SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

SYLLABUS FOR

M. Sc. Biotechnology

National Education Policy-2020

(Two Year Course- Semester System)

School of Basic and Applied Sciences

(Effective from Academic Session 2024-2025 Revised in 2025)

VISION AND MISSION- DEPARTMENT OF BIOTECHNOLOGY

Vision

1. To be producing technical manpower through excellence in research and development, teaching, learning and training, with concern for worldwide environment and human society.
2. To provide well and quality education in the field of Life Sciences and Applied Sciences with proper training and practical expertise responsive to the needs of present and future century so that students excel and enhance in their professional life.

Mission

1. Providing friendly learning ambience to develop competence in diversified areas to create excellence in industrial, educational, research and technical areas.
2. Provide an efficient educational environment where students and research scholars can realize their full potential in their chosen disciplinary subjects and attain quality education to face the challenges of the future.
3. Establish networks collaborations and linkages with industries and academic institutes to produce ethically and morally strong workforce contributing to the development of knowledge economy.
4. Harness the skills of the students and assist them to excel in their professional life by providing lifelong learning skills, sound theoretical knowledge, practical experience and all-round development with the help of well qualified and experienced faculty. Inculcate moral and ethical values for character building.

C U R R I C U L U M

M. Sc. BIOTECHNOLOGY POSTGRADUATE DEGREE PROGRAMME (2023-24 Onward)

1. Nomenclature:

There will be full time Master's Degree Programme named as M.Sc. in Biotechnology which will be written as M.Sc. Biotechnology. **For the completion of one year (two semester) it will be consider as PG Diploma in Biotechnology and for the For the completion of two years (four semester) it will be consider as PG Degree (Master in Biotechnology) in Biotechnology** .The duration of this programme shall be of two years (two full academic years) which shall be divided in to four semesters. Each semester will be of six months . Actual teaching in each semester is required minimum of 90 days. The examination for the first and third semester will normally be held in the month of December and for the second and fourth semester in the month of May or as convenient to the University.

2. The Medium of Instruction:

The medium of Instruction will be English.

3. The Medium of Examination:

The medium of examination will be English.

4. Eligibility to apply for Admission:

No candidate shall be eligible for admission to Two Year Full Time M.Sc. Biotechnology unless he/she has successfully completed a three year Under Graduate Degree (with any biological subjects/agriculture/medical sciences) with prescribed number of Credits through the Examinations conducted by a University/Autonomous Institution or possesses such qualifications as recognized by the University. Further a candidate holding three year Bachelor Degree in any biological science discipline from a recognized University without credit system shall also be eligible. The maximum age of a candidate for taking admission in the programme and the gap between the last Degree/Diploma courses shall be as per the norms as prescribed by the university from time to time.

5. Selection Procedure for Admission: A candidate willing to seek admission to M.Sc. Biotechnology will have to appear in Written Entrance Test conducted by the University or on behalf of the University and followed by the counseling as per University norms. The selection for admission will be made on merit basis or as per University norms.

6. Semesters:

(a) An academic year shall consist of two semesters:

Odd Semester (I and III Semester) : generally July to November/December

Even Semester (II and IV Semester): generally December to January to May/ June

The academic calendar for each semester shall be notified well before the commencement of the semester by the Dean, School of Basic and Applied Sciences.

(b) A semester shall normally extend over a period of 15 weeks. Each week shall have 30 hours of instruction including lab/ field work as applicable.

7. Credits:

(a) Credit defines the quantum of contents/ syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus credits shall be assigned on the basis of the number of lectures/ tutorials / laboratory work/ project work and other forms of learning required to complete the course contents in a 15 week schedule.

(b) 1 Credit = 1 hour of lecture for theory and 1 Credit = 3 hour of laboratory for practicals and dissertation.

(c) Motivate students with industrial visit, educational trip, seminar/conference during semesters (not mandatory).

8. Roll Numbers and Enrollment Numbers:

The University shall allot a Roll Number to the students after payment realization, thorough scrutiny / verification of the required documents for the course. After the completion of the admission procedure the enrolment number for the students shall be allotted by the University at the entry point which shall remain same for the entire period of study in the University.

9. The Credit Based Course Structure: Master of Science (Biotechnology)-Two Year Programme- Choice Based Credit System (CBCS)

Master's Program in Biotechnology shall be based on the choice based credit system or as per NEP 2020 in which credit defines the quantum of content/ syllabus prescribed for a course system and determines the number of hours of instruction per week.
The student shall be eligible for admission to a Master's Degree Program in Biotechnology after he/she has successfully completed a three year undergraduate degree or earned prescribed number of credits through the examinations conducted by University as equivalent to an undergraduate degree.
Core courses prescribed for every Semester shall be mandatory for all students registered for the Master's Program in Biotechnology and shall carry minimum 80 credits (for two year program). There shall be Elective courses offered in semester III and IV and shall carry a minimum of 20 credits. A self-study course would comprise of maximum 06 credits of which minimum 03 credits shall be mandatory which shall not be included while calculating grades. The student may choose self-study course either only in one of the two semesters (III/IV). The self study course shall be based on advanced topics.
In order to qualify for a two year master's degree, a student must acquire a minimum of 80 credits including a minimum of 20 credits in electives choosing at least two electives (10 Credit) in Semester III offered either by the parent department or other departments and one qualifying self-study course.
The dissertation is a semester long core course of 10 (Elective) credits and is mandatory for every student. The dissertation would be allotted in the beginning of III Semester and candidate would submit the thesis/report during IV Semester examination. The dissertation may be in the form of a field based research work/ project work/ practical training. The students may complete the dissertation work in the department/ other research institutes/ industries/ hospitals etc.

The 2- Year Masters Programme will have the following components:

1) Core course (C): Minimum 60 credits
2) Elective course (E): Minimum 20 credits (10 credits in III Semester and 10 credits dissertation in IV Semester)
3) Self study course: Maximum 06 credits (one minimum 03 credits shall be mandatory but not to be included while calculating grades).

10. Student Advisor:

Every student shall have a teacher of the Department as his/her Student Advisor. All teachers of the department shall function as Student Advisors and will have more or less equal number of students with them. The Student Advisor will advise the students in choosing Elective courses and offer all possible student support services.

11. Attendance:

a. The teacher handling a course shall be responsible for maintaining a record of attendance of students who have registered for the course.
b. All teachers shall intimate the Head of the Department at least seven calendar days before the last instruction day in the semester, the particulars of all students who have less than 75% attendance in one or more courses.
c. A candidate who has less than 75% attendance shall not be permitted to sit for the End-semester examination in the course in which the shortfall exists. However, it shall be open to the Dean/HOD to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons on payment of prescribed fee and such exemptions shall not under any circumstances be granted for attendance below 65%.
d. A candidate who fails to put in least 75% attendance in I semester shall not be allowed to pursue the studies in II semester. Such candidates may apply to the Dean/HOD for re-registration in the I semester in the next academic session. A candidate who fails to put in at least 75% attendance in the II semester shall not be promoted to III semester. Such candidates may apply to the Dean/HOD for re-registration in the II semester in the next academic session.

Note : Rest of the provisions will be as framed by the University.

12. Fee and Resource Generation

As per decision of the University.

13. Examination and Evaluation

(a) Evaluation will be done on a continuous basis. Three times during each semester. For The purpose of uniformity, there will be a uniform procedure of examination to be adopted by all teachers. There will be two Sessional tests (Three if any student are unable to attend any sessional test) and one End-semester examination.

(b) Sessional tests (of one to two hours duration) may employ one or more assessment tools such as objective tests, assignments, paper presentation, laboratory work, etc suitable to the course. This requires an element of openness. The students are to be informed in advance about the nature of assessment. It will be obligatory for the Students to attend the both Sessional tests, failing which they will not be allowed to appear in the

concerned semester examination. The Sessional test as part of the continuous internal assessment shall be conducted and evaluated by the teacher offering the course.

A Student cannot repeat Sessional Tests (without permission from HOD). However, if for any compulsive reason the student could not attend the test, the prerogative of arranging a special test lies with the teacher with the approval of the Head of the Department. In case of students who could not attend any of the Sessional tests due to medical reason or under extraordinary circumstances, a separate test shall be conducted before the concerned semester examinations by the concerned faculty member after the approval of the Head of the Department and the Dean concerned.

(c) The Sessional tests will carry 40% of total marks for the course. The marks of the two Sessional Tests shall be taken into account for the computation of Grades.

(d) There shall be a written End Semester Examination which shall be of 2/3 hours duration carrying 60% of total Marks assigned for the course, covering the entire syllabus prescribed for the course.

(e) The End Semester practical examinations (field tour report, project report and Training report) shall normally be held before the theory examination/or as per convenience by the Department . The internal faculty shall associate themselves with the examination process.

(f) Valuation of Dissertation and Viva- voce: Dissertation / project report shall be evaluated jointly by internal and one external examiner.

OUTCOME BASED EDUCATION

Programme outcome (POs)

The Student will be able to:

PO 1	Acquire knowledge and enhance their fundamentals pertaining to basic and applied fields of biotechnology and allied sciences including microbiology, computer application, biostatistics etc.
PO2	Exhibit technical skills to apply modern tools, techniques (bio-analytical, IT, biostatistics) and identify the utility and application in scientific studies.
PO3	Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
PO4	Exhibit ability to design and conduct laboratory-based experiments and inculcate research aptitude and critical thinking ability to analyze and interpret data.
PO5	To identify entrepreneurship potential of biotechnological process and products, impact on environment and society, along with associated ethical issues.
PO6	Enhance their presentation, communication and writing skills through trainings, seminars, research writing, report writing.
PO7	Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
PO8	Demonstrate an ability to identify the potential of biotechnology (basic and applied) to recognize and propose/ design/derive a solution to complex problem. Attain eligibility and competency pursue career in research, various industries, entrepreneurship and inculcate lifelong learning ability.
PO9	Effective Writing: Got Skill for Write up in scientific literature and other social media platform related to life science.
PO10	Effective Communication: Speak, read, write and 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.
PO11	Social Interaction and Ethics: Elicit views of others, mediate disagreements and help reach conclusions in group. Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them settings conclusions in group settings.
PO12	Interdisciplinary approach and Practical learning: Analyse the relationships among animals, plants, microbes and Industry. Perform procedures as per laboratory standards in the areas of Biochemistry, Bioinformatics, Genomics, industrial biotechnology and fermentation technology.

Program Specific Outcome (PSOs)

PSO 1	Demonstrate proficiency in theoretical as well as practical knowledge in the field of biotechnology and allied sciences (molecular & cell biology, biochemistry, bioinformatics, RDT, plant & animal science environmental biotechnology, immunology, IPR, Genomics, microbiology, Computer application, biostatistics & others).
PSO2	Exhibit potential to design and conduct experiments, analyze and interpret data in different field of biotechnology along with inculcation of research-oriented learning.
PSO3	Identify the potential and application of biotechnology and scientific knowledge to design / derive a solution of problem pertaining to environment conservation, health, agriculture, society and industry considering associated ethical issues.
PSO4	Ability to analyze prevailing career opportunities to pursue a career in research, industries, other organizations, setup start-ups.

Eligibility for admission:

Any candidate who has passed the B. Sc. with Biological Science/Pharmaceutical Sciences/Agricultural Sciences/Medical Sciences subjects with not less than 45%- marks in aggregate is eligible for admission; However, SC/ST, OBC and other eligible communities shall be given relaxation as per University rules.

Duration of the Programme: **2 Years**

STUDY & EVALUATION SCHEME
Choice Based Credit System /ECS
Master of Science (Biotechnology)

First Semester (PG Diploma in Biotechnology)

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MBTC 101	Cell Biology, Developmental Biology & Biophysics	3	0	0	3	40	60	100
2	Core	MBTC 102	Biological Tools & Radiotracer Techniques	3	0	0	3	40	60	100
3	Core	MBTC 103	Molecular Biology & Genetics	3	0	0	3	40	60	100
4	Core	MBTC 104	Biochemistry	3	0	0	3	40	60	100
Practical										
1	Core	MBTL 105	Lab Course 1 based on course MBTC 101 & MBTC 102	0	0	4	4	40	60	100
2	Core	MBTL 106	Lab Course 2 based on course MBTC 103 & MBTC 104	0	0	4	4	40	60	100
			Total	12	0	8	20	240	360	600

L – Lecture, T – Tutorial, P – Practical, C – Credit

Second Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MBTC 201	Immunology	3	0	0	3	40	60	100
2	Core	MBTC 202	Microbiology & Microbial Genetics	3	0	0	3	40	60	100
3	Core	MBTC 203	Molecular Endocrinology & Enzymology	3	0	0	3	40	60	100
4	Core	MBTC 204	Biomaths, Biostats, Computers Programming & Applications	3	0	0	3	40	60	100
Practical										
1	Core	MBTL 205	Lab Course 1 based on course MBTC 201 & MBTC 202	0	0	4	4	40	60	100
2	Core	MBTL 206	Lab Course 2 based on course MBTC 203 & MBTC 204	0	0	4	4	40	60	100
			Total	12	0	8	20	240	360	600

L – Lecture, T – Tutorial, P – Practical, C – Credit
*Skill= Not compulsory in II Semester

Third Semester (PG Degree in Biotechnology)

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MBTC 301	Recombinant DNA Technology & Genomics	3	0	0	3	40	60	100
2	Core	MBTC 302	Bioinformatics, Legal Biotechnology & Bio Business Management	3	0	0	3	40	60	100
3	Elective	MBTE 304	Food and Beverages Biotechnology	3	0	0	3	40	60	100
		MBTE 305	Research Methodology: Tools & Techniques	3	0	0	3	40	60	100
		MBTE 306	Chemical Sciences & Biomaterials	3	0	0	3	40	60	100
4	Elective	MBTE 307	Pharmaceutical Biotechnology & Drug Designing	3	0	0	3	40	60	100
		MBTE 308	Plant Biotechnology	3	0	0	3	40	60	100
		MBTE 309	Advanced Bioinformatics	3	0	0	3	40	60	100
5	Self Study (Any one)	MBTS 311	Bio – Entrepreneurship	3	0	0	3	40	60	100
6		MBTS 312	IPR, Patenting & Bioethics	3	0	0	3	40	60	100
7		MBTS 313	Biomedical Technology	3	0	0	3	40	60	100
8		MBTS 314	Genomics and Proteomics	3	0	0	3	40	60	100
Practical										
1	Core	MBTL 303	Lab Course 1 based on course MBTC 301 & MBTC 302	0	0	4	4	40	60	100
2	Core	MBTL 310	Lab Course 2 based on course MBTE 304/305/306 & MBTE 307/308/309	0	0	4	4	40	60	100
			Total	15	0	8	20+3*	280	420	700

L – Lecture, T – Tutorial, P – Practical, C – Credit

* A self-study course would comprise of maximum 06 credits of which minimum 03 credits shall be mandatory which shall not be included while calculating grades.

Fourth Semester

S. No.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MBTC 401	Cell & Tissue Culture	3	0	0	3	40	60	100
2	Core	MBTC 402	Environmental Biotechnology & Bioprocess Engineering	3	0	0	3	40	60	100
3	Core	MBTE 404	Dissertation	0	0	0	10	60	240	300
4	*Self Study Any one	MBTS 405	Enzyme Technology	3	0	0	3	40	60	100
5		MBTS 406	Molecular Virology & Infections	3	0	0	3	40	60	100
6		MBTS 407	Basics of Forensic Science	3	0	0	3	40	60	100
7		MBTS 408	Agriculture Biotechnology	3	0	0	3	40	60	100
Practical										
1	Core	MBTL 403	Lab Course 1 based on course MBTC 401 & MBTC 402	0	0	4	4	40	60	100
			Total	6	0	4	20	180	420	600

L – Lecture, T – Tutorial, P – Practical, C – Credit

* Self Study = Student can take either in III Semester or IV Semester (Not mandatory in 4th semester)

Examination Scheme:

Components	Ist internal Assignment/Presentation-I	IInd Internal Written/Attendance/ Presentation-II	External (ESE)
Weightage (%) Theory	**20 Marks**	**20 Marks**	**60 Marks**
Practical	**20 Marks**	**20 Marks**	**60 Marks**
Weightage (%) Dissertation	**-----**	**60 Marks**	**240 Marks**

Master of Science (Biotechnology)

Course code	**: MBTC 101**			
Course Name	**: Cell Biology, Developmental Biology, Biophysics**			
Semester /Year	**: I**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To study and provide profound knowledge about the cell ultrastructure, physiological and molecular pathways within cell.
2. To study the cell organelles, basic components of prokaryotic and eukaryotic cells. cellular motility and transportation mechanism
3. To study the cell-signaling pathways for cellular division or cell cycle and molecular level pathways in a living organisms.
4. To study about the cancer, types, molecular basis of cancer, mutation, genes for cancer and cell death and mode of action.

Course Contents [Credit = 3]

Unit 1

Plasma membrane: Structure, organisation, lipid bilayer, proteins & glycoconjugates, liposomes. Function- Ionic transport, types of transport (symport, antiport, active & passive), channel proteins. Structure, organization and functions of Nucleus, Mitochondria, lysosome, Golgi body, Chloroplast, Peroxisome, Endoplasmic reticulum (Rough and smooth). Structure and functions, Microfilament, Microtubules and Intermediate filament.

Unit 2

Vesicular traffic in the secretory and endocytic pathway: transport from endoplasmic reticulum through the Golgi network to lysosome, endocytosis, exocytosis, Molecular mechanisms of vesicular transport and the maintenance of compartments diversity. Cell signaling: General principles (Types of signaling). Cell surface receptor mediated signaling (ion channel, G protein and enzyme linked).

Unit 3

Cell cycle, Molecular events and regulation. Cell division: General strategy and regulation, Molecular mechanism of mitosis and meiosis. Cancer- Biology: Types of cancer, onset of cancer, Proto-oncogenes and tumor suppresser genes, Oncogenic mutations affecting cell proliferation, cell cycle and genome stability.Programmed cell death, Apoptosis.

Unit 4

Developmental Biology: Gametogenesis: Spermatogenesis and Oogenesis including structure, differentiation and longevity of gametes. Chemical and metabolic events during gamete formation. Types of eggs. Fertilization: Significance of fertilization, approximation of gametes, Capacitation, Acrosome reaction, formation of fertilization membrane, egg activation, Blockage to polyspermy, Parthenogenesis.

Unit 5

Cleavage: Patterns, control of cleavage patterns, chemical changes during cleavage.

Physical phenomena and processes in the living organisms. Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.

Suggested Reading and Text Books

1. Lodish et al.: Molecular Cell Biology 2021 (9th ed.)
2. Alberts et al.: Molecular Biology of the cell 2022 (7th ed.)
3. Scott F. Gilbert: Developmental Biology 2023 (13th ed.)
4. Zubay, Parson & Vance: Principles of Biochemistry 1995
5. De Robertes & Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger

Philadelplna(1987)

6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of general character of Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology.	1 Remembering
CO2	**Perceive** the specific and basic concepts and applications of Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating

CO6	**Constructing** the take part in Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	3	3	2	3	2	2	2	2	2	3	2	2
CO2	3	2	2	3	3	3	3	2	3	2	3	2	2	2	2	2
CO3	3	2	2	2	2	2	2	2	3	2	3	3	3	2	2	3
CO4	3	3	2	3	3	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	3	3	3	3	2	3	2	2	3	3	3	3	3
CO6	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code	**: MBTC 102**			
Course Name	**: Biological & Radiotracer Techniques**			
Semester /Year	**: I**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide scientific and computational knowledge related to various techniques associated with biotechnology.
2. To impart laboratory skills for handling analytical tools in industry and research institution.
3. To give the scientific knowledge regarding safety regulations for handling of instruments in the laboratory and industry.
4. To demonstrate the operating procedures associated with upstream and downstream process like chromatography, electrophoresis, centrifugation, etc.

Course Contents [Credit = 3]

Unit 1

Analytical separation methods: Chromatography - General principle and application Adsorption chromatography, Partition chromatography, Gas chromatography, liquid chromatography, Paper chromatography, Thin layer chromatography, Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, HPLC (High Performance/Pressure Liquid chromatography).

Unit 2

Electrophoresis - General principle and application of Paper electrophoresis, Moving boundary method, Gel electrophoresis (Native, Denaturing & Reducing), Disc Gel electrophoresis, Slab Gel electrophoresis, Isoelectrofocussing (IEF), Isotachophoresis.

Unit 3

Centrifugation: Basic principles. Common centrifuges used in laboratory (clinical, high speed & ultra centrifuges). Sedimentation rate, Sedimentation coefficient, Zonal centrifugation, Equilibrium density gradient centrifugation, Types of rotors (fixed angle, swing bucket), Types of centrifugation: Preparative, differential & density gradient

Unit 4

Basic knowledge of the principles and applications of Microscopy: Light, phase contrast, Fluorescence and Confocal microscopy, Scanning and Transmission Electron microscopy. Biosensors: Introduction & principles. First, second & third generation instruments, cell based biosensors, enzyme immunosensors.

Unit 5

Spectroscopic methods: principle and applications of UV-visible, IR, NMR, ESR Spectroscopy. Principle & application of X-ray crystallography. Application of radioisotopes in biology. Properties and units of radioactivity. Radioactive isotopes and half life. Measurement of radioactivity: GM Counter, gamma counter, liquid scintillation counter. Tracer techniques of Autoradiography, Radioimmunoassay. .

Safety rules in handling of radioisotopes and hazardous chemicals

Suggested Reading and Text Books

1. Sharma, V.K.: Techniques in Microscopy and Cell Biology Tata McGraw Hill, 1991.
2. Alberts et al.: Molecular Biology of the cell (2nd ed.), Garland, 2022.
3. Biochemical Technique: Theory & Practical J.F. Robyt & B.J. White $ 30.95. Waveland Press, Inc. 1990
4. Wilson & Walker: Practical Biochemistry 2000 (5th ed) University of Hertfordshire Cambridge University Press.
5. Jayraman: Laboratory Manual in Biochemistry 2nd ed. 2011
6. Arnold L. Demain & Julian E. Davies: Manual of Industrial Microbio. & Biotech. 3rd ed. 1999

7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of general character of Biological & Radiotracer Techniques: Analytical separation: chromatography, electrophoresis, centrifugation, principles and applications of microscopy, Spectroscopic methods and Safety rules in handling of radioisotopes and hazardous chemicals.	1 Remembering
CO2	**Perceive** the specific and basic concepts and applications of Biological & Radiotracer Techniques: Analytical separation: chromatography, electrophoresis, centrifugation, principles and applications of microscopy, Spectroscopic methods and Safety rules in handling of radioisotopes and hazardous chemicals.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of Biological & Radiotracer Techniques: Analytical separation: chromatography, electrophoresis, centrifugation, principles and applications of microscopy, Spectroscopic methods and Safety rules in handling of radioisotopes and hazardous chemicals.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to Biological & Radiotracer Techniques: Analytical separation: chromatography, electrophoresis, centrifugation, principles and applications of microscopy, Spectroscopic methods and Safety rules in handling of radioisotopes and hazardous chemicals.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the Biological & Radiotracer Techniques: Analytical separation: chromatography, electrophoresis, centrifugation, principles and applications of microscopy, Spectroscopic methods and Safety rules in handling of radioisotopes and hazardous chemicals.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in Biological & Radiotracer Techniques: Analytical separation: chromatography, electrophoresis, centrifugation, principles and applications of microscopy, Spectroscopic methods and Safety rules in handling of radioisotopes and hazardous chemicals.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	3	3	3	3	2	3	2	3	2	2	2	2	2
CO3	3	2	2	2	2	3	3	3	3	2	3	3	3	2	2	3
CO4	3	3	2	3	3	2	2	2	3	1	3	2	3	3	3	3
CO5	2	3	3	3	3	3	3	2	3	2	2	3	3	3	3	3
CO6	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code : MBTC 103				
Course Name : Molecular Biology & Genetics				
Semester /Year : I				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide fundamental aspects of molecular biology with detailed basics of cellular organization and biochemical molecules present in the cell.
2. To understand the basic knowledge molecular events like replication, transcription and translation that is important for cell.
3. To provide basic knowledge and understanding of principle and mechanism of inheritance.
4. To provide students basic knowledge of gene expression ant its regulation in prokaryotes and eukaryotes.

Course Contents [Credit = 3]

Unit 1

Chemical and physical properties of nucleic acids, Structure and types of RNA and DNA, The Watson-Crick model. DNA as genetic material. Different forms of DNA. Topological properties of DNA. DNA renaturation kinetics.

Unit 2

Mechanism of DNA replication in prokaryotes and eukaryotes. Mechanism of transcription in prokaryotes and eukaryotes. Reverse transcription. Post transcriptional processing of RNA: (capping, polyadenylation, splicing, RNA editing). Mechanism of translation in prokaryotes and eukaryotes.

Unit 3

Concept of genetic code, Gene expression and regulation in prokaryotes (Lac operon and tryptophan operon). Gene expression and regulation in eukaryotes. Introduction to various types of DNA damage and repair. Retrovirus and cancer.

Unit 4

Mendelism: The basic principles and applications of inheritance, exceptions to mendelian law. The chromosomal basis of Mendelism (chromosomal theory of heredity). The molecular structure of chromosome in eukaryotes: structure of chromatin and Higher order packaging in chromosome. Centromere and telomere Giant chromosome : polytene and lampbrush chromosome. Linkage, Recombination and chromosome mapping in eukaryotes. Cytoplasmic inheritance.

Unit 5

Chromosomal Aberrations: Change in Number and Structure. Allelic variation and Gene function. Sex chromosome and sex determination. Dosage compensation of X-linked gene. Sex linked gene in human. Pedigree analysis in man.

Suggested Reading and Text Books

1. Lewin: Genes, Vol. XII Oxford, 2017, Inded.
2. Straehan & Read: Human Molecular Genetics ,2018, John Wiley & Sons Pte. Ltd.5th Ed.
3. Snustad et al: Principles of Genetics 7th Ed. 2015, John Wiley & Sons.
4. De Robertes & Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger Philadelplna.
5. Strickberger: Genetics, 2015, Prentice Hall.
6. Friefelder: Molecular Biology (2nd ed.), 2005 Narosa Publ. House.
7. Alberts et al: Molecular biology of the cell (7th ed.) 2022, Garland Publ. New York.
8. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to molecular biology and genetics: DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation, concept of genetic code, Mendelism's and concept of chromosomal aberrations.	1 Remembering
CO2	**Perceive** the specific and basic concepts of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. concept of genetic code, Mendelism's and concept of chromosomal aberrations.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation, concept of genetic code, Mendelism's and concept of chromosomal aberrations.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to concepts of genetic code, Mendelism's and concept of chromosomal aberrations, DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation, concept of genetic code, Mendelism's and concept of chromosomal aberrations.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in concept of genetic code, Mendelism's and concept of chromosomal aberrations, DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	2	2	3	3	2	3	3	2	2	2	2	2
CO3	3	3	2	3	3	3	2	2	3	2	2	2	3	2	2	2
CO4	3	2	2	3	2	3	2	2	3	1	3	2	2	2	2	3
CO5	3	2	2	2	2	2	2	2	3	2	2	3	2	2	2	2
CO6	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code : MBTC 104				
Course Name : Biochemistry				
Semester /Year : I				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide exposure to the students on biochemical reactions & processes inside the living system providing the detailed concepts on biomolecules.
2. To broadened the understanding of biochemical changes related to physiological alteration in the body and understanding the chemical aspects of biological processes.
3. To instill students the techniques to analyze kinetic data with the aid of quantification experiments and other qualitative & quantitative analysis as of enzymes and how they catalyze reactions as well as enzyme kinetics.
4. To elucidate metabolism of living system well enough for the prediction and control the various changes that occur in cells with the help of theoretical and practical concepts

Course Contents [Credit = 3]

Unit 1

Enzymes: Classification, overview and specific example Zymogens and their activation (protease and Prothrombin) Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Lock and Key Hypothesis, Induced –Fit Hypothesis, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax . Enzyme inhibition: types of inhibition, suicide Inhibitor.

Unit 2

Carbohydrate – Classification, structure and functions. Carbohydrate Metabolism I: Pathway and regulation of Glycolysis, Gluconeogenesis, Glycogenolysis, Glycogenesis. Carbohydrate Metabolism II: Citric acid cycle and its regulation, electron transport chain and oxidative phosphorylation, pentose phosphate pathway and its regulation.

Unit 3

Protein – Classification, structure and functions. Urea cycle and its regulation. Conversion of nitrogen to ammonia by microorganisms, overview of amino-acid biosynthesis. N_2 fixation.

Unit 4

Fatty Acids - Classification and structure, Fatty Acid Metabolism: Fatty Acid Oxidation and regulation β-oxidation, Oxidation of unsaturated fatty acids and odd chain fatty acids. Ketone bodies and their over production. Fatty Acid Biosynthesis and Regulation. Cholesterol biosynthesis.

Unit 5

Nucleic Acid - structure and functions. Nucleic Acid Metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis and its regulation. Formation of deoxyribonucleotides. Salvage pathway for purine & pyramid in nucleotides, Degradation of purines and pyrimidines into uric acid and urea.

Suggested Reading and Text Books

1. Lehninger: Principles of Biochemistry, 8th ed., Nelson & Cox, WH Freeman and Company, 2017
2. Voet & Voet: Biochemistry, 4th ed., Wiley & Sons 2018.
3. Berg, Tymoczko, Stryer: Biochemistry, 5th ed., WH Freeman and Company, 2003.
4. Garett & Grisham: Biochemistry, 7th ed., Brooks/Cole Cengage learning, 2023.
5. Murray, Granner, Rodwell: Harper's Illustrated Biochemistry, 27th ed. McGraw Hill, 2006.
6. Conn & Stumpf: Outlines of Biochemistry, 5th ed., Willey India, 2007.
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Descriptin	Bloom's Taxonomy Level
CO1	**Reminisce** the define the terms and basic concepts of Biochemistry Enzyme metabolism, Mechanism and their different roles in biological systems, carbohydrates, proteins, fatty acids and nucleic acids.	1 Remembering
CO2	**Perceive** the principle, mechanism of basic and advanced Biochemistry.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed process of structure and function of biomolecules and enzymes.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the coordinated regulation of carbohydrate bisynthesis, Protein bisynthesis and lipid bisynthesis, nucleic acid bisynthesis and enzyme metabolic pathway.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of enzymes and molecules.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the Biomolecules and Enzymes.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	1	1	1	1	3	1	1	1	3	2	1	1
CO2	3	3	1	1	1	1	1	1	3	1	1	1	3	2	1	1
CO3	2	3	3	3	3	3	2	2	3	2	2	2	3	2	2	1
CO4	3	2	3	3	3	3	1	1	3	1	0	1	3	3	2	1
CO5	3	2	3	1	1	1	2	2	3	3	2	1	3	2	1	1
CO6	1	1	1	1	1	1	1	1	2	2	2	1	3	2	2	1

3: High, 2: Medium, 1: Low

Course code : MBTL 105				
Course Name : Laboratory Course-I				
Semester /Year : I				
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents [Credit = 4]

1. To study the cell organelles, basic components of prokaryotic and eukaryotic cells. cellular motility and transportation mechanism
2. To study and provide profound knowledge about the cell ultrastructure, physiological and molecular pathways within cell.
3. To study about the cancer, types, molecular basis of cancer, mutation, genes for cancer and cell death and mode of action.
4. To study the cell-signaling pathways for cellular division or cell cycle and molecular level pathways in a living organisms
5. To provide scientific and computational knowledge related to various techniques associated with biotechnology.
6. To impart laboratory skills for handling analytical tools in industry and research institution.
7. To give the scientific knowledge regarding safety regulations for handling of instruments in the laboratory and industry.
8. To demonstrate the operating procedures associated with upstream and downstream process like chromatography, electrophoresis, centrifugation, etc.

Course code : MBTL 106				
Course Name : Laboratory Course-II				
Semester /Year : I				
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents [Credit = 4]

1. To provide students basic knowledge of DNA isolation from various tissues using molecular biology techniques.
2. To understand, learn and apply the principle, tools and techniques of molecular biology, which prepares students for further study and /or higher education and employment.
3. To provide basic knowledge of Mendelian inheritance, concept and principle of pedigree analysis.
4. To provide basic learning of different genetic crosses to enhance the analytical skills in the students.
5. To provide exposure to the students on biochemical reactions & processes inside the living system providing the detailed concepts on biomolecules.
6. To instill students the techniques to analyze kinetic data with the aid of quantification experiments and other qualitative & quantitative analysis as of enzymes and how they catalyze reactions as well as enzyme kinetics.
7. To broadened the understanding of biochemical changes related to physiological alteration in the body and understanding the chemical aspects of biological processes.
8. To elucidate metabolism of living system well enough for the prediction and control the various changes that occur in cells with the help of theoretical and practical concepts.

Course code : MBTC 201				
Course Name : Immunology				
Semester /Year : II				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To instill detailed study of the molecular and cellular components that comprises the immune system including their function and interaction to provide a lifelong learning & disciplinary knowledge to implement the concepts.
2. To appraise study of the different analytical techniques for the disease diagnosis, assist advancement and career options in the field of molecular diagnostics and applicate as well emerge with the solutions concerned with health and environment.
3. To broaden the area of understanding the structure, function, components of immune system for better advancement & comprehend the need of tools & techniques with broadening the area in distinguished fields.
4. To comprehend the essential elements of immune system clearing up the facts of theoretical and technical aspects and help in employing the scientific knowledge for development of medical interventions.

Course Contents [Credit = 3]

Unit 1

Overview of the Immune System. Cells and Organs of the Immune System. Antigens. Haptens & Epitopes.

Unit 2

Immunoglobulins: Structure and Function. Major Histocompatibility Complex. Antigen processing and presentation. Structure and functions of BCR & TCR.

Unit 3

Cytokines. Complement System. Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis. Ab-dependent cell mediated cytotoxicity (ADCC).

Unit 4

Overview of Hypersensititivity and Introduction to Transplantation. Vaccines: Active and Passive Immunization.

Unit 5

Introduction to Monoclonal Antibodies and polyclonal Antibodies. Antigen-Antibody Interactions RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence.

Suggested Reading and Text Books

1. Kuby : Immunology (8^{th} ed.)2022
2. Roitt, Male & Brostof : Immunology (13^{th} ed)2017.
3. Elgert & Elgert : Immunology 2nd edition (2009)
4. Wilson & Walker: Practical Biochemistry (4^{th} ed.) 1994
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA.	1 Remembering
CO2	**Perceive** the specific and basic concepts of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to concepts of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	2	2	2	2	2	2	2	2	3	2	3	2
CO2	2	2	3	3	3	2	3	3	2	3	3	2	2	2	2	2
CO3	2	3	2	3	3	3	2	2	2	2	3	3	3	2	2	2
CO4	3	2	2	3	2	3	2	2	2	1	3	2	2	2	2	3
CO5	3	2	2	2	2	3	3	3	3	2	2	3	2	2	2	2
CO6	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code	**: MBTC 202**			
Course Name	**: Microbiology & Microbial Genetics**			
Semester /Year	**: II**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide knowledge about the microbial world, classification and study about the branch of bacteriology, virology, and their distinguishing features associated with them such as morphological, chemical, structural and metabolic characteristics.
2. To learn and study about the laboratory guidelines, sterilization methods, aseptic conditions for microbial culture, genetics, microbial nutrients, culture medium, their type and metabolic pathways.
3. To study about the extra-chromosomal genome or plasmids, their types, properties and bacteriophages genetics and understand the techniques used to study the genetic recombination in bacteria and their role in genetic mapping.
4. To study about the different techniques used to elucidate physiological processes of microbes their growth process and their mode of action, principles, tools and techniques for the screening of microbes and to know their beneficial and harmful effects.

Course Contents [Credit = 3]

Unit 1

Classification of living organisms and general account of microorganisms: Bacteria, Fungi and Viruses. Introduction to bacteriology: Fine structure of bacteria; Laboratory identification and staining techniques.

Unit 2

Media for microbial culture, selective Differential media and Enriched media; Pure culture techniques, Sterilization techniques. Introduction to virology: classification, general structure and reproduction of viruses. Cultivation of bacteriophages, Plant Viruses, Animal Viruses.

Unit 3

Microbial growth: Synchronous & Diauxic, Factors affecting Microbial growth, Measurement of microbial growth (cell number & cell count). Modes of nutrition: Photoautotrophs, photoorganotrophs, chemolithotrophs, Chemoorganotrophs. Microbial metabolism: Overview of Energy production and utilization, N_2 fixation.

Unit 4

Modes of Genetic Recombination in Bacteria: Conjugation – F-factor, conjugal transfer process, high frequency recombination (hfr) strains. Transformation – competence, DNA uptake by competent cells. Mechanism of transformation.

Unit 5

Transduction – General & specialized transduction. Genetics of bacteriophages: Lytic and lysogenic cycle, expression of phage genes in regulation of lytic and lysogenic circuit.

Suggested Reading and Text Books

1. Tortora, Funke, Case: Microbiology, (14th ed.) Pearson Education, Inc, 2023.
2. Prescott, Harley & Kliens: Microbiology (7th ed.) McGraw-Hill International Edition, 2008.
3. Michael J. Pelczar, E.C.S. Chan, Noel R. Krieg: Microbiology (5th ed.) Tata McGrall-Hill, 2008.
4. Alcamo's Jeffrey C. Pommerville: Fundamental of Microbiology (12th ed.) Jones & Bartlet Publ. 2021.
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different concept of fundamentals, History and Evolution of Microbiology, microbial diversity, Cultivation and Maintenance of microorganisms, Microbial growth, Microbial Metabolism, Bacterial Reproduction, Control of Microorganisms, water microbiology and food	1 Remembering
CO2	**Perceive** the concept of fundamentals, History and Evolution of Microbiology, microbial diversity, Microbial growth, Microbial Metabolism, Bacterial Reproduction, Control of Microorganisms, water microbiology, food microbiology and Cultivation and Maintenance of	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of microbiology, genetic recombination in microbiology, diversity and metabolism of microbiology along with Control of pathogenic microorganisms, water microbiology and food	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to different concept of microbiology, genetic recombination in microbiology, diversity and metabolism of microbiology along with Control of pathogenic microorganisms, water microbiology and food microbiology.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of essential techniques and features of microbiology, genetic recombination in microbiology, diversity and metabolism of microbiology along with Control of pathogenic microorganisms, water microbiology and food microbiology.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the Take part in essential techniques and features of microbiology, genetic recombination in microbiology, diversity and metabolism of microbiology along with Control of pathogenic microorganisms, water microbiology and food microbiology.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	3	3	2	3	2	2	2	3	2	1	2
CO2	3	2	2	3	3	2	1	3	3	3	3	3	3	2	1	2
CO3	3	3	2	2	3	3	2	2	3	2	2	2	2	2	2	2
CO4	3	3	3	3	2	3	2	2	3	1	1	1	2	3	2	2
CO5	3	2	3	2	2	2	2	2	3	3	2	3	2	2	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3: High, 2: Medium, 1: Low

Course code : MBTC 203				
Course Name : Molecular Endocrinology & Enzymology				
Semester /Year : II				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide the basic knowledge of endocrinology and their molecular aspects.
2. To provide the basic knowledge of endocrine glands, functions and their molecular aspects.
3. To provide the basic knowledge about enzymatic reactions and factors effecting it.
4. To instill the concept and fundamentals about the classification of enzymes.
5. To provide exposure to students about mechanism of enzyme actions and industrial use of enzyme.

Course Contents [Credit = 3]

Unit 1

Mechanism of hormone action: Signal discrimination, signal transduction and signal amplification. Receptors: identification and physico-chemical properties. Hormone-receptor interaction, binding to cellular receptors. Pineal hormone.Pineal as a photo-transducer. Biosynthesis, secretion and physiological actions of protein hormones.

Unit 2

Biosynthesis, control of secretion & physiological actions of amino acid derived hormones (Thyroid).Environmental Iodine deficiency disorders and thyroid.Pancreatic hormones.

Biosynthesis of steroid hormones: Steroidogenesis, cellular sites of synthesis. Physiological actions of estrogen, progesterone. Hormonal control of Estrus/ Menstrual cycle.

Unit 3

Biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions. Stress & Adrenal. Brief introduction to female & male infertility (causes and diagnosis).

Unit 4

Historical perspectives of enzyme. Isolation, crystallization and purification of enzymes, Methods of enzyme analysis. Enzyme technology: Methods for large scale production of enzymes. Immobilized and soluble enzymes and their application. Artificial enzyme. Enzyme electrodes, Enzyme reactors. Two substrate reactions: Random ordered and ping pong mechanism.

Unit 5

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: nucleophillic and covalent. Mechanism of reactions catalyzed by enzymes. Specific examples: chymotrypsin, lysozyme, ribonuclease and carboxypeptidase. Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Concerted and sequential models. Isozymes special reference to lactate dehydrogenase. Ribozymes.

Suggested Reading and Text Books

1. Endocrinology, Mac E. Hadley: Prentice-Hall International Sixth ed. 2009.
2. Basic and Clinical Endocrinology, F.S. Greenspan & P.H. Forsham: Maruzen Asian Ed. Lange Medical Publ. USA, Singapore 10th edition 2017
3. Williams Textbook of Endocrinology, Wilson Foster, 15th Ed..Saunders Inter. ed. London, 2024.
4. Essential Endocrinology John F. Laycock Peter H. Wise: 3rd edition, 1996.
5. Lodish et al. Molecular Cell Biology 9th edition
6. Ross & Stanbury: Plant Physiology 7th edition 2022
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of general character of endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1 Remembering
CO2	**Perceive** the specific and basic concepts and applications of endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	3	3	3	3	2	3	2	3	2	2	2	2	2
CO3	3	2	2	2	2	3	3	3	3	2	3	3	3	2	2	3
CO4	3	3	2	3	3	2	2	2	3	1	3	2	3	3	3	3
CO5	2	3	3	3	3	3	3	2	3	2	2	3	3	3	3	3
CO6	1	2	2	2	1	1	1	1	3	2	2	1	1	1	1	1

3: High, 2: Medium, 1: Low

Course code : MBTC 204				
Course Name : Biomaths, Biostats, Computers Programming & Applications				
Semester /Year : II				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To learn to define and find the solution of arithmetic mean, median and mode, Quartiles, deciles and percentiles.
2. To demonstrate knowledge of chi square test, t-test, distributions, correlation and regression.
3. To develop the concepts of moments, skewness and kurtosis and determining whether the given distribution is normal or not.
4. To understand and illustrate the theory and applications of the probability.
5. To demonstrate computer programming and components of a computer system.

Course Contents [Credit = 3]

Unit 1

Relation of Life Science with mathematics, Linear function concept, 0.5 coordinate system, trigonometry relations, differentiation & integration concept, logarithms, complex numbers, Plotting of graphs, matrices.

Unit 2

Importance of statistics in biomedical research. Mean, Mode, median, range, mean deviation, standard deviation, standard error, skewness & kurtosis. Correlation & Regression. Probability: Theorems, Addition rules, multiplication rules, probability applications, probability distributions- Binomial, Poisson & Normal Distributions.

Unit 3

Chi square test-characteristics of Chi square test, validity of Chi square test, applications of Chi square test. Test for significance- comparison of means of two samples, comparison of means of three or more samples (f-test, t-test).

Unit 4

Introduction to algorithm, flowchart, problem solving methods, need for computer language, reading C Programs, C Character sets, identifier & keywords, data types, constants & variables, pre-processor directives, operators & expressions, control statements, for, while, do-while loops, if-else, switch, break, continue & goto statements.

Unit 5

Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units). Data storage device, Memory concepts. Software and types of software. Elementary idea of Disk operating system (DOS). Elementary ideas of applications of common packages, WINDOWS (95, 98). Computer applications in biology and information communications (databases,e-mail and local networks). Applications of common packages, Microsoft Office: Microsoft word, Microsoft excel, Microsoft Power Point.

Suggested Reading and Text Books

1. Rajaraman V: Computer Programming in “C”. PHI 2nd edition 2018.
2. Yashwant Kanetker: Let us “C” BPB. 19th edition 2023
3. Peter Norton’s: Introduction to Computer 6th Edition 2004.
4. Hoel, P.G: Elementary Statistics John Wiley & Sons, Inc. New York.
5. Mahajan: Methods in Biostatistics (11th ed.) Jaypee Bros. 2024.
6. Sokal & Rohlf: Introduction to Biostatistics, Freeman, Toppan, 2nd Edition 2009.
7. D. Rajaraman & V. Rajaraman: Computer primer (2nd ed.) 1980 Prentice Hall of India, New Delhi.
8. Roger Hunt & John Shelley: Computer and Commonsense Prentice Hall of India, New Delhi 2nd Ed 1979.
9. Norton, Peter: Introduction to Computers (6th ed.), TMH Publishing Company Ltd., New Delhi.

10. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character and concepts of biostatistics, Biomaths and computer applications: Relation of Life Science with mathematics, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences. Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units).	1 Remembering
CO2	**Perceive** the specific and basic concepts of measurement of biostatistics, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences. Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units).	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of biostatical analysis, Types of Data, Measures biostatical analysis, Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units), Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to measurement of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the measurement of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences. Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units).	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	2	2	2	2	2	2	3	2	3	3	3	3
CO3	2	3	2	2	3	3	3	2	3	2	2	2	2	2	2	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

Course code : MBTL 205				
Course Name : Laboratory Course-I				
Semester /Year : II				
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents [Credit = 4]

1. To teach students about the diagnostic significance, Principles of ELISA, RIA, Immunodiffusions etc in clinical approaches and their limitations.
2. To introduce students to the challenges involved in diagnostics & health.
3. To adhere skills regarding the use of all laboratory devices related to immunological tests and kits.
4. Demonstrate the ability to recognize and admit mistakes or discrepancies in laboratory protocols or results and, take appropriate corrective measures.
5. To study about the microbiology techniques and methods for sterilization.
6. To be expertise in isolation, identification, preservation of microbial cell.
7. To learn the about the methods of the preparation of culture media for the cultivation, microbial culture and their analysis.
8. To be expertise in handling of biological samples and analysis of microbial growth pattern or data.

Course code : MBTL 206				
Course Name : Laboratory Course-II				
Semester /Year : II				
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents [Credit = 4]

1. To provide the basic knowledge of endocrinology and their molecular aspects.
2. To provide the basic knowledge of endocrine glands, functions and their molecular aspects.
3. To provide the basic knowledge about enzymatic reactions and factors effecting it.
4. To instill the concept and fundamentals about the classification of enzymes.
5. To provide exposure to students about mechanism of enzyme actions and industrial use of enzyme.
6. To learn to define and find the solution of arithmetic mean, median and mode, Quartiles, deciles and percentiles.
7. To demonstrate knowledge of chi square test, t-test, distributions, correlation and regression.
8. To develop the concepts of moments, skewness and kurtosis and determining whether the given distribution is normal or not.
9. To understand and illustrate the theory and applications of the probability.
10. To demonstrate computer programming and components of a computer system.

Course code	**: MBTC 301**			
Course Name	**: Recombination DNA Technology & Genomics**			
Semester /Year	**: III**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. This course offer students to learn about molecular basis tools and technology used in genetic engineering, modern molecular diagnosis methods.
2. Demonstrate the study working principle of various instrument utilized in RDT.
3. To identify the ethical values related to transgenic and recombinant DNA technology.
4. To develop team effort practices within students with experiments of recombinant DNA technology in the field of modern biomedical science, agriculture.

Course Contents [Credit = 3]

Unit 1

Introduction to Recombinant DNA technology and applications. Cloning vector: Plasmids, Phages, cosmids, Yeast cloning vectors, Animal and plant viruses as vectors. BAC, PAC & YAC. Nucleic acid modifying enzymes. Restriction endonuclease. Isolation of nucleic acid from plant, animal & bacteria.

Unit 2

Basic steps of gene cloning: Construction of cDNA and genomic libraries. Selection of r DNA clones and their expression products, chromosome walking. Expression of cloned genes in heterologous host. Probe labeling and hybridization. Blotting techniques: Southern, Northern and Western blotting (Methodologies and applications)

Unit 3

DNA sequencing: chemical and enzymatic methods. PCR. Site directed mutagenesis. Ribonuclease protection assay, Gel retardation assay, DNA foot printing, DNA finger printing, DNA profiling.

Unit 4

Genomic analysis: Exon-intron trapping, S-1 mapping, RFLP, RAPD, AFLP. Transgenic Technology (Plant & Animals).

Unit 5

Gene therapy: Principles, strategies and ethics of gene therapy. Genomics. Human Genome Project-Strategy and implications.

Suggested Reading and Text Books

1. Gene cloning T.A Brown 8th edition 2020.
2. Molecular Biotechnology 6th edition 2022, Glick & Pasternak: Panima Publ. Corporation, 1994
3. Molecular biology & Biotechnology (7thed), Walker & Gingold: Panima Publ. Corporation,2020
4. Lewin: Genes, Vol. XII Oxford, 2018, Inded.
5. Straehan & Read: Human Molecular Genetics 2nd edition 1999, John Wiley & Sons Pte. Ltd.
6. Gene cloning, Glover: 1984 2nd edition
7. Recombinant DNA, Watson et al: 3rd edition 2006
8. Genetic Engineering Vol. 1-4, Villiamson (ed) 1982
9. Genetic Engineering Vol. 1-7 Setton and Bolanden (ed) 2009

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants.	1 Remembering
CO2	**Perceive** the specific and basic concepts of basic principle components of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants. Develop understanding of various modern tools, instruments and RDT techniques and their utilization to solve the society and industry-related problems.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants. Apply the basic and advanced recombinant DNA techniques for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to concepts of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants. Comprehend the range of molecular biology techniques for DNA or genome profiling, DNA sequencing/synthesis. Knowledge of the biological systems information and the explanation of the key concepts Omics technologies-genomics.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants. Demonstrate an understanding of transgenic technology and applications in health, agriculture and environment, alongwith associated social and environmental issues.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants. Acquire domain-specific knowledge and develop globally-relevant skills for academic and professional enhancement.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	2	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	3	3	3	2	3	2	2	3	3	3	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	3	3	2	2	2	3	3

3: High, 2: Medium, 1: Low

Course code	**: MBTC 302**			
Course Name	**: Bioinformatics, Legal Biotechnology & Bio Business Management**			
Semester /Year	**: III**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide scientific and computational knowledge related to various techniques associated with biotechnology.
2. To impart laboratory skills for handling analytical tools in industry and research institution.
3. To give the scientific knowledge regarding safety regulations for handling of instruments in the laboratory and industry.
4. To demonstrate the operating procedures associated with upstream and downstream process like chromatography, electrophoresis, centrifugation, etc.

Course Contents [Credit = 3]

Unit 1

Introduction to bioinformatics. Objectives, Application and Scopes, IT in biology, bioinformatics resources on NET, Internet, Word wide web, Web Browsers. Biological databases-Primary, secondary database, Bibliographics, GEN BANK, EMBL, DDBJ, SWISSPROT. Search engine-Entrez, SRS Web Server-NCBI, EBI.

Unit 2

Sequence alignment and applications: Local and Global alignment; Scoring Matrices; Homology and related concepts; Dot matrix; general gap, gap penalty. Dynamic Programming methods for global and local alignments; sequence similarity searching tools – FASTA, BLAST; Statistical and biological significance. Multiple Sequence alignment and applications. AI & ML in Bioinformatics. Application of AI in Biotechnology.

Unit 3

Legal and IPR issues in Biotechnology, Intellectual Property Protection (IPP), Trade secret protection, licensing of bio-product, procedure for obtaining patent, characteristics of the disclosure for a biotechnology invention, marketing, a biotechnology invention, trade regulations.

Unit 4

Worldwide market scenario of biotechnology based business, Biobusiness prospective in India. Management Process & organization, General analysis of Indian Biobusiness, Project formulation and selection based on size, technological assessment, technical report, feasibility and commercial viability of project.

Unit 5

Total product cost, capital investment and profitability, manufacturing and cost estimation for biological products for R & D decision making. Marketing management and consumer behavior, Marketing of pharmaceuticals and other bioproducts.

Suggested Reading and Text Books

1. Lesk: Introduction to Bioinformatics 5th edition 2019, Wiely Publication.
2. Primrose and Twyman: Principles of genomes and genomics 3rd edition 2009.
3. ROM and Holmas EC: Molecular Evolution: a phylogenetic approach, Blackwell science.
4. Des Higgins and Willie Taylor: Bioinformatics: Sequences, structure and databanks, Oxford University Press. P. Narayan: Patent Law.
5. S. L Rao: Economic reforms and Indian markets.
6. Sharma, Munjal, Shankar: A Text Book of Bioinformatics, Rastogi Publication.
7. Bioinformatics: Methods and Applications Genimics Proteomics and Drug Discovery, S C Rastogi, N.
8. Mendiratta, P. Rastogi: Prentice Hall of India Private Ltd.
9. Manual of Industrial Microbiology and Biotechnology by A. L. Demain and N.A. Solomon 3rd edition.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to bioinformatics, legal biotechnology & bio Business management: Introduction to bioinformatics, objectives, application and scopes, Sequence alignment and applications, legal and IPR issues in biotechnology, Worldwide market scenario of biotechnology based business and total product cost, capital investment and profitability, manufacturing and cost estimation for biological products for R & D decision making.	1 Remembering
CO2	**Perceive** the specific and basic concepts of basic principle components of bioinformatics, legal biotechnology & bio Business management: Introduction to bioinformatics, objectives, application and scopes, Sequence alignment and applications, legal and IPR issues in biotechnology, Worldwide market scenario of biotechnology based business and total product cost, capital investment and profitability, manufacturing and cost estimation for biological products for R & D decision making and their utilization to solve the society and industry-related problems.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of bioinformatics, legal biotechnology & bio Business management: Introduction to bioinformatics, objectives, application and scopes, Sequence alignment and applications, legal and IPR issues in biotechnology, Worldwide market scenario of biotechnology based business and total product cost, capital investment and profitability, manufacturing and cost estimation for biological products for R & D decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to concepts of bioinformatics, legal biotechnology & bio Business management: Introduction to bioinformatics, objectives, application and scopes, Sequence alignment and applications, legal and IPR issues in biotechnology, Worldwide market scenario of biotechnology based business and total product cost, capital investment and profitability, manufacturing and cost estimation for biological products for R & D decision making knowledge of the biological systems information and the explanation of the key concepts Omics technologies-genomics.	1,2,3,4 Remembering, Understanding, Applying, Analysing

CO5	**Assess** the principle, methods, properties and functions of bioinformatics, legal biotechnology & bio Business management: Introduction to bioinformatics, objectives, application and scopes, Sequence alignment and applications, legal and IPR issues in biotechnology, Worldwide market scenario of biotechnology based business and total product cost, capital investment and profitability, manufacturing and cost estimation for biological products for R & D decision making.Demonstrate an understanding of transgenic technology and applications in health, agriculture and environment, alongwith associated social and environmental issues.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in bioinformatics, legal biotechnology & bio Business management: Introduction to bioinformatics, objectives, application and scopes, Sequence alignment and applications, legal and IPR issues in biotechnology, Worldwide market scenario of biotechnology based business and total product cost, capital investment and profitability, manufacturing and cost estimation for biological products for R & D decision making. Acquire domain-specific knowledge and develop globally-relevant skills for academic and professional enhancement.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	3	3	2	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	3	3	3	2	3	2	2	3	3	3	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	3	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	3	3	2	2	2	3	3

3: High, 2: Medium, 1: Low

Course code : MBTL 303				
Course Name : Laboratory Course-I				
Semester /Year : III				
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents [Credit = 4]

1. This course offer students to learn about molecular basis tools and technology used in genetic engineering, modern molecular diagnosis methods.
2. Demonstrate the study working principle of various instrument utilized in RDT.
3. To identify the ethical values related to transgenic and recombinant DNA technology.
4. To develop team effort practices within students with experiments of recombinant DNA technology in the field of modern biomedical science, agriculture.
5. To study about the molecular biology techniques, bio-informatics tools and databases for genomic sample collection, preparation and estimation.
6. To learn the about the methods of protein and genome estimation and separation.
7. To be expertise in running of programs, bio-informatics tools, software and instruments for the genomic data analysis.
8. To develop practical skill in handling of biological samples, pedigree chart, analysis of inheritance pattern.
9. To provide scientific and computational knowledge related to various techniques associated with biotechnology.
10. To impart laboratory skills for handling analytical tools in industry and research institution.
11. To give the scientific knowledge regarding safety regulations for handling of instruments in the laboratory and industry.
12. To demonstrate the operating procedures associated with upstream and downstream process like chromatography, electrophoresis, centrifugation, etc.

Course code : MBTE 304				
Course Name : Food and Beverages Biotechnology				
Semester /Year : III				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide scientific knowledge related to various techniques associated with Food and Beverages Biotechnology.
2. To impart laboratory skills for handling analytical tools in Food and Beverages industry and research institution.
3. To give the scientific knowledge regarding safety regulations for handling of instruments in the laboratory and industry.
4. To demonstrate the operating procedures associated with upstream and downstream process related to Food and Beverages.

Course Contents [Credit = 3]

Unit 1

Food and Microorganism: Microorganism in food & beverage industry, contamination of food. General principles underlying spoilage and chemical changes

Unit 2

Contamination and spoilage of different kinds of food & beverages: Cereals & cereal products, sugar and sugar products, vegetables and fruits, meat, fish, poultry & eggs,sea food, milk & milk products, canned foods, Alcohol & alcoholic beverages fruit juices & soft drinks etc.

Unit 3

Biotechnology of food and feed; cultures & fermentation,Beverage production: Alcohol & alcoholic beverages, fruit furies, soft drinks, feed production, SCP, fats, amino acid, food additives.

Unit 4

Food, Beverages & Disease : Food borne illness due to bacterial food poisoning, infection and intoxication. Food-borne disease outbreaks, Disease-investigation, Materials & Equipments, laboratory testing, field analysis, interpretation of data and preventive measures.

Unit 5

Food hygiene: Food sanitation, Bacteriology of water and food products, food manufacturing practice. Hazard Analysis Critical Points. Processing Industry and Microbial criteria of food. Principles of food preservation: Preservation by high temperature, low temperatures, Drying, Food additives and Radiation.

Suggested Reading and Text Books

1. Food Sciences and Food biotechnology- G.F.G. Lopez, G. Canaas, E.V.Nathan 2003
2. Genetically Modified Foods- M.Ruse, D. Castle (Eds.) 2002
3. Biotechnology of Food Crops in Developing Countries- T.Hohn and K.M. Leisinger (Eds.) 1999
4. Biotechnology and Food Process Engineering- H.G. Schwartzberg, M.A. Rao (Eds.) 1990
5. Food Biotechnology- (Eds.) R.Angold, G.A.Beech, J.Taggart 1989.
6. Food Biotechnology—Microorganisms- (Ed.) Y.H. Hui et al 1994.
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Development of scientific and analytical knowledge regarding various tools and techniques in the field of Food and Beverages Biotechnology. Food, Beverages & Disease : Food borne illness due to bacterial food poisoning, infection and intoxication, Food and Microorganism Contamination and spoilage of different kinds of food & beverages and Food hygiene.	1 Remembering
CO2	**Perceive** the specific and basic concepts of basic principle components of tools and techniques in the field of Food and Beverages Biotechnology. Food, Beverages & Disease : Food borne illness due to bacterial food poisoning, infection and intoxication, Food and Microorganism Contamination and spoilage of different kinds of food & beverages and Food hygiene and their utilization to solve the society and industry-related problems.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of apply modern techniques in spoilage and contamination for solving various scientific problems in food industry and food and beverages related research institution.decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge regarding safety regulations for handling of hazardous microbes, chemicals and food hygiene in the laboratory decision making Knowledge of the biological systems information and the explanation of the key concepts. Demonstrate the biotechnological principles and working food and feed.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of the scientific knowledge regarding safety regulations for handling of hazardous microbes, chemicals and food hygiene in the laboratory decision making Knowledge of the biological systems information and the explanation of the key concepts of Food and Beverages Biotechnology. Demonstrate an understanding of transgenic technology and applications in health, agriculture and environment, alongwith associated social and environmental issues.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating

CO6	**Constructing** the take part in the scientific knowledge regarding safety regulations for handling of hazardous microbes, chemicals and food hygiene in the laboratory decision making Knowledge of the biological systems information and the explanation of the key concepts of Food and Beverages Biotechnology. Acquire domain-specific knowledge and develop globally-relevant skills for academic and professional enhancement.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	3	2	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	3	3	3	2	3	2	2	3	3	3	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	3	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	3	3	2	2	2	3	3

3: High, 2: Medium, 1: Low

Course code	**: MBTE 305**			
Course Name	**: Research Methodology: Tools & Techniques**			
Semester /Year	**: III**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
2. To acquire knowledge on measurement & scaling techniques as well as the quantitative data analysis.
3. To acquire knowledge regarding awareness of data analysis-and hypothesis testing procedures.
4. To develop data analytics skills and meaningful interpretation to the data sets so as to solve the business/Research problem.

Course Contents [Credit = 3]

Unit 1

Importance and need of scientific research. Problem identification, obective, significance, scope and limitations. Literature survey: use of books, journal, libraries, online survey. Importance and designing of the problem to be undertaken.

Unit 2

Fiel Survey, Site Selection, Source selection for data acquisition. Sampling technique: Simple and random Sampling, Systematic sampling, Stratified sampling, multistage sampling, Cluster sampling, Multiphase sampling, sample size, frequency, Bias, Error

Unit 3

Methods: Data collection, type of data, Qualitative and quantitative data. Primary and secondary data. Data representation: Tabular and diagrammatic representationof data. Measures of central tendency: use of mean, mode, median, data interpretation.

Unit 4

Measures if dispersion: use of range , variance, standard deviation, standard error. Correlation, multiple correlations, Regression, multiple regressions, standard error of estimate. Test of significance: t-test, 95% confidence limit, Chi square test, F test, Multivariate test.

Unit 5

Proect Report: Preparation, introduction of the problem, Materials and Methods, Review of literaturre, Results, Discussion (interpretation of results), Referencing technique, summary of research/abstract etc. Publication of scientific data, writing research paper and report.

Suggested Reading and Text Books

1. Holmes, Moody, Dine: Research Methods for the Biosciences, 3rd Indian ed., Oxford University Press, 2017.
2. N. Gurumani: Research Methodology for Biological Sciences, 1st ed., MJP Publishers, 2008.
3. Wilson and Walker: Principles & Techniques, 8th ed. Cambridge low price ed., 2018.
5. Schmauder: Methods in Biotechnology, Taylor & Francis Publishers, 2003
6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of research methodology, tools and techniques: Acquire knowledge on measurement & scaling techniques as well as the quantitative data analysis. Importance and need of scientific research, Fiel Survey, Site Selection, Source selection for data acquisition, Methods: Data collection, type of data, Qualitative and quantitative data, Measures if dispersion and project report.	1 Remembering
CO2	**Perceive** the specific and basic concepts and applications of research methodology, tools and techniques: Acquire knowledge on measurement & scaling techniques as well as the quantitative data analysis. Importance and need of scientific research, Fiel Survey, Site Selection, Source selection for data acquisition, Methods: Data collection, type of data, Qualitative and quantitative data, Measures if dispersion and project report.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of research methodology, tools and techniques: Acquire knowledge on measurement & scaling techniques as well as the quantitative data analysis. Importance and need of scientific research, Fiel Survey, Site Selection, Source selection for data acquisition, Methods: Data collection, type of data, Qualitative and quantitative data, Measures if dispersion and project report. Publication of scientific data, writing research paper and report.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to research methodology, tools and techniques: Acquire knowledge on measurement & scaling techniques as well as the quantitative data analysis. Importance and need of scientific research, Fiel Survey, Site Selection, Source selection for data acquisition, Methods: Data collection, type of data, Qualitative and quantitative data, Measures if dispersion and project report. Publication of scientific data, writing research paper and report.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the research methodology, tools and techniques: Acquire knowledge on measurement & scaling techniques as well as the quantitative data analysis. Importance and need of scientific research, Fiel Survey, Site Selection, Source selection for data acquisition, Methods: Data collection, type of data, Qualitative and quantitative data, Measures if dispersion and project report. Publication of scientific data, writing research paper and report.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating

CO6	**Constructing** the take part in research methodology, tools and techniques: Acquire knowledge on measurement & scaling techniques as well as the quantitative data analysis. Importance and need of scientific research, Fiel Survey, Site Selection, Source selection for data acquisition, Methods: Data collection, type of data, Qualitative and quantitative data, Measures if dispersion and project report. Publication of scientific data, writing research paper and report.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	3	3	3	3	2	3	2	3	2	2	2	2	2
CO3	3	2	2	2	2	2	2	3	3	2	3	3	3	2	2	3
CO4	3	3	2	3	3	2	2	2	3	1	3	2	3	3	3	3
CO5	2	3	2	2	2	2	2	2	3	2	2	3	3	3	3	3
CO6	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code	**: MBTE 306**			
Course Name	**: Chemical Sciences & Biomaterials**			
Semester /Year	**: III**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To acquire knowledge polymer materials, biodegradable materials and bioactive polymers.
2. To develop knowledge about Biocompatibility of biomaterials.
3. To acquire knowledge regarding awareness of chemical sciences and biomaterials.
4. To develop analytics skills and meaningful interpretation to blood compatibility, Interactions of bacteria with biomaterials, Cardio vascular applications and Orthopedic applications

Course Contents [Credit = 3]

Unit 1

Polymer materials: synthesis, characterization (inter polymers, biodegradable polymers, hydro gels, natural polymers, genetically engineered polymers, Bioactive polymers).

Unit 2

Biocompatibility of biomaterials, protein structure, interaction of proteins with synthetic materials; methods for evaluating protein adsorption.

Unit 3

Cell: interactions with proteins and materials, characterization of cell material interaction, Blood compatibility: platelets adhesion and aggregation, coagulation effects.

Unit 4

The mechanical environment: In vitro assessment of blood compatibility, Interactions of bacteria with biomaterials: methods of sterilization, assessment of sterility. Design of biocompatible materials: modification of materials to improve biocompatibility.

Unit 5

Cardio vascular applications: grafts, catheters, stents valves, embolic agents. Orthopedic applications: joint prostheses, fracture fixation devices, interaction of bone with implanted materials and resulting complications. Drug delivery: types of devices, targeting gene therapy, stability of drug in contact with biomaterials.

Suggested Reading and Text Books

1. Remingtons Pharmaceutical Sciences, 23th editions, Lippincott, William and Wilkins 2020.
2. Ansel's Pharmaceutical Dosage forms and drug Delivery System 10th edition by Loyd V, Allen, Nicholas G., Popovich, Howardc. Ansel, Publisher Lippincott, Williams and Wilkins 2021.
3. Remingtons: The science and practice of Pharmacy 23rd Edition, 2020.
4. An Introduction to Biocomposites Vol 1 (2004) by Seeram Ramakrishna et al World Scientific Publishing Company 1st Edition, 2004
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to chemical sciences and biomaterials: Polymer materials, biocompatibility of biomaterials, cell: interactions with proteins and materials, the mechanical environment, interaction of bacteria with biomaterials, cardio vascular applications and drug targeting.	1 Remembering
CO2	**Perceive** the specific and basic concepts of basic principle components of tools and techniques in the field of chemical sciences and biomaterials: Polymer materials, biocompatibility of biomaterials, cell: interactions with proteins and materials, the mechanical environment, interaction of bacteria with biomaterials, cardio vascular applications and drug targeting and their utilization to solve the society and industry-related problems.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of apply modern techniques in spoilage and contamination for solving various scientific problems in food industry and food and beverages related research institution.decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge of chemical sciences and biomaterials: Polymer materials, biocompatibility of biomaterials, cell: interactions with proteins and materials, the mechanical environment, interaction of bacteria with biomaterials, cardio vascular applications and drug targeting. Knowledge of the chemical sciences in biological systems information and the explanation of the key concepts. Demonstrate the biotechnological principles and working food and feed.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of chemical sciences and biomaterials: Polymer materials, biocompatibility of biomaterials, cell: interactions with proteins and materials, the mechanical environment, interaction of bacteria with biomaterials, cardio vascular applications and drug targeting. Knowledge of the chemical sciences in biological systems information and the explanation of the key concepts and applications in health, agriculture and environment, alongwith associated social and environmental issues.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating

CO6	**Constructing** the take part in the scientific knowledge regarding chemical sciences and biomaterials: Polymer materials, biocompatibility of biomaterials, cell: interactions with proteins and materials, the mechanical environment, interaction of bacteria with biomaterials, cardio vascular applications and drug targeting. Knowledge of the chemical sciences in biological systems information and the explanation of the key concepts. Knowledge Acquire domain-specific knowledge and develop globally-relevant skills for academic and professional enhancement.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	3	2	2	2	3	2	2	2	3	2	3	2
CO2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	1	1	1	1	1	2	2	1	3	2	2	2	1	3

3: High, 2: Medium, 1: Low

Course code	**: MBTE 307**			
Course Name	**: Pharmaceutical Biotechnology & Drug Designing**			
Semester /Year	**: III**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the Concept, Need and Importance of Biotechnology in Pharmaceutical Biotechnology & Drug Designing.
2. To demonstrate the scientific method and the use of problem-solving within the field of Pharmaceutical Biotechnology & Drug Designing.
3. To develop scientific knowledge regarding vaccines and role of biotechnology in development of pharmaceutical drugs.
4. To demonstrate the scientific method and the use of Drug targeting and drug delivery systems.

Course Contents [Credit = 3]

Unit 1

Delivery considerations of biotechnological products: Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification(protein engineering), Toxicology profile characterization.

Unit 2

Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.

Unit 3

Vaccines: Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotype vaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems.

Unit 4

Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation.

Unit 5

Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.

Suggested Reading and Text Books

1. Leon Lachman. Theory and Practice of Industrial Pharmacy, 4th Edition, Lea and Febiger, 2017 .
2. Remington's Pharmaceutical Science, Mark Publishing and Co 23rd edition 2020.
3. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling.	1 Remembering
CO2	**Perceive** the specific and basic concepts of basic principle components of tools and techniques in the field of Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling and their utilization to solve the society and industry-related problems.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of apply modern techniques in Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling.related research institution.decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge of Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling. Knowledge of the pharmaceutical sciences and drug designing in biological systems information and the explanation of the key concepts.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling. Knowledge of the pharmaceutical sciences and drug designing in biological systems information and the explanation of the key concepts and applications in health, agriculture and environment, alongwith associated social and environmental issues.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating

CO6	**Constructing** the take part in the scientific knowledge regarding Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling. Knowledge Acquire domain-specific knowledge and develop globally-relevant skills for academic and professional enhancement.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	3	2	2	2	3	2	3	2
CO2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	1	1	1	1	2	2	1	3	2	2	2	1	3

3: High, 2: Medium, 1: Low

Course code : MBTE 308				
Course Name : Plant Biotechnology				
Semester /Year : III				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To enable students acquire knowledge of the fundamental principles of plant tissue culture.
2. To learn about different kinds of plant culture techniques.
3. To make students understand the principles of Agrobacterium tumefaciens biology and Ti-plasmid.
4. To impart knowledge about the diverse applications of plant biotechnology and genetically- modified crops.

Course Contents [Credit = 3]

Unit 1

Clonal propagation/micropropagation and its applications to horticulture and forestry. Production of disease free plants. Incompatibility in plants. Methods to overcome incompatibility.

Unit 2

Somatic embryogenesis and production of synthetic seeds. Selection of stress tolerant cell lines, resistance to cold, high temperature, salt, drought, diseases and inhibitors. Conservation of plant genetic resources in vitro, its applications and limitations.

Unit 3

Application of Plant Transformation for productivity and performance: herbicide resistance, insect resistance, Bt genes, non-Bt like protease inhibitors, alpha amylase inhibitor, disease resistance, nematode resistance.

Unit 4

Control mechanisms and manipulation of phenyl propanoid pathway, shikimate pathway; alkaloids, industrial enzymes, biodegradable plastics, therapeutic proteins.

Unit 5

Biofertilisers, Ecological risks of transgenic crop and global market, Biodiversity and its conservation, germplasm collection. Restoration of degraded lands , Nurserry technology, green house technology.

Suggested Reading and Text Books

1. P.K. Gupta: Elements of Biotechnology, Rastogi and Co. Meerut, 1996
2. R.J. Hanry: Practical Application of Plants Molecular Biology, Champan and Hall, 1997
3. H.D. Kumar: Modern Concepts of Biotechnology, Vikas Publ. Pvt. Ltd.
4. B.D. Singh: Biotechnology, Kalyani Publ.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria.	1 Remembering
CO2	**Perceive** the specific and basic concepts of plant biotechnology, cryo and organogenic differentiation, types of culture, Somatic embryogenesis and production of synthetic seeds , In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Somaclonal variation nomenclautre, methods, applications basis and disadvantages.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Somaclonal variation nomenclautre, methods, applications basis and disadvantages	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Somaclonal variation nomenclautre, methods, applications basis and disadvantages.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Control mechanisms and manipulation, Somaclonal variation nomenclautre, methods, applications basis and disadvantages	1,2,3,4,5 Remembering, Understanding, Applying, Analysing,
CO6	**Constructing** the take part in plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Biofertilisers, Ecological risks of transgenic crop and global market, Biodiversity and its conservation Somaclonal variation nomenclautre, methods, applications basis and disadvantages.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code	**: MBTE 309**			
Course Name	**: Advanced Bioinformatics**			
Semester /Year	**: III**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To acquire sound knowledge pertaining to concepts of bioinformatics, its resources on Internet and to identify their application and scope.
2. To study structure, format and applications of biological databases; different softwares and techniques utilized for sequence alignment, searching databases, phylogentic studies, gene identification tools, search engines.
3. To comprehend concepts and acquire knowledge of advanced bioinformatics.
4. To make students understand about various bioinformatics tools used for DNA, RNA and protein sequence analysis.
5. To impart knowledge about biological sequence alignment.

Course Contents [Credit = 3]

Unit 1

Introduction to Bioinformatics: Definition and History of Bioinformatics, Introduction to internet, Bibliographic and non bibliographic search, PubMed. Introduction to various biological databases (primary, secondary and composite databases). Introduction to biological information system: SRS, ENTREZ (Structure and use on web).

Unit 2

Introduction to Data mining**:** Classification, Clustering, Data collection, Data Warehousing, Data preprocessing, Applications of Data Mining and Genomes mining. Data Bases: Nucelotide sequence information sources: GenBank, EMBL, EBI, DDBJ, UCSC. Protein sequence information sources: PIR, ExPASy, UniProt KB, SwissProt, TrEMBL, Protein structure information sources: PDB, SCOP, CATH, HSSP.

Unit 3

Biocomputing **:** Introduction to String Matching Algorithms, Database Search Techniques, Sequence Comparison and Alignment Techniques, Use of Biochemical Scoring Matrices, Introduction to Graph Matching Algorithms, Automated Genome Comparison and its Implication, Automated Gene Prediction, Gene Arrays, Analysis of Gene Arrays. Introduction to Signaling Pathways and Pathway Regulation (KEGG), Systems Biology-an introduction.

Unit 4

Genoinformatics. Genome Annotation-: Introduction, ORF's. Gene mapping and applications: Genetic and Physical Mapping, Transcriptome and Proteome- General Account. Sequence Alignment: Pairwise and multipule alignment, Dynamic programming. Soft wares (SSearch, BLAST, FASTA, CLUSTAL W), Phylogenetic analysis: phenatic and cladistic approach. Phylogenetic Tree Construction (rooted and unrooted method), Completed Genomes: Bacterium, Nematode, Plant and Human.

Unit 5

Production of Protein Structure & Modeling. Protein Primary & Secondary Structure, Prediction Methods – Introduction to various methods. Tertiary structure prediction (Homology & Threading Methods) Profiles, Motifs – Regular Expressions. Repeat Finding and pattern Recognition Molecular modeling, Docking and Rational Drug design.

Suggested Reading and Text Books

1. Moorhouse & Barry: Bioinformatics, Biocomputing and Perl (Wiley-liss publications) 2004.
2. Jones & Prvzner: Introduction to Bioinformatics Algorithm 2004, Anne Press.
3. Pevsner: Bioinformatics & Functional Genomics 3rd edition 2015, Wiley-publication.
4. Zimmerman: Introduction to Protein Information.
4. Bourne & Weissig: Structural Bioinformatics 2nd edition , Wiley-Liss Publication.
5. Gustafson, Shoemaker, Snape: Genome Data Mining Exploitation: the Genome 2000.
6. Richard S Larson: Bioinformatics and drug discovery, humana press 2nd edition 2005.

7. Sharma, Munjal & Shankar: A Text Book of Bioinformatics, Rastogi Publication 2008.
8. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1 Remembering
CO2	**Perceive** the specific and basic concepts of Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2
CO3	3	3	3	3	3	3	3	2	2	2	3	3	3	3	3	3
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	3	3	2	2	3	3	3	2	2	2	2	2	2	2
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

Course code : MBTL 310				
Course Name : Laboratory Course-II				
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents [Credit = 4]

1. To identify the objectives of cell and tissue culture and understand principles, processes and widespread tools and techniques employed in animal and plant tissue culture studies.
2. To design for animal and plant tissue culture medium, laboratory protocols, data interpretation along with assessment of associated risk factors and safety measures.
3. To study widespread applications of cell and tissue culture (plant as well as animal) process pertaining to health, industry, research etc.
4. Compare and analyze different vectors and methods employed in transgenic technology and to assess applicability of transgenics.
5. To demonstrate the experimental techniques associated with aseptic process, media preparation and related upstream and downstream process
6. To provide the knowledge related to needs of various parts of fermenter and their operation in laboratory as well as industrial level.3. To identify the ethical values related to transgenic and recombinant DNA technology.
7. To acquire knowledge regarding awareness of data analysis-and hypothesis testing procedures.
8. To develop data analytics skills and meaningful interpretation to the data sets so as to solve the business/Research problem.
9. To acquire knowledge regarding awareness of chemical sciences and biomaterials.
10. To develop analytics skills and meaningful interpretation to blood compatibility, Interactions of bacteria with biomaterials, Cardio vascular applications and Orthopedic applications.
11. To develop scientific knowledge regarding vaccines and role of biotechnology in development of pharmaceutical drugs.
12. To demonstrate the scientific method and the use of Drug targeting and drug delivery systems.
13. To enable students acquire knowledge of the fundamental principles of plant tissue culture.
14. To learn about different kinds of plant culture techniques.
15. To study structure, format and applications of biological databases; different softwares and techniques utilized for sequence alignment, searching databases, phylogentic studies, gene identification tools, search engines.
16. To make students understand about various bioinformatics tools used for DNA, RNA and protein sequence analysis.

Course code : MBTS 311				
Course Name : Bio –Entrepreneurship				
Semester /Year : III				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the meaning and importance of Entrepreneurship .
2. To understand the various forms of business organisation .
3. To analyze the importance of finance in an enterprise .
4. To analyze the importance of marketing management in an enterprise.
5. To understand the meaning of international business.

Course Contents [Credit = 3]

Unit 1

Starting a venture; Assessment of feasibility of a given venture/ new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/ Plan for seeking loans from financial institution & Banks; Funds from bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management.

Unit 2

Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping. Estimation of income, expenditure, profit. Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/Advertising.

Unit 3

Services Marketing Negotiations/Strategy with financiers, bankers, Government/ law enforcement authorities; with companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/Avoiding/Managing. Information Technology: How to use IT for business administration; Use of IT in Improving business performance; Available software for better financial management; E-business setup, management.

Unit 4

Human Resource Development (HRD): Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up. Fundamentals of Entrepreneurship, Support mechanism for entrepreneurship in India.

Unit 5

Role of knowledge centre and R&D. Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies. Case Studies.

Suggested Reading and Text Books

1. Handbook of Bioentrepreneurship Vol 4. by Holger Patzelt & Thomas Brenner (ed) Springer(2008)
2. Handbook of Entrepreneurship Research, 2005. Zoltan J. Acs and David B. Audretsch (eds.)
3. Handbook of Entrepreneurship Research: Interdisciplinary Perspectives, 2005. Sharon A. Alvarez, Rajshree Agarwal, and Olav Sorenson (eds.):
4. The Life Cycle of Entrepreneurship Ventures, 2006.Simon Parker (ed.)
5. Handbook of Bioentrepreneirship 2008, Holger Patzelt and Thomas Brenner (eds.)
6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** and define the terms and basic concepts of entrepreneurship development and their different roles to influencing entrepreneurship, features of a successful Entrepreneurship	1 Remembering
CO2	**Perceive** the introduction and principle, mechanism of entrepreneurship, features, financing the enterprise, marketing management and entrepreneurship and international business.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes of mechanism of entrepreneurship, features, financing the enterprise, marketing management and entrepreneurship and international business.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed and complete study related to Biotechnological entrepreneurship features for the growth or individual person and society	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the properties of mechanism of entrepreneurship, features, financing the enterprise, marketing management and entrepreneurship and international business.	1, 2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the entrepreneurship and the awareness, appreciation and applicability in environment, and their diverse functions.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	3	1	1	1	3	2	1	2
CO2	2	2	2	2	2	2	1	1	3	2	2	2	2	2	1	2
CO3	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	1	1	3	1	1	1	2	2	2	2
CO5	2	2	3	1	1	1	2	2	3	2	2	1	2	2	2	2
CO6	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3: High, 2: Medium, 1: Low

Course code : MBTS 312				
Course Name : IPR, Patenting and Bioethics				
Semester /Year : III				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To acquire sound knowledge of IPR, Patenting & Bioethics.
2. To study structure, format and applications of bioethics. Social and ethical issues in Biotechnology.
3. To comprehend concepts and issues of Intellectual property rights and assess the application of same in licencing of bioproduct, marketing of biotechnological invention along with associated trade regulation.
4. To compare and contrast types of patent, treaties, amendments, drafting patent application along with aspects of international patenting.
5. To study social and ethical issues in biotechnology.

Course Contents [Credit = 3]

Unit 1

Introduction to Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs. IP as a factor in R&D; IPs of relevance to Biotechnology and few.

Unit 2

Agreements and Treaties: History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments.

Unit 3

Patents: Basics of Patents and Concept of Prior Art. Introduction to Patents: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet (EPO), PATENTScope (WIPO), IPO, etc.).

Unit 4

Patent filing procedures: National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting– disclosure/non-disclosure; Financial assistance for patenting- introduction to existing schemes. Patent licensing and agreement. Patent infringement- meaning, scope, litigation, case studies

Unit 5

Introduction to Bioethics. Social and ethical issues in Biotechnology, causes of unethical acts, ignorance of laws, codes, policies and Procedures, recognition, friendship, personal gains. Professional ethics - professional conduct, Ethical decision making, ethical dilemmas, good laboratory practices, good manufacturing practices, laboratory accreditation.

Suggested Reading and Text Books

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007
3. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Indian Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety.	1 Remembering
CO2	**Perceive** the specific and basic concepts of Indian Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to concepts of Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1,2,3,4 Remembering, Understanding,Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1, 2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the Take part in essential techniques and features of Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	3	3	2	3	2	2	2	3	2	1	2
CO2	2	3	2	2	2	2	1	3	2	3	3	3	2	2	1	2
CO3	2	3	2	2	3	3	2	2	3	2	3	3	2	2	3	2
CO4	3	2	2	3	2	3	2	2	3	1	1	1	2	3	2	2
CO5	3	2	2	2	2	2	2	2	3	3	2	3	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code : MBTS 313				
Course Name : Biomedical Technology				
Semester /Year : III				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.To understand various types of cancer, tumor invasion, markers in cancer research and diagnosis
2.To acquire knowledge related to genetic disease, gene diagnosis, gene tracking & other diagnostic application of biomedical technology.
3.To understand the concept and types of mutations in Molecular biology.
4.To acquire knowledge related to cellular and molecular mechanisms in biomedical technology.

Course Contents [Credit = 3]

Unit 1
Molecular diagnosis (genetic disease, gene diagnosis, gene tracking & other diagnostic application of RDT) Molecular diagnostic- direct gene diagnosis, Linkage analysis. Nucleic acid sequences as diagnostic tools, SNPs, VNTRs, Non-invasive methodology. MRI, CT-SCAN. Reproductive Health Technologies – ICSI, IVE.

Unit 2
Mutations and genetic disorders. Single gene disorders, Receptor proteins (hypercholesterolemia). Cytogenic disorders (Trisomy, Klienfelters). Mutation in mitochondrial genes (LHDN), Fragile X Syndrome.

Unit 3
Types and grading of cancer. Introduction to molecular diagnosis of cancer. (Southern & Northern blot analysis, PCR based diagnosis). Gene therapy, Immunotherapy and chemotherapy of cancer cells.

Unit 4
Chemical mutagens. Carcinogenic agents and their cellular interactions. Radiation as health hazard. (Types, measurements, effects & protective measures) Introduction to DNA damage and repair mechanism.

Unit 5
Cellular Pathology: causes of cell injury, necrosis, biochemical mechanism, Ischemic and hypoxic injury. Apoptosis (Biochemical features, mechanisms) Immunological basis of diseases: Hypersensitivity (I – IV) Autoimmune diseases, Preparation of polyclonal antisera: characterization of antisera, Immunodiagnostic – RIA, ELISA.

Suggested Reading and Text Books

1. Biomedical Technology and Devices Handbook, James E Moore, George Zouridakis, CRC Press (2004).

2. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology.	1 Remembering
CO2	**Perceive** the specific and basic concepts of Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of apply modern techniques in Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems and decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge of Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems. Knowledge of the Biomedical technology in biological systems information and the explanation of the key concepts.	1,2,3,4 Remembering, Understanding,Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems	1, 2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating

CO6	**Constructing** the take part in the scientific knowledge regarding Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	3	2	2	2	3	2	3	2
CO2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	1	1	1	1	2	2	1	3	2	2	2	1	3

3: High, 2: Medium, 1: Low

Course code : MBTS 314				
Course Name : Genomics and Proteomics				
Semester /Year : III				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide sound knowledge pertaining to different methods, tools and techniques utilized to study structure and function of genomics, proteomics and transcriptomics.
2. To study about the origin of genome and different molecular biology techniques for the design of synthetic genes, gene modification and expression analysis.
3. To study about basic concepts, methods and software for the analysis of genome and proteome.
4. To learn the various techniques and tools for genetic study and interpretation of collected data for the research purposes.

Course Contents [Credit = 3]

Unit 1

The origin of genomes- Origin of macromolecules, RNA world and DNA world Acquisition of new genes (By gene duplication) and Gene families – (Types, Pseudogenes, Origin of gene families (lateral gene transfer, allopolyploidy). Synthetic genomes and their applications.

Unit 2

Introduction: Genome, Genomics, Omics and importance, Structural and Functioanl genomics, Application of genomics, Genome Mapping, DNA sequencing methods – Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

Unit 3

Genome databases, Annotation of genome. Genome diversity: taxonomy and significance of genomes – bacteria, Caenorhabditis, Homo sapiens, etc. Transcriptomics: Gene expression analysis, Identification of Biomarkers, techniques for studying the transcriptome: Microarray, Substractive Hybridization, Northern Blotting, SAGE, cDNA sequencing.

Unit 4

Introduction to Proteomics: Concept and applications, Isolation of Proteins, Separation of Proteins: Isoelectric Focussing, 2D-Gel electrophoresis, Protein Protein Interactions, Protein DNA Interaction, Native PAGE.

Unit 5

Mass spectrometry based methods for protein Sequencing and identification. *De novo* sequencing using mass spectrometric data. MALDI-TOF, SELDI, ESI, Protein Sequencing – Edman degradation. Introduction to Comparative Genomics, Metagenomics, Protein engineering.

Suggested Reading and Text Books

1. Cantor, C. R. and Smith, C. L., Genomics, John Wiley & Sons, 1999.
2. Lesk, M., Introduction to Genomics, Oxford University Press, 3rd edition 2017.
3. Twyman, R.M., Principles of Proteomics, BIOS Scientific Publishers,2nd edition 2013.
4. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1 Remembering
CO2	**Perceive** the specific and basic concepts of genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of Mass spectrometry based methods for protein identification, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1,2,3,4 Remembering, Understanding,Applying, Analysing
CO5	**Assess** the genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1, 2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	2	2	2	2	2	3	3	3	3	2	3	3	3	3
CO3	2	3	2	2	3	3	3	2	2	2	3	3	3	3	3	3
CO4	2	3	2	3	2	2	3	3	3	1	3	2	2	2	2	2
CO5	2	3	3	3	2	2	3	3	3	2	2	3	3	3	3	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code	**: MBTC 401**			
Course Name	**: Cell & Tissue Culture**			
Semester /Year	**: IV**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To identify the objectives of cell and tissue culture and understand principles, processes and widespread tools and techniques employed in animal and plant tissue culture studies.
2. To design for animal and plant tissue culture medium, laboratory protocols, data interpretation along with assessment of associated risk factors and safety measures.
3. To study widespread applications of cell and tissue culture (plant as well as animal) process pertaining to health, industry, research etc.
4. Compare and analyze different vectors and methods employed in transgenic technology and to assess applicability of transgenics.

Course Contents [Credit = 3]

Unit 1

Tissue & Cell Culture: Objectives & goals. Structure & organization of animal and plant cell. Equipments and materials for culture technologies & Aseptic techniques. Safety: Risk assessment, general safety.

Unit 2

Animal cell culture medium: BSS & simple growth medium. Serum free media, Role of CO_2 serum & supplements. Primary cell culture & cell lines, Cell separation, Biology & characterization of cultured cells.

Unit 3

Cell cloning & cell transformation. Application of animal cell culture: stem cell culture, Embryonic stem cells, cell cultured based vaccines. Specialized cell.

Unit 4

Introduction to plant cell & tissue culture, Plant tissue culture media-composition & preparation. Micro propagation, Callus culture, suspension culture, organogenesis. Meristem culture. Haploid culture: Androgenesis & Gynogenesis.

Unit 5

Ti & Ri plasmids, Binary vector, expression vector, cointegrated vector. Transformation: Vector mediated and vector less DNA transfer (Particle bombardment, electroporation, microinjection) in plants. Detection of DNA transfer.

Suggested Reading and Text Books

1. R. Ian Freshney: Culture of Animal Cells (8th ed.), Wiley-Liss 2021.
2. M. Butler & M. Dawson: Cell Culture Lab Fax. Eds. Bios Scientific Publ. Ltd. Oxford 1992
3. M.K. Razdon; Plant tissue culture, IBH & Oxford publ. Pvt. Ltd 3rd edition 2019.
4. H. S. Chawla: Introduction to Plant biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi 3rd ed 2011
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the knowledge about the different basic concepts of introduction to general character of cell and tissue culture, equipments and materials for culture technologies, types of culture, Animal cell culture medium, Cell cloning & cell transformation , *in vitro* haploid production, protoplast Isolation and fusion. Plant tissue culture media-composition & preparation. Plamids ans vectors.	1 Remembering
CO2	**Perceive** the specific and basic concepts of cell and tissue culture, equipments and materials for culture technologies, types of culture, Animal cell culture medium, Cell cloning & cell transformation , *in vitro* haploid production, protoplast Isolation and fusion. Plant tissue culture media-composition & preparation, methods, applications basis and disadvantages.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of cell and tissue culture, equipments and materials for culture technologies, types of culture, Animal cell culture medium, Cell cloning & cell transformation , *in vitro* haploid production, protoplast Isolation and fusion. Plant tissue culture media-composition & preparation. Plamids ans vectors.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to cell and tissue culture, equipments and materials for culture technologies, types of culture, Animal cell culture medium, Cell cloning & cell transformation , *in vitro* haploid production, protoplast Isolation and fusion.	1,2,3,4 Remembering, Understanding,Applying, Analyzing
CO5	**Assess** the cell and tissue culture, equipments and materials for culture technologies, types of culture, Animal cell culture medium, Cell cloning & cell transformation , *in vitro* haploid production, protoplast Isolation and fusion. Plant tissue culture media-composition & preparation. Plamids ans vectors.	1, 2,3,4,5 Remembering, Understanding, Applying, Analyzing, Evaluating
CO6	**Constructing** the cell and tissue culture, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Somaclonal variation nomenclautre, methods, applications basis and disadvantages. equipments and materials for culture technologies, types of culture, Animal cell culture medium, Cell cloning & cell transformation.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code	**: MBTC 402**			
Course Name	**: Environmental Biotechnology & Bioprocess Engineering**			
Semester /Year	**: IV**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide knowledge related to environmental problems and implication of scientific principles for remediating the environmental problems.
2. To give knowledge related to solutions for effective management of different types of pollution and its remediation.
3. To demonstrate the experimental techniques associated with aseptic process, media preparation and related upstream and downstream process
4. To provide the knowledge related to needs of various parts of fermenter and their operation in laboratory as well as industrial level.

Course Contents [Credit = 3]

Unit 1

Environmental Biotechnology: Concept, components of environment. Air pollution and its control through Biotechnology (deodorization, reduction in CO_2 emission, bioscrubbers, biobeds, biofilters etc). Water pollution and its controls: Sources of water pollution, waste water treatment-physical, chemical and biological processes (aerobic & anaerobic processes) Solid waste: Sources and management (composting, vermiculture and biogas production)

Unit 2

Xenobiotics in Environment: Xenobiotic compounds, Recalcitrance, Bioleaching and Biomining. Bioremediation: Types, in situ and ex situ bioremediation; Bioremediation for herbicides, Pesticides, hydrocarbons and oil spills. Hospital wastes, hazardous waste and their management. Biopesticides in integrated pest management. Biofertilizers.

Unit 3

Global Environmental Problems: Ozone depletion, UV-B, green-house effect and acid rain, their impact and biotechnological approaches for management. Restoration of waste land/degraded ecosystem. Industrial pollution and its control: Pulp & Paper, Tannery, Dairy and Petroleum. Basic concepts of Environmental Impact Assessment (EIA). Environment Management: Concept & Approaches.

Unit 4

Introduction to fermentation processes and types of fermentation. Microbial Growth Kinetics; Isolation, Preservation and Improvement of industrially important microorganisms. Production of solvents (Ethanol, Butanol), Antibiotics (Penicillin, Tetracycline) and Alcoholic beverages by fermentation.

Unit 5

Bioreactors: Types and Design; medium rheology. K_{La} measurement and kinetics of media sterilization. Downstrem processing and product recovery.

Suggested Reading and Text Books

1. Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals., Jean R Neeser & J. B German –CRC Press (2004)
2. Environmental Biotechnology, T.R.Srinivas, [1st Ed. ed.] New Age International Pvt Ltd Publishers (2008)
3. Environmental Biotechnology, R.A.Sharma, Pointer Publishers (2007)
4. Environmental Biotechnology (Handbook of Environmental Engineering, Volume 10), Yung-Tse Hung, Lawrence K. Wang, Volodymyr Ivanov, Joo-Hwa Tay, Humana Press. (2010) (1st Ed ed.)
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of general character of environmental biotechnology and bioprocess technology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching. Environmental significance of genetically modified microbes, plants and animals.	1 Remembering
CO2	**Perceive** the specific and basic concepts and applications environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of Environmental significance of genetically modified microbes, plants and animals, environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers, Bioleaching and bioprocess technology.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching, Environmental significance of genetically modified microbes, plants and animals. Bioprocess technology.	1,2,3,4 Remembering, Understanding,Applying, Analyzing
CO5	**Assess** the environmental biotechnology and bioprocess technology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching, Environmental significance of genetically modified microbes, plants and animals.	1, 2,3,4,5 Remembering, Understanding, Applying, Analyzing, Evaluating
CO6	**Constructing** the take part in environmental biotechnology and bioprocess technology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching, Environmental significance of genetically modified microbes, plants and animals. Global Environmental problems.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	3
CO4	2	3	2	3	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code : MBTL 403				
Course Name : Laboratory Course-I				
Semester /Year : IV				
	L	**T**	**P**	**C**
	0	**0**	**4**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents [Credit = 4]

1. To identify the objectives of cell and tissue culture and understand principles, processes and widespread tools and techniques employed in animal and plant tissue culture studies.
2. To design for animal and plant tissue culture medium, laboratory protocols, data interpretation along with assessment of associated risk factors and safety measures.
3. To study widespread applications of cell and tissue culture (plant as well as animal) process pertaining to health, industry, research etc.
4. Compare and analyze different vectors and methods employed in transgenic technology and to assess applicability of transgenics.
5. To provide knowledge related to environmental problems and implication of scientific principles for remediating the environmental problems.
6. To give knowledge related to solutions for effective management of different types of pollution and its remediation.
7. To demonstrate the experimental techniques associated with aseptic process, media preparation and related upstream and downstream process
8. To provide the knowledge related to needs of various parts of fermenter and their operation in laboratory as well as industrial level.

Course code : MBTE 404				
Course Name : Dissertation				
Semester /Year : IV				
	L	**T**	**P**	**C**
	0	**0**	**20**	**20**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents [Credit = 20]

1. To exhibit competent scientific writing (with critical analysis) and enhance presentation skills.
2. To demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution / conclusion to complex problem.
3. To analyze scientific advancements to identify a research area, design objectives and utilize modern tools, e-resources for literature survey.
4. Each student will be allotted a supervisor and a specific topic on which the dissertation work will be carried out.
5. Each student will submit 3 (1 Departmental copy, 1 Exam Cell copy and 1 Supervisor copy) copies of hard bound in the department.
6. Final evaluation will be done on the basis of quality of work, performance presentation of findings in seminar/conference/workshop/ publications and final presentation.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to Dissertation: Acquire ability to analyze scientific advancements to identify a research area, design objectives and utilize modern tools, e-resources for literature survey. Demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution / conclusion to complex problem.	1 Remembering
CO2	**Perceive** the specific and basic concepts of Dissertation: Acquire ability to analyze scientific advancements to identify a research area, design objectives and utilize modern tools, e-resources for literature survey. Demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution/conclusion to complex problem. Exhibit competent scientific writing (with critical analysis) and enhance presentation skills.	1,2 Remembering, Understanding

CO3	**Demonstrating** the detailed processes, essential techniques and features of apply modern techniques in Dissertation: Acquire ability to analyze scientific advancements to identify a research area, design objectives and utilize modern tools, e-resources for literature survey. Demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution/ conclusion to complex problem and decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge of Dissertation: Acquire ability to analyze scientific advancements to identify a research area, design objectives and utilize modern tools, e-resources for literature survey. Demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution / conclusion to complex problem.Knowledge of the dissertation in research of biological systems information and the explanation of the key concepts.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of Dissertation: Acquire ability to analyze scientific advancements to identify a research area, design objectives and utilize modern tools, e-resources for literature survey. Demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution / conclusion to complex problem. Exhibit competent scientific writing (with critical analysis) and enhance presentation skills.	1, 2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part the scientific knowledge regarding Dissertation: Acquire ability to analyze scientific advancements to identify a research area, design objectives and utilize modern tools, e-resources for literature survey. Demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution / conclusion to complex problem. Exhibit competent scientific writing (with critical analysis) and enhance presentation skills and their utilization to solve the society and industry-related problems.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	1	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	1	1	1	1	2	2	1	3	2	2	2	1	3

3: High, 2: Medium, 1: Low

Course code : MBTS 405				
Course Name : Enzyme Technology				
Semester /Year : IV				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To provide the basic knowledge about enzymatic reactions and factors effecting it.
2. To instill the concept and fundamentals about the classification of enzymes.
3. To provide exposure to students about mechanism of enzyme actions and industrial use of enzyme

Course Contents [Credit = 3]

Unit 1

Properties of enzymes : catalytic power, specificity, holoenzymes, apoenzyme, coenzyme and cofactor. Nomenclature and classification of enzymes, active site-Fischer and Koshland models. Collision theory, activation energy and transition state energy, the law of mass action and order reaction.

Unit 2

Enzyme kinetics: Kinetics of single substrate enzyme catalysed reaction, equilibrium steady state assumption (Michaelis-Menten), transformation of Michaelis Menten equation, Lineweaver Burk, Eadie-Hofstee, Hanes plots. Determination of Vmax, Km, Kcat and their significance. Effect of pH, temperature, enzyme and substrate concentration on enzyme activity. Single displacement and Double displacement reaction.

Unit 3

Enzyme Inhibition: Reversible inhibition- competitive, uncompetitive and non competitive inhibition, allosteric and irreversible inhibitions. Assay of enzymes: Coupled kinetic assay, units of enzyme activity (IU), Turnover number, purification of enzymes and criteria of purity.

Unit 4

Enzyme catalysis: Tapping the enzyme substratecomplex, use of substrate analogues, enzyme modifications by chemical procedures affecting aminoacid chain, treatment with protease, site directed mutagenesis, Factors contributing to the catalytic efficiency-proximity and orientation, covalent catalysis, acid-base catalysis, metal ion catalysis. Mechanisms of enzymes action-lysozyme, chymotrypsin and ribonuclease.

Unit 5

Vitamin coenzymes: structure and functions, enzyme regulation, feedback inhibition, allosteric kinetics(ATCase), cooperativity, symmetry and sequential models. Isoenzymes (LDH) Multi-enzyme complex (PDH complex), Ribozymes (catalytic RNA) Abzymes (catalytic antibodies), immobilized enzymes and applications.

Suggested Reading and Text Books

1. Principles of Biochemistry general aspects **7th edition**,1983- Smith et al McGraw Hill.
2. Principles of Biochemistry, **8th edition** 2017, nelson & Cox, CBS India.
3. Biochemistry, Leninger, A.H.
4. Text book of Biochemistry, West,E.S., Todd, Manson & Vanbruggen. Macmillon.
5. Organic chemistry, I.L.Finar, ELBS, 1985.
6. Biochemistry, Zubay,C.Addison. Wesley 2nd edition 1988.
7. Biochemistry of Nucleic acides, Adams.e.T.Al. Chapmann and Hall, 10th edition 1986

8. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to enzyme technology: effect of temperature, pH and substrate concentration on reaction rate. Interpret the application of Michaelis - Menten equation and enzyme kinetics. Understand and illustrate mechanism of enzyme action, Enzyme Inhibition, Enzyme catalysis, vitamins and coenzymes. Compare different methods of enzyme immobilization and analyze their respective industrial application, functional relationship of enzyme.	1 Remembering
CO2	**Perceive** the specific concepts of enzyme technology: effect of temperature, pH and substrate concentration on reaction rate. Interpret the application of Michaelis-Menten equation and enzyme kinetics. Understand and illustrate mechanism of enzyme action, Enzyme Inhibition, Enzyme catalysis, vitamins and coenzymes. Compare different methods of enzyme immobilization and analyze their respective industrial application, functional relationship of enzyme. Exhibit competent scientific writing (with critical analysis) and enhance presentation skills.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of enzyme technology: effect of temperature, pH and substrate concentration on reaction rate. Interpret the application of Michaelis - Menten equation and enzyme kinetics. Understand and illustrate mechanism of enzyme action, Enzyme Inhibition, Enzyme catalysis, vitamins and coenzymes. Compare different methods of enzyme immobilization and analyze their respective industrial application, functional relationship of enzyme. Demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution/ conclusion to complex problem and decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge of enzyme technology: effect of temperature, pH and substrate concentration on reaction rate. Interpret the application of Michaelis - Menten equation and enzyme kinetics. Understand and illustrate mechanism of enzyme action, Enzyme Inhibition, Enzyme catalysis, vitamins and coenzymes. Compare different	1,2,3,4 Remembering, Understanding,Applying, Analysing

	methods of enzyme immobilization and analyze their respective industrial application, functional relationship of enzyme.	
CO5	**Assess** the principle, methods, properties and functions of enzyme technology: effect of temperature, pH and substrate concentration on reaction rate. Interpret the application of Michaelis - Menten equation and enzyme kinetics. Understand and illustrate mechanism of enzyme action, Enzyme Inhibition, Enzyme catalysis, vitamins and coenzymes. Compare different methods of enzyme immobilization and analyze their respective industrial application, functional relationship of enzyme.Exhibit competent scientific writing (with critical analysis) and enhance presentation skills.	1, 2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part the enzyme technology: effect of temperature, pH and substrate concentration on reaction rate. Interpret the application of Michaelis - Menten equation and enzyme kinetics. Understand and illustrate mechanism of enzyme action, Enzyme Inhibition, Enzyme catalysis, vitamins and coenzymes. Compare different methods of enzyme immobilization and analyze their respective industrial application, functional relationship of enzyme.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	3	2	3	2	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	1	1	3	1	2	2	1	3	2	2	2	2	3

3: High, 2: Medium, 1: Low

Course code : MBTS 406				
Course Name : Molecular Virology and Infections				
Semester /Year : IV				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To instill detailed study of the molecular and cellular components that comprises the immune system including their function and interaction to provide a lifelong learning &disciplinary knowledge to implement the concepts.
2. To appraise study of the different analytical techniques for the disease diagnosis, assist advancement and career options in the field of molecular diagnostics and applicate as well emerge with the solutions concerned with health and environment.
3. To broaden the area of understanding the structure, function, components of immune system for better advancement & comprehend the need of tools & techniques with broadening the area in distinguished fields.
4. To comprehend the essential elements of immune system clearing up the facts of theoretical and technical aspects and help in employing the scientific knowledge for development of medical interventions.

Course Contents [Credit = 3]

Unit 1

History of Virology and Biosafety: History and principles of virology, virus taxonomy. Structures of animal and plant viruses and their morphology. Principles of biosafety, containment facilities, maintenance and handling of laboratory animals, and requirements of virology laboratory.

Unit 2

Virus Replication: Structure and replication strategies of bacteriophages - T7, λ, ΦX174, and plant viruses - ss RNA virus (TMV) and ds DNA virus (CaMV). Structure and replication strategies of animal viruses - Influenza virus, Adeno virus and Retro virus.

Unit 3

Interferon and Antiviral Agents: Viral Interference and Interferons. Nature and source of interferons, Classification of interferons. Induction of interferon. Antiviral agents (chemical and biological) and their mode of actions.

Unit 4

Cultivation of Viruses and Viral Vaccines : Cultivation of viruses in embryonated egg, tissue culture and laboratory animals. Conventional vaccines - Killed and attenuated. Modern vaccines - Recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines). Vaccine delivery and adjuvants, large-scale manufacturing.

Unit 5

Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Quantitative diagnostic methods - Haemagglutination, complement fixation, neutralization, Western blot, flowcytometry. Nucleic acid based diagnosis - PCR, microarray and nucleotide sequencing. Application of Microscopic techniques - Fluorescence, confocal and electron microscopic techniques.

Suggested Reading and Text Books

1. General Virology - Luria and Darnel Virology and Immunology – Jokli
2. Text book of Virology - Rhodes and Van Royen 5th edition 1968
3. Plant Virology - Smith 5th edition 2013
4. Genetics of bacteria and their viruses - W. Hayes
5. Molecular Biology of the gene - Watson, Roberts, Staitz and Weiner
6. A laboratgory guide in virology - Charles H. Lunningham
7. Basic lab procedures in diagnostic virology - Marty Cristensen
8. Review of medical microbiology - Jawitz et al
9. Medical laboratory Manual for tropical countries Vol I & II by Monica Cheesbrough
10. Text Book of Microbiology - Ananthanarayanan and Jayaram Paniker Viral and Ricketsial

11. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods.	1 Remembering
CO2	**Perceive** the specific concepts of Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Exhibit competent scientific writing (with critical analysis) and enhance presentation skills.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution/ conclusion to complex problem of virology and infections.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge of Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods.	1,2,3,4 Remembering, Understanding,Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Exhibit competent scientific writing (with critical analysis) and enhance presentation skills.	1, 2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	3	2	2	3	2	2	2	3	2	3	2
CO2	3	2	3	2	2	2	3	2	3	2	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	3	2	3	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	1	3	1	2	2	1	3	2	2	2	2	3

3: High, 2: Medium, 1: Low

Course code	**: MBTS 407**			
Course Name	**: Basics of Forensic Science**			
Semester /Year	**: IV**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the Concept, Need, Importance and History of Forensic Science.
2. To demonstrate the scientific method and the use of problem-solving within the field of forensic science in criminal cases.
3. To demonstrate competency in the collection, processing, analyses, and evaluation of evidence under forensic science.
4. To understand the role of the biotechnology and bioanalytical tools for forensic science within the criminal justice system.

Course Contents [Credit = 3]

Unit 1

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

Unit 2

History of Development of Forensic Science in India Functions of forensic science. Historical aspects of forensic science. Definitions and concepts in forensic science. Scope of forensic science. Need of forensic science. Basic principles of forensic science.

Unit 3

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit 4

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification

Unit 5

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

Suggested Reading and Text Books

1. Fundamentals of forensic science Book by Max M Houck 3rd Edition 2015.
2. Forensic Science: The Basics, Second Edition by Jay A. Siegel and Kathy Mirakovits 4th Edition 2021.
3. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction and principles of forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	1 Remembering
CO2	**Perceive** the specific and basic concepts of forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to concepts of crime scene detection methods, forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	1,2,3,4 Remembering, Understanding,Applying, Analysing
CO5	**Assess** the principle, methods, properties and functions of forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	1, 2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in forensic science, forensic science laboratory and its organization and service, Classification of fire arms and explosives, Role of the toxicologist and findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine and introduction to Cyber security.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3	3	3	3	2	3	2	2	2	3	2	3	2
CO2	3	3	2	2	2	2	3	3	2	3	3	3	2	2	3	2
CO3	3	3	2	2	2	2	2	2	3	2	2	3	3	2	3	2
CO4	3	2	2	3	2	3	2	2	3	1	3	3	2	2	3	3
CO5	3	2	2	2	2	2	2	2	3	3	2	3	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Course code	**: MBTS 408**			
Course Name	**: Agriculture Biotechnology**			
Semester /Year	**: IV**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To acquire sound knowledge pertaining to concepts, principles widespread tools and techniques involved in agricultural biotechnology along with designing of protocols for crop improvement and conservation.
2. To study about microbes (plant growth promoting rhizobacteria) which support plant growth and development along with specific reference to siderophores, biofertilizer, biopesticides and nitrogen fixation.
3. To acquire conceptual and practical knowledge pertaining to tools and techniques involved in plant genetic engineering along with critical analysis of ethical issues associated with production and release on GMO's and concept of integrated pest management.
4. To identify and appraise widespread applications of agriculture biotechnology and gene transfer technology pertaining to enhancing crop productivity, increasing shelf life producing biotic and abiotic stress tolerant plants.

Course Contents [Credit = 3]

Unit 1

Introduction to Agricultural biotechnology, Crop improvement hybridization and plant breeding techniques. Micropropagation and plant tissue culture technique and its application in agriculture. Somatic hybridization, haploid production and cryopreservation.

Unit 2

Agricultural microbiology: Introduction, Biofertilizers: VAM production and applications, *Azolla*, *Azospirillum*, *Frankia*, *Azotobacter*, *Cyanobacteria*. Microbial insecticides, biocontrol agents and applications. Concepts on plant growth promoting bacteria, Siderophores. Bacterial diseases of agriculture and aquaculture. Mechanism of biological nitrogen fixation process, study of NIF, NOD and HUP genes in nitrogen fixation process.

Unit 3

Different methods of gene transfer to plant genetic engineering for crop improvement. Current status of transgenic, Bioethics and biosafety norms and controlled field trials and release of transgenic (GMOs).

Unit 4

Applications of Plant Genetic Engineering – crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. BT gene, Application of Plant Transformation for productivity and performance, Study of biopesticides used in agriculture (neem as example), integrated pest management.

Unit 5

Genetic modification in Agriculture, Transgenic Plants and Crop Improvement Transgene plants with beneficial traits (biotic stresses, Virus resistance, Abiotic stresses, Herbicide resistance, storage, Protein quality, increasing shelf-life) in plant genetic engineering.

Suggested Reading and Text Books

1. Nag. A., Textbook of Agricultural Biotechnology, PHI Learning, 2008, 2nd[t] Edition.
2. George, A., Principles of Plant Genetics and Breeding, Wiley-Blackwell, 2020, 3rd Edition.
3. Bonnen, J. J. 1983. Historical sources of U.S. agricultural productivity: implications for R&D policy and social science research. Am. J. Agric. Eco. 65:958–966.
4. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of agriculture biotechnology, crop hybridization and differentiation, Agricultural microbiology, Different methods of gene transfer to plant, transgenesis, Plant Genetic Engineering and gene modification in agriculture.	1 Remembering
CO2	**Perceive** the specific and basic concepts of agriculture biotechnology, crop hybridization and differentiation, Agricultural microbiology, Different methods of gene transfer to plant, transgenesis, Plant Genetic Engineering and gene modification in agriculture, methods, applications basis and disadvantages.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Somaclonal variation nomenclautre, methods, applications basis and disadvantages.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to agriculture biotechnology, crop hybridization and differentiation, Agricultural microbiology, Different methods of gene transfer to plant, transgenesis, Plant Genetic Engineering and gene modification in agriculture.	1,2,3,4 Remembering, Understanding, Applying, Analysing
CO5	**Assess** the agriculture biotechnology, crop hybridization and differentiation, Agricultural microbiology, Different methods of gene transfer to plant, transgenesis, Plant Genetic Engineering and gene modification in agriculture methods, applications basis and disadvantages.	1, 2,3,4,5 Remembering, Understanding, Applying, Analysing, Evaluating
CO6	**Constructing** the take part in agriculture biotechnology, crop hybridization and differentiation, Agricultural microbiology, Different methods of gene transfer to plant, transgenesis, Plant Genetic Engineering and gene modification in agriculture. Applications of agriculture biotechnology.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analysing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	3	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Agenda No. 11. List of Examiner for Theory/Practical/Dissertation/Viva voce examinations:

Resolutions:

S. No.	Name of Examiner	Affiliating Institute/University
1.	Professor Dhruv Kumar	Professor & Cluster Head, Allied Health Sciences , School of Health Sciences & Technology (SoHST), UPES, Dehradun, Uttrakhand
2.	Professor Gulshan Kumar Dinghra	Department of Botany, Shri Dev Suman University, Rishikesh, Uttrakhand
3.	Professor Pravindra Kumar	Department of Biosciences and Bioengineering, Indian Institute of Technology, Roorkee- 247667, Uttarakhand
4.	Professor V. K. Bajaj	Department of Biotechnology, Jammu University, J&K
5.	Professor Rahul Kumar	Department of Plant Breeding and Genetics, Meerut University, Meerut -250004, Uttar Pradesh
6.	Professor Gaurav Sharma	Department of Biotechnology, Suresh Gyan Vihar University, Jaipur-333031, Rajasthan
7.	Dr. Sujeet Kumar	Department of Biotechnology, Amity University, Lucknow-226010, Uttar Pradesh
8.	Dr. Mamta Arya	Department of Biotechnology, Hemvati Nandan Bahuguna University, Garhwal-246174,
9.	Dr. Kumud Bala	Department of Medical Biotechnology, Amity University, Noida-201303, Uttar Pradesh
10.	Dr. Pooja Saklani	Department of Biotechnology, Hemvati Nandan Bahuguna University, Garhwal-246174,
11.	Dr. Poonam Choudhary	Department of Biosciences and Bioengineering, Indian Institute of Technology, Roorkee- 247667,
12.	Professor Harsh Vardhan Pant	Department of Chemistry, Shri Guru Ram Rai (PG) College, Dehradun- 248001, Uttarakhand
13.	ProfessorDeepshikhaPandeKatare	Department of Medical Biotechnology, Amity University, Noida-201303, Uttar Pradesh
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*No of Examiner may be increase or decrease as per University Norms