PROGRAMME GUIDE

MASTER OF SCIENCE (BIOTECHNOLOGY)

SESSION 2020-2021

- **Scheme of Examination**
- **Detailed Syllabus**

DR. C.V.RAMAN UNIVERSITY

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Deputy Registrar (Academic)
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DEPARTMENT OF BIOTECHNOLOGY

INTRODUCTION

This programme is offered by the department of Biotechnology as an effective program targeting the students who wish to pursue research and development in the field of Bacteriology, Virology, Immunology, Parasitology, Fermentation, Mycology, Phycology, Industrial microbiology, Agriculture and Food Microbiology or higher studies in the field of Microbiology. It offers in depth knowledge of teaching and research programs in diverse areas of microbiology viz Bacterial Microbiology, Enzymology, Applied Microbiology. The programs of MSc in Microbiology is a fulltime postgraduate degree program of a period of 2 years distributed in 4 semesters containing 20 credites per semester and 80 total credites in 4 semesters as per the norms and guidelines prescribed by UGC. The program consists of 4 courses of theory papers and 2 courses practical laboratories in each semester upto 3rd semester and 2 courses of theory papers and one laboratory with one major project work in its fourth semester along with appropriate incorporation of the core, Elective and discipline specific electives as the course attributes in a well defined manner in the curriculum. The programs of M.Sc. in Microbiology. Is a full-time Postgraduate degree program of a period of 2 years distributed in 4 semesters containing 20 credits per semester and 80 total credits in 4 semesters as per the norms and guidelines prescribed by UGC. The program consists of 4 courses of Theory papers and 2 courses of practical laboratories in each semester upto 3rdsemester and 2 courses of theory papers and one laboratory with one major project work in its fourth semester along with appropriate incorporation of the Core, Elective & Discipline Specific Electives as the course attributes in a well defined manner in the curriculum. The M.Sc. program of Dr. C. V. Raman University targets to prepare its students as ready to work.

VISION

To develop the department of biotechnolgy as a center of excellence for research and knowledge resource. To promote understanding the Inter-Intra discipline research activity and competence building. To promoting Quality research in faculty of Life-Science discipline and scientific temperament.

MISSION

- To make quality Pre and Post Ph.D. education accessible to all sector of Society including Tribal Population of Chhattisgarh.
- To provide quality education in Inter and Intra discipline of Zoology,Botany, Microbiology and Biotechnology.
- To develop human resource with International class competence and skills in respective discipline.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO's):

- The objective of the Master's programme in Biotechnology is to equip the students to apply the knowledge of Microbes and their uses in different field.
- The laboratory training and Pathogenicity analysis of microbes in Microbiology. prepare the students for their careers in the Medical and industrial area.

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- The student have a knowledge of different culture Skill viz Blood culture, Urin –Culture , Pus culture . Identification of microbes and their causing diseases and control to develop own Business, marketing and self employment.
- The students are work on mushroom cultivation, algal fuel production, ethanol production.
- The goal is to impart student the knowledge and skills which are contemporary and useful to them as well as for society. The student will write the standard operating protocols (SOPs) and identify requirement for experimental Microbes, ethics and welfare.
- Large scale production of microbes through fermentation process and uses of their secondary metabolites (Byproducts) in different field.

Program Name: M.Sc.(BIOTECHNOLOGY):

Program Outcomes (PO's)

[PO.1.] **Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking & actions.

[PO.2.] **Effective communication:** Speak, read, write & listen clearly in person and through electronic media in English and in one Indian Language, and make meaning of the world by connecting people, ideas, books, media and technology.

[PO.3.] **Social interaction:** Elicit views of others, mediate disagreements and help reach conclusions in group settings.

[PO.4.] **Effective citizenship:** Demonstrate empathetic social concern and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

[PO.5.] **Ethics:** recognize different value systems including your own, understand the moral dimensions of decisions and accept the responsibility for them.

[PO.6.] **Environment and sustainability:** Understand the issues of environmental contents and sustainable development in terms of biotechnology.

[PO.7.] **Self-directed and long-life learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-economic and socio technological changes & develop an aptitude for continuous learning and professional development with ability to engage in biotechnological practices and education program.

[PO.8.] **Knowledge:** Provide basic knowledge for understanding the principles and their applications in the area of biotechnology, Instrumentation & Technology.

[PO.9.] **Technical Skills:** Develop an ability to use various instruments and equipment with an indepth knowledge on standard operating procedures for the same.

[PO.10.] **Research & Development:** To Demonstrate knowledge of identifying a problem, critical thinking, analysis and provide rational solutions in different disciplines of Biotechnology & biotechnological Sciences.

[PO.11.] **Modern Tool Usage:**Develop appropriate technique, resources and IT tools for prediction and modelling to complex issues of Biotechnobiology.

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[PO.12.] **The Society:** Apply regional biotechnological reasoning informed by the con.textual knowledge to comprehend and receive instructions on safety and the consequent responsibilities relevant to the society as well as social well being.

[PO.13.] **Problem analysis**

[PO.14.] **Conduct investigations of complex problems**

[PO.15.] **Design/Development of Solutions**

[PO.16.] **Individual and Teamwork**

Program Name: M.Sc.(BIOTECHNOLOGY):

Program specific outcomes (PSO's)

PSO1-Industry applications of better understanding of the key principles of biochemical functioning at an advanced level

PSO2-To get better awareness of the major issues at the forefront of the discipline of Biotechnology.

PSO3-Possess an in-depth understanding of the area of Biotechnology &biochemistry chosen for research emphasis

PSO4-ability to design and carry out experiments (safely) and to interpret experimental data

PSO5-production of substantial original research of significance and quality sufficient for publication of ability to present their work through written, oral, and visual presentations, including an original research proposal awareness of ethical issues in biochemical & Biotechnological research and careers options.

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MASTER OF SCIENCE (BIOTECHNOLOGY)

Duration: 24 Months (2Years)

Eligibility: Graduation with Science Subjects

COURSE STRUCTURE M.SC BIOTECHNOLOGY SEMESTER Ist													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks				
Theory Group													
6SMBT101	Core Course	Cell Biology & Biomolecules	100	50	17	20	08	30	12	4	-	-	4
6SMBT102	Core Course	Tools And Techniques	100	50	17	20	08	30	12	4	-	-	4
6SMBT103	Core Course	Microbial Physiology	100	50	17	20	08	30	12	4	-	-	4
6SMBT104	Core Course	Genetic Engineering	100	50	17	20	08	30	12	4	-	-	4
Practical Group				Term End Practical Exam		Lab Performance		Sessional					
6SMBT105	Practical	LAB 1	50	25	08	-	-	25	08	-	-	2	2
6SMBT106	Practical	LAB 2	50	25	08	-	-	25	08	-	-	2	2
	Grand Total		500							16	-	4	20

Minimum Passing Marks are equivalent to Grade D **L- Lectures T- Tutorials P- Practical**

Major- Term End Theory / Practical Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/ Lab Performance Assignment 50%

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COURSE STRUCTURE M.SC BIOTECHNOLOGY SEMESTER IInd

Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks				
Theory Group													
6SMBT201	Core Course	Biostatistics And Computer Application	100	50	17	20	08	30	12	4	-	-	4
6SMBT202	Core Course	Molecular Biology	100	50	17	20	08	30	12	4	-	-	4
6SMBT203	Core Course	Environmental Biotechnology	100	50	17	20	08	30	12	4	-	-	4
6SMBT204	Core Course	Macromolecules and Enzymology	100	50	17	20	08	30	12	4	-	-	4
Practical Group				Term End Practical Exam		Lab Performance		Sessional					
6SMBT205	Practical	LAB 1	50	25	08	-	-	25	08	-	-	2	2
6SMBT206	Practical	LAB 2	50	25	08	-	-	25	08	-	-	2	2
Skill Courses								Sessional					
	Skill Enhancement	Skill EnhancementElective Course-1	50	-	-	-	-	50	20	1	-	1	2
	Grand Total		550							17		5	22

Minimum Passing Marks are equivalent to Grade D **L- Lectures T- Tutorials P- Practical**

Major- Term End Theory / Practical Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/Lab Performance Assignment 50%

Skill Elective I – Any other course being offered in this semester as per the list given at the end of course structure.

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COURSE STRUCTURE M.SC BIOTECHNOLOGY SEMESTER IIIrd													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
				Major		Minor		Sessional***					
Course Code	Course Type	Course Title	Total Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	L	T	P	Subject wise Distribution
Theory Group													
6SMBT301	Core Course	Animal Biotechnology	100	50	17	20	08	30	12	4	-	-	4
6SMBT302	Core Course	Biology of Immune System	100	50	17	20	08	30	12	4	-	-	4
****	Discipline Specific Elective	Elective –I (Select anyone from below given Elective-I)	100	50	17	20	08	30	12	4	-	-	4
****	Discipline Specific Elective	Elective –II (Select anyone from below given Elective-I)	100	50	17	20	08	30	12	4	-	-	4
Practical Group				Term End Practical Exam		Lab Performance		Sessional					
6SMBT311	Practical	LAB 1	50	25	08	-	-	25	08	-	-	2	2
6SMBT312	Practical	LAB 2	50	25	08	-	-	25	08	-	-	2	2
Skill Courses								Sessional					
	Skill Enhancement	Skill EnhancementElective Course-1	50	-	-	-	-	50	20	1	-	1	2
	Grand Total		550							17	-	5	22

Minimum Passing Marks are equivalent to Grade D **L- Lectures T- Tutorials P- Practical**

Major- Term End Theory / Practical Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/ Lab Performance Assignment 50%

Skill Elective I – Any other course being offered in this semester as per the list given at the end of course structure.

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COURSE STRUCTURE M.SC BIOTECHNOLOGY SEMESTER IVth

Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional ***		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks				
Theory Group													
****	**Discipline Specific Elective**	Elective –III (Select anyone from below given Elective-I)	100	50	17	20	08	30	12	4	-	-	4
****	**Discipline Specific Elective**	Elective –IV (Select anyone from below given Elective-I)	100	50	17	20	08	30	12	4	-	-	4
Practical Group				**Term End Practical Exam**		**Lab Performance**		**Sessional**					
6SMBT409	**Practical**	LAB-I	50	25	08	-	-	25	08	-	-	2	2
6SMBT410	**Practical**	LAB-II	50	25	08	-	-	25	08	-	-	2	2
6PRSC401	**Research Component**	Project/Internship/Field work & Viva Voce	200	100	33	-	-	100	40	-	-	8	8
	Grand Total		**500**							**8**	**-**	**12**	**20**

Minimum Passing Marks are equivalent to Grade D **L- Lectures T- Tutorials P- Practical**

Major- Term End Theory / Practical Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/ Lab Performance Assignment 50%

Compulsory Project/Dissertation with choice in any Disciplinary specific elective. Compulsory one paper presentation certificate in related dicipline.

PROJECT

All the candidates of M.Sc. (**biotechnology**) are required to submit a project-report based on the work done by him/her during the project period. A detailed Viva shall be conducted by an external examiner based on the project report. Students are advised to see the detailed project related guidelines on the website of RNTU. (www.rntu.ac.in) under Project Guidelines for student section.

Outcome-The student will identify a problem on which he/she would be able to work, identify the scope of research on the chosen topic and will frame the objectives to be addressed in the project through a w

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SPECILIZATION WITH ELECTIVE

***Note** - Students need to select any one group and choose any two subjects from selected group for third and fourth semester.

Electives for Third Semester			Electives for Fourth Semester		
Course Code	Course Type	List of Electives	Course Code	Course Type	List of Electives
GROUP ELECTIVE -I Name – biotechnology			**GROUP ELECTIVE -III Name – biotechnology**		
6SMBT303	Discipline Specific Elective-1	Bioprocess Engineering & Technology	6SMBT401	Discipline Specific Elective-3	Enzyme Technology
6SMBT304	Discipline Specific Elective-1	Bacterial Genetics	6SMBT402	Discipline Specific Elective-3	Bioinformatics
6SMBT305	Discipline Specific Elective-1	Clinical Pathology	6SMBT403	Discipline Specific Elective-3	Clinical Biochemistry
6SMBT306	Discipline Specific Elective-1	Traditional Cancer Therapies	6SMBT404	Discipline Specific Elective-3	Pharmaceutical Biotechnology
GROUP ELECTIVE -II NAME: biotechnology			**GROUP ELECTIVE -I V Name – biotechnology**		
6SMBT307	Discipline Specific Elective-2	Medical Biotechnology	6SMBT405	Discipline Specific Elective-4	Microbial Techniques
6SMBT308	Discipline Specific Elective-2	Food Microbiology	6SMBT406	Discipline Specific Elective-4	Biological Chemistry
6SMBT309	Discipline Specific Elective-2	plant biotechnology	6SMBT407	Discipline Specific Elective-4	Ethics, Patenting &Bioentrepreneurship
6SMBT310	Discipline Specific Elective-2	Food Science & Technology	6SMBT408	Discipline Specific Elective-4	Genomics, Proteomics & Biosafety

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SKILL ENHANCEMENT ELECTIVE COURSES

Non-Technical			
Elective No.	**Department/ Faculty Name**		
	Faculty of Information Technology		
I	SCIT 201	Data Entry Operation	2(1+0+1)
II	SCIT 301	Multimedia	2(1+0+1)
III	SCIT 501	Web Designing with HTML	2(1+0+1)
IV	SCMIT 201	Web Development	2(1+0+1)
V	SCMIT 301	LINUX	2(1+0+1)
	Faculty of Management		
I	SMGT 201	Briefing and Presentation Skills	2(1+0+1)
II	SMGT 301	Resolving Conflicts and Negotiation Skills	2(1+0+1)
III	SMGT 802	Entrepreneurship Development	2(1+0+1)
	Faculty of Commerce		
I	SCOM 201	Tally ERP 9	2(1+0+1)
II	SCOM 302	Multimedia	2(1+0+1)
III	SCOM 803	Data Analyst	2(1+0+1)
	Faculty of Humanities		
I	SHBA 301	Pursuing Happiness	2(1+0+1)
II	SHBA302	Communication Skill and Personality Development	2(1+0+1)
III	SHMA301	Tourism in M.P	2(1+0+1)
	Faculty of Science		
I	SSBI 301	Mushroom Cultivation	2(1+0+1)
II	SSPH 301	House Hold Wiring	2(1+0+1)
III	SSPH 301	Basic Instrumentation	2(1+0+1)
IV	SSPH 301	DTP Operator	2(1+0+1)
V	SSCH 301	Graphic Designing	2(1+0+1)
	Faculty of Education		
I	SCBE 403	Understanding of ICTC (Information Communication Technology)	2(1+0+1)
II	SCPE 201	Yoga Education	2(1+0+1)

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SEMESTER - 1st | **Subject Code:6SMBT101**
Course: M.Sc. Biotechnology | **Theory Max. Marks: 50**
SUBJECT:Cell Biology&Biomolecules | **Theory Min. Marks: 17**

Objective- Students will understand the structures and purposes of cellular components.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Cell theory 2. Structure of prokaryotic and eukaryotic cells 3. Diversity of cell size and shape diversity of prokaryotic cell and eukaryotic cell. 4. Cellular organelles- plasma membrane, cell wall, their structural organization, mitochondria, chloroplast nucleus, and other organelles and their organization. 5. Transport of nutrients, ions and macromolecules across membranes. 6. Cell cycle – molecular events and model systems	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Cellular responses to environmental signals in plants and animals – mechanism of signal transduction. 2. Cell motility – cilia, flagella of eukaryotes and prokaryotes 3. Biology of cancer 4. Biosynthesis of proteins in eukaryotic cell, co and post translational modification, intracellular protein traffic. 5. Cellular basis of differentiation and development – mitosis, gametogenesis and fertilization.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Chemical foundations of biology – pH, pK, acids, bases, buffers, weak bonds, covalent bonds. 2. Principles of thermodynamics. 3. Amino acid and peptides – classification, chemical reactions and physical properties 4. Sugars – classification and reactions. 5. Hetrocyclic compounds and secondary metabolites in living systems – nucleotides, pigments, isoprenoids.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Lipids – classification and separation, purification and criteria of homogeneity, end group analysis, hierarchy in structure, ramachandran map. 2. Polysaccharides – types structural feature, method and compositional analysis. 3. Analytical techniques in biochemistry and biophysics for small molecules and macromolecules for quantitation.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Nucleic Acid: Structure of purine and pyrimidine bases, nucleoside and nucleotide; DNA. 2. Structure and conformation; RNA - Structure, types and functions.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- Students will be able to explain the basic concepts of cell biology and biomolecules.

Books:

- Gerald Karp - Cell and Molecular Biology 5th Edition (2007)
- Geoffrey M. Cooper; Robert E. Hausman - The Cell: A Molecular Approach (2009)
- E. J. Ambrose and Dorothy M. Easty, Second Edition (1977), Book Society and Nelson.
- C.B. Powar – Cell Biology Third Edition, reprint (2005), Himalaya Publishing House.
- Tortora,Funke and Case – Microbiology: An introduction 6th Edition (1998)Binjamin/Cummings Publishing Co.
- Lewis J. Klein smith and Valerie M. Kish - Principles of cell and molecular biology –
- Third Edition (2002)
- P. K. Gupta – Cell and molecular biology, Second Edition (2003), Rastogi publications.
- Lodish et al., Molecular cell Biology, 6th Edition, W.H. Freeman & Company, 2008.
- Nelson and Cox – Principles of Biochemistry, 5thedition (2009)
- Albert L. Lehninger – Biochemistry, Second Edition (2005).
- Todd and Howards Mason – Text book of Biochemistry, Fourth Edition (2004).
- Jeremy M. Berg, John L. Tymoczko and LubertStryer – Biochemistry, 6thedition (2007)
- Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
- Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil - Harper's Illustrated Biochemistry, 28th Edition (2007)

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, Biotechnologist, molecular biologist	Genetic engineering	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab

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SEMESTER - 1st | **Subject Code:6SMBT102**
Course: M.Sc. Biotechnology | **Theory Max. Marks: 50**
SUBJECT:Tools And Techniques | **Theory Min. Marks: 17**

Objective-The use of biological processes or organisms for the improvement of the characteristics of plants, animals.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Principles and application of microscopy, centrifugation, chromatography, electrophoresis, HPLC. 2. Principle and application of colorimetry, spectrophotometry and densitometry 3. RIA and autoradiography in biology, ELISA	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Methods in microbiology – pure culture techniques, theory and practice of sterilization, principle of microbial nutrition, construction of culture media 2. Principle and application of thermocycler, DNA sequencer	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Principle and application of DNA microarray 2. Fluorescence spectroscopy 3. NMR and X-ray diffraction	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Principle and application of cytophotometry. 2. Flow cytometry 3. Sothern, northern and western blotting	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Centrifugation: Principle, techniques. Preparative, analytical and ultracentrifuges, sedimentation coefficient. Application of centrifugation. 2. Radioactivity: GM counter, liquid Scintillation counter, solid Scintillation counter, gamma counters.Autoradiography: applications.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome-Providing powerful and useful tools, in a continuum of technical evolution that contributes or could contribute to the improvement of crop production.

Books:-

- K. Wilson and J. Walker: Principle and Techniques of Biotechnology and Molecular Biotechnology.
- Upadhya and Upadhya: Biophysical Chemistry.
- David, L. Nelson and Michael, M. Cox: Lehniger: Principal of Biochemistry. 4th Edition. W.H. Freeman and Company, New York.
- J.F. Griffiths, William M. Gelbart, Richard C. Lewontin and Jeffrey H.
- Miller; Modern Genetic Analysis; Publisher: W. H. Freeman
- Ralf Pörtner; Animal cell biotechnology: methods and protocols; Humana Press

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician,molecular Biotechnologist,immunologist	HPLC and chromatography instruments handling.	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Molecular diagnostic center, lab technician,

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SEMESTER - 1st | **Subject Code:**6SMBT103
Course: M.Sc. Biotechnology | **Theory Max. Marks: 50**
SUBJECT:Microbial Physiology | **Theory Min. Marks: 17**

Objective- The objective of this course are to learn the fundamentals of molecular microbial physiology.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. The beginning of microbiology, discovery of the microbial world, 2. Microbial evolution, systematics and taxonomy – new approaches to bacterial taxonomy, nomenclature and bergy,s manual.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Microbial growth – the definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields 2. Metabolic diversity among microorganisms – photosynthesis in microorganism role of chlorophylls, carotenoids and phycobillins, calvin cycle, nitrogen metabolism, nitrogen fixation. 3. Prokaryotic cells, structure and function – cell wall of eubacteria (peptidoglycan) and related molecule, outer membrane of gram negative bacteria, cell wall and cell membrane synthesis,	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Algae, fungi, slime moulds and protozoa, viruses, bacterial, plant, animal and tumor viruses, discovery, 2.DNA viruses, example of herpes, pox adenoviruses, reteroviruses.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Viruses: Structure and classification of viruses; morphology and ultra structure; capsids and their arrangements, types of envelopes, viral genome, their types and structure, virus related agents (viroids, prions). 2. Bacteriophages (MS2, X174, M13, T3, T4). Lysogeny and Lytic phase. General account of plant and animal viruses	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Microbial diseases – infectious diseases transmission, respiratory infections caused by bacteria and viruses, tuberculosis, sexually transmitted diseases including AIDS 2. Chemotherapy/ antibiotics – antibiotics and antimicrobial agents, broad spectrum, antibiotics, antibiotics from prokaryotes, antifungal antibiotics, mode of action, resistance to antibiotics.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- study of how microbial cell structures, growth and metabolism function in living organisms.**Books**:

- General Microbiology, Stainer, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. The Macmillanb Press Ltd.
- Brock Biology of Microorganisms, Madigan, M.T. Martinko, J.M. and Parker, J. Prentice-Hall.
- Microbiology, Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R. Tata mcgrawHill (2009)
- Microbial Genetics, Maloy, S.R., Cronan, J.E. Jr.AndFreifelder, D. Jones, Bartlett

Publishers.

- Microbiology- a Laboratory Manual, Cappuccino, J.G. and Sherman, N. Addison Wesley.
- Microbiological Applications, (A Laboratory Manual in General Microbiology) Benson, H.J. WCB: Wm C. Brown Publishers.
- Microbiology: Lansing Prescott, John Harley, and Donald Klein; mcgrawHil 5th Edition (2001)
- Microbiology -Tortora, Funke and Case; 10th Edition Pearson Education Benjamin Cummings publishers

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician,molecular Biotechnologist,immunologist, microbiologist	Medical microbiology	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Molecular diagnostic center, lab technician,

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SEMESTER - 1st | **Subject Code:**6SMBT104
Course: M.Sc. Biotechnology | **Theory Max. Marks: 50**
SUBJECT: Genetic Engineering | **Theory Min. Marks: 17**

Objective- The objective of this process is to introduce the physiological and physical or characteristics.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Scope of genetic engineering. 2. Molecular tools and their application: restriction enzyme, modification enzyme, DNA and RNA markers. 3. Gene cloning vectors: plasmids, bacteriophages, phagemid, cosmids, artificial chromosomes. 4. C-DNA synthesis and cloning: mRNA enrichment, reverse transcription, DNA primer, linker, adaptor and their chemical synthesis, library construction and screening.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Site- direct mutagenesis and their protein engineering. 2. DNA transfection, southern blot, western blot, primer extension, s1 mapping, RNAse protection assay, and reporter assay. 3. Processing of recombinant protein: purification and refolding, characterization of recombinant protein, stabilization of protein.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Gene knockout, gene augmentation, gene correction/gene editing, gene regulation and silencing. 2. T – DNA, identification and isolation of genes through t – DNA or transposon, targeted gene replacement. 3. Gene therapy: vector engineering. Strategies of gene delivery-viral & non-viral,	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Mendel and genetics; Mendel's laws of genetics; physical and chemical basis of Heredity 2. Gene- Type of genes, Prokaryotic, Eukaryotic 3. Fine structure of gene – coding sequences, satellite DNA; rearrangement in DNA, Central dogma. 4. Operon concept; DNA methylation. 5. Mutation;; Type of mutation, changes in chromosome number and structure, Euploidy and Aneuploidy, mutagens – UV; 6. Extra chromosomal inheritance 7. Genes and quantitative tracts; genotypes and phenotypic distribution; genes. 8. Genetic disorder and syndromes.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Bacterial genetic system: Transformation, conjugation, transduction, recombination, plasmids and transposon. 2. Virus and their genetic system: Phage I and its life cycle; 3. Genetic system of yeast and Neurospora. 4. Genetic recombination: Mechanism of crossing over, molecular mechanism of recombination, role of Rec-A and Rec-B,C, D enzyme. 5. Site specific recombination. 6. linkage, linkage group, genetic marker.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- Genetic engineering eliminates and has an array of technical and ethical concerns that make it not feasible.

Books:-

- Genetics; Benjamin Pierce; W. H. Freeman
- Modern Genetic Analysis; Anthony J.F. Griffiths, William M. Gelbart, Richard C.
- Lewontin and Jeffrey H. Miller; W. H. Freeman
- Principles Of Genetics; Eldon John Gardner, Michael J. Simmons, D. Peter Snustad;
- Wiley India Pvt Ltd
- Principles of Gene Manipulation and Genomics; SANDY PRIMROSE and RICHARD
- TWYMAN; Wiley-Blackwell
- Philip m. Gilmaritin – molecular plant biology edition (2005), oxford university press.
- Ta brown – gene cloning and DNA analysis, 4th edition (2005).
- Rusell and peter – genetics edition (2002), pearson education, inc, san francisco.

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- Old and primrose –principles of gene manipulation 6th edition (2001).
- B.d. singh – biotechnology: an expanding horizons, 1stedition (2004).
- W.h. elliott and d. C. Elliott – biochemical and molecular biology iind edition (2001).
- Eldon johngardner, michael j. Simmons and peter snustad – principles of genetics eigth edition (1991), john wiley and sons, inc.
- Benjamin lewin – genes ix, 9th edition (2007) pearson education inteRNAtional.
- Hdkumar – modern concepts of biotechnology third repring edition (2003), vikas
- Brown ta, genomes, 3rd ed. Garland science 2006
- James dwatson, richard m. Myers, amy a. Caudyandjan a. Witkowski recombinant DNA: genes and genomes 3rd edition; wh freeman 2007
- Sandy primrose and richardtwyman - principles of gene manipulation and genomics 7th edition; wiley-blackwell 2006

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, molecular Biotechnologist, Genetic engineer	Genetic engineer , gene mapping	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	molecular diagnosis lab, gene therapy

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SEMESTER- 1st
Course: M.Sc. Biotechnology
SUBJECT:Laboratory I

Subject Code: 6SMBT105
Practical Max. Marks: 25
Practical Min. Marks: 08

Experiments based on the paper 1(Cell Biology & Biomolecules) & Paper 2 (Tools & Techniques)

List of practical

1. To prepare the temporary standard slide of onion blub to peel to study the structure of plant cell.
2. To prepare the temporary stained slide of cheek squamous epithelial cells of the mouth of human beings.
3. Preparation and study of slide of mitosis using from onion root tips squash.
4. Schedule for study of mitotic index.
5. To determine the abnormal mitotic index.
6. Preparation and study of slide for meiosis using young anthers of aliumcepa.
7. To determine the meiotic index in the flower bud of aliumcepa.
8. Qualitative test for carbohydrate. (molisch's test)
9. Qualitative test for carbohydrate. (anthrone test)
10. Qualitative test for carbohydrate. (benedict test)
11. Qualitative test for carbohydrate by barfoed test.
12. Qualitative test for amino acid by ninhydrin reaction.
13. Qualitative test for amino acid by xanthoprotic reaction.
14. Qualitative test for proteins using biuret test.
15. Qualitative test for amino acid by milliom's test.

List of practical

1. Preparation of different culture media for culture of various microorganism like bacteria, fungi, yeast, actinomycetes, algae etc.
2. Perform the various culture techniques for microbial culture
3. Perform various laboratory techniques like – centrifugation, chromatography, spectrophotometry, electrophoresis etc.
4. Pure culture techniques of microbes from various sources perform the advance biotechnological techniques like ELISA, PCR, southern blotting etc.

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SEMESTER- 1st | **Subject Code:**6SMBT106
Course: M.Sc. Biotechnology | **Practical Max. Marks: 25**
SUBJECT:Laboratory II | **Practical Min. Marks: 08**

Experiments based on the paper 3 (Microbial Physiology) & Paper 4 (Genetic Engineering)

List of practical:

1. Preparation of liquid or solid media for growth of microorganisms.
2. Isolation and maintenance of organism by plating, streaking, serial dilution, methods, slant and stab cultures, storage of microorganisms.
3. Isolation of pure culture from soil and water.
4. Growth and growth curve, measurement of bacterial population by turbidity and serial dilution methods. Effect of ph, temperature and carbon nitrogen sources on growth.
5. Microscopic examination of bacteria, yeast and molds and study of organisms by gram stain, acid fast stain and staining for spores.
6. Study of mutations by Ames test.
7. Assay of antibiotics and demonstration of antibiotic resistance.
8. Analysis of water for probability and determination of MPN.
9. Bacterial transformation.
10. Biochemical characterization of selected microbes.
11. Transduction.
12. One step growth curve of bacteria.

List of practical

1. Extraction of DNA from *E.coli.* Bacteria.
2. Estimation of bacterial DNA by spectrophotometer methods.
3. Separation of bacterial genomic DNA by agarose gel electrophoresis.
4. Hot phenol method for preparation of total cellular RNA from *E.coli.*
5. Estimation of cellular RNA by spectrophotometer method.
6. Restriction digestion of DNA with restriction enzymes.
7. Ligation of DNA.
8. Isolation of plasmid DNA from *e.coli.*
9. DNA amplification by PCR.
10. Expression for Mendel's experiments.
11. Studies of prokaryotic & Eukaryotic cells.
12. Karyo-type studies.
13. Mutation in Bacteria.
14. Plasmid mutation.

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SEMESTER – 2nd **Subject Code:** 6SMBT201
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT:Biostatistics And Computer Application **Theory Min. Marks: 08**

Objective- The basic objective of this course is to get familiar with biostatistics and computers.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Introduction to data structure and database concepts, Brief description and tabulation of data and its graphical representation. 2. Measures of central tendency and dispersion: mean, median, mode, range standard deviation, variance, idea of two types of errors and level of significance.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Simple linear regression and correlation. 2. Test of significance (F & T test), chi-square test.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Cumulative frequency distributions. Random sampling. Parameters and statistics. Data transformations: Log-transformation, Square-root transformation. 2. Probability and frequency. Multiple-sample hypothesis (ANOVA): Single factor and two factors ANOVA.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Introduction to digital computers: organization, low level and high level languages, binary number system. 2. Flow charts and programming techniques.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Introduction to internet and its application. 2. Introduction to MS-office software, covering word processing, spreadsheets and presentation software. 3. Bioinformatics and biotechnology – an overview.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- Students will be able to understand biostatistics and apply in research.

Books:

- Animesh K. Dutta: Basic Biostatistics and Its Application. New Central Book Agency (P) Ltd. Kolkata.
- P.K. Banerjee: Introduction to Biostatistics. S. Chand & Company Ltd.
- C.S.V. Murthy (2003) Bioinformatics. First Edition, Himalaya Publishing House.
- S.C. Rastogi, NamitaMendiratta, ParagRastogi (2003) Bioinformatics: Concepts, Skills and Applications, CBS Publishers and Distributors, New Delhi.
- C. Subramanian (2004) A Text Book of Bioinformatics. Dominant Publishers and Distributors, New Delhi.
- David W. Mount (2005) Bioinformatics: sequence and genome analysis. Second edition. CBS Publishers and Distributors, New Delhi, Bangalore (India).

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, computer operator, data analyst	Computer, statistics	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Quality analyst

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SEMESTER – 2nd | **Subject Code:6SMBT202**
Course: M.Sc. Biotechnology | **Theory Max. Marks: 50**
SUBJECT:Molecular Biology | **Theory Min. Marks: 08**

Objective- Molecular biology deals with nucleic acids and protein and how these molecules interact within the cell to promote proper growth division and development.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Introduction to Molecular Biology 2. DNAReplication– Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication. Enzymes and accessory proteins involved in DNA replication. 3. DNA Repair and Recombination. Homologous recombination – Holiday junction,	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Transcription – Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors. 2. Translation – Prokaryotic and Eukaryotic translation, 3. The translation machinery, Mechanisms of initiation, elongation and termination,	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Oncogenes and Tumor Suppressor Genes – Viral and cellular Oncogenes. 2. Tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Antisense and Ribozyme technology – Molecular mechanism of Antisense molecules. 2. Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Application of RFLP in forensic, disease prognosis, genetic counseling, etc.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Protein Localization – Synthesis of secretary and membrane proteins, Import into nucleus, mitochondria, chloroplast and peroxisomes. 2. Receptor mediated endocytosis.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- Molecular biology gives you in-depth knowledge of biological and/or medicinal processes through the investigation of the underlying molecular mechanisms.

Books:

- Gerald Karp - Cell and molecular biology, 5thEdition (2007)
- Lewis J. Klein smith and Valerie M. Kish - Principles of cell and molecular biology – Third Edition (2002)
- Richard M. Twyman-Advanced Molecular Biology, First South Asian Edition (1998),Viva Books Pvt. Ltd.
- Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
- J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
- TA Brown – Genomes 2nd Edition; Bios Scientific Publishers 2002
- Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, HiddePloegh and Paul Matsudaira – Molecular Cell Biology, 6th Edition; WH Freeman 2008

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, molecular Biotechnologist	DNA sequencing	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	molecular diagnosis lab,

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SEMESTER – 2nd **Subject Code:**6SMBT203
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT:Environmental Biotechnology **Theory Min. Marks: 08**

Objective- One of the main objectives of environmental biotechnology is the conservation of resources via the recycling of waste materials.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Environment: Basic concepts and issues. 2. Environmental pollution: Type of pollution, 3. Air pollution and its control through Biotechnology.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Water pollution and its control: waste water treatment – physical, chemical, biological processes. 2. Microbiology of waste water treatments, aerobic process; Activated sludge, oxidation ditches, trickling filter, rotating discs, rotating drums, oxidation ponds. 3. Anaerobic process: Anaerobic digestion, anaerobic filters,	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Treatment schemes for waste water of dairy, distillery, tannery, sugar, antibiotic industries. Bioremediation. 2. Xenobiotics in Environment- Ecological considerations, oil pollution, surfactants, pesticides.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Global Environment problems: Ozone depletion, UV-B, green house-effect and rain, their impact and biotechnological approaches for management. 2. IPR.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Biodegradation of cellulose lignins and hydrocarbons (superbug). 2. Composting, treatment of solid wastes. 3. Bioaccumulation of metals and detoxification	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- Environmental biotechnology is a system of scientific and engineering knowledge related to the use of microorganisms and their products in the prevention of environmental pollution through biotreatment of solid, liquid, and gaseous wastes, bioremediation of polluted environments and biomonitoring of environment and treatment processes.

Books:-

- Gareth G. Evans, Judy Furlong - Environmental Biotechnology: Theory and Application 2nd Edition; John Wiley and Sons 2011
- Hans-Joachim Jördening, Josef Winter - Environmental biotechnology: concepts and applications; Wiley-VCH 2005
- InduShekhar Thakur – Environmental Biotechnology: Basic concepts and Applications. First Edition (2006). I. K. InteRNAtional Pvt. Ltd.
- A.K. Chatterji – Introduction to Environmental Biotechnology. First Edition (2002). Prentice Hall of India Pvt. Ltd. New Delhi.
- ManojTiwari, KapilKhulbe and ArchanaTiwari – Environmental Studies. First Edition (2007), I. K. InteRNAtional Publishing House Pvt. Ltd.
- H.D. Kumar – Modern Concepts of Biotechnology Third repring Edition (2003), Vikas Publishing House. Pvt. Ltd.
- B.D. Singh – Biotechnology: Expanding Horizons, 1st Edition (2004). Kalyani Publishers.
- Alan Scragg – Environmental Biotechnology First Edition, reprinted (2005). Oxford University Press.

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, environmental biotechnologist, pollution controller	Environmentalist, bio fertilizer, composting, IPR	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Composting and fertilizing, research and development

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SEMESTER – 2nd
Course: M.Sc. Biotechnology
SUBJECT:Macromolecules and Enzymology

Subject Code: 6SMBT204
Theory Max. Marks: 50
Theory Min. Marks: 08

Objective- This course will introduce the general structure and function of the biological macromolecules. Basic knowledge of enzyme kinetics, the parameters of the enzymatic reaction.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Macromolecules – Types of macromolecules in biological systems 2. Sequencing of proteins and nucleic acids.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Protein – protein and protein – ligand interactions, 2. Conformational properties of polynuleotides and polysaccharides	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Enzyme catalysis in solution – kinetics and thermodynamic analysis, 2. Physical and chemical methods for immobilization of enzyme. 3. Glyco and lipoproteins – structure and function	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Ribozymes and Catalytic antibodies – Functional proteins – structure and drug targets (enzymes and receptors) 2. Nucleic acid hybridization – structural and biological study.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Carbohydrate metabolism: glycolysis, gluconeogenesis, glycogenolysis, glyconeogenesis. 2. Protein metabolism: urea cycle, deamination, transamination. 3. Fat metabolism: β-oxidation.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- Students will gain an enhanced overall understanding of macromolecules and enzymology.

Books:

- Nelson and Cox – Principles of Biochemistry, 5thEdition (2009) Albert L. Lehninger – Biochemistry, Second Edition (2005).
- Todd and Howards Mason – Text book of Biochemistry, Fourth Edition (2004).
- Jeremy M. Berg, John L. Tymoczko and LubertStryer – Biochemistry, 6th Edition (2007)
- Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
- Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W.
- Rodwell, P. Anthony Weil - Harper's Illustrated Biochemistry, 28th Edition (2007)

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, biotechnologist	Protein and dna sequencing	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	research and development

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SEMESTER- 2nd
Course: M.Sc. Biotechnology
SUBJECT:Laboratory I

Subject Code:6SMBT205
Practical Max. Marks: 25
Practical Min. Marks: 08

Experiments based on the paper 1(Biostatistics & Computer Application) & Paper 2 (Molecular Biology)

Biostatistics

1. Calculate the mean value of given leaves.
2. Calculate the median of the given sample of leaves.
3. Find out the mode value of given leaves.
4. To complete correlation of leaf length & breadth of a given leaf sample.
5. To perform the t-test for the given data of sample. (Leaves)
6. To perform the Chi- Square test for the given data.
7. To calculate Standard deviation from the data (Sample).

Computer

1. Formulation of Basic Programs on Q basic
2. Writing basic programs on C
3. Draw Histogram, Pie, Graph, Line graph.
4. Data management
5. Slide preparation
6. Use of Internet.
7. To perform spreadsheet application.

List of Practical:-

1. Extraction of DNA from plant leaves by CTAB methods.
2. Estimation of plant genomic DNA by Spectrophotometer methods.
3. Separation of plant genomic DNA by Agarose gel electrophoresis.
4. Extraction of DNA from animal cells.
5. Estimation of animal genomic DNA by Spectrophotometer methods.
6. Separation of animal genomic DNA by Agarose gel electrophoresis.
7. Separation of Bacterial proteins by vertical SDS-PAGE electrophoresis.
8. Extraction of RNA from Yeast cells.
9. Estimation of Yeast cellular RNA by Spectrophotometer methods.

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SEMESTER- 2nd | **Subject Code:**6SMBT206
Course: M.Sc. Biotechnology | **Practical Max. Marks: 25**
SUBJECT:Laboratory II | **Practical Min. Marks: 08**

Experiments based on the paper 3(Environmental Biotechnology) & Paper 4 (Macromolecules & Enzymology)

List of practical's:-

1. To determine the Total dissolved solids of water (TDS).
2. Determination of Dissolved oxygen (DO) of water.
3. Determination of chemical oxygen demand (COD) of water.
4. Determination of Biological oxygen demand (COD) of water.
5. To Screen the antagonism between *Trichoderma* sp. And *Curvularia* sp.
6. Determination of effect of fungicide on the growth of fungi (*Trichoderma* sp.).
7. Effect of fungicide on the antagonism between *Trichoderma* sp. And *Curvularia* sp.
8. To determine the Most Probable Number (MPN) of a given water sample.

List of Practical:-

1. Qualitative assay of Protein by the Biuret method.
2. To estimation of Protein Qualitatively by Folin Lowry Method.
3. Estimation of cholesterol by the method of Crawford
4. Determine the activity of Alkalie Protease.
5. Determine the activity of neutral Protease.
6. Effect of temperature on the activity of α-amylase.
7. Determine the activity of catalase.
8. Determine the activity of urease.
9. Perform protein isolation by SDS PAGE.
10. Enzyme kinetics

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SEMESTER – 3rd
Course: M.Sc. Biotechnology
SUBJECT:Animal Biotechnology

Subject Code:6SMBT301
Theory Max. Marks: 50
Theory Min. Marks: 17

Objective- Is to reduce the environmental impact of livestock farming.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Animal cell: Structure & organization. 2. Equipments& materials for animal cell culture. 3. Primary & established cell line culture. 4. Constituent of culture media & their applications.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Biology and characterization of the cultured cell, measuring parameters of growth. 2. Basic technique of mammalian cell culture in vitro; disaggregating of tissue and primary culture; maintenance of cell culture; cell separation. 3. Application of animal cell culture.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Cell synchronization: Cell growth stages. 2. Cell transformation: Characteristics of transformed cells.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Transgenic animals: Mice, Sheep, Birds and Fish. 2. Apoptosis. 3. Tissue engineering: Elementary idea of tissue engineering, Artificial skin & cartilage.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Cell cultured based vaccines: general introduction, vaccines for malaria and AIDS. 2. Somatic cell genetics. 3. Ethical issues in relation to animal biotechnology.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- Animal biotechnology introduces applications of animal biotechnology and implications for human future prospects.

Books:-

- Animal Cell Culture, Practical Approach: RW Masters; Oxford University Press 2000
- Animal cell biotechnology: Ralf Pörtner; Humana Press 2007
- Animal Cell Culture Techniques, M Clynes.
- Animal Cell Biotechnology methods and Protocols. Nigel Jenkins. Humana Press, Totowa, New Jersey.
- B.D. Singh, (2004) Biotechnology. Expending Horizons.FirstEdition.Kalyani Publishers, Ludhiana.
- U. Satyanarayana (2005) Biotechnology. Books and Allied (P) Ltd., Kolkata.

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, biotechnologist	Animal tissue culture, single cell protein, tissue engineering	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	research and development, transgenic animal production, animal organ culture, single cell protein production

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SEMESTER – 3rd
Course: M.Sc. Biotechnology
SUBJECT:Biology of Immune System

Subject Code: 6SMBT302
Theory Max. Marks: 50
Theory Min. Marks: 17

Objective- Describes surface membrane barriers and their protective functions.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Introduction – Phylogeny of immune system, innate and acquired immunity 2. Nature and biology of antigen and super antigens. 3. Antibody structure and function; antibody engineering. 4. Antigen – Antibody interaction.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Major histocompatibility complex. 2. BCR &TCR, generation of diversity. 3. Cells of immune system- Hematopoiesis and differentiation, Lymphocyte trafficking, B-lymphocyte, T-lymphocyte, Macrophages, Dendritic cells, Natural killer and lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Activation of B & T- lymphocyte; cytokines and their role in immune regulation; T-cell regulation, **2.** Cell- mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Complement system 2. Hypersensitivity – early and delayed type 3. Autoimmunity and autoimmune disease	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Transplantation: General concept and application. 2. Immunity to infectious agents (intracellular parasites, helminthes and viruses). AIDS and their immunodeficiencies. 3. Hybridoma technology and Monoclonal antibodies.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- Physicians often observe immune system improvements in health on a clinical level.

Books:-

- J. Kuby – Immunology 5thEdition; W.H. Freeman and Company, New York 2003
- Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby – Immunology, 6th Edition; WH Freeman 2007
- Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt - Roitt's Essential Immunology,
- 11th Edition; Wiley-Blackwell 2006
- H.D. Kumar – Modern Concepts of Biotechnology 3rd Edition (2003), Vikas Publishing House. Pvt. Ltd.
- K. Banerjee and N. Banerjee –Fundamental of Microbiology and Immunology, First Edition (2006). New Central Book Agency (P) Ltd. Kolkata.
- Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical publishing, 2002.
- Abul K. Abbas, Andrew H. Lichtman, & Shiv Pillai; Cellular and Molecular immunology; Elsevier Inc

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, biotechnologist, Immunologist	Monoclonal antibody,	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	research and development, Monoclonal antibody production, health advisor

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SEMESTER – 3rd **Subject Code:** 6SMBT303
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT: elective 1 Bioprocess Engineering & Technology **Theory Min. Marks: 17**

Objective- the course provides the basics of microbiology to build a foundation for more advanced studies in biotechnology.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Introduction to Bioprocess Engineering. 2. Isolation, Preservation and maintenance of industrial microorganism. 3. Media for industrial fermentation. 4. Air and Media sterilization.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. General Considerations: Fermentation biotechnology – An historical perspective. 2. metabolic pathways and metabolic control mechanisms	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Types of fermentation processes: Bioreactors- Analysis of batch, fed-batch and continuous bioreactors. 2. Downstream processing: Introduction, Removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane process, Drying and crystallization,	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. Whole cell immobilization and their industrial applications. 2. Industrial production of chemical: Alcohol (ethanol), Acids (citric acetic and gluconic), solvent (glycerol, acetone, butanol), Antibiotic (penicillin, streptomycin, tetracyclin), Amino acid (lysine, glutamic acid).	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Introduction to food technology: Elementary idea of canning and packing, sterilization and pasteurization of food product. 2. Scale up, instrumentation control, Bio-sensors in bio-process monitoring and control.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- Analyze and identify Limiting factors in a bioprocess and propose solutions to address biological and engineering problems.

Books:-

- Shuler ML andKargi F, Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
- Stanbury and Whittaker – Principles of Sterilization techniques, First Indian reprint Edition (1997). Aditya Book (P) Ltd. New Delhi
- Michael J. Waites - Industrial microbiology: an introduction 7th Edition; Wiley-Blackwell 2008
- Damien and Devies – Microbial Technology Edition (1994).
- LE Casida – Industrial Microbiology Edition (1994)
- H Patel – Industrial Microbiology 4th Edition (2003).
- KS Bilgrami and AK Pandey – Introduction to Biotechnology Edition 2nd (1998).
- U Satayanarayan – Biotechnology, First Edition (2005) Books and Allied (P) Ltd. Kolkata.
- Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, quality controller, quality analyst	Ethanol production, antibiotics production, single cell protein	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Bioprocessing industries,biochemical production, research and development, food processing industries, SCP production

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SEMESTER -3rd **Subject Code:** 6SMBT304
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT: Elective 1-BACTERIAL GENETICSTheory **Min. Marks: 17**

Objectives: The purpose of the course is to teach the students about basics and advanced concepts of bacterial Genetics and ensuring that students acquire an extensive and sound knowledge base for future studies.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	**Gene transfer in bacteria :** History; Transduction – generalized and specialized; Conjugation – F, F', Hfr; F transfer; Hfr-mediated chromosome transfer; Transformation – natural and artificial transformation.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	Merodiploid generation; Gene mapping; Transposable genetic elements; Insertion sequences; Composite and Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	**Bacteriophages:** Bacteriophage–structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	**Plasmids :** plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	**Restriction-modification systems :** History; Types of systems and their characteristics; Methylation dependent restriction systems; applications. Regulation of gene expression in bacteria	ICT & Green Board based Class Room Teaching, individual presentation

Outcomes: After the completion of the course, the students would acquire the knowledge of plasmid bacteriophage and gene transfer in bacteria. They would learn advanced techniques of restriction modification . They would also be acquainted with methodological concepts and tools needed to acquire top-level skills in the field of bacterial genetics.

Texts/References:

- S.R. Maloy, J.E. Cronan, D. Friefelder, Microbial Genetics, 2nd Edition, Jones and Bartlett Publishers, 1994.
- N. Trun and J. Trempy, Fundamental Bacterial Genetics, Blackwell publishing, 2004.
- Hartl L D and Jones B, Analysis of genes and genomes, 3rd Edition, Jones and Bartlett Publishers, 1994.
- S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, Biotechnologist, molecular biologist	Genetic engineering	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab

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SEMESTER – 3rd
Course: M.Sc. Biotechnology
SUBJECT: elective 1 clinical pathology

Subject Code:6SMBT305
Theory Max. Marks: 50
Theory Min. Marks: 17

OBJECTIVES:

- To understand basic histology and cytology.
- To learn different method involved in the processing of tissue
- To understand the principle of various test at pathology lab

Units	Unit Wise Course Content	Methodology Adopted
Unit I	**INTRODUCTION TO HISTOLOGY** Cell, Organelles, nucleus, cell division, tissues, fresh & fixed tissues. Differenttypes of Embedding Viz. Wax, Resin, Cryostat, receiving of specimens Theuse of Microscope, screening techniques.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	**BASIC CYTOLOGY** Fixation of tissue, different kind of fixatives, sample fixative, compound fixative, formaldehyde, mercusic chloride, osmium, Picric acid, alcohols, other acids, formaline, buffered fomaline, osmic acid, zenleer soln, hely's soln, cytological fixatives, nuclear fixatives, fixation of smear etc., decalcification, method of decalcification, assessment of decalcification, solution for decalcification.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	**PROCESSING OF TISSUE** dehydration, impregnation in the wax, manual and automatic tissue processor,gelatin embedding, celloidin embedding, double embedding, cytologicalfixatives, preparation of different smears, vaginal, sputum, membrane.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	**DIAGNOSTIC TECHNIQUES USED IN PATHOLOGY** Histopathology, Cytopathology, Hematopathology, Immunohistochemistry,Microbiological examination, Biochemical examination, Cytogenetics, Moleculartechniques, Autopsy	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	**CLINICAL PATHOLOGY** Theory of Urine examination a. Physical b. Chemical c. Microscopic, Examination of body fluids, cell counts, Semen analysis, Cerebrospinal Fluid (CSF), Stool examination.	ICT & Green Board based Class Room Teaching, individual presentation

OUTCOMES:

- Student will learn basic histology and cytology.
- learn different and understand method involved in the processing of tissue
- learn and understand the principle of various test at pathology lab

REFERENCE:

- Advances in Clinical Chemistry. Latner, A.L. and Schwartz, M.K. (Eds.).Academi 1998. Annual volumes. Biochemical Basis of Pediatric Disease.Soldin, S.J., Rifai, N., Hicks, J.M.B., 3rd edition, American Association for Clinical Chemistry, 1998. Cases in Chemical Pathology: A DiagnosticApproach. Walmsley.

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, Biotechnologist, molecular biologist	biochemist	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab

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SEMESTER – 3rd | **Subject Code:**6SMBT306
Course: M.Sc. Biotechnology | **Theory Max. Marks: 50**
SUBJECT: elective 1 traditional cancer therapies | **Theory Min. Marks: 17**

OBJECTIVES:

the aim of the study is to know about:

- The basics of cancer its types and the etiology of cancer
- The several diagnostic method for several types of cancer
- The traditional and advanced therapy for the cancer treatment

Units	Unit Wise Course Content	Methodology Adopted
Unit I	**CANCER BASIC CONCEPT** introduction of cancer biology and cancer genetics, intra and extra cellular control of cell division, programmed cell death (apoptosis), intrinsic and extrinsic pathways of cell death, necrosis, malignancies, metastasis, apoptosis in relation with cancer.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	**CANCER: EPIDEMIOLOGY AND ETIOLOGY** awareness and challenges faced by cancer patients, different types of cancer,lung, liver, prostate, breast, colorectal, cervical, mutagens, carcinogens andmutations.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	**STEM CELLS** Introduction to concepts in stem cell biology, definition, introduction tissuestem cells, stem cell and cancer, epidermal stem cell and neural stem cells,embryonic stem cell, moving stem cell to clinic, stem cell as future treatmentof disease	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	**DIAGNOSTIC METHODS** Common practice of diagnostic methods, cytogenetics and molecular test,routine diagnostic test, purpose of frozen section, biopsy, endoscopy,diagnostic imaging, blood test, Proteomics and genomic approach, microarray.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	**TRADITIONAL THERAPIES** Treatment tradtional chemotherapies, limitation in therapies, treatmentimmunotherapy, conventional chemotherapy, drawbacks, role of immunesystem in suppressing cancer.	ICT & Green Board based Class Room Teaching, individual presentation

OUTCOMES:

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

- Know about cancer and their several types
- Have the information regarding various cause for the cancer
- Understand what are the therapies and treatment Module for the cancer patient

REFERENCES:

1. DNA repair in cancer therapy: molecular targets and clinical applications. Edited by Mark R. Kelley Academic press Elsevier, 2012.
2. The biology of cancer by Robert Weinberg G. Garland sciences, Taylor and Francis group, New york ISBN 0-8153-4076-1.

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, Biotechnologist, molecular biologist	biochemist	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab

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SEMESTER – 3rd **Subject Code:**6SMBT307
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT:elective 2 medical biotechnology **Theory Min. Marks: 17**

Objective- Develops basic skills necessary to work in the medical biotechnology laboratory.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	Introduction to the origin and significance of medical biotechnology, classification and impact of genetic diseases.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	Down syndrome, Translocations, sex chromosome errors, sex determination, klinefelter's and Turner's syndromes. Human genome project – Ethical, Legal and Social Issues.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	Metabolic disorders and inherited diseases,Inborn Errors of metabolism, disorders of amino acid, carbohydrate and lipid metabolism- phenylketonuria (PKU), GM2-gangliosidosis, Gaucher's disease, Mucopolysaccharidoses, Homocystinuris; inherited diseases-Diabetes, , haemophilia, sickle cell anemia.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	Immunogenetics - genetic basis of antibody diversity; hybridoma technique and development of monoclonal antibodies; antibodies and therapy. Plants of medicinal Importance – *Phyllanthus neruri, Vitex negundo, Vinca rosea.*	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	Diagnosis and treatment of genetic diseases, methods for prenatal diagnosis of Chromosome disorders, impact of chromosome errors upon human health, human reproductive loss.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- The student will be able to identify common infectious agents and the diseases that they cause.

Recommended Books

- Review of Medical Microbiology by Jawitz, Melnick and Adelberg
- Diagnostic Microbiology by Bailey and Scott

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, Biotechnologist, molecular biologist	Biochemist, pharmacist	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab, Biochemist, microbiologist

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SEMESTER – 3rd **Subject Code:** 6SMBT308
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT:elective 2 food microbiology **Theory Min. Marks: 17**

Objective- in this course, the study of microorganisms involving both beneficial and deleterious effects of microbes on the quality and safety of processed and raw food materials.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	Introduction to fermented foods, Microbial products of milk. Microbiology of cheese, butter, yogurt, Microbiology of bread, sauerkraut, idly Bacteriological examination of fresh and canned foods Spoilage of foods and factors governing the spoilage Food preservation methods. Role of microorganisms in beverages– beer, wine and vinegar fermentation.**Dairy Microbiology** - Types of microorganisms in milk, significance of microorganisms in milk, microbiological examination of milk, control of microbial flora of milk Microbes and animal interactions – Rumen Microbiology Termite microbial communities, Silage.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	Mycotoxins: Groups of mycotoxins, effects on human and animal health, Detoxification methods(Physical, Chemical and biological). Mechanism of toxicity, Microbial threats and Bioterrorism, Test procedures to detect disturbances of microbial communities. Current and future implications concerning food safety, hazards and risks.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	Microbial flora of fresh food, grains, fruits, vegetables, milk, meat, eggs and fish. Microbiological examination of foods for their infestation by bacteria, fungi &viruses. Chemical preservatives and food additives.Factors influencing microbial growth in food-Extrinsic and intrinsic factors. Food as a substrate for micro-organism.Canning, processing for heat treatment – D, Z and F values and working out treatment parameters; microbial spoilage of canned foods, detection of spoilage and characterization.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	The roles of microorganisms in the food industry, positive and negative perspectives. Food-borne infections and intoxications: Bacteria and nonbacterial-with examples of infective and toxic types- Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia; nematodes, protozoa, algae, fungi and viruses. Food borne outbreak-laboratory testing procedures; Sources and transmission of bacteria in foods: human, animal, and environmental reservoirs; cross-contamination.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	Prevention Measures-Food sanitation in manufacture and retail trade; Plant sanitation-Employee's Health standards-waste treatment-disposal- quality control. Government Agency and Food Safety Policy: Government Branches (FDA, CDC, USDA and how they work to control food safety), HACCP, Risk Assessment.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- The student has knowledge of how food poisoning, food spoilage, preservation of food is dealt under food microbiology.

Recommended Books

- Food Microbiology by Frazier
- Microbial Ecology – A conceptual approach by Lynch and Poole
- Basic food microbiology (Abridged edition) by George J. Banwart
- Laboratory experiments in microbiology by Gopal Reddy et al Brock's

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, Biotechnologist, molecular biologist	Biochemist, microbiologyst	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	microbiologist

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SEMESTER – 3rd
Course: M.Sc. Biotechnology
SUBJECT:Elective 2 Plant Biotechnology

Subject Code:6SMBT309
Theory Max. Marks: 50
Theory Min. Marks: 17

Objective-The objective of the course is to give student new knowledge and widening of the knowledge acquired in other course by handling of classical and modern plant biotechnology.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1. Introduction to cell and tissue culture 2. Tissue culture media (composition and preparation) 3. Initiation and maintenance of callus and suspension culture; single cell clones.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	1. Organogenesis; somatic embryogenesis; 2. Embryo culture and embryo rescue 3. Anther, pollen and ovary 4. Protoplast isolation, culture and fusion	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	1. Features of TI and RI plasmids, role of virulence genes, use of Ti and Ri as vectors, 2. directDNA transfer method 3. Germplasm conservation – Cryopreservation and slow growth cultures	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	1. biodegradable plastics, therapeutic proteins, antibodies, edible vaccines. 2. Molecular Marker –RFLP maps, linkage analysis, RAPD markers, STS, microsatellites.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	1. Plant transformation technology: Basis of tumor formation, Mechanism of DNA transfer. 2. Metabolic Engineering and Industrial Products: plant secondary metabolites	ICT & Green Board based Class Room Teaching, individual presentation

Outcome- The course will provide an overview of plant biotechnology with focus on industrial applications

Books:-

- Razdan MK – Introduction to Plant Tissue Culture 2nd Edition; Oxford &Ibh Publishing Co. Pvt Ltd 2010
- Vasil IK – Plant Cell and Tissue Culture; Springer 1994
- Bhojwani SS and Razdan MK – Plant Tissue Culture; Elsevier
- TJ Fu, G Singh and WR Curtis (Eds): Plant Cell and Tissue Culture for the production of Food Ingredient. Kluwer Academic/Plenum Press, 1999
- J Hammond, P McGarvey& V Yusibov (Eds): Plant Biotechnology, Springer Verlag.2000.
- H.S. Chawla: Biotechnology in Crop Improvement, InteRNAtional Book Distributing Company, 1998.
- H.S. Chawla: Introduction to plant biotechnology. Oxford & IBH Publishing Co. (P) Ltd.
- B.D. Singh, (2004) Biotechnology. Expending Horizons. First Edition. Kalyani Publishers, Ludhiana.

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, Plant biotechnologist, genetic engineer,	single cell protein, edible vaccines, plant tissue culture	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Bioprocessing industries, plant tissue culture, research and development, food processing industries, SCP production

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SEMESTER -3rd **Subject Code:** 6SMBT310
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT: ELECTIVE 2 -FOOD SCIRNCE &TECHNOLOGY **Theory Min. Marks: 17**
Objectives:

- To convey better knowledge among the students about modern day food biotechnology, its associated techniques like packaging etc and Food safety and Quality control.
- To ensure better quality of education by continuous monitoring and review of performance and counseling students.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	**Introduction to Food Processing:** Biotechnology in relation to the food industry, nutritive value of food, and types of microorganisms associated with food, its sources, types and behavior in foods.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	**Food additives & preservation techniques** Food additives- definitions, need for food additives, classification and functions of different additives: thickeners, antioxidants, coloring agents, flavoring agents, sweeteners, emulsifiers, flour improvers; Preservation techniques: techniques like refrigeration & freezing, dehydration, heating etc., antimicrobial agents used in food preservation.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	**Food Spoilage & Food Borne Diseases:** Microbial spoilage of food, Food -borne infections & intoxications.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	**Fermented Food Products:** Dairy products, non-beverage plant products, beverages and related products of baking. Microbes as food, Probiotics, prebiotics, single cell proteins, single cell oil.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	**Food Safety and Quality Control** Introduction to concepts of food safety and food quality assurance; Food adulteration, nature of adulterants, methods of evaluation of food adulterants and toxic constituents. Role of national and international regulatory agencies, Bureau of Indian Standards (BIS), AGMARK, Food Safety and Standards Authority of India (FSSAI), USFDA, International organization for standards (ISO) and its standards for food quality and safety (ISO 9000 series, ISO 22000, ISO 15161, ISO 14000).	ICT & Green Board based Class Room Teaching, individual presentation

Outcomes: Food biotechnology has a great scope at present and in future. As there is increasing popularity and explosive growth, there are plenty of opportunities available in Food Biotechnology field. Students get training and skill development in the field of food biotechnology such as:Biotech foods and supplements as GM foods, food from fungi, algae and bacteria and their large scale production.

TEXT BOOKS

- Roger A., Gordan B., and John T., Food Biotechnology, 1989.
- Frazier, Food Microbiology.
- G. Reed, Prescott and Dunn's Microbiology, CBS Publishers,

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, food Biotechnologist, molecular biologist, quality controller	Information about dairy products, fermented food products, food sefety	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Food processing industries, research and development,

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SEMESTER- 3rd | **Subject Code:** 6SMBT311
Course: M.Sc. Biotechnology | **Practical Max. Marks: 25**
SUBJECT:Lab (Animal Biotechnology & Immune System) | **Practical Min. Marks: 08**

Experiments based on the paper 1(Animal Biotechnology) & Paper 2 (Biology of Immune System)

List of practical:-(Animal Biotechnology)

1. Demonstration of animal cell structure.
2. Demonstration of different animal tissue culture medium.
3. Extraction and estimation of DNA from blood.
4. Extraction and estimation of DNA from muscle tissue.
5. Extraction and estimation of DNA from spleen.

List of practical:-(Biology of Immune System)

1. Enumeration of WBC in blood sample.
2. Preparation of a blood smear and differential blood count.
3. To separate serum from the given blood sample.
4. To determine Albumin globulin ratio in given serum sample.
5. Estimation of serum protein by folin Lowry test.
6. Isolation of immunoglobulin.
7. Separation of serum protein by SDS PAGE.
8. Detection of class specific Antibody by Double Diffusion method.
9. Observe Ag-Ab interaction by immunoelectrophoresis.
10. Observe Ag-Ab interaction by counter current immunoelectrophoresis.
11. Study of Agglutination reaction.
12. Study of ELISA technique.
13. Immuno diffusion test.
14. Blood group determination by slide agglutination reaction.

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SEMESTER- 3rd **Subject Code:** 6SMBT312
Course: M.Sc. Biotechnology **Practical Max. Marks: 25**
SUBJECT:Lab (Bioprocess Engineering&Plant Biotechnology)Practical Min. Marks: 08

Experiments based on the paper (Bioprocess Engineering & Technology) & Paper(Plant Biotechnology)

List of practical:-(Bioprocess Engineering & Technology)

1. Isolation and identification of microorganism from industrial waste water.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism (Bacteria and fungi).
3. To study the production of citric by Aspergillusniger and also qualitative and quantitative test.
4. To study the bacterial growth curve.
5. To study the fungal growth curve.
6. Enzyme kinetics.
7. Bio-ethanol production.

List of practical: (Plant Biotechnology)

1. Media preparation
2. Meristem / bud culture, shoot multiplication & rooting
3. Organogenesis
4. Somatic embryogenesis
5. Plantlet acclimatization
6. Embryo culture
7. Anther culture
8. Study of molecular markers
9. Extraction of DNA from plant
10. Estimation of plant DNA by Agarose gel electrophoresis and Spectrophotometer.

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SEMESTER-3rd **Subject Code: 6SMBT13**
Course: M.Sc. Biotechnology **Practical Max. Marks: 25**
SUBJECT: Lab(Bacterial Genetics And Food Science And Technology) **Practical Min. Marks: 08**

BACTERIAL GENETICS

1. Bacterial cell
2. Growth of bacteria on agar slant
3. Growth of bacteria on agar stab.
4. Isolation of bacterial plasmid dna
5. Isolation of bacterial genomic dna

FOOD SCIENCE AND TECHNOLOGY

1. Preparation of synthetic medium for yeast culture.
2. To study the production of yeast.
3. To study the production of algae using natural raw/ industrial waste materials and synthetic medium.
4. To study the cultivation of mushrooms.
5. To study the various sterilization and food preservation techniques.
6. Estimation of a) Iodine value, (b) Saponification value (c) acid value of fats and oils.
7. Determination of moisture, total crude fat in a given food sample.
8. Determination of Acidity & pH in food sample/beverages.
9. Determination of total, non-reducing and reducing sugars.

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SEMESTER -4th **Subject Code:** 6SMBT401

Course: M.Sc. Biotechnology **Theory Max. Marks: 50**

SUBJECT:elective 3 ENZYME TECHNOLOGY Theory Min. Marks: 17

Objectives: This Enzyme-Technology oriented course covers the applications of enzymes in various industries; classification of enzymes on the basis of their structures, functions and their salient features; How enzymes work and their regulation; Strategies being adopted for production, isolation, purification and Characterization of enzymes at laboratory and industrial scale from plant, animal and microbial sources; Strategies for immobilization and engineering of enzymes etc.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	Introduction to enzymology and historical developments in enzymology. Enzyme classification, IUBMB enzyme classification. Enzyme Activity: Techniques of enzyme isolation, Principle and techniques of enzyme assay, factors affecting enzyme activity.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	Intracellular localization of enzymes Mechanism of Enzyme Action : Investigation of active site Enzyme activators, co-enzymes and co-factors in enzyme catalysis Purification of enzyme : Techniques of separation and purification, test of homogeneity.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	Enzyme Kinetics, Bioenergetics and Catalysis Single substrate kinetics : Equilibrium and steady state kinetics, significance of Km, Vmax & Kcat. Multisubstrate reaction kinetics : General rate equation, ordered, random order and ping-pong mechanisms	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	Enzyme inhibition and its kinetics: Reversible and irreversible inhibition, competitive, non-competitive and uncompetitive, mixed, partial and substrate inhibition. Thermal kinetics : Effect of temperature on reaction rate, enzyme stability, Arrhenius equation and activation energy.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	Allosteric enzymes Isoenzymes, multienzyme complex and multifunctional enzymes, and their physiological significance. Biosensors ; Enzymes as analytical reagents. Ribozymes and catalytic antibodies.	ICT & Green Board based Class Room Teaching, individual presentation

Outcomes: This foundation course on Enzyme Technology will help the students to understand the nature, structure, function, kinetics, specificity, categories and regulation of enzymes. The students will get acquainted with their role in various sectors and how their structure can be modified to make them industrially suitable.

References

- Enzymes : Dixon & Webb
- Principles of Biochemistry : Lehninger
- Methods in Enzymology : Relevant volumes
- Enzymes : Boyer
- Handbook of Enzymes : Dr. Anil Kumar
- Biochemistry: U satyanarayna

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, Biotechnologist, Quality controller , production	Instrument handling, biosensor	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab, research and development

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SEMESTER -4th **Subject Code:** 6SMBT402
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT:Elective 3 -BIOINFORMATICS Theory Min. Marks: 17

Objectives: The aim of this course is to introduce the students to the basics of bioinformatics. This includes teaching the basis of the biological system via information and technology.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	Elements of programming languages- C and PERL; Database concept; Database management system;Database browsing and Dataretrieval;Sequence data base and genome database;	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	Data Structures and Databases;Databases such as GeneBank; EMBL; DDBJ; Swissplot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmoDB; ECDC; Searching for sequence database like FASTA and Blastalgorithm.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequencepattern; Markov models; Concept of HMMS; Use of profile HMM for protein family classification; Pattern recognition methods.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	Goals of a Microarray experiment; Normalization of Miroarraydata; Detecting differential geneexpression; Principle componentanalysis; Clustering of microarraydata; Structured etermination by X-raycrystallography; NMR spectroscopy; PDB (ProteinDataBank) and NDB (NucleicAcidDataBank); File formats for storage and dissemination of molecular structure.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation	ICT & Green Board based Class Room Teaching, individual presentation

Outcomes: After completing the course, students will be able to learn various methods of shortlisting, analyzing, interpreting the vast biological data generated in *in vitro* and *in vivo* experiments. They will also learn application of various bioinformatics tools that will help in generating more accurate predictions.

Texts/References:

- Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
- Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician,molecular Biotechnologist,Bioinformatician computer operator, data analyst	instruments handling, Microarray analysis,	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Molecular diagnosis, protein modeling

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SEMESTER -4th **Subject Code:** 6SMBT403
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT:elective 3 clinical biochemistry **Theory Min. Marks: 17**

objective• Overview of various disorder due to defect in the metabolism of biomolecules.
- To know about Electrolytes and acid base balance
- To learn in detail about hormonal disbalance.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	**disorders of carbohydrate and lipid metabolism** Disorders of carbohydrate metabolism: Diabetes mellitus, glycohemoglobins, hypo glycemias, galactosemia and ketone bodies. Various types of glucose tolerance tests. Glycogen storage diseases. Physiology of lipids/lipoproteins. Lipidosis. Clinical inter-relationships of lipids (sphingolipidosis and multiple sclerosis), lipoproteins and apolipoproteins. Diagnostic tests for HDLcholesterol, LDL-cholesterol and triglyceride disorders. Inborn errors of metabolism.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	**disorders of amino acid and lipid metabolism** Phenylalanemia, homocystinuria, tyrosinemia, phenylketonuria, alkaptonuria, albinism and animoacidurias. Disorders of nucleic acid metabolism- Disorders in purine/ pyrimidine metabolism.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	**electrolytes and acid-base balance and digestive enzyme** Regulation of electrolyte content of body fluids and maintenance of pH, reabsorption of electrolytes Diagnostic enzymes: Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase. Enzyme tests in determination of myocardial infarction. Enzymes of pancreatic origin and biliary tract.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	**hormonal disturbances** Protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and reproductive endocrinology. 95 Disturbances in thyroid function.Disorders of mineral metabolism: Hypercalcaemia, hypocalcaemia, normocalcaemia, hypophosphataemia and hyperphosphataemia.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	**biochemical aspects of hematology** Disorders of erythrocyte metabolism, hemoglobinopathies, thalessemias thrombosis and anemias. Laboratory tests to measure coagulation and thrombolysis. Detoxification in the body: enzymes of detoxification, polymorphism in drug metabolizing enzymes. Mechanism of drug action and channels of its excretion, Disorders of vitamins and trace elements.	ICT & Green Board based Class Room Teaching, individual presentation

OUTCOME:
- Student will be able to undersatnd various disorder due to defect in the metabolism of biomolecules.
- They will learn about Electrolytes and acid base balance
- Learn and understand in detail about various hormonal disbalance.

REFERENCES :

1. Textbook of Medical Biochemistry By MN Chatterjea and Rana Shinde, Jaypee Brothers.
2. Lehninger Principles of Biochemistry 5th Edition By David L. Nelson and

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, Biotechnologist, molecular biologist	biochemist	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab

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SEMESTER -4th **Subject Code:**6SMBT404
Course: M.Sc. Biotechnology **Theory Max. Marks:50**
SUBJECT:elective 3 pharmaceutical biotechnology **Theory Min. Marks: 17**

Objective- in this course, generally pharmaceutical microbiology provides knowledge of the presence of bacteria, yeasts, moulds, viruses and toxins in pharmaceutical raw material.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	Introduction – Overview of products, classification of pharmacologic agents based on chemistryand source. Phytopharmaceuticals: Screening tests for phyto constituents – alkaloids andterpenoids. Three examples of commercial natural products from marine and terrestrialorganisms.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	Drug development: Biology guided fractionation methods : *in vitro* assay systems based onenzymes, tissue, organ or growth inhibition.Antimicrobial activity studies (antibacterial, antiviral, antifungal and antiparasitic activities).	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	Gene therapy: General introduction, ex vivo and in vivo gene therapy, potential targets for gene therapy, inherited disorders. Vaccine design and production, classification, recombinant vaccines, Advantages and disadvantages – examples – Hepatitis B vaccines, Cholera vaccines, Edible vaccines, DNA vaccines..	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	Immunologicals: Antisera – hyper immune gamma globulin – monoclonal antibodies – uses. Recombinant proteins: strategies and genetic manipulations for over production of biomolecules – interferons and insulin. Other biomolecules; Probiotics and Neutraceuticals.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	Economic and legal considerations in Pharmaceutical biotechnology, ICMR guidelines fordesign and conduct of clinical trials, licensing and drug control.	ICT & Green Board based Class Room Teaching, individual presentation

outcome- this course is to help student will be able to develop expertise in identification, cultivation and counting of microorganisms, preparation and sterilization of bacterial culture, various staining techniques, aseptic processing etc.

Reference Books :

- Disinfection, sterilization and preservation. Block, S.S. (ed). Lea and Febigor, Baltimore Pharmaceutical Microbiology. Huge, W.B. and Russel, AD.Blackwell Scientific, Oxford
- Principles and methods of sterilization in health sciences. Perkins, JK. Pub: Charles C. Thomos, Springfield.
- Compendium of methods for the microbiological examination of foods. Vanderzant, C. and Splittstoesser, D. Pub: American Public Health Association, Washington, D.C.

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, Biotechnologist, molecular biologist	Biochemist, pharmacist	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab, Biochemist, microbiologist

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SEMESTER – 4th **Subject Code:** 6SMBT405
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT:elective 4 microbial techniques **Theory Min. Marks: 17**

Objectives : To aquaint students with basic techniques in Staining and Sterilization

Units	Unit Wise Course Content	Methodology Adopted
Unit I	**Microscopy and Stains** Microscope- Simple and Compound: Principle. Parts, Functions and Applications. Dark Field and Phase Contrast Microscope Stains and Staining Solutions-Definition of Dye and Chromogen. Structure of Dye and Chromophore. Functions of Mordant and Fixative. Natural and Synthetic Dyes. Simple Staining, Differential Staining and Acid Fast Staining with specific examples	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	Definition : Sterilization and Disinfection. Types and Applications Dry Heat, Steam under pressure, Gases, Radiation and Filteration Chemical Agents and their Mode of Action - Aldehydes, Halogens, Quaternary Ammonium Compounds, Phenol and Phenolic Compounds, Heavy Metals, Alcohol, Dyes, and Detergents Ideal Disinfectant. Examples of Disinfectants and Evaluation of Disinfectant	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	**Nutrition and Cultivation of Microorganisms** Nutritional Requirements : Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulphur and Growth Factors.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	Classification of Different Nutritional Trypes of Organisms. Design and Types of Culture Media. Simple Medium, Differential, Selective and Enrichem Media Concept of Isolation and Methods of Isolation. Pure Culture Techniques	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	**Growth and Enumeration** Growth Phases, Growth Curve. Arithmatic Growth and Growth Yield. Measurement of Growth. Chemostat and Turbidostat Enumeration of Microorganisms- Direct and Indirect Methods Preservation of Cultures- Principle and Methods. Cryogenic Preservation Advantages and Limitations	ICT & Green Board based Class Room Teaching, individual presentation

Outcome : To impart the knowledge of growth of microorganisms

Books:-

- K. Wilson and J. Walker: Principle and Techniques of Biotechnology and Molecular Biotechnology.
- Upadhya and Upadhya: Biophysical Chemistry.
- David, L. Nelson and Michael, M. Cox: Lehniger: Principal of Biochemistry. 4th Edition. W.H. Freeman and Company, New York.

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, Biotechnologist, molecular biologist, pharmacist biochemist	Biochemist, pharmacist	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab, Biochemist, microbiologist

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SEMESTER -4t **Subject Code:** 6SMBT406
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT:elective 4 biological chemistry **Theory Min. Marks: 17**

Objective: The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of a stem/branch lecture series and a research project.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	1.1. **Carbohydrates**-Importance, classification and physical and chemical properties of carbohydrates 1.2. Structure, configuration and biochemical importance of Monosaccharides (Glucose and Fructose)Oxidation, Reduction, Osazone formation, Aldose & Ketose, Glycosides (Streptomycin, Cardiac glycosides and Ouabain)	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	**Proteins** 2.1 Classification, structure and physical and chemical properties of aminoacids and synthesis of Peptide bond 2.2 Lipids,Fattyacids-importance, properties and classification, Simple lipids-TAG, Complex lipids, Derived lipids, sterols, Fatty acids: Saturated and Unsaturated fatty acids with examples. Biosynthesis of Fatty acids -palmitoyl-CoA, Cholesterol	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	**Bioenergistics of biomolecules** 3.1 Glycolysis 3.2 Gluconeogenesis and its significance 3.3 TCA Cycle, electron transport, Oxidative phosphorylation 3.4 β-oxidation of fatty acid 3.5 Transamination and Oxidative deamination reactions of amino acids. Amino acid	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	4.1**Enzymes**-classification and nomenclature. Michaelis Menton Equation-Factors influencing the enzyme reactions and Enzyme inhibition(Competitive and Non-competitive), role of co-enzymes and Enzyme Techonology. 4.2 Hormones, mode of action, (Thyroid gland) 4.3 Vitamins- classification, sources, functions and applications	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	**Bioanalytical techniques** 5.1. Microscopy – light, inverted, fluorescent and electron microscopy 5.2. Colorimetry: Beer and Lambert's laws and UV- Vis spectrophotometry. 5.3. Separation techniques – Chromatography(Paper, thin layer, ion exchange and HPLC). 5.4 Electrophoresis (Native gels and SDS-PAGE, Agarose) 5.5 Basic principles of Centrifugation	ICT & Green Board based Class Room Teaching, individual presentation

OUTCOMES:

At the end of the course students will be able to

• demonstrate broad knowledge of the biomolecules, machinery and information flowwithin living cells, and an appreciation of how these underpin all biological processes, in both normal and diseased states

REFERENCE BOOKS

1. Lehninger Principles of Biochemistry By: David L. Nelson and Cox
2. Biochemistry By: Rex Montgomery
3. Harper's Biochemistry By: Robert K. Myrray

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, Biotechnologist, molecular biologist, pharmacist biochemist	Biochemist, pharmacist	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Pathology lab, Biochemist, microbiologist

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SEMESTER -4th **Subject Code:** 6SMBT407
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT: elective 4ETHICS PATENTING AND BIOENTERPRENURSHIP Theory Min. Marks: 17

Objective:

The objective of the course is to make students learn about the legal, safety and public policy issues raised due to the rapid progress in biotechnology and development of new products.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	Bioethics: Ethical issues related to biotechnology research; Ethical issues associated with consumptions of genetically modified foods and other products, Bioremediations and environmental impacts of using GMOs.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	Social, economical and legal issues related to biotechnology; Social and ethical implications of biological weapons, Ethics of patenting- and its impact on biodiversity rich developing countries; Use of animals for research and testing and Alternatives for Animals in Research.	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	Testing of drugs on human volunteers; Human cloning and Gene therapy - ethical and social issues; Organ transplantation- ethical and legal implications; Research focus to address the need of the poor and of environment	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	Entrepreneurship: Potential entrepreneurship activities in biotechnology, product development, marketing, research and training units. Industrial licensing, venture capital, Biotechnological industries in India and potential job opportunities.	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	Types of IPR: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Protection of GMOs, IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies. Examples of patents in biotechnology	ICT & Green Board based Class Room Teaching, individual presentation

Outcome:

At the end of the course, it is expected that students have understood the basic issues of biosafety, bioethics and IPR arising from the commercialization of biotech products. They are now supposed to follow the regulatory framework in their future venture to ensure product safety and benefit the society

Recommended Books:

1. Thomas, J.A. and Fuch, R.L. Biotechnology and Safety Assessment. Academic Press. (2002).
2. Fleming, D.A., Hunt, D.L., Biological safety Principles and practices. ASM Press.
3. Sateesh, M.K. Bioethics & Biosaftey, IK Publishers. (2008).
4. Sassaon A. Biotechnologies and development. UNESCO Publications.
5. Sasson A. Biotechnologies in developing countries, UNESCO Publishers,
6. Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani.
7. Singh K., Intellectual Property Rights on Biotechnology BCIL, New Delhi. (2008).

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Academician, Biotechnologist,	IPR based skills, Bioethics	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	IPR advisor

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SEMESTER -4th **Subject Code:** 6SMBT408
Course: M.Sc. Biotechnology **Theory Max. Marks: 50**
SUBJECT: Elective 4 -GENOMICS, PROTEOMICS & BIOSAFTEYTheory Min. Marks: 17

OBJECTIVES: During the course students would learn about genomics including genetic features of nuclear genomes of prokaryotes and eukaryotes, eukaryotic organelle genomes, genome evolution and molecular phylogenetics.The course also aims to introduce the students to the fields of proteomics and metabolomics.

Units	Unit Wise Course Content	Methodology Adopted
Unit I	**Introduction :** DNA sequencing principles and Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Recognition of coding and non-coding sequences gene annotation, EST's and SNP's.	ICT & Green Board based Class Room Teaching, individual presentation
Unit II	**Tools for genome analysis:-**RFLP, DNA fingerprinting, RAPD, , Linkage and Pedigree analysis-physical and genetic mapping, Primer design; PCR: its types and applications, Site Specific Mutagenesis	ICT & Green Board based Class Room Teaching, individual presentation
Unit III	**Proteomics :** Protein analysis (includes measurement of concentration, aminoacid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE.	ICT & Green Board based Class Room Teaching, individual presentation
Unit IV	**Functional genomics and proteomics:** Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Structural proteomics	ICT & Green Board based Class Room Teaching, individual presentation
Unit V	**Biosafety:** Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels: Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines- Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosfety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture.	ICT & Green Board based Class Room Teaching, individual presentation

Outcome: After the completion of the course, it is expected that students have understood the concept of genome, proteome and biosafety and their correlation with each other. They would understand genetic organization of nuclear genomes of prokaryotes and eukaryotes, features of eukaryotic organelle genomes, genome evolution and molecular phylogenetics.

Texts/References:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007

Job Opportunities	Employability Skill Developed	Local/National/UNDP Goal Achieved	Entrepreneurship Opportunity
Cell Biologist, Academician, Biotechnologist, molecular biologist	Genetic engineering, genomics, proteomics, DNA finger printing , forensic, DNA sequencing	Goal 04 (Quality education) Goal 13 (Climate action) Goal 15 (Life on land)	Bio safety advisor, protein analysis

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SEMESTER-4th **Subject Code:6SMBT409**
Course: M.Sc. Biotechnology **Practical Max. Marks: 25**
SUBJECT:Lab 1(Enzyme &Ethics, Patenting &Bioenterpreneurship)Practical Min. Marks: 08
ENZYME & ETHICS, PATENTING & BIOENTERPRENURSHIP

ENZYME TECHNOLOGY

1. To estimate the quantity of protein by UV-absorption method
2. To estimate the activity of amylase enzyme in serum/urine, saliva
3. Assaying of alkaline phosphatase activity
4. Study of enzyme kinetics
5. Time course of enzyme catalysed reaction
6. Effect of substrate concerntration on the activity of enzyme
7. To determine the Km and Vmax of the reaction
8. Effect of enzyme concentration
9. Temperature optima for the enzyme
10. pH optima for the enzyme
11. Partial purification of enzyme by change of pH, temperature, addition of organic solvents and ammonium sulphate fractionation and to determine the specific activity of the enzyme
12. Purification of enzyme by Adsorption/Affinity/Ion exchange/gel-filtration chromatography and to determine the specific activity of the enzyme

ETHICS PATENTING & BIOENTERPRENURSHIP

1. Safety measures to be taken while handling Biohazards.
2. Mushroom cultivation technique
3. Vermi composting technique
4. Plant tissue culture
5. Good laboratory practices(GLP)
6. Disposal of lab wastes and cultures.
7. Lab safety equipments
8. Causes of infection in lab.

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Course: M.Sc. Biotechnology **Practical Max. Marks: 25**
SUBJECT: Lab 2 (Bioinformatics&Genomics , Proteomics & Biosafety)Practical Min. Marks: 08

BIOINFORMATICS

- Introduction to MSEXCEL-Use of worksheet to enter data, edit data, copy data, move data.
- Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc.
- Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data.
- Introduction to SYSTAT package.
- Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis.
- Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

GENOMICS , PROTEOMICS& BIOSAFETY

- PCR amplification gene and analysis by agarose gel electrophoresis.
- Polymerase Chain reaction, using standard 16srRNA eubacterial primers.
- RFLP analysis of the PCR product.
- Plasmid isolation and confirming recombinant by PCR and RE digestion.
- Southern hybridization of *B. subtilis* genome with probe and non-radioactive detection.

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SEMESTER- 4th
Course: M.Sc. Biotechnology
SUBJECT:Project Work

Subject Code: 6PRSC401
Theory Max. Marks: 100
Theory Min. Marks: 33

PROJECT

All the candidates of M.Sc.(Biotechnology) are required to submit a project-report based on the work done by him/her during the project period. A detailed Viva shall be conducted by an external examiner based on the project report. Students are advised to see the detailed project related guidelines on the website of CVRU. (www.cvru.ac.in) under Project Guidelines for student section.

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