JAMIA HAMDARD

DEPARTMENT OF BIOTECHNOLOGY

CBCS ENABLED SYLLABUS
M.SC BIOTECHNOLOGY

SYLLABUS FOR M.SC. BIOTECHNOLOGY

Choice Based Credit System (CBCS)

Approval Date: 9TH JULY 2021

(29TH BOARD OF STUDIES)

DEPARTMENT OF BIOTECHNOLOGY

JAMIA HAMDARD

Deemed to be University

Accredited in 'A' Grade by NAAC

Declared to be designated as Institute of Eminence (IoE) by MHRD, GOI

New Delhi 110 062

www.jamiahamdard.edu

PROGRAMME NAME : M.SC BIOTECHNOLOGY
PROGRAMME CODE: 508
ACADEMIC SESSION OF INTRODUCTION OF THE PROGRAMME: (2022-2023)
SCHOOL NAME : SCLS
DEPARTMENT NAME: DEPARTMENT OF BIOTECHNOLOGY

APPROVAL DATE OF THE BOARD OF STUDIES(B.O.S) MEETING FOR THE PRESENT SYLLABUS

9TH JULY 2021(29TH BOARD OF STUDIES)

APPROVAL DATE AND NUMBER OF ACADEMIC COUNCIL OF MEETING FOR THE PRESENT SYLLABUS

41st AC (15TH MARCH 2021)

The Department of Biotechnology at Jamia Hamdard, New Delhi was established in the year 1997. It was rRanked No. 4 in 2013 amongst the Biotechnology Departments of the Country as per survey of BioSpectrum. The Department is supported by FIST (DST, Govt. of India) and SAP (UGC).

VISION:

The Department of Biotechnology at Jamia Hamdard, New Delhi was established with a vision to be recognized as a Department of International repute with a strong interdisciplinary research and teaching base in Plant and Animal Biotechnology with active collaboration of industries and health-care institutions.

MISSION STATEMENTS:

- MS1: To create opportunities for multi-disciplinary education, training and research in biotechnology.
- MS2: To provide Biotechnology Educational Program with impetus to generate quality workforce.
- MS3: To create awareness about potentials of Biotechnology with socio-ethical implications.
- MS4: To instill spirit of innovation and creativity in young minds with sound research aptitude.
- MS5: To nurture confident individuals who are effective contributors towards growth of the nation.
- MS6: To establish industry academia partnership and partnership with health care institutions for health and industry-oriented research.
- MS7 : To provide in depth knowledge and practical exposure to students, so that they should qualify national exams and go for higher training in National/International laboratories.

COURSES OFFERED:

- **5-Year dual -BSc-MSc degree** with exit clause after 3 years leading to **BSc (Hons) degree in Biotechnology,** and after 5 years leading **to MSc degree in Biotechnology**.
- **Two-year postgraduate degree course leading to MSc in Biotechnology.**
- **Doctoral research leading to PhD degree.**
- **Post-doctoral research.**

THRUST AREAS

- Molecular biology and regulation of gene expression in infectious and non-infectious diseases.
- Host pathogen interaction, molecular immunology, molecular virology and drug delivery.
- Clinical virology and vaccine development.
- Development of diagnostic tests.
- Development of nano-enabled interfaces and multiplexed paper-based devices for the detection of diseases.
- Genomics/ Proteomics of cancers and development of biomarkers for early detection and valuable therapeutic targets.
- Conservation of medicinally important endangered plants through in vitro approach.
- Enhancement in the yield of secondary metabolites in medicinal plants via stress, culture conditions, genetic engineering and nanoparticles.
- Transgenics of vegetables, floriculture and oil crops.
- Evaluation of anti-Cancer potential of herbal based compounds and their nano formulations.
- Stress Biology, mechanism of protein folding and stabilization.

ACADEMIC STAFF

S.No	Name	Designation	Specialization
1	Dr. M.Z. Abdin	Professor & Head	Plant Biotechnology and Physiology
3	Dr. Humaira Farooqi	Asst. Professor	Protein Biochemistry, Stress & Cancer Biology
4	Dr. Saima Wajid	Asst. Professor	Clinical Genomics and Proteomics, Molecular Oncology
5	Dr. Jagriti Narang	Asst. Professor	Environmental Biotechnology
6	Dr. Javaid Ahmad Sheikh	Asst. Professor	Immunology
7	Dr. Mairaj Ahmad Ansari	Asst. Professor	Immunology

QUALIFICATION DESCRIPTORS (QDS) M.S.C PROGRAMME

After completion of this academic program, the students will be able to :	
QD 1	Illustrate substantial skills and knowledge in specific fields of biotechnology like Plant and Animal Biotechnology, fundamentals of genetic engineering., Molecular Biology, Expression of genetic information, Medical microbiology, Biotechnology: Environmental &Ethical Aspects Immunology, Biotechnology and Human welfare.
QD 2	Utilize knowledge and skills to recognize problems and challenges, collect relevant scientific data, analyze and evaluate data using methodologies appropriate to the subject(s), and offer evidence-based solutions.
QD 3	Apply subject knowledge and transferable skills in areas such as molecular biology, transgenic technology, plant and animal biotechnology, and pharmaceutical biotechnology to different contexts.
QD 4	Understand and execute effectively their societal roles as biotechnology professionals, employers and employees in a various industries and academic institutes.

S, Substantial Correlation (75%-100); M,Moderate Correlation(60-75%);L, Low correlation (40-60%)

		MAPPING OF	QUALIFICATION	DESCRIPTORS (QD'S WITH MISSION STATEMENTS)				
	QD	MS1	MS2	MS3	MS44	MS5	MS6	MS7
QUALIFICATION DESCRIPTORS	QD1	S	S	M	S	M	M	S
	QD2	M	M	M	S	S	M	S
	QD3	S	M	M	M	M	S	S
	QD4	M	S	S	S	S	S	M

S, Substantial Correlation (75%-100); M,Moderate Correlation(60-75%);L, Low correlation (40-60%)

MAPPING OF **QUALIFICATION DESCRIPTORS (QD'S WITH PROGRAM LEARNING OUTCOMES)**

	QD	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
QUALIFICATION DESCRIPTORS	QD1	M	M	M	S	M	M	M	M	L	S
	QD2	S	M	M	M	M	M	M	L	L	M
	QD3	S	M	S	M	S	S	M	M	M	M
	QD4	M	M	M	M	M	M	M	S	S	S

M. Sc. BIOTECHNOLOGY

PROGRAM LEARNING OUTCOMES (PLOs)

At the end of the programme, students will be able to :	
PLO 1	apply the knowledge of basic, advanced and applied sciences to solve complex research and industrial problems;
PLO 2	identify, formulate and obtain solutions to the challenging problems in interdisciplinary fields using principles of chemical and life sciences;
PLO 3	design and develop materials or products or processes suitable for applications in agriculture, medicine and environment that will meet the needs of the stakeholders;
PLO 4	conduct investigation on materials and living organisms and execute novel research in chemical and life sciences with proper experimental design and suitable controls;
PLO 5	choose and apply appropriate, analytical techniques and resources to analyze and address complex problems and come up with logical reasoning through integrative problem-solving approaches;
PLO 6	apply reasoning informed by the contextual knowledge to assess day-to-day issues pertaining to agriculture, environment, medicine and society and the incumbent responsibilities relevant to the careers in chemical and life sciences;
PLO 7	evaluate the impact of chemical and life processes in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development;
PLO 8	commit and conform to professional ethics, responsibilities and norms in professional and societal interactions; and
PLO 9	function effectively as an individual, as a member or as a leader in diverse cross-functional teams and multi-disciplinary groups.
PLO 10	develop critical thinking and problem solving skills, which helps students to grow as a scientist or scientifically literate citizen.

PROGRAMME SPECIFIC OUTCOMES

At the end of the programme, students will be able to:	
PSO 1	understand the basic concepts of interdisciplinary biotechnology courses for better comprehension and bring their inclination towards research approaches for their career in the field of biotechnology.
PSO 2	apply various biotechnological skills (including, cell biology, immunology, molecular biology, micro biology, recombinant DNA technology, bioinformatics, genetic engineering, bioprocess and fermentation and food technology) and its applications in industries and human welfare.
PSO 3	demonstrate knowledge of strong analytical thinking to identify, design, and solve challenges linked to Biotechnology, Pharma, Medical or Healthcare organisations, and Academic institutions.
PSO 4	embrace and carry out their societal roles as biotechnology experts, workers and employers in a various industries, researchers, teachers, and administrators.
PSO 5	collaborate in the laboratories either independently or as a team towards solving the broad social and national issues.

DEPARTMENT OF BIOTECHNOLOGY
SCHEME AND COURSE STRUCTURE
M.Sc. BIOTECHNOLOGY PROGRAM

SEMESTER – I							
Course Code	**Course Name**	**Paper Category**	**Duration**	**Credits**	**Max Marks**	**Sessional**	**Exam Marks**
MBT-CC100	Fundamentals of Biotechnology	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC101	Molecular Biology	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC102	Essentials of Genetic Engineering	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC103	Medical Microbiology	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-OE104	Cellular Biology & Biomolecules	Open Elective	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC105	**Practical** – Biomolecules, Genetic Engineering and Molecular Biology	Core	**150 hrs**	**8**	**200**	**50**	**150**
			Total	**28**	**700**	**175**	**525**

SEMESTER – II							
Course Code	**Course Name**	**Paper Category**	**Duration**	**Credits**	**Max Marks**	**Sessional**	**Exam Marks**
MBT-CC201	Expression of Genetic Information	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC202	Molecular Plant Physiology	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC203	Plant Tissue Culture & its Applications	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC204	Biotechnology : Environmental & Ethical Aspects	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-OE205	Biostatistics	Open Elective	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC206	**Practical** – Molecular Plant Physiology & Plant Tissue Culture	Core	**150 hrs**	**8**	**200**	**50**	**150**
MBT-DE207	Seminars/ Assignments	Discipline Centric Elective	**36 hrs**	**2**	**50**	**0**	**50**
			Total	**30**	**750**	**175**	**575**

SEMESTER – III							
Course Code	**Course Name**	**Paper Category**	**Duration**	**Credits**	**Max Marks**	**Sessional**	**Exam Marks**
MBT-CC301	Animal Biotechnology	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC302	Plant Biotechnology	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC303	Immunology	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-CC304	Biotechnology and Human Health	Core	**72 hrs**	**4**	**100**	**25**	**75**
MBT-OE305	Bioinformatics	Open Elective	**100 hrs**	**4**	**100**	**25**	**75**
MBT-CC306	**Practical:** Immunology, Animal and Plant Biotechnology	Core	**150 hrs**	**8**	**200**	**50**	**150**
MBT-DE307	Seminars/Assignments	Discipline Centric Elective	**100 hrs**	**2**	**50**	**0**	**50**
			Total	**30**	**750**	**175**	**575**

SEMESTER – IV							
Course Code	**Course Name**	**Paper Category**	**Duration**	**Credits**	**Max Marks**	**Sessional**	**Exam Marks**
MBT-CC401	Dissertation/ Viva voce	Core	**720 hrs**	**20**	**500**	**50**	**450**
			Total	**20**	**500**	**50**	**450**

- One Practical/ Tutorial credit is gained by two hours
- For Open Elective papers candidate has to compensate for the required credits per semester (25) if he/she chooses the elective paper from any other Department of Science Faculty
- One Open Elective each for first three semesters is proposed; therefore 9 credits may be gained from any other Department of SCLS.

LIST OF CORE COURSES [CC]

- **MBT-CC100 -**Fundamentals of Biotechnology
- **MBT-CC101-** Molecular Biology
- **MBT-CC102-** Essentials of Genetic Engineering
- **MBT-CC103 -**Medical Microbiology
- **MBT-CC105 Practical** – Biomolecules, Genetic Engineering and Molecular Biology
- **MBT-CC201** - Expression of Genetic Information
- **MBT-CC202 -** Molecular Plant Physiology
- **MBT-CC203 -** Plant Tissue Culture & its Applications
- **MBT-CC204 -** Biotechnology : Environmental & Ethical Aspects
- **MBT-CC206 - Practical -** Molecular Plant Physiology & Plant Tissue Culture
- **MBT-CC301 -**Animal Biotechnology
- **MBT-CC302 -** Plant Biotechnology
- **MBT-CC303 --**Immunology
- **MBT-CC304 -** Biotechnology and Human Health
- **MBT-CC401 -** Dissertation/ Viva voce

LIST OF OPEN ELECTIVE [OE]

- **MBT-OE104-** Cellular Biology & Biomolecules
- **MBT-OE205-** Biostatistics
- **MBT-OE305** – Bioinformatics

LIST OF DISCIPLINE CENTRIC ELECTIVE [DCE]

- **MBT-DE207 -** Seminars/Assignments
- **MBT-DE307-** Seminars/Assignments

SCHOOL OF CHEMICAL AND LIFE SCIENCES

HAMDARD NAGAR, NEW DLEHI

M.Sc. Bye-Laws

Foundation Course – for all students of the faculty

1. Programme : Master of Science (M. Sc.)

M.Sc. in the following subjects:

i) Biochemistry
ii) Biotechnology
iii) Botany
iv) Chemistry
v) Toxicology
vi) Clinical Research

Foundation course	**001**

Each programme shall be denoted by three digit code as follows :

a)	Biochemistry	507
b)	Biotechnology	508
c)	Botany	509
d)	Chemistry	510
e)	Toxicology	511
f)	Clinical Research	540

Each course of programme shall be given a course number which shall be preceded by three abbreviation as follows :

a)	Biochemistry	MBC
b)	Biotechnology	MBT
c)	Botany	MBO
d)	Chemistry	MCH

e)	Toxicology	MTX
f)	Clinical Research	MCR
g)	Foundation course	MFC

These all are full time regular courses.

The Core, discipline Centric and Open elective Courses shall be abbreviated as follows :

Core Course : CC

Discipline Centric Elective : DCE

Open Elective : OE

These abbreviations shall be preceded course number of each course of programme.

During an academic year, a candidate who is enrolled in the M.Sc. Programmes, shall not be allowed to enroll for any other full-time programme of study and shall not appear in any other examination of a full time course of this or any other university.

2. Duration : Two Years of Four semesters (two in each year) designated as under:

1st Semester - July-Nov of 1st year

2nd Semester - Dec-April of 1st year

3rd Semester - July-Nov of 2nd year

4th Semester - Dec-April of 2nd year

Teaching days in each semester shall be not less than **90 days**.

Medium of instruction and examinations : English

3. Eligibility of Admission:

All candidates seeking admission to any of the above M.Sc. programmes must appear in the Entrance Test conducted by Jamia Hamdard. Also, the candidates should fulfill the following qualifications for admission to as mentioned below for each programme :

M.Sc. Biochemistry: Must have passed B. Sc. from a recognized university under 10+2+3 system with Biochemistry or Chemistry as one of the subjects and secured at least 45% marks in the aggregate.

M.Sc. Biotechnology: Must have passed B. Sc. from a recognized university under 10+2+3 system with Biological Sciences and secured at least 45% marks in the aggregate. The candidates having passed B.Sc. (Agriculture) or B.V. Sc. are also eligible.

M.Sc. Botany: Must have passed B. Sc. from a recognized university under 10+2+3 system with Botany/Plant Sciences as one of the subjects and secured at least 45% marks in the aggregate.

M.Sc. Chemistry : Must have passed B. Sc. or equivalent examination from a recognized university under 10+2+3 system with Chemistry as one of the subjects and secured at least 45% marks in the aggregate.

M.Sc. Toxicology: Must have passed B. Sc. from a university recognized by Jamia Hamdard under 10+2+3 system with any three of the following subjects: Botany, Zoology, Chemistry, Biochemistry, Biotechnology, Microbiology, Environmental Biology or a subject of Life Sciences and secured at least 45% marks in the aggregate. Candidates who have studied biology at 10+2 level and have B. Pharm./B.V.Sc./B.Sc.(Ag.) degree are also eligible to apply. The minimum required percentage will be 45% in aggregate.

M.Sc. Clinical Research : Candidates with any of the following qualifications from a university recognized by Jamia Hamdard, with at least 45% marks in aggregate, shall be eligible for admission to this programme:

MBBS / BDS / BAMS / BUMS / BVSc./B.Pharm/BSc-Nursing/BOT/ BPT/ BSc-Medical Lab. Techniques/BSc with Biochemistry/ Biotechnology/ Microbiology/ Zoology/ Bioinstrumentaion or any other life sciences/ allied health sciences.

4. Course Structure :

a) Foundation course will be of 8 credits (200 marks) and 120 hours duration. The internal assessment (Sessional Tests) shall be of 50 marks while the final examination will be of 150 marks. There will be three Sessional tests. In each sessional test question from all the units will form the question paper. Each unit, on an average would be allocated two marks each in each sessional.

b) There shall be not less than **twenty credits** of courses in each semester, e.g., there may be 4 theory courses of 4 credits and a lab course of 4 credits or 5 theory courses of 3 credits each and a lab course of 5 credits, making each semester of 20 credits. Similarly, there could be seminars, etc with not less than 3 or 6 credits. In such cases credits to theory and practical papers are to be adjusted accordingly.

c) A project of not less than 10 credits may be prescribed in the course structure in 4th semester in place of theory papers or theory papers and project. The project work may involve experimental work and literature survey on a specified topic.

d) Though for project work the topics shall be given in advance, the credits assigned for the project work shall be awarded at the end of 4th semester. For project work, the Head of the Department shall call a meeting of all the teachers of the Department and assign appropriate number of students to each teacher to act as the supervisor for project work. The student in consultation with the supervisor shall select a topic for the project work and inform the Head of the Department.

e) The contents of each theory course shall be divided into four units. Each unit shall preferably have equal teaching hours.

f) At the end of 2nd and /or 4th semester(s) a department may arrange summer training of students for 6-12 weeks in an industry/research organization/university.

5. Attendance

a) All Students must attend every lecture and practical class. However, to account for unforeseen contingencies, the attendance requirement for appearing in the semester examinations shall be a minimum of 75% of the classes prescribed for each course.

b) In order to maintain the attendance record of a particular course, a roll call will be taken by the teacher in every scheduled lecture and practical class. For the purpose of attendance, each practical class will count as one attendance unit, irrespective of the number of contact hours. Attendance on account of participation in the prescribed and notified activities such as, NCC, NSS, Inter University sports, educational tours/field work, shall be granted provided the participation of the student is duly verified by the officer-in-charge and is sent to the Head of the Department within two weeks of the function/activity, etc.

c) The teacher shall consolidate the attendance record for the lectures and practicals at the end of each month and submit to the Head of the Department. At the end of the semester, the teacher shall consolidate the attendance record for the whole semester and submit it to the Head of the Department. The statement of attendance of students shall be displayed by the

Head of the Department on the Notice Board. A copy of the same shall be preserved as record. Attendance record displayed on the Notice Board shall deemed to be a proper Notification for the students and no individual notice shall be sent to any student.

d) If a student is found to be continuously absent from the classes without any information for a period of 30 days, the concerned teacher shall report the matter to the Head of the Department who will report the matter to the Registrar through Dean of the Faculty for appropriate action that will include striking off the name of such student(s) from the rolls. Such a student may, however, apply for re-admission within 7 days from the date of issue of the notice of striking off the name of such student(s) from the rolls. The request for re-admission may be considered by the Dean of the Faculty. Such a student shall not be eligible for re-admission after the prescribed period of 7 days. The re-admission shall be effected only after the payment of prescribed re-admission fee.

e) **A student with less than 75% attendance in a course in a semester shall be detained from appearing in the semester examination of that course. The Dean of the Faculty may consider application for condoning up to 5% of attendance on account of sickness, provided the medical certificate, duly certified by a Registered Medical Practitioner/Public Hospital had been submitted in the office of the Head of the Department at the time of rejoining the classes immediately after the recovery from illness.** The HoD shall forward such cases along with all related documents to the Dean. The cases of students with less than 70% attendance may be forwarded to the Vice-Chancellor through Dean for considering these case to further condone the attendance as special case.

f) A student detained on account of shortage of attendance in any semester shall be re-admitted to the same class in the subsequent academic year on payment of prescribed fees applicable in that year to complete the attendance requirement of that course.

6. Internal Assessment :

The Internal Assessment marks will constitute upto 30% of the total marks allotted to a course. For awarding Internal Assessment marks, there shall be three Sessional tests of 5 marks each for each course in a semester. First sessional test shall be taken in the beginning of the session, 2nd after two months of the session, and the 3rd sessional test 15 days before the commencement of the final semester examination. 5 marks shall be allotted for assignment, while 5 marks will be allotted to the attendance in the respective courses in the following manner :

100% attendance	05 Marks
75 - 99.9% attendance	04 Marks
60 – 74.9% attendance	03 Marks
below 60% attendance but not less than 50%	02 Marks

For the evaluation of lab work, laboratory notebook, practical test/viva voce shall be taken into account. The marks shall be awarded by the respective teachers conducting the practical course. For sessionals and during the examination, no department shall permit discontinuance of classes. Under the compelling circumstance such as sickness of the student or mourning in the family the candidate may be given another chance. For sickness only a credible medical

certificate issued by a hospital shall be considered. In case of causalities a letter from the parents would be required.

For Foundation course, there shall be three Sessional tests of 10 marks each. In each sessional, question from all the units shall form the question paper. Each unit, shall be allocated 2 marks each in each sessional. These sessional tests shall be taken in the manner as described for internal assessment of other courses. 10 marks will be allotted for assignment, while 10 marks for the attendance in the following manner :

100% attendance	10 Marks
75 - 99.9% attendance	08 Marks
60 – 74.9% attendance	06 Marks
below 60% attendance but not less than 50%	04 Marks

The questions for the Foundation Course sessional test should be sent to the Dean, Faculty of Science by respective Head of the Departments one week prior to the commencement of the test.

For assignment, a list of topics from each unit of Foundation Course should be sent by the teachers, who are involved in teaching Foundation Course through Head of the Departments. The list of these topics should be provided to the Dean latest by 1st week of August. The student will have choice to select a topic from the list. The assignment will be submitted in the office of the Dean in the month of September by the students, which will be sent, thereafter, to Head of the Departments for evaluation.

7. Semester Examination:

Each credit should be given weitage of minimum 25 marks. Foundation course shall be of 08 credits (200 marks) and 200 hours duration. The internal assessment (Sessional Tests) shall be of 50 marks, while the final examination shall be of 150 marks.

There shall be not less than two theory courses and one lab course in each semester, except 4th Semester. The detailed contents of the courses of studies shall be prescribed by respective Board of Studies and shall be reviewed regularly.

The botanical tour/educational tour shall be organized in the vacations. The final year students shall participate as per University rules and regulations.

A student who fails in theory papers of end semester examination may be given a chance to appear in 3 papers in Makeup examination to clear those papers. In no case shall it be allowed to the students who abstain from appearing in the semester examination. Students who are detained due to shortage of attendance shall not be allowed to appear in the Makeup examination.

Semester examination shall be held at the end of each semester as per schedule given in the Academic Calendar of the Faculty.

Upto maximum of seven days preparatory holidays may be given to the examinees before the start of the semester examinations.

The question paper for semester examinations, shall be set either by the external examiner or an internal examiner. The Board of Studies of a department shall draw a panel of name of examiners, both internal and external, for approval by the Vice chancellor. **If the external examiner is unable to send the question paper by the deadline set by the examination branch of the University, the Head of the Department after consultation with the examination branch shall get the paper set internally by a faculty.** The papers set by the examiners can be moderated in consultation with the teacher who taught that course. Teachers appointed on contractual basis with appointment of less than one academic session, and temporary as well as ad-hoc teachers may not ordinarily be appointed as examiners. All such teachers, however, will be expected to assist in the practical examination.

The question paper shall have five questions. There shall be one question from each of the 4 units of the course and one question shall contain objective type/short answer questions covering all the units of the course. The candidate shall have to answer all the five questions. There shall, however, be internal choice within a unit. The choice shall be given by setting alternative questions from the same unit. The question paper should be such that it covers all the topics of that course.

The duration of the semester examination of a theory course shall be Three hours. Practical exams of a lab course shall be of at least four hours duration. The practical examination shall be conducted by an external and an internal examiner and assisted by other teachers.

For projects, **each student shall submit three typed bound copies of his/her project work to the supervisor(s)** by the end of the 4th semester. A student shall not be entitled to submit the project report unless he/she has pursued project work during 4th semester under the guidance of a duly appointed supervisor(s). The report shall embody the candidates own work and an up-to-date review of the subject area. The write-up shall detail a critical assessment of the subject area and indicate in what respect the work appears to advance the knowledge of the subject concerned and future course of investigation required.

The project report shall be examined by a Board of Examiners and the student shall have to appear for viva-voce. The Board of Examiners shall consist of the following :

- An external examiner
- Head of the Department
- A senior teacher of the Department
- Concerned Supervisor(s)

The Board shall examine the project report of all the students, **conduct the viva-voce and award marks for the project and viva-voce. All other teachers of the department will also be invited by the Head of the Department to be present during the examination.** In case a student fails to secure the minimum pass marks, he/she may be asked to appear in the viva-voce again, or he/she may be asked to revise the project report in the light of the suggestions of the examiners and resubmit. For this, he/she will have to enroll as an ex-student in the next session. A resubmitted project report will be examined as above and viva voce shall be conducted along with other students.

8. Choice Based Credit System (CBCS)

Definitions of key words:

a) **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.
b) **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).
c) **Course:** Usually referred to, as 'papers' is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/term papers/assignments/ presentations/ self-study etc. or a combination of some of these.

d) **Credit Based Semester System (CBCS)**: Under the CBCS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students.
e) **Credit Point:** It is the product of grade point and number of credits for a course.
f) **Credit:** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
g) **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
h) **Grade Point:** It is a numerical weight allotted to each letter grade on a 10-point scale.
i) **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.
j) **Programme:** An educational programme leading to award of a Degree, diploma or certificate.
k) **Semester Grade Point Average (SGPA):** It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.
l) **Semester:** Each semester will consist of 15-18 weeks of academic work equivalent to not less than 90 actual teaching days. The odd semester may be scheduled from July to November and even semester from December to April.

m) **Transcript or Grade Card or Certificate :** Based on the grades e:rrned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

9. Semester System and Choice Based Credit System

The semester system accelerates the teaching-learning process and enables vertical and horizontal mobility in learning. The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice based credit system provides a 'Cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.

10. Types of Courses :

Courses in a programme may be of three kinds according to CBCS : Core, Elective and Foundation.

a. Core Course:- There may be a Core Course in every semester. This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

b. Elective Course:- Elective course is a course which can be chosen from a pool of papers. It may be:

- Supportive to the discipline of study.
- Providing an expanded scope.
- Enabling an exposure to some other discipline/domain.
- Nurturing student's proficiency/skill.

An elective may be "Open Elective" focusing on those courses which add generic proficiency to the students. An elective may be "Discipline centric" or may be chosen from an unrelated discipline. It may be called an "Open Elective."

c. Foundation Course:-

The Foundation Courses may be of two kinds: Compulsory Foundation and Elective foundation. "Compulsory Foundation" courses are the courses based upon the content that leads to Knowledge enhancement. They are mandatory for all disciplines. Elective Foundation courses are value-based and are aimed at man-making education.

11. Classification of Result :

a) Two methods -relative grading or absolute grading- have been in vogue for awarding grades in a course. The relative grading is based on the distribution (usually normal distribution) of marks obtained by all the students of the course and the grades are awarded based on a cut-off marks or percentile. Under the absolute grading, the marks are converted to grades based on pre-determined class intervals. To implement the following grading system, the colleges and universities can use any one of the above methods.
b) Following grading system with 10 point scale shall be followed to represent performance of students in the examination:

Grades and Grade Points :

Letter Grade	Grade Point	Marks
O (Outstanding)	10	90 – 100
A+ (Excellent)	9	80 – 89
A (Very Good)	8	70 – 79
B+ (Good)	7	60 – 69
B (Above Average)	6	50 – 59
C (Average)	5	45 – 49
P (Pass)	4	40 – 44
F (Fail)	0	Less than 40
AB (Absent)	0	

Earned Credits (EC) :

The credits for the courses in which a student has obtained P (minimum passing grade for a course) or a higher grade in the semester exam shall be counted as credits earned by him/her. Any course in which a student has obtained 'F' or 'AB' grade shall not be counted towards his/her earned credits.

12. Computation of SGPA and CGPA :

Following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

a) SGPA (Semester Grade Point Average) shall be awarded on successful completion of each semester.

b) CGPA (Cumulative Grade Point Average), which is the Grade Point Average for all the completed semesters at any point in time shall be awarded in each semester on successful completion of the current semester as well as all of the previous semester. In 1st semester, CGPA is not applicable.

13. Calculation of SGPA and CGPA of A Student in a Semester :

$$SGPA = \frac{\Sigma \text{ (Earned Credits X Grade Point)}}{\Sigma \text{ (Total Course Credits in a Semester)}}$$

$$CGPA = \frac{\sum_{j=1}^{m} \text{(Earned Credits X grade point)}}{\Sigma \text{ (Total Course Credit in a Semester)}}$$

Where m is the number of semesters passed

14. Promotion :

a) Promotion from 1st semester to 2nd semester and from 3rd semester to 4th semester shall be automatic.

b) A student shall be promoted to the 3rd semester of the programme if he/she has passed in each theory and practical courses separately of 1st and 2nd semesters. Provided that a student may carry over a maximum of 8-9 credits (equivalent to two-three theory papers, which may be of 3 or 4 credits each) of courses uncleared, to the 3rd semester). A candidate will be given a total number of 2 attempts, inclusive of the first attempt, to clear the papers in which he/she fails. For such students, promotion to the next higher class will be considered subject to rules relating to passing the 1st and 2nd semester examinations within two academic years. Award of degree shall be subject to successfully completing all the requirements of the programme of study within four years from admission. A student who fails in theory papers of end semester examination may be given a chance to appear in 3 papers in Make-up examination to clear those papers. In no case shall it be allowed to the students who abstain from appearing in the semester examination.

c) Candidates who are unable to appear in the examination because of serious illness at the time of examinations may be given another chance. The request has to be processed through the Head of the Department to the Vice Chancellor. The Vice chancellor may look into the merit of the case and decide accordingly.

15. Classification of Successful Candidates :

The result of successful candidates who fulfill the criteria for the award of M. Sc. shall be classified after the 4th semester, on the basis of his/her CGPA of all the four semesters.

Classification shall be done on the basis of following criteria:

a) He/She will be awarded “Ist Division” if his/her final marks are greater than or equal to 60% in all the semester examinations in the first attempt.
He/she will be awarded “Ist Division” if his/her final CGPA is 7 or above

b) He/She will be awarded “2nd Division” if his/her final marks are greater than or equal to 50% but less than 60% in all the semester examinations in the first attempt.
He/she will be awarded “2nd Division” if his/her final CGPA is 6 or above but less than 7

c) He/She will be awarded "Pass" if his/her final marks are greater than or equal to 40% but less than 50% in all the semester examinations in the first attempt.
He/She will be awarded "Pass" if his/her final CGPA is 5 or above but less than 6.

d) He/She will be treated as "fail" if his/her final marks are less than 40% in all the semester examinations in the first attempt.
He/She will be treated as "fail" if his/her final CGPA is less than 5

16. Span Period :

a) 1st and 2nd Semester Exams: Within two years from the first admission to the programme
b) All requirement of M. Sc. degree within a total period of four years from the date of their first admission.

17. Improvement :

A candidate who wishes to improve the previous performance will be allowed to do so as per the following regulation :

a) A student shall be allowed only once to reappear in the semester examination of up to four theory courses along with regular students of that semester to improve upon the previous performance. The examination fee charged from such candidates shall be double the current examination fee.
b) Such a student shall inform the Head of the Department in writing of his/her intention to improve the performance two months before the date of semester examination is to be held. Only the candidates who have attained at least C grade shall be eligible for improvement of performance.
c) If the student improves the performance, he/she shall be required to submit the earlier mark-sheet/degree. A new mark-sheet and degree shall be issued. The new mark-sheet/degree shall bear the year in which the student improved the grade.
d) In case the grade obtained in improvement is lower than the one obtained earlier, the higher grade shall be retained.

18. Consolidated Mark sheet :

On successful completion of the course, a consolidated marksheet consisting of marks of all the Semesters shall be issued to the students by the Examination Section.

19. Award of Gold Medal :

Gold Medal will be given to the toppers of each course. However, only the overall topper in all the disciplines of any course will be given Gold Medal by the Chief Guest in the Convocation. Criterion for giving the Gold Medals will be percentage of marks. Therefore students with highest % of Marks will be given the Gold Medal in each discipline of a course.

DETAILED SYLLABUS

&

LEARNING /ASSESMENT PEDAGOGIES

Semester - I

FUNDAMENTALS OF BIOTECHNOLOGY

MBTCC-100

Credit :4, Max. Marks: 100 [Sessional Marks: 25, Exam. Marks: 75] Time :72 hours

COURSE OBJECTIVES

The purpose of this course is to provide an understanding of fundamental concepts of pH, buffer and solution preparation. They will also get an understanding of principles of techniques. Used in biotechnology. To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products. To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as genetic modifications and role of biotechnology immunotherapeutic and diagnostic.

COURSE LEARNING OUTCOMES

Upon the completion of course, the student will understand:

CLO100.1: Concept and Significance of Biotechnology; Concept of pH, buffers, thermodynamics, Molarity, Normality (Cognitive Level: Understand)

CLO100.2: Applications of techniques like Microscopy, Cell sorting, Recombinant DNA technology, Somatic hybridization, (Cognitive Level: Apply)

CLO100.3: Application of Plant Breeding technology, GMOs, Biofuel and Sewage treatment, Gene therapy, monoclonal antibodies, Gene pool conservation, Bio fortification, Nutraceuticals (Cognitive Level: Apply)

CLO100.4: Analyze the Ethical issues in Biotechnology for Agriculture and health care,

Quality control, good manufacturing /laboratory practices. (Cognitive Level: Analyze)

			MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
	COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
SEMESTER IST																	
	Fundamentals	CLO100.1	1	2	1	2	3	2	1	1	2	3	3	2	3	1	1
	of	CLO100.2	3	3	2	3	3	2	3	1	2	3	2	3	2	1	3
	Biotechnology	CLO100.3	3	3	3	3	3	2	2	2	2	3	3	3	3	3	2
	MBT-CC100	CLO100.4	2	3	2	3	3	2	2	3	1	2	1	2	1	2	2

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

UNIT 1: Overview **16 hours**

Introduction and Definition. Historical Perspectives. Scope and Importance of Biotechnology. Commercial Potential. Medical and social implications of Biotechnology. Transgenic animals and plants. Role of Biotechnology in immunotherapeutics and diagnostics. Implications of Biostatistics, Bioinformatics and Structural Biology in Biotechnology.

Unit II: Tools and Techniques in Biotechnology **20 hours**

Fundamentals of Techniques; Concept of pH and Buffers. Principles of Thermodynamics and Free energy. Exergonic and Endergonic reactions. Molarity and Normality. Dimensions and Units. Measurement Conventions.

Cellular Techniques; Microscopy. Cell Sorting. Cell Fractionation. Cell- Growth Determination.

Genetic Techniques; Recombinant DNA Technology. Recombination in Bacteria. Breeding Methods in Plants. Somatic Hybridization. Pedigree Analysis in Humans.

Unit III: Applications of Biotechnology **20 hours**

Genetic engineering of plants and animals: Development of GMOs-pros and cons and Future.

Environmental Biotechnology; Biological Fuel Generation. Sewage Treatment. **Medical Biotechnology**; Gene therapy. Monoclonal antibodies and recombinant enzymes.

Agriculture and Forest Biotechnology; Gene pool conservation. Biofortification. **Food and Beverage Biotechnology**; Single-cell Proteins. Nutraceuticals. Food preservation.

Unit IV: Biotechnology and Society **16 hours**

Public perception of Biotechnology. Patenting (Intellectual Property Rights— IPR). Varietal Protection. Ethical Issues in Biotechnology—Agriculture and Health Care. Quality Control in Manufacturing. Product Safety. Good Manufacturing Practices (GMP). Good Laboratory Practices (GLP). Marketing. Safety in Biotechnology.

Reference Books

Biotechnology: Science for the New Millennium by Ellyn Daugherty

Biology-A Global Approch by Campbell

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

MOLECULAR BIOLOGY

MBT — CC101

Credit :4, Max. Marks: 100 [Sessional Marks: 25, Exam. Marks: 75] Time :72 hours

COURSE OBJECTIVES

This course is to expose the students to the chromosome structure, transcription in both prokaryotes and eukaryotes. It also familiarizes students with extra chromosomal elements, mutagenesis and genetics of evolution.

COURSE LEARNING OUTCOME

Successful completion of the Molecular Biology course will allow students to:

CLO101.1: Understand the chemical and molecular processes of life based on the genetic constituents of the cell. (Cognitive Level: Understand)

CLO101.2: Comprehend the properties of the heritable material along with all the enzymes involved for proper replication fidelity. (Cognitive Level: Understand)

CLO101.3: Appreciate the diversity of life and the changes occurring through mutations and the underlying molecular mechanism. (Cognitive Level: Evaluate)

CLO101.4: Illustrate the connectivity of living system and divergence through molecular evolution (Cognitive Level: Apply)

CLO101.5: Employ scientific methods and design the experiments along with interpreting biological data to communicate concepts of molecular biology to wider scientific community as well as general public. (Cognitive Level: Apply)

			MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
	COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
SEMESTER IST																	
	Molecular	CLO101.1	3	3	1	2	2	2	3	1	1	3	3	3	1	2	1
	Biology	CLO101.2	3	3	1	3	1	2	3	1	1	3	3	3	3	2	1
	MBT-CC101	CLO101.3	3	3	3	3	1	2	3	1	1	2	3	3	3	1	1
		CLO101.4	3	2	1	3	1	2	3	1	1	2	3	3	1	1	1
		CLO101.5	3	2	3	3	2	2	3	1	1	2	3	3	1	2	1

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

UNIT – I **18 hours**

Genetic material: Eukaryotic Genome. Organisation of Chromatin (Supercoiling). Repetitive DNA, Types of DNA. Properties of DNA in solution. Dissociation-reassociation kinetics. Cot curves. RNA: RNA genome and its replication. Replication of retroviruses and reoviruses. Reverse transcriptase; RNA dependant RNA polymerase. Types of RNA and their primary and secondary structure. Functions of RNA. Replication of DNA. Role of DNA polymerases and other DNA modifying enzymes. Mechanism of replication. Multiple origins of replication. Proof reading function and fidelity of DNA replication. Extrachromosomal replicons. Replication of circular DNA: Theta model and rolling circle models.: DNA and RNA fingerprinting (including probes and labeling techniques). DNA sequencing and sequencing strategies: Maxam & Gilbert's, Sanger's and Next generation (454, Solexa, SoLID).

UNIT – II **18 hours**

Transcription: Structure of gene, regulatory and transcriptional units. Promoters and other regulatory elements. Special features of eukaryotic genes. Exons and introns. Transcription in prokaryotes. Prokaryotic RNA polymerase and its components. Initiation, elongation and termination of transcription. Role of Rho factor. Transcription and translation are coupled in prokaryotes. Polarity effect. Eukaryotic transcription. Types of eukaryotic RNA polymerases and their role. RNA modifying enzymes. Transcription factors. Termination of eukaryotic transcription. Modification of primary transcript in eukaryotes; Removal of introns, Intron-exon junction. Splice sites. Nuclear splicing, Role of SnRNPs. Self-splicing of Type I and Type II introns. Role of 'G' nucleotide. Catalytic activity of RNA. Enzymatic splicing of tRNA. Self-cleavage of viroids and virusoids, Ribozyme. Alternate splicing and gene regulation. Cap addition, polyadenylation and RNA editing.

UNIT – III **18 hours**

Mutation and mutagenesis: Physical and chemical mutagens and their effect on DNA. Beneficial mutations; Site directed mutagenesis, oligonucleotide directed point mutations; DNA damage and repair in prokaryotes and eukaryotes. Base and nucleotide excision mechanisms. Direct repair. Mismatch repair, role of methylation, UV induced damage and repair system. Error prone repair. SOS response.

Genome Editing: Concept, applications in plants and animals, prospects and limitations.

UNIT – IV **18 hours**

Molecular Evolution: Separation, natural selection and evolution of proteins as well as, nucleotide sequences. Molecular clock, evolution by gene duplication and exon shuffling, deleterious genes. Eugenics, Gene frequencies, conservation of gene frequencies.

Transposable elements in bacteria. Mobile elements in eukaryotes. Insertional sequences (IS elements), transposons and composite transposons, retroposons. Replicative and non-replicative transpositions. Molecular mechanism of transposition events.

Reference Books

Principles of Molecular Biology by Burton E. Tropp

Genes XI by Jocelyn E. Krebs

Mol. Biology of the Cell by Alberts

Molecuar Cell Biology by Lodish Berk

Molecular biology of the gene by Alexander Gann, Tania A. Baker, Michael Levine, Richard Losick, James Watson

Molecular Biology Genes to Proteins by Burton E. Tropp

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

ESSENTIALS OF GENETIC ENGINEERING

MBT — CC102

Credit: 4, Max. Marks: 100 [Sessional Marks: 25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES

The objectives of this course are to take students through basics of genetics and classical genetics covering prokaryotic/ phage genetics to yeast and higher eukaryotic domains. On covering all classical concepts of Mendelian genetics across these life-forms, to provide students with experimental knowledge of molecular biology and genetic engineering.

COURSE LEARNING OUTCOME

Upon completion of the course the student will be able to:

CLO102.1: understand the basic applications of genetic engineering involving use of enzymes and vectors. (Cognitive Level: Understand)

CLO102.2: gain knowledge and training on high end versatile tools and techniques employed in recombinant DNA technology to construct DNA, cDNA libraries. (Cognitive Level: Apply)

CLO102.3: understand the applications of microbes in genetic engineering (Cognitive Level: Apply)

			MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
	COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
	Essentials of	CLO102.1	3	2	3	3	1	1	3	1	1	2	3	3	2	3	2
	Genetic	CLO102.2	3	2	3	3	3	2	3	1	1	2	3	3	3	3	2
	Engineering	CLO102.3	3	1	2	2	1	2	3	1	1	2	3	3	2	3	2
	MBT- CC102																

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

UNIT – I **16 hours**

Mendelian & Post mendelian genetics: Mendelian and Non-Mendelian inheritance. Inheritance of Quantitative traits. Gene discovery- forward and reverse genetics approaches. Molecular Mapping and tagging. RNAi, siRNA and miRNA. Epigenetics. Comparative genomics: insights into genome organization; application in gene and cis-element detection.

UNIT – II **18 hours**

Genomics of microbes: General characteristics of different groups: acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya,

Archaea and Bacteria; Eukarya: Algae, Fungi and Protozoa). Mechanism of gene transfer in bacteria: conjugation, transduction and transformation. Recombination in Bacteriophages. Mapping the structure of bacterial chromosome. Far western blotting, Analysis of DNA-Protein Interactions, Electromobility shift assay, Methyl Interference assay, DNase Foot printing. PCR in molecular diagnostics: Detection of hepatitis, herpes, HIV, and EBV. The role of PCR in detecting minimum residual diseases (MRD).

UNIT – III **16 hours**

Characteristics and application of vectors and enzymes: Introduction to gene manipulation, Plasmid, phages, cosmids, YAC, BAC and Ti-plasmid. Vectors for making RNA probes. Vectors for maximizing protein synthesis, protein purification and enhanced protein export. Vectors with combination of features (Litmus and pin point vector series).

Nucleic acid modifying enzymes (Restriction endonuclease, Polymerase, Kinase, Phosphatase, Methylase, Ligase). Concept of adapters and linkers for insert modification.

UNIT – IV **22 hours**

Molecular markers, Cloning and library construction: Construction of genomic and c-DNA libraries. Synthesis of cDNA (mRNA isolation, purification and strategies of cDNA synthesis). Cloning strategies (conventional and advanced cloning strategies). Introducing DNA into bacterial cells. Screening of libraries: Grunstein Hogness method, probe based screening, Blue and white screening, replica plating. Southern, Northern, Western and South-Western blotting. Molecular markers: PCR and derived techniques including RAPD, AFLP, iPCR, qRT-PCR, RFLP. *In-situ* hybridization – FISH, GISH. Micro arrays: DNA and RNA microarrays for transcriptomics and re-sequencing/mutation detection. Applications of recombinant DNA technology.

Reference Books:

Recombinant DNA by James D. Watson
Mol. Biotechnology principles & App. of recombinant DNA by Glick B.R.

Gene Cloning and DNA Analysis: An Introduction by T.A Brown
Genetic A Conceptual Biotechnology science for Approach by Pierce B.A.
Genomes 4 by T.A Brown

Teaching – Learning Strategies in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

MEDICAL MICROBIOLOGY

MBT-CC103

Credit :4, Max. Marks: 100 [Sessional Marks: 25, Exam. Marke: 75] Time :72 hours

COURSE OBJECTIVES

The objectives of this course are to introduce field of microbiology with special emphasis on microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host microbe interactions.

COURSE LEARNING OUTCOME

Upon completion of the course the student will understand:

CLO103.1: Normal microflora their impact on health, virulence factors and pathogenesis during bacterial, fungal and parasitic diseases. (Cognitive Level: Understand)

CLO103.2: Bacteria, viruses, fungi and parasites including their classification and characteristic features, diagnosis and prevention measures including use of drugs and inhibitors. (Cognitive Level: Understand)

CLO103.3: the treatment strategies including the appropriate use of antimicrobial agents and common mechanisms of antimicrobial action and resistance. (Cognitive Level: Apply)

CLO103.4: applications of the host pathogen interaction in terms of bacterial pathogenesis and invasion mechanisms. (Cognitive Level: Apply

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Medical	CLO103.1	1	1	2	2	3	3	2	3	2	2	3	1	3	1	1
Microbiology	CLO103.2	2	2	2	2	2	3	3	3	3	3	2	1	3	2	1
MBT- CC103	CLO103.3	1	2	1	1	2	2	2	2	2	2	3	1	3	1	1
	CLO103.4	1	2	1	1	3	3	3	3	3	3	3	3	3	3	2

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

Unit I Bacterial diseases **20 hours**

Normal microflora (microbiome) of human body and its role — Skin, mouth and respiratory tract, intestinal tract, urogenital tract; Pathogenesis and virulence factors.

-Koch's postulates, Adherence and invasion, Toxins, Enzymes, Antiphagocytic factors, Antigenic heterogeneity, Iron acquisition (*Bacillus anthracis*, Clostridium spp., *Corynebacterium diptheriae*; *E. coli*, *Vibrio cholerae*, *Helicobacter pylori*, *Salmonella typhi* and *paratyphi*, *Shigella dysenteriae*; *Listeria monocytogenes*, Mycobacterium spp). Rickettsial diseases; *Haemophilus influenzae*, *Bordetella pertussis*, Brucellosis, Streptococcal and Staphylococcal infections; Antibacterial chemotherapy (with examples of antibiotics); Inhibition of cell wall synthesis, inhibition of cell membrane function, inhibition of protein and nucleic acid synthesis, antimetabolites, antimicrobial activity in vitro and in vivo, Drug resistance- origin {genetic and non-genetic), mechanisms, Multi-drug resistance and its mechanisms e.g., MDR-TB.

Unit II Viral diseases **20 hours**

Viral Pathogenesis - Routes of entry, Viral spread (local and systemic infection), Viral persistence {chronic and latent infection); Polio, Chicken pox, Mumps, Measles, Rubella; Viral hemorrhagic fever, viral encephalitis, Dengue and Yellow fever; Influenza virus infection (emphasis on Avian and swine flu), Rabies and Prion diseases; Hepatitis and Human Cancer viruses; Emerging viral diseases — Ebola,

Marburg, SARS, Hanta, Chikungunya, Zika, Chandipura; Antiviral chemotherapy and Viral vaccines; Nucleotide and nucleoside analogs, Reverse transcriptase inhibitor, protease inhibitor, fusion inhibitor etc., Interferons, Killed and attenuated vaccines.

Unit III Fungal and protozoan infections **16 hours**

Types of Mycoses (with specific example of causative fungi) — Superficial, Cutaneous, Sub-cutaneous; Types of Mycoses (with specific example of causative fungi) - Endemic and Opportunistic; Mycotoxins and Antifungal chemotherapy — Mycetismus, Aflatoxins, classes of currently available drugs and new inhibitors in the pipeline; Protozoan diseases - Giardiasis, Amoebiasis; Leishmaniasis, African sleeping sickness; Malaria, Cryptosporidiosis; Infection by Helminths — Nematodes, Trematodes, Cestodes.

Unit IV Host-pathogen interaction **16 hours**

Intracellular and extracellular pathogens, Principles of microbial pathogenesis, host damage, inflammatory responses, adaptation strategies of pathogen- impact of host and pathogen metabolism on immunity and pathogen survival; Chronic pathogens and mechanisms of persistence; Evasion mechanisms of pathogens; Bacterial — host interaction- Mycobacterium tuberculosis, Borrelia burgdorferi; Viruses — host interaction: HIV, Influenza; Protozoan — host interaction: Plasmodium spp., Leishmania major.

Reference Books:

Microbiology a Textbook of Microorganisms General & Applied by Marshall.CE
Microbiology an Evolving Science by Slonczewsk Foster

Microbiology by Parker

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

CELLULAR BIOLOGY & BIOMOLECULES

MBT-OE104

Credit :4, Max. Marks: 100 [Sessional Marks: 25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES *

The main aim of this course is to teach students basic concepts of cell structure and function, cell cycle and cell signalling pathways, including cell growth, differentiation, survival and death. Explain the basic molecular properties of biological molecules and demonstrate how the structure of biological molecules dictates functions and illustrate how regulatory systems maintain homeostasis in biological system.

COURSE LEARNING OUTCOME

Upon completion of the course, the student shall be able to:

CLO104.1: Gain insight on the basic functionalities of the cell as the unit of life and its growth phases and communication mode by various cellular signaling pathways. (Cognitive Level: Understand)

CLO104.2: Comprehend the structure and functions of the major classes of the biomolecules and their significance. (Cognitive Level: Remember)

CLO104.3: Analyze the significance and mechanisms of major metabolic pathways and their regulation and their role in metabolic disorders. (Cognitive Level: Analyze)

CLO104.4: Comprehend the principles and applications of protein purification and molecular biology techniques. (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
*																
Cellular	CLO104.1	3	2	1	2	1	2	2	2	3	3	3	3	3	3	2
Biology &	CLO104.2	3	2	1	2	1	2	2	2	3	3	3	3	3	3	2
Biomolecules	CLO104.3	3	3	1	2	2	3	3	2	3	3	3	3	3	3	2
MBT-OE104	CLO104.4	3	3	1	2	3	3	2	2	3	3	3	3	3	3	2
3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)																

***open elective**

COURSE CONTENT

UNIT – I **18 hours**

The cell & cell cycle: Structure and function of cell. Phases of the cell cycle; regulation of the cell cycle by cell growth and extra cellular signals; cell cycle check points; coupling of S-phase to M phase. Regulators of cell cycles progression – MPF; families of cyclins and cyclin – dependent kinases; growth factors and D-type cyclins. Inhibitors of cell cycle progression. Cell growth and division.

Cell Signaling: Signaling molecules and their receptors; functions of cell surface receptors; pathways of intracellular signal transduction; signal transduction and the cytoskeleton; signaling in development and differentiation. Bacterial Chemotaxis and Quorum Sensing; Cell signaling and Cancer.

UNIT –II **18 hours**

Carbohydrates& Lipid Metabolism:

Carbohydrates: Structures and functions of carbohydrates; Bioenergetics, glycans and proteoglycans. Aerobic and anaerobic pathways. Glycolysis, TCA cycle, electron transport chain and oxidative phosphorylation. Galactose and fructose metabolism. Gluconeogenesis, glycogen synthesis and breakdown.

Lipids: Structure and functions; Metabolism and synthesis of phospholipids, glycolipids, sphingolipids and other derived lipids. . α, β and ω oxidation of fatty acids. Mobilization of fats.

Inborn errors of metabolism: Glycogen storage diseases in human- Von Gierke's disease, Pompe's disease, Cori's disease, Mc Ardle's syndrome. Inherited human diseases related to membrane lipids -Gangliosidoses, Gaucher's disease, Niemann-pick disease.

UNIT – III **18 hours**

Amino acid and Protein metabolism: Acid base chemistry of amino acids Amino acid synthesis and metabolism. Primary, secondary, tertiary and quarternary structure of proteins. Super secondary structures. Isomerism and types. Dihedral angles, Ramachandran plot. Hydropathy plot, Models of protein folding. Chaperone assisted protein folding; Amyloid disease, Dnak and DnaJ mechanism of action; Circular dichroism. Sequencing, Peptide synthesis, Interrelationship of protein and carbohydrate metabolism. Urea cycle. Hyperammonemia. Regulation of cell metabolism.

UNIT – IV **18 hours**

Protein purification and enzymes: Cofactors and types; vitamin derived coenzymes (Role of TPP, CoA, FMN, FAD, PLP, Biotin as cofactors in various enzymatic reactions); Fat and Water soluble vitamins, and their deficiencies.

Purification of proteins: Salt fractionation, gel filtration (FC), PAGE-native and SDS, ion-exchange chromatography, affinity chromatography, 2D gel electrophoresis, isoelectric focusing.

Enzyme Kinetics: Characteristic of enzymes, Nomenclature and Classification, Michaelis Menten Kinetics Inhibition of enzyme catalyzed reactions, Multifunctional enzymes, multi-enzyme complexes, coupled reactions, cyclic reactions.

Reference Books

Cellular and Biochemical Sciences by G.Tripathi

Biochemistry by Brown

Principles of Biochemistry by Lehninger

Methods in Enzymology by Jon Lorah
Lewin's Cell by Lynne Cassimeris
The Cell: A Molecular Approach by Geoffrey M. Cooper

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

PRACTICAL – BIOMOLECULES, GENETIC ENGINEERING AND MOLECULAR BIOLOGY

MBT-CC105

Credit: 8 Max. Marks: 200 [Sessional Marks: 50, Exam. Marks: 150] Time: 200 hours

COURSE OBJECTIVES

The purpose of this course is to provide an understanding of fundamental concepts and underlying principles in the instruments used in Genetic Engineering, Biomolecules and Molecular Biology. In addition, the course is expected to develop the analytical skill to enable them to interpret the data.

COURSE LEARNING OUTCOME

Upon completion of the course students shall be able to:

CLO105.1: Make the solutions and buffers for various lab experiments. (Cognitive Level: Apply)

CLO105.2: Explain the working and principles of major instruments in the laboratory and Central instrumentation facility. (Cognitive Level: Apply)

CLO105.4: Analyze the difference between different in structure of biomolecules (Carbohydrates, Proteins and lipids). (Cognitive Level: Analyze)

CLO105.3: Perform and analyze the Chromatography techniques (TLC and size exclusion Chromatography, Gel electrophoresis (SDS PAGE) and Agarose gel electrophoresis and southern blotting (Cognitive Level: Analyze)

CLO105.5: Perform the Isolation of DNA, from bacteria, Restriction digestion of plasmid DNA and bacterial genomic DNA. (Cognitive Level: Analyze)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Practical Biomolecules, Genetic Engineering and Molecular Biology	CLO105.1	3	2	1	2	2	1	1	3	3	3	1	3	2	2	1
	CLO105.2	2	2	2	1	2	2	2	2	2	3	2	3	2	2	1
	CLO105.3	1	2	1	1	2	2	1	2	2	3	1	3	2	3	2
	CLO105.4	3	2	2	2	3	2	3	3	2	3	2	3	2	3	2
	CLO105.5	3	2	3	2	2	2	2	3	2	3	3	3	2	3	2

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

1. Instrumentation
2. Preparation of solutions and buffers.
3. Water analysis - Hardness, Conductivity and pH.
4. Qualitative and Quantitative analysis of Carbohydrates and detection of reducing sugars by Folin-Wu-method.
5. Isolation and hydrolysis of starch & casein from biological samples.
6. Quantitative tests of Lipids & their separation by thin layer chromatography (TLC).
7. Qualitative analysis of proteins and amino acids.
8. Separation and identification of amino acids by ascending paper chromatography.
9. Extraction of proteins from biological samples and quantification by Lowry's and Bradford's method.
10. Separation of proteins by SDS-PAGE.
11. Subcellular fractionation by differential centrifugation.
12. Sonication of subcellular fractions and quantification of proteins by micro-Bradford's assay.
13. Column chromatography (Molecular sieving)
14. Preparation of Luria Bertani (LB) medium for bacterial culture and solutions.
15. Inoculation of *E. coli* DH5α strain on LB medium.
16. Extraction, quantification and agarose gel electrophoresis of genomic DNA from *E. coli* DH5α.
17. Effect of temperature and alkali on UV absorption of DNA: Hyperchromicity.
18. Preparation of competent cells by $CaCl_2$ method.
19. Ligation of linearized pGEM-T vector with an insert.
20. Transformation of chemically competent *E. coli* DH5α with plasmid blue script using $CaCl_2$ and heat shock method.
21. Isolation of plasmid DNA from *E. coli* by alkaline lysis method.
22. Agarose gel electrophoresis for plasmid DNA.

23. Restriction of λ-DNA, plasmid DNA and bacterial genomic DNA.
24. Agarose gel electrophoresis of restricted samples
25. Southern blotting of gel of restricted samples.
26. Isolation of RNA and its quantitation by UV spectrophotometer.

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 50 marks. End semester exam is of 150 marks.

Total Marks are 200 for the subject (Internal Assessment: 50 Marks and End semester examination: 150 Marks).

Semester - II

EXPRESSION OF GENETIC INFORMATION

MBT — CC201

Credit :4. Max. Marks: 100 [Sessional Marks: 25. Exam. Marks: 75]

COURSE OBJECTIVES

The main objective of the course is to understand the molecular aspects of translation, post translational modification, protein trafficking to organelles, genes and its regulation in prokaryotic and eukaryotic cell.

COURSE LEARNING OUTCOME

Successful completion of this course will allow students to:

CLO201.1: Exhibit knowledge in area of genetic expression and the related concepts to comprehend its universal nature and variations thereof. (Cognitive Level: Analyze)

CLO201.2: Understand the various aspects of protein structure modifications to appreciate diversity in function and subcellular localization. (Cognitive Level: Understand)

CLO201.3: Apply the knowledge of intricate regulation of genetic expression to design biological experiments (Cognitive Level: Apply)

CLO201.4: Appreciate the complexity of regulation in eukaryotic systems to better understand the interaction across scales of space and time. (Cognitive Level: Analyze)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Expression of Genetic Information	CLO201.1	2		3	3	1	1	2	1	1	2	3	3	3	2	2
	CLO201.2	1	1	3	3	1	2	2	1	1	3	3	3	2	1	1
	CLO201.3	3	3	2	3	1	2	3	1	1	2	3	3	3	3	2
	CLO201.4	3	3	1	3	2	2	1	1	2	2	3	3	3	2	2
MBT 20204																
3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)																

COURSE CONTENT

UNIT – I **18 hours**

Translation: mRNA, genetic code and its salient features. The structure of tRNA. Genesis of –CCA. Adapter role of tRNA. Wobble hypothesis. Ribosome as the site of protein synthesis. Structure and assembly. Polysomes.

Activation of amino acids: aminoacylation of tRNA. Initiation, elongation and termination of protein synthesis in prokaryotes and eukaryotes. Role of Initiation and Elongation factors. Peptidyl transferese activity and peptide bond formation. Translocation of ribosomes. Fidelity of protein synthesis: GTPase timer. Bioenergetics of protein synthesis.

UNIT – II **18 hours**

Post-translational processing of nascent polypeptide: Acylation, methylation, phosphorylation, sulfation, glycosylation, vitamin C-dependent modifications, vitamin K-dependent carboxylation and proteolytic processing. Inhibitors of protein and RNA synthesis. Role of antibiotics.

Protein Targeting to Organelles: Localization signals. Role of ER and Golgi bodies in protein transport, transport vesicles, endocytosis and exocytosis. Protein transport to nucleus, mitochondrion and chloroplast.

UNIT – III **18 hours**

Regulation of gene expression in prokaryotes: Constitutive and regulated gene expression. Enzyme induction and repression in prokaryotes. DNA binding motifs. Operon Theory: Lac, Trp, Ara and Gal operons. Role of cAMP. Transcriptional termination control via alternate RNA conformations: Attenuation. Regulatory cascades. Control of lytic and lysogenic cycles of lambda phage. Flip flop circuits by genetic recombination. Role of sigma factor in control of sporulation.

UNIT – IV **18 hours**

Regulation of gene expression in eukaryotes: General considerations. Auto regulation, Role of methylation, Response elements. Britten-Davidson models. Control by hormones and other primary messengers. Role of receptor-ligand binding. Adenylcyclase, cAMP and other signal molecules. Regulation of gene expression by chromatin structure. Regulation of Gal genes in yeast. Switching of yeast mating types. Cytoplasmic regulation of gene expression. Control of translation. Role of mRNA stability. Hormonal regulation of translation. Role of micro-nutrients. Regulation of rRNA ribosomal protein synthesis.

Reference Books

Principles of Molecular Biology by Burton E. Tropp
Genes XI by Jocelyn E. Krebs
Mol. Biology of the Cell by Alberts
Molecuar Cell Biology by Lodish Berk
Molecular biology of the gene by Alexander Gann, Tania A. Baker, Michael Levine, Richard Losick, James Watson
Molecular Biology Genes to Proteins by Burton E. Tropp

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

MOLECULAR PLANT PHYSIOLOGY

MBT – CC202

Credit :4, Max. Marks: 100 [Sessional Marks: 25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES

The main objectives of the course are to impart knowledge of the detailed mechanism of different plant respiratory process and to understand the nutritional requirements and role of phytohormones in plant growth. The course also enables the learner to understand the various aspects of plant physiology under abiotic and biotic stress.

COURSE LEARNING OUTCOME

Upon the completion of the course, the students shall be able to:

CLO202.1: analyze the knowledge of stress adaptations in biological systems. (Cognitive Level: Analyze).

CLO202.2: deliver molecular understanding of primary and secondary metabolic process. (Cognitive Level: Understand)

CLO202.3: present perspectives of the current tools for application in biological system for biotechnological research. (Cognitive Level: Analyze)

CLO202.4: develop a molecular understanding of the principles of photosynthesis and photomorphogenesis, molecular basis of nutrient uptake and utilization with emphasis on plant stress physiology (Cognitive Level: Understand)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Molecular	CLO202.1	1	2	2	3	3	2	2	1	2	2	2	3	3	2	2
Plant	CLO202.2	2	2	2	3	2	1	2	1	2	2	3	2	2	1	2
Physiology	CLO202.3	3	3	3	2	3	2	2	1	2	3	3	3	3	2	2
MBT- CC20 1	CLO202.4	2	2	3	3	2	2	3	1	2	2	3	2	2	1	2
3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)																

COURSE CONTENT

UNIT – 1 **18 hours**

Photosynthesis, alternative respiration and Hexose monophosphate stunt: Light harvesting complexes and light reaction. The photosynthetic carbon reduction cycle (PCR), C_4 and Crassulacean acid metabolism (CAM) pathway. Photo-inhibition and photorespiration. Synthesis, transport and storage of starch. Cyanide resistant respiration. Oxidative Pentose phosphate pathway.

UNIT – II **18 hours**

Mineral Nutrition in Plants: Importance of mineral nutrition in plant growth, development and productivity**.** Criteria for the essentiality of mineral nutrients, and their physiological functions. Nutrient uptake (active and passive uptake); active transport and electrogenic pumps. Assimilation of mineral nutrients (nitrogen, sulphur and phosphorus)

and their physiological functions. Biological nitrogen fixation: nif genes, nodulin genes and nodule development. Nitrogen and Sulphur-use efficiency.

UNIT – III **18 hours**

Phytohormones, Photoreceptors and Dormancy: Structure, biosynthesis and molecular mechanism of action of phytochromes (Auxins, Gibberellins, Cytokinins, Abscisic Acid, Ethylene). Structure and functions of brassinosteroids and polyamines.

Photoreceptors: structure and function of phytochromes and cryptochromes; role in signal transduction. Flower and seed development. Seed dormancy and germination. Types of seed dormancy and methods to overcome dormancy.

UNIT – IV **18 hours**

Stress and Post Harvest Physiology: Abiotic stresses (drought, submergence, low and high salinity. temperature, salt and heavy metal stresses). Role of LEA proteins in stress tolerance. Biotic stresses (insects and diseases), stress induced gene expression. Molecular basis of senescence, ageing and programmed cell death in plants. Molecular biology of fruit ripening and control of post - harvest deterioration of fruits, vegetables and cut flowers.

Reference Books

Plant Biochemistry by Florence K. Gleason
Plant Physiology and Development by Lincoln Taiz, Eduardo Zeiger

Plant Pathogen Resistance Biotechnology by David B. Collinge

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

PLANT TISSUE CULTURE AND ITS APPLICATIONS

MBT — CC203

Credit :4, Max. Marks: 100 [Sessional Marks:25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES

The main objectives of the course are to acquire knowledge in plant tissue culture fundamentals involving *in-vitro* propagation of totipotent explants by different biotechnological approaches and their transformation and production of improved crop varieties. The course introduces the various plant genetic engineering techniques involving protoplast isolation, purification and culture and applications of plant biotechnology in the production and propagation of genetically modified plants.

COURSE LEARNING OUTCOME

Upon the completion of the course, the students shall be able to understand:

CLO203.1: concept and significance of plant tissue culture, principles and methods. (Cognitive Level: Understand)

CLO203.2: *In vitro* differentiation using different approaches and explants, applications, floral development in Arabidopsis and Antirrhinum, clonal fidelity, Bioreactors for mass propagation. (Cognitive Level: Analyze)

CLO202.3: application of Tissue Culture: Somaclonal variation, varietal improvement, Crop improvement (drought and salt stress/ herbicide, pesticide and insect tolerant and disease resistant plants). Synthetic seeds and cryopreservation for conservation. (Cognitive Level: Apply)

CLO203.4: applications of somatic hybrids and cybrids in crop improvement and Vector Independent transformation. (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Plant Tissue	CLO203.1	3	1	1	1	2	2	1	1	2	2	3	1	1	1	1
Culture & its	CLO203.2	3	2	2	2	1	2	1	1	1	2	3	3	2	2	1
Applications	CLO203.3	3	1	2	1	2	2	1	1	2	2	3	3	2	2	1
MBT -CC20 3	CLO203.4	3	2	3	2	1	2	2	1	1	1	3	3	2	2	1

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

UNIT – I **16 hours**

***In Vitro* culture of plant cells and tissues:** Concept and significance of plant tissue culture, principles and methods. Introduction of techniques, basic media, physical parameters, culture of various explants and possible *in-vitro* responses. Single cell and cell suspension culture.

UNIT – II 20 hours

In vitro differentiation: Organogenesis, embryogenesis, micropropagation, haploids through anther and pollen culture, endosperm culture and induction of triploids, nucellus culture, ovary ovule and embryo culture and rescue of hybrids, floral bud culture, floral

development in *Arabidopsis* and *Antirrhinum,* culture of shoot primordia, stem and root culture, clonal fidelity of regenerants. Bioreactors.

UNIT – III **20 hours**

Application of Tissue culture: Somaclonal variation and its application in varietal improvement, Use of plant tissue culture technology in crop improvement- selection for drought and salt stress tolerant plants; development of herbicide and pesticide tolerant plants; induction of disease resistant and insect tolerant plants. Synthetic seeds, Cryo-preservation for conservation of plants.

UNIT – IV **16 hours**

Protoplast culture and Vector Independent Transformation: Isolation of protoplasts and somatic hybridization. Applications of somatic hybrids and cybrids in crop improvement. Methods of protoplasts and tissue transformation; microprojectile bombardment, electroporation and microinjection. The advantages and disadvantages of these techniques.

Reference Books

Plant Biotechnology and Transgenic Plants by Oksman

Plant Development and Biotechnology by Robert N. Trigiano
Plant Physiology and Development by Lincoln Taiz, Eduardo Zeiger

Chloroplast Biotechnology by Pal Maliga

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three

sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

BIOTECHNOLOGY: ENVIRONMENTAL & ETHICAL ASPECTS

MBT — CC204

Credit :4, Max. Marks:100 [Sessional Marks:25, Exam. Marks:75] Time: 72 hours

COURSE OBJECTIVES

The main aim of the course is to give an introduction to the various aspects of environmental biotechnology to students. The course aims to develop the students understanding of ethical aspects of biotechnological interventions and their impact on the environment and the regulatory aspects associated with the implications of biotechnology products. The course provides basic knowledge on intellectual property rights and their implications in biological research and product development. The course promotes learning of the biosafety and risk assessment protocols of products derived from biotechnology. The course enables the understanding of basic ecological concepts and discusses various approaches to maintain environmental monitoring programs.

COURSE LEARNING OUTCOME

Upon the completion of the course, the students shall be able to understand:

CLO204.1: Ethical, Social and Biosafety aspects, Research Ethics, concept of Plagiarism, Ecological impact and biosafety issues of GM crops (Cognitive Level: Evaluate)

CLO204.2: Applications of biosafety levels. (Cognitive Level: Apply)

CLO204.3: Applications of Biosensors and Bioindicators in environmental monitoring programs, Bio-fertilizers and vermicomposting. (Cognitive Level: Analyze)

CLO204.4: Ecological concepts, Ecosystem, Energy flow in ecosystems Biomagnification, population dynamics and Ecological successions. (Cognitive Level: Understand)

CLO204.5 Evaluate the g**e**neration and production of biofuels and risks associated, Biodiversity Conservation Gene flow monitoring. Environmental Audit; Green audit and Energy audit. (Cognitive Level: Evaluate)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Biotechnology	CLO204.1	3	3	2	2	2	2	2	3	2	3	3	2	2	2	2
: E nviron	CLO204.2	3	2	2	2	3	2	1	2	2	3	2	2	3	3	2
mental &	CLO204.3	3	3	3	2	3	3	3	2	2	3	2	2	3	3	2
Ethical	CLO204.4	2	2	3	2	2	3	2	2	2	3	3	2	2	2	2
Aspects	CLO204.5	3	3	3	2	3	3	2	2	2	3	2	2	2	2	2

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

UNIT – I **18 hours**

Ethical, Social and Biosafety aspects: Socio-economic and ethical aspects of biotechnology. Environmental laws; Intellectual property rights; Objective of patent system, patentable subjects and protection in biotech; Basic Principles of patent system, UPOV for plant protection. GLP andGMP.

Objectives and levels of biosafety: Objectives; recombinant DNA safety; biological containment; risk groups and risk analysis. Carategana Protocol; OECD guidelines. Govt of India guidelines for r- DNA technology and GMO's. Ecological impact and biosafety issues of GM crops.

UNIT – II **18 hours**

Biotechnology and Environment Management: Bio-indicators and their applications in environmental monitoring programmes, role of biosensors. Carry over effects of herbicides

and pesticides on human health. Bio-fertilizers: types of biofertilizers, production technology for major biofertilizers (*Rhizobium, Azotobacter, Azolla*, Phosphate solubilizing microbes and Mycorrhizae). Vermi-composting. Bio-pesticides: Development of biopesticides: management of weeds, insect pests and diseases.

UNIT – III **18 hours**

Basic ecological concepts: Habitat ecology, systems ecology, synecology, autecology; Ecosystem concept; Structure and functions of biotic and abiotic components; Energy in ecosystems and environment; Energy exchange and productivity-food chains and food webs-ecological pyramids, nutrient cycles and recycle pathways; Biomagnifications Population - characteristics and measurement. Communities - habitats, niches, population dynamics, species and individual in the ecosystem. Ecological succession - types and causes.

Research Ethics:

- Concept of Plagiarism.
- Reviewing literature.
- Identification of research problem and proposal writing.

UNIT – IV **18 hours**

Bioremediation: Conventional and advanced technologies for the treatment of sewage and industrial effluents, bioremediation of xenobiotics: characteristics and classification of recalcitrant xenobiotics, metabolic pathways involved in their biodegradation, factors affecting biodegradation of xenobiotics. Phytoremediation and wasteland reclamation.

Biofuels; Generation of biofuels. Different Sources; Production of biodiesel and bioethanol. Advantages of biofuels over petrol. Biofuels risks.

Biodiversity Conservation: Types of Biodiversity and Conservation. Afforestation programmes: NAP and EDF schemes; Gene banks: Objectives and types of gene banks; Gene flow monitoring.

Environmental Audit: Green audit and Energy audit.

Reference Books:

Environmental Biotechnology by Viswanath Buddolla
Environmental Biotechnology by Daniel A. Vallero
Textbook of Environmental Microbiology by P.K. Mohapatra

Biotechnology Biofuel production and Optimization by Carrie A. Eckert

Teaching – Learning Strategies in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

BIO-STATISTICS

MBT - OE205

Credit :4, Max. Marks: 100 [Sessional Marks: 25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES *

The course is designed to understand the fundamental concepts of biostatistics applicable for research data analysis in life sciences and biotechnology. The course introduces basic concepts in variation, regression, correlation, probability and different statistical models' application in data interpretation. The course imparts knowledge on the applications of computer in biotechnology by apprising with the concepts of data handling, acquisition and mining by various computerized tools. The course explores the connection between basics as well the advance tools of the subject to demonstrate the link between theory and its real-world applications.

COURSE LEARNING OUTCOME

Upon the completion of the course, the students shall be able to understand:

CLO204.1: the principal concepts about biostatistics. (Cognitive Level: understand)

CLO204.2: the data relating to variable/variables; define the principal concepts of probability. (Cognitive Level: Analyze)

CLO204.3: the concepts about hypothesis testing and apply hypothesis testing to the data through these concepts. (Cognitive Level: Apply)

CLO204.4: applications of different types of Statistical Tests. (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
*																
Biostatistics MBT- OE205	CLO204.1	2	1	1	2	2	2	1	1	1	3	2	2	2	1	2
	CLO204.2	3	3	2	1	3	3	3	2	2	2	3	1	2	3	3
	CLO204.3	3	3	3	1	1	3	1	2	2	3	2	1	2	3	3
	CLO204.4	3	2	3	2	2	3	2	2	2	3	2	2	2	3	3

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

***open elective**

COURSE CONTENT

UNIT-1

Arithmetic Mean, Median and Mode (Theory and simple numerical problem)

Measures of variation: Standard Deviation, variance, coefficient of variation, properties (Theory and simple numerical problems)

Correlation: Types of correlation, methods of correlation, simple, multiple and linear and nonlinear correlation, spearman's correlation coefficient, Rank correlation (Theory and simple numerical examples)

UNIT – II

Regression: Linear regression, curvilinear regression (for two variables X and Y only), Regression lines by least square methods, Regression equations of X on Y and Y on X only (Theory and simple numerical examples only)

UNIT – III

Tests of significance: Null hypothesis, standard error, level of significance, Degrees of freedom, significance in mean for large samples, significance in means for small samples (students t-test)/ Significance in ratio of two samples. F-test (for difference between variance of two samples), chi square test (Simple numerical examples and theory), Analysis of variance test (ANOVA) for one and two way classification. Signed Rank test, Dunnet's-t-test (Theory and numerical examples)

UNIT-IV

Representation of statistical data: Software's used in plotting and representation of data (Excel, SPSS, Sigma Plot, R)

Diagrams and Graphs: Simple bar, Multiple bars, Component bar, pie diagram, histogram.

Reference Books

Introductory Biostatisticsby Le CT.
Advanced Biology Statistics by Edmondson A and Druce D. Danial W.
Biostatistics: A foundation for Analysis in Health Sciences, John Wiley

Biostatistics by M.V. Ismail.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

PRACTICAL-MOLECULAR PLANT PHYSIOLOGY AND PLANT TISSUE CULTURE

MBT — CC206

Credit: 8. Max. Marks: 200; sessional Marks: 50; Exam. Marks: 150; Time: 200 hours

COURSE OBJECTIVES

To train students on basic molecular plant physiology and plant tissue culture techniques. The course gives hands own experience in the plant tissue culture.

COURSE LEARNING OUTCOMES

Upon completion of the course, the student shall be able to:

CLO206.1: Compete in exploring physiology and anatomical structures of Plants (Cognitive Level: Understand)

CLO206.2: Perform the paper chromatography for the separation of plant pigments; Perform the respiration process in plants.; Perform and analyze experiments on the opening and closing of stomata (Cognitive Level: Analyze)

CLO206.3: Perform experiments on inoculation of seeds of *Trigonella, Brassica* and *Cichorium* sp. and evaluation of their percent germination in *in vitro* conditions. And study the regeneration potentials of juvenile explants (hypocotyls/ epicotyls) of *Trigonella foenum graecum.* (Cognitive Level: Analyze)

CLO206.4: Perform the enzyme isolation from plants and analyze their kinetic parameters. (Cognitive Level: Analyze)

CLO206.5: Perform *In vitro* endosperm culture; and Study differentiation potentials of nodal segment/ leaf/ petiole of *Tylophora indica*. (Cognitive Level: Analyze)

MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES

COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Practical -	CLO206.1	3	3	1	3	2	2	1	1	2	3	3	3	2	2	1
Molecul ar	CLO206.2	2	2	2	1	3	2	3	2	3	3	3	3	2	2	2
Plant	CLO206.3	3	3	2	2	3	3	2	2	2	3	3	2	2	2	2
Physiology &	CLO206.4	3	3	2	1	2	3	1	2	2	1	3	3	2	1	2
Plant Tissue	CLO206.5	2	2	1	2	2	2	2	3	2	1	2	2	1	2	2

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

1) Estimation of nitrite in biological samples.
2) Estimation of nitrate in biological samples by hydrazine reduction method.
3) Assay of *in vivo* nitrate reductase activity in biological samples.
4) Estimation of chlorophyll 'a', 'b' and total chlorophyll from biological samples by Hiscox and Israelstam method.
5) Extraction and quantification of proteins from plant tissues.
6) Isolation of acid phosphatase from germinated wheat and determination of its activity.
7) Determination of phosphatase activity at different temperature, pH and substrate concentration and calculation of Km and Vmax.

8) Preparation of MS and WB media.
9) Inoculation of seeds of *Trigonella, Brassica* and *Cichorium* sp. and evaluation of their percent germination in *in vitro* conditions.
10) Study the regeneration potentials of juvenile explants (hypocotyls/ epicotyls) of *Trigonella foenum graecum.*
11) Standardization of regeneration protocol of lilium using bulb/ bulbscale/ leaf base.
12) Study the effect of 2,4-D in developing micropropagation protocol for *Linum* using cotyledonary leaves.
13) *In vitro* endosperm culture.
14) Study differentiation potentials of nodal segment/ leaf/ petiole of *Tylophora indica.*
15) Raising haploid cultures using anthers of *Datura innoxia* under in vitro conditions.
16) Inoculation of nodal segment and leaf of *Nicotiana tobaccum (from in vitro source).*
17) Subculturing of selected plant under *in vitro* conditions.
18) Establishment of cell suspension culture from the friable callus.

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Assessment methods and weightages in brief

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Total Marks are 200 for the subject (Internal Assessment: 50 Marks and End semester examination: 150 Marks).

Seminars/Assignments

MBT-DCE207

Credit:02, Max. Marks: 50 Time: 36 hours

COURSE OBJECTIVES *

To acquire the skills necessary to read and evaluate original research articles. Most of the course will involve the discussion of current issues in the domain of biotechnology. To encourage the students to study advanced engineering developments. To prepare and present technical reports. To encourage the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

COURSE LEARNING OUTCOMES

Upon the completion of the course, the students shall be:

CLO207.1: Able to select a research Paper relevant to the field. (Cognitive Level: Understand)

CLO207.2: Critically understand and analyze the data present in the selected research paper (Cognitive Level: Analyze)

CLO207.3: Present it in the form of power point presentation and make others understand (Cognitive Level: Apply)

CLO207.4: Confidently answer the queries of the audience and discuss the issues raised. (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
*																
Seminars/ Assignments MBT DE207	CLO207.1	2	2	1	3	2	1	1	3	3	2	1	3	2	1	1
	CLO207.2	2	3	3	3	2	2	1	2	3	2	2	3	3	1	2
	CLO207.3	2	1	2	3	2	2	2	3	3	3	2	3	2	2	2
	CLO207.4	2	1	2	3	2	1	1	2	3	2	1	2	3	2	2

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

***Discipline Centric Elective**

COURSE CONTENT

The students will be assigned topics in various areas of Biotechnology for seminars and assignments. The assignments are to be submitted to the mentors for evaluation at the end of semester. The evaluation of students for seminars will be based on the quality of subject matter, templates and presentation. The seminars will be attended by all the teachers of the Department and individually evaluated. Participation of all the students in seminars is compulsory and their attendance will be marked.

Semester - III

ANIMAL BIOTECHNOLOGY

MBT - CC301

Credit :4, Max. Marks: 100 [Sessional Marks:25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES

It gives introduction to the various transformation techniques employed in animal systems. It also describes the application of genetically modified animals in the various fields of science. The techniques of animal cell culture and its industrial and medical applications are described. To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences. To expose students to application of recombinant DNA technology in biotechnological research. To train students in strategizing research methodologies employing genetic engineering techniques. To gain knowledge on gene manipulation using genetic engineering methods and its importance in animal biotechnology.

COURSE LEARNING OUTCOMES

Successful completion of this course will allow students to:

CLO301.1: Understand the principles of animal cell culture and upscaling methods for research and commercial ventures (Cognitive Level: Understand)

CLO301.2: Comprehend the basics of heterologous protein expression by designing specific vectors. (Cognitive Level: Understand)

CLO301.3: **Understand the a**pplications of the complex expression systems in insects and mammals (Cognitive Level: Apply)

CLO301.4: Gain information regarding various methods of recombinant protein production, their bioactivity and commercial scale production for benefit of human health (Cognitive Level: Analyze)

CLO301.5: Inculcate basic understanding and application of production of biomedical products by recombinant DNA technology. (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Animal Biotechnology MBT- CC 30 1	CLO301.1	3	1	3	3	1	2	2	2	2	2	3	3	3	3	2
	CLO301.2	3	2	3	3	1	1	3	1	1	2	3	3	3	3	1
	CLO301.3	3	2	2	3	1	1	2	1	1	2	3	3	2	2	1
	CLO301.4	3	2	3	3	1	2	3	1	1	2	3	3	3	2	3
	CLO301.5	3	2	2	3	2	2	3	2	2	2	3	3	3	3	2
3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)																

COURSE CONTENT

UNIT – 1 **18 hours**

Insect cell and mammalian cell culture: Primary and secondary cultures, cell lines. Upscaling of anchor dependent and suspension cell cultures.

Expression of cloned genes in heterologous systems. General considerations. Expression vectors. Promoters and other elements. Selection markers.

Production of bio-molecules by rDNA technology, expression of independent and fused proteins, simple and glycosylated proteins. Choice of expression system. Expression strategies. Construction of expression cassettes. Factors effecting high level expression.

UNIT – II **18 hours**

Prokaryotic expression systems: *E. coli,* Bacillus and Streptopmyces: General features and strong promoters. Natural and hybrid promoters. The pIN series of vectors. Phage promoters. His and other tags. Secretory signal and secretion of r-proteins to periplasm. Inclusion bodies.

Yeast as host for expression of foreign genes: *Saccharomyces* and *Pischia.* Yeast plasmids. Yeast expression vectors. YEP, YIP, YRPs and YAC.

UNIT – III **18 hours**

Insect cells and Baculovirus Expression Vector system: Early and late promoters. Advantages of polyhedron promoter. Indirect cloning in baculovirus. Silkworm larva as biofactory for the production of r-proteins.

Mammalian cell expression system: Strong promoters. SV40 and Cos cells. Shuttle vectors. Helper virus and binary vector system. BPV, EBV and BKV promoters for development of expression vector. Vaccinia virus: Potential applications and pros and cons of its use. Adeno and retrovirus based expression vectors.

UNIT – IV **18 hours**

Proteomics and r-Proteins: *In vitro* cell free protein synthesis: wheat germ S-30, Rabbit reticulocytes; *In vivo* protein synthesis: frog oocyte system; Protein engineering; Interactome: Protein-protein interactions. Proteome analysis.

Isolation and purification of r-proteins. Bioactivity of r-proteins. Strategies for commercial production. Gene dose and expression levels.

Commercially available recombinant proteins. Production of GH, insulin; TPA, gonadotropins, HBsAg and other biomedical products by r-DNA technology.

Reference Books:

Molecular biology Labfax II: Gene analysis by T.A Brown

Animal cell culture and technology: The basics by M.Butler

Molecular Biotechnology- Principles and applications of recombinant DNA. By Glick, B.R. and Pasternak, J.J

Recombinant DNA- genes and genomes- A short course by Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

PLANT BIOTECHNOLOGY

MBT — CC302

Credit :4, Max. Marks: 100 [Sessional Marks:25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES

It gives introduction to the various transformation techniques employed in plant systems. It also describes the application of genetically modified plants in the various fields of science.

COURSE LEARNING OUTCOMES

Upon the completion of the course, the students shall be able to:

CLO302.1: Understand the molecular mechanism of Agrobacterium mediated transformation of plants, Cloning and expression vectors, Plant Promoters, Reporter and selectable markers. Transgene integration, expression, inheritance and Silencing. (Cognitive Level: Understand)

CLO302.2: Apply the Plastome engineering technique - vectors used and application in enhanced secondary metabolites and for development of male sterile plants and edible vaccines. (Cognitive Level: Apply)

CLO302.3: Apply the knowledge of transgenic plants for production of therapeutics and plantibodies, production of edible vaccines, for quantitative and qualitative improvement of carbohydrates, proteins, lipids micronutrients, vitamins and secondary metabolites. (Cognitive Level: Analyze)

CLO302.4: Analyze the use of transgenics for increasing the shelf-life of fruits and flowers. Herbicide, insect pest resistant and stress tolerant plants through transgenic technology. (Cognitive Level: Analyze)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Plant	CLO302.1	3	2	2	3	3	2	3	2	2	2	3	3	2	2	3
Biotechnology	CLO302.2	3	2	2	2	2	3	3	2	2	2	3	3	2	2	2
MBT CC302	CLO302.3	3	2	3	2	2	2	2	1	2	2	3	3	2	2	2
	CLO302.4	3	3	2	2	1	1	2	2	3	2	3	3	2	3	2

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

UNIT – I 20 hours

Transgenic technology: Agrobacterium, the natural genetic engineer. Molecular mechanism of *Agrobacterium* mediated genetic transformation of plants. Cloning (Plasmid, Pragemids, Cosmids, BACs and YACs) and expression vectors (co-integrative vectors, Binary vectors, Gateway vectors, multicistronic vectors) for plant genes, structure, types, their advantages and disadvantages. Plant Promoters types: Constitutive, tissue specific and inducible; their applications in transgenic technology. Scorable and selectable markers. Transgene integration, copy number, stability, expression, silencing and inheritance in transgenic plants. Excision system for removal of undesirable genetic elements (selection marker gene) from transgenic plants.

UNIT – II 17 hours

Plastome engineering and applications: Introduction of plastome and vectors used in plastome engineering. Transformation of plastids and their use as bioreactors for the production of various metabolites of therapeutic importance. Plastome engineering for development of male sterile plants and edible vaccines.

UNIT – III **18 hours**

Value addition of plants through genetic engineering-I: Transgenic plants for production of therapeutics and plantibodies; production of edible vaccines through transgenics; genetic engineering for quantitative and qualitative improvement of carbohydrates, proteins, micro-nutrients, vitamins and secondary metabolites.

UNIT – IV **17 hours**

Value addition of plants through genetic engineering-II: Transgenics with increased shelf-life of fruits and flowers. Use of genetic engineering technology for improved lipid metabolism. Herbicide plants through transgenic technology. Genetic engineering for insect-pest resistance and generation of stress tolerant plants for enhanced productivity.

Reference Books

Plant Biotechnology and Transgenic Plants by Oksman

Plant Development and Biotechnology by Robert N. Trigiano
Plant Physiology and Development by Lincoln Taiz, Eduardo Zeiger

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IMMUNOLOGY

MBT — CC303

Credit: 4, Max. Marks: 100 [Sessional Marks:25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES

Role of antibody engineering in biomedical applications and the importance of immunology in disease processes, tissue transplantation and immune regulation are some of the areas of attributes of this course which can help the students to understand the biotechnology related to human kind.

COURSE LEARNING OUTCOMES

Upon completion of the course, the student shall be able to:

CLO303.1: Identify different biological processes involved in immune responsiveness to different infections and diseases. (Cognitive Level: Remember)

CLO303.2: Gain insight into the different arms of immune regulation: innate and adaptive immune systems, and their role in protection of host. (Cognitive Level: Understand)

CLO303.3: Elucidate the ways by which immune cells change their phenotype following exposure to antigens and activation. (Cognitive Level: Analyze)

CLO303.4: Understand different immunological techniques and their implications in basic research. (Cognitive Level: Evaluate)

CLO303.5: Exposure to disorders of immune system and remedial measures for different auto-immune disorders and allergies. (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Immunology	CLO303.1	1	2	1	2	2	2	2	2	1	1	3	2	2	1	1
MBT- CC30 3	CLO303.2	1	2	1	2	1	2	3	1	2	2	3	2	1	1	2
	CLO303.3	3	3	3	3	3	3	3	3	3	3	2	3	2	1	1
	CLO303.4	3	2	3	3	2	2	3	2	2	3	3	2	2	1	2
	CLO303.5	3	3	2	3	2	3	3	2	2	3	3	2	1	1	1

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

UNIT-1 **20 hours**

Overview of immune system: Principles of Immunology – Origin of Immunology and its evolution.

Cells and organs of immune system. T and B cells, macrophages, dendritic cells, NK cells. Primary, secondary and tertiary lymphoid organs.

Types of immunity - Innate and adaptive, Humoral and cell-mediated, Active and passive, PAMP:TLR, Clonal selection theory.

Immunological memory, Antigens and immunogens, B and T cell epitopes; Haptens. Structure and functions of antibodies. Classes of immunoglobulins. CDRs, immunoglobulin fold. Valence, affinity and avidity. Antibody variants - Isotypes, allotypes and idiotypes.

UNIT – II **20 hours**

Recognition of antigens: The immunoglobulin genes: organization and assembly; generation of immunological diversity; Allelic exclusion. Major histocompatibility complex (MHC): structure and organization of MHC Class I and Class II molecules. Antigen processing and antigen presentation. T cell Receptor: αβ and γδ receptors; Costimulatory molecules; Superantigens. B cell activation and maturation; B1B and B2B cells; T-cell dependent and T-cell-independent antigens. T cell development and activation. Cytotoxic T cell mediated killing. Complement system and mechanism of its fixation. Complement deficiencies.

UNIT – III **20 hours**

Immune effector mechanisms: Products and factors produced by T-cell activation. Cytokines and chemokines-Interleukins, interferons, growth factors. Antigen-antibody interactions: equilibrium approach. Immunoprecipitation, Agglutination, Immunoelectrophoresis, Immunofluorescence, RIA, ELISA: indirect, sandwich and competitive; Elispot assay. Cytotoxicity assay: MTT assay and Trypan blue; MLR, Hemolytic plaque assay

Flow cytometry and FACS; Confocal microscopy and imaging. MHC inbred, nude, congenic, syngeneic and knockout mice – Utility

UNIT – IV **12 hours**

Immune system in health and disease: Immunological tolerance. Autoimmunity and associated disorders. Allergy and hypersensitivity. Transplantation immunology - Graft rejection, graft versus host reaction. Tumor immunology, cancer immunotherapy. Immune response to infectious diseases – viral, bacterial, protozoal. Immunosuppression - immunodeficiency diseases (e.g., AIDS).

Reference Books

Encyclopedia of Immunbiology by Michael J.H. Ratcliffe

Kuby Immunology by Kindt, T.L., Goldsby, R.A. & Osborne, B.A

Janeway's Immunobiology by Murphy, K., Mowat, A. & Weaver, C.T.

Immunology: A Short Course by Coico, R. & Sunshine, G

Teaching – Learning Strategies in brief

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BIOTECHNOLOGY AND HUMAN HEALTH

MBT — CC304

Credit :4, Max. Marks: 100 [Sessional Marks:25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES

The main objectives of the course are to provide a practical understanding of various biotechnological techniques in product formulations and their applications in human health. The course will provide a necessary and relevant background to understand the engineering of monoclonal antibodies, vaccines and microbial products with respect to their functionality and production methodologies. Besides, suitable role of stem cells in tissue engineering and regenerative medicine will be learned.

COURSE LEARNING OUTCOME

Upon completion of the course, the student shall learn:

CLO304.1: Understand how monoclonal antibodies are generated and the historical significance of the developmental procedures. (Cognitive Level: Understand)

CLO304.2: Realize the potential of monoclonal antibodies for therapeutic and diagnostic applications. How to isolate and preserve the stem cells along with the intended use and
potential. (Cognitive Level: Analyze)

CLO304.3: Understand the process and applications to Engineer the antibodies to enhance their functional value. (Cognitive Level: Understand)

CLO304.4: The role and function of different vaccines and analyze which disease needs which kind of vaccine; how the efficacy of vaccines and drugs are evaluated on the humans along with the process and timeline required for the approval. (Cognitive Level: Analyze)

CLO304.5: The applications of fermentation and how this technology can be used in favor of mankind. Develop probiotics and understand different bacteria that are used for the human health. Understand the activity of enzymes and how enzymes can be isolated and immobilized for improved functions (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Biotechnology and Human Health MBT CC 304	CLO304.1	2	2	2	2	2	1	2	2	2	3	3	3	2	2	1
	CLO304.2	2	1	2	3	3	2	2	2	2	3	3	2	2	2	2
	CLO304.3	2	2	3	3	3	2	3	2	2	3	2	2	3	2	1
	CLO304.4	2	3	3	3	3	3	3	2	2	3	2	3	3	2	1
	CLO304.5	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2
3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)																

COURSE CONTENT

UNIT – I **18 hours**

Hybridoma Technology: Production of murine monoclonal antibodies (MoAbs)-Fusion strategies, HAT Selection; Strategies for production of human MoAbs-Humanization and antigenization of MoAbs-Chimeric, CDR-grafted, SDR-grafted, veneered MoAbs.

Antibody Engineering: Antibody fragments, Antibody gene cloning; Expression of recombinant antibody genes; Next generation display technologies for production of antibodies *in vitro;* Combinatorial libraries and phage display libraries; Bispecific and bi-functional antibodies; Immunoconjugates; Catalytic antibodies.

Clinical applications of MoAbs and engineered antibodies: In diagnostics, therapeutics and other uses.

UNIT – II **18 hours**

Microbial Biotechnology and its applications: Components of culture media, synthetic defined media, complex media, supportive media, enriched media, selective media, differential media; Pure culture isolation by streaking, serial dilution and plating methods; Cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria; Control of microorganisms- physical and chemical agents; Antibiotics and antiviral agents; Use of prokaryotic and eukaryotic microorganisms in biotechnological applications; Genetically engineered microbes for industrial application-Bacteria and yeast; Recombinant microbial production processes in pharmaceutical industries-Streptokinase, Hepatitis-B recombinant vaccines.

UNIT – III **18 hours**

Fermentation and Food microbiology: Scope, classification based on nature of the products and kinetics of cell growth; Substrates for fermentation; Isolation and preservation of cultures; Design of fermenters, various types of fermenters; Common problems and troubleshooting; Downstream processing; Purification of products; Probiotics and fermented foods; Applications

Cell and enzyme immobilization: Methods of immobilization, kinetics and uses of immobilized enzymes; Bioreactors using immobilized enzymes; Applications of immobilized enzymes in medical science and Industry; Biocatalyst technology, biosensors and analytical applications.

UNIT – IV **18 hours**

Diagnostics: Nucleic acid and protein based diagnostic.

Strategies of Vaccine development: Traditional and new generation vaccines; Live vaccines- (Polio, Rotavirus); Recombinant vaccines (Hepatitis B); Sub unit, VLPS and DNA vaccines; Reverse vaccinology; Newer concept: Rational design based on Structural biology & System vaccinology approach

Preclinical and clinical evaluation of vaccines

Gene therapy: Concept, principle, strategies and applications.

Stem Cells, Tissue Engineering and Regenerative medicine: Types of stem cells, Isolation of stem cells and cryopreservation; Therapeutic cloning, Nuclear reprogramming; Induced pluripotent stem cells; Ethical issues in stem cell research; clinical applications (cardiovascular disease, cancer, spinal injury); Cord blood banking**;** Tissue engineering: Technology in general and applications; Regenerative medicine.

Reference Books

Genetically modified organisms in food by Ronald Ross R.Preedy

Fermented Foods by Ramesh C. Ray

Kuby Immunology by Kindt, T.L., Goldsby, R.A. & Osborne, B.A

Methods in Enzymology by Jon Lorah

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Question & Answer sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

BIOINFORMATICS

MBT — OE305

Credit :4, Max. Marks: 100 [Sessional Marks:25, Exam. Marks: 75] Time: 72 hours

COURSE OBJECTIVES *

Spell the concepts and applications of Bioinformatics. Demonstrate the bioinformatics skills to solve biological problems. Model the Biological databases. Construct and evaluate open access biological databases and sequence alignment algorithm. Demonstrate about the heuristic algorithms, phylogenetic analysis and structure prediction. Simplify the knowledge on the latest trends in new drug discovery.

COURSE LEARNING OUTCOMES

Upon completion of the course, the student shall be able to:

CLO305.1: Understand and explore sequence and structural databases relevant in the area of biology and disease understand the nature of biological big data and need for biological databases (Cognitive Level: Understand)

CLO305.2: Study and analyze various algorithms for sequence analysis and understand underlying statistics; understand when and why to use these algorithms to answer some of the biological questions. (Cognitive Level: Analyze)

CLO305.3: Analyze algorithms and methods for alignment-free phylogeny role of phylogeny and clustering in typing viral and bacterial species. (Cognitive Level: Analyze)

CLO305.4: Know the computational approaches for structure analysis. (Cognitive Level: Analyze)

CLO305.5: Understand algorithms and methods for drug design and development. (Cognitive Level: Understand)

CLO305.6: Evaluate the use approaches for vaccine design. (Cognitive Level: Evaluate)

COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
*																
Bioinformatics	CLO305.1	2	2	2	2	2	1	1	2	2	2	2	3	2	2	2
MBT OE305	CLO305.2	3	2	2	1	3	2	1	1	2	3	2	3	3	2	2
	CLO305.3	3	2	2	1	3	2	2	2	2	3	2	3	2	2	2
	CLO305.4	2	2	2	2	3	1	1	1	3	2	2	3	2	2	2
	CLO305.5	2	2	3	2	3	2	2	2	3	3	2	3	3	3	3
	CLO305.6	3	2	3	2	3	2	2	2	3	3	2	3	3	3	3

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

***open elective**

COURSE CONTENT

UNIT – I **16 hours**

Introduction to Bioinformatics: Introduction and branches of Bioinformatics. Aim, scope and research areas of Bioinformatics.

Databases in Bioinformatics: Introduction. Biological databases. Classification format of biological databases. Biological database retrieval system.

Biological Sequence Databases:

- **National Center for Biotechnology Information (NCBI):** Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Nucleotide Database, Protein Database, Gene Expression Database.
- **EMBL Nucleotide Sequence Database (EMBL-Bank):** Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.
- **DNA Data Bank of Japan (DDBJ):** Introduction, Resources at DDBJ, Data Submission at DDBJ.
- **Protein Information Resource (PIR):** About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.
- **Swiss-Prot:** Introduction and salient features.

UNIT – II **19 hours**

Bioinformatics resources on the internet.

Computational methods for sequence analysis: Pairwise and multiple sequence alignment for DNA and protein sequences. Local and global sequence similarity.

Methods of sequence alignment: Dot matrix method, Dynamic programming method and Heuristic method.

Scoring matrices: PAM, BLOSUM, Gonnet, Lookup tables.

Tools for similarity search and sequence alignment: BLAST and types, FASTA.

UNIT – III **18 hours**

Genome analysis and Gene identification: Sequencing, Assembly, Annotation, Sequencing pipelines and databases.

Genome comparison and analysis.

Molecular Phylogeny: Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Comparative genomics: Homologs, Paralogs and orthologs; Synteny; Comparative genomics of *Arabidopsis* and *Brassica rapa* / Chimpanzees and human.

Structural analysis of Nucleic acids: Tools for prediction and designing.

UNIT – IV **19 hours**

Application tools: Primer designing.

Molecular imaging and design: CADD, QSAR.

Tools for molecular mapping: QTL, minisatellites, SNP's.

Mapping techniques: JoinMap, MapQTL, LOD Score method for estimating recombination frequency.

Prediction of 3 dimensional structures of proteins: protein secondary and tertiary structure prediction by using techniques: Chou-Fasman/GOR method, comparative modeling, Threading and ab initio structure prediction.

Systems Biology – Concept and applications

Reference Books

Fundamentals of Bioinformatics and computational Biology by Gautam B. Singh

Introduction to Systems Biology by Sangdun Choi

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

PRACTICAL: IMMUNOLOGY, ANIMAL AND PLANT BIOTECHNOLOGY

MBT-CC306

Credit :10, Max. Marks: 250 [Sessional Marks: 50, Exam. Marks: 200] Time: 250 hours

COURSE OBJECTIVES

The main objective of the course is to develop a practical understanding of the immunological techniques to understand the components of immune system. This practical module will help students to develop the necessary experimental skills to handle animal models and study immunization protocols. The practical module will also provide a hand-on training on animal cell culture and isolation and quantification of genetic material from plants.

COURSE LEARNING OUTCOMES

Upon completion of the course, the student shall be able to:

CLO306.1: be proficient in handling and immunization of experimental animals. (Cognitive Level: Apply)

CLO306.2: understand the use of adjuvants and utility of different sites and modes of immunization (Cognitive Level: understand)

CLO306.3: Isolate Blood and serum to analyze the antibodies formed against the antigen of interest. (Cognitive Level: Apply)

CLO306.4: Perform ELISA to quantify the antibodies formed in different groups of animals (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Practical:	CLO306.1	1	3	2	2	2	2	3	2	2	2	2	3	2	2	1
Immunology,	CLO306.2	1	2	3	2	2	3	3	2	3	2	3	2	3	2	3
Animal and	CLO306.3	2	2	3	3	3	2	3	2	2	2	2	3	2	3	2
Plant	CLO306.4	1	3	2	2	2	2	2	2	3	2	3	2	2	2	3

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

1) Preparation of Dulbecco's Modified Eagle's medium for mammalian cell culture.
2) Revival and maintenance of CHO cells.
3) Trypsinization and storage of CHO cell line.
4) Cryopreservation of mammalian cell (CHO).
5) Transfection of mammalian cell (CHO) by calcium phosphate co-precipitation method.
6) Ammonium sulphate precipitation of antibodies in serum.
7) Preparation of antigen -adjuvant (FCA) emulsion.
8) Immunization of mice with antigen-adjuvant formulations.
9) Collection of blood from mice and separation of serum.
10) Analysis of antibodies raised in immunized mice by ELISA
11) Determination of immunogenic proteins by Western Blot Analysis.
12) Preparation of synthetic seeds and *in vitro* germination.
13) Isolation and culture of protoplast.
14) Isolation of total plant genomic DNA by Doyle and Doyle's method from different plant samples.
15) Quantitative and Qualitative analysis of plant genomic DNA.
16) Extraction of RNA from plant samples.
17) Quantitative and qualitative analysis of RNA sample.
18) Kanamycin sensitivity test in leaf segments.
19) Semi-solid and liquid cultures of *Agrobacterium tumefaciens*
20) Growth kinetics of *Agrobacterium tumefaciens* in liquid culture.
21) Transformation of explants with *Agrobacterium tumefaciens* and regeneration of explants.

Reference Books:

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Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 50 marks. End semester exam is of 150 marks.

Total Marks are 200 for the subject (Internal Assessment: 50 Marks and End semester examination: 150 Marks).

Seminars/Assignments

MBT-DCE307

Credit:02, Max. Marks: 50 Time: 36 hours

COURSE OBJECTIVES *

To acquire the skills necessary to read and evaluate original research articles. Most of the course will involve the discussion of current issues in the domain of biotechnology. To encourage the students to study advanced engineering developments. To prepare and present technical reports. To encourage the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

COURSE LEARNING OUTCOME

Upon the completion of the course, the students shall be able to:

CLO307.1: Able to select a research Paper relevant to the field. (Cognitive Level: Understand)

CLO307.2: Critically understand and analyze the data present in the selected research paper (Cognitive Level: Analyze)

CLO307.3: Present it in the form of power point presentation and make others understand (Cognitive Level: Apply)

CLO307.4: Confidently answer the queries of the audience and discuss the issues raised. (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Seminars/Assi	CLO307.1	2	2	2	1	3	2	1	1	3	3	2	1	3	2	1
gnments	CLO307.2	3	2	3	3	3	2	2	1	2	3	2	2	3	3	2
MBT DE 307	CLO307.3	2	2	1	2	3	2	2	2	3	3	3	2	3	2	2
	CLO307.4	3	2	1	2	3	2	1	1	2	3	2	1	2	3	2
3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)																

***Discipline Centric Elective**

COURSE CONTENT

The students will be assigned topics in various areas of Biotechnology for seminars and assignments. The assignments are to be submitted to the mentors for evaluation at the end of semester. The evaluation of students for seminars will be based on the quality of subject matter, templates and presentation. The seminars will be attended by all the teachers of the Department and individually evaluated. Participation of all the students in seminars is compulsory and their attendance will be marked.

Semester - IV

DISSERTATION

MBT-CC401

COURSE OBJECTIVES

The objectives of this course are to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.

COURSE LEARNING OUTCOMES

Upon the completion of the course, the students shall able to:

CLO401.1: Plan and execute the experiments independently. (Cognitive Level: Analyze)

CLO401.2: Collect, interpret and analyze the data of the research problem selected. (Cognitive Level: Analyze)

CLO401.3: Write their dissertation report and discuss the results obtained with a scientific proof. (Cognitive Level: Apply)

CLO401.4: Recognize the importance of a review article and write it according to scientific methodology in order for it to be published in a reputable journal. (Cognitive Level: Apply)

		MAPPING OF PROGRAMME OUTCOMES, PROGRAMME SPECIFIC OUTCOMES WITH COURSE OUTCOMES														
COURSE TITLE & CODE	CLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PSO1	PSO2	PSO3	PSO4	PSO5
Dissertation/	CLO401.1	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3
Viva voce	CLO401.2	3	3	2	3	3	3	2	3	3	3	2	3	3	3	2
MBT- CC40 1	CLO401.3	2	2	2	3	2	2	2	2	2	3	3	3	3	3	1
	CLO401.4	2	2	2	3	3	2	2	2	2	3	3	2	3	3	1

3, Substantial Correlation (75%-100); 2,Moderate Correlation(60-75%);1, Low correlation (40-60%)

COURSE CONTENT

1. Research Project and submission of dissertation.
2. Preparation and submission of a Review article

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