THIRUVALLUVAR UNIVERSITY

SERKKADU, VELLORE–632115

M.SC.,

BIO-TECHONOLOGY

SYLLABUS

FROM THE ACADEMIC YEAR

2023 – 2024

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc. BIO-TECHNOLOGY**
Programme Code	
Duration	**PG – 2 YEARS**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence**

	Possess knowledge of the values and beliefs of multiple cultures and a global perspective. **PO 10: Moral and ethical awareness/reasoning** Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes **(PSOs)**	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Template for P.G., Programmes

Semester–I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester–IV	Credit	Hours
1.1. Core-I	4	5	2.1. Core-IV	3	4	3.1. Core-VII	5	6	4.1. Core-XI	5	6
1.2 Core-II	4	5	2.2 Core-V	4	5	3.2 Core-VIII	5	6	4.2 Core-XII	5	6
1.3 Core – III	3	5	2.3 Core – VI	4	5	3.3 Core – IX	5	6	4.3 Project with viva voce	7	10
1.4 Core practical I	3	5	2.4 Core practical II	3	4						
1.5 Discipline Centric Elective -I	3	5	2.5 Discipline Centric Elective – III	3	4	3.4 Core – X	4	6	4.4Elective - VI (Industry / Entrepreneurship) 20% Theory 80% Practical	3	4
1.6 Generic Elective-II:	3	5	2.6 Generic Elective -IV:	3	4	3.5 Discipline Centric Elective - V	3	3	4.5 Skill Enhancement course / Professional Competency Skill	2	4
			2.7 NME I	2	4	3.6 NME II	2	3	4.6 Extension Activity	1	
						3.7 Internship/ Industrial Activity	2	-			
	20	**30**		**22**	**30**		**26**	**30**		**23**	**30**
Total Credit Points -91											

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits and Hours Distribution System for all Post – Graduate Courses including Lab Hours

First Year – Semester – I

Part	List of Courses	Credits	No. of Hours
	Core – I	4	5
	Core – II	4	5
	Core – III	3	5
	Core practical – I	3	5
	Elective – I	3	5
	Elective – II	3	5
		20	**30**

Semester-II

Part	List of Courses	Credits	No. of Hours
	Core – IV	3	4
	Core – V	4	5
	Core – VI	4	5
	Core practical – II	3	4
	Elective – III	3	4
	Elective – IV	3	4
	Skill Enhancement Course [SEC] - I	2	4
		22	**30**

Second Year – Semester – III

Part	List of Courses	Credits	No. of Hours
	Core – VII	5	6
	Core – VIII	5	6
	Core – IX	5	6
	Core (Industry Module) – X	4	6
	Elective – V	3	3
	Skill Enhancement Course - II	2	3
	Internship / Industrial Activity [Credits]	2	-
		26	**30**

Semester-IV

Part	List of Courses	Credits	No. of Hours
	Core – XI	5	6
	Core – XII	5	6
	Project with VIVA VOCE	7	10
	Elective – VI (Industry Entrepreneurship)	3	4
	Skill Enhancement Course – III / Professional Competency Skill	2	4
	Extension Activity	1	-
		23	**30**

Total 91 Credits for PG Courses

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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3. COURSE OF STUDY AND SCHEME OF EXAMINATIONS:

FIRST SEMESTER

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

FIRST SEMESTER

Core Paper-1

BIOCHEMISTRY

Paper – 1			
Title of the paper	BIOCHEMISTRY	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	1st	4

Learning Objectives:

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	15	CO1	K1&k2
II	Lipids: Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycol lipids. Cholesterol biosynthesis,	15	CO2	K1,K2 & K3

	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 as 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.	15	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	15	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	15	CO5	K1,K2 & K3

Reference books:

- Philip Kuchel, Simon Easterbrook-Smith, Vanessa Gysbers, Jacqui M. Matthews, 2011. Schaum.s Outline of Biochemistry, Third Edition (Schaum.s Outline Series), McGraw-Hill.
- 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

MOLECULAR GENETICS

Paper – 1			
Title of the paper	MOLECULAR GENETICS	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	1st	4

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-2 | MOLECULAR GENETICS				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Genes and chromosomes, Colinearity of Genes and Proteins, Genetic code, Identification of DNA as the genetic material. The complexity of eukaryotic genome (introns, exons, repetitive DNA sequence, gene duplication and pseudogenes). DNA markers - VNTR, STR, microsatellite, SNP and their detection techniques	15	CO1	K1,K2 & K3
II	Replication of DNA, Gene expression and regulation in prokaryotes and eukaryotes. Mutation: Spontaneous and virus induced mutation, Radiation	15	CO2	K1,K2 &K3

	induced mutation. Ionizing radiation, UV radiation. Chromosomal Abnormalities and associated genetic diseases, Techniques in the study of chromosomes and their applications, Recombination – models			
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). Mechanisms, control consequences and application of transposition by simple and complex elements	15	CO3	K1,K2 &K3
IV	Allele frequencies and genotype frequencies, Random mating population, Hardy-Weinberg principle, complications of dominance, special cases of random mating – multiple alleles, different frequencies between sexes (autosomal and X-linked) inbreeding, genetics and evolution, random genetic drift, Karyotyping and usefulness of chromosomes in understanding Genetic variation, Genetics of eukaryotes gene linkage and chromosome mapping.	15	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-	15	CO5	K1,K2 & K3

	Human Genome Project, Genomics and Modern methodologies in understanding genome.			

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-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	3

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	Introduction to cell Biology- Basic properties of cells- Cellular dimension-Size of cells and their composition-Cell origin and Evolution (Endosymbiotic theory)–Microscopy- Light Microscopy, Electron Microscopy, Application of Electron Microscopy in cell biology, Phase Contrast Microscopy, Fluorescence Microscopy, Flow Cytometry and FRET .Organelles of the eukaryotic cell and its functions; Biomembranes - structural organization, transport across membrane (Passive, Active and Bulk transport); Cell-Cell adhesion- Cell	15	CO1	K1,K2 &K3

	junctions (Tight junctions, gap junctions, desmosomes, adherens); Extra cellular matrix (ECM)-components and role of ECM in growth			
II	Structure of Nucleic acids, Genome organization in Eukaryotes, DNA Replication, Transcription, Translation and post translational Modification. Synthesis, sorting and trafficking of proteins: site of synthesis of organelle and membrane proteins – transport of secretary and membrane proteins across ER – post-translational modification in RER – transport to mitochondria, nucleus, chloroplast and peroxisome - protein glycosylation – mechanism and regulation of vesicular transport – golgi and post-golgi sorting and processing – receptor mediated endocytosis; Synthesis of membrane lipids.	15	CO2	K1,K2 &K3
III	Nucleus: Nuclear envelope – Nuclear pore complexes-nuclear matrix – organization of chromatin – supercoiling, linking number, twist - nucleosome and high order of folding and organization of chromosome(Solenoid and Zigzag model)-Global structure of chromosome –(Lamp brush and polytene chromosomes).	15	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).	15	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.	15	CO5	K1,K2 & K3

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- David E.Sadva., 2009. Cell biology organelles structure and function, CBS publishers and distributors, New Delhi.
- Prakash S. Lohar , 2009. Cell and Molecular Biology.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, 2007.,Molecular Biology of the Cell, Fifth edition. Garland Science.
- Lodish,H., Berk, A., Zipursky, S.L., Matsudaira, P., Kaiser, A., Krieger, Scott and Darnell, J. 2007. Molecular Cell Biology. Media Connected, sixth edition. W.H.Freeman and Company
- Geoffrey.M.Cooper, Robert.E.Hausman.2007.The Cell-A Molecular Approach, Fourth edition. Sinauer Associates. •
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- Paul A, 2001, Text Book Of Cell And Molecular Biology 2edition Niyogi Books •
- T.Fleming. 2002. Cell interactions: A practical approach Second edition.
- Alberts B, Molecular Cell Biology. 8. Casimeris et al., Lewin's cells. Jones and Bartlett.
- 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

Core Paper-4

PRACTICAL-I

(Biochemistry, Molecular Genetics & Molecular Cell biology)

Paper – 4			
Title of the paper	PRACTICAL-I (Biochemistry, Molecular Genetics & Molecular Cell biology)	Subject code:	
Category of the course	Year	Semester	Credits
Core Paper	1st	1st	3

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 | Core Paper-4 | 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 5. Preparation of biological buffer - phosphate buffer 6. Estimation of Proteins by Lowry's method/Biuret method/Bradford method 7. Estimation of RNA by orcinol method 8. Estimation of DNA by diphenylamine method	25	CO1 CO2 CO3 CO4 CO5	K3 & K4

	9. Estimation of Carbohydrate by Anthrone method 10. Separation of amino acids by Paper Chromatography 11. Separation of sugars by Paper Chromatography 12. Separation of amino acids by Thin layer chromatography 13. Separation of sugars by Thin layer chromatography **Demo Experiments** 1. Gel permeation chromatography, 2. Ion exchange chromatography			
B	**(B) Molecular Genetics - Practical** 1. Isolation of DNA from bacteria 2. Isolation of DNA from plants 3. Isolation of DNA from animal tissue 4. Isolation of DNA from blood 5. Plasmid DNA isolation. 6. Agarose gel electrophoresis of DNA 7. Isolation of RNA 8. Radiation induced genetic damage assessment 9. Chemical induced genetic damage assessment.	25	CO1 CO2 CO3 CO4 CO5	K3,K4 &K5
C	**(C) Molecular Cell Biology -Practical** 1. Introduction to Microtome and types 2. Microtomy-Fixation of tissue 3. Microtomy -Embedding 4. Microtomy-Sectioning of tissue 5. H&E Staining of tissues 6. Histochemical staining to localize proteins 7. Histochemical staining to localize carbohydrates	25	CO1 CO2 CO3 CO4 CO5	K3,K4 & K5

	8. Histochemical staining to localize lipids. 9. Subcellular fractionation and marker enzyme detection (mitochondria). 10. Giant chromosome studies in Chironomous larvae 11. Meiotic study in flower bud sand cockroach or grasshopper			

Elective Paper-1

BIOINSTRUMENTATION

Paper – 1			
Title of the paper	BIOINSTRUMENTATION	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	1st	1st	3

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.	15	CO1	K1 & K2
II	Centrifugation: Principle and Applications of various types of centrifugation, Sedimentation Coefficient, Svedberg unit, RCF, Density Gradient Centrifugation. Chromatography Techniques: Principle and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC &	15	CO2	K1, K2,K3

	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)	15	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	15	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.	15	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

ENZYMOLOGY

Paper – 3			
Title of the paper	ENZYMOLOGY	Subject code:	
Category of the course	Year	Semester	Credits
Elective Paper	1st	1st	3

Learning Outcome:

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

Course outcomes:

CO-1	(K2) Explain the basics of enzyme nomenclature and properties
CO-2	(K3) Classify and Cognize the native and immobilized enzyme
CO-3	(K4) Examine the equations of steady state kinetics
CO-4	(K5) Assess extraction and downstream processing of enzymes
CO-5	(K6) Compile the uses of enzymes and design enzymes for Industrial and Clinical application

SYLLABUS | Elective Paper-3 | ENZYMOLOGY				
Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Introduction to enzymes, Classification, nomenclature and general properties like effects of pH, substrate and temperature on enzyme catalysed reactions. Extraction Isolation and purification of enzymes by precipitation, centrifugation, chromatography and electrophoresis and liquid-liquid extraction methods	15	CO1 CO5	K3 & K5
II	Kinetics of catalysed reaction : Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics, line weaver burk plot, Hanes wolf equation, Eadie hoofstee equation ,Inhibition of enzyme activity	15	CO1 CO2 CO5	K3 & K5
III	Enzyme catalysis: enzyme specificity and the concept of active site, determination of active site.	15	CO1 CO3	K3 & K4

	Stereospecificity of enzymes. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis			
IV	Theories on mechanism of catalysis.-Mechanism of enzymes action: mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymerase. Multienzymes system, Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complex	15	CO1 CO4	K3, K4 & K6
V	Coenzyme action. Enzyme regulation: General mechanisms of enzyme regulation, Allosteric enzymes, sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Reversible and irreversible covalent modification of enzymes, Immobilized enzymes and their industrial applications.Clinical and industrial applications of enzymes, Enzyme Engineering	15	CO1 CO5	K3,K4, K5 & K6

Reference Books

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

Useful Websites

- www.lsbu.ac.uk/biology/enztech/
- www. lsbu.ac.uk/biology/enzyme/
- http://www.aetlted.com/tech/applications.html