical methods.
4. Investigate gene expression and regulation and Study protein interactions and signaling pathways.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	(K2) Illustrate basic separation procedures	K3,K4 &K5
CO2	(K3) study the methods of estimation of biomolecules	K3,K4 &K5
CO3	(K4) isolate &Analyze DNA, RNA & protein	K3,K4 &K5
CO4	(K5) evaluate the quality and purity of DNA, RNA & Protein	K3,K4 &K5
CO4	(K5) critically analyze the isolated biomolecules	K3,K4 &K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

S.No	Experiments – Molecular Genetics	Hours
1	Isolation of Genomic DNA from Bacteria	7
2	Isolation of Genomic DNA from Plants	7
3	Plasmid DNA isolation from Bacteria	7
4	Agarose gel electrophoresis of DNA	7
5	Restriction digestion of DNA	7
	Experiments – Molecular Cell Biology	
6	Meiotic study in flower bud sand cockroach or grasshopper	5
7	Cell counting and cell viability	5

References

1. **Molecular Cloning: A Laboratory Manual** by Joseph Sambrook, David W. Russell, and Michael R. Green - This is a classic reference for techniques in molecular cloning, gene expression analysis, and DNA manipulation
2. **Current Protocols in Molecular Biology** - A comprehensive collection of protocols covering various

aspects of molecular genetics, including PCR, cloning, sequencing, and mutagenesis.

3. **Cell and Molecular Biology: Concepts and Experiments** by Gerald Karp
4. **Principles of Gene Manipulation and Genomics** by Sandy B. Primrose and Richard M. Twyman.

****

Year	I	Program	M.Sc., Biotechnology	Code	23P1BTDE01
Sem	I	DSE – I : BIOINSTRUMENTATION		Credits	3
Hrs.	45			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

The paper imparts a thorough knowledge on the basics of all the instrumentation concepts, in biology. The student will get to understand the core concepts of biological instruments and their principle

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Introduction and various types of microscopic techniques	K1 & K2
CO-2	Impart understanding on centrifugation instruments and techniques	K1, K2, K3
CO-3	Separation of Biomolecules	K1, K2 & K3
CO-4	Analytical methods on Spectroscopic Analysis	K1, K2 & K3
CO-5	Understand the application and Detection on Bioinstrumentation	K1, K2 & K3

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Microscopic Techniques:**	**09 Hrs**

Principles and Applications: Compound, Light, Stereo, Phase Contrast, Fluorescent Microscopy, Scanning and Transmission Electron Microscopy, Scanning Electron Microscopy, Atomic Force Microscopy, Confocal Microscopy, FRET and Flow Cytometry

Unit – II	**Centrifugation:**	**09 Hrs**

pH meter, Principle and Applications ofvarious types of centrifugations, Sedimentation Coefficient, Svedberg unit, RCF, Density Gradient Centrifugation. Chromatography Techniques: Principle and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC & HPLC.

Unit – III	**Electrophoretic Techniques:**	**09 Hrs**

Principle and Application of Agarose Gel Electrophoresis, 2D-gelElectrophoresis, PAGE- NATIVE & SDS PAGE, Iso- electric Focusing, High resolution Electrophoresis, Immuno Electrophoresis (Immunofixation EP,), ELISA, RIA, Southern, Northern and Western Blotting.Electro blotting, PCR and RT-PCR, Microarray (DNA, Proteins)

Unit– IV	**Spectroscopic Techniques:**	**09 Hrs**

Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, IR Spectroscopy NMR, ESR, Atomic Absorption Spectroscopy, X- ray Spectroscopy, Laser Spectroscopy and Raman Spectroscopy

Unit – V	**Radio-isotopic Techniques:**	**09 Hrs**

Introduction to Radioisotopes, Uses and their Biological Applications, Radioactive Decay – Types and Measurement, Principles and Applications of GM Counter, Solid and Liquid Scintillation Counter, Autoradiography, RIA, Radiation Dosimetry, Health effects of radiations

References

1. M.H. Fulekar and Bhawana Pandey Bioinstrumentation, Wiley
2. Keith Wilson, John Walker, 2010. Principles and Techniques of Biochemistry and MolecularBiology (7th Edition), Cambridge University Press
3. David L. Nelson, Michael M. Cox. Menninger (2008). Principles of Biochemistry, Fifth edition W. H. Freeman, New York.
4. Experiments in Biochemistry: A Hands-On Approach by Shawn O. Farrell, Ryan T. Ranallo, Paperback: 324 pages, Publisher: Brooks Cole. 20
5. Metzler D.E. 2001, the chemical reactions of living cells –Academic Press. 2nd edition.
6. Stryer L,1999, Biochemistry-W.H. Freeman & Company, New York. 1. 4th edition
7. L.Veerakumari (2006) Bioinstrumentation MJP Publisher Kindle edition
8. Jefrey. M., Backer el al., 1996. Biotechnology- A Laboratory Course. Academic Press, NewYork.
9. Holcapek, M., Byrdwell, Wm. C. 2017. Handbook of Advanced Chromatography /Mass Spectrometry Techniques, Elsevier

Year	I	Program	M.Sc., Biotechnology	Code	24P1BTDE02
Sem	I	DSE – I : TOOLS IN BIOTECHNOLOGY		Credits	3
Hrs	45			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. Students will gain in-depth knowledge of the structure and organization of prokaryotic and eukaryotic genomes, various cloning vectors, and the tools and techniques used for gene manipulation.
2. Students will master selection and screening methods for recombinant DNA clones and explore the practical applications of cloning, such as in gene therapy and DNA fingerprinting, while also addressing relevant biosafety considerations.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand the structure of prokaryotic and eukaryotic genomes and the role of extra-chromosomal DNA.	K1
CO2	Learn about various cloning vectors and transformation techniques.	K2
CO3	Master the tools and enzymes used in gene manipulation.	K3
CO4	Learn strategies for selecting and screening recombinant DNA clones.	K4
CO5	Understand the applications of cloning and associated biosafety issues.	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Gene and Genomes:**	**09 Hrs**

Prokaryotic and Eukaryotic Genomes - Structure of Gene - DNA as the genetic material; Extra chromosomal DNA: Plasmid, mitochondrial DNA and chloroplast DNA.

Unit – II	**Cloning Vectors:**	**09 Hrs**

Vectors: Plasmid, phagemid, cosmid, Artificial Chromosomes (BAC) - Transformation techniques: Electroporation, CaCl2 method.

Unit – III	**Tools for Gene Manipulation**	**09 Hrs**

Enzymes: Gel Electrophoresis: AGE and PAGE; Restriction Enzymes, Ligases, Modifying Enzymes - Markers for Selection: selectable and scorable - Examples.

Unit– IV	**Selection Strategy and Screening for Transformants**	**09 Hrs**

Selection of rDNA Clones: Blue-White Selection, Colony Hybridization, PCR, Molecular analysis: Western blotting, Southern Blotting and Northern Blotting

Unit – V	**Application of Cloning**	**09 Hrs**

Over expression of Biomolecules (Insulin) - Gene therapy – GMO – DNA Finger printing Application and Biosafety issues

Reference:

1. Primrose. S.B., Twyman R.M., Old. R.W. (2001) Principles of Gene Manipulation. Blackwell Science Limited. 2. Molecular Biotechnology. S.B Primrose, Blackwell Scientific Publishers, Oxford, 1994.

3. Principles of Gene Manipulation. T.A.Brown

4. DNA Science – A first course in rDNA technology, D.A. Mickloss nd G.A.Freyar, Cold Spring Harbor laboratory Press, New York, 1990.

5. Molecular Cloning. Maniatis, Fritsch and Sambrook.

Year	I	Program	M.Sc., Biotechnology	Code	23P1BTDE03
Sem	I	DSE - I : BIOSTATISTICS		Credits	3
Hrs	45			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. The paper imparts a thorough knowledge on the basics of all the statistical concepts, in biology.
2. The student will get to understand the core concepts of computation principles for the data analysis.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	To understand the major Methods of collection & presentation of data	K1 & K2
CO-2	To provide basic knowledge about methods of analysis of variance	K3
CO-3	To enlighten the students about the methods of setting hypothesis and calculation of errors.	K3 & K4
CO-4	To update the knowledge on Tests of significance for large and small samples.	K4 & K5
CO-5	To assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches.	K5 & K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Introduction**	**9 Hrs**

Statistics – Scope –collection, classification, tabulation of Statistical Data. Measures of central tendency.

Unit – II	**Correlation and Regression**	**9 Hrs**

Methods of correlation table – coefficient of correlation– regression – Difference between regression and correlation. Probability distributions – Binomial and Poisson distribution.

Unit – III	**Probability Distribution and Basis of Statistical Inference**	**9 Hrs**

Normal distribution. Basis of Statistical Inference – Sampling Distribution – Standard error – Testing of hypothesis – Null Hypothesis –Type I and Type II errors.

Unit– IV	**Tests of Significance for Large and Small samples**	**9 Hrs**

Tests of significance for large and small samples based on Normal t test and z test, chi-square test of goodness of fit – contingency tables – c2 test for independence of two attributes, 2×2 table.

Unit – V	**Tests of Significance**	**9 Hrs**

F tests – Analysis of variance – one way classification – Two way classification, Spreadsheets – Data entry –mathematical functions – statistical function – Graphics display – printing spreadsheets – use as a database word processes – databases – statistical analysis packages graphics/presentation packages.

References

1. Veer bala Rastogi. 2011. Fundamentals of Biostatistics. Ane books Pvt Ltd, Chennai.
2. Rosner,B (2005), "Fundamentals of Biostatistics", Duxbury Press.
3. Warren,J; Gregory,E; Grant,R (2004), "Statistical Methods in Bioinformatics",1st edition, Springer
4. Milton,J.S.(1992),. "Statistical methods in the Biological and Health Sciences", 2nd edition, Mc Graw Hill,
5. Sundar Rao P. S.S., Jesudian G. & Richard J. (1987), "An Introduction to
6. Biostatistics", 2nd edition,. Prestographik, Vellore, India,.
7. Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition.

Year	I	Program	M.Sc., Biotechnology	Code	24P1BTDE04
Sem	I	DSE – II : ENZYME TECHNOLOGY		Credits	3
Hrs	45			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1.The subject imparts knowledge on the fundamentals of enzyme structure and its kinetics.
2.The student will be provided with a basic knowledge and understanding about the functions of enzyme as well as the industrial application of enzymes.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Explain the basics of enzyme nomenclature and properties.	K3 & K5
CO-2	Classify and Cognize the native and immobilized enzyme.	K3 & K5
CO-3	Examine the equations of steady state kinetics.	K3 & K4
CO-4	Assess extraction and downstream processing of enzymes.	K3, K4 & K6
CO-5	Compile the uses of enzymes and design enzymes for Industrial and Clinical application.	K3,K4, K5 & K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Introduction to Enzymes**	**09 Hrs**

Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalysed reactions. Extraction Isolation and purification of enzymes by precipitation, centrifugation, chromatography and electrophoresis and liquid-liquid extraction methods

Unit–II	**Kinetics of Catalysed Reaction**	**09 Hrs**

Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, line weaver burk plot, Hanes wolf equation, Eadie hoofstee equation ,Inhibition of enzyme activity.

Unit–III	**Enzyme Catalysis**	**09 Hrs**

Enzyme specificity and the concept of active site, determination of active site. Inhibition of enzyme activity. Stereospecificity of enzymes. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis.

Unit–IV	**Theories on Mechanism of Catalysis**	**09 Hrs**

Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex.

Unit–V	**Enzyme Regulation and Industrial Applications**	**09 Hrs**

Coenzyme General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modification of enzymes, Immobilized enzymes and their industrial applications. Clinical and industrial applications of enzymes, Enzyme Engineering – Directed evolution.

References

1. Nicholas C.Price and Lewis Stevens., 2010. Fundamentals of Enzymology. Oxford UniversityPress,
2. New Delhi
3. Lehninger, Nelson and Cox, 2005, Principles of Biochemistry - 4th edition, WH Freeman and
4. Company, New York, USA
5. Principles of Biochemistry with human focus - Garrett and Grisham, 2002, Harcourt College
6. Publishers, Orlando, Florida, USA.
7. Geoffrey L, Zubay, Biochemistry -, 1998, 4th edition. 23
8. Donald Voet, Judith Voet and Pratt, 1995, Fundamentals of Biochemistry, 2nd edition.
9. Harper.s Biochemistry - Murray et al, 2000, 25th edition, Appleton and Lange Publishers.
10. Enzymes – Trevor Palmer 2002.

Year	I	Program	M.Sc., Biotechnology	Code	23P1BTSP01
Sem	I	Soft Skill – I : LAB IN STATISTICS USING R PROGRAM		Credits	2
Hrs	60			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. Teach learners how to proficiently import data from various file formats (txt, csv, excel) into R, ensuring they can manage diverse data sources effectively for subsequent analysis and manipulation tasks.
2. Enable learners to master data reshaping and manipulation techniques in R, including restructuring data frames, merging datasets, and aggregating information, fostering competence in preparing and transforming data for analytical purposes.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Introduce learners to R programming fundamentals, including data types and structures, essential for basic script writing and data handling.	K1
CO2	Enable proficiency in data manipulation and reshaping tasks, focusing on importing, exporting, and transforming data using R, crucial for data preparation in analysis and visualization.	K2
CO3	Develop skills in creating and customizing various types of plots and graphs in R to effectively visualize and interpret data for analytical insights and communication.	K3
CO4	Provide a solid foundation in basic statistical concepts and methods in R, essential for summarizing data, assessing distributions, and performing initial data analyses.	K4
CO5	Equip learners with advanced statistical techniques and tests in R for comparing groups, analyzing relationships, and conducting comprehensive research data analysis.	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

S.No	Experiments	Hours
1	Install R and R Studio & Load R Studio and understand the interface.	6
2	Perform basic arithmetic operations.	6
3	Create and manipulate manipulate vectors, matrices, factors, data frames, and lists.	6
4	Import & Export data from CSV, TXT, and Excel files into R.	6
5	Perform data manipulation tasks (subsetting, merging, aggregating).	6
6	Generate various plots: histogram, scatter plot, box plot, bar plot.	6
7	Create density plots, violin plots, lollipop charts, and heat maps.	6

8	Calculate mean, median, mode, range, variance, and standard deviation.	6
9	Perform normality tests (Shapiro-Wilk, Kolmogorov-Smirnov).	6
10	Perform t-tests (independent, paired), ANOVA, and non-parametric tests (Wilcoxon rank-sum, Kruskal-Wallis).	6

References

1. "R for Data Science" by Hadley Wickham and Garrett Grolemund (2017, 1st edition)
2. "An Introduction to Statistical Learning: with Applications in R" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani (2013, 1st edition)
3. "Discovering Statistics Using R" by Andy Field, Jeremy Miles, and Zoe Field (2012, 1st edition)
4. "R Graphics Cookbook" by Winston Chang (2013, 1st edition)
5. "Advanced R" by Hadley Wickham (2014, 1st edition)
6. "Applied Predictive Modeling" by Max Kuhn and Kjell Johnson (2013, 1st edition)
7. "Data Manipulation with R" by Phil Spector (2008, 1st edition)
8. "Modern Data Science with R" by Benjamin S. Baumer, Daniel T. Kaplan, and Nicholas J. Horton (2017, 1st edition)
9. "ggplot2: Elegant Graphics for Data Analysis" by Hadley Wickham (2009, 1st edition)
10. "Introductory Statistics with R" by Peter Dalgaard (2008, 1st edition)

VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN (AUTONOMOUS)

DEPARTMENT OF BIOTECHNOLOGY

M.Sc., Biotechnology Curriculum

(Autonomous, CBCS & OBE pattern)

(For the Candidates admitted during the academic year **2023-2024** onwards)

SCHEME OF EXAMINATION

S.No	Course Component	Course Code	Course	Credits	Hours		Maximum Marks		
					T	P	Int	Ext	Total
SEMESTER - III									
1	Core -7	23P3BTC07	Immunology	4	4		25	75	100
2	Core -8	23P3BTC08	Bioprocess Technology	4	4		25	75	100
3	Core -9	23P3BTC09	Bioinformatics	4	4		25	75	100
4	Core Practical -III	23P3BTCP03	Lab in Immunology and Bioprocess Technology	3		6	40	60	100
5	Core Practical -IV	23P3BTCP04	Lab in Bioinformatics	2		3	40	60	100
6	DSE - I	23P3BTDE07	Molecular DevelopmentalBiology	3	3		25	75	100
		23P3BTDE08	Nano Biotechnology						
7	Soft Skill -III	23P3BTSP03	Lab in Omics Data analysis	2		3	40	60	100
8	Val.Edu	23P3HR01	Human Rights	1	1		25	75	100
9	Internship	23P3BTINT01	Internship	1					
Total				**24**	**16**	**12**	**245**	**555**	**800**

Theory	05
Practical	03
Internship	01

23P3BTCP03	Lab in Immunology and Bioprocess Technology	6 Hrs
23P3BTCP04	Lab in Bioinformatics	3 Hrs
23P3BTSP03	Lab in Omics Data analysis	3 Hrs

Year	II	Program	M.Sc., Biotechnology	Code	23P3BTC07
Sem	III	Core – 7 : IMMUNOLOGY		Credits	4
Hrs	60			Effect from	2023-2024

Course Objectives:

The main objectives of this course are:

1. The paper imparts a thorough knowledge on the basics of immunology.
2. The student will get to understand the core concepts of immune systems and their non-specificand specific mechanisms, vaccine, etc.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Illustrate various mechanisms that regulate immune responses and maintain tolerance.	K1 & K2
CO-2	Describe key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effectors responses.	K2,K3 & K5
CO-3	Learn the concepts of cellular and molecular processes that represents the human immune system.	K2 & K5
CO-4	Elucidate the role of immunological regulation and tolerance at a cellular and molecular level.	K4 & K5
CO-5	Compile concepts on immunological principles and diagnosis.	K3,K4 & K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	Fundamentals of Immunology	12 Hrs

History and overview of the immune system. Types of immunity - innate, acquired, passive and active, self vs non-self-discrimination. Physiology of immune response: HI and CMI specificity and memory. Cells and organs of the immune system .Lymphoid tissue, origin and development. Hematopoiesis and differentiation of lymphocytes.

Unit – II	Immune Cells and Its function or Cellular Immunology	12 Hrs

Lymphocyte-sub-populations of mouse and man. APCcells, lymphokines, Phagocytic cells, macrophage, dendritic cells, K and NK Cells. Nature and biology of antigens, epitopes, haptens, adjuvents. Immunoglobulins- structure, distribution and function. Immunoglobulin super family Isotypic, Allotypic and Idiotypic variants, generation of antibody diversity.

Unit – III	Clinical Immunology	12 Hrs

Monoclonal antibody production and its applications. Types of vaccine and vaccination schedule. Role of MHC antigens in immune responses, Structure and function of class I and class II MHC molecules. MHC antigens in transplantation and HLA tissue typing. Transplantation immunology-immunological basis of graft rejection, cinical transplantation and Immunosuppressive therapy. Tumour Immunology - Tumour antigen, Immune response to tumours.

Unit– IV	Immunological Effector Mechanisms	12 Hrs

Effector mechanisms in immunity - macrophage activation, cell mediated cytotoxicity, cytotoxicity assay. Hypersensitivity reactions and types. The complement system, mode of activation, classical and alternate pathway, biological functions of C proteins.

Unit – V	**Immunological Techniques and Applications**	**12 Hrs**

Immuno techniques- Principle and Applications: Immuno diffusion, Immuno fluorescence, Insitu localization technique - FISH and GISH. RIA and ELISA, FACS, Western blot, ELISPOT assay. Agglutination tests. VDRL test. Purification of antibodies, Quantitation of immunoglobulin by RID, EID and nephelometry, CMI techniques and Immunotherapy.

References

1. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt,2011.
2. Roitt.s Essential Immunology, 12 edition, Wiley-Blackwell. USA.
3. Kannan. I., 2010. Immunology. MJP Publishers, Chennai.
4. Abbas, A.K., A.H.L. Lichtman and S.Pillai, 2010. Cellular and MolecularImmunology. 6thEdition.
5. Saunders Elsevier Publications, Philadelphia.
6. SeemiGarhat Bashir, 2009. Text Book of Immunology, PHI LearningPvt. Ltd. New Delhi.
7. Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby, 2006.Kuby Immunology, 6thedition,
8. W. H. Freeman & Company. Nandini Shetty, 1996, Immunology: introductory textbook - I. NewAge International, NewDelhi.

Year	II	Program	M.Sc., Biotechnology	Code	23P3BTC08
Sem	III	Core – 8 : BIOPROCESS TECHNOLOGY		Credits	4
Hrs	60			Effect from	2023-2024

Course Objectives:

The main objectives of this course are:

1. To make the students on understanding basic principles of fermentation techniques and applying them in the production value added products such as antibiotic, vitamins and organic acids.
2. The students also gain added knowledge on the production of agro-based products for human welfare.
3. To provide students with a comprehensive understanding of the principles and practicesinvolved in Bioprocess Technology.
4. To explore the application of bioprocess technology in various industries such as pharmaceuticals, food and biofuels.
5. To highlight recent advancements and emerging trends in bioprocess technology.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand the basics of fermentation processes and their importance in various industries.	K1 & K2
CO2	Classify different types of bioreactors, including submerged, surface, mechanically agitated, and non-mechanically agitated reactors.	K2 & K3
CO3	Introduce bioproducts and bio separation techniques used in downstream processing.	K4
CO4	Discuss chromatography techniques and membrane separation methods used in downstream processing.	K4 & K5
CO5	Differentiate between aerobic and anaerobic fermentation processes and their applications in biotechnology industries.	K4 & K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Introduction to fermentation**	**12 Hrs**

General requirements of fermentation. Microbial growth kinetics of batch, fed batch and continuous culture. Solid substrate, slurry fermentation and its application. Microbial cell culture preparation. Immobilization of cells and enzymes. Food Safety- Introduction to food safety aspects and food related hazards – HACCP, EU, PEM/NPEM and ISO/IEC standards.

Unit – II	**Types of Bioreactors**	**12 Hrs**

Submerged reactors, surface reactors, mechanically agitated reactors, non-mechanically agitated reactors. Design of fermenters, body construction. Production of citric acid, penicillin and insulin. Isolation and improvement of Industrially important Micro-organisms, Media for Industrial fermentation and Sterilization.

Unit – III	**Introduction to bioproducts and bio separation**	**12 Hrs**

Primary recovery process- Cell disruption methods. Cell lysis and Flocculation: Osmotic and mechanical methods of lysis. Flocculation by electrolysis; polymorphic flocculation. Precipitation methods. Filtration- Principles, Conventional, Crossflow filtration. Sedimentation- Principles, Sedimentation coefficients. Extraction Principles, Liquid extraction, aqueous two-phase extraction, supercritical fluid extraction.

Unit– IV	**Down Stream Processing**	**12 Hrs**

Chromatography Techniques, Membrane separation, ultrafiltration. Drying. Principles and operation of vacuum dryer, shelf/tray dryer, rotary dryer, freezer and spray dryer. Crystallization and Whole broth processing.

Unit – V	**Application of Bioprocess Technology**	**12 Hrs**

Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry. Production of commercially important primary and secondary metabolites, Effluent Treatment and Fermentation Economics.

References

1. "Bioprocess Engineering: Basic Concepts" by Michael L. Shuler and Fikret Kargi
2. "Principles of Fermentation Technology" by Peter F. Stanbury, Allan Whitaker, and Stephen J. Hall
3. "Bioseparations Science and Engineering" by Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri P. Petrides
4. "Bioseparations: Principles and Techniques" by B.S. Narayan
5. "Bioprocess Engineering Principles" by Pauline M. Doran
6. Covers the principles of bioprocess optimization and scale-up strategies.
7. "Biochemical Engineering Fundamentals" by James E. Bailey and David F. Ollis
8. "Biotechnology: A Textbook of Industrial Microbiology" by Wulf Crueger and Anneliese Crueger
9. Focuses on the application of microbial biotechnology in industrial processes.
10. "Industrial Microbiology: An Introduction" by Michael J. Waites, Neil L. Morgan, John S. Rockey, and Gary Higton
11. Provides insights into advanced bioprocessing techniques and industrial applications.
12. Additional Reference Books:

Year	II	Program	M.Sc., Biotechnology	Code	23P3BTC09
Sem	III	Core – 9 : BIOINFORMATICS		Credits	4
Hrs	60			Effect from	2023-2024

Course Objectives:

The main objectives of this course are:

1. To gain basic knowledge in the concept of essential of bioinformatics.
2. To understand the usage of prediction tools that are used to predict the biological system.
3. To understand basic concepts of drug designing.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand the structure and organization of various biological databases, including nucleic acid sequence databases (GenBank/NCBI, EMBL, DDBJ) and protein sequence databases (UniprotKB, PIR).	K1
CO2	Develop skills in sequence alignment, including both pairwise sequence alignment (local and global alignments) and multiple sequence alignment using tools like Clustal X.	K2 & K3
CO3	Learn to use gene prediction methods (ORF Finder, Genscan), restriction site analysis, PRIMER designing, and RNA/protein secondary structure prediction methods (Chou-Fasman, GOR).	K3
CO4	Understand the principles of molecular mechanics, including force fields, bond length, torsion angle, non-bonded interactions (electrostatic and van der Waals interactions), and energy minimization (local and global).	K4 & K5
CO5	Learn the concepts and techniques of drug designing, including rational drug design, computer-aided drug design, ligand-based approaches, and target-based approaches.	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Biological Databases**	**10 Hrs**

Biological Databases, Nucleic acid sequence databases– GenBank/NCBI, EMBL, and DDBJ. Protein sequence databases – UniprotKB and PIR, Structure databases – PDB, CATH and SCOP. Specialized Databases- PUBMED, OMIM and KEGG. gene expression data, proteinprotein interaction (PPI) data, pathway data and gene ontology (GO) data.

Unit – II	**Sequences Analysis**	**15 Hrs**

Sequence alignment, Pairwise Sequence Alignment- Local alignment and Global alignments, Dynamic programming algorithm, Scoring matrices, gap penalties. Multiple Sequence AlignmentClustal X, Phylogenetic Analysis- Tree construction methods- Maximum likelihood and maximum parsimony- NJ methods, UPGMA and WPGMA, Database Similarity Search – BLAST and types.

Unit – III	**Prediction and Analysis Tools**	**10 Hrs**

Genome sequencing - EST Clustering and analyses, Finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis, Genome maps and markers, understanding Genome variation, Gene Prediction methods – ORF Finder, Genscan, Restriction Site Analysis, PRIMER Designing, RNA Secondary Structure Predictions, Protein Secondary Structure Methods- Chau-Fasman and GOR.

Unit– IV	**Molecular Modeling**	**12 Hrs**

Molecular Mechanics – force fields; Bond length, Torsion angle, Non- bonded interactions electrostatic and van der Waals interactions, energy minimization- local and global, Homology Modeling, Molecular dynamics and simulation.

Unit – V	**Drug Designing**	**13 Hrs**

Drug Discovery. History. Steps in drug discovery. Target Identification. Target Validation. QSAR. Lead Identification. Preclinical pharmacology and toxicology. ADME. Drug designing. Rational drug design. Computer aided drug design. Ligand based approach. Target based approach.

References

1. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount, 2nd Edition (2004)
2. "Bioinformatics: Principles and Applications" by Zhumur Ghosh and Bibekanand Mallick, 1st Edition (2008).
3. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount, 2nd Edition (2004).
4. "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins" by Andreas D. Baxevanis and B. F. Francis Ouellette, 3rd Edition (2004).
5. "Molecular Modelling: Principles and Applications" by Andrew R. Leach, 2nd Edition (2001).
6. "Drug Design: Methodology, Concepts, and Mode-of-Action" by Thierry Langer and Rolf W. Hartmann, 1st Edition (2006).
7. "The Organic Chemistry of Drug Design and Drug Action" by Richard B. Silverman and Mark W. Holladay, 3rd Edition (2014).

Year	II	Program	M.Sc., Biotechnology	Code	23P3BTCP03
Sem	III	Core Practical – III:		Credits	3
Hrs	40	LAB IN IMMUNOLOGY AND BIOPROCESS TECHNOLOGY		Effect from	2023-2024

Course Objectives:

The main objectives of this course are:

1. To provide students with practical exposure to immunological techniques, including the handling of laboratory animals and the qualitative and quantitative estimation of antigen- antibody specificity.
2. The course aims to provide hands-on experience and theoretical knowledge on various microbial fermentation processes and their applications.
3. Students will learn the techniques for fermenter operation, microbial cell immobilization, qualitative analysis of milk, and the production and estimation of bio-products like ethanol, citric acid, and acetic acid.
4. The course also focuses on the isolation and application of beneficial microorganisms in food and beverage fermentation, enhancing the understanding of microbial biotechnology.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	To provide students with practical exposure to immunological techniques, including gaining knowledge on handling of laboratory animals.	K3
CO2	To Gain comprehensive knowledge of the design and function of various fermenter components.	K3 & K4
CO3	To learn the technique of immobilizing yeast cells using the sodium alginate method.	K4 & K5
CO4	To perform and interpret the Methylene Blue Reduction Test (MBRT) to assess milk quality.	K5 & K6
CO5	To understand the entire process of wine fermentation, learn the microbial production process of citric acid and understand the microbial process for acetic acid production.	K5 & K6

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze; K5 – Evaluate; K6 – Create

Immunology

S.No	Experiments	Hours
1	Differential Leukocyte Count	3
2	Total Leukocyte Count	3
3	C – Reactive Protein Test	3
4	Rapid Plasma Reagin Test	3
5	Rocket Immuno Electrophoresis	5

6	Counter Current Immunoelectrophoresis	3
	Bioprocess Technology	
7	Isolation of Lactobacillus from Dairy Products	5
8	Yogurt Fermentation with Lactobacillus Culture	3
9	Production of Ethanol by Yeast	3
10	Production of Vitamin B_{12}	3
11	Production of Antibiotics (Penicillin)	3
12	Production of Beer	3

References

1. Clinical Laboratory Tests: Values and Implications by Springhouse (Published in 2001)
2. Textbook of Medical Laboratory Technology by Praful B. Godkar (Published in 2014)
3. Clinical Laboratory Diagnostics: Use and Assessment of Clinical Laboratory Results by Thomas L. Lehmann and Georg D. Hirsch (Published in 2012)
4. Clinical Laboratory Science Review by Robert R. Harr (Published in 2015)
5. Clinical Laboratory Hematology by Shirlyn B. McKenzie, Lynne Williams, and Turgeon ML (Published in 2014)
6. Clinical Laboratory Tests: Values and Implications by Springhouse (Published in 2001)
7. Textbook of Medical Laboratory Technology by Praful B. Godkar (Published in 2014)
8. Clinical Laboratory Diagnostics: Use and Assessment of Clinical Laboratory Results by Thomas L. Lehmann and Georg D. Hirsch (Published in 2012)
9. Clinical Laboratory Science Review by Robert R. Harr (Published in 2015)
10. Clinical Laboratory Hematology by Shirlyn B. McKenzie, Lynne Williams, and Turgeon ML (Published in 2014)

Year	**II**	**Program**	**M.Sc., Biotechnology**	**Code**	**23P3BTCP04**
Sem	**III**	**Core Practical – IV : LAB IN BIOINFORMATICS**		**Credits**	**2**
Hrs	**30**			**Effect from**	**2023-2024**

Course Objectives:

The main objectives of this course are:

1. Equip students with comprehensive bioinformatics skills for analyzing and interpreting biological data, including sequence similarity searching, multiple sequence alignment, phylogenetic analysis, and structural modeling using various databases and tools such as ExPASy, NCBI, BLAST, and Modeller.
2. Develop students' proficiency in utilizing specialized software and servers for advanced bioinformatics applications, including predicting physicochemical properties, secondary structures, drug-like properties, performing site-directed mutagenesis, and conducting docking analyses with tools like ProtParam, NPSA, Molinspiration, Swiss-PdbViewer, AutoDock Vina, and Protein Plus.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand and navigate ExPASy and NCBI databases for retrieving and analyzing biological data and principles of sequence alignment and similarity searching.	K1
CO2	Conduct multiple sequence alignments and phylogenetic analysis to infer evolutionary relationships among sequences. Gain proficiency in performing both local and global pairwise alignments, understanding their applications.	K2
CO3	Predict and analyze the physicochemical properties of protein sequences using ProtParam and protein secondary structures and interpret the results using the NPSA server.	K3
CO4	Gain expertise in performing comparative modeling of protein structures using Modeller and validating these models with the SAVES server and assessing drug-like properties of molecules using Molinspiration.	K4
CO5	Master the techniques of docking analysis using AutoDock Vina and the Protein Plus server to predict and evaluate protein-ligand interactions.	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

S.No	**Experiments**	**Hours**
1	Biological database with reference on ExPASy and NCBI.	3
2	Sequence similarity searching using BLAST, Multiple sequence and phylogenetic analysis.	3
3	Pairwise alignment – Local & Global Alignment.	3
4	Predicting Physiochemical properties of protein sequence using Protparam.	3

5	Predicting protein secondary structure using NPSA server.	3
6	Comparative Modeling using Modeller and Validation using SAVES server	3
7	Determine Drug like properties using Molinspiration.	3
8	Drawing chemical compounds and predicting properties using Chemsketch.	3
9	Performing site directed mutagenesis using Swiss-PdbViewer.	3
10	Docking analysis using Autodock Vina and protein plus server.	3

References

1. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount, 2004.
2. "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins" by Andreas D. Baxevanis and B. F. Francis Ouellette, 2005.
3. "Introduction to Protein Structure" by Carl-Ivar Brändén and John Tooze, 1999.
4. "Structural Bioinformatics" edited by Philip E. Bourne and Helge Weissig, 2003.
5. "Molecular Modelling: Principles and Applications" by Andrew R. Leach, 2001.
6. "Computational Drug Design: A Guide for Computational and Medicinal Chemists" by David C. Young, 2009.
7. "Essential Bioinformatics" by Jin Xiong, 2006.
8. "Protein Structure Prediction: A Practical Approach" edited by Michael J. E. Sternberg, 1997.

Year	II	Program	M.Sc., Biotechnology	Code	23P3BTDE07
Sem	III	DSE – I : MOLECULAR DEVELOPMENTAL BIOLOGY		Credits	3
Hrs	45			Effect from	2023-2024

Course Objectives:

The main objectives of this course are:

1. Explore the molecular basis of developmental processes such as cell differentiation, tissue patterning, and organ formation.
2. Investigate how gene expression and regulation control developmental pathways and morphogenesis.
3. Study the intricate signaling networks that coordinate cell-cell interactions and tissue development during embryogenesis.
4. Explore how disruptions in molecular pathways lead to developmental abnormalities and genetic disorders.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Illustrate the structure and function of developmental biology, Gametogenesis	K1
CO-2	Discuss basic fertilization process of animals	K2
CO-3	Demonstrate the functions of embryonic development process	K4 & K5
CO-4	Illustrate the organ development of vertebrate animals	K6
CO-5	Demonstrate the impact of gene in developmental biology and developmental disorders	K3

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Fundamentals of Developmental Biology**	**9 Hrs**

Definition and scope of developmental biology. Gametogenesis - Spermatogenesis and Oogenesis. Structure of Sperm and oocyte. Instructive and permissive interactions, competence, epithelial - mesenchymal interactions. Important signaling pathways in vertebrate development

Unit – II	**Fertilization Mechanisms and Molecular Organizers**	**9 Hrs**

Fertilization - Definition, mechanism of fertilization in mammal & sea urchin. Types of fertilization. Nieuwkoop center, Molecular role of organizer

Unit – III	**Cleavage to Gastrulation : Mapping Developmental Pathways**	**9 Hrs**

Cleavage in Xenopus, Chick and mammals, Regulation of cleavage cycle. Morphogenetic movements, Gastrulation in Xenopus, Chick and mammals. Fate Maps.

Unit– IV	**Foundation of Verterbrate Development**	**9 Hrs**

Vertebrate Development: Formation of the neural tube, myogenesis, and hematopoiesis. Mechanism of vertebrate eye development

Unit – V	**Gene Insights and Developmental Disorders**	**9 Hrs**

Drosophila Maternal effect genes, induction at single cell level - differentiation of photoreceptors in ommatidia. Developmental disorders Spina bifida, Anencephaly, and craniorachischis, Cyclopia, Thanotrophic dysplasia

References

1. Developmental Biology, by Scott F.Gilbert, 2020. 9th edition, Sinauer Associates Inc.
2. "Developmental Biology" by Gerald M. Edelman and Rodney J. Taylor
3. "Developmental Biology" by Charles B. Kimmel, Brian K. Hall, and Alan M. Weiner
4. "Essential Developmental Biology" by Jonathan M. W. Slack 2012

Year	II	Program	M.Sc., Biotechnology	Code	23P3BTDE08
Sem	III	DSE I: NANO BIOTECHNOLOGY		Credits	3
Hrs	45			Effect from	2023-2024

Course Objectives:

The main objectives of this course are:

1. Understanding of Fundamental Concepts
2. Knowledge of Synthesis and Characterization Techniques
3. Developing the problem-solving skills to address complex challenges in Nanobiotechnology
4. Understanding the role of nanoparticles in imaging and diagnostic techniques, such as MRI contrast agents and biosensors.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Understand the bases for Introduction to Nanotechnology	K1
CO-2	To impart understanding on Nanoparticle based Drug Delivery	K2
CO-3	Fabrication of nanomaterials for bone tissue grafting	K4 & K5
CO-4	Methods of Nanofabrication	K3
CO-5	Understand the application of Nanotechnology	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Introduction to Nanotechnology**	**09 Hrs**

Introduction to Nanotechnology- Scientific revolution, Feynman's vision, Classification of Nano biomaterials - Types of Nanomaterials – Nanoparticles, Nanotubes, Nanowires, Nanofibers, Size dependent variation in the properties of Nanomaterials, Nature's Nanophenomena

Unit – II	**Preparation and Types of Nanomaterials**	**09 Hrs**

Preparation of Nanomaterials, Top down and bottom up approaches, Biosynthesis, Nano biomaterials- Polymer, Ceramic, Metal based Nano biomaterials, Carbon based Nanomaterials, DNA based Nanostructures, Protein based Nanostructures, Quantum dots, Magnetic Nanoparticles, Nanofibres, Hydrogels, Films and Scaffolds

Unit – III	**Applications of Nanomaterials**	**09 Hrs**

Application of Nanomaterials in Bone substitutes and Dentistry, Food and Cosmetic applications, Bio-sensors and Lab-on-a-chip, Bio-devices and implantable devices, Bioremediation, Nanomaterials for anti - microbial coating – Medical implants. Application of Nanotechnology in textile industry

Unit– IV	**Nanomaterials in Medicine**	**09 Hrs**

Nanomaterials for diagnosis and therapy, Implications of drug delivery, Nano-carriers for application in medicine, polymeric nanoparticles as drug carriers, Drug release mechanism, Targeted Drug Delivery using Nano carriers, Nanoparticle technologies for cancer therapy and diagnosis, Point of Care and Personalized medicine, Magnetic nanoparticles for imaging and Hyperthermia

Unit – V	**Nano Toxicology and Safety**	**09 Hrs**

Nano toxicology, Portals of Entry of the nanoparticles into the Human Body, Bio-toxicity of Nanoparticles, Nanoparticles in Mammalian systems and Health threats, Biological response and cellular interaction of implant materials and scaffolds, Risk assessment and Safety Regulation of nanoparticles.

References

1. Nanobiotechnology: Nanoscience and Nanobiotechnology. Ralf S. Frese, Aharon Gedanken. Royal Society of Chemistry.1st Edition (2019) ISBN: 978-1788013801
2. Nanotechnology:Principles and Practices. Kulkarni, Sulabha K. 2014
3. Advanced Nanomaterials and Their Applications. Bikash Sharma , Chandan Kumar Sarkar. 2024
4. The Nanobiotechnology Handbook. Yubing Xie. 2012
5. Nanotechnology and tissue engineering. T.Laurencin, Lakshmi S. Nair, CRC press. 2012
6. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, CRC Press, 2013
7. Nanotechnology and Its Applications in Medicine: Anna Pratima Nikalje. 2017.

Curriculum for M. Sc Biotechnology

MASTER OF SCIENCE

M. Sc SYLLABUS

[For the Candidates admitted under Autonomous, CBCS & OBE pattern]

(EVEN SEMESTER)

DEPARTMENT OF BIOTECHNOLOGY

VIVEKANANDHA

COLLEGE OF ARTS AND SCIENCES FOR WOMEN

[AUTONOMOUS]

An ISO 9001:2015 Certified Institution | Affiliated to Periyar University Approved by AICTE | Re-accredited with "A" Grade by NAAC|
Recognized under 2(f) and 12 (b) of UGC Act, 1956.
Elayampalayam, Tiruchengode-637 205, Namakkal Dt., Tamil Nadu, India

M.Sc BIOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

GRADE	OBJECTIVE
PEO: 1	Biotechnology graduate students shall attain professional/industrial expertise by developing competent, creative and ever ready personality to accept recent, innovative and challenging roles in Industry and Academic and Research sectors
PEO: 2	Students shall inculcate in the development of entrepreneurial traits in order to cuddle innovative opportunities by adapting emerging biotechnological concepts in terms of techniques with subsequent development of leadership in the course of start-up of small-medium scale biotech based industry
PEO: 3	Students shall progressively adapt, follow and learn the concepts of biotechnology continuously by aiding modern teaching tools
PEO: 4	Imparting the basic and outstanding knowledge in all terms of biotechnology
PEO: 5	Students shall acquire the concepts to disseminate the advanced biotechnological aspects and its cutting edge developments in specific and developing area in the field of Biotechnology

PROGRAMME OUTCOMES (POs)

GRADE	OUTCOME
PO: 1	To train and develop students with the much needed biotechnological education, so that they develop added competitive skill metrics (CSM) for industrial employment higher education and employment upon graduation
PO: 2	To comprehend the assorted knowledge of biotechnical concepts domains and their applicability in the development of value added products for the welfare of the society
PO: 3	To develop a broad range of biotechnological skills and knowledge, development of general and specific competences to meet-out current expectations and requirements of medical, pharmaceutical, bio-molecular and agricultural sectors
PO: 4	To understand and merge the knowledge and concepts of biochemical, biophysical and bio statistical domains
PO: 5	To clarify various challenges in health care by integrating different biological domains including clinical, immunological, pharmaceutical and cancer genomics

PROGRAMME SPECIFIC OUTCOMES (PSOs)

GRADE	SPECIFIC OUTCOME
PSO: 1	To provide solutions for the challenges faced by pharmaceutical and molecular diagnostic Sectors
PSO: 2	To provide technical products with high frequency of reproducibility to the society
PSO: 3	To gain vertical mobility in career that will make students more competent to face national/international qualifying exams with practical knowledge acquaintance and in modern biotechnology field
PSO: 4	To solve complex problems in the field of Biotechnology with an understanding of social, ethical, legal and cultural aspects of the society
PSO: 5	To understand the over-all theme/concepts of each specialization in biotechnology and analysing the frequency of its applicability in industry, research and for the goodness of Society

DEPARTMENT OF BIOTECHNOLOGY

M.Sc. DEGREE COURSE IN BIOTECHNOLOGY
Choice-Based Credit System
REVISED REGULATIONS AND SYLLABUS (w.e.f. 2023-2024)
(in compliance with TANSCHE)

The recent development in the field of biotechnology as rapid growth and the establishment of biotechnological industries. This has resulted in great demand for trained manpower in this field and has opened new career opportunities for the young generation of students to acquire skills, training and knowledge to enhance their thinking, comprehension and application abilities and prepare them to compete, succeed and excel globally. Sustained initiatives are required to reform the present higher education system for improving and upgrading the academic resources and learning environments by raising the quality of teaching and standards of achievements in learning outcomes. The academic research into innovations for practical use in society and economy, promoting efficient and transparent governance and management of the higher education system, enhancing the capacity of the higher education system to govern itself through coordinated regulatory reform and increasing both public and private sector investment in higher education, with special emphasis on targeted and effective equity-related initiatives.

Learning Outcomes based approach to Curriculum Planning:

The Learning Outcomes based approach to Curriculum planning aims to factor in on the aptitude, interests and strengths of the students during their progress through the coursework and at the same time focus on overall student attainment. The main objective of the learning outcomes based framework is to better equip the students in their pursuit of knowledge, with the required employability skills, innovation in research and entrepreneurship skills. The course is so designed with practical work that will help students to apply their theoretical knowledge in experimenting and exploring. The curriculum envisions that the student, once graduates as specialists in a discipline, have an important role to play in the newer developments and innovations in the future in the subject for the advancement of the discipline.

Graduate Attributes in Biotechnology:

Graduate attributes are the high-level qualities, skills and understandings that a student should gain as a result ofthe learning and experiences. They equip students and graduates for lifelongpersonal development, learning andto be successful in society. Students will be equipped to be active citizens both nationally and globally. The students graduating in biotechnology should also develop excellent communication skills both in the written as well as spoken language which are a must for them to pursue higher studies from some of the best and internationally acclaimed universities and research institutions spread across the globe. The graduate attributes reflect both disciplinary knowledge and understanding, generic skills, including global competitiveness all students in different academic fields of study should acquire/attain and demonstrate. Some of the

characteristic attributes that a graduate should demonstrate are as follows

- Leadership Readiness
- Moral and ethical awareness/reasoning.
- Multicultural Competence.
- Life–long Learning.
- Communication Skills.
- Critical thinking.
- Problem-solvingng.
- Research-related skills.
- Scientific reasoning.
- Self-directed learning.
- Disciplinary knowledge.

Qualification Descriptors:

Upon successful completion of the course, the students receive an M.Sc. degree in Biotechnology. Biotechnology postgraduates of this department are expected to branch out into different paths of seeking advanced research-based knowledge, professional employment, or entrepreneurship that they find fulfilling. They will be able to demonstrate knowledge as well as skills in diverse fields of Biotechnology. This will provide a foundation, whichshall help them to embark on research careers by attaining doctoral positions in coveted institutions, as well as securing employment in research projects in industry or institutes. Besides research, they can get suitable teaching positions in Colleges and Universities as Assistant professors after qualifying National Eligibility Test (NET). It is expected that besides the skills specific to the discipline, the wider life skills of analysis, logical reasoning, scientific aptitude, communication skills, research and life ethics, and moral values will be inculcated in the students. The list below provides a synoptic overview of possible career paths provided by postgraduate training in Biotechnology:

- Biotechnology entrepreneurship
- Patents and Law
- Scientific Writing and Editing
- Document preparation and publication
- Research
- Industry
- Teaching
- Administration and Policy Making
- Scientific Communication

Teaching-learning process

The Learning Outcomes-Based Approach to curriculum planning and transaction requires that the teaching- learning processes are oriented towards enabling students to attain the defined learning outcomes relating to the courses within a programme. The outcome-based approach, particularly in the context of undergraduate studies, requires a significant shift from teacher-centric to learner-centric pedagogies, and from passive to active/participatory pedagogies. Planning for teaching therein becomes critical. Every programme of study lends itself to a well-structured and sequenced

acquisition of knowledge and skills. Practical skills, including an appreciation of the link between theory and experiment, will constitute an important aspect of the teaching- learning process. Teaching methods, guided by such a framework, may include:

- ✓ **Classroom Teaching** for intensely information-based topics. This is a very regular feature of all thecourses in Biotechnology.
- ✓ **PowerPoint slides** for topics that involve information and use of PowerPoint presentations are alsomade whenever the lectures are to be summarized in a crisp and point-wise mannerto highlight salient/importantconclusions from the topics.
- ✓ **Classroom Discussions** are a regular feature while teaching. The students are drawn into impromptudiscussions by the teacher during the process of teaching.
- ✓ **Video Displaying**, both real-time and animations, are used for topics that require 3D dimensional viewing of the biological mechanisms to drive the point home. These have proved to be very helpful while teaching concepts of molecular biology like DNA replication, transcription and translation.
- ✓ **Model Making** is also used especially for understanding and building a perception of the students.
- ✓ **Laboratory Practical** are an integral part of every course included in the PG programme in Biotechnology. The is also a daily affair for PG students of Biotechnology.
- ✓ **Problem Solving** is encouraged during the laboratory work.
- ✓ **Group Activity** as well as discussions with the laboratory supervisor/ among the students themselves/ Mentor is also encouraged during laboratory work.
- ✓ **Project Work** is included in the programme where students work individually or in groups to design experiments to solve/answer a problem suggested by the Mentor or identified by the students in consultation with the Mentor. The students are mentored regularly during the duration of the project.
- ✓ **Presentations by the Students** are regularly done. The students are mentored in the presentation ofdata, interpretation of data and articulation with the students/teachers/Research Scholars during their presentation.
- ✓ **Presentations by Experts** in different specialties of Biotechnology are arranged to broaden the horizons of the students.
- ✓ **Interaction with Experts** is also encouraged during/after presentations to satisfy/ignite the curiosities of the students related to developments in the different areas of Biotechnology.
- ✓ **Visit to Industries/Laboratories** related to Biotechnology like fermentation, food, pharmaceuticals; diagnostics etc. are organized to acquaint the students with real-life working environments of the professional biotechnologist with a view to broadening their perspective on the subject of Biotechnology.

Assessment methods

The students of PG Biotechnology program must achieve the desired results in terms of the learning outcomes to be professionally sound and competitive in a global society. Achieving the desired learning outcomes is also imperative in terms of job employment leading to a happy and prosperous individual further leading to a happy and prosperous family and thereby a happy and

prosperous society or nation. The assessment tasks are pivotal to getting authentic feedback for the teaching- learning process and mid-course corrections and further improvements in the future. The assessment tasks are carried out at various stages of the duration of the PG Biotechnology programme like Mid-term assessments, End-term assessments, Semester examinations, Regular assessments, viva-voce,etc. The assessment tasks are listed below:-

- ✓ **Short-Answer Questions** during term and semester examinations are used to assess the ability of the student to convey his thoughts in a coherent way where prioritization of the information interms of their significance is tested.
- ✓ **Problem Solving questions** are generally given during the laboratory work.
- ✓ **Surprise Quizzes** are regularly used during continuous assessment while the teaching-learning process is continuing which prepares the student to quickly recall information or quickly analyze a problem and come upwith proper solutions.
- ✓ **Impromptu Opinions** on biotechnological problems are sought from student during regular teaching- learning which help them to think quickly in a given context. This help build their ability to come up with solutionsto problems that the students might not have confronted previously.
- ✓ **Data Interpretation** is also another assessment task that is used to develop the analytical skills of the students. This assessment is used during laboratory work as well as during project work.
- ✓ **Analytical Skills** are assessed during work related to several experiments like enzyme kinetics, growth of bacteria and Bacteriophages, and mutation frequencies.
- ✓ **Paper/ Project presentations** are used to assess the articulation skills of the student. These are carried out both during the duration of the teaching-learning processes as well as during end- Semester examinations.
- ✓ **Report Writing** is used to assess the keenness of the students for details related to Biotechnology while visiting laboratories/industries as students invariably are required to submit a report after such visits.
- ✓ **Assignment Writing** is used to assess the writing abilities of the students during midterm vacations.
- ✓ **Viva-voce** during the laboratory working hours and during laboratory, examinations are used to assessthe overall knowledge and intelligence of the students.

Key Words:

Biotechnology, Teaching, Learning outcomes, Curriculum, Curriculum Framework, Programme outcomes, Course outcomes, PG Programme, Postgraduate programme, Teaching-learning processes, Assessment Tasks, Evaluation Tasks, Online Courses, MOOCS, SWAYAM, UGC, India, Higher Education Institutions.

****

1. CONDITIONS FOR ADMISSION:

A Candidate with a Bachelor's Degree in Science in the disciplines of Biotechnology, Biology, Botany, Zoology, Microbiology, Genetics, Chemistry, Biochemistry, Physics, Agriculture from this University or B.E/ B.TECH (Biotech), B.V.Sc, MBBS, BDS or any area of Biological Sciences / Agriculture and allied sciences; Veterinary and allied sciences or an examination of some other University accepted by the Syndicate as equivalent there to shallbe for the M.Sc Degree Examination of this University after a course of two academic years in an Affiliated Colleges of this University.

2. DURATION OF THE COURSE:

The duration of the course is for two academic years consisting of four semesters.

3. STRUCTURE OF THE COURSE

The course is organized on semester basis with a total off our semesters. In the first, second and third semesters, there arethree (core) theory papers (9 hrs per week), one Core Practical (15hrs per week) and Two elective/ optional papers(4hrs per week), per semester and in the fourth semester, there are only one core theory paper(Research Methodology) (4hrs per week), a core project/ dissertation work constituting a total of 20 hrs per week, two electives (4hrs per week), and a Soft skill program (2hrs perweek).

Elective paper: Each student shall opt for a comprehensive, interactive course with one of the faculty member. The topic of specialization and course content will be determined by the department/ course advisor.

Core Practical Laboratory: Independent practical shall be held under each component. It is recommended that the practical training be organized as an exercise rather than simple demonstration. The students must actually perform theexperiments.

4. ELIGIBILITY FOR THE AWARD OF DEGREE:

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed course of study in a college affiliated to the University for a period of not less than two academic years, passed the examination of all the four semesters prescribed earning minimum of 91 credits and fulfilled such conditions as have been prescribed therefore.

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed courses on Soft Skills and internship in addition to the courses prescribed by the respective Board of Studies for the subject of the Masters Degree. For two years Master's Degree Programme, a candidate shall undergo a minimum of 4 courses (4 x 2=8 credits) from the courses on Soft skills.

A two year Master's Degree student shall undergo 4-6 weeks (2 credits internship during the summer vacation of the First year and submit a report in the beginning of third semester. The report will be evaluated in third semester and the marks forwarded to the University along with third semester internal assessment (CIA) marks.

5. EXAMINATIONS:

There shall be four semester examinations: first semester examination sat the middle of the first academic year and the secondsemester examination at the end of the first academic year. Similarly,

the third and fourth semester examinations shall be heldat the middle and the end of the second academic year, respectively. Practical examination shall be conducted independently at the end of even semesters. For practical examination, a single comprehensive) (covering different courses offered during that semester) practical examination (6hrsperday) beheld for each component of the core practicalat the end of even semesters.

Examinations for the courses on soft skills will be held along with the semester examinations of the core an delective courses. There is no written examination for internship. A student shall submit a report after completing the summer internship. The report will be evaluated by two examiners within the Department of the college/ institution.

VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN (AUTONOMOUS)

DEPARTMENT OF BIOTECHNOLOGY

M.Sc., Biotechnology Curriculum

(Autonomous, CBCS & OBE pattern)

(For the Candidates admitted during the academic year **2024-2025** onwards)

SCHEME OF EXAMINATION

S.No	Course Component	Course Code	Course	Credits	Hours		Maximum Marks		
					T	P	Int	Ext	Total
SEMESTER - II									
1	Core – 4	23P2BTC04	Plant Biotechnology	4	4		25	75	100
2	Core – 5	23P2BTC05	Animal Biotechnology	4	4		25	75	100
3	Core – 6	23P2BTC06	Microbiology	4	4		25	75	100
4	Core – 7	23P2BTC07	Genetic Engineering	4	4		25	75	100
5	Core Practical-III	23P2BTCP03	Lab in Plant and Animal Biotechnology, Microbiology & Genetic Engineering	3		6	40	60	100
6	DSE – II	23P2BTDE05	Pharmaceutical Biotechnology	2	3		25	75	100
7	DSE – II	23P2BTDE06	Environmental Biotechnology	2	3		25	75	100
8	Soft skill - II	24P2BTSP02	Lab in Python & Linux	2		2	40	60	100
Total				**25**	**22**	**08**	**230**	**570**	**800**

Theory	06
Practical	02

Year	I	Program	M.Sc., Biotechnology	Code	23P2BTC04
Sem	II	Core – 4 : PLANT BIOTECHNOLOGY		Credits	4
Hrs.	60			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. Demonstrate understanding of the fundamentals and significance of plant biotechnology.
2. Describe genetic engineering techniques and gene transfer methods used in plants.
3. Explain tissue culture techniques and their applications in agriculture and conservation.
4. Discuss the structure and function of plant genomes and the role of molecular breeding.
5. Evaluate the applications of transgenic plants and biotechnology in environmental management.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Understand the basic principles and tools of plant biotechnology.	K1, K2
CO-2	Apply tissue culture techniques for plant propagation and conservation	K3, K4
CO-3	Interpret genomic data and employ molecular breeding techniques	K3, K5
CO-4	Assess the applications and implications of transgenic plants in agriculture and the environment	K5, K6
CO-5	Analyze ethical and intellectual property issues in plant biotechnology	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Introduction to Plant Biotechnology**	**12 Hrs**

Fundamentals of Plant Biotechnology- Scope, historical development, and significance. Plant Cell and Molecular Biology- Structure and function of plant cells. Genetic Engineering Tools and Techniques- Restriction enzymes, ligases, and vectors, Methods of gene transfer (Agrobacterium-mediated transformation, biolistics). Gene Expression and Regulation in plants. Genetic Markers- RFLP, AFLP, SSR, SNP.

Unit – II	**Plant tissue culture and Micropropagation**	**12 Hrs**

Basics of Plant Tissue Culture- Principles, techniques, and applications. Totipotency and Organogenesis- Somatic embryogenesis, callus formation, and regeneration. Types of Tissue Culture- Meristem culture, embryo culture, anther culture. Micropropagation and Somatic Hybridization- Techniques and applications in clonal propagation and hybrid crop production. Germplasm Conservation- Cryopreservation and in vitro storage methods for endangered plant species.

Unit – III	**Plant Genomics and Molecular Breeding**	**12 Hrs**

Genomics in Plant Biotechnology- Structure and sequencing of plant genomes. Functional genomics, proteomics, and metabolomics. Marker- Assisted Selection (MAS)- Role in plant breeding, QTL mapping. Plant Breeding and Genetic Improvement- Conventional vs. molecular breeding approaches. Development of transgenic plants. Genetic Biodiversity and Conservation- Molecular methods to assess genetic diversity in plant populations.

Unit– IV	**Applications of Plant Biotechnology**	**12 Hrs**
Transgenic Plants- Development and applications in agriculture (disease resistance, pest resistance). Biofortification- Enhancing nutritional value in crops -Golden Rice & Vitamin A fortification. Phytoremediation- Use of plants for environmental cleanup, heavy metal accumulation, and removal. Molecular Farming- Production of pharmaceuticals and industrial enzymes in plants. Biotic and Abiotic Stress Tolerance-Engineering plants for drought, salinity, and heat resistance.		
Unit – V	**Regulatory, Ethical, and Intellectual PropertyIssues**	**12 Hrs**
Biosafety and Bioethics in Plant Biotechnology- Regulatory frameworks for GM crops and environmental safety, Ethical considerations in genetic modification. Intellectual Property Rights (IPR)- Patents, copyrights, and plant breeder's rights. Public Perception and Socioeconomic Impact-Pros and cons of GM crops in society. Environmental Impact-Ecological considerations, biodiversity, and conservation concerns. Future Trends in Plant Biotechnology.		

References

1. Bhojwani, S. S., & Razdan, M. K. Plant Tissue Culture: Theory and Practice. Elsevier,1996.
2. Chawla, H. S. Introduction to Plant Biotechnology. Science Publishers, 2012.
3. Slater, A., Scott, N. W., & Fowler, M. R. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press, 2008.
4. Trigiano, R. N., & Gray, D. J. Plant Tissue Culture, Development, and Biotechnology.CRC Press, 2010.
5. Taiz, L., & Zeiger, E. Plant Physiology and Development. Sinauer Associates, 2018.
6. Glick, B. R., & Pasternak, J. J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press, 2010.

Year	I	Program	M.Sc., Biotechnology	Code	23P2BTC05
Sem	II	Core – 5 : ANIMAL BIOTECHNOLOGY		Credits	4
Hrs.	60			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. To provide an in-depth understanding of animal biotechnology and cell culture techniques.
2. To introduce the methods of genetic manipulation in animal cells and explore transgenic animal applications.
3. To understand stem cell technology, tissue engineering, and their therapeutic applications.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Understand the basics of animal cell culture, its requirements, and significance in biotechnology	K1, K2
CO-2	Apply knowledge of genetic manipulation techniques for developing transgenic animals and explore gene editing tools like CRISPR	K3, K4
CO-3	Explain stem cell technology, tissue engineering, and their applications in regenerative medicine and tissue repair	K3,K4& K5
CO-4	Demonstrate understanding of cloning and reproductive techniques for conservation and genetic improvement	K4, K5
CO-5	Critically analyze ethical, biosafety, and regulatory considerations in animal biotechnology and forecast emerging trends	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	Introduction to Animal Biotechnology and Cell Culture Techniques	12 Hrs

Basics of Animal Biotechnology- Overview, history, and applications. Animal Cell Culture- Types of cell cultures (primary, secondary and continuous cell lines), requirements and principles of aseptic techniques. Culture Media- Types of culture media (natural and synthetic), serum vs. serum-free media, and preparation and sterilization of media. Cell Growth and Maintenance- Growth kinetics, cell proliferation, cell cycle, and measuring cell viability and cytotoxicity.

Unit – II	Genetic Manipulation in Animal Cells	12 Hrs

Gene Transfer Techniques: Microinjection, electroporation, lipofection, and viral vectors. Genetic Engineering in Animals- Creation of transgenic animals (mice, sheep, fish) and applications. CRISPR and Other Gene-Editing Tools- Mechanisms, design, and application of CRISPR/Cas9 and other modern gene-editing techniques. Applications of Transgenic Animals.

Unit – III	Stem Cell Technology and Tissue Engineering	12 Hrs

Stem Cells- Types (embryonic, adult, and induced pluripotent stem cells), characteristics, and differentiation potential. Stem Cell Culturing- Culture requirements, differentiation, and maintenance of pluripotency. Therapeutic Applications of Stem Cells. Ethics and Regulatory Aspects and clinical trials.

Unit– IV	**Animal Cloning and Reproductive Biotechnology**	**12 Hrs**
Animal Cloning- Somatic cell nuclear transfer (SCNT), reproductive cloning and therapeutic cloning. In Vitro Fertilization (IVF) and Embryo Transfer- Techniques, applications, and limitations. Artificial Insemination (AI) and Embryo Cryopreservation- Process, success rates and applications in animal breeding. Applications in Genetic improvement, cloning for endangered species and biodiversity conservation.		
Unit – V	**Applications and Ethical Issues in Animal Biotechnology**	**12 Hrs**
Biomedical Applications- Production of recombinant insulin, vaccines and monoclonal antibodies using animal biotechnology. Xenotransplantation- Use of animal organs for human transplantation, challenges and ethical concerns. Biosafety and Bioethics- Biosafety levels, ethical guidelines, animal welfare concerns and regulatory frameworks.		

References

1. Freshney, R. I. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell, 2016.
2. Butler, M. Animal Cell Culture and Technology. Taylor & Francis, 2004.
3. Masters, J. R. W., and Stacey, G. N. Animal Cell Culture: A Practical Approach. Oxford University Press, 2000.
4. Portner, R. Animal Cell Biotechnology: Methods and Protocols. Humana Press, 2007.
5. Glick, B. R., Pasternak, J. J., and Patten, C. L. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press, 2010.

Year	I	Program	M.Sc., Biotechnology	Code	23P2BTC06
Sem	II	Core – 6 : MICROBIOLOGY		Credits	4
Hrs.	60			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

To provide a comprehensive knowledge on taxonomy and microbial diversity, growth, their harmful effects and beneficial role of microorganisms in agriculture and environment.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	To understand the major discoveries of microbiology and describe microbial diversity, Microbial growth and metabolism.	K2
CO-2	To provide basic knowledge about microbial culture, identification of microbes, principle and working of microscopes and sterilization techniques	K3, K4
CO-3	To enlighten the students on host microbe interaction and Epidemiology of microbial disease	K3, K5
CO-4	To update the knowledge on epidemic and pandemic diseases.	K4, K5
CO-5	To assess and appraise the role of novel microbes in environment and integrate them in specific innovative approaches.	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	History and Microbial Taxonomy	12 Hrs

History and microbial taxonomy: Major discoveries related to the field of microbiology: Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch and Edward Jenner. Microbial taxonomy: Bacteria, viruses, fungi, algae and protozoa, Microbial diversity: Biovars, Serovars and Prions, Microbial growth and metabolism: Microbial growth: Growth curve, factors affecting growth, Microbial metabolism- Methanogenesis, acetogenesis and auxotrophs.

Unit – II	Microbial Culture, Identification, and Control	12 Hrs

Microbial culture, identification, and control: Nutritional requirements for growth - Growth media and types, Pure culture techniques: Serial dilution and plating methods, Staining methods - Principles and types of staining (simple and differential), Identification of bacteria – Biochemical – IMViC, 16s rRNA sequencing. Microscopy: principles and applications of Bright field, florescent and Scanning electron microscopes, Microbial growth control: Physical Methods – Heat, Filtration, Low Temperatures, High Pressure, Desiccation, Osmotic Pressure, Radiation; Chemical Methods

Unit – III	Host-Microbe Interaction and Epidemiology	12 Hrs

Host microbe interaction and Epidemiology: Human microbiome; Skin, Gastrointestinal tract, Oral cavity, Lung. Symbiotic relationship of microbes: Symbiosis, Mutualism, Parasitism, Commensalism and endophyte. Epidemiology of microbes: causes, types and transmission of epidemic, endemic and pandemic diseases.

Unit– IV	Microbial Diseases	12 Hrs

Microbial Diseases: Microbial diseases - General characteristics, pathogenesis, laboratory diagnosis and control measures of Pandemic and Epidemic diseases: Tuberculosis, Leprosy, Cholera, Typhoid, COVID-19, Yellow Fever, Flu, AIDS, Ebola, Zika Virus, Small Pox, Dengue, Chickungunya, Malaria, filariasis, Candidiasis, superficial mycosis

Unit – V	**Agricultural and Environmental Microbiology**	**12 Hrs**

Agricultural and Environmental Microbiology: Biological nitrogen fixation, free living, symbiotic nitrogen fixation, mechanism of Nitrogen, Biofertilizers- types and applications; Rhizosphere effect. Biogeochemical cycles-Carbon, Nitrogen, Sulphur and Phosphorous; Methanogenic bacteria Extremophiles- Thermophiles Acidophiles, Halophiles and alkalophiles; Biotechnological application of extremophiles

References

1. Joanne Willey, Linda Sherwood, Christopher J. Woolverton, (2017). Prescott's Microbiology, (10th edition), McGraw-Hill Education, ISBN: 978-1259281594.
2. Maheshwari D K, Dubey R C 2013. A Textbook of Microbiology.4th Edn S Chand Publishing India.
3. Ananthanarayan and Paniker's (2017) Textbook of Microbiology, (10th edition), The Orient Blackswan, ISBN: 978-9386235251.
4. Benson HJ. (1999). Microbiological Applications: A Laboratory manual in General Microbiology, 7th Edition, McGraw Hill. 5
5. Managing epidemics- Key facts about major deadly diseases, World Health Organization (WHO) 2018. 9. O'Flaherty, Vincent & Collins, Gavin & Mahony, Thérèse. (2010). Environmental Microbiology, Second Edition. 10.1002/9780470495117.ch11.
6. Agriculture Microbiology, 2016. E-Course Developed By TNAU (ICAR)

Year	**I**	**Program**	**M.Sc., Biotechnology**	**Code**	**23P2BTC07**
Sem	**II**	**Core – 7 : GENETIC ENGINEERING**		**Credits**	**4**
Hrs.	**60**			**Effect from**	**2024-2025**

Course Objectives:

The main objectives of this course are:

The paper imparts a thorough knowledge on the basics of all the biotechnological application on plant and animals. The student will get to understand the core concepts of biotechnology.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Understanding the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering.	K2
CO-2	Getting detailed knowledge of gene transfer methods and identifying suitable hosts for cloning.	K3, K4
CO-3	Acquiring theoretical knowledge in the techniques, tools, and application and safety measures of genetic engineering.	K3, K5
CO-4	Describes the genome mapping and sequencing and methods for gene therapy.	K4, K5
CO-5	Elucidate different techniques involved in genetic engineering	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Gene Cloning and Genetic Engineering Tools**	**12 Hrs**

Gene cloning. Genetic engineering tools. Nucleic acid manipulating enzymes. Promoters, Selectable markers and reporters used in rDNA technology. Restriction digestion, Ligation, Transformation, Selection of Recombinants. Construction of gene libraries.

Unit – II	**Cloning Vectors in Bacteria**	**12 Hrs**

E.Coli vectors - pBR322 and its derivatives; Cloning vectors for gram negative bacteria - ColE1, p15A, R1, IncPa, pSC101; Lambda bacteriophage vectors, filamentous phages, Cosmids, Phasmids, Phagemids. Cloning in gram-positive bacteria (*Bacillus subtilis*).

Unit – III	**Cloning in Yeast and Eukaryotic vectors**	**12 Hrs**

Cloning in yeast Saccharomyces cerevisae. Life cycle and types of vectors; Eukaryotic vectors. SV40 (molecular genetics and expression); Specialized cloning vector for cDNA; Synthesis of specific RNA in vitro,cellular reprograming;Vectors for cloning promoters and terminators; vectors with adjustable copy number.

Unit– IV	**Nucleic acid Hybridization and Sequencing**	**12 Hrs**

Nucleic acid hybridization techniques; Molecular probes (Types of probes and its construction); probe labeling. Nick translation, End labeling and Random primer labeling.Blotting Techniques. Polymerase chain reaction and its variants; DNA fingerprinting; DNA sequencing first generation sequencing methods (Maxam and Gilbert sequencing, Sangers Dideoxy sequencing, Pyrosequencing, PCR based sequencing and hybridization sequencing).

Unit – V	**Applications of Genetic Engineering**	**12 Hrs**

Site directed mutagenesis; DNA microarray; chromosome walking and jumping.Molecular techniques in prenatal diagnosis gene therapy, Transgenic animals (knockout mice) and plants (Flavrsavr tomato), Pharmaceutical products (Vaccine, Humulin, etc), Crop improvement. Pesticide resistance, herbicide resistance, transgenic animals and GM foods; Modern Concepts in Genetic Analysis.Genome editing – CRISPR-Cas9, Prospects Safety and Ethics.

References

1. T.A. Brown, 2010. Gene cloning and DNA analysis: An introduction, 6th edition, Wiley-Blackwell.
2. Sandy B.Primrose and Richard Twyman, 2006. Principles of Gene Manipulation andgenomics, 7th
3. edition, Wiley-Blackwell.
4. Lewin, 2009. Genes X, 10th edition, Jones & Barlett Publishers
5. Raymond Rodriguez and David T.Denhart 2003.Vectors, A survey of molecular cloningvectors
6. and their uses
7. Errst-L. Winnacker 1987.From genes to clones. Introduction to Gene Technology,
8. Ed. David V. Geoddel 2002.Gene Expression technologies. Methods in enzymology (Vol.185)
9. William Wu, Michael J.Welsh, Peter B.Kaufrmar, Helen H.Zhang 2001. Methods in Gene
10. Biotechnology

Year	I	Program	M.Sc., Biotechnology	Code	23P2BTCP03
Sem	II	Core Practical – III : LAB IN PLANT AND ANIMAL BIOTECHNOLOGY, MICROBIOLOGY & GENETIC ENGINEERING		Credits	3
Hrs	45			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. To master aseptic techniques for both plant and animal biotechnology, ensuring successful surface sterilization, media preparation, and culture maintenance.
2. To understand and apply in vitro plant tissue culture techniques, including seed germination, shoot and root induction, and plantlet acclimatization.
3. To develop hands-on skills for isolating and studying organelles, such as chloroplasts, from plant tissues.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Apply aseptic techniques and prepare media for plant and animal tissue cultures, ensuring optimal conditions for growth	K1, K2 & K3
CO2	Demonstrate plant tissue culture skills, including surface sterilization, in vitro seed germination, shoot/root induction, and acclimatization of plantlets	K2, K3 & K4
CO3	Isolate and examine chloroplasts from plant tissue for biochemical and physiological studies	K2,K3 & K4
CO4	Establish primary animal cell cultures from different tissues, ensuring proper handling and culture maintenance	K3,K4 & K5
CO4	Evaluate cell viability and health using MTT and Trypan Blue exclusion assays to assess cytotoxicity and cell proliferation	K4, K5 & K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

S.No	Experiments	Hours
	Plant Biotechnology	
1	Media Preparation and Explants Sterilization	3
2	Callus, Shoot & Root Induction	5
3	Isolation of Protoplast from plant cell.	4
	Animal Biotechnology	
4	Aseptic Technique and Media Preparation	3
5	Primary culture of Animal Cells (Kidney, skin, & spleen)	5
6	Cell Viability Assay (MTT and Trypan Blue Exclusion)	5

Microbiology		
7	Enumeration of microorganism from soil, water and air	4
8	Staining of Gram, Negative and spore.	3
9	Determination of growth of bacteria – *E.Coli* (Growth curve)	3
Genetic Engineering		
10	Preparation of plasmid DNA by alkaline lysis method	4
11	Preparation of competent cell using calcium chloride.	3
12	Transformation.	3

References

1. Plant Tissue Culture: Techniques and Experiments by Roberta H. Smith - Comprehensive resource on plant tissue culture protocols and applications.
2. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker - Covers techniques for cell viability assays and organelle isolation.
3. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney - Essential guide for animal cell culture techniques.
4. Practical Manual of Plant Biotechnology by K. R. K. Easwari and V. S. K. Prasad - Useful for applied plant biotechnology methods, including seed germination and hardening.
5. Molecular Biology of the Cell by Bruce Alberts et al. - Detailed reference on cellular functions, useful for chloroplast isolation and primary culture background.
6. Biotechnology Procedures and Experiments Handbook by S. Harisha - A comprehensive lab handbook for both plant and animal biotechnology techniques.

****

Year	I	Program	M.Sc., Biotechnology	Code	23P2BTDE05
Sem	II	DSE – II : PHARMACEUTICAL BIOTECHNOLOGY		Credits	2
Hrs.	45			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

The subject imparts knowledge on the fundamentals of pharmaceutical biotechnology. The student will be provided with a basic knowledge and understanding about the pharmaceutical products produced based on biotechnological methods and its biomedical applications.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Explain the basic components of pharmaceutical and biotechnology industry and methods and applications of biosensor	K1
CO-2	Describe the Scientific, technical and economic aspects of vaccine & rDNA technology	K3, K4
CO-3	Describe the basic concepts of protein Engineering, therapeutic proteins and enzyme immobilization techniques.	K2
CO-4	Describe the concepts of hybridoma technology, microbial biotransformation and microbial bio-transformed products.	K2, K4
CO-5	Explain the basic components of somatic gene therapy, Xeno-transplantation and fermenter and bio safety methods	K1,K2, K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Concepts and Technologies in Pharmaceutical Biotechnology**	**09 Hrs**

Introduction to concepts and technologies in pharmaceutical biotechnology and industrial applications, Biosensors- Working and applications of biosensors in pharmaceutical Industries; Pharmacology and Ethnopharmacology: Scope, applications and Importance.

Unit – II	**Vaccine and Enzyme Production**	**09 Hrs**

Scientific, technical and economic aspects of vaccine research and development, Preparation of bacterial vaccines, toxoids, viral vaccine and antitoxins, Storage conditions and stability of vaccines, Recombinant DNA technology, Application of rDNA technology and genetic engineering in the production of: (i) Interferon (ii) Vaccines - hepatitis- B (iii) Hormones – Insulin, Brief introduction to Protein Engineering, Therapeutic proteins, Production of Enzymes- General consideration – Amylase, Catalase, Peroxidase, Lipase,Protease, Penicillinase, Methods of enzyme immobilization and applications.

Unit – III	**Biotech Product Formulation and Microbial Biotransformation**	**09 Hrs**

Hybridoma technology - Production, Purification and Applications, Formulation of biotech products - Rituximab, Introduction to Microbial biotransformation and applications, Study of theproduction of – penicillins, citric acid, Vitamin B12, Glutamic acid and Griseofulvin Somatic gene therapy, Xenotransplantation in pharmaceutical biotechnology, Large scale production fermenter design and its various controls, Biosafety in pharmaceutical industry.

Unit– IV	**Pharmacology of Plant Based Drugs**	**09 Hrs**
Pharmacological activity of Plant drugs, Plant Chemicals in modern pharmacology; biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, taxol, vinca alkaloids, synthetic substitutes for therapeutically active plant constituents; drug improvement by structure modification and bio-transformation. Criteria for pharmacological evaluation of drugs.		
Unit – V	**Clinical Pharmacology and Drug Therapy**	**09 Hrs**
Clinical Pharmacology, Drug therapy, therapeutic situation, benefits and risk of use of drugs, Mechanism of drug action, Therapeutic efficacy, Therapeutic index, tolerance, dosage forms and routes of drug action , factors affecting drug action; Adverse Drug reactions and drug poisoning-classification and causes of ADR; principle clinical manifestations and treatment of ADR, General principles of management of drug poiosoning; antidotes, classisfication of drugs.		

References

1. Harbans lal, 2011. Pharmaceuticals biochemistry. CBS Publishers and distributors Pvt. Ltd, Chennai.
2. Carlos A. Guzmán and Giora Z. Feuerstein, 2009. Pharmaceutical Biotechnology, 1st edition, Springer.
3. Daniel Figeys (Ed.). 2005. Industrial Proteomics: Applications for Biotechnology and Pharmaceuticals. Wiley, John & Sons, Incorporated.
4. Kayser, O and Muller R.H.. 2004. Pharmaceutical Biotechnology Drug Discovery and Clinical Applications. WILEY-VCH
5. Leon Shargel, Andrew B. C. Yu, Susanna Wu-Pong, and Yu Andrew B. C. 2004. Applied Biopharmaceutics & Pharmacokinetics. McGraw-Hill Companies
6. Stefania Spada, Garywalsh. 2004. Directory of approved biopharmaceutical
7. Gary Walsh. 2003. Biopharmaceutical, Biochemistry & Biotechnology.
8. Heinrich Klefenz. 2002. Industrial pharmaceutical biotechnology.
9. Thomas Lengauer (Ed.). 2002. Bioinformatics – from Genomes to Drugs. Volume I& II.WileyVCH.
10. John F. Corpenter (editor), Mark C. Manning. 2002. Rational Design of stable formulation Theory and Practice (Pharmaceutical Biotechnology). Plenum, US. Ist edition.

Year	**I**	**Program**	**M.Sc., Biotechnology**	**Code**	**23P2BTDE06**
Sem	**II**	**DSE - II : ENVIRONMENTAL BIOTECHNOLOGY**		**Credits**	**2**
Hrs.	**45**			**Effect from**	**2024-2025**

Course Objectives:

The main objectives of this course are:

The subject imparts knowledge on the fundamentals of ecology and pollution. The student will be provided with a basic knowledge and understanding about the functions of ecosystem and reduction of pollution by biotechnological tools.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO-1	Explain various waste management methods	K2
CO-2	Classify potential methods of biodegrading organic pollutants.	K3, K4
CO-3	Examine the techniques involved in remediation of polluted environments	K3, K5
CO-4	Assess types of pollution & its control	K4, K5
CO-5	Compile biotechnological approaches to degrade xenobiotic compounds	K5, K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Environmental Pollution and Its Control Strategies**	**09 Hrs**

Environment: Basic concepts and issues; Environmental management and Conservation, Environmental Laws & Agencies involved in conservation. Environmental Pollution: Types of pollution & its control strategies -Air pollution, Soil pollution, Water pollution, Oil pollution & Radioactive pollution.

Unit – II	**Biofilm Kinetics and Reactor Engineering**	**09 Hrs**

Biofilm Kinetics: Completely mixed biofilm reactor-Soluble microbial products and inert biomass-Special-case biofilm solution. Reactor types:- batch reactor, continuous flow stirredtank reactor, Plugflow reactor, airlift reactor& MBR. Engineering design of reactors- Reactors in series.

Unit – III	**Wastewater Management Processes and Treatment**	**09 Hrs**

Waste water management, source of waste water, Waste water treatment- physical, chemical and biological treatment. Microbiology of Waste water; Exploring the role of microbes in wastewater treatment, with a focus on aerobic and anaerobic processes. Understanding and calculating Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Dissolved Solids (TDS) in assessing wastewater quality.

Unit– IV	**Toxicity Assessment and Biosensor Applications**	**09 Hrs**

Overview of toxicity types (acute, chronic, sub-lethal) and standard tests for evaluating toxicity levels in environmental samples. Application of biosensors for detecting pollutants and toxic materials, with examples in environmental safety. Biomonitoring of toxic materials. Biomagnification, Biomining and Biofuels.

Unit – V	**BIOREMEDIATION AND SOLID WASTE MANAGEMENT**	**09 Hrs**

Bioremediation; In-situ and Ex-situ Bioremediation of contaminated soils and waste land; Microbiology of degradation of Xenobiotics in environment; Pesticides, Surfactants, Microplastics, Degradative plasmids. Solid waste: Composting, Vermiculture and methane production - UASBR.

References

1. Gareth M. Evans, Gareth G. Evans, Judy Furlong 2011
2. Environmental biotechnology: theory and application John Wiley & Sons, Ltd. West Sussex, UK
3. M. Moo-Young, W.A. Anderson, A.M. Chakrabarty, 2010. Environmental Biotechnology: Principles and Applications. Springer.
4. M. H. Fulekar, 2010 Environmental Biotechnology, by Science Publishers Department of Life Sciences, University of Mumbai, India,
5. Stanley E. Manahan, 2009. Environmental Chemistry, Ninth Edition, CRC Press.
6. Environmental chemistry 5th edition by A.K.De. 1997.
7. Bruce E. Rittmann and Perry L. McCarty. 2001. Environmental Biotechnology :Principles and applications. McGraw Hill, Newyork.
8. Ahmed N, Qureshi, F.M. and Khan, O.Y. 2001.Industrial and Environmental Biotechnology. Horizon Press.

Year	I	Program	M.Sc., Biotechnology	Code	24P2BTSP02
Sem	II	Soft skill – II : LAB IN PYTHON & LINUX		Credits	2
Hrs	20			Effect from	2024-2025

Course Objectives:

The main objectives of this course are:

1. Introduce File Handling and Scripting in Python: Develop skills in reading, writing, creating, and deleting files, and manipulating data using Python scripts.
2. Apply Python for Bioinformatics Analysis: Learn to implement Python scripts for DNA sequence analysis, including counting nucleotides, determining molecular weight, and identifying restriction sites.
3. Introduce Basic Linux Commands for File and System Management: Gain familiarity with essential Linux commands for efficient file handling, navigation, and system management to support bioinformatics workflows.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand and utilize Python file handling operations for reading, writing, creating, and deleting files in bioinformatics applications.	K1, K2
CO2	Implement basic mathematical operations (addition, subtraction, multiplication, division) using Python to solve biological data problems.	K2, K3
CO3	Analyze DNA sequences using Python scripts to count nucleotide frequencies and predict AT/GC content.	K2,K3 & K4
CO4	Translate and transcribe DNA sequences into RNA and proteins using Python, applying bioinformatics functions for molecular studies.	K3,K4 & K5
CO4	Demonstrate competency in essential Linux commands to manage files, directories, and system navigation for efficient bioinformatics processing.	K4, K5 & K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

S.No	Experiments	Hours
1	Python File Handling – Read, Write / Create, Delete Files	2
2	Python script to add two numbers (Addition, subtract, Multiplication & Division)	2
3	Count the number of nucleotides in a DNA sequence.	2
4	Count the number of nucleotides in a DNA sequence using file handles.	2
5	Python script for determining the Molecular weight.	2
6	Python script for predictiong of AT/GC content.	2
7	Python script for identifying the restriction site.	2

8	Python script for transcripting the DNA sequence.	2
9	Python script for translating the DNA sequence.	2
10	Basic Linux Commands – Is, pwd, mkdir, cd, rmdir, cp, mv, rm, touch etc.	2

References

1. Jones, Martin. Python for Biologists: A Complete Guide to Python for Biological Research. 2nd Edition, 2017.
2. Model, Mitchell L. Bioinformatics Programming Using Python: Practical Programming for Biological Data. 1st Edition, 2009.
3. Lutz, Mark. Learning Python. 5th Edition, 2013.
4. Blum, Richard, and Christine Bresnahan. Linux Command Line and Shell Scripting Bible. 4th Edition, 2015.

****

VIVEKANANDHA COLLEGE OF ARTS AND SCIENCES FOR WOMEN (AUTONOMOUS)

DEPARTMENT OF BIOTECHNOLOGY

M.Sc., Biotechnology Curriculum

(Autonomous, CBCS & OBE pattern)

(For the Candidates admitted during the academic year **2023-2024** onwards)

SCHEME OF EXAMINATION

S.No	Course Component	Course Code	Course	Credits	Hours		Maximum Marks		
					T	P	Int	Ext	Total
SEMESTER - IV									
1	Core – 10	23P4BTC010	Research Methodology	5	6		25	75	100
2	Elective –5	23P4BTDE10	Stem Cell Biology	3	3		25	75	100
3	EDC	23P4BTED01	Bioinformatics - EDC	2	2		25	75	100
4	Soft Skill -IV	23P4BTSP04	Lab in AI	2		2	40	60	100
5	Dissertation	23P4BTPR01	Project Viva Voce	5		17	40	60	100
Total				**17**	**11**	**19**	**155**	**345**	**500**

Theory	03
Practical	01
Project	01

Year	**II**	**Program**	**M.Sc., Biotechnology**	**Code**	**23P4BTC010**
Sem	**IV**	**Core – 10 : RESEARCH METHODOLOGY**		**Credits**	**05**
Hrs	**75**			**Effect from**	**2023-2024**

Course Objectives:

The main objectives of this course are:

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the core concepts of methodologies & ethics to pursue research.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand the bases for research	K1
CO2	To know about research proposal and dissertation writing.	K2 &K6
CO3	To know about Statistical application in research	K3
CO4	To know about office tools used in research	K1 & K4
CO5	To know about search engines.	K1 & K2

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Research Methodology - An Introduction**	**15 Hrs**

Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Defining the Research Problem; Research Design; Sampling Design; Methods of Data Collection; Processing and Analysis of Data; Sampling Fundamentals.

Unit – II	**Review of Literature, Writing the Research Report**	**15 Hrs**

Review of literature, Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography.

Unit – III	**Statistical Tools and Analysis**	**15 Hrs**

Standard Deviation- T test. Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, ANOVA for random effects model, Estimation of variance components, Model adequacy checking. Two factor Factorial Design, Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two factor factorial design.

Unit– IV	**Spreadsheet and Presentation Tools**	**15 Hrs**

Spreadsheet Tool: Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. Presentation Tool: Introduction to presentation tool, features and functions, Creating presentation, Customizing presentation, Showing presentation. Tools used may be Microsoft Power Point, Open Office or similar tool.

Unit – V	**Web Search for Academic Research**	**15 Hrs**

Web Search: Introduction to Internet, Use of Internet and WWW, Using search engine like Google, Yahoo, Pubmed, Science direct, Scopus etc, and Using advanced search techniques
References
1. Kothari, C.R. (2019). Research Methodology: Methods and Techniques (4th Edition). New Age International. 2. Day, R.A. (2011). How to Write and Publish a Scientific Paper (7th Edition). Cambridge University Press. 3. Montgomery, D.C. (2017). Design and Analysis of Experiments (9th Edition). Wiley. 4. Excel 2019 Bible by John Walkenbach, Michael Alexander, and Richard Kusleika (Wiley). 5. Koller, D., & Tucker, A. (2015). Practical Google Analytics and Google Tag Manager for Developers (1st Edition). Apress.

Year	**II**	**Program**	**M.Sc., Biotechnology**	**Code**	**23P4BTDE10**
Sem	**IV**	**Elective – 5 : STEM CELL BIOLOGY**		**Credits**	**03**
Hrs	**45**			**Effect from**	**2023-2024**

Course Objectives:

The main objectives of this course are:

1. The subject imparts knowledge on the fundamentals of stem cells. The student will be provided with a basic knowledge and understanding about the application of stem cell biology.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	To understand the major discoveries of stem cell biology	K1
CO2	To provide basic knowledge about stem cell niche and functions	K1 & K2
CO3	To enlighten the students on Stem cell isolation and culture techniques	K3, K4
CO4	To update the knowledge on Stem cell cycle	K3,K3 & K5
CO5	To assess and appraise Applications of Embryonic stem cells.	K3,K4 & K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Introduction to Stem cells**	**9 Hrs**

Stem cells - Definition, Characterization, Pluripotency, Self-renewal and differentiation. Types of stem cells- Embryonic stem cells, Adult stem cells and mesenchymal stem Cells, Adipose stem cells.

Unit – II	**Stem Cell Culture and Techniques**	**9 Hrs**

Stem cell isolation, maintenance, and culture conditions. Techniques: flow cytometry, immunohistochemistry, and cell sorting Stem cell differentiation and lineage tracing.

Unit – III	**Therapeutic Applications of Stem Cells**	**9 Hrs**

Stem cell therapy in regenerative medicine: tissue engineering, organ repair, and transplantation. Clinical trials and ethical issues in stem cell therapy. Disease modeling and drug discovery

Unit– IV	**Stem Cell Signaling Pathways**	**9 Hrs**

Stem cell cycle. Chromatin modification and transcriptional regulation, chromatin modifying factors, Chromosomal inactivation. JAK -STAT pathway, Ras\Raf pathway, PI3K cell signaling, p53 check points, Role of LIF pathway in cell cycle control.

Unit – V	**Application of Stem Cell Research**	**9 Hrs**

Applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells. Ethics in human stem cell research.

References

1. Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
2. Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
3. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer, STEM CELL TECHNOLOGY Syllabus - Semester First References:
4. Stem Cell Biology and Gene Therapy. Quesenberry PJ, Stein GS, eds. (£65.00.) Wiley, 1998.
5. Progress in gene therapy, Volume 2,Pioneering stem cell/gene therapy trials, Roger Bertolotti, Keiya Ozawa and H. Kirk Hammond, VSP international science publishers
6. Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003,
7. Human Embryonic Stem Cells: The Practical Handbook by Stephen Sullivan and Chad A Cowan

Year	II	Program	M.Sc., Biotechnology	Code	23P4BTSP04
Sem	IV	Soft Skill – IV : Lab in AI - Based Biotechnology		Credits	2
Hrs	30			Effect from	2023-2024

Course Objectives:

The main objectives of this course are:

1. Introduce students to AI-driven tools and platforms used for gene expression analysis, protein structure prediction, microbiome data analysis, and promoter-enhancer prediction in genomes.
2. Equip students with the ability to apply AI techniques to analyze single-cell data, predict gene regulatory networks, and classify complex biological datasets.
3. Enable students to leverage AI for biomarker discovery, disease prediction, and drug discovery through case studies and practical exercises.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Analyze and classify gene expression data using AI algorithms and platforms such as TensorFlow, PyTorch, or specific bioinformatics AI tools.	K1
CO2	Predict protein structures using AI-based techniques like AlphaFold and interpret structural implications for drug design and disease understanding.	K2
CO3	Apply machine learning models to identify and predict gene regulatory networks from experimental and simulated datasets.	K3
CO4	Perform single-cell data analysis to classify cell types and states using AI frameworks such as Seurat or Scanpy.	K4
CO5	Design workflows for disease prediction and biomarker discovery using AI-based methodologies, integrating omics data and clinical information.	K5

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

S.No	Experiments	Hours
1	AI Tools and Platforms for Biotechnology	3
2	Gene Expression Analysis and Classification	3
3	Protein Structure Prediction Using AI	3
4	AI Applications in Drug Discovery	3
5	Image-Based Biological Analysis	3
6	Microbiome Data Analysis Using AI	3
7	Predicting Gene Regulatory Networks	3
8	Promoter and Enhancer Prediction in Genomes	3
9	Single-Cell Data Analysis and Classification	3
10	Biomarker Discovery and Disease Prediction	3

References

1. Chicco, D., & Jurman, G. (2020). Machine Learning with Applications in Bioinformatics. Springer.
2. Greener, J. G., Kandathil, S. M., & Jones, D. T. (2021). Deep Learning for Protein Structure Prediction. Wiley.
3. Yip, S. H., & Sham, P. C. (2019). AI in Genomic Medicine. Cambridge University Press.
4. Raj, A., & van Oudenaarden, A. (2018). Single-Cell Data Analysis Using AI: A Practical Guide. Oxford University Press.
5. Topol, E. J. (2019). Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic Books.

Year	II	Program	B.Sc., Biotechnology	Code	23P4BTED01
Sem	IV	EDC : Bioinformatics		Credits	2
Hrs	45			Effect from	2023-2024

Course Objectives:

The main objectives of this course are:

1. To gain basic knowledge in the concept of essential of bioinformatics.
2. To understand the usage of prediction tools that are used to predict the biological system.
3. To understand basic concepts of drug designing.

Course Outcomes:

On the successful completion of the course, student will be able to:

CO1	Understand the structure of various biological databases, nucleic acid sequence (GenBank/NCBI, EMBL, DDBJ) and protein sequence databases (UniprotKB, PIR).	K1
CO2	Develop skills in sequence alignment, including both pairwise sequence alignment (local and global alignments) and multiple sequence alignment.	K2 & K3
CO3	Learn to use gene prediction methods (ORF Finder), and RNA/protein secondary structure prediction methods (GOR).	K3
CO4	Understand the principles of molecular mechanics, including force fields, bond length, torsion angle, non-bonded interactions (van der Waals interactions)	K4 & K5
CO5	Learn the concepts and techniques of drug designing, including computer-aided drug design, Ligand-based approaches, and target-based approaches.	K5&K6

K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create

Unit – I	**Biological Databases**	**09 Hrs**

Biological Databases, Nucleic acid sequence databases– GenBank/NCBI, EMBL, and DDBJ. Protein sequence databases – UniprotKB and PIR, Structure databases – PDB, CATH and SCOP.

Unit – II	**Sequences Analysis**	**09 Hrs**

Sequence alignment, Pairwise Sequence Alignment- Local alignment and Global alignments, Dynamic programming algorithm, Scoring matrices, gap penalties.

Unit – III	**Sequences Similarity and Analysis Tools**	**09 Hrs**

Multiple Sequence alignment, Phylogenetic Analysis- tree construction methods- Maximum likelihood and maximum parsimony- distance methods. Database similarity search – BLAST and types.

Unit– IV	**Gene Prediction Methods**	**09 Hrs**

Gene Prediction methods – ORF Finder, Protein Secondary Structure Methods- GOR IV. Molecular Mechanics – force fields; Bond length, Torsion angle, and van der Waals interactions and analyzing Ramachandran plots.

Unit – V	**Drug Designing**	**09 Hrs**

Drug Discovery. History. Steps in drug discovery. Target Identification. Target Validation. ADME. Drug designing - Computer aided drug design. Ligand based approach. Target based approach.
References
1. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount, 2nd Edition (2004) 2. "Bioinformatics: Principles and Applications" by Zhumur Ghosh and Bibekanand Mallick, 1st Edition (2008). 3. "Bioinformatics: Sequence and Genome Analysis" by David W. Mount, 2nd Edition (2004). 4. "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins" by Andreas D. Baxevanis and B. F. Francis Ouellette, 3rd Edition (2004). 5. "Molecular Modelling: Principles and Applications" by Andrew R. Leach, 2nd Edition (2001). 6. "Drug Design: Methodology, Concepts, and Mode-of-Action" by Thierry Langer and Rolf W. Hartmann, 1st Edition (2006). 7. "The Organic Chemistry of Drug Design and Drug Action" by Richard B. Silverman and Mark W. Holladay, 3rd Edition (2014).