THIRUVALLUVAR UNIVERSITY

SERKKADU, VELLORE-632115

M.Sc. Biotechnology

UNIVERSITY DEPARTMENT

CURRICULUM AND SYLLABUS

FROM THE ACADEMIC YEAR
2023 – 2024

Tamil Nadu State Council for Higher Education (TANSCHE)

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

REVISED REGULATIONS AND SYLLABUS (w.e.f. 2022-2023)

TANSCHE COMPLIANCE

Preamble:

The learning outcome is designed to help learners understand the objectives of studying biotechnology that is, to analyze, appreciate understand the use of the living system and organisms to develop or make products. Biotechnology is a fast-growing field of science where biological systems are used in diverse applications in the areas of environment, food industry, fermentation, etc. Interdisciplinary life science provides high-quality education and performs cutting-edge technological research. The fundamental research as well as in modern industrial enterprise patents, copyrights and various regulatory processes to make their efforts a success. In the increasingly globalized society, it is important that the younger generation especially the students are equipped with knowledge, skills, mindsets and behaviors so that they become important contributors to the development of society. Biotechnology is an interdisciplinary field that brings together knowledge from diverse fields such as cell biology to molecular biology, biochemistry to biophysics, genetic engineering to stem cell research, bioinformatics to genomics-proteomics, environmental biology to biodiversity, microbiology to bioprocess engineering, from bioremediation to Insilco drug discovery and so on. The proposed credit-based curriculum and grading system will even add much more to the existing interdisciplinary nature of biotechnology and will also offer many courses to the other branches of life science. The Choice Based Credit System (CBCS) curriculum for Biotechnology at the postgraduate level has now been developed into a new system called Learning Outcome Curriculum Framework (LOCF) under the recommendations and guidance of the University Grants Commission (UGC). The LOCF approach first envisioned the programme learning outcomes of the M.Sc. program in Biotechnology as well as the learning outcomes of the courses being taught under this programme, keeping in view the graduate attributes of the subject. A variety of learning assessment tasks has been included in the curriculum. The new Curriculum of M.Sc Biotechnology offers essential knowledge and technical skills. Students would be trained in all areas of biotechnology with significant interdisciplinary components. The theory and experimental knowledge suit the need of academics and industry. The curriculum will motivate the students to pursue research and entrepreneurial skill development.

Introduction:

The higher education institutions all over the globe are in grip of this urgent task and India needs to keep pace with future developments. 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 of the learning and experiences. They equip students and graduates for lifelong personal development, learning and to 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, which shall 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 the courses in Biotechnology.

- **PowerPoint slides** for topics that involve information and use of PowerPoint presentations are also made whenever the lectures are to be summarized in a crisp and point-wise manner to highlight salient/important conclusions from the topics.
- **Classroom Discussions** are a regular feature while teaching. The students are drawn into impromptu discussions 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 of data, 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 in terms 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 up with 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 solutions to 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 assess the 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.

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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 Universityor 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 thereto shall be 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 courseis organizedonsemesterbasiswithatotal offour semesters. In thefirst, second and third semesters, there are three (core) theory papers (9 hrsperweek), one Core Practical(15hrsperweek) and Twoelective/ optionalpapers(4hrs perweek), persemesterandinthefourthsemester, there are only one core theory paper(Research Methodology) (4hrs perweek),acore project/ dissertationworkconstituting atotalof 20 hrs per week, two electives (4hrs per week), and a Softskillprogram (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 the experiments.

4. ELIGIBILITY FOR THE AWARD OF DEGREE:

A candidate shall be eligible for the award of the degree onlyif 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 theexaminationofallthefour semestersprescribedearningminimumof 91 creditsandfulfilledsuchconditionsashavebeenprescribedtherefore.

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 marksforwardedtotheUniversityalongwiththird semesterinternalassessment(CIA) marks.

5. EXAMINATIONS:

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semesterexamination attheendofthefirstacademicyear. Similarly,thethirdandfourthsemester examinations shall be held at 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) practicalexamination(6hrsperday) be heldforeachcomponent of the core practical at the end of even semesters.

Examinations for the courses on soft skills will be held along with the semester examinations of the core and elective courses. There is nowritten examinationforinternship. Astudentshallsubmitareportaftercompleting the summer internship. The report will be evaluated by two examiners within the Department of the college/ institution.

6. COURSE OF STUDYAND SCHEME OF EXAMINATIONS (2023-24):

FIRST SEMESTER

S.No.	Course Components	Name of Course	Inst. Hours	Credits	Exam HRS	Max. Marks	
						CIA	External
1	Core Paper-1	Biochemistry	6	4	3	25	75
2	Core Paper-2	Microbiology	5	3	3	25	75
3	Core Paper-3	Molecular Cell Biology	5	3	3	25	75
4		Practical – I (A) Biochemistry (B) Microbiology (C) Molecular Cell biology	6	4	4	25	75
5	Elective-I	Bioinstrumentation	5	3	3	25	75
6	Elective-II	Pharmaceutical Biotechnology	5	3	3	25	75
			32	**20**			
Total Credits : 20							

SECOND SEMESTER

S. No.	Course Components	Name of Course	Inst. Hours	Credits	Exam HRS	Max. Marks	
						CIA	External
7	Core Paper-4	Immunology	5	4	3	25	75
8	Core Paper-5	Molecular Genetics	4	3	3	25	75
9	Core Paper-6	Genetic Engineering	4	3	3	25	75
10		Practical – II (A) Immunology (B) Molecular Genetics (C) GeneticEngineering	5	4	4	25	75
11	Elective Paper-3	Regulatory affairs and Industrial standards (or) Enzymology	3	3	3	25	75
12	Elective Paper-4	Environmental Biotechnology	3	3	3	25	75
13	Skill	1. Vermiculture 2. Basics in diagnostic lab technology 3. Food Biotechnology	4	2			
		Human Rights	2	2			
		MOOC Course	-	2			
		Total	**30**	**26**			

THIRD SEMESTER

S. No.	Course Components	Name of Course	Inst. Hours	Credits	Exam HRS	Max. Marks	
						CIA	External
14	Core Paper-7	Bioinformatics	6	5	3	25	75
15	Core Paper-8	Plant and Animal Biotechnology	6	5	3	25	75
16	Core Paper-9	Bioprocess Technology	6	5	3	25	75
17	Core Paper-10 Practical-III	Practical – III (A) Bioinformatics (B) Plant and Animal Biotechnology (C) BioprocessTechnology	6	4	6	40	60
18	Elective Paper-5	Nano Biotechnology*(OR)*Molecular Developmental Biology	3	3	3	25	75
19	NME II	1. Basics tools in Biotechnology 2. Environmental Sciences 3. Basics in Pharamaceutical Biotechnology	3	2			
20	**Internship	Internship in Industries to Biotechnology Field (food / clinical trial/ dairy/ aqusciences, pharmaceutical)CSIR/DBT/DST research laboratories	0	2	-	-	100
		Total	**30**	**26**			

** Internshipwillbecarriedoutduringthesummervacationof IISemester andthereportwillbeevaluatedbytwoexaminers withintheDepartment ofthecollege/ institution.

FOURTH SEMESTER

S. No.	Course Components	Name of Course	Inst. Hours	Credits	Exam HRS	Max. Marks	
						CIA	External
21	Core Paper-11	Research Methodology	6	5	3	25	75
22	Core Paper-12	Biostatistics	6	5			
23	Project Work &*Vive Voce*	Dissertation	10	7		60	240 (40-work book, 150 Dissertation +50- Viva)
24	Elective Paper-6	Stem Cell Biology (or) Bioethics, Human Rights and Social Issues	4	3	3	25	75
25	Skill Enhancement		4	2			
26	Extension Acitivity		-	1			
		Total	**30**	**23**			

Core Paper-1

BIOCHEMISTRY

Paper – 1			
Title of the paper	BIOCHEMISTRY	Subject code:	
Category of the Course	Year	Semester	Credits
Core Paper	1st	1st	6

Learning Outcome:

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:

At the end of the Course, the Student will be able to:

CO-1	To understand the basics of pH and related principles and carbohydrate metabolism.
CO-2	To provide basic knowledge about lipid metabolism and related significance.
CO-3	To enlighten the students on Bio-energetics and Biological oxidation pathways.
CO-4	To update the knowledge on Amino acids and Protein.
CO-5	To assess and appraise the role of Nucleic acids.

SYLLABUS | Core Paper-1 | BIOCHEMISTRY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	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	10	CO1	K1&k2
II	Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids.	10	CO2	K1,K2 & K3

	Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycol lipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroid hormones.			
III	Bioenergetics – Concept of energy, Principle of thermodynamics, Relationship between standard free energy and Equilibrium constant, ATP ads universal unit of free energy in Biological systems. Biological oxidation: Electron transport chain, oxidative phosphorylation, glycolysis, citric acid cycle, cori.s cycle, glyoxalate pathway. Oxidation of fatty acids-mitochondrial and peroxisomal ß-oxidation, alpha and beta oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Photosynthesis, urea cycle, hormonal regulation of fatty acids and carbohydrates metabolisms, Mineral metabolism	10	CO3	K1,K2 & K3
IV	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	10	CO4	K1,K2 & K3
V	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	10	CO5	K1,K2 & K3

Reference books:

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- Sathyanarayana.U and U.Chakrapani., 2011. Biochemistry. Books and Allied private limited, Kolkata.
- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, 2010. Biochemistry, Seventh Edition, W. H. Freeman.
- Albert Lehninger, David L. NelsonVoet Donald, Judith G.Voet and Charlotte W.Pratt., 2008. Principles of Biochemistry. John Wiley and sons, Inc., New Jersey.
- Michael M. Cox, 2008. Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman publishers.

Useful web sites:

- mcdb-webarchive.mcdb.ucsb.edu/.../biochemistry/.../website-tourf.htm
- www.biochemweb.org/
- http://golgi.harvard.edu/biopages.html
- webarchive.mcdb.ucsb.edu/sears/biochemistry/info/website-

Core Paper-2

MICROBIOLOGY

Paper – 2			
Title of the paper	MICROBIOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	1st	5

Learning Outcome:

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:

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

SYLLABUS | Core Paper-5 | MICROBIOLOGY				
Unit	**Content**	**Hours**	**Cos**	**Cognitive level**
I	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	10	CO1 CO2	K1,K2 &K3

II	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	10	CO2 CO3 CO5	K2,K3,K5
III	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	10	CO1 CO3 CO4	K1,K2,K3
IV	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	10	CO4 CO5	K4 &K5
V	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,	10	CO1 CO2 CO3	K4 & K5

	Sulphur and Phosphorous; Methanogenic bacteria Extremphiles- Thermophiles Acidophiles, Halophiles and alkalophiles; Biotechnological application of Extremophiles			

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- https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf ISBN 978-92-4-156553-0. https://doi.org/10.3389/fmicb.2020.631736
- https://www.agrimoon.com/wp-content/uploads/AGRICULTURAL-Microbiology.pdf.

Core Paper-3

MOLECULAR CELL BIOLOGY

Paper – 3			
Title of the paper	MOLECULAR CELL BIOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	1st	5

Learning Outcome:

The paper imparts a thorough knowledge on the basics of all the Cell biology concepts, molecules and its regulation. The student will get to understand the core concepts of molecules and cell biology.

Course outcomes:

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.
CO-2	Identify the structures and purposes of basic components in prokaryotic and eukaryotic cells and their molecular mechanism
CO-3-	Demonstrate knowledge and understanding of the principles and basic mechanisms of nuclear envelope and its functions.
CO-4	Understand the metabolic pathways and the process of transmission of extracellular Signals
CO-5	Demonstrate the operation of various microscopes and microtomy in the laboratory

SYLLABUS | Core Paper-3 | MOLECULAR CELL BIOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Cell Biology: Introduction to cell Biology- Basic properties of cells-Cellular dimension-Size of cells and their composition-Cell origin and Evolution. Structure of Prokaryotic and Eukaryotic cell. 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.	10	CO1	K1,K2 &K3
II	Cell Division, Central dogma, DNA as genetic	10		K1,K2 &K3

	material; Prokaryotic and Eukaryotic Genome Organization; Structure of eukaryotic chromosomes: DNA compaction, nucleosome, Heterochromatin and Euchromatin; DNA melting and buoyant density; Tm; DNA reassociation kinetics (Cot curve analysis); Structure of Nucleic acids, Prokaryotic and Eukaryotic DNA Replication, Enzymes and accessory proteins and mechanisms and Transcription, RNA processing and regulation in Prokaryote and Eukaryotes.		CO2	
III	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-golgi sorting and processing – receptor mediated endocytosis; Synthesis of membrane lipids	10	CO3	K1,K2 &K3
IV	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). Gene regulation: Repressors, activators, positive and negative regulation, Constitutive and Inducible, small molecule regulators, operon concept: lac, trp, his operons .	10	CO4	K1, K2 & K3
V	Cancer Biology: Multistage cancer development Mitogens, carcinogens, oncogenes and proto-oncogenes, tumor suppressor genes-Rb, p 53, Apoptosis and significance of apoptosis.	10	CO5	K1,K2 & K3

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- Plopper, Principles of cell Biology. Jones and Bartlett.
- Gartner, Cell Biology and Histology. LWW.
- Pollard et al., Cell Biology. Sounders.
- Copper, The Cell a Molecular approach. Sinauer

PRACTICAL-I

(Biochemistry, Microbiology & Molecular Cell biology)

Title of the paper	PRACTICAL-I (Biochemistry, Microbiology & Molecular Cell biology)	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	1st	6

Learning Outcome:

The practical will establish a basic study skills on the subject and will improve the student's ability to calculate and improve their practical skill and knowledge.

Course outcomes:

On successful completion of the course the students will be able to

CO 1	(K2) Illustrate basic biochemistry procedures
CO 2	(K3) study the methods of estimation of biomolecules
CO 3	(K4) isolate & Analyze DNA, RNA & protein
CO 4	(K5) critically analyze the isolated biomolecules
CO 5	(K5) evaluate the quality and purity of DNA, RNA & Protein

SYLLABUS | PRACTICAL-I				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
A	**(A) Biochemistry - Practical** 1. Basic calculations in Biochemistry - Normality, Molarity, Molality percent solutions (v/v, w/v). 2. Calibration of pH meter 3. Transition interval of commonly used pH indicators 4. Preparation of biological buffer - phosphate buffer 5a. Extraction of Proteins from biological materials 5b Protein separation methods:-Ammonium sulphate Precipitation,	15	CO1 CO2 CO3 CO4 CO5	K3 & K4

	5c. Membrane Dialysis, 5d. SDS PAGE 6. Urea-SDS PAGE for separation of low molecular weight proteins 7. Estimation of Proteins by Lowry's method 8. Estimation of Proteins by Biuret method 9. Estimation of Proteins by Bradford method 10. Estimation of RNA by orcinol method 11. Estimation of DNA by diphenylamine method 12. Estimation of Carbohydrate by Anthrone method 13 Purity check of DNA & RNA by UV Spectrophotometry - A260/280 14. Separation of amino acids by Paper Chromatography 15. Separation of sugars by Paper Chromatography 16. Separation of amino acids by Thin layer chromatography 17. Separation of sugars by Thin layer chromatography 18. Thermal Denaturation of DNA and UV absorption studies **Demo Experiments** 1. Gel permeation chromatography, 2. Affinity chromatography, 3. Ion.exchange chromatography 4. Western blotting 5. PCR			
B	**(B) Microbiology-Practical** 1. Sterilization of glassware using dry heat- hot air oven	15	CO1 CO2 CO3	K3,K4 &K5

	2. Sterilization of media using moist heat – autoclave 3. Filter sterilization 4. Liquid media preparation – nutrient broth 5. Solid media preparation – SDA plates 6. Preparation of Agar slants 7. Streak plate method 8. Pour plate method 9. Spread plate method 10. Enumeration of total count of the bacteria 10. 11. Isolation of microbes from soil 12. Isolation of microbes from water 13. Isolation of microbes from air 14. Isolation of microbes from plant surface. 15. Isolation of pure culture of E.coli, 16. Isolation of pure culture of Aspergillus niger, 17. Isolation of pure culture of Streptomyces. 18. Gram staining and morphological characterization of microbes. 19. Negative staining of bacteria 20. Determination of growth curve of bacteria – E.coli 21. IMViC test of enteric bacteria **Demonstration** 16srRNA sequencing		CO4 CO5	
C	**(C) Molecular Cell Biology –Practical** 1. Isolation of Genomic DNA from E.coli 2. Isolation of plasmid DNA from E.coli 3. Elution & quantification of DNA from agarose gel. 4. Preparation of competent cells and transformation 5. Polymerase chain reaction 6. Isolation of Total RNA from bacteria 7. Synthesis of cDNA by Reverse transcription polymerase chain reaction	15	CO1 CO2 CO3 CO4 CO5	K3,K4 & K5

Elective Paper-1 BIOINSTRUMENTATION

Paper – 1			
Title of the paper	BIOINSTRUMENTATION	Subject code:	
Category of the Course	Year	Semester	Credits
Elective Paper	1st	1st	4

Learning Outcome:

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 principles.

Course outcomes:

At the end of the Course, the Student will be able to:

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

SYLLABUS | Elective Paper-1 | BIOINSTRUMENTATION				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Microscopic Techniques: 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.	7	CO1	K1 & K2
II	Centrifugation: pH meter, Principle and Applications of various types of centrifugation, Sedimentation Coefficient, Svedberg unit, RCF, Density Gradient Centrifugation. Chromatography Techniques: Principle and Application of Paper Chromatography,	7	CO2	K1, K2,K3

	TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC & HPLC.			
III	Electrophoretic Techniques: Principle and Application of Agarose Gel Electrophoresis, 2D-gel Electrophoresis, 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)	7	CO3	K1, K2 & K3
IV	Spectroscopic Techniques: 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	7	CO4	K1,K2 & K3
V	Radio-isotopic Techniques: 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.	7	CO5	K1,K2 & K3

Reference books

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

Elective Paper-2

PHARMACEUTICAL BIOTECHNOLOGY

Paper – 2			
Title of the paper	PHARMACEUTICAL BIOTECHNOLOGY	Subject code:	
Category of the Course	Year	Semester	Credits
Elective Paper	1st	1st	4

Learning Outcome:

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:

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

SYLLABUS | Elective Paper-5 | PHARMACEUTICAL BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	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.	7	CO1	K1
II	Scientific, technical and economic aspects of vaccine	7		K3 & K4

	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		CO2	
III	Hybridoma technology - Production, Purification and Applications, Formulation of biotech products - Rituximab, Introduction to Microbial biotransformation and applications, Study of the production 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, Bio safety in pharmaceutical Industry	7	CO3	K2
IV	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.	7	CO4	K2 & K4
V	Clinical Pharmacology, Drug therapy, therapeutic situation, benefits and risk of use of drugs,	7	CO5	K1,K2 &K5

	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.			

Reference Books:

- Harbans lal, 2011. Pharmaceuticals biochemistry. CBS Publishers and distributors Pvt. Ltd, Chennai.
- Carlos A. Guzmán and Giora Z. Feuerstein, 2009. Pharmaceutical Biotechnology, 1st edition, Springer.
- Daniel Figeys (Ed.). 2005. Industrial Proteomics: Applications for Biotechnology and Pharmaceuticals. Wiley, John & Sons, Incorporated.
- Kayser, O and Muller R.H.. 2004. Pharmaceutical Biotechnology Drug Discovery and Clinical Applications. WILEY-VCH
- Leon Shargel, Andrew B. C. Yu, Susanna Wu-Pong, and Yu Andrew B. C. 2004. Applied Biopharmaceutics & Pharmacokinetics. McGraw-Hill Companies
- Stefania Spada, Garywalsh. 2004. Directory of approved biopharmaceutical
- Gary Walsh. 2003. Biopharmaceutical, Biochemistry & Biotechnology.
- Heinrich Klefenz. 2002. Industrial pharmaceutical biotechnology.
- Thomas Lengauer (Ed.). 2002. Bioinformatics – from Genomes to Drugs. Volume I& II. Wiley-VCH.
- John F. Corpenter (editor), Mark C. Manning. 2002. Rational Design of stable formulation Theory and Practice (Pharmaceutical Biotechnology). Plenum, US. Ist edition.
- D.I.A. Crommelin, et al., 2002. Pharmaceutical Biology. Amazon prime publications.
- Werner Kalow, Urs A Meyer and Rachel F. Tyndale. 2001.
- Pharmacogenomics. CPL press.

Useful Websites:

- https://tugasakhirsttifbogor.files.wordpress.com/2018/08/pharmaceutical-biotechnology.pdf
- http://library.nuft.edu.ua/ebook/file/Gad2007.pdf
- https://oasis.iik.ac.id:9443/library/repository/a932eb462c49885a2c72755977036b81.pdf

Core Paper-4

IMMUNOLOGY

Paper – 4			
Title of the paper	IMMUNOLOGY	Subject code:	
Category of the Course	Year	Semester	Credits
Core Paper	1st	2nd	4

Learning Outcome:

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

Course outcomes:

At the end of the course the students will be able to

CO-1	(K2) Illustrate various mechanisms that regulate immune responses and maintain tolerance
CO-2	(K3) describe key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effector responses
CO-3	(K4) learn the concepts of cellular and molecular processes that represents the human immune system.
CO-4	(K5) elucidate the role of immunological regulation and tolerance at a cellular and molecular level
CO-5	(K6) compile concepts on immunological principles and diagnosis

SYLLABUS | Core Paper-4 | IMMUNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	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	10	CO1	K1 & K2
II	Lymphocyte-sub-populations of mouse and man.	10		K2,K3 & K5

	APC cells, 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		CO2	
III	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	10	CO3	K2 & K5
IV	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	10	CO4	K4 & K5
V	Immunotechniques- 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 ofantibodies, Quantitation of immunoglobulin by RID, EID and nephelometry, CMI techniques and Immunotherapy.	10	CO5	K3,K4 & K6

Reference Books:

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

Useful Websites:

- www.library.csusm.edu/course guides/biology
- www.immunologylink.com

http://www.wiley.com/college/bio/karp12791/weblinks.html

Core Paper-5

MOLECULAR GENETICS

Paper – 5			
Title of the paper	MOLECULAR GENETICS	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	2nd	3

Learning outcome:

The paper imparts a thorough knowledge on the basics of all the Genetics concepts, molecules and its regulation. The student will get to understand the core concepts of molecules and genetics.

Course outcomes:

At the end of the Course, the Student will be able to:

CO-1	To acquire good knowledge about the molecular mechanisms of gene expression and understand the theories behind the organization and functions of genetic material in the living world.
CO-2	Identify and distinguish genetic regulatory mechanisms at different levels and explain the processes behind mutations and other genetic changes and study various chromosomal abnormalities.
CO-3-	Make the students understand different range of DNA damage and range of their tools for their detection an.
CO-4	Learn the concepts of the transposons and their applications.
CO-5	Detects the Allele frequencies and genotype frequencies in populations and describe the concepts behind the theory of evolution

SYLLABUS | Core Paper-5| MOLECULAR GENETICS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Genes and chromosomes, Colinearity of Genes and Proteins, Genetic code, The complexity of eukaryotic genome (introns, exons, repetitive DNA sequence, gene duplication and pseudogenes). DNA markers - VNTR, STR, microsatellite, SNP and their detection Techniques.	10	CO1	K1,K2 & K3
II	Mutation and Gene polymorphism: Types, Mutagens, Mutable and Mutator Genes. Spontaneous and virus induced mutation, Radiation induced mutation. Ionizing radiation, UV radiation. Chromosomal Abnormalities and associated genetic diseases, Techniques in the study of chromosomes and their applications, Karyotyping and usefulness of chromosomes in understanding Genetic variation,	10	CO2	K1,K2 &K3
III	DNA Damage and Repair-Internal and external agents causing DNA damages, DNA damages (Oxidative damages, Depurinations, Depyrimidinations, O6-methylguanines, Cytosine deamination, 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), Discovery: Early experiments of McClintock in maize. Insertion sequences in prokaryotes. Complex transposons (ex. Tn3, Tn5, Tn9 and Tn10).	10	CO3	K1,K2 &K3

IV	Allele frequencies and genotype frequencies, Hardy-Weinberg principle, complications of dominance, special cases of random mating – multiple alleles, different frequencies between sexes (autosomal and X-linked) inbreeding, random genetic drift, Genetics ofeukaryotes gene linkage and chromosome mapping. Crossing over, types, and mechanism of crossing over.	10	CO4	K1 &K2
V	Extrachromosomal heredity: Biology of Plasmids, their discovery, types and structure of F.RTH. *col* factors and Ti – Replication and partitioning, Incompatibility and copy number control-natural and artificial plasmid transfer and their applications-Human Genome Project, Genomics and Modern methodologies in understanding genome.	10	CO5	K1,K2 & K3

References:

- Principles of Genetics- 8th Edition, Gardner, Simmons and Snustad, 2002.
- The Cell- A Molecular Approach. 3rd Edition. Geoffrey M. Cooper, Robert E. Hausman, 2003.
- Genetics- Kavitha B. Ahluwalia, New Age International Pvt Ltd and Publishers, New Delhi, 2010
- Genetics – P.S Verma and A.K Agarwal (Rack 3, Central Library)
- Robert Brooker.2011. Genetics- Analysis and Principles. 4th edition. McGraw Hill.
- Leland Hartwell,Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver,2010.Genetics: From Genes to Genomes, 4th Edition, McGraw Hill.
- Rastogi Smita and Neelam Pathak.,2010. Genetic Engineering, Oxford University Press, New Delhi. (Rack 3, Central Library)
- Watson, Hopkins, Roberts, Steitz, Weiner, 2004. Molecular Biology of Genes, 4th Edition.
- DNA markers Protocols, applications and overviews Anolles G. C. & Gresshoff P. M. Wiley-Liss
- Molecular markers in Plant Genetics and Biotechnology Vienne De. D. Science Publishers
- Genetics of Population Hedrick P.W. Jones & Bartlett 4 Principle of Population Genetics Hartl D. L. and Clark A. G. Sinauer Associates

Core Paper-6

GENETIC ENGINEERING

Paper – 6			
Title of the paper	GENETIC ENGINEERING	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	2nd	3

Learning Outcome:

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:

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

SYLLABUS | Core Paper-6 | GENETIC ENGINEERING				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	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	10	CO1	K1,K2, K5
II	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.	10	CO2	K2,K3, K4

	Cloning in gram-positive bacteria (Bacillus subtilis)			
III	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; Vectors for cloning promoters and terminators; vectors with adjustable copy number	10	CO4	K3,K4 &K6
IV	Nucleic acid hybridization techniques; Molecular probes (Types of probes and its construction); probe labeling. Nick translation, End labeling and Random primer labeling. 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).Second generation sequencing methods	10	CO4	K3,K4,K5 & K6
V	Site directed mutagenesis; DNA microarray; chromosome walking and jumping.Molecular techniques in prenatal diagnosis gene therapy, Transgenic animals (knockout mice) and plants (Flavr savr tomato), Pharmaceutical products (Vaccine, Humulin, etc), Crop improvement. Pesticide resistance, herbicide resistance, transgenic animals and GM foods; Modern Concepts in Genetic Analysis.	10	CO5	K3,K4,K5 & K6

Reference Books:

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

PRACTICAL-II

(Immunology, Molecular Genetics & Genetic Engineering)

Title of the paper	PRACTICAL-II (Immunology, Molecular Genetics & Genetic Engineering)	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	2nd	4

Learning Outcome:

The practical will establish a basic study skill on the subject and will improve the student's ability to have a hands on experience on the above core subjects.

Course outcomes:

CO-1	(K2) Isolate and identify microbes from various sources.
CO-2	(K3) Characterize microbes.
CO-3	(K4) Examine Plant and Animal cells and their functions
CO-4	(K5) Assess extracted DNA, RNA and protein for rDNA technology
CO-5	(K6) To study cloning tools

SYLLABUS | PRACTICAL-II				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
A	**(A) Immunology – practical** 1. Identification of various immune cells from human peripheral blood. 2. Lymphocyte separation and identification 3. Determination of lymphocyte viability by trypan blue method 4. WBC counting 5. Preparation of serum and plasma 6. Electrophoretic profile of human serum in native PAGE 7. Preparation of cellular antigen – human RBC 8. Preparation of antigen-adjuvent mixture for production of polyclonal antibody 9. Isolation of IgG molecule from serum 10. Immunodiagnostics: CRP	15	CO1 CO2 CO3 CO4 CO5	K,.K2,K3,K4,K5 &K6

	11. Immunodiagnostics: ASO 12. Immunodiagnostics: Widal 13. Immunodiagnostics: RA 14. Immunodiagnostics: Blood grouping and typing 15. Immunodiagnostics: hCG 16. ELISA 17. Radial Immunodiffusion 18. Ouchterlony Immunodiffusion 19. Immunoelectrophoresis 20. Rocket electrophoresis 21. Counter current immunoelectrophoresis. 22. Bioassays for cytokines 23. Radioimmunoassays (Demonstration)			
B	**(B) Molecular Genetics – Practical** 1. Isolation of DNA from blood. 2. Isolation of RNA from animal tissue. 3. Formaldehyde denatured Agarose gelelectrophoresis of RNA. 4. Urea denatured agarose gel electrophoresis of RNA. 5. Radiation induced genetic damage assessment 6. Chemical induced genetic damage assessment. 7. Single Strand Confirmation Polymorphism (SSCP) 8. Preparation of metaphase chromosomes from Animal / Plant sample. 9. Karyotype analysis.	15	CO1 CO2 CO3 CO4 CO5	K3,K4 & K5

C	**(C) Genetic Engineering – Practical** 1. Preparation of plasmid DNA by alkaline lysis method. 2. Agarose gel electrophoresis 3. Silver staining of gels 4. Methylene blue DNA staining 5. Elution of DNA from agarose gel. 6. Restriction enzyme digestion. 7. Restriction mapping of plasmid DNA. 8. Ligation. 9. Competent cell preparation 10. Transformation and selection of recombinants. 11. Cloning of fragments in PBR322 12. Insertional inactivation/Blue white screening 13. RAPD 14. RFLP 15. Amplification of DNA - PCR 16. Determination of molecular weight of DNA **Demonstration:** RT-PCR for COVID-19	15	CO1 CO2 CO3 CO4 CO5	K3,K4 &K5

Elective Paper-3

REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS

Paper – 3			
Title of the paper	REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	1st	2nd	3

Learning Outcome:

The subject imparts knowledge on the fundamentals of regulatory requirement in industries. The student will be provided with a basic knowledge and understanding about the regulatory affairs based on biotechnological industry requirements.

Course outcomes:

CO-1	Elucidate the basic requirements of establish laboratory for testing samples as per the regulatory body's requirements
CO-2	Describe the Scientific, technical knowledge about various food preservation Techniques
CO-3	Describe the basic concepts of packing of food materials, various parameters observed during packaging
CO-4	Describe the testing of food materials and identifying of microbial food contaminant
CO-5	Explain the basic of food safety management system, good manufacturing practice and good hygienic practices

SYLLABUS | Elective Paper-3 | REGULATORY AFFAIRS AND INDUSTRIAL STANDARDS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Planning, Organisation and setting of Food testing laboratory and laboratory safety** Understand the requirements for setting up a laboratory for the legal defensibility of analytical data. The ideal structure design, environment, layout for microbiological testing and Air handling etc., Introduction about accreditation, Different accreditation bodies (NABL, APLAC, ILAC), Requirements for ISO/IEC 17025:2017, documentation, pre-requisites for accreditation, management requirements, technical requirements, measurement of traceability, Laboratory safety: Personnel and laboratory hygiene, emergency planning, general hazards in a food laboratory, safety equipment, storage of chemicals, acids, flammables etc, handling and biological spills and waste disposal.	7	CO1	K2,K3,K4
II	**Principles of Food Preservation technology** Heat: Principles of Heat transfer, Blanching, Pasteurization, Heat sterilization, thermal extrusion, cooking. Water Removal: Forms of Water in Foods, Sorption of water in foods, Water activity, drying and evaporation technology. Temperature reduction: Chilling, Freezing, Radiation: Ionizing Radiation, Microwave, Use of chemicals: Class-I & Class-II preservatives, smoke other chemical additives, New non-thermal methods: High hydrostatic pressure, modified atmosphere, high intensity pulsed electric fields, intense pulsed light, oscillating magnetic fields,	10	CO2	K2 & K3

	hurdle technology, ultrasonic and ohmic heating etc.			
III	**Principles of Food Packaging technology** Effect of environment on food stability: light, oxygen, water, temperature, sensitivity to mechanical damage and attack by biological agents, Different packaging materials used for food packaging and their properties including barrier properties, strength properties, optical properties: Glass, metals, paper, plastics, biodegradable and edible films and coatings aseptic packaging and combinations, Selection of packaging material and design for various food commodities including fresh produce (Fruits and vegetables), milk and milk products (dairy), cereal, pulses, oil, meat, fish, poultry, water and processed foods, Evaluation of quality and safety of packaging materials- different testing procedures, Function of packaging: Protective packaging and active packaging smart and intelligent packaging, Newer packaging technologies-CAP/MAP packaging aseptic processing and packaging, irradiated packaging, retort pouch and microwaveable packaging.	10	CO3	K2,K3 & K4
IV	**Food Microbiology and testing** Introduction of Food microbiology: Classification and nomenclature of microorganisms. Morphology and structure of microorganisms in foods (yeast and Molds, Bacterial cells viruses), Important genera of mold, yeast, bacteria (Gram positive and Gram negative, facultative aerobic and anaerobic, endospore forming bacteria and non-sporulating bacteria), Bacterial groups (lactic acid, acetic acid, butyric acid etc.,), thermophilic, proteolytic, saccharomyticetc,	10	CO4	K2,K3,K4

	coliforms, faecal coliforms, enteric pathogens and emerging microbes, Sources of microorganisms in food chain (raw materials, water, air, equipment etc) and microbiological quality of foods, Microbial growth characteristics: Reproduction and growth (fission, generation time optimum growth, growth curve etc). Microbial growth in foods: intrinsic (pH, Moisture content, oxidation-reduction potential, nutrient content, antimicrobial constituents and extrinsic parameters (temperature of storage, relative humidity of environment, presence and concentration of gases in the environment, Thermal destruction of microorganisms: Thermal death time, D Value, Z-Value, F-Value, thermal death time curve, 12 D Concept, Microbial food spoilage and food borne diseases, food pathogens, bacillus *cereus and other bacillus species, campylobacter, clostridium species, Enterobacteriaceae, E. coli, listeria monocytogens, salmonella, shigella, staphylococcus aureus, vibrio species, yersinia enterocolitica, fungi, virus etc.,* Methods for the Microbiological examination of foods: Sampling activity and sampling plan, pure culture isolation: streaking, serial dilution and plating, cultivation, maintenance and preservation/stocking of pure culture, Observation of Indicator organisms: Direct examination, enumeration methods, plate count, MPN, biochemical test, Rapid methods detection of specific organisms.			
V	**HACCP and Food safety management systems:** ISO 22000: Importance of implementing a HACCP system and how it can be applied to various products.	7	CO5	K2,K3 & K6

	Prerequisite programs, HACCP principles, some limitation of HACCP food safety objective (FSO). Food safety audits: Management review, audit certification and importance. Good manufacturing practices (GMP), Good hygienic practices (GHP), Food safety plan, food safety management risk analysis. Traceability food products recall and sanitation.			

References:

- ISO 9001, Quality management systems – Requirements
- ISO 17034 General requirements for the competence of reference material producers
- ISO/IEC 17043 Conformity assessment – General requirements for proficiency testing.

Food safety standards authority regulation 2011.

Elective Paper-4

ENVIRONMENTAL BIOTECHNOLOGY

Paper – 4			
Title of the paper	ENVIRONMENTAL BIOTECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	1st	2nd	3

Learning Outcome:

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 successful completion of the course the students will be able to

CO-1	(K2) explain various waste management methods
CO-2	(K3) classify potential methods of biodegrading organic pollutants.
CO-3	(K4) examine the techniques involved in remediation of polluted environments
CO-4	(K5) assess types of pollution & its control
CO-5	(K6) compile biotechnological approaches to degrade xenobiotic compounds

SYLLABUS | Elective Paper-4 | ENVIRONMENTAL BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	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	7	CO1 CO5	K2
II	Biofilm Kinetics: Completely mixed biofilm reactor-Soluble microbial products and inert biomass-Special-case biofilm solution. Reactor types:- batch reactor - continuous-flow stirred-tank reactor- Plug-flow	7	CO1 CO2 CO5	K3

	reactor. Engineering design of reactors- Reactors in series			
III	Waste water management, source of waste water, Waste water treatment- physical, chemical and biological treatment. Microbiology of Waste water; Aerobic and anaerobic process, BOD and COD.	7	CO3	K4
IV	Toxicity: Types and Test for evaluating Toxicity. Biosensors, Biomonitoring of toxic materials .Biomagnification, Biomining and Biofuels	7	CO4	K5
V	Bioremediation; *In-situ and Ex-situ* Bioremediation of contaminated soils and waste land; Microbiology of degradation of Xenobiotics in environment; Pesticides, Surfactants, Degradative plasmids. Solid waste: Composting, Vermiculture and methane production.	7	CO5	K6

Reference Books:

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

Useful Websites:

- lbewww.epfl.ch/LBE/Default_E.htm
- http://lbe.epfl.ch

Non-Major Elective Paper-IA

VERMICULTURE TECHNOLOGY

NME-IA			
Title of the paper	VERMICULTURE TECHNOLOGY	Subject code:	
Category of the Course	Year	Semester	Credits
Elective Paper	I year	2nd	2

Learning Outcome:

The subject imparts knowledge on the importance of vermiculture and Vermicompost. The student will be provided with a basic knowledge and understanding about the procedure of vermiculture technology and applications of Vermicompost.

Course outcomes:

On successful completion of the course the students will be able to

CO-1	(K2) Understand the Vermiculture and 4R's of recycling.
CO-2	(K3) Identify the organic matter and Humus formation.
CO-3	(K4) Differentiate nutritional value of fertilizer and Vermicompost.
CO-4	(K5) Practice and handle vermicomposting
CO-5	(K6) Identification, harvest and transport

SYLLABUS | Non-Major Elective Paper-6 | VERMICULTURE TECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction, Definition, meaning and economic importance of vermiculture. Concept of Recycling and 4R's. (Reduce, Reuse, Recycle, and Restore)	2	CO1	K2
II	Introduction to matter, types and Humus. Humus Cycle.	2	CO1 CO2	K3
III	Introduction to fertilizers and their importance. Vermicompost as fertilizer and comparison with other fertilizers.	2	CO1 CO3	K4

IV	Vermicomposting: Vermibeds, types, preparation, composting conditions, and maintenance.	2	CO2 CO4	K5
V	Vermicompost identification, separation, Packing, Storage, and transport.	2	CO5	K6

Reference Books:

1. Rahudakar V.B (2004). Gandul khatashivay Naisargeek Paryay, Atul Book Agency, Pune.
2. Sultan Ahmed Ismail, 2005. The Earthworm Book, second Revised Edition. Other India Press, Goa,India. Bhatnagar & Patla, 2007.
3. Earthworm vermiculture and Vermin-composting, Kalyani Publishers, New Delhi.

Non-Major Elective Paper-IC

FOOD BIOTECHNOLOGY

NME-IC			
Title of the paper	FOOD BIOTECHNOLOGY	Subject code:	
Category of the Course	Year	Semester	Credits
Elective Paper	I year	2nd	2

Learning Outcome:

The subject imparts knowledge on the Food Science and Technology. The student will be provided with a basic knowledge and understanding about the Food groups, Nutrition, Fermented foods, and Techniques used for food safety.

Course outcomes:

On successful completion of the course the students will be able to

CO-1	(K1) Understand the Food science and Nutrition
CO-2	(K2) Identify the Food quality and processing
CO-3	(K3) Understand the role of enzymes in fermented and food processing
CO-4	(K4) Understand the food hazards and safety
CO-5	(K5) Knowledge of techniques used in food industry.

SYLLABUS | Non-Major Elective -IC| FOOD BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**Cos**	**Cognitive level**
I	Introduction to Food Science and Technology: Food chemistry, carbohydrates, proteins, lipids, vitamins, minerals. Nutrition, calorific value of foods, Diet and different types of diet.	2	CO1	K1
II	Standards for food analysis; identity, purity and methods (cereals, vegetables, fruits and dairy products) Food processing and preservation.	2	CO1 CO2	K2

III	Fundamentals of Food Biotechnology; Role of biotechnology in fermented food products (dairy products, oriental fermentations, alcoholic beverages, and food ingredients), Enzymatic processing of fruit juices. Role of enzymes in baking and meat processing.	2	CO3	K3
IV	Food Safety; Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues),	2	CO2 CO4	K4
V	Biotechniques; Applications of immunological techniques to food industry; Detection methods for pathogens from food samples, pesticide Residues, Newer sources of Ingredients.	2	CO4 CO5	K5

Reference Books:

1. Manay, S.; Shadaksharaswami, M., (2004). *Foods: Facts and Principles*, 4th Ed. New Age Publishers.
2. Meyer, (2004). *Food Chemistry*. New Age Publishers.
3. Ramaswamy H. and Marcott M. (2005), *Food Processing Principles and Applications*. CRC Press.
4. Byong H.Lee, (2015), *Fundamentals of food biotechnology*. Wiley-Blackwell.
5. Food safety by Laura K Egendorf, 2000.
6. Emerging technologies; food process by Da-wen, 2005.
7. Keith H. Steinkraus, (2004), *Industrialization of indigenous fermented foods*. CRC Press.

Core Paper-7

BIOINFORMATICS

Paper – 7			
Title of the paper	BIOINFORMATICS	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	3rd	5

Learning Outcome:

The paper imparts a thorough knowledge of the basics of bioinformatics tools. The student will get to understand the core concepts of in Silico biological research.

Course outcomes:

CO-1	To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis.
CO-2	Describe the history, scope and importance of Bioinformatics and role of internet in Bioinformatics.
CO-3	Explain about the methods to characterize and manage the different types of Biological data.
CO-4	Classify different types of Biological Databases.
CO-5	Introduction to the basics of sequence alignment and analysis

SYLLABUS | Core Paper-7 | BIOINFORMATICS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Database concepts, Introduction to internet and its application, Introduction to bioinformatics, Protein and nucleotide databases, Information retrieval from biological databases, Sequence alignment and database searching-similarity searches using BLAST and FASTA. Artificial Intelligence: Introduction to biological neural network, motivation for artificial neural network (ANN), Big data analysis - DNA/RNA/protein sequence or structure data, gene expression data, protein-protein interaction (PPI) data, pathway data and gene ontology (GO) data	10	CO1	K1 & K2

II	Sequence alignment basics, match, mismatch, similarity, scoring an alignment, gap penalty, protein vs DNA alignments, Dot-matrix alignment, pairwise alignment. Global and local alignment algorithms, multiple sequence alignment-progressive alignment and Iterative alignment algorithms, consensus sequence, patterns and profiles, Database searching: Pairwise alignment based rigorous algorithm (Smith and Waterman) and Heuristic algorithms (FASTA and Blast). Multiple sequence alignment based database searching. PSI- Blast, PAM and Blosum matrices	10	CO2	K2,K3 & K5
III	Bioinformatics for genome sequencing, EST Clustering and analyses, Finding genes in prokaryotic and eukaryotic genomes, Regulatory sequence analysis, Bioinformatics for Genome maps and markers, Bioinformatics for understanding Genome variation, Protein structure-X-ray crystallography, The protein databank and the PDBSum-SCOP, CATH, DALI and HSSP ;Visualization of molecular structures-RasMol and Pymol; Protein secondary structure prediction, Fold Recognition; Transmembrane topology prediction	10	CO3	K2 & K5
IV	Molecular visualization tools. Rasmol, Chime and Spdb viewer. Structure analysis tools. VAST and DALI, Structural biology - Homology modeling, Bioinformatics for micro array designing and transcriptional profiling, Bioinformatics for metabolic reconstruction, Bioinformatics for phylogenetic analysis	10	CO4	K4 & K5
V	Medical application of Bioinformatics. Disease genes, Drug Discovery. History. Steps in drug discovery.	10	CO5	K3,K4 & K6

	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			

Reference Books:

- DassanayakeS.Ranil, Y.I.N. Silva Gunawardene, 2011. Genomic and Proteomic Techniques, Narosa Publishing House Pvt. Ltd, New Delhi.
- Thiagarajan B, Rajalakshmi.P.A., 2009. Computational Biology, MJP publishers, Chennai.
- BosuOrpita, SimminderKaurThukral, 2007. Bioinformatics Databases, Tools and Algorithms, Oxford University press, New Delhi.
- Rastogi.S.C, Mendiratta.N, Rastogi.P, 2004. Bioinformatics methods and applications, Prentice-Hall of India private limited, New Delhi.
- Lohar s. Prakash, 2009. Bioinformatics, MJP Publishers, Chennai.
- Stephen misener and Stephen A. Krawetz., 2000. Bioinformatics methods and protocols, Humana press Inc, New Jersey.
- Durbin.R, S.Eddy, A.Krogh and G.Mitchison, 1998. Biological sequence analysis, Cambridge university press, Cambridge.

Core Paper-8

PLANT AND ANIMAL BIOTECHNOLOGY

Paper – 8			
Title of the paper	PLANT AND ANIMAL BIOTECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	2nd	5

Learning Outcome:

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:

CO-1	To impart theoretical knowledge on various techniques of plant biotechnology like tissue culture, plant genetic transformation and their application in industries.
CO-2	Importance of secondary metabolites and production in plants.
CO-3	To develop concepts, principles and processes in animal biotechnology.
CO-4	Concept and different types in Animal Cell Culture and animal cell lines.
CO-5	Use of molecular biology techniques genetically engineer the animals to improve sustainability, productivity and suitability for pharmaceutical and industrial applications.

SYLLABUS | Core Paper-8 | PLANT AND ANIMAL BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction of plant tissue culture, composition of media, Micropropagation, organogenesis, somatic embryogenesis, haploid and triploid production, protoplast isolation and fusion, hybrid and cybrid, synthetic seed production. Secondary metabolites in plants - Phytochemicals- Glycosides and Flavonoids; Anthocyanins and Coumarins - Lignans, Terpenes, Volatile oils and Saponins; Carotenoids and Alkaloids: biogenesis, therapeutic applications	10	CO1 CO5	K1,K2 &K3
II	Plant Transformation Direct transformation by	10	CO1	K1,K2 & K5

	electroporation and particle gun bombardment. Agrobacterium, Ti plasmid vector. Theory and techniques for the development of new genetic traits, conferring resistance to biotic and abiotic. Plant engineering towards the development of enriched food products, plant growth regulators; Molecular Marker aided breeding: RFLP maps, Linkage analysis, RAPD markers, STS Mirco satellite, SCAR, SSCP, QTL, Map based cloning and Molecular marker assisted selection.		CO2 CO5	
III	Animal health disease diagnosis, hybridoma technique, monoclonal antibodies, application of probes for disease diagnosis of existing and emerging animal diseases. Prophylaxis - Vaccines, Oral vaccines DNA Vaccines in animal disease. Cell culture: primary and established culture; organ culture; tissue culture	10	CO1 CO3 CO5	K4 & K5
IV	Disaggregation of tissue and primary culture; cell separation, Slide and coverslip cultures, flask culture, test tube culture techniques, cell synchronization, cryo preservation. Scaling up of animal cell culture, cell line and cloning micromanipulation and cloning, somatic cell cloning. Karyotyping; measuring parameters for growth, measurement of cell death, apoptosis and its determination, cytotoxicity assays	10	CO4 CO5	K2,K3,K4 & K5
V	Nuclear magnetic resonance methods of monitoring cell metabolism culturing animal cells in fluidised bed reactors. Application of animal cell culture for in vitro testing of drugs, in production of human and animal viral vaccines and pharmaceutical proteins. Culture Scale up and mass production of biologically	10	CO5	K3,K4 & K6

	important compounds. Harvesting of products, purification and assays. Transgenic animals: Production and application; transgenic animals in livestock improvement, transgenic animals as model for human diseases; Stem Cells- Properties, Types, Therapy, Prospects and Ethics in stem cell research.			

Reference Books

- Razdan. M. K., 2011. Plant tissue culture. Oxford and IBH publishing Company Pvt. Ltd, New Delhi.
- Chawla. H. S., 2010. Introduction to plant biotechnology. Oxford and IBH publishing company pvt. Ltd, New delhi.
- Ian Freshney, 2010. Culture of animal cells. 6th edition, Wiley-Blackwell publishers.
- Slater, 2008. Plant Biotechnology: The Genetic manipulation of plants, Second Edition, Oxford University Press, USA.
- J.D.Watson, Gillman, J.Witknowski and M.Zoller, 2006. Recombinant DNA. 3rd ed.
- W.H.Freeman. 26 K. Dass. 2005, Text book of Biotechnology, Second Edition, Wiley Dreamtech, India (P) Ltd.
- H.Kreuzer & A.Massey. 2001. Recombinant DNA and Biotechnology: A guide for teachers Second Edition. ASM press, Washington.
- M.Sudhir. 2000. Applied Biotechnology & Plant Genetics. Dominant publishers & Distributors.
- Genetic Engineering of Animals by (Ed) A.Puhler, VCH Publishers, Weinheim, FRG, 1993.
- Animal Cell culture Practical approach. Ed. John R.W.Masters, Oxford.2004.
- Concepts in Biotechnology D. Balasubramaniam, Bryce, Dharmalingam, Green, Jayaraman Univ. Press, 1996

Core Paper-9

BIOPROCESS TECHNOLOGY

Paper – 9			
Title of the paper	BIOPROCESS TECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	3rd	5

Learning Outcome:

The paper imparts a thorough knowledge on the basics of bioprocess and industrial fermentation. The student will get to understand the core concepts of fermentation and its commercial application.

Course outcomes:

The student will learn about the:

CO-1	(K2) Outline the basis of Bioprocess Engineering
CO-2	(K3) Relate reactors in fermentation
CO-3	(K4) Differentiate fermentation processes
CO-4	(K5) Assess Scale up and Scale down
CO-5	(K6) Compile the output of fermentation processes

SYLLABUS | Core Paper-9 | BIOPROCESS TECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to fermentation. General requirements of fermentation. Microbial growth kinetics of batch and continuous culture. Solid substrate, slurry fermentation and its application. Microbial cell culture. Immobilization of cells and enzymes. Food Safety: Introduction to food safety aspects and food related hazards – HACCP and ISO.	10	CO1	K1 & K2
II	Types of bioreactors: Submerged reactors, surface reactors, mechanically agitated reactors, non-	10	CO2	K2,K3 & K5

	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.			
III	Introduction to bioproducts and bioseparation. 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 liquid extraction, aqueous two phase extraction, supercritical fluid extraction.	10	CO3	K2 & K5
IV	Down Stream Processing: Chromatography Techniques, Membrane separation, ultrafiltration. Drying .Principles and operation of vacuum dryer, shelf dryer, rotary dryer, freezer and spray dryer. Crystallization and Whole broth processing.	10	CO4	K4 & K5
V	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.	10	CO5	K3,K4 & K6

Reference Books:

- Min-tzeLiong, 2011. Bioprocess Sciences and Technology. NovaScience Pub Inc.
- Michael L.Shuler, FikretKargi. 2003. Bioprocess Engineering. PHIpublishers.
- P.A.Belter, E.L.Cursler, and W.S.Hu. 1988.Bioseparation: Downstream processing for Biotechnology. John Wiley and sons.
- R.G. Harrison, P.Todd, SR.Rudge and D.P. Petrides. 2003.Bioseparation science and engineering. Oxford Press.

Useful Websites:

- www.wildfermentation.com/John Schollar and BenedikteWatmore, Practical Fermentation-a technicalguide

web.mit.edu/professional/short.../fermentation_technology.html

PRACTICAL-III

(Bioinformatics, Plant and Animal Biotechnology & Bioprocess Technology)

Title of the paper	PRACTICAL-III (Bioinformatics, Plant and Animal Biotechnology & Bioprocess Technology)	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	3rd	4

Learning Outcome:

The practical will establish a basic study skill on the subject and will improve the student's ability to calculate and improve their practical skill and knowledge.

Course outcomes:

CO-1	(K2) to learn the Bioinformatics tools for sequence retrieval and alignment
CO-2	(K3) to apply the learned tools for various applications
CO-3	(K4) to isolate, identify & enumerate immune cells
CO-4	(K5) to learn the technique of immunodiagnostics
CO-5	(K6) to study upstream & downstream techniques

SYLLABUS | PRACTICAL-III				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
A	**(A) Bioinformatics-practical** 1. Sequence retrieval from Genbank 2. Sequence retrieval from Uniprot. 3. Sequence identity search- Sequence similarity search using BLAST 4. Sequence similarity search using FASTA 5. Sequence similarity search using PSI BLAST 6. Sequence similarity search using PHI- BLAST. 7. Prediction of signal sequence using SignalP online tool 8. Pattern Search (Domains & Motifs) using Pfam 9. ORF gene Search - Genscan 10. Sequence translation using ExPASy translate tool 11. Characterization of retrieved protein sequence by ProtParam tool. 12. Pair-wise global sequence alignment using EBI-	15	CO1 CO2 CO3 CO4 CO5	K1,K2,K3,K4 &K5

	EMBOSS Needleman Wunsch tool 13. Pair-wise local sequence alignment using EBI-EMBOSS Smith Waterman tool 14. Multiple sequence alignment using EBI-CLUSTALW2. 15. PHYLOGENY- Phylogenetic tree using PHYLIP. 16. Prediction of secondary protein structure using GOR (Garnier Osguthorpe-Robson) server. 17. Prediction of tertiary protein structure using SWISS-MODEL Server 18. Validation of the predicted structure using PROCHECK server 19. Molecular visualization of proteins using RASMOL. 20. Docking of small molecule with protein structure using Hex software. 21. Docking of two proteins using PatchDock (Protein-Protein docking) tool. 22. Retrieval of E.Coli glycolytic pathway from KEGG			
B	**B) Plant and Animal Biotechnology - Practical:** 1. Plant tissue culture media preparation 2. Plant tissue culture sterilization techniques. 3. Generation of Callus from leaf 4. Generation of Callus from root 5. Generation of Callus from bud 6. Generation of Callus from shoot apex 7. Maintenance of callus culture. 8. Cell suspension culture 9. Anther culture 10. Pollen culture 11. Embryo culture. 12. Isolation of plant protoplast 13. Culture of plant protoplast. 14. Protoplast viability test. 15. Localization of nucleus using nuclear stain. 16. Agrobacterium culture maintenance and isolation	15	CO1 CO2 CO3 CO4 CO5	K2,K3,K4

	of plasmid DNA. 17. Mass culture of Chlorella /Spirulina 18. Introduction to Animal Cell culture: Procedure for handling cells and medium. 19. Cleaning and sterilization of glassware and plastic tissue culture flasks 20. Preparation of tissue culture media 21. Preparation of sera for animal cell culture 22. Preparation of single cell suspension from chicken liver (Primary cell culture). 23. Trypsinization of established cell culture. 24. Cell counting and viability - staining of cells (a) Vital Staining (Trypan blue, Erythrosin (b) Giemsa staining. 25. MTT Assay			
C	**(C) Bioprocess Technology – Practical** 1. Parts and design of fermenter 2. Solid state fermentation 3. Submerged fermentation 4. Foaming and antifoaming agents 5. Media preparation and sterilization 6. Isolation of industrially important microorganisms for microbial processes. 7. Conservation of Bacteria by Lyophilization. 8. Production and estimation of protease 9. Production and estimation of amylase. 10. Production of wine using grapes 11. Production of penicillin 12. Determination of penicillin activity 13. Citric acid production 14. Use of alginate for cell immobilization. 15. Media standardization (C:N ratio) for maximum biomass production of an industrially important microorganism. 16. Cell disruption (Sonication) 17. Aqueous Two Phase Extraction of enzymes	15	CO1 CO2 CO3 CO4 CO5	K2,K3,K4 & K5

Elective Paper-5

NANO BIOTECHNOLOGY

Paper – 5			
Title of the paper	NANO BIOTECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	2nd	3rd	3

Learning Outcome:

The subject imparts knowledge on the fundamentals of nanoparticles. The student will be provided with a basic knowledge and understanding about the role of nanoparticles in biotechnology.

Course outcomes:

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

SYLLABUS | Elective Paper-5 | NANO BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to Nanotechnology- Scientific revolution, Feynman's vision, Classification of nanobiomaterials -Types of nanomaterials – nanoparticles, nanotubes, nanowires, Nanofibers, Size deoendent variation in the properties of Nanomaterials, Nature's Nanophenomena.	7	CO1	K1
II	Preparation of Nanomaterials, Top down and bottom up approaches, Biosynthesis, Nanobiomaterials- Polymer, Ceramic, Metal based Nanobiomaterials, Carbon based Nanomaterials, DNA based Nanostructures, Protein based Nanostructures, Quantum dots, Magnetic Nanoparticles, Nanofibres, Hydrogels, Films and Scaffolds.	7	CO2	K4

III	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 and paints, Application of Nanotechnology in textile industry.	7	CO3	K1 & K5
IV	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 nanocarriers, Nanoparticle technologies for cancer therapy and diagnosis, Point of Care and Personalized medicine, Magnetic nanoparticles for imaging and Hyperthermia.	7	CO4	K2
V	Nanotoxicology, 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.	7	CO5	K5

Reference Books:

- Nanotechnology, S.Shanmugam, Mjp publication. 2011.
- Advanced nanomaterials, kurt E. geckeler, Hiroyuki Nishide , Wiley VHC.2010.
- Nanotechnology and tissue engineering. T.Laurencin, Lakshmi S. Nair, CRC press. 2012.
- Handbook of carbon nanomaterials. Francis D souza, Karl M. Kadish.
- World scientific publishing co. pte. ltd. 2011.
- Oded Shoseyov (Editor), Ilan Levy, 2010. NanoBioTechnology: BioInspired Devices and Materials of the Future, Humana Press.
- Chad A. Mirkin and Christof M. Niemeyer, 2007. Nanobiotechnology II: More Concepts and Applications, Wiley-VCH.
- Challa S.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag Gmbh & Co, KgaA.
- K.K.K.Jain 2006. Nanobiotechnology in Molecualr Diagnostics: Current Techniques and Applications Horizon Bioscience
- Niemeyer, C.M., Mirkin, C.A. (Eds). 2004. Nanobiotechnology Concepts, Applications and Perspectives, Wiley-VCH, Weinheim.
- Andrze w. Miziolek, Shashi P.Karna, J malthew Mauro and Richard A.Vaia. 2005 Defense Applications of Nanomaterials :
- Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag (2004)
- The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag (2004)
- Nanomaterials for medical diagnosis and therapy, Challa Kumar, Wiley-VCH, 2007.
- Nanotechnology for cancer therapy, Mansoor M. Amiji, CRC Press, 2007.
- K.K.Jain, Nano Biotechnology, Horizions Biosciences, 2006
- Nanomaterials: An introduction to synthesis, properties and application, Dieter Vollath, Wiley VCH, 2008
- Cato T. Laurencin and Lakshmi S. Nair, Nanotechnology and Tissue Engineering The
- Scaffold, CRC Press taylor& Francis Group.
- Introduction to Nanoscience and Nanotechnology, Gabor .L et al, Fundamentals of Nanotechnology, Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, CRC Press, 2009.
- Assessing Nanoparticle Risks to Human Health, Gurumurthy Ramachandran, Elesvier, 2011.
- Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010.
- Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, CRC Press, 2013

Useful Websites:

http://www.zyvex.com/nano www.fda.gov/nanotechnology/ www.nature.com/nnano/

Non-Major Elective Paper -II

Basic Tools in Biotechnology

NME-IIA			
Title of the paper	Basic Tools in Biotechnology	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	II year	IIIrd	3

Learning Outcome:

The subject imparts knowledge in basic aspects of biotechnology. Know the basic tools and techniques in Biotechnology.

Course outcomes:

On successful completion of the course the students will be able to

CO-1	(K2) Knowledge of genes and genomics
CO-2	(K3) Basics of genetic engineering.
CO-3	(K4) Tools and techniques of gene manipulation
CO-4	(K5) Methods used in screening and selection.
CO-5	(K6) Application of r-DNA tools in plant and animal biotechnology.

SYLLABUS | Non-Major Elective Paper-| Basic tools in Biotechnology				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Unit: 1 Gene and Genomes** Gene and genomes: Prokaryotic and eukaryotic genomes - structure and form. DNA as the genetic material. Extra chromosomal DNA - plasmid. Central dogma – DNA-RNA-Protein	2	CO1	K2
II	**Unit: 2 Cloning Vectors and rDNA Technology** Cloning vectors: Plasmid, phagemid, cosmid, artificial chromosomes - BAC. rDNA technology overview. Transformation techniques - CaCl2 transformation technique and electroporation.	2	CO1 CO2	K3
III	**Unit: 3 Tools for Gene Manipulation** Tools for gene manipulation: Restriction enzymes, DNA ligases, DNA modifying enzymes - alkaline	2	CO1 CO3	K4

	phosphatase, polynucleotide kinase, and terminal transferase. PCR, Gel Electrophoresis - AGE and PAGE.			
IV	**Unit: 4 Selection Strategy and Screening of Transformants** Selection strategy and screening of transformants: Selection of rDNA clones - Blue-White selection, Markers for selection - selectable and scorable - examples. Colony hybridization, western blotting, Southern blotting, and northern blotting.	2	CO2 CO4	K5
V	**Unit: 5 Application of rDNA Tools** Application of rDNA Tools: Cloning of insulin gene in bacteria, gene therapy, GMO -application and biosafety issues.	2	CO5	K6

Reference Books:

1. Primrose. S.B., Twyman R.M. (2014) Principles of Gene Manipulation and Genomics,7th Edition, Blackwell Science Limited.
2. Primrose .S.B (1994) Molecular Biotechnology., Blackwell Scientific Publishers, Oxford.
3. Alberts. B., Johnson. A.D., Lewis. J., Morgan. D (2014) Molecular Biology of the Cell.
4. Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
5. Old, R. W., Primrose, S. B., &Twyman, R. M. (2001). Principles of Gene Manipulation: an Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.

Brown T. A. (2016) Gene Cloning and DNA Analysis. An Introduction, 7th Edition Blackwell Scientific Publications.

Non-Major Elective Paper

ENVIRONMENTAL SCIENCES

NME-IIB			
Title of the paper	ENVIRONMENTAL SCIENCES	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	II year	III[rd]	3

Learning Outcome:

The paper imparts knowledge on the basics of 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.

Course outcomes:

On successful completion of the course the students will be able to

CO-1	(K2) Students understand the basics of Environment.
CO-2	(K3) Students understand the distribution of life and life forms on earth.
CO-3	(K4) Students will be aware of the basic structure and functions of ecosystem.
CO-4	(K5) Students understand the distribution and cycling of energy and matter in the Environment.
CO-5	(K6) Knowledge of different case studies, tragic Incidents.

SYLLABUS | Non-Major Elective Paper-6 | VERMICULTURE TECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Definition, Principle and Scope of Environmental Sciences. Earth, Man and Environment Interactions. Geographical Classification and Zones – Torrid, Temperate and Frigid Zones. Significance of Atmosphere, Lithosphere, Hydrosphere and Biosphere. Environmental Pollution: Definition and Types (Air, Water and Soil).	2	CO1	K2

II	**Air Pollution** - Sources and Classification of Air Pollutants - Sinks of Air pollutants – Automobile pollution in India - Zero emission standards. **Water pollution**; Classification of water pollutants, Ground water pollution, Sources and sinks, Eutrophication. **Soil pollution** Sources, sinks and broad classification, movement and sorption mechanisms of organic and inorganic contaminants and their impacts on physio-chemical and biological properties of soil and plants.	2	CO1 CO2	K3
III	Ecosystems and natural balance – biodiversity, Population and Growth trends, Animal and Human Population, Health related issues - Indoor and Outdoor air pollution, Persistent organic pollutants (POP's) Water borne infections (Salmonellosis, Cholera, Shigellosis) heavy metal related diseases (Cd-Itai-Itai, Hg-Minamata, Pb-Neurotoxin).	2	CO1 CO3	K4
IV	Bio energy – Definition, sources, types and characteristics - characteristics and energy content of coal, petroleum and natural gas. Energy use pattern in India and the world, emissions of CO2 in and global warming.	2	CO2 CO4	K5
V	Case Studies – London Smog, Minamata Disease, Love Canal, Bhopal Gas Tragedy, Chernobyl Disaster. Biodiversity – Definition, Concept and Types.	2	CO5	K6

Reference Books:

1. Environmental Science, Botkin, Keller (2012), John Wiley & Sons.
2. Environmental Science, G. Tyler Miller, Scott E. Spoolman (2014), Cengage Learning.
3. Environmental Pollution and its Control, Abbasi. S. A (1998), Cogent publications (P).
4. Environmental Pollution and its Control, Bhatia H.S (1998) ,Golgotia publications (P) Limited, New Delhi.
5. Air Pollution and Plant Life, (II ed.) Bell, J.N.B. (2002) John Wiley and Sons, New Delhi.
6. Air Pollution, Rao M.N and H.V.N Rao (1989, Tata Mcgraw Hill Publishing Co. Ltd,.
7. Soil and Noise Pollution, Sharma, B.K. and H. Kaur (1994) Goel Publishing House.
8. Water Pollution, Sharma, B.K. and H. Kaur (1994) Goel Publishing House.
9. Introduction to Bioenergy (Energy and the Environment) by Vaughn C. Nelson (Author), Kenneth L. Starcher (Author).
10. Bioenergy by Judy D. Wall and Caroline S. Harwood.
11. Bioenergy: Sustainable Perspectives by Ted Weyland.
12. Environmental Issues and Sustainable Development, S. C. Kalwar (2002), Pointer Publishers.

Non-Major Elective -IIC

BASICS IN PHARMACEUTICAL BIOTECHNOLOGY

Title of the paper	BASICS IN PHARMACEUTICAL BIOTECHNOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	1st	III	3

Learning Outcome:

The subject imparts knowledge on the fundamentals of pharmaceutical biotechnology and the pharmaceutical products produced based on biotechnological methods.

Course outcomes:

CO-1	Explain the basic components of pharmaceutical and biotechnology industry.
CO-2	Knowledge of Scientific, technical and economic aspects of vaccine
CO-3	Knowledge of production of antibodies and biotech products.
CO-4	Know basics of drugs and pharmacology.
CO-5	Knowledge about therapeutics and factors affecting drug action.

SYLLABUS |NME-IIC | BASICS IN PHARMACEUTICAL BIOTECHNOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
UNIT I	Drug- Structural feature and pharmacology activity. Ethno pharmacology: Scope, applications and Importance.	03 hours	CO1	K1
UNIT-II	Scientific, technical and economic aspects of vaccine development - Preparation of bacterial vaccines, Storage conditions and stability of vaccines, Methods of enzyme immobilization and applications.	03 hours	CO2	K3 & K4
UNIT – III	Hybridoma technology - Production, Purification and applications and formulation of biotech products - Penicillin, citric acid and Vitamin B12, Bio safety in pharmaceutical industry.	03 hours	CO3	K2

UNIT – IV	Pharmacological activity of Plant drugs in modern pharmacology; Drug improvement by structure modification and bio-transformation.	03hours	CO4	K2 & K4
UNIT-V	Clinical Pharmacology, Mechanism of drug action, Therapeutic efficacy, Therapeutic index, tolerance, dosage forms and routes of drug action. Factors affecting drug action and classification of drugs.	03 hours	CO5	K1,K2 &K5

Reference Books:

- Kayser, O and Muller R.H.. 2004. Pharmaceutical Biotechnology Drug Discovery and Clinical Applications. WILEY-VCH
- Stefania Spada, Garywalsh. 2004. Directory of approved biopharmaceutical
- Heinrich Klefenz. 2002. Industrial pharmaceutical biotechnology.
- John F. Corpenter (editor), Mark C. Manning. 2002. Rational Design of stable formulation Theory and Practice (Pharmaceutical Biotechnology). Plenum, US. Ist edition.
- D.I.A. Crommelin, et al., 2002. Pharmaceutical Biology. Amazon prime publications.

Useful Websites:

- https://tugasakhirsttifbogor.files.wordpress.com/2018/08/pharmaceutical-biotechnology.pdf
- http://library.nuft.edu.ua/ebook/file/Gad2007.pdf

INTERNSHIP

Title of the paper	INTERNSHIP	Subject code:	
Category of the course	Year	Semester	Credits
Paper	2nd	3nd	2

Learning Outcome:

To gain hands on training and expertise in handling sophisticated instruments and acquire in depth knowledge in their applications.

Course outcomes:

The student will learn to

CO-1	(K2) understand working principles and the techniques of various processes
CO-2	(K3) apply standard operating procedures followed in industries
CO-3	(K3) prepare to face challenges & gain confidence in the field of study.
CO-4	(K5) critically assess the utilization of sophisticated instruments and expensive consumables
CO-5	(K6) develop work ethics to be followed in a scientific laboratory

Core Paper-11

RESEARCH METHODOLOGY

Paper – 11			
Title of the paper	RESEARCH METHODOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	4th	5

Learning Outcome:

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:

CO-1	Understand the bases for research
CO-2	To know about research proposal and dissertation writing.
CO-3	To know about Statistical application in research
CO-4	To know about office tools used in research
CO-5	To know about search engines.

SYLLABUS | Core Paper-11 | RESEARCH METHODOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	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	10	CO1	K1
II	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	10	CO2	K2 &K6

	and Bibliography			
III	Standard Deviation- T test. Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; 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	10	CO3	K3
IV	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	10	CO4	K1 & K4
V	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	10	CO5	K1 & K2

Reference Books:

- Montgomery, Douglas C. (2007), 5/e, Design and Analysis of Experiments, (Wiley India).
- Montgomery, Douglas C. & Runger, George C. (2007), 3/e, Applied Statistics & Probability for Engineers (Wiley India).
- Kothari C.K. (2004), 2/e, Research Methodology- Methods and Techniques (New Age International, New Delhi).
- Krishnaswamy, K.N., Sivakumar, Appa Iyer and Mathiranjan M. (2006), Management Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi).
- The complete reference Office Xp – Stephan L. Nelson, Gujulia Kelly (TMH).
- Basic Computer Science and Communication Engineering – R. Rajaram (SCITECH).

Useful Websites

- www.ask.com/Methodology+Researchwww.qmethod.org/

Core Paper-12

BIOSTATISTICS

Paper – 12			
Title of the paper	BIOSTATISTICS	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	2nd	4th	3

Learning Outcome:

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

Course outcomes:

At the end of the Course, the Student will be able to:

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

SYLLABUS | Elective Paper-12 | BIOSTATISTICS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Statistics – Scope –collection, classification, tabulation of Statistical Data – Diagrammatic representation – graphs – graph drawing – graph paper – plotted curve –Sampling method and standard errors –random sampling – use of random numbers – expectation of sample estimates – means – confidence limits – standard errors – variance. Measures of central tendency – measures of dispersion – skewness, kurtosis, moments	7	CO1 CO2 CO3	K1,K2,K3 & K4
II	Correlation and regression – correlation table –	7	CO1	K1,K2,K3 & K4

	coefficient of correlation – Z transformation – regression – relation between regression and correlation. Probability – Markov chains applications – Probability distributions – Binomial (Gaussian distribution) and negative binomial, compound and multinomial distributions – Poisson distribution		CO2 CO5	
III	Normal distribution – graphic representation.– frequency curve and its characteristics –measures of central value, dispersion, coefficient of variation and methods of computation – Basis of Statistical Inference – Sampling Distribution – Standard error – Testing of hypothesis – Null Hypothesis –Type I and Type II errors	7	CO1 CO4 CO5	K1,K2,K3 & K4
IV	Tests of significance for large and small samples based on Normal, t, z distributions with regard to mean, variance, proportions and correlation coefficient – chi-square test of goodness of fit – contingency tables – c2 test for independence of two attributes – Fisher and Behrens 'd' test – 2×2 table – testing heterogeneity – r X c table – chi-square test in genetic experiments – partition X 2 – Emerson's method	7	CO1 CO2 CO3	K1,K2,K3 & K4
V	Tests of significance –t tests – F tests – Analysis of variance – one way classification – Two way classification, CRD, RBD, LSD. Spreadsheets – Data entry –mathematical functions – statistical function – Graphics display – printing spreadsheets – use as a database word processes – databases – statistical analysis packages graphics/presentation packages	7	CO1 CO2 CO4 CO5	K1,K2,K3 & K4

References Books:

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

Useful Websites:

- www.statsoft.com/textbook/ biosun1.harvard.edu/
- www.bettycjung.net/Statsites.htm
- www.ucl.ac.uk/statistics/biostatistics

DISSERTATION

Title of the paper	DISSERTATION	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	2nd	4th	7

Learning Outcome:

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

Elective Paper-6

STEM CELL BIOLOGY

Paper – 6			
Title of the paper	STEM CELL BIOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	2nd	4th	3

Learning Outcome:

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:

At the end of the Course, the Student will be able to:

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

SYLLABUS | Elective Paper-6 | STEM CELL BIOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	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	7	CO1	K1
II	Stem cell niche, Niche specification - Drosophila germ line stem cells. Receptors, genes and markers of stem cells	7	CO2	K1 & K2
III	Stem cell isolation and culture techniques. Characterization of stem cells	7	CO3	K3, K4
IV	Stem cell cycle. Chromatin modification and	7		K3,K3 & K5

	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		CO4	
V	Applications of Embryonic stem cells, Bone marrow stem cells, Adipose derived stem cells and Hematopoietic stem cells. Ethics in human stem cell research	7	CO5	K3,K4 & K5

Reference Books:

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