Regulations and Curriculum for
Master of Science in Biotechnology
M.Sc. (Biotechnology)

Choice Based Credit System (CBCS)
For Batch Admitted from 2019-20

(Deemed to be University under Section 3 of UGC Act, 1956)
(Placed under Category 'A' by MHRD, Govt. of India, Accredited with 'A' Grade by NAAC)
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VISION

To build a humane society through excellence in education and healthcare

MISSION

To develop
Nitte (Deemed to be University)
as a centre of excellence imparting quality education,
generating competent, skilled manpower to face the scientific and social
challenges with a high degree of credibility, integrity,
ethical standards & social concern

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No. F.9-13/2007-U.3 (A)
Government of India
Ministry of Human Resource Development
(Department of Higher Education)
U.3(A) Section

Shastri Bhawan, New Delhi,
Dated the 4th June, 2008

NOTIFICATION

1. Whereas the Central Government is empowered under Section 3 of the University Grants Commission (UGC) Act, 1956 to declare, on the advice of the UGC, an institution of higher learning as a deemed-to-be-university;
2. And whereas, a proposal was received in February, 2007 from Nitte Education Trust, Mangalore, Karnataka seeking grant of status of deemed-to-be-university in the name of Nitte University under Section 3 of the UGC Act, 1956;
3. And whereas, the University Grants Commission has examined the said proposal and vide its communication bearing No. F.26-10/2007(CPP-I/ DU) dated the 10th March, 2008 has recommended conferment of status of 'Deemed to-be-University' in the name and style of Nitte University, Mangalore,
   Karnataka, comprising A.B. Shetty Memorial Institute of Dental Sciences, Mangalore;
4. Now, therefore, in exercise of the powers conferred by section 3 of the UGC Act, 1956, the central Government, on the advice of the University Grants Commission (UGC), hereby declare that Nitte University, Mangalore, Karnataka, comprising A.B. Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore, shall be deemed to be a University for the Purposes of the aforesaid Act.

Sd/
(Sunil Kumar)
Joint Secretary to the Government of India

(True Extract of the Notification)

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002

No. F.26-5/2008(CPP-1) Dated: 24th March, 2009

OFFICE MEMORANDUM

1. Whereas the Government of India, Ministry of Human Resource Development, Department of Higher Education vide Notification No. F.9-13/2007-U.3(A) dated 4th June, 2008 declared Nitte University, Mangalore, Karnataka comprising A.B. Shetty Memorial Institute of Dental Sciences, Deralakatte, Mangalore as Deemed to be University under Section 3 of UGC Act, 1956.
2. And whereas now, the University Grants Commission, on the recommendation of an Expert Committee constituted by the Chairman, UGC has agreed for bringing (i) K.S. Hegde Medical Academy, Deralakatte, Mangalore, (ii) Nitte Usha Institute of Nursing Sciences, Deralakatte, Mangalore, (iii) Nitte Gulabi Shetty Memorial Institute of Pharmaceutical Sciences, Deralakatte, Mangalore, (iv) Nitte Institute of Physiotherapy, Deralakatte, Mangalore under the ambit of Nitte University, Deralakatte, Mangalore.

Sd/
(K.P. Singh)
Joint Secretary
University Grants Commission

(True Extract of the Notification)

Ref: NU/REG/AC (SC) NUCSER/2018-19/761 Date: 17-05-2019

NOTIFICATION

Sub: Starting of two new PG programs M.Sc in Microbiology and M.Sc in Biotechnology at NUCSER.

In exercise of the powers conferred under Rule No. R.9 of the MOA, the 23rd meeting of the Sub Committee of the Academic Council held on 16th May 2019 under the agenda item no. 1-23/19 has approved the start of two new programs namely M.Sc in Microbiology and M.Sc in Biotechnology with an intake of 5 (Five) each from the Academic Year 2019-20 and to accept the Regulations and Curriculum of the same.

By Order,

REGISTRAR

(Deemed to be University under Section 3 of UGC Act, 1956)
(Placed under Category 'A' by MHRD, Govt. of India, Accredited with 'A' Grade by NAAC)
Mangaluru, Karnataka, India

Regulations and Curriculum for Master of Science in Biotechnology M.Sc. (Biotechnology)

Choice Based Credit System (CBCS)

Preamble:

M.Sc. (Biotechnology) program is instituted in Nitte University Centre for Science Education and Research (NUCSER) from the year 2019-20. From the academic year 2019-20, the institute has adopted and implemented the CBCS in M.Sc. (Biotechnology). The regulations for this program are formulated as under:

1. Introduction:

1.1. These regulations shall be called Nitte (Deemed to be University) Regulations for M.Sc.(Biotechnology) program and govern the policies and procedures including selection, admission, imparting of instructions, conduct of examinations, evaluation and certification of candidate's performance and all amendments thereto, leading to the award of M.Sc.(Biotechnology) degree. The regulations shall come into effect from the academic year 2019-20.

1.2. This set of regulations shall be binding on all the candidates undergoing the said degree programme.

1.3. These regulations may be modified from time to time as mandated by the statutes of the University.

1.4. This set of regulations may evolve and get refined or updated or amended or modified or changed through appropriate approvals from the Academic Council or the Board of Management from time to time and shall be binding on all parties concerned including the Candidates, Faculty, Staff, Departments and Institute Authorities.

1.5. All disputes arising from this set of regulations shall be addressed to the Board of Management. The decision of the Board of Management is final and binding on all parties concerned. Further, any legal disputes arising out of this set of regulations shall be limited to jurisdiction of Courts of Mangalore only.

2. Definitions:

Unless the context otherwise requires:

Academic year means two consecutive (one odd + one even) semesters

BoM means Board of Management of Nitte(Deemed to be University) *BoS* means Board of Studies in Biological Sciences

Course Coordinator/Head of the Department / Director means a full time faculty appointed /nominated by the University for managing the department/Institute and authorize to and responsible for the implementation of the rules and procedures pertaining to the Department /Institute.

Course: referred to, as 'papers' is a component of a programme. All courses need not carry the same weight.

- *Core Course:*
  A course, which should compulsorily be studied by a candidate as a core requirement.
- *Discipline Specific Core Course (DSC):*
  A course, which should compulsorily be studied by a candidate related to the main discipline/subject of study.
- *Elective Course:*
  A course, which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill.
- *Discipline Specific Elective Course(DSE):*
  Elective courses related to the main discipline/subject of study.
- *Generic Elective Course(GE):*
  An elective course chosen generally from an unrelated discipline/subject with an intention to seek exposure.
- *Skill EnhancementCourse (SEC):*
  These are value-based and/or skill- based and are aimed at providing hands-on-training, competencies, skills, etc. May be chosen from a pool of courses.

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 lecture/tutorial or two hours of practical work/project work.

Credit Based Semester System (CBSS): The degree is prescribed in terms of number of credits to be completed by the students.

Credit Point: It is the product of grade point and number of credits for a course.

Continuous Internal Evaluation (CIE): A method of evaluation aimed to assess values, skills and knowledge imbibed by the student during the semester. To be done at the Institute level.

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.

Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.

Letter Grade: It is an index of the performance of students in a said course. Grades may be denoted by letters like O, S, A+, A, B, C, Fand I.

School means any Institution under the ambit of the Nitte (Deemed to be University).

*Semester Grade Point Average (SGPA):*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.

Semester End Evaluation (SEE): A method of evaluation in the form of grades to determine the objectives of a course at the end of the semester through term papers to show how good or how satisfactory the student is in accomplishing the objectives of the course.
He/him/his/himself includes all genders as the case may be.
Institute means Nitte University Centre for Science Education and Research
Regulations means this set of academic regulations
University means Nitte (Deemed to be University)

3. Duration of the program:

The duration of M.Sc. (Biotechnology) shall be two academic years (4 semesters)

4. Medium of Instruction and Examinations:

The medium of Instruction and Examinations shall be in English.

5. Maximum period for completion of the program:

The maximum period for completion of M.Sc.(Biotechnology) program is 4 years.

6. Eligibility for Admissions:

A candidate seeking admission to M.Sc. Biotechnology program must have passed minimum three years of Bachelor's degree in Basic/ Applied Biological Sciences (Bio-medical/ Bio-science/ Biotechnology/ Biochemistry/ Microbiology/ Agricultural Sciences/ Food and Nutrition/ Environmental Science/ Veterinary Science/ Fisheries Science/ Medical Imaging Technology/ Operation Theatre Technology/ Medical Lab Technology/ BE-Biotechnology/ B Tech Biotechnology/ Medical/ Dental/ Pharmacy/ and any other equivalent life science degrees of any Board/University or an equivalent examination of any other approved Board or University with not less than 50% marks in aggregate.

For candidates belonging to SC/ST or Category I, the minimum percentage of marks shall be a pass in degree or its equivalent examination.

Foreign Nationals and candidates who have qualified from a Foreign University/Board should obtain permission from Nitte (Deemed to be University) prior to the admission for equivalence of the qualification.

7. Selection of Eligible candidates:

Selection to the M.Sc. (Biotechnology) program shall be on the basis of merit obtained in qualifying examination.

8. Withdrawal -Temporary and Permanent:

8.1. Temporary

8.1.1. A candidate who has been admitted to the program may be permitted to withdraw temporarily for a period of six months or more up to one year on the grounds of prolonged illness, grave calamity in the family etc. provided:

a. He applies stating the reason of withdrawal with supporting documents and endorsement by parent/guardian.
b. The Institute is satisfied that the candidate is likely to complete his requirement of the degree within maximum time specified.
c. There are no outstanding dues or demands with the department, library, hostel, Institute etc.

8.1.2. The tuition fee for the subsequent year may be collected in advance based on the severity of the case before giving approval for any such temporary withdrawal.

8.1.3. Scholarship holders are bound by the appropriate rules applicable.

8.1.4. The decision of the Institute/University regarding withdrawal of a candidate is final and binding.

8.2. Permanent

8.2.1. A candidate who withdraws admission before closing date of admission for the academic session is eligible for the refund of the deposit only. The fees once paid will not be refunded on any account.

8.2.2. Once the admission for the year is closed and if a candidate wants to leave the Institution, he will be permitted to do so and take the Transfer Certificate from the College, if required, only after remitting the tuition fees for the remaining years.

8.2.3. Those candidates who have received any scholarship/stipend/other forms of assistance from the Institute shall repay all such amounts in addition to those mentioned in the clause above.

8.2.4. The decision of the Institute/University regarding withdrawal of a student is final and binding.

9. Conduct and Discipline:

9.1. Candidates shall conduct themselves within and outside the premises of the Institute in a manner befitting a student.

9.2. As per the order of Honorable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

9.3. The following act**s** of omission and /or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures.

9.3.1. Ragging as defined and described by the Supreme Court/Government.

9.3.2. Lack of courtesy and decorum, indecent behavior anywhere within or outside the campus.

9.3.3. Willful damage or stealthy removal of any property/belongings of the Institute/Hostel or of fellow students/citizens.

9.3.4. Possession, consumption or distribution of alcoholic drinks or any kind of hallucinogenic drugs.

9.3.5. Mutilation or unauthorized possession of library books.

9.3.6. Noisy or unseemly behavior, disturbing studies of fellow students.

9.3.7. Plagiarism of any nature.

9.3.8. Hacking of computer systems (such as entering into other person's domain without prior permission, manipulation and/or damage to the computer hardware and software or any other cyber crime, etc.)

9.3.9. Any other act of gross indiscipline as decided by the Board of Management from time to time.

9.4. Commensurate with the gravity of offence, the punishment may be: reprimand, fine, expulsion from the hostel, debarment from an examination, disallowing the use of certain facilities of the institute, rustication for a specific period or even outright expulsion from the institute, or even handing over the case to appropriate law enforcement authorities or the judiciary as required by the circumstances.

9.5. For any offence committed in -
(i)a hostel, (ii) a department (iii) a class room, and (iv) elsewhere, the Chief Warden, the Head of the Department and the Asst. Director (Student Affairs**)/**Head of the Institution Authorities of the University respectively, shall have the authority to reprimand or impose fine.

9.6. All cases involving punishment other than reprimand shall be reported to the Vice-Chancellor.

9.7. Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the HoD/Director/Principal/Dean of the Institute, as the case may be for taking the appropriate action

10. Graduation Requirements:

Candidate shall be declared eligible for the award of the degree if he has**:**

- Fulfilled the degree requirements.
- No dues to the University, Institute, Departments, Hostels, Library, etc.
- No disciplinary action pending against him.

The award of the degree must be recommended by the Board of Management.

11. Convocation:

Degrees will be awarded in person to all the eligible students who have graduated during the preceding academic year at the annual convocation. For eligible students who are unable to attend the convocation, degree will be sent by post. Students are required to apply for the convocation along-with prescribed fee within the specified date, after satisfactory completion of all degree requirements.

12. Structure of the Program:

12.1. The program is structured on choice based credit based system. For the award of degree, a candidate must take a total of 80 credits comprising of 7 Core Courses, 3 Discipline Specific Core Courses, 2 Generic Elective Courses, 1 Discipline Specific Elective Course, 1 Skill Enhancement Course and 1 year of project work and 2 seminars. The electives to be chosen from a pool of courses.

12.2. The program consist of the following:

Core Courses:	28 credits
Discipline Specific Core Courses:	12 credits
Discipline Specific Elective Courses:	03 credits
Generic Elective Courses:	06 credits
Skill Enhancement Course:	03 credits
Seminar:	02 credits
Project Work:	21 credits
Co-curricular/Extra curricular activities:	05 credits

13. Semester wise subjects of study and examination pattern:

Subject Code	Subject Types	Subject Title	Credits		Marks					
					Theory		Practical		Total Marks	Grade Point
			T	P	SEE	CIE	SEE	CIE		
I SEMESTR										
19MBT11	C1	General Microbiology	2	2	50	20	20	10	100	10
19MBT12	C2	Cell and Molecular Biology	2	2	50	20	20	10	100	10
19MBT13	C3	Biochemistry	2	2	50	20	20	10	100	10
19MBT14	C4	Immunology	2	2	50	20	20	10	100	10
19MBT15	GE	Generic Elective	1	2	50	20	20	10	100	10
	NC1	GLP and Biosafety*	0	0	-	100	-	-	100*	-
		Total credits	**19**							
II SEMESTER										
19MBT21	C5	Genetic engineering	2	2	50	20	20	10	100	10
19MBT22	C6	Bioinformatics and Computational Biology	2	2	50	20	20	10	100	10
19MBT23	C7	Research Methodology & Biostatistics	2	2	50	20	20	10	100	10
19MBT24	GE	Generic Elective	1	2	50	20	20	10	100	10
19MBT25	SEC	Skill Enhancement Course	0	3	-	-	70	30	100	10
	NC2	Research Ethics and IPR*	0	0	-	100	-	-	100*	-
		Total credits	**18**							
III SEMESTER										
19MBT31	DSC1	Bioprocess Engineering and Technology	2	2	50	20	20	10	100	10
19MBT32	DSC2	Medical Biotechnology	2	2	50	20	20	10	100	10
19MBT33	DSC3	Plant and Environmental Biotechnology	2	2	50	20	20	10	100	10
19MBT34	DSE	Discipline Specific Elective	1	2	50	20	20	10	100	10
19MBT35	P1	Project Work-I	0	5		-	80	20	100	10
19MBT36	S1	Seminar-I	0	1	-	-	-	100	100	10
		Total credits	**21**							
IV SEMESTER										
19MBT41	P2	Project Work-II	0	16			80	20	100	10
19MBT42	S2	Seminar-II	0	1	-	-	-	100	100	10
19MBT43	CC	Co-curricular/Extra Curricular Activities	0	5	-	-	-	-	100	10
		Total credits	**22**							

T:Theory classes; P:Practical Classes; IA:InternalAssesment
C:Core Courses; CIE: Continuous Internal Evaluation; DSC: Discipline Specific Core Courses; DSE: Discipline Specific Elective Course; GE: Generic Elective Course; S:Seminar, SEC: Skill Enhancement Course; SEE: Semester End Evaluation; P:Project Work; NC: Non-credit courses; CC:Co-curricular activities.
*Non-credit courses- To be mentioned as 'Pass' or 'Fail', Examination will be conducted at institute level.
The marks obtained will not be counted for the computation of SGPA/CGPA

List of elective subjects

Subject Code	Subject Title	Credits		Marks					
				Theory		Practical		Total Marks	Grade Point
		T	P	SEE	CIE	SEE	CIE		
I SEMESTER									
Generic Electives [Any One]									
19MBT15-1	GE- Genetics	1	2	50	20	20	10	100	10
19MBT15-2	GE- Microbial Physiology	1	2	50	20	20	10	100	10
II SEMESTER									
Generic Electives [Any One]									
19MBT24-1	GE- Medical Genetics	1	2	50	20	20	10	100	10
19MBT24-2	GE- Microbial Genetics	1	2	50	20	20	10	100	10
Skill Enhancement Course [Any One]									
19MBT25-1	SEC- Analytical Techniques in Biotechnology	0	3	-	-	70	30	100	10
19MBT25-2	SEC- Molecular Diagnostics	0	3	-	-	70	30	100	10
III SEMESTER									
Discipline Specific Electives [Any One]									
19MBT34-1	DSE- Nano-Biotechnology	1	2	50	20	20	10	100	10
19MBT34-2	DSE- Genomics and Proteomics	1	2	50	20	20	10	100	10

14. Electives:

14.1 For an elective course to be offered, atleast 50% of the class should opt for that particular course.

14.2 Electives shall be offered based at the discretion of the institution.

15. Co-curricular/Extra curricularactivites

A total of 5 credit points is assigned for extracurricular and co-curricular activities and shall be earned by the students on the basis of their performance in defined activities (Shown below). The assessment of the extracurricular and co-curricular attainment shall be made by the activity coordinators, guides and the Heads of the Departments on the basis of assessment rubrics defined for each type of activity. The grades obtained by the students shall be sent to the University by the Head of the Institution at the end of the fourth

semester. A student should participate in a minimum of 4 types of activities and not more than 60 points may be derived from a single type of activity.The marks attained by the students shall be converted into letter grades and grade points as indicated in clause 20.1 of programme regulations, which shall be taken into account while calculating CGPA.

15.1.Defined co-curricular/extracurricular activities:

Sl. No.	Name of the Activity	Points*	Evidence
1	Webinars related to the specialization of the student/program	10	Attendance certificate issued by the organizers
2	Online Certificate Courses related to the specialization of the student/program	30	Completion certificate issued by the organizers
3	Participation in Seminar/Conference/Workshop/Symposium/Training Programs(related to the specialization of the student)	10	Participation certificate issued by the organizers
4	Presentation of papers/posters in Conference/ Workshop/Symposium (related to the specialization of the student)	15	Participation certificate issued by the organizers
5	Publication of research paper in indexed (Scopus or Web of Science) journals as first author	30	Acceptance letter from the journal
6	Publication of research paper in indexed (Scopus or Web of Science) journals as co-author	15	Acceptance letter from the journal
7	Publication of popular articles in college magazines/newspapers/bulletins/wall magazines	05	Proof of publication
8	Academic Award/Research Award from State Level/National Agencies	10	Award certificate
9	Academic Award/Research Award from International Agencies	20	Award certificate
10	Active participation in sports as institute representative in inter-university and above	10	Certification by student welfare incharge and guide
11	Participation in NSS activites of the institute	02	Certification by NSS coordinator and guide
12	Participation in Swacch Bharat Internship	05	Participation certificate issued by competent authorities

* The points mentioned are for each activity
A student should participate in a minimum of 4 types of activities and not more than 60 points may be derived from a single type of activity.

16. Attendance and Monitoring Progress of Studies:

16.1. A candidate shall study in the Institution for the entire period as a full time student. No candidate is permitted to work in any outside laboratory/college/hospital/pharmacy etc., while studying. No candidate should join any other course of study or appear for any other degree examination conducted by this University or any other University in India or abroad during the period of registration.

16.2. Each semester shall be taken as a UNIT for the purpose of calculating attendance.

16.3. A candidate who has put in a minimum of 75% of attendance in the theory and practical separately and who has fulfilled other requirements of the course shall be permitted to appear for SEE.

16.4. A candidate having shortage of attendance in a particular subject in a semester shall not be permitted to write the SEE for that subject. He shall be permitted to appear for SEE for that subject only after fulfilling the attendance requirement.

17. Examination and Assessment:

There shall be a SEE at the end of each semester.

17.1. Scheme of Examination

Evaluation is based on formative evaluation (CIE) and summative evaluation (SEE).

17.1.1. CIE

The CIE for theory shall be 20 marks and shall be 10 marks for practicals. CIE for theory shall be calculated based on sessional examinations, assignments, seminars, regularity and punctuality. There shall be two sessional examinations and the average of the two shall be considered for calculating the marks from sessionals. The CIE for practicals shall be calculated on the basis of the records of the practicals maintained, assignments etc. A candidate must secure at least 50% of total marks for CIE in a particular course in order to be eligible to appear in the SEE of that subject.

17.1.2. SEE

A candidate who satisfies the requirements of attendance, progress and conduct shall be eligible to appear for the SEEs. There shall be a SEE at the end of each semester.

To be eligible to appear for SEE a candidate should fulfil all the following conditions:

a. Undergone satisfactorily the approved program of the study in the course/courses for the prescribed duration;
b. 75% attendance separately in theory and in practical in each course;
c. Should have the minimum attendance requirement in all courses of that semester for the first appearance;
d. Secured at least 50% of total marks for CIE in a particular course; and
e. Fulfilled any other requirement that may be prescribed by the University from time to time.

17.1.3. Allotment of Marks

For subjects, which have theory and practical component, the theory examination will be for 70, which will include 50 marks for SEE and 20 marks for CIE. Practical marks allotment will be for 30, which will include 20 marks for SEE and 10 for CIE. There will be10 marks for CIE of practicals done and record maintenance.

For subjects, which do not have University theory examination, the practical examination will be for 100, which will include 70 marks for SEE and 30 marks for CIE, of which 10 marks will be for practical record maintenance. For each subject, the maximum marks allotted is 100, which corresponds to a grade point of 10.

18. Project work / Dissertation:

As a partial requirement of the program, a candidate is required to carry out a research study in a selected area, under the supervision of a faculty Guide. The results of the study shall be submitted to the University in the form a dissertation as per the prescribed format and within the date stipulated by the University. Only a candidate who has put in a minimum of 75% of attendance in the third and fourth semester shall be eligible to submit the dissertation.

The project is aimed at training a postgraduate candidate in research methodology and techniques. It includes identification of the problem, formulation of a hypothesis, review of literature, getting acquainted with recent advances, designing of a research study, collection of data, critical analysis, and comparison of results and drawing conclusions.

18.1. Guide

A Guide shall be a full time faculty in the respective department of the Institute and recognized by University as a Guide for supervision of dissertation work. However, a Co-Guide can be opted wherever required with prior permission of the Institute and University. The Co-Guide should be a postgraduate teacher recognized by the University as Guide.

A candidate shall submit a synopsis to the University through the Guide and Head of the Institute within the date notified by the University.

In the event of registered Guide leaving the institute or in the event of the death of the Guide, a change of Guide shall be permitted by the University on the specific recommendation of the Institute.

18.2. Schedule

The following procedure and schedule shall be strictly followed.

18.2.1. Ethical clearance

Ethical clearance should be obtained for a study involving any procedure on human subject. The candidate should apply for the certificate to the Ethics Committee of the Institute, through the Guide and present the study before the Committee for clearance. A copy of the certificate should be forwarded along with the synopsis at the time of approval**.** All such clearance should be sought before commencement of the project work.

18.2.2. Submission of the synopsis

The synopsis of the proposed study in the prescribed format with the clearances from the Ethics Committee (if required) should be submitted to the office of the Controller of Examinations through the Guide, HoD/Course Co-ordinator and Director of the Institute. The synopsis should be submitted before the commencement of the III semester. Once the synopsis is approved and registered by the University no change in the topic or Guide shall be made without the prior approval of the University.

18.2.3. Final submission of the Dissertation

The dissertation complete in all respects and duly certified by the Guide/Co-Guide, Course Coordinator/ HoD and Director of the Institute should be forwarded to the Controller of Examinations as per the date specified by the University.

18.3. Preparation of Dissertation

The written text of dissertation shall be not less than 50 pages and shall not exceed 100 pages (cover to cover). It should be neatly typed with 1.5 line spacing on one side of the paper (A4 size: 8.27” x 11.69”) and lightly bound (paper back with flexible cover, no hard bind). E- submission of the dissertation is mandatory as it will be archived in the library in electronic format.

The dissertation should be written under the following headings in order.

- Introduction
- Aims or Objectives, Scope of the study
- Review of literature
- Materials and Methods
- Results (including tables and figures/diagrams, graphs)Discussion
- Summary and Conclusions
- References
- Annexures

18.4. Scheme of evaluation

The dissertation will be evaluated for 200 Marks at two levels, once during the end of third semester and once at the end of fourth semester, with 100 marks per semester.The CIE component will be 20%, while the SEE will constitute the remaining 80%.

A mid-term evaluation will be conducted at the end of third semester. The students will have to present a mid-term research seminarwith a focus on methodology and research protocol.

The final evaluation will be conducted at the end of fourth semester. The students will have to present the final research seminarhighlighting the results of the project. A *viva-voce* examination shall be held after the submission of final dissertation. The *viva-voce* examination shall aim at assessing knowledge, logical reasoning, confidence and oral communication skills. If any candidate fails to submit the dissertation on or before the date prescribed, his *viva-voce* will be conducted during the subsequent semester examination.

The CIE at the end of third and fourth semester will be for the regularity & attendance in the lab, colloquium, methodology, maintenance of record (raw data), periodic discussion with the guide, proper disposal of lab waste, neatness, dissertation preparation and presentation.

The SEE at the end of third and fourth semester will be done by the University appointed Internal and External examiners, with a weightage of 50% for each examiner.

18.5. Distribution of marks for project work evaluation

Project Evaluation	**CIE**	**SEE**	**Total**
	20	80	100

Evaluation pattern for III Semester

Evaluation parameters	**CIE**	**SEE**		**Total**
		Internal Examiner	**External Examiner**	
Development of Protocol	20	-	-	20
Evaluation of Protocol (including presentation)	-	40	40	80
Total				100

Evaluation pattern for IV Semester

Evaluation parameters	**CIE**	**SEE**		**Total**
		Internal Examiner	**External Examiner**	
Thesis Preparation	20	-	-	20
Evaluation of Thesis (including *viva- voce*)	-	40	40	80
Total				100

19. Criteria for pass and award of degree:

A candidate is declared to have passed the examination in a course if he/she secures 50% of the marks separately in theory (including CIE) and in practical (including CIE).

For a pass in theory, a candidate has to secure a minimum of 50% marks separately in both SEE and CIE. Further, in practical, a candidate has to secure a minimum of 50% marks separately in the University practical examination and CIE for practical.

A candidate who fails in any subject shall have to appear only in that subject in the subsequent examination. However, if the candidate has cleared only theory or only practical for that subject, he is exempted from appearing for the same in subsequent attempts.

20. Academic Performance Evaluation:

20.1. Grading System

The performance of a candidate shall be evaluated according to Letter Grading System, based on both CIE and SEE provided he passes each one separately. The letter grades (O, S, A+, A, B, C, F and I) indicate the level of academic achievement assessed on a 10 point scale (0 to 10).

Marks Range (%)	Grade Point	Letter Grade	Descriptor	Classification	CGPA
90 & above	10	O	Outstanding	First Class with Distinction	7.50 and above
80-89	9	S	Excellent		
75-79	8	A+	Very Good		
65-74	7	A	Good	First Class	6.50 -7.49
60-64	6	B	Average	Second Class	6.00 - 6.49
50-59	5	C	Pass		5.00 - 5.99
Below 50	0	F	Fail	Fail	Less than 5.00
Absent	0	I	Absent		

For non-credit courses ‘Satisfactory’ (P) or ‘Unsatisfactory’ (F) shall be indicated and this will not be counted for the computation of SGPA/CGPA

20.1.1. A candidate shall be considered to have completed a course successfully and earned the credits assigned, if he secures an acceptable letter grade in the range O-C. Letter grade ‘F’ in any course implies failure in that course and no credit is earned.

20.1.2. A candidate having satisfactory attendance at classes and meeting the passing standard at CIE in a course, but remained absent from SEEs shall be awarded ‘I’ grade in that course.

20.2. Grade Point Averages

The overall performance of a candidate will be indicated by Grade Point Average (GPA). For each course grade points will be awarded as per a letter grading system.

Semester Grade Point Average (SGPA) is computed as follows:

$$SGPA = \frac{\sum [(\text{Course credit}) \times (\text{Grade point})] \text{ for all courses with Letter grades, including F}}{\sum [(\text{Course credits})] \text{ for all courses with Letter grades, including F}}$$

Cumulative Grade Point Average (CGPA) is computed as follows:

$$CGPA = \frac{\sum [(\text{Course credit}) \times (\text{Grade point})] \text{ for all courses for all semesters with, Letter grades excluding F}}{\sum [(\text{Course credits})] \text{ for all courses for all semesters with Letter grades, excluding F}}$$

20.3. Conversion of Grades into Percentage

Formula for conversion of GPA into percentage:

CGPA earned X10 = Percentage of marks scored

Illustration: (CGPA Earned 8.18 X 10) = 81.80 %

20.4. Award of Class

The candidate, who has passed all the courses prescribed, shall be declared to have passed the program. Class will be awarded only to those who pass the entire examination in the first attempt.

- A candidate who secures GPA ≥ 7.50 and above in first attempt shall be declared to have passed in 'First Class with Distinction'.
- A candidate who secures GPA ≥ 6.50 or more but less than 7.50 in the first attempt shall be declared to have passed in 'First Class'.
- A candidate who secures GPA ≥ 5.00 or more but less than 6.50 in the first attempt shall be declared to have passed in 'Second Class'.

Candidates who pass the examinations in more than one attempt shall be declared as passed in 'Pass'class irrespective of the percentage of marks secured.

- An attempt means the appearance of a candidate for one or more courses either in part or full in a particular examination.
- A candidate who fails in main examination and passes one or more subjects or all subjects in the supplementary examination is not eligible for award of class or distinction. Passing in supplementary examination by such candidates shall be considered as an attempt.

- If a candidate submits application for appearing for the regular examination but does not appear for any of the courses/subjects in the regular University examination, he can appear for supplementary examination provided other conditions such as attendance requirement, internal assessment marks, etc. are fulfilled and his appearing in the supplementary examination shall be considered as the first attempt.
- Candidates who pass the subjects in the supplementary examination are not eligible for the award of Gold Medal or Merit Certificate.

20.5. Carry Over

A candidate must take the minimum prescribed credits in a given semester. If he fails in one/more courses without repeating all courses in a given semester, he can take those credits in the spilled over semester:

a) A candidate shall clear the the courses of the I semester to become eligible for promotion to the III semester.
b) Similarly, a candidate must clear the courses of the II semesterto become eligible for promotion to the IV semester.

20.6. Re-totaling

Re-totaling of marks is permitted only for theory papers. The University, on application within the stipulated time and remittance of a prescribed fee, shall permit a recounting of marks for the subject(s) applied. The marks obtained after re-totaling shall be the final marks awarded.

21. Supplementary Examinations:

Supplementary examination shall be conducted by the University for the benefit of unsuccessful candidates. Supplementary examinations will be conducted within six weeks/six months from the date of announcement of results.

- A candidate detained for lack of attendance, internal attendance marks will be barred from appearing in any one or all course/s for the supplementary examination.
- A candidate dropping from appearance in any or all courses at the regular examination is disallowed from taking dropped course(s) at the supplementary examination.
- If a candidate submits application for appearing for the examination but does not appear forany of the courses in the University examination, he can appear for supplementary examination provided other conditions such as attendance requirement, internal assessement marks etc. are fulfilled.
- A candidate who is promoted to the next higher class as per carry over regulations (except where apex bodies do not permit), if he clears the lower year/semester/phase examination in the main examination is allowed to appear for the higher class examination duringsupplementary examinations provided other conditions such as attendance requirement, internal assessment marks, etc. are fulfilled.

A candidate permitted to appear for the supplementary examination can improve his internal assessment marks before he takes the supplementary examination by subjecting himself to CIE procedure as practiced in the Institute.

22. Award of Merit Certificates:

Merit Certificates will be awarded on the basis of overall CGPA of I to IV semester examinations. Further, only those candidates who have completed the program and fulfilled all the requirements in the minimum number of years prescribed (i.e. two years) and who have passed each semester in the first attempt are only eligible for the award of Merit Certificates.

Curriculum for

Master of Science in Biotechnology
M.Sc. (Biotechnology)

PROGRAM OUTCOME

At the end of the program graduates will be able to...

PO1: To acquire knowledge of complex life processes in prokaryotic and eukaryotic cells.

PO2: To gain in-depth understanding of handling biological systems and biomolecules.

PO3: To plan and accomplish research project in relevant topics through critical analysis and logical interpretation of scientific data.

PO4: To formulate and solve research hypothesis in biological sciences.

PO5: To enunciate potential career paths in lifescience.

PO6: To appraise responsible conduct of research relevant to social need and to practise bioethics and biosafety in scientific research.

PO7: To apply knowledge and to offer solution to emerging challenges in food, health and environment sectors.

Core courses (Theory+Practical)

Subject types	Subject title
I semester	
C1	General Microbiology
C2	Cell and Molecular Biology
C3	Biochemistry
C4	Immunology
II semester	
C5	Genetic Engineering
C6	Bioinformatics and Computational Biology
C7	Research Methodology & Biostatistics
III semester	
DSC1	Bioprocess Engineering and Technology
DSC2	Medical Biotechnology
DSC3	Plant and Environmental Biotechnology

C: Core course
DSC: Discipline Specific Core Course

Master of Science in Biotechnology
M.Sc. (Biotechnology)

I Year
Semester I and II

I SEMESTER	
C1	General Microbiology
C2	Cell and Molecular Biology
C3	Biochemistry
C4	Immunology
GE	Generic Elective
NC1	GLP and Biosafety
II SEMESTER	
C5	Genetic Engineering
C6	Bioinformatics and Computational Biology
C7	Research Methodology & Biostatistics
SEC	Skill Enhancement Course
GE	Generic Elective
NC2	Research Ethics and IPR

C: Core course
GE: Generic Elective
SEC: Skill Enhancement Course
NC: Non Credit Course

I SEMESTER
Course C1: General Microbiology (19MBT11)

Preamble: A thorough comparison and understanding on classification, structure and cultivation of various groups of microorganisms to understand the diversity in microbial life is designed in this course. This basic understanding will provide as a strong foundation to understanding the applications of microbiology.

Course Outcomes

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

CO1: Summarize the diversity among microorganisms in the environment
CO2: Distinguish microorganisms based on their general characteristics
CO3: Perform microscopic examination of microorganisms
CO4: Culture microorganisms based on their growth requirements

THEORY **Total Lectures :32**

UNIT I: Introduction **(2 Lectures)**

History and scope of Microbiology.

Classification of Microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese; classification and salient features of bacteria according to Bergey's Manual of Systematic Bacteriology; Nomenclature and modern methods used in Microbial taxonomy.Microscopy: Working principle of light microscope,phase contrast microscope, fluorescence microscope and electron microscope.

UNIT II: **Bacteria and Archae** (**8 Lectures)**

Morphology and ultra-structure of bacteria; morphological types; L-forms.
Structure and function of cell components: bacteria and archaeal cell wall; bacteria and archaeal flagella; fimbriae and pili; capsule- type, slime layers; cell inclusions; nucleoid.
Endospore: structure, formation and germination of bacterial endospore.
Bacteria growth: growth requirements- nutritional and environmental factors; types of culture media; aerobic and anaerobic culture; shaker and still culture; batch, continuous and synchronous culture; growth kinetics, growth curve and measurement of growth.

UNIT III: **Fungi** (**8 Lectures)**

Structure, reproduction and classification of fungi, general characteristics of Myxomycetes, Zygomycetes, Ascomycetes, Basidiomycetes, and Deuteromycetes.
Fungal growth: culture media for fungal growth, growth requirements and parameters affecting growth;Economic importance of fungi

UNIT IV: **Algae and Protozoa** **(4 Lectures)**

Algae: distribution, classification, nutrition, structure and reproduction; green algae, diatoms, euglenoids, brown and red algae
Protozoa: distribution, classification, nutrition, structure and reproduction.

UNIT V:**Acellular Forms** **(6 Lectures)**

Discovery and origin of viruses. General properties of viruses: morphology, ultra-structure, capsid and their arrangements, types of envelopes and their composition and life cycle. Cultivation of viruses: embryonated eggs, experimental animals and cell lines.
Composition, replication and significance of viroids and prions.

UNIT VI: **Control of Microorganisms** **(4 Lectures)**

Microbial death curve, concept of bioburden, thermal death time and decimal reduction time. Factors influencing the effectiveness of antimicrobial agents.
Control of microorganisms by physical agents: heat, filtration and radiation.
Chemical control of microorganisms: Halogens, phenol and other phenolic compounds, heavy metals, alcohols, ethylene oxide and aldehydes.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Safety while handling micro organisms: Biosafety levels and precautions/protective equipment at each level
2. Microscopy:
    a. Wet mount techniques
    b. Simple staining: Positive and negative staining technique.
    c. Differential staining techniques: Gram staining, Spore staining and capsule staining
    d. Permanent slide preparations
3. Sterilization techniques:
    a. Dry heat and moist heat
    b. Filtration
    c. Radiation
4. Preparation, use of bacterial culture media and culture characteristics: Nutrient medium, Tryptic soya medium, Blood agar, MacConkey agar, Eosin methylene blue agar, Thiosulphate citrate bile sucrose agar, Mannitol Salt agar, Hektoen Enteric agar, Cetrimide agar
5. Bacterial and Fungal culture techniques: Enrichment culture, serial dilution and Spread plate/ pour plate and streak plate methods; Slide culture technique
6. Bacterial growth measurement: Microscopic cell count; optical density and standard plate count
7. Long term preservation of bacterial culture
8. Type study of Fungi: *Rhizopus, Mucor, Aspergillus, Penicillium, Cladosporium, Fusarium* and *Alternaria*

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests (average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1.0	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Prescott's Microbiology 9th edition (2014) M.J .Willey,M.L.Sherwood, M.L. and J.C. Woolverton, McGraw-Hill Companies. Inc. New York.ISBN: 9780077510664
2. Microbiology, 8th edition. (2013) G.J. Black, John Wiley & Sons, USA.ISBN: 9781118213414
3. Microbiology, 5th edition. (1993) J.M.Pelczar, E.C.S. Chan, and R.N. Krieg, McGraw –Hill Companies, Inc. New York.ISBN:9780074623206
4. Brock Biology of Microorganisms, 14th edition. (2014) T.M.Madigan, M.J.Martinko, S.K.Bender, H.D.Buckley, A.D.Stahl and T.Brock, Pearson Education, Inc. San Francisco.ISBN: 9781292068312
5. Introductory mycology. 4th Edition (2002) C.J.Alexapoulos, C.W.Mims and M.Blackwell, Wiley India.ISBN :9788126511082
6. Textbook of Microbiology, 8th edition (2010) R. Ananthanarayan and J.C.K.Panikar, University Press Private Limited, India. ISBN: 978-9350905340
7. Microbiology: A Laboratory Manual, 11th Edition (2017) J.G.Cappuccino, and N.Sherman Pearson,USA. ISBN: 978-0321840226.

I SEMESTER

Course C2: Cell and Molecular Biology (19MBT12)

Preamble: The principle aim of this course is to introduce the students to classical and modern concepts in cell and molecular biology and its applications in biomedical research. In particular, it focuses on identifying key components that constitute living cells and to integrate the field of biochemistry, molecular cell biology and genetics. This course provides a basic and comprehensive grounding in multidisciplinary science of modern and classical biomedical science.

Course Outcomes

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

CO1: Demonstrate the use of modern cell-related techniques
CO2: Explain the structure/function of DNA, replication, damage and repair of DNA of cell
CO3: Describe the structure/function of RNA, transcription and synthesis of polypeptide chain of cell
CO4: Perform techniques used in molecular biology
CO5: Perform the extraction of DNA, RNA and protein
CO6: Identify molecules using gel electrophoresis techniques
CO7: Recognize the structure and function of nucleic acids
CO8: Describe the regulation of prokaryotic and eukaryotic genes

THEORY **Total Lectures: 32**

UNIT I: Membrane Structure and Transport (6 Lectures)

Chemical composition of membrane, structure and function of membrane protein, membrane lipid and fluidity, lipid rafts, deformation of membranes

Transport across membrane: Transport of small molecules: Passive and active transport (P, V, F and ABC transporters); transport of large molecules: endocytosis and exocytosis

Protein sorting and vesicular trafficking: Transport of molecules into and out of the nucleus, transport of proteins into mitochondria and chloroplasts, transport from the ER through golgi apparatus to lysosomes

UNIT II: Cytoskeleton, Interaction of Cells and their Environment (4 Lectures)

Cytoskeleton: Cytoskeleton proteins. Microfilaments: types, structure and function, Intermediate: structure and function, Microtubule: structure and functional organization, Cell interaction: Interaction between cell and extracellular matrix (ECM): ECM proteins (collagens, elastin, proteoglycans, fibronectins and laminins); Interaction between cells: Tight junction, anchoring junction, gap junction, Cell adhesion molecules: seletins, cadarins, immunoglobins

UNIT III: Cell Signalling, Cell Cycle and Cell Death (6 Lectures)

Cell Signalling and communication: general principle of communication, Cell surface receptors, G-protein mediated signalling, camp, receptors tyrosine kinases, second messengers, Cell cycle: overview, model organism and methods to study cell cycle, regulation of cell cycle, Cell death: apoptosis, necrosis, caspases, cell death pathways

UNIT IV: Replication of DNA in Prokaryotes and Eukaryotes (4 Lectures)

Chemical composition of DNA/RNA. DNA structure, DNA denaturation and renaturation. DNA replication: Mechanism of DNA replication in prokaryotes and eukaryotes. Transposable elements in prokaryotes and eukaryotes, Mechanisms of transposition.

UNIT V: Transcription in Prokaryotic and Eukaryotic (6 Lectures)

Structural features of prokaryotic and eukaryotic RNA - rRNA, tRNA, mRNA. Prokaryotic transcription: promoters and regulatory elements; RNA polymerase; initiation, elongation and termination; transcriptional regulation-positive and negative; operon concept-lac and trp operons. Eukaryotic transcription; promoters and regulatory elements; RNA polymerase structure and assembly; RNA polymerase I, II, III; initiation, elongation and termination.
Post-transcriptional modifications: 5'-cap formation, 3'-end processing, splicing, RNA editing, catalytic RNA. Regulatory RNA: antisense RNAs, micro RNAs, RNA interference. RT-PCR.

UNIT VI: Translation in Prokaryotic and Eukaryotic (6 Lectures)

Genetic code: Salient features, Universal genetic code; Wobble hypothesis. Translation: Mechanism of initiation, elongation and termination of translation process. Regulation of protein synthesis, Polyribosomes, Post-translational modifications; Transport of proteins and molecular chaperones; protein stability and degradation pathways.

PRACTICAL

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Safety consideration in a molecular biology laboratory
2. Basics of reagents/chemical preparation (Buffer, Molar, Normal, percent solution)
3. Microscopy-as a tool in cell biology
4. Staining techniques in cell biology
5. Cell culture preservation and revival
6. Cell viability assay: MTT/trypan blue test
7. Observation of various stages of cell cycle
8. Extraction and quantification of genomic DNA from prokaryotic and eukaryotic cell
9. Extraction and quantification of plasmid DNA from bacterial cell
10. Quantitative estimation of DNA/RNA using spectrophotometer.
11. Polymerase chain reaction (PCR) assay and variants
12. Extraction, quantification of total RNA and Reverse transcriptase PCR
13. Agarose gel electrophoresis of PCR product
14. Extraction of protein prokaryotic and eukaryotic cell
15. Separation of proteins by sodium dodecyl sulfate polyacrylamide gel electrophoresis(SDS-PAGE)

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1.0	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of Examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of Examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Molecular biology of the cell, 6th edition (2014), B.Alberts.,A. Johnson., J. Lewis., D.Morgan. and M. Raff, Garland Science, New York, USA. ISBN:978-0815344322.
2. Molecular cell biology, 7th edition (2013), H.Lodish., A. Berk., C.A. Kaiser and M.Krieger, W H Freeman and Company, New York, USA. ISBN:9781429234139.
3. Cell: molecular approach, 6thedition (2013), G.M. Cooper and R.E. Hausman, ASM Press, USA. ISBN:978-0878939640.
4. Cell and Molecular Biology, 7thedition (2013), G. Karp, John Wiley, New York, USA. ISBN: 9781118301791.
5. Cell biology, 2ndedition (2008), T.D. Pollard and W.C. Earnshaw, Saunders, USA. ISBN:9781416022558.
6. Cell and Molecular Biology. 3rdedition (2010),S.C Rastogi, New Age International publishers, India ISBN-10: 8122430791

I SEMESTER
Course C3: Biochemistry (19MBT13)

Preamble: The course highlights the importance of Biochemistry in all our lives and helps to understand the biochemical basis of life and to describe metabolic pathways of biomolecules. This would enable the student to know the disease processes to understand clinical problems. This paper introduces the concepts of various biomolecules, metabolic pathways and disorders of metabolism. Also able to gain knowledge on metabolism of biomolecules in various tissues of the human body in normal healthy individuals and help to understand the regulation of biomolecules under various circumstances. The experiments are designed towards developing problem solving ability of the students through analysis and objective scientific reasoning.

Course Outcomes

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

CO1: Review the importance of biochemistry in biomedical science
CO2: Illustrate the structure of biomolecules
CO3: Estimate the concentrations of various biomolecules by qualitative and quantitative analysis
CO4: Identify disorders associated with metabolism of biomolecule

THEORY **Total Lectures: 32**

UNIT I: Carbohydrate **(7 Lectures)**

Classification and biological importance of carbohydrates; carbohydrate metabolism: glycolysis, Krebs cycle, hexose degradation pathways, gluconeogenesis, glycogenesis and glycogenolysis pathway and its regulation. Disorders of glycogen metabolism, interrelation of carbohydrates with other metabolism.

UNIT II: Lipid **(7 Lectures)**

Classification and biological importance of lipid, triglycerides, phospholipids, glycolipids, sulpholipids; metabolism and regulation: fatty acid synthesis, oxidation of fatty acids, ketogenesis; structure of cholesterol and its metabolism; lipoprotein role in lipid storage; hormones, steroids.

UNIT III: Protein and Enzymes **(10 Lectures)**

Protein structure: primary, secondary, tertiary and quaternary; protein folding, Ramachandran plot; metabolism of proteins and its regulation; transamination, urea cycle; structure and function of haemoglobin, myoglobin, and immunoglobulins. Vitamins: water and lipid soluble, vitamin deficiency diseases.

Enzymes: characteristic feature, nomenclature, classification, theories of enzyme specificity, factors affecting the rate of enzyme catalysed reaction, enzyme kinetics: Michaelis-Menten equation, Lineweaver-Burke plot; enzyme Inhibition: competitive, non-competitive and uncompetitive inhibitions.

UNIT IV: Nucleic acid and Bioenergetics (8 Lectures)

Purine and pyrimidine, structure of DNA, RNA and its types; nucleic acid metabolism: De Novo and salvage pathway. Inborn errors of metabolism.

Bioenergetics: electron transport chain, oxidative phosphorylation, inhibitors of electron transport chain and oxidative phosphorylation.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Qualitative analysis of carbohydrate, protein and non-protein nitrogen
2. Estimation of reducing sugar by dinitrosalicylic acid method
3. Estimation of fructose by resorcinol method
4. Estimation of glucose by iodometric method
5. Determination of pKa value of aminoacid by titrimetric analysis
6. Determination of pI of casein from milk.
7. Estimation of proteins by Folin-Ciocalteu method and Bradford method
8. Separation of pigments by adsorption chromatography, gel filtration chromatography
9. A-G ratio by paper chromatography
10. Colorimetric estimation of inorganic phosphate by Fiske-Subbarow method
11. Estimation of vitamin C by dichlorophenol indophenol method.
12. Determination of Km and Vmax of alkaline phosphatase / salivary amylase
13. Determine saponification number and peroxide value of Fat
14. Estimation of nucleic acids

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

***Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

***Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Lehninger: Principles of Biochemistry, 6th Edition (2013), D.L. Nelson, and M.M. Cox; Freeman Publishers, ISBN:9781464109621
2. Biochemistry, 4th Edition (2016), P. Naik; Jaypee Brothers Medical Publishers Private Limited, ISBN: 9789351529897
3. Biochemistry, 4th Edition (2016), U. Satyanarayana and U. Chakrapani; Elsevier Publishers, ISBN: 9788131236017
4. Text Book of Biochemistry, 2nd edition (2014), K. Rambabu, P. Sivkumar and P. Kameswari; AITBS Publishers, ISBN:9788174733610
5. Text book of Biochemistry for Medical Students, 8th edition (2016), D.M Vasudevan, S. Sreekumari and K.Vaidyanath; Jaypee Brothers Medical Publishers Private Limited, ISBN: 9789385999741
6. Practical Biochemistry, 3rd edition (2014), G. Rajgopal and B.D. Toora; Ahuja publishers, ISBN:9789380316314

I SEMESTER
Course C4: Immunology (19MBT14)

Preamble: The immune system comprises innate and acquired defense mechanisms against microorganisms. Initial lectures will cover the cells of the immune system, their function, the structure of lymphoid organs and the how cells move around the within and between lymphoid organs to bring about crucial interactions. A detailed knowledge of cellular and molecular components of the immune system will be integrated to provide a working understanding of biological mechanisms important in health and disease.

Course Outcomes

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

CO1: Discuss the different organs, cells and molecules of immune system
CO2: Illustrate various types of immune response.
CO3: Discuss different antigens and antibodies and their interactions.
CO4: Describe various types of vaccines and vaccination methods.
CO5: Demonstrate practical skills in undertaking simple immunological experiments.
CO6: Gather information on research activities in the field of immunology and their applications.

THEORY **Total Lectures: 32**

UNIT I: Cells and Organs of Immune System (4 Lectures)

Historical perspective, general concepts of the immune system
Cells involved in the immune system: lymphoid cells, mononuclear cells, granulocytic cells, antigen presenting cells
Organs involved in the immune system: primary and secondary lymphoid organs

UNIT II: Innate and Adaptive Immune Response (10 Lectures)

Innate defense response: First line defense: Anatomical barriers, antimicrobial substances, normal flora, surface receptors, adhesion molecules, phagocytosis
Complement system: Components of the complement activation pathways; biological consequence of complement activation, Inflammation
Adaptive immune response: humoral and cellular immunity
Antigens: structure and properties, factors affecting the immunogenicity, epitopes, pattern recognition receptors, haptens, mitogen and superantigens
Antibodies: structure, function and properties of the antibodies, different classes and subclasses, biological activities of antibodies
Production of polyclonal and monoclonal antibody

UNIT III: Immunodiagnostic Techniques (5 Lectures)

Antigen-antibody interactions: precipitation reactions, agglutination reactions
Advance immunological techniques: radioimmunoassay, enzyme-linked immunosorbent assay,Western blotting, immunoprecipitation, flow cytometry, immunofluorescence, immunoelectron microscopy and complement fixation test

UNIT IV: Major Histocompatibility Complex (3 Lectures)

Major histocompatibility complex: organization classes and function

Antigen processing and presentation by cytosolic and endocytic pathway of MHCs Cytokines: properties, cytokines receptors, cytokine-related diseases

UNIT V: Vaccines and Immunotherapeutic (2 Lectures)

Vaccinology: Active and passive immunization; different types of vaccines: live, killed, attenuated, recombinant DNA and protein based vaccines, synthetic peptide vaccines; reverse vaccinology; role of adjuvants

UNIT VI: Dysfunctions of Immune System (8 Lectures)

Hypersensitivity: type I, II, III and types IV hypersensitivity Immunodeficiency diseases: primary and secondary immunodeficiency

Autoimmunity:organ specific autoimmune diseases and systemic autoimmune diseases Transplantation immunology: immunologic basis of graft rejection, clinical manifestation of graft rejection and clinical transplantation.

Cancer immunology: tumor antigen, immune response to tumor, cancer immunotherapy

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of blood smear and differential count
2. Antigen identification by agglutination (Widal test)
3. Antigen identification by agglutination (ABO typing)
4. Precipitation assay: immunodiffusion
5. ELISA assay: plate ELISA (direct)
6. ELISA assay: plate ELISA (indirect)
7. ELISA assay: dot ELISA
8. Fluorescent antibody test
9. Immunoelectrophoresis assay
10. SDS-PAGE analysis of protein samples
11. Western blotting analysis

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Cellular and Molecular Immunology. 6th Edition (2005), A. K.Abbas and L.Andrew, Philadelphia, PA: Saunders. ISBN: 9781437715286
2. Kuby Immunology, 7th Edition (2012), J.Owen, J. Punt and S. Stranford, W. H. Freeman and Company, NY. ISBN:9781464119910
3. Roitt's Essentials of Immunology, 12th Edition (2011), P.J. Delves, S.J.Martin, D.R. Burton and I.M,RoittRiott's Wiley-Blackwell, London. ISBN: 9781118415771
4. Immunology. 2nd Edition (2006), C. V. Rao, Narosha Publishing House, India ISBN: 9788173196577

II SEMESTER
Course C5: Genetic Engineering (19MBT21)

Preamble: This course aims to provide a comprehensive knowledge about genetic engineering and its broad applications including cloning and expression of desired gene, gene manipulations, amplification of DNA by polymerase chain reactions and various cutting edge applications. Student studying this course will gain knowledge about how gene cloning and gene manipulation are applied in modern science

Course Outcomes

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

CO1: Discuss the process of cloning
CO2: Perform DNA extraction and estimate the purity.
CO3: Construct recombinant DNA for applications
CO4: Explain the applications of genetic engineering
CO5: Integrate biotechnological approaches to applications in various fields

THEORY **Total Lectures: 32**

UNIT I: Basics concepts **(4 Lectures)**

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing.

UNIT II: Cloning vectors **(8 Lectures)**

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and Pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

UNIT III: Cloning Methodologies **(6 Lectures)**

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression.

UNIT IV: PCR and its Applications **(7 Lectures)**

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

UNIT V: Sequencing Methods (9 Lectures)

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- *in vivo* and *ex-vivo;* Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Isolation of genomic DNA
2. PCR amplification of gene of interest and analysis by agarose gel electrophoresis
3. Preparation of plasmid from given bacterial sample and gel analysis.
4. Restriction digestion of vector and insertion using Ligase.
5. Competent cell preparation for transformation
6. Transformation in *E.coli* DH5α.
7. Plasmid isolation and confirming recombinant by PCR and RE digestion.
8. Induction of protein with IPTG and analysis on SDS-PAGE
9. Purification of protein and analysis of purification by SDS-PAGE
10. Southern/Northern/Western blotting hybridization

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Gene cloning and DNA Analysis: An introduction. 7th edition(2016),T. ABrown, Wiley-Blackwell, ISBN: 9781119072560
2. Molecular Cloning: A Laboratory Manual, 4th edition (2012), M.R. Green and J. Sambrook Three-volume set by; Cold Spring Harbor Laboratory Press, ISBN: 1936113422
3. An introduction to genetic engineering, 3rd edition (2013), D.S.T. Nicholl, Cambridge University press. ISBN: 9780521188142
4. Principles of gene manipulation and genomics, 7th edition (2006), S.B, Primrose and R. Twyman, Wiley-Blackwell. ISBN: 978-1405135443
5. Introduction to Biotechnology. 3rd edition (2012), W. J. Thieman and M.A. PalladinoPearson publications, ISBN: 9780321766113
6. An Introduction to Biotechnology. 1st edition (2014),W.T.Godbey,Woodhead Publishing, ISBN: 9781907568282

II SEMESTER
Course C6: Bioinformatics and Computational Biology (19MBT22)

Preamble: Bioinformatics is an interdisciplinary field comprising biology, biotechnology and computer science. The course is aimed at analyzing biological data which is critical for understanding life sciences. Vast amount of data generated and stored in public databases need to be analysed. The course also aims at studying and analyzing data which is generated in wet labs. The computational analysis and methods find applications in molecular biology and biotechnology. The students would be able to appreciate the systems approach designed towards understanding disease at the genetic level in various life forms from bacteria to Homo sapiens.

Course Outcomes

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

CO1: Review the techniques of bioinformatics
CO2: Apply biological databases to solve problems in research
CO3: Discuss bioinformatics methods using different computational tools
CO4: Perform sequence analysis
CO5: Utilize major databases for various in-silico analysis.
CO6: Predict the outcome of analysis based on statistical parameters
CO7: Insight into various levels of analysis and review whole genome assembly

THEORY **Total Lectures: 32**

UNIT I: Introduction and Biological Databases (10 Lectures)

Introduction to Bioinformatics, Introduction to various databases and their classification (primary and secondary databases) e.g. types of biological data

General Introduction of Biological Databases- Nucleic acid databases (NCBI, DDBJ & EMBL) Protein sequence databases: Uniprot-KB: SWISS -PROT, TrEMBL,

Specialized Genome databases: (SGD, TIGR) Structure databases (CATH, SCOP and PDBsum)

Repositories for high throughput genomic sequences: EST, STS

GSS, Genome Databases at NCBI, EBI, TIGR, SANGER

3D Structure Database: PDB, Chemical Structure database: Pubchem

Derived databases- Sequence: InterPro, Prosite, Pfam, ProDom, Gene Ontology

UNIT II: Sequence Analysis (8 Lectures)

Various file formats for bio-molecular sequences: GenBank, FASTA.

Basic concepts of sequence similarity, identity and homology, definitions of homolog, ortholog, paralog

Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series

Sequence-based Database Searches: BLAST, various versions of basic BLAST, Sequence filtering, E value

Sequence alignment: Global alignment, Local alignment, Gap penalty, Dot plots, Dot matrix algorithm, look up tables, Similarity and Homology, Needleman-Wunsch, Smith-Waterman algorithms

Multiple sequence alignment: goal of multiple sequence alignment, consensus sequence ClustalW /MUSCLE; Motif and Domain: Motif databases and analysis tools.

UNIT III: Phylogenetic Analysis (5 Lectures)

Basics and tools for phylogenetic analysis, tree-building methods (character and distance based methods), construction of phylogenetic trees and identifying homologs (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method

UNIT IV: Predicting Protein Structure (Homology Modelling) (5 Lectures)

Predicting protein structure and function from sequence; Predicting 3D structure, Structure prediction by homology modelling, Steps in homology modelling, Accuracy check of models. Visualization of structures using Rasmol and CHIMERA

UNIT V: Comparative Genomics (4 Lectures)

Comparative genomics: Basic concepts and applications, whole genome alignments: understanding significance. Basic concepts of whole genome sequencing, sequencing platforms.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Information retrieval- referring journals, PubMed & Medline
2. Similarity searches in various databases using BLAST program
3. Identifying conserved domains in various super-families
4. Evolution of protein domains using phylogenetic methods
5. To design primers for the given gene sequences
6. Search tool for retrieval of interacting genes
7. KEGG pathway analysis using annotation tool DAVID
8. Meta-analysis of microarrays
9. Download the atomic coordinates from PDB using the coordinate file and view the molecules using molecular visualization tools- Rasmol, Chimera
10. To build protein models using Swiss-model and validation
11. Annotation of ligand binding site in protein structure
12. To predict gene using gene finding tools
13. To search for exons using genome viewing tools
14. SNP extraction from UCSC browser and its effect on protein structure

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Discovering genomics, proteomics and bioinformatics, 2nd edition (2007), A.M.Campbell and L.J. Heyer; Cold Spring Harbor Laboratory Press, Pearson, ISBN:9788131715598
2. Bioinformatics sequence and genome analysis, 2nd Edition. (2004), D.W.Mount; Cold Spring Harbour Laboratory Press. CBS Publishers, ISBN:0879697121
3. Bioinformatics: Concepts, skills and applications, 2nd edition (2014), S.C., Rastogi, N.Mendiratta, P.C.Rastogi, P. (2014) C B S publishers, ISBN:8123914822
4. Developing Bioinformatics Computer Skills, 1st edition. (2013), C. Gibas and P. Jambeck.O'Reilly Media, ISBN:9788173662423
5. Molecular Modelling-Principles and Applications, 2nd edition (2003), A.R. Leach; Pearson Education Limited, UK, ISBN: 9780582382107

II SEMESTER
Course C7: Research Methodology and Biostatistics (19MBT23)

Preamble: Statistical concepts are indispensable for carrying out and understanding biological hypothesis, experimentation as well as validations. It is aimed at creating awareness about the applications of statistics in biological sciences including medical and para-medical sciences along with building confidence in students to logically test their Research data with an appropriate set of test of significance. Use of open source software and web material is encouraged as the course intends to give wings to the students.

Course Outcomes

At the end of the course studentse will be able to...

CO1: Organize and conduct researchin a more appropriate manner.
CO2: Identify various sources experimental designs and their applications.
CO3: Review statistical data collected in biomedical research.
CO4: Develop skill about summarizing, presenting and analyzing result data
CO5: Comprehend the methods and results published in research paper.

THEORY **Total Lectures: 32**

UNIT I: Research Methodology, Experimental Designs and Research Tools (8 Lectures)

Introduction to research methodology - Research processes, quantitative and qualitative research, Structure of a research proposal, Ethics in research, writing of references, Plagiarism and publishing of a report

Types of research designs - Randomized experimental design, Quasi- experimental design, and Non – experimental designs

Experimental design - Two group experimental design, Factorial design, Cross over design, Randomized block designs, and Latin square design

Descriptive and analytical study designs - Case reports, Case series, Cross – sectional, Case control, Cohort, and Randomized controlled trials

Development of a research tools - Steps in developing a questionnaire; Contents, structure, format and sequence of a questionnaire, pilot study, evaluation of a questionnaire, difference between questionnaire and schedule.

Concept of Validity - Content validity, Face validity, Criterion validity, Concurrent validity, and Construct validity

Concept of Reliability – Test retest reliability, Equivalent-Forms or Alternate-Forms Reliability, Cronbach's alpha, and Split-Half Reliability

UNIT II: Data Collection, Presentation and Sampling Techniques (8 Lectures)

Measures of agreement - Intra class correlation coefficient, Kappa Statistic,Sensitivity, specificity and Receiver Operating Characteristics (ROC) analysis

Measurement and scaling techniques - Nominal scale, ordinal scale, ratio scale, interval scale, types of variable, primary data, secondary data, and sources of secondary data

Methods of data collection - Personal interview, telephone interview, self-administered questionnaire survey, mail questionnaire, and focus group discussion

Presentation of data - Tabular representation of data, graphical representation of data: Histogram, Frequency polygon, Ogive, Line diagram, Pie diagram, and bar diagrams

Descriptive statistics - Mean, Median, Mode, Range, Quartiles, Deciles, Percentile, Variance, Standard Deviation, Coefficient of Variation, Mean Deviation, and their respective relative measures

Sampling techniques - Sampling frame, Statistic, Parameter, Probability sampling – simple, stratified, systematic, cluster, and sampling; non probability sampling – purposive, judgment, snowball, quota sampling, and characteristics of a good sample

Concept of probability - Probability of standard distributions and their applications, The Binomial distribution and Poisson distribution

UNIT III: Distribution, Test of Significance and Measures of Associations (8 Lectures)

Normal distribution - Properties and its importance, standard normal distribution, use of standard normal probability table, sampling distribution, standard error of mean, and standard error of proportion, Confidence intervals, and Sample size determination

Test of significance - Types of hypothesis, P - value, type I & II errors, statistical and clinical significance, Power of the test, Parametric tests – Z test, one sample t test, two sample t test, paired t test, One way Analysis of Variance, repeated measures ANOVA. Non parametric tests - Mann Whitney U test, Wilcoxon sign rank test, Kruskall Wallis test and Friedman's ANOVA test, Measures of association - Chi square, Odds Ratio, Mantel- Haenszel Odds ratio, Relative Risk, Risk difference, and Number Needed to Treat.

UNIT IV: Correlation and Regression, Applications of Statistical Tools (8 Lectures)

Correlation and regression analysis - Scatter diagrams, Pearson correlation, Spearman's correlation, Simple and multiple linear regression models

Introduction to Binary logistic regression models and survival analysis

Role of statistical packages in health science research

PRACTICAL

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Representation of Statistical data by (a) Histograms (b) Ogive (c) Pie diagrams (d)
2. Frequency curve.
3. Determination of Statistical averages/ central tendencies- (a) Arithmetic mean (b)
4. Median (c) Mode
5. Determination of measures of Dispersion- (a) Mean deviation (b) Standard deviation (c) coefficient of variation (d) Quartile deviation
6. Tests of Significance-Application of following- (a) Chi- Square test (b) t- test (c) Standard error
7. Forming frequency table and computation of descriptive statistics of data using computer

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Research Methodology: Methods and Techniques, 3rd Edition(2014), C.R.Kothari.,New Age international (P) Ltd. ISBN: 9788122436235.
2. Biostatistics – A Foundation for Analysis in the Health Science, 7th Edition (1999),W.W. Daniel, .John Wiley Publications.ISBN: 978-471163862.
3. Text book of preventive and social Medicine. 21st Edition (2011), Park K. BanarsidasBhanot Publishers. ISBN: 9788190607995.
4. Biostatistics: A Foundation for Analysis in the Health Sciences,10th edition (2013), W. W. Daniel and C. L. Cross, Wiley. ISBN13: 9781118302798.
5. Principles of Biostatistics, 2nd edition (2000), M. Pagano and K.Gauvrean., Thompson learning. ISBN: 9780534229023.
6. Biostatistical Analysis, 5th edition (2009), J. H. Zar, Pearson. ISBN: 9780131008465.

Master of Science in Biotechnology

M.Sc. (Biotechnology)

II Year

Semester III and IV

III SEMESTER	
DSC1	Bioprocess Engineering and Technology
DSC2	Medical Biotechnology
DSC3	Plant and Environmental Biotechnology
DSE	Discipline Specific Elective
P1	Project Work –I
S1	Seminar-I
IV SEMESTER	
P2	Project Work –II
S2	Seminar-II

DSC: Discipline Specific Core Course
DSE: Discipline Specific Elective Courses
S: Seminar
P: Project Work

Discipline Specific Core (DSC) Course

Master of Science in Biotechnology
M.Sc. (Biotechnology)

Discipline Specific Core (DSC) Course

III Semester

DSC1: Bioprocess Engineering and Technology
DSC2: Medical Biotechnology
DSC3: Plant and Environmental Biotechnology

III SEMESTER
Course DSC1: Bioprocess Engineering and Technology (19MBT31)

Preamble: The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry. This course aims to provide a comprehensive knowledge about biotechnological applications in industries. This course will enable students acquire theoretical and practical knowledge about concepts of fermentation and its application in biotechnology.

Course Outcomes

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

CO1: Discuss the basic principles of fermentation using different microbes.
CO2: Illustrate the techniques and methods of biochemical engineering.
CO3: Describe the recent advances in food processing with use of enzymes.
CO4: Demonstrate knowledge and practical skills on the use of microbes in food process operation and production.
CO5: Discuss theoretical and practical knowledge about downstream processing.

THEORY **Total Lectures: 32**

UNIT I: Basic Principle of Biochemical Engineering (3 Lectures)

Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

UNIT II: Concepts of Basic Mode of Fermentation Processes (9 Lectures)

Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design- mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

UNIT III: Downstream Processing (5 Lectures)

Bio-separation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

UNIT IV: Applications of Enzymes in Food Processing (5 Lectures)

Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions eg. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

UNIT V: Applications of Microbes in Food Process Operations & Production (5 Lectures)
Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins from lactic acid bacteria – Production and applications in food preservation.

UNIT VI: Enzyme Kinetics (5 Lectures)
Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzymes; Enzyme mechanism; Enzyme inhibitors and active site determination, Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications.

PRACTICALS
(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.
2. Determination of mixing time and fluid flow behaviour in bioreactor under variety of operating conditions.
3. Rheology of microbial cultures and biopolymers and determination of various rheological constants.
4. Production of microbial products in bioreactors.
5. Studying the kinetics of enzymatic reaction by microorganisms.
6. Production and purification of various enzymes from microbes. .
7. Comparative studies of Ethanol production using different substrates.
8. Microbial production and downstream processing of an enzyme, e.g. amylase.
9. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.ISBN: 0335158102
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.ISBN: 0130819085, 9780130819086
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology,Pergamon press, Oxford, 1997. ISBN: 0080361323
4. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986. ISBN-13:978-0-07-070123-6
5. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
6. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004. ISBN 0-080-32510-6 (Vol 2), ISBN 0-08-026204-X (4-Vol.Set)
7. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.eBook ISBN9780429190605

III SEMESTER
Course DSC2: Medical Biotechnology (19MBT32)

Preamble: This course aims to provide a comprehensive knowledge about biotechnological applications such as cloning and expression of desired genes.They will also gain knowledge about DNA fingerprinting, probe preparation and hybridization methods. This course will enable students acquire theoretical and practical knowledge about medical biotechnology, which will make them competent in the field of life sciences and prepare them for advanced studies or research in this field.

Course Outcomes

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

CO1: Discuss the use of DNA modifying enzymes in genetic engineering.
CO2: Illustrate the techniques and methods of sequencing.
CO3: Describe the recent advances in PCR and DNA fingerprinting.
CO4: Demonstrate knowledge and practical skills on the use of basic molecular tests in genetic disease diagnosis
CO5: Construction of various recombinant molecules using molecular biology tools.
CO6: Discuss theoretical and practical knowledge about medical biotechnology

THEORY **Total Lectures: 32**

UNIT I: **Enzymes, Vectors, Cloning and Expression of Gene** **(6 Lectures)**

Introduction to medical biotechnology and gene manipulating enzymes. Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseIfootprinting; Methyl interference assay.

UNIT II: Vectors **(4 Lectures)**

Cloning vectors: plasmids vectors, bacteriophages as cloning vectors, phagmidvector,cosmid and artificial chromosomes, expression vectors. Cloning and expression of gene of insert: selection of insert, cloning components, method of cloning, selection and screening of recombinants.

UNIT III: DNA Sequencing: **(2 Lectures)**

Enzymatic and chemical sequencing of DNA; next generation DNA Sequencing, Construction and application of genomic and cDNA libraries.

UNIT IV: Amplification of Nucleic Acids and DNA Fingerprinting **(5 Lectures)**

Polymerase Chain Reaction (PCR); Types of PCR: multiplex PCR, nested PCR and reversetranscriptase PCR, random amplified polymorphic DNA, PCR-restriction fragment lengthpolymorphism.

UNIT V: DNA Fingerprinting and Profiling (5 Lectures)

Ribotyping, amplified fragment length polymorphism,micro and minisatellite,short tandem repeats, variable number tandem repeats and single-nucleotide polymorphisms. Real time PCR: principle, non-specific and specific reporters and its application.

UNIT VI: DNA Hybridization (5 Lectures)

Probes: properties and application. Preparation of probes.

Hybridization techniques: southern hybridization, northern hybridization, fluorescence *Insitu* hybridization, microarray and colony hybridization.

UNIT VII: Application of Medical Biotechnology (5 Lectures)

Production of recombinant biomolecules: recombinant insulin, recombinant human growth hormones, recombinant factor VIII and recombinant vaccines. Concept and applications of gene silencing, gene knockouts and genome editing. Gene therapy- somatic and germline gene therapy, suicide gene therapy

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Isolation of plasmid DNA
2. DNA digestion using restriction enzymes
3. PCR amplification of targeted gene
4. PCR-RFLP analysis
5. RAPD analysis
6. Multiplex PCR
7. Nested PCR
8. Real time PCR (qPCR)
9. Preparation of *E. coli* competent cells for transformation
10. Molecular cloning of gene
11. DNA dot blotting
12. Southern and/or colony hybridization

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Gene cloning and DNA Analysis: An introduction. 7th edition (2016),TABrown, Wiley-Blackwell, ISBN: 9781119072560
2. Molecular Cloning: A Laboratory Manual, 4th edition (2012), M.R. Green and J. Sambrook Three-volume set by; Cold Spring Harbor Laboratory Press, ISBN: 1936113422
3. An introduction to genetic engineering, 3rd edition (2013), D.S.T. Nicholl,Cambridge University press. ISBN: 9780521188142
4. Principles of gene manipulation and genomics, 7th edition (2006), S.B, Primrose and R. Twyman,Wiley-Blackwell. ISBN: 978-1405135443
5. Introduction to Biotechnology. 3rd edition (2012), W. J. Thieman and M.A.Palladino Pearson publications, ISBN: 9780321766113
6. An Introduction to Biotechnology. 1st edition (2014), W.T. Godbey,Woodhead Publishing, ISBN: 9781907568282
7. Medical Biotechnology (2014), Bernard R. Glick, Terry L. Delovitch and Cheryl L. Patten ASM Press, ISBN: 9781555817053

III SEMESTER

Course DSC3: Plant and Environmental Biotechnology (19MBT33)

Preamble: The course amis to provide a comprehensive knowledge about biotechnological applications in plant sciences such as tissue culture, Crop improvement. It also provides an insight into biotechnological applications in environmental science. The use of biological organisms for removal of pollutants, use of biopesticides and biofuels is elaborated. The course introduces the students to alternative areas of biotechnological applications.

Course Outcomes

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

CO1: Identify the fundamental principles and applications in plant biotechnology
CO2: Perform the basic and advanced techniques used in plant biotechnology
CO3: Identify with the concept of bioremediation, biofuels at an advanced level
CO4: Choose research career in the field of environmental studies and remediation
CO5: Make objective decisions about use of biological agents in environmental friendly agricultural practices

THEORY **Total Lectures: 32**

UNIT I: Plant Tissue Culture: **(8 Lectures)**

Plant tissue culture: historical perspective; totipotency; organogenesis; Somatic embryogenesis; establishment of cultures – callus culture, cell suspension culture, media preparation – nutrients and plant hormones; sterilization techniques; Applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production.

UNIT II: Crop Improvement **(8 Lectures)**

Crop improvement: Plant biotechnology for enhancing cold and heat stress tolerance; Plant biotechnology in enhancing drought and salt stress tolerance; for enhancing resistance against fungal pathogens; anti-microbial proteins; Plant biotechnology to enhance viral resistance-pathogen derived resistance; coat protein, antisense, SiRNA and ribozyme approaches to enhance resistance for extending shelf life of fruits and flowers (ACC synthase gene and polygalacturonase).

UNIT III: Remediation and Biopesticides **(10 Lectures)**

Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation. Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation). Application of bacteria and fungi in bioremediation:

Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration, phytostabilization).

Bioinsecticides: *Bacillus thuringiensis*, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (e.g. Trichoderma, *Pseudomonas fluorescens*); Biofertilizers: Symbiotic systems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungi symbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application.

UNIT IV: Biotechnology and Biofuels (6 Lectures)

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

PRACTICALS:

1. Prepare culture media with various supplements for plant tissue culture.
2. Prepare explants for inoculation under aseptic conditions.
3. Attempt *in vitro* andro and gynogenesis in plants.
4. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG (available material).
5. Culture *Agrobacterium tumefaciens* and attempt transformation of any dicot species.
6. Generate an RAPD and ISSR profile of model plant
7. Undertake plant genomic DNA isolation by CTAB method and its quantitation by as spectrophotometeric methods.
8. Estimation of dissolved oxygen, salinity, H_2S, BOD and COD
9. Estimation of heavy metals (Cu/Cd/Pb/Hg)
10. Demonstration – estimation of pesticide residues, petroleum hydrocarbons
11. Microscopic studies of biofilm using test panels
12. Preparation of biofertilizers
13. Isolation and study the mode of infection of rhizobium.

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science. ISBN 1-57808-228-5
2. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science. ISBN 0-444- 81623-2
3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.ISBN:978-0-19-928261-6
4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons. ISBN9780470714218
5. Evans G. M and Furlong J. C. (2003), Environmental Biotechnology: Theory and Chawla, H. S. (2000). Introduction to Plant BiotechnologyApplications, Wiley Publishers. ISBN:0-470-84373- X, 0-470-84372-1
6. RitmannB. and. McCarty, P. L (2000), Environmental Biotechnology: Principle & Applications, 2nd Ed., McGraw Hill Science. ISBN: 0072345535
7. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.ISBN: 0199268673, 9780199268672

Discipline Specific Elective (DSE) Course

Master of Science in Biotechnology
M.Sc. (Biotechnology)

Discipline Specific Electives (DSE) Course

III SEMESTER

DSE1: Nano-Biotechnology

DSE2: Genomics and Proteomics

III SEMESTER

DSE: Nano-Biotechnology (19MBT34-1)

Preamble: The course is focused on introducing emerging techniques in diagnosis, treatment and drug deliver using nanoparticles. It offers basic foundation in the concepts of synthesis and types of nanostructures, their self-assembling nature and interaction with biomolecules.

Course Outcomes

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

CO1: Define the concepts in Nanotechnology
CO2: Demonstrate the applications of Nanotechnology in diagnostic and biosensors
CO3: Identity the concerns of safety and regulatory issue of nanomedicine
CO4: Illustrate the pharmaceutical preparations of nanoparticles
CO5: Practice handling nanoparticle based products

THEORY **Total Lectures: 16**

UNIT I: Principles and Perspective **(4 Lectures)**

Introduction Current medical practice - treatment methodology - Principles of nanomedicine– nanomedical perspective and the medical applications – Ethical, safety and regulatory issues of nanomedicine.

UNIT II: Molecular Nanotechnology **(4 Lectures)**

Molecular manufacturing - MEMS - NEMS - BioMEMS - protein Nano arrays - nano fluidics and micro fluidics -self-assembly of nanoparticles for biomedical applications – bacterial structures – cubosomes – dendrimers – DNA nanoparticle conjugates – Bioactive nanomaterials-Au nanoparticles and Cadmium Selenide quantum dots – molecular motors – Nanoparticle and protein interactions.

UNIT III: Biosensors and Diagnostics **(4 Lectures)**

Nanomolecular diagnostics and Biosensor Nanodiagnostics - Nanoarrays for diagnostics - detection of single DNA - self-assembled protein nanoarrays- protein nanobiochip - nanoparticles for molecular diagnostics - DNA nanomachines - Nanobiosensor - CNT biosensor- DNA nanosensor - Nanowire biosensor - application of nanodiagnostics.

UNIT IV: Applications in Pharmaceuticals **(4 Lectures)**

Nanopharmaceutical, Nanobiotechnology for drug discovery - protein and peptide based compounds for cancer and diabetes - drug delivery - nanoparticle based drug delivery - lipid nanoparticles - vaccination - cell therapy -Gene therapy. Bio-compatibility of nanomedical materials

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Nanoparticle synthesis through chemical route
2. Synthesis of Silver nanoparticles
3. Synthesis of Gold nanoparticles
4. Ferrofluid synthesis using oleic acid surfactant dissolved in kerosene
5. Preparation of thin film by Spray pyrolysis
6. Colloidal synthesis of Nanomaterials
7. Preparation of Self-Assembled Monolayers (SAM)
8. Synthesis of thin film by Sol-Gel method
9. Preparation of nanostructures by Spray pyrolyses
10. Spin coating method

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Nanomedicine, Volume I: Basic Capabilities (1999), A. Robert and Freitas Jr.; Landes Bioscience, Georgetown, TX. ISBN 1-57059-645-X.
2. Nanomedicine, Volume IIA: Biocompatibility (2003) A. Robert and Freitas Jr.; Landes Bioscience, Georgetown, TX, ISBN 1570597006, 9781570597008.
3. The Hand book of Nanomedicine, (2008) Kewal K. Jain,Humana Press, Springer. ISBN: 1493969668.
4. Nanomaterials for medical diagnosis and therapy (2007), S.S.R. ChallaKumar,Viley-VCH, ISBN: 3527313907.
5. Nano Medicines (2006), P. Diwan and A. Bharadwaj (Eds); Pentagon Press. ISBN: 8182744059.
6. The chemistry of nanomaterials: Synthesis, properties and applications (2004), C.N.R.Rao, A. Muller, A.K.Cheetham (Eds); Wiley VCH VerlagGmbh& Co, Weinheim. ISBN:3527604170.

III SEMESTER
DSE: Genomics and Proteomics (19MBT34-2)

Preamble: The objectives of this course is to provide introductory knowledge concerning genomics, proteomics and their applications. Students should be able to acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology.

Course Outcomes

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

CO1: Discuss concept and various aspects of prokaryote and eukaryote genomics.
CO2: Apprehend how genome sequencinghasrevolutionize the healthcare sector.
CO3: Create an awarnessonpharmacogenomics and role in functional genomics.
CO4: Develop knowledge on genetic tests and personalized health solutions
CO5: Perform techniques involved in genome analysis, annotation and interpretations
CO6: Updating current knowledge regarding theoretical and practical knowledge about human genome sequencing, NGS data analysis, disease pathway analysis.

THEORY **Total Lectures: 16**

UNIT I: Introduction **(3 Lectures)**

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

UNIT II: Genome Sequencing Projects **(4 Lectures)**

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

UNIT III: Proteomics **(6 Lectures)**

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

UNIT IV: Pharmacogenetics, Functional Genomics and Proteomics **(3 Lectures)**

High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development.
Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Structural proteomics.

PRACTICALS

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Human gene, protein, variant nomenclature and databases
2. Various file formats (including .vcf), databases, process, tools and pipelines (open source) for clinical and personal genome/exome analysis, annotation, and interpretation for personalized diagnosis and therapy.
3. Polygenic risk score and its implementation in disease (cancers, diabetes, obesity, CVDs, diabetes), nutrition, fitness, sports, and other health and wellness traits, adverse drug reaction (PGx) prediction
4. Use of transcriptome, epigenome, and metagenome in precision health: case studies
5. Data and text manning, scoring, used in precision systems.
6. Virtual doctor/pharmacist and decision support systems / precision health systems: components, architecture and functions
7. Artificial intelligence and big data analysis in precision medicine
8. Demonstration of eHealth systems/ expert systems and their uses in personalized healthcare decision making
9. Case studies on various aspects of personalized health: nutrition, fitness, sports etc.

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Progress and Challenges in Precision Medicine. 1st Edition (2017), M. Verma and D. Barh, Elsevier, ISBN:9780128094112
2. Clinical Genomics. 1st Edition (2014), S.Kulkarni and J.Pfeifer, Elsevier, ISBN: 9780124047488
3. Essentials of Genomic and Personalized Medicine. 1st Edition (2010), G.S. Ginsburg and H.F. Willard, Elsevier, ISBN: 9780123749345
4. Omics for Personalized Medicine. 1st Edition (2013), D.Barh.D.DhawanandN.K. Ganguly, Springer, ISBN: 9788132211846
5. Computational Exome and Genome Analysis. 1st Edition (2017), N.P.Robinson,R.M. Piro and M. Jager, Taylor and Francis, ISBN: 9781498775984
6. Genome Annotation. 1st Edition (2012), J.Soh,P.M.K. Gordon and C.W. Sensen, Taylor and Francis, ISBN 9781439841174
7. Medical Applications of Artificial Intelligence. 1st Edition (2017), A.Agah, Taylor and Francis, ISBN: 9781138072275

Generic Elective (GE) Course

Master of Science in Biotechnology
M.Sc. (Biotechnology)

GE: Generic Electives Course

I Semester

GE1: Genetics

GE2: Microbial Physiology

II Semester

GE1: Medical Genetics

GE2: Microbial Genetics

I SEMESTER
Course GE: Genetics (19MBT15-1)

Preamble: The objectives of this course are to take students through basics of genetics. The course will give an in-dept knowledge on causes and diagnosis of human genetic disorders. They will also learn the application of pedigree drawing and analysis of patterns of inheritance of genetic conditions in humans.

Course Outcomes

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

CO1: Describe the fundamental genetic inheritance patterns.
CO2: Understand and demonstrate the drawing of human pedigree charts for genetic disorders.
CO3: Develop capacity to solve quantative and qualitative data based genetic problems.

THEORY **Total Lectures: 16**

UNIT I: Mendelian Genetics Introduction to Human Genetics (8 Lectures)

Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases. Non Mendelian inheritance patterns Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of quantitative and qualitative traits

UNIT II: Cytogenetics (8 Lectures)

Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes; Molecular cytogenetics – Fluorescence In Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH). Developmental genetics Genes in early development; Maternal effect genes; Pattern formation genes; Homeotic genes; Signalling and adhesion molecules. Immunogenetics Major histocompatibility complex; Immunoglobulin genes - tissue antigen and organ transplantation; Single gene disorders of immune system.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Identification of syndromic cases based on the clinical features of Klinefelter syndrome, Down syndrome, Turner syndrome, Fragile X syndrome etc.
2. Karyotyping: Preparation of metaphase plate by using case-control blood samples.
3. Pedigree drawing using a family history of particular genetic disease.
4. Disease gene amplification using PCR and identification of polymorphisms.
5. Video based demonstration for prenatal diagnosis and gene therapy methods.
6. Genetic counselling and case study.

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1.0	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Microbial Genetics, 2nd Edition(1994) S.R. Maloy, J.E. Cronan, D. Friefelder, Jones and Bartlett Publishers ISBN 9780867202489
2. Fundamental Bacterial Genetics (2004) N. Trun and J. Trempy, Blackwell publishing, ISBN:0-632-04448-9
3. Human molecular genetics, 4rd Edition (2011) T.Strachan and A.P.Read, Wiley Bios, 4rd Edition (2010) T.Strachan and A.P.Read, Wiley Bios, ISBN 978-0-815-34149-9
4. Human genetics, 2nd Edition (1999) E.J. Mange and A.P.Mange, Sinauer Associates publications, ISBN: 0878934979, 9780878934973
5. Analysis of genes and genomes, 7th Edition(2009) L.D.Hartl and B.Jones, Jones and Bartlett Publishers. ISBN 076375868X, 9780763758684
6. Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics. 7th Edition (2018), R. ISBN 0128126841, 9780128126844
7. Pyeritz, B.Korf and W. Grody, Elsevier, ISBN: 9780128125373

I SEMESTER
Course GE: Microbial Physiology (19MBT15-2)

Preamble: The course on microbial physiology gives an in-depth study on the functioning of microorganisms. Metabolism in these life forms and cell signalling are essential to their various functions including role in disease as well as useful applications. It includes integrating biochemistry and genetics to understand the robust and diverse nature of microbial life.

Course Outcomes

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

CO1: Summarize the metabolic pathways in microorganisms
CO2: Culture microorganisms based on their specific nutritional requirements
CO3: Design experiments to grow microorganisms based on their physiology
CO4: Correlate quorum sensing with virulence, biofilm formation and antimicrobial resistance

THEORY **Total Lectures: 16**

UNIT I: **Bioenergetics** (**2 Lectures)**

Enthalpy and entropy in biological systems; electron carriers, artificial electron donors, electron transfer chain, oxidative phosphorylation ,inhibitors,anduncouplers

UNIT II: **Metabolism** (**6 Lectures)**

Photosynthesis: bacterial photosynthetic and accessory pigments; oxygenic and anoxygenic photosynthesis; autotrphic generation of ATP; Carbon fixation.
Chemolithotrophy: sulphur , iron, hydrogen and nitrogen oxidation; methanogenesis. Aerobic and anaerobic respiration in microorganisms; homo and heterolactic fermentations

UNIT III: **Microbial signalling** **(6 Lectures)**

Two component signal transduction in prokaryotes: chemotaxis, quorum sensing, biofilms , response to antimicrobials; Sporulation inducing signals and events in sporulation ; Dormancy; Osmolarityporin regulation in *E.coli* (Omp system) Phosphate assimilation in *E.coli* (Pho system), Nitrogen fixation in *Klebsiella*&*Rhizobium* (Ntr system).

UNIT IV: **Adaptations** **(2 Lectures)**

Adaptations in thermophiles, halophiles, alkaliphiles and acidophiles; Multicellular organisation in microorganisms; Extremophiles: adaptations & significance in biotechnology

PRACTICALS:

1. Demonstrating bacterial growth under aerobic, microaerophilic and anaerobic conditions
2. Bacterial utilization of glucose by oxidation or fermentation
3. Detection of cytochrome oxidase in bacteria
4. Measurement of ATP in a given bacterial suspension by bioluminescence and correlation with viable cell count

5. Isolation of photosynthetic pigments from microalgae
6. Biofilm assays:
a. Tube method
b. Microtitre plate method
c. Congo red method
7. Isolation of thermophiles, halophiles, alkaliphiles and acidophiles from different environments

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests (average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1.0	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Microbial Physiology, 4th Edition (2003) A.G.Moat,J.W.Foster and M.P.Spector, Wiley India, ISBN: 978-0-471-39483-9
2. Prescott's Microbiology, 9thedition(2014) M.J.Willey, M.L. Sherwood and J.C. Woolverton, McGraw-Hill Companies. Inc. New York. ISBN: 9780073402406
3. Brock Biology of Microorganisms, 14thedition(2014) T.M.Madigan, M.J.Martinko, S.K.Bender,H.D.Buckley,A.D.Stahl and T.Brock, Pearson Education, Inc. San Francisco. ISBN: 978-0-321-94374-3
4. Microbiology: A Laboratory Manual, 11th Edition (2017)J.G.Cappuccino and N.Sherman Pearson,USA. ISBN: 9780134098630

II SEMESTER
Course GE: Medical Genetics (19MBT24-1)

Preamble: This course is designed to developed to gain insight into human genetics. The primary focus is towards gaining knowledge on types of nuclear and mitochondrialrelated disorders in humans. The causes of congenital abnormalties and their early detection are dealth with in detail. The course will also introduce concepts of gene therapy and stem cell therapy.

Course Outcomes

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

CO1: Define the terms and concepts in Human genetics.
CO2: Demonstrate the applications of genetics in classifying the types of human genetic disorders.
CO3: Understand the concepts in mitochondrial genetic disorders.
CO4: Illustrate the chromosomal abnormalities and predict their inheritance patterns.
CO5: Awareness about the invasive and noninvasive methods of diagnosis of genetic disorders.

THEORY **Total Lectures: 16**

UNIT I: Introduction to Medical Genetics **(4 Lectures)**

Introduction to Medical genetics, human chromosomes, karyotyping, chromosome structure and function, Patterns of inheritance, Mendelian inheritance, Sex linked inheritance, Linkage and Interaction of genes, Pedigree analysis, Eugenics

UNIT II: Genetics in Medicine **(8 Lectures)**

Types of human genetic diseases (Monogenic and polygenic), new born screening, Monogenic diseases: Hemoglobinopathies, Metabolic Disorders: Disorders of amino acid metabolism (PKU, OCA), Disorders of Carbohydrate Metabolism (Galactosemia, Hereditary Fructose Intolerancetabolic disorders), Glycogen storage diseases (affecting liver and muscle), Disorders of Lipid Metabolism (FH), Lysosomal Disorders (Tay - Sachs disease), Disorders of copper metabolism (Menkes and Wilson); Polygenic diseases: Cancers: (BC, LC, GC) Metabolic: (diabetes, obesity, hypertension), Neuro: (Schizophrenia, and Alzheimer's) mtDNAdisease:Kearns-Sayre syndrome, Pearson's syndrome, and progressive external ophthalmoplegia, MELAS syndrome, Leber's hereditary optic neuropathy, Defects in nuclear genes leading to dysfunction of mitochondrial proteins (Friedreich's ataxia)

UNIT III: Chromosomal Disorders **(2 Lectures)**

Congenital abnormalities and dysmorphic syndromes: classification and causes, Genetic disorders of chromosomal abnormalities: Numerical (Down's syndrome, Fragile-X syndrome, Edward's syndrome), Microdeletions (DiGeorge Syndrome, Prader Willi and Angelman Syndrome)

UNIT IV: Diagnosis and Management of Genetic Diseases (2 Lectures)

Prenatal and postnatal diagnosis, techniques used (invasive, noninvasive), Non-Invasive Prenatal Testing, genetic test and DTC, Genetic counseling, treatment of genetic diseases (Conventional approaches), Gene therapy, Stem cell therapy, personalized medicine.

PRACTICALS

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Identification of syndromic cases based on the clinical features of Klinefelter syndrome,Down syndrome, Turner syndrome, Fragile X syndrome etc.
2. Karyotyping: Preparation of metaphase plate by using case-control blood samples.
3. Pedigree drawing using a family history of particular genetic disease.
4. Disease gene amplification using PCR and identification of polymorphisms.
5. Video based demonstration for prenatal diagnosis and gene therapy methods.
6. Genetic counselling and case study.

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1.0	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Emery's elements of medical genetics. 14th Edition (2012), P.D. Turnpenny and S. Ellard, Churchill Livingstone, ISBN: 9780702056291
2. Medical genetics at a glance. 3rd Edition (2013), D.J. Pritchard and B.R. Korf, Willey-Blackwell, ISBN: 9780470656549
3. Medical Genetics. 5th Edition (2015), L. Jorde. J. Carey and M Bamshad, Elsevier, ISBN: 9780323188357
4. Emery's Elements of Medical Genetics. 15th Edition (2017), P. Turnpenny, and S. Ellard, Elsevier, ISBN: 9780702066856
5. Human Molecular Genetics. 4th edition (2010), T. Strachan and Andrew. Garland Science, ISBN 9780815341499
6. Practical Genetic Counselling. 7th Edition (2010), P. S. Harper, Taylor and Francis, ISBN: 9780340990698
7. Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics. 7th Edition (2018), R. Pyeritz, B.Korf and W. Grody, Elsevier, ISBN: 9780128125373

II SEMESTER
Course GE: Microbial Genetics (19MBT24-2)

Preamble: The objectives of this course are to take students through basics of microbial genetics. The course will give an in-dept knowledge on bacterial and phage genetics. It also introduces the students to concepts of natural and induced mutations and recombination in microbes.

Course Outcomes

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

CO1: Describe the fundamental concept of genetics in prokaryotes.
CO2: Understand and demonstrate the natural and induced mutation concepts in prokaryotic system.
CO3: Develop the capacity to understand basic inheritance patterns in eukaryotic model system of yeast.

THEORY **Total Lectures: 16**

UNIT I: Genetics of Bacteria and Bacteriophages (6 Lectures)

Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene.Genetic

UNIT II: Mutations and Recombination (4 Lectures)

Mutations – spontaneous and induced, base pair changes, frame shifts, deletions, inversions, tandem duplications, insertions. Mutagens - Physical and Chemical mutagens. Outlines of DNA damage and repair mechanisms. Genetic recombination in bacteria – Conjugation, Transformation and Transduction

UNIT III: Yeast Genetics (6 Lectures)

Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.

PRACTICALS:

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Isolation of genomic DNA and plasmid DNA from bacteria
2. Inducing mutations in bacterial systems using chemicals / physical agents
3. Screening of auxotrophic mutants
4. Generation and screeninf of antibiotic resistant mutants
5. Transformation of DNA in bacterial system
6. Demonstration of conjugation
7. Transdution
   a. Specialized transduction using Lambda phage
   b. Generalized transduction

Continuous Internal Evaluation (CIE)- Theory

Sl. No.	Component	Marks	Weight	IA Marks
1	Sessional tests			
	Two Written tests(average of two)	20		
	Total	20	0.5	10
2	Continuous assessment			
	Seminars/Assignments	05		
	Regularity and Punctuality	05		
	Total	10	1.0	10
Total CIE marks (Theory)				**20**

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals	05
2	Record maintenance and neatness	05
Total CIE marks		**10**

Semester End Evaluation (SEE)

1. Theory Paper

Type of question	No. of questions to be set	No. of questions to be answered	Marks per question	Total
Answer in Detail	2	1	10	10
Answer in Brief	7	5	5	25
Short Answers	5	5	3	15
Total marks				**50***

*Duration of examination: 3 hours

2. Practical Paper

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	8	8
Minor Experiment	1	4	4
Spotters	3	1	3
Viva voce	-	5	5
Total marks			**20***

*Duration of examination: 4 hours

SUGGESTED READING (Latest Editions):

1. Microbial Genetics, 2nd Edition(1994) S.R. Maloy, J.E. Cronan, D. Friefelder, Jones and Bartlett Publishers. ISBN 9780867202489
2. Fundamental Bacterial Genetics (2004) N. Trun and J. Trempy, Blackwell publishing. ISBN: 9780702066856
3. Genetics: Principles and Analysis 7^{th} edition (2009) D. L.Hartl and E. W. Jones: Jones and Bartlett. ISBN076375868X, 9780763758684
4. Genetics: a Conceptual Approach. (2013) B. A. Pierce, New York: W.H. Freeman. ISBN: 1464150842, 9781464150845
5. Principles of Genetics ,7^{th} Editions (1991) R. H.Tamarin and R. W. Leavitt, Tata Mc Graw Hill Edition. ISBN: 0071243208, 9780071243209

Skill Enhancement Course (SEC)

Master of Science in Biotechnology
M.Sc. (Biotechnology)

Skill Enhancement Course (SEC)

II Semester

SEC1: Analytical Techniques in Biotechnology

SEC2: Molecular Diagnostics

II SEMESTER

Course SEC: Analytical Techniques in Biotechnology (19MBT25-1)

Preamble: The course aims to give the student a detailed view of newly developed principles and methods of biotechnology. The course provides a basic and technical understanding of the biotechnological methods such as biochemical techniques, PCR, hybridizations, immunoassays, blotting and DNA fingerprinting. The course stresses a novel approach to the study the basic techniques there by imparting to the students the concept of integrative approach.

Course Outcomes

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

CO1: Explain the principles of various biochemical, immunological and molecular based techniques

CO2: Perform laboratory techniques such as biochemical assays, spectrophotometry, gel electrophoresis, blotting and PCR.

CO3: Appraise the role of modern biotechniques in addressing issues in health,biomedical research, and product development.

Number of sessions: **16 (Each session has 6 hours)**

UNIT I: . Preparing Various Stock Solutions and Working Solutions **(1 Session)**

Laboratory 1: To prepare an Acetic-Na Acetate Buffer and validate the Henderson-Hasselbach equation.

UNIT II: Spectrophotometry: **(1 Session)**

Laboratory 2: To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.

UNIT III: Chromatography: **(1 Session)**

Laboratory 3: Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by thin layer chromatography

UNIT IV: Separation Techniques: **(3 Session)**

Laboratory 4: Separation of cell organelles using gradient centrifuging techniques

Laboratory 5: Horizontal gel electrophoresis of DNA

Laboratory 6: Vertical gel electrophoresis of proteins

UNIT V: Immunological Techniques: **(1 Session)**

Laboratory 7: Immunochromatographic assay, Enzyme-linked immunosorbent assay

UNIT VI: Blotting Techniques: (3 Sessions)

Laboratory 8: *In-situ* hybridization

Laboratory 9: Western blotting

Laboratory 10: Southern blotting

UNIT VII: Nucleic Acid Based Techniques (4 Sessions)

Laboratory 11: DNA extraction, purification and quantification from blood / bacteria /plant sample

Laboratory 12: Conventional PCR

Laboratory 13: Real time PCR quantification,

Laboratory 14: Loop-mediated isothermal amplification assay

UNIT VIII: Cloning Techniques (2 Sessions)

Laboratory 15: Restriction digestion and ligation

Laboratory 16: Transformation

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals, timely submission of records,	10
2	Record maintenance and neatness	10
3	Internal practical evaluation	10
Total CIE marks		**30***

*Duration of examination: 4 hours

Semester End Evaluation (SEE)- Practical

Type of question	No. of questions	Marks per question	Total
Major Experiment	1	30	30
Minor Experiment	1	20	20
Spotters	5	1	05
Viva voce	-	15	15
Total marks			**70***

*Duration of examination: 6 hours

SUGGESTED READING (Latest Editions):

1. Cappuccino, J. G., & Welsh, C. (2016). Microbiology: a Laboratory Manual. Benjamin-Cummings Publishing Company. ISBN: 978-0321840226.
2. Molecular Diagnostics: Current Research and Applications (2014), T, J. Hugget and O' Grady, J. Caister Academic Press. ISBN: 9781908230645
3. Molecular Cloning: A Laboratory Manual, 4th edition (2014), R. G. Michael, Cold Spring Harbor Laboratory Press, ISBN: 978-1-93611

II SEMESTER
Course SEC: Molecular Diagnostics (19MBT25-2)

Preamble: The course aims to give the student a detailed view of newly developed biotechnical principles and methods of diagnosis. The course provides a basic and technical understanding of the diagnostics methods such as microscopis techniques, PCR, hybridizations, immunoassays, blotting and DNA fingerprinting. The course stresses a novel approach to the study within its social context and imparts onto students the concept of integrative approach.

Course Outcomes

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

CO1: Explain the principles of various immunological and molecular based techniques
CO2: Perform laboratory techniques involed in molecular diagnosis
CO3: Appraise the role of modern molecular techniques in addressing issues in health,research, and product development.

Number of sessions: 16 (Each session has 6 hours)

UNIT I: Microscopic Techniques for Microbial Identification (4 sessions)

Laboratory 1:Fixation of smears for microscopy by different methods and Simple staining techniques
Laboratory 2:Differential staining techniques: Gram's staining and ZiehlNeelson staining
Laboratory 3:Special staining methods to detect granules,endospore and capsules

UNIT II: Immunological Techniques (6 sessions)

Laboratory 4: Pecipitationmethods :Immunodiffufionandimmunoelectrophoresis
Laboratory 5: Agglutionation methods: Widal and Haemagglutination
Laboratory 6: Enzyme-linked immunosorbent assay
Laboratory 7: Colony hybridization
Laboratory 8: Western blotting

UNIT III: Nucleic Acid Based Techniques (6 sessions)

Laboratory 9: PCR for detection of pathogens/virulence genes/ resistance genes
Laboratory10 : Real time PCR quantification
Laboratory 11: Loop-mediated isothermal amplification assay
Laboratory 12: DNA fingerprinting techniques to determine genetic diversity in microorganisms

Continuous Internal Evaluation (CIE)- Practical

Sl. No.	Component	IA Marks
1	Involvement in practicals, timely submission of records,	10
2	Record maintenance and neatness	10
3	Internal practical evaluation	10
Total CIE marks		**30***

*Duration of examination: 4 hours

Semester End Evaluation (SEE)- Practical

Type of question	No.of questions	Marks per question	Total
Major Experiment	1	30	30
Minor Experiment	1	20	20
Spotters	5	1	05
Viva voce	-	15	15
Total marks			**70***

*Duration of examination: 6 hours

SUGGESTED READING (Latest Editions):

1. Basic Microbiology: An Illustrated Laboratory Manural, (2013), B. K.Khuntia,Daya PublishingHouse, ISBN: 978-81-7035-683-7
2. Molecular Diagnostics: Current Research and Applications (2014), T, J.Hugget and O'Grady, J. Caister Academic Press. ISBN: 9781908230645
3. Molecular Cloning: A Laboratory Manual, 4th edition (2014), R. G.Michael, Cold Spring Harbor Laboratory Press, ISBN: 978-1-93611