CMS COLLEGE KOTTAYAM
(AUTONOMOUS)

Affiliated to the Mahatma Gandhi University
Kottayam, Kerala

CURRICULUM FOR POST GRADUATE PROGRAMME

MASTER OF SCIENCE IN BIOTECHNOLOGY

UNDER CREDIT AND SEMESTER SYSTEM (CSS)
(With effect from 2019 Admissions)

Approved by the Board of Studies on 24th April 2019

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ACKNOWLEDGEMENTS

The biotechnology sector in India is extremely innovative and on the rise. Next few years are bound to see exponential growth in this sector. The Board of Studies in Biotechnology, CMS College, Kottayam, had the pleasant but hard task of redesigning the curriculum of the M.Sc. Biotechnology program, after the College became autonomous in 2016. A meticulous and structured approach has been adopted to accomplish the Course Curriculum Revision exercise. Several experts in the field of Biotechnology at various levels in higher education and research as well as the entire faculty of the Department were deeply involved in this task.

On behalf of the Department of Biotechnology, I wish to place on record our thanks to the Principal, Dr. Roy Sam Daniel and the Vice Principal Dr. Mini Chacko for their support and encouragement all through.

Dr. A. Jayakumaran Nair, Head, Department of Biotechnology, University of Kerala and Dr. K. Jayachandran, Associate Professor, School of Biosciences, M. G. University, Subject Expert in the Board of Studies, were constant source of inspiration and support. We wish to thank them for the meticulous care with which they approached the entire curriculum redesigning work with us, always taking care to see that the redesigned curriculum is as perfect as possible. We wish to thank him for his earnest efforts and good will.

Dr. Bindu Roy, Scientist, Germplasm Division, Rubber Research Institute of India attended most of the meetings of the BoS and helped in the redesigning of the curriculum in a meaningful manner. We place on record, our gratefulness to her.

I wish to express my sincere gratitude to the other board members - Dr. Jinu John and Mr. Renji Varghese, Dr. Smitha S, Mrs. Prisho Mariam Paul, Ms. Ashalakshmi, Dr. Vishnu Kannan, Dr. Linu Kuruvila, Dr. Sheena Devasia and Mr. Kiran George Koshy for their valuable contributions towards the designing of the curriculum. We do acknowledge the motivation and encouragement from Prof. Dr. Joseph P. Varghese and Prof. John Varghese towards the development of our PG curriculum.

It is our hope that the present redesigned curriculum for the Post graduate program in Biotechnology will enable the students to discover the immense possibilities for research or employment in various areas in modern Biotechnology.Let me thank all who were involved in this curriculum designing effort with us.

Dr. Unnikrishnan N
Chairman
Board of Studies

24.04.2019
Kottayam

PREFACE

Biotechnology at the core envisages the comprehensive study of Life and the interdisciplinary potential of Biotechnology has led to a unique status for it in Research and Industry. The applied aspect of Biotechnology is now getting established with its applications in Industry, Agriculture, Health and Environment. Biotechnology sector in Research and Industry is expanding which is set to augur the next major revolution in the world. Academic and Research Sectors also require interdisciplinary trained manpower to further the Biotechnology Revolution.

The need of the hour is to design an appropriate syllabus which keeps pace with changing times and technology with emphasis on applications while elucidating technology in depth. The present Syllabus is restructured anticipating the future needs of Biotechnology Sector with more emphasis on imparting hands-on skills. The curriculum aims to impart basic knowledge with emphasis on its applications to make the students industry ready.

Taking into cognizance the changing needs of the age and to keep abreast with latest developments in the field of biotechnology, CMS College Kottayam proactively initiated revision of course curricula of Post-Graduate Program in Biotechnology. The present exercise has been undertaken by Biotech Board of Studies (BBS), CMS College Kottayam.

A meticulous and structured approach has been adopted to accomplish the Course Curriculum Revision exercise. BBS had initiated the exercise with a review of documents on curriculum design and planning for biotechnology programmes of premier national as well as international universities, guidelines by UGC, DBT, ICMR and Indian Institute of Science Education & Research. Feedback was received from subject experts and students belonging to academic institutions, research organizations and industry regarding addition of advanced topics, deletion of elementary, redundant and overlapping topics, updation of laboratory practical etc. The members of Board of studies agreed that revised course curriculum should provide skill and outcome based education and help the students to gain domain knowledge, ability to design and interpret research experiments and acquire effective communication skills.

We wish to put on record of our sincere appreciation for constant guidance and encouragement received from Dr. Jayachandran K, M.G. University, Dr. A. Jayakumaran Nair, University of Kerala and Dr. Bindu Roy, Rubber Research Institute of India, for bringing out this syllabus. We wish to acknowledge the whole-hearted support of the members of the Board of Studies in this revision.

REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM 2019

Preamble

CMS College Kottayam (Autonomous) was conferred with the Autonomous status as per UGC No.F.22-1/2016(AC) Dtd. 9th March 2016 and Mahatma Gandhi U.O.No.2732/VII/2016/Acad. Dtd.12th May 2016.

REGULATIONS

CMS College Kottayam (Autonomous) follows Credit Semester System (CSS) for the Post Graduate programmes from the Academic year 2019-20. The Post Graduate programmes of the college are being redesigned and revised in tune with the modifications effected at the UGC Curriculum Framework. This will be reflected in the scheme, course content and mode of examination and Evaluation system. The scheme and syllabus of all the programmes are being revised accordingly. The revisions were effected based on the recommendations made at the Curriculum Revision workshops conducted for the purpose besides several sittings of the Curriculum Revision Committee.

1. TITLE

1.1. These regulations shall be called **"CMS COLLEGE KOTTAYAM (AUTONOMOUS) REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT AND SEMESTER SYSTEM 2019"**

2. SCOPE

2.1 Applicable to all regular Postgraduate Programmes conducted by the CMS College Kottayam (Autonomous) with effect from 2019 admissions.

2.2 Medium of instruction is English unless otherwise stated therein.

3. DEFINITIONS

3.1. **Academic Week** is a unit of five working days in which the distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day.

3.2. **Semester** means a term consisting of **90** working days, within **18** five-day academic weeks for teaching, learning and evaluation.

3.3. **Programme** means a two year programme of study and examinations, spread over four semesters, with a set of courses, the successful completion of which would lead to the award of a degree.

3.4. **Course** comprises a set of classes or a plan of study on a particular subject which will be taught and evaluated within a semester of a study programme.

3.5. **Core course** means a course which should compulsorily be studied by a student as requirement in the subject of specialization within a degree programme.

3.6. **Elective Course** means an elective course chosen from the discipline/ subject, in an advanced area.

3.7. **Credit** is the numerical value assigned to a course according to the duration of the classes or volume of the syllabus of the course**.**

3.8. **Department** means any teaching department in the college.

3.9. **Dean of Academic Affairs** is a teacher nominated by the Academic Council to coordinate the academic affairs of the college relating to academic planning, curriculum implementation and review.

3.10. **Dean of Student Affairs** is a teacher nominated by the Academic Council to coordinate the admissions, grievances and other student related services.

3.11. **Department Council** means the body of all teachers of a department in the college.

3.12. **Department Coordinator** is a teacher nominated by a Department Council to co-ordinate the ^{In}-Semester examination of the PG programme in that department.

3.13. **Faculty Advisor** means a teacher from the parent department nominated by the Department Council, who will advise the students of a class on academic matters.

3.14. **Course Teacher** means a teacher who is in charge of a course. If a course is taught by more than one teacher, one teacher should be assigned as course teacher, nominated by the HOD. The course teacher shall be responsible for the valuation of answer scripts of examinations and other continuous assessments.

3.15. **In-Semester Assessment (ISA)** means assessment consisting of Attendance, Assignment/Seminar/Viva voce and Examination (theory and practical).

3.16. **End Semester Assessment (ESA)** means Examination conducted at the end of each semester for all courses (theory and practical).

3.17. **Internal Examiner** means a teacher working in the college.

3.18. **External Examiner** means a teacher from outside the college.

3.19. **Grace Marks** shall be awarded to candidates as per the orders issued by Mahatma Gandhi University.

3.20. **Grade** means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a Course/ Semester/Programme.

3.21. **Grade Point** (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.22. **College Average (CA)** means average mark secured (ISA+ESA) for a course at the college level.

3.23. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the University, UGC Regulations and the Constitution of the CMS College Kottayam (Autonomous).

4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

Eligibility for admission, norms for admission and reservation of seats for various Postgraduate Programmes shall be according to the regulations framed/orders issued by Govt. of Kerala, Mahatma Gandhi University and CMS College Kottayam in this regard.

5. PROGRAMME STRUCTURE

5.1 The nomenclature of all PG programmes shall be as per the specifications of University Grants Commission and the Mahatma Gandhi University.

5.2 Credit Semester System (CSS) will be followed for all PG Programmes from the academic year 2019– 2020.

5.3 All the PG Programmes will be of two-year duration with four Semesters. A student may be permitted to complete the Programme, on valid reasons, within a period of 8 continuous semesters from the date of commencement of the first semester of the programme.

5.4 There will be three/four/five courses in each semester and one viva voce and dissertation at the end of the fourth semester.

5.5 There will be three components for the programme viz. core course, elective course and project spread over four semesters.

5.6 The total credits required for completing a PG Programme is **80**.

5.7 The Syllabus for all courses in each semester has been divided into five modules based on certain thematic commonalities.

6. EVALUATION SYSTEM

i. The evaluation scheme for each course shall contain two parts:
(a) In-Semester Assessment (ISA)
(b) End-Semester Assessment (ESA)

ii. The proportion of ISA to ESA will be 1:3.

iii. The marks secured for each course shall be converted as grades. The grades for different semesters and overall programme are assigned based on the corresponding semester grade point average and cumulative grade point average respectively.

iv. A separate minimum of 40% is mandatory for both ISA and ESA to pass for every course.

6.1 EVALUATION OF THEORY COURSES

The marks allotted for theory courses in End-Semester Assessment shall be 120 and that for the In-Semester Assessment will be 40.

A. IN-SEMESTER ASSESSMENT

The In-semester assessment for theory is based on the marks obtained for Attendance, Assignment, Major Seminar and two Test Papers for a particular course.

(i) Attendance

Percentage of attendance	Mark
90 and above	6
85 - 89	5
80 - 84	4
76 - 79	3
75	2
Below 75	0

Maximum marks = 6

(ii) Assignment (One assignment per course)

Evaluation Component	Mark
Review of related literature	2
Content	3
Reference	2
Punctuality	1

Maximum marks = 8

(iii) Major Seminar

A student should present one Major Seminar in a Semester. The faculty advisor should allot students to the respective course teacher in a semester. The seminar topics shall be incorporated in the syllabus for each course/ declared in the beginning of each semester. The student shall prepare the seminar paper with the guidance of the course teacher. The student is expected to make a detailed presentation in a common session in the department, with students and all course teachers. The student shall also make a brief conclusion including the future scope of studying the topic. The teacher in charge of the particular course has to act as the moderator for the seminar.

The course teachers of that semester shall evaluate the seminar and give marks for their course or the average mark of all the evaluators shall be taken as the seminar mark for each course of a semester.

Evaluation Component	Mark
Involvement/punctuality	1
Review of related literature	1
Content	3
Presentation	3
Interactions/ justification	1
Conclusion	1

Maximum marks = 10

(iv) Test paper

For each course, two In-Semester examinations of total 16 marks shall be conducted. One of the test paper will be centralized examination of 8 marks and the remaining 8 marks will be awarded with one or more class tests conducted by the course teacher.

B. END -SEMESTER ASSESSMENT

End-Semester examinations for each course are conducted at the end of every semester with a maximum marks of 120. The examination for each course will have two components viz., descriptive test and an objective type test. Questions shall be set to evaluate the attainment of course outcomes. The question paper for each course will be generated from the Question Bank which is prepared by due mapping of Course outcomes and Program Specific Outcomes.

(i) Descriptive Test

A written examination with a maximum marks of 100 and of three hours duration will be conducted.

PATTERN OF QUESTIONS

A question paper shall be a judicious mix of short answer type, short essay/problem solving type and long essay type questions.

No.	Section	Type of questions	Total Questions	Number of questions to be answered	Mark for each question	Total Marks
1	Section A	Short answer type	8	5	4	20
2	Section B (One pair should be from each module)	Short essay/problem solving type	10 (Either/or)	5	8	40
3	Section C	Long essay type	4	2	20	40
	Total		**22**	**12**	**-**	**100**

(ii) Objective Test

A Multiple Choice Objective type Test shall be a component of the End-semester examination which will be conducted in the online mode for each course. The marks obtained shall be converted into 20. The objective type examination for all courses in a semester shall be conducted in a session of one hour. The number of questions in Arts stream will be 50 and that of Science and Mathematics stream will be 40.Questions should be equally distributed among the courses in a semester. There will be four choices for each question. Each question carries 4 marks for correct answer, zero marks for no answer and -1 marks for wrong answer.

6.2 EVALUATION OF PRACTICAL COURSES

Practical examination will be conducted at the end of each semester/ end of an academic year. The time of conduct of the practical examination will be decided by the respective BOS.

A. **IN-SEMESTER ASSESSMENT**

Evaluation Component	Mark
Attendance	6
Lab Involvement	8
Test	12
Record	8
Viva	6

Maximum Marks = 40

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. **END- SEMESTER ASSESSMENT**

Evaluation Component	Mark
Attendance	18
Lab Involvement	24
Test	36
Record	24
Viva	18

Maximum Marks = 120

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.3 EVALUATION OF PROJECT

An academic project work shall be done and a dissertation shall be submitted in the final semester of the programme. There will be both In semester and End semester assessment for the project work.

A. **IN- SEMESTER ASSESSMENT**

Evaluation Component	Mark
Relevance of the topic	5
Project content and report	15
Presentation	15
Project viva	10
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	5

Maximum marks = 50

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. **END -SEMESTER ASSESSMENT**

The dissertation at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	Mark
Relevance of the topic	15
Project content and report	45
Presentation	45
Project viva	30
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be sub mitted)	15

Maximum marks = 150

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.4 EVALUATION OF COMPREHENSIVE VIVA VOCE

A comprehensive viva voce shall be done at the end of the final semester. There will be both In-semester and End-semester assessment for the viva voce examination.

A. IN - SEMESTER ASSESSMENT

Evaluation Component	Mark
+2/ UG level questions	4
PG syllabus level questions	10
Subject of interest based questions	8
Advanced level questions	3

Maximum marks = 25

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END- SEMESTER ASSESSMENT

The comprehensive Viva Voce Examination at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	Mark
+2/ UG level questions	12
PG syllabus level questions	30
Subject of interest based questions	24
Advanced level questions	9

Maximum marks = 75

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

7. Grievance Redressal Mechanism

In order to address the grievance of students regarding In-Semester assessment, a two-level Grievance Redressal mechanism is established.

Level 1: Department Level: The Department cell is chaired by the HOD, Department Coordinator as member secretary and Course teacher in-charge as member. If the grievance is not redressed at the Department level, the student shall report the grievance to the College Level Grievance Redressal Cell.

Level 2: **College level**: College Level Grievance Redressal Cell has the Vice-Principal as the Chairman, Dean of Student Affairs as the Member Secretary and HOD of concerned Department as member.

8. Eligibility for End Semester Examination

A minimum of 75% average attendance for all the courses is mandatory to register for the examination. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the College on valid grounds. Attendance may be granted to students attending University/College union/Co-curricular activities for the days of absence, on production of participation/attendance certificates, within one week, from the teacher in charge of the activity and endorsed by the Dean of Student Affairs. This is limited to a maximum of 10 days per semester. Monthly Attendance report will be published in the college website on or before the 10^{th} of every month. Those students who are not eligible even with condonation of shortage of attendance shall repeat the semester along with the next batch after obtaining readmission.

9. Promotion to the next Semester

Those students who possess the required minimum attendance and have registered for the End Semester Examination during an academic semester are promoted to the next semester.

Those students who possess the required minimum attendance and progress during an academic semester and could not register for the semester examination are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next semester.

10. Eligibility for Readmissions

An additional chance of readmission will be given to those students who could not register for the examination due to shortage of attendance. Readmitted students shall continue their studies with the subsequent batch of students. If an applicant for readmission is found to have indulged in ragging or any other misconduct in the past, readmissions shall be denied.

11. MARK CUM GRADE CARD

The College under its seal shall issue to the student a MARK CUM GRADE CARD on completion of each semester/programme, which shall contain the following information:

(a) Name of the College
(b) Title of the Postgraduate Programme
(c) Name of the Semester
(d) Name and Register Number of the student
(e) Date of publication of result
(f) Code, Title, Credits and Maximum Marks (ISA, ESA & Total) of each course opted in the semester.
(g) ISA, ESA and Total Marks awarded, Grade, Grade point and Credit point in each course opted in the semester
(h) College average (CA) of the marks of all courses
(i) The total credits, total marks (Maximum & Awarded) and total credit points in the semester
(j) Semester Grade Point Average (SGPA) and corresponding Grade.
(k) Cumulative Grade Point Average (CGPA) and corresponding Grade.

The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the study programme and the overall mark/grade for the total programme.

There shall be a College Level Monitoring Committee comprising Principal, Vice Principal as member-secretary, Dean of Academic Affairs, Controller of

Examinations, IQAC Director and Administrative Assistant as members for the successful conduct of the scheme.

12. CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a course is calculated using the formula:-
CP = C × GP, where C is the Credit and GP is the Grade point

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula:-
SGPA = TCP/TC, where TCP is the Total Credit Point of that semester, ie, $\sum_1^n$ CPi*;*
TC is the Total Credit of that semesterie, $\sum_1^n$ Ci*, where n is the number of courses in that semester*

Cumulative Grade Point Average (CGPA) is calculated using the formula:-
CGPA = TCP/TC, where TCP is the Total Credit Point of that programmeie, $\sum_1^n$ CPi*;*
TC is the Total Credit of that programme, ie, $\sum_1^n$ Ci *, where n is the number of courses in that programme*

Grades for the different courses, semesters and overall programme are given based on the corresponding CPA as shown below:

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

13. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of six months from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

The Principal is also authorized to issue orders for the perfect realization of the regulations.

Annexure I

(Model Mark Cum Grade Card)

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Affiliated to Mahatma Gandhi University Kottayam

(Autonomous College as per UGC order no.F.22-1/216(AC)dated 9th March 2016)

MARK CUM GRADE CARD

Section :

Name of the Candidate :

Unique Permanent Registration Number :

Degree :

Programme :

Stream :

Name of the Examination :

Date of Publication of Result :

Course Code	Course Title	Credits (c)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (C x	College Average	Result
			ISA		ESA		TOTAL						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

ISA - In - Semester Assessment, ESA – End - Semester Assessment

SGPA: **SG:**

Checked by **Section Officer** **Controller of Examinations**

Date:

Annexure II

CMS COLLEGE KOTTAYAM (AUTONOMOUS)
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Affiliated to Mahatma Gandhi University Kottayam, Kerala
(Autonomous College as per UGC Order No.F.22-1/216 (AC) dated 9th March 2016)

CONSOLIDATED MARK CUM GRADE CARD

PHOTO

Name of the Candidate:

Unique Permanent Register Number (UPRN):

Degree:

Programme:

Stream:

Date of Birth:

Date of Eligibility for the Degree:

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Name: UPRN:

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (CxGP)	College Average (CA)	Result
			ESA		ISA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

Final Result

Cumulative Grade Point Average CGPA :

Semester Summary

Sl.No	Semester	Credit	SGPA	Grade	Month/year	Result
	Semester 1 Semester 2 Semester 3 Semester 4					

Date: **Controller of Examinations**

Annexure III

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

(Reverse side of the Mark cum Grade Card (COMMON TO ALL SEMESTERS))

Description of the Evaluation Process

Grade and Grade Point

The Evaluation of each Course comprises of Internal and External Components in the ratio 1:3 for all Courses.

Grades and Grade Points are given based on the percentage of Total Marks (Internal + External) as given in Table 1 (Decimals are to be rounded mathematically to the nearest whole number)

Credit point and Credit point average

Grades for the different Semesters and overall Programme are given on a 7-point Scale based on the corresponding CPA, as shown in Table 2.

Table 1

% Marks	Grade	GP
Equal to 88 and above	A+ Outstanding	5
Equal to 76 and < 88	A Excellent	4
Equal to64 and < 76	B+ Very Good	3
Equal to 52 and < 64	B Good(Average)	2
Equal to 40 and below 52	C Marginal	1
Below 40	D Deficient (Fail)	0
	Ab Absent	

Table 2

CPA	Grade with r
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

Credit point (**CP**) of a paper is calculated using the formula $\boldsymbol{CP = C \times GP}$**,where C is the Credit; GP is the Grade Point**

Semester or Programme (cumulative) Grade Point Average of a Course/Programme is calculated using the formula

SGPA/CGPA = $\frac{\boldsymbol{TCP}}{\boldsymbol{TC}}$**, where TCP is the Total Credit Point; TC is the Total Credit**

NOTE

A separate minimum of 40% marks each for internal and external (for both theory and practical) are required for a pass for a course. For a pass in a programme, a separate minimum of **Grade C** is required for all the individual courses. If a candidate secures **D Grade** for any one of the course offered in a Semester/Programme **only D grade** will be awarded for that Semester/Programme until he/she improves this to **C GRADE** or above within the permitted period.

CURRICULUM

GRADUATE PROGRAMME OUTCOMES (GPO) – POST GRADUATE PROGRAMMES

At the completion of the Post Graduate Programme, the student will be able to accomplish the following programme outcomes.

GPO No.	Graduate Programme Outcomes
GPO.1	**Critical Thinking**: Ability to engage in independent and reflective thinking in order to understand logic connections between ideas.
GPO.2	**Effective Communication:** Development of communication skills for effectively transmitting and receiving information that focuses on acquiring knowledge, problem solving, improving on arguments and theories thereby paving the way for better employability and entrepreneurship.
GPO.3	**Social Consciousness:** Acquire awareness towards gender, environment, sustainability, human values and professional ethics and understand the difference between acting, responding and reacting to various social issues.
GPO.4	**Multidisciplinary Approach:** Combining various academic disciplines and professional specializations to cross borders and redefine problems in order to explore solutions based on the new understanding of complex situations.
GPO.5	**Subject Knowledge:** Acquiring knowledge at a higher level that would help develop the necessary skills, fuel the desire to learn and contribute to the field of expertise thereby providing valuable insights into learning and professional networking with the aim of catering to the local, national and global developmental needs.
GPO.6	**Lifelong Learning**: Understanding the necessity of being a lifelong learner for personal enrichment, professional advancement and effective participation in social and political life in a rapidly changing world.

PROGRAMME SPECIFIC OUTCOMES

PSO No.	*Upon completion of the two year M.Sc. Biotechnology program, the student will be able to:*	GPO No.
1	Recall the fundamentals of Biotechnology, Microbiology, Bioinformatics, Immunology and Biochemistry which would enable them to comprehend the emerging and advanced engineering concepts of life sciences.	1
2	Demonstrate proficiency in basic laboratory skills common to research laboratories, including aseptic technique, operating current instrumentation, preparing samples for various analyses, and maintaining a proper scientific laboratory notebook.	4, 5
3	Identify the importance of bioethics, IPR and entrepreneurship so as to usher in the next generation of Indian Industrialists	3,5
4	Evaluate the need and impact of scientific solutions on the environment and the society, keeping in view of their sustainable development.	3
5	Explain and properly apply the scientific method by developing valid hypotheses, designing experiments, gathering relevant data using current technology, and interpreting quantitative and qualitative data.	4, 5
6	Prepare written and oral scientific communications that use tables and graphs to report results, that describe detailed experimental procedures, and that clearly explain conclusions.	1, 2
7	Understand the foundational concepts of biotechnology, and how these impact research and development in the diverse fields that span healthcare, agriculture and environmental sustainability.	3,5
8	Propose the technological knowhow in domains of biotechnology for their applications in industry and research.	1,5
9	Recognize the need and have the ability to engage in independent and life-long learning in the broadest context of technological change, there by exhibit growth in personal and professional responsibility.	6

PROGRAMME DESIGN

The Post graduate programme in Biotechnology is a two year programme of four semesters. There are four components for the programme namely, the core course, elective course, practical courses and the project spread over four semesters. There are four theory courses and one practical course in each semester, one dissertation towards the end of the course and a comprehensive viva at the end of the fourth semester. The last four courses in the fourth semester are Elective courses by choice. The total credits for completing a PG programme is 80.

The Course Design is given below:

Sl No	**Course Type**	**No of courses**	**Total credits**
1.	Core courses	12	45
2.	Elective courses	4	12
3.	Practical courses	4	16
3	Viva voce	1	3
4.	Dissertation	1	4
	TOTAL	**22**	**80**

PROGRAMME STRUCTURE

Sem	S.No.	Course Code	Course Name	Course Type	Credits	Hrs/ week
I	1	BT1921101	Biochemistry I- Biomolecules	Core – Theory	4	4
	2	BT1921102	Cell Biology and Genetics	Core – Theory	4	4
	3	BT1921103	Biophysics and Instrumentation	Core – Theory	3	3
	4	BT1921104	Microbiology	Core – Theory	4	4
	5	BT1921601	Laboratory Course 1	Core-Practical	4	10
II	6	BT1922105	Molecular Biology	Core – Theory	4	4
	7	BT1922106	Immunology and Immunotechnology	Core – Theory	4	4
	8	BT1922107	Bioinformatics and Biostatistics	Core – Theory	4	4
	9	BT1922108	Biochemistry II- Metabolism and Enzymology	Core – Theory	3	3
	10	BT1922602	Laboratory Course 2	Core-Practical	4	10
III	11	BT1923109	Bioprocess Technology	Core – Theory	4	4
	12	BT1923110	Recombinant DNA technology	Core – Theory	4	4
	13	BT1923111	Plant and Animal Biotechnology	Core – Theory	3	3
	14	BT1923112	Environmental Biotechnology	Core – Theory	4	4
	15	BT1923603	Laboratory Course 3	Core-Practical	4	10
IV	16	BT1924301	Cancer Biology	Elective-Theory	3	3
	17	BT1924302	IPR, Biosafety and Biodiversity	Elective- Theory	3	3
	18	BT1924303	Biopharmaceuticals and Applied Nanotechnology	Elective - Theory	3	3
	19	BT1924304	Research Methodology in Biotechnology	Elective - Theory	3	3
	20	BT1924604	Laboratory Course 4	Core -Practical	4	10
	21	BT1924801	Project	Core -Project	4	-
	22	BT1924901	Comprehensive Viva-voce	-	3	-
			Total		**80**	

Elective Papers:

1. Cancer Biology - BT1924301
2. IPR, Biosafety and Biodiversity- BT1924302
3. Biopharmaceuticals and Applied Nanotechnology - BT1924303
4. Research Methodology in Biotechnology - BT1924304
5. Nutritional Biochemistry - BT1924305
6. Physiology - BT1924306

DETAILED SYLLABUS OF ALL COURSES

SEMESTER I

Course	Details			
Code	BT1921101			
Title	**BIOCHEMISTRY - I – BIOMOLECULES**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	1/I			
Type	Core Course			
Credits	4	Hrs/week	4	Total hours: 72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the basic chemistry of life	U	1,8,9
2	Interpret the concepts of p^H and buffers	U	1,8,9
3	Analyze the structure and functions of biomolecules	An	1,8,9
4	Examine the purification and analysis of carbohydrates	An	1,8,9
5	Classify the sterols in plant and microbial systems	U	1,8,9
6	Recall the methods of protein sequencing	R	1,8,9
7	Discuss the methods of DNA sequencing	U	1,8,9
8	Distinguish fat soluble and water soluble vitamins	U	1,8,9
9	Assess the structure, sources and significance of vitamins	E	1,8,9
10	Compare and Contrast the mechanism of action of various hormones	An	1,8,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**CHEMISTRY OF LIFE**	**9**	
1.1	Biomolecules: Monomers and Polymers.	1	1
1.2	Biomolecules: Chemical bonds - Ionic, Covalent and Hydrogen bonds.	1	1
1.3	Biomolecules: Functional groups and their chemical Properties.	1	1
1.4	Biomolecules: Oxidation and Reduction reactions.	1	1
1.5	Water, the universal solvent: Structure and ionization of water.	1	1
1.6	Concepts of pH.	1	2
1.7	Measurement of pH.	1	2

1.8	Concepts of Buffers.	1	2
1.9	Henderson-Hasselbalch equation with derivation.	1	2
2.0	**CARBOHYDRATES**	**9**	
2.1	Structure and Function of Monosaccharides.	1	3
2.2	Structure and Function of Oligosaccharides.	1	3
2.3	Structure and Function of Homopolysaccharides: Starch and Glycogen.	1	3
2.4	Structure and Function of Homopolysaccharides: Cellulose and Chitin.	1	3
2.5	Structure and Function of Heteropolysaccharides: Bacterial peptidoglycan, Hyaluronic acid and Heparin.	1	3
2.6	Glycoconjugates: Proteoglycans, Glycoproteins, and Glycolipids.	1	3
2.7	Glycoconjugates: Glycosaminoglycans, N-linked and O-linked Carbohydrates	1	3
2.8	Purification of Carbohydrates.	1	4
2.9	Analysis (Quantitative and Qualitative) of Carbohydrates.	1	4
3.0	**LIPIDS**	**12**	
3.1	Structure and Function of lipids.	1	3
3.2	Structure and Function of Fatty acids.	1	3
3.3	Membrane lipids.	1	3
3.4	Storage lipids.	1	3
3.5	Lipids as intracellular signals.	1	3
3.6	Lipids as cofactors.	1	3
3.7	Lipids as steroid hormones – Glucocorticoids, Mineralocorticoids, Androgens and Progesterone.	1	3
3.8	Glycosphingolipids: Structure and Function of sphingosine, ceramides and sphingomyelin.	1	3
3.9	Structure and Function of Prostaglandins.	1	3
3.10	Structure and Function of Leukotrienes and Thromboxanes.	1	3
3.11	Sterols in Microbial system.	1	5
3.12	Sterols in Plant system.	1	5
4.0	**PROTEINS AND NUCLEIC ACIDS**	**20**	
4.1	Name (with one letter and three letter code) and structures of the 20 standard amino acids occurring in proteins.	1	3
4.2	Peptide bond – structure and characters	1	3
4.3	Primary structure of protein	1	3
4.4	Secondary structure of protein	1	3
4.5	Tertiary structure of protein	1	3
4.6	Quaternary structure of protein	1	3
4.7	Protein sequencing	1	3
4.8	Membrane proteins including ATP synthase	1	3
4.9	Globular protein: Haemoglobin, Myoglobin	1	3

4.10	Fibrous protein: Collagen	1	3
4.11	Protein sequencing	1	6
4.12	Nucleosides, Nucleotides and Phosphodiester bond	1	3
4.13	Formation of Nucleic acids	1	3
4.14	Watson-Crick base pairing	1	3
4.15	Forms of DNA	1	3
4.16	Nucleosome model of chromosomes	1	3
4.17	RNA types in Prokaryotes and Eukaryotes	1	3
4.18	Structure of tRNA	1	3
4.19	Denaturation of nucleic acids	1	3
4.20	DNA sequencing	1	7
5.0	**VITAMINS AND HORMONES**	**22**	
5.1	Properties of Fat soluble and water soluble vitamins.	1	8
5.2	Structure, Function, Sources, RDA and Deficiency manifestations of Vitamin A.	1	9
5.3	Structure, Function, Sources, RDA and Deficiency manifestations of Vitamin D.	1	9
5.4	Structure, Function Sources, RDA and Deficiency manifestations of Vitamin E and K.	1	9
5.5	Structure, Function, Sources, RDA and Deficiency manifestations of Vitamin C.	1	9
5.6	Structure, Function, Sources, RDA and Deficiency manifestations of Vitamin B1, B2, and B3.	1	9
5.7	Structure, Function, Sources, RDA and Deficiency manifestations of Vitamin B5, B6, and B7.	1	9
5.8	Structure, Function, Sources, RDA and Deficiency manifestations of Vitamin B9, and B12.	1	9
5.9	Vitamins as cofactors and coenzymes: TPP, FAD, FMN	1	9
5.10	Vitamins as cofactors and coenzymes: NAD^+, $NADP^+$, Co.A, PLP	1	9
5.11	Vitamins as cofactors and coenzymes: Biotin, THFA and Cyanocobalamin.	1	9
5.12	Classification of hormones	1	10
5.13	Site of formation of hormones	1	10
5.14	Target organs of hormones	1	10
5.15	Mechanism of action of peptide/protein/amine hormones – Insulin.	1	10
5.16	Mechanism of action of peptide/protein/amine hormones – Glucagon.	1	10
5.17	Mechanism of action of peptide/protein/amine hormones – Epinephrine.	1	10

5.18	Mechanism of action of peptide/protein/amine hormones – Norepinephrine.	1	10
5.19	Mechanism of action of peptide/protein/amine hormones – Thyroid hormones	1	10
5.20	Mechanism of action of steroid hormones – Testosterone.	1	10
5.21	Mechanism of action of steroid hormones – Estrogen.	1	10
5.22	Mechanism of action of steroid hormones – Progesterone.	1	10

Reference

1. Biochemistry by Donald Voet, Judith G. Voet Publisher: John Wiley &Sons Inc (2004) ISBN: 047119350X ISBN-13: 9780471193500, 978-0471193500.
2. Principles of Biochemistry by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: Mcgraw-hill Book Company – Koga (1995) ISBN: 0697142752 ISBN-13: 9780697142757, 978-0697142757.
3. Principles of Biochemistry, 4/e by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson(2006) ISBN: 0131977369, ISBN13:978013197736 5, 978-0131977365.
4. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain, (2008) Publishers: S. Chand &Co Ltd ISBN: 81-219-2453-7 p: 73.
5. Lehninger Principles of Biochemistry by Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008) 5thEdition, ISBN: 978-0-230-22699-9, Publisher: W. H. Freeman and, Company, New York p: 239-255.
6. Biochemistry (6thEdition) by Jeremy M. Berg, John L. Tymoczko Lubert Stryer Publisher: B.I publications Pvt. Ltd (2007) ISBN: 071676766X ISBN13: 978071676 7664,978716767664.
7. A Text Book of Biochemistry by E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, Oxford and IBH Publishing Co., New Delhi, 1974.

Course	Details			
Code	BT1921102			
Title	**CELL BIOLOGY AND GENETICS**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	1/I			
Type	Core			
Credits	4	Hrs/Week	4	Total hours: 72

CO No.	Expected Course Outcome Upon completion of this course the students will be able to	Cognitive Level	PSO No
1.	Understand the concept of cellular complexity in Eukaryotic system	An	1,7
2.	Analyse the protein sorting mechanisms in cellular organelles (ER, Golgi, Mitochondria, Lysosomes)	An	1,7
3.	Remember the structure of cytoskeleton and its significance	R	1,7,8
4.	Understand the relevance of cell adhesion molecules	U	1,7,8
5.	Create various membrane transport systems, signal transduction process, different sensing mechanisms and their secondary messengers	C	1,7,8
6.	Understand the various signal transduction pathways and its downstream targets	U	1,7,8
7.	Evaluate the role of eukaryotic cell cycle check points, monitor the role of various cyclins and about Hox genes	E	1,7,8
8.	Explain about the cellular programming events: Apoptosis and necrosis in the cell	E	1,7,8
9.	Understand the hallmarks of cancer and different types of tumor	U	1,7,8
10.	Analyse the molecular concept of cellular ageing	An	1,7,8
11.	Recall the concepts of mendelian genetics	R	1,7,8
12.	Apply the terminology in area of mendelian genetics (Mono- hybrid, Di-hybrid, Test cross etc)	Ap	1,7,8,9
13.	Examine about the chromosome abnormalities and their significance.	E	1,7,8,9
14.	Evaluate the concept of ecological theory linked with genetics	E	1,4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
1.0	**Cell Unit of Life**	**12**	
1.1	Cell theory, Chemical components of a cell: Prokaryotic and Eukaryotic	1	1
1.2	Cellular differentiation, Structure and Function of cellular organelles: cell wall, Plasma membrane, Fluid mosaic model, membrane fluidity	1	1
1.3	Cytoplasm, Nucleus, Endoplasmic Reticulum, Golgi Complex	1	1
1.4	Mitochondria	1	1
1.5	Chloroplast, Photosystems	1	1
1.6	Modification of proteins, protein sorting and trafficking	1	2
1.7	Exo – Endocytosis, Lysosomes and peroxisomes	1	2
1.8	Enzymatic components and Functions, Ribosome.	1	2
1.9	Cytoskeleton: Microtubule assembly and organisation	1	3
1.10	Microfilaments , Actin structure and assembly, Intermediate filaments and types	1	3
1.11	Filament based movement in muscle, Sliding Filament model, cell junctions: Tight and Gap	1	3
1.12	Cell adhesion and extracellular matrix, Integrins, Introduction to stem cells.	1	4
2.0	**MEMBRANE TRANSPORT AND SIGNAL TRANSDUCTION**	**19**	
2.1	Membrane Transport System: Active and Passive, Regulation of transport: porins, facilitated diffusion	1	5
2.2	Porter molecules, Facilitated transport: symport, antiport, uniport, anion porter	1	5
2.3	Glucose porter, Active transport: proton pumps	1	5
2.4	Sodium, Potassium pumps, Calcium pumps,	1	5
2.5	General characteristics of ion channels.	1	5
2.6	Types of Ion channels	1	5
2.7	Cell communications: Cell surface receptors	1	5
2.8	Cell signalling: Hormone and their receptors. Cell surface receptor signalling through G - protein coupled receptors.	1	5
2.9	Secondary messengers: cAMP, Calcium ions.Regulation of signalling pathways: Bacteria and Plant two component systems	1	5
2.10	Light Signalling in Plants, Bacterial chemotaxis	1	5
2.11	Quorum sensing	1	5
2.12	Signal transduction: Electrical impulses and their transmission	1	6
2.13	Structure and electrical properties of neurons. Resting and action potential, propagation of action potential	1	6
2.14	Voltage gated and ligand gated channels.	1	6
2.15	Synaptic transmission, chemical signals and receptors	1	6
2.16	Chemical signals and receptors	1	6
2.17	Second messengers: cAMP, Calcium ions.	1	6

2.18	Ras pathway	1	6
2.19	Glycogen breakdown by epinephrine	1	6
3.0	**Cell cycle and Cellular differentiation**	**21**	
3.1	Structure of chromosomes, Chromosome banding	1	7
3.2	Mitosis and Meiosis	1	7
3.3	Model organisms	1	7
3.4	MPF, cyclins	1	7
3.5	Cell cycle: G1, S, G2 , M phases	1	7
3.6	Model organisms, MPF and cyclins	1	7
3.7	Checkpoints	1	7
3.8	Role of Rb and p53	1	7
3.9	Cell cycle inhibitors	1	7
3.10	Cellular differentiation	1	7
3.11	Maternal, Segmentation and Homeotic genes	1	7
3.12	Hox genes	1	7
3.13	Gene interactions bicoid – nanos system	1	7
3.14	Cell death and cancer	1	8, 9
3.15	Apotosis and Necrosis	1	8
3.16	Apoptotic pathways	1	8
3.17	Types of tumor	1	9
3.18	Induction of cancer	1	9
3.19	Properties of Cancer Cell, Oncogenes, Tumor suppressors	1	9
3.20	Molecular pathways - PIP3, Akt, MAP kinase	1	9
3.21	Molecular basis of aging	1	9
4.0	**Fundamentals of Genetics**	**10**	
4.1	Introduction to Mendelian genetics	1	11
4.2	Mendelian principles: Mono, di and trihybrid crosses, Punnett square, Dominance, epistasis	1	12
4.3	Punnett square	1	11,12
4.4	Dominance	1	11,12
4.5	Epistasis	1	11,12
4.6	Pleiotropic Interactions, Multiple alleles – ABO blood groups, pseudoalleles, Atavism, Linkage	1	11,12
4.7	Sex Linkage, Sex influenced genes, Sex limited genes.	1	11,12
4.8	Linkage groups: Two and three point test cross.	1	11,12
4.9	Penetrance and expressivity, Phenocopy, Pedigree Analysis, Quantitative Genetics	1	11,12
4.10	Polygenic Inheritance, heritability and its measurements , QTL mapping	1	11,12
5.0	**Modern Genetics**	**10**	
5.1	Chromosomal theory of genetics, structural and functional genomics	1	13
5.2	Determination of Gene order, Chromosome mapping	1	13
5.3	Autosomal mutations and chromosomal disorders	1	13
5.4	Inherited Disorders in metabolism, Maple syrup urine disease, leschNyhan syndrome,	1	13
5.5	Cytoplasmic Inheritance, cytoplasmic male sterility	1	13
5.6	Down's syndrome, Polyploidy and aneuploidy, Behavioral genetics	1	13

5.7	Behavioral genetics: Hardy Weinberg principle, Natural selection, Genetic Drift, Genetic Variation	1	14
5.8	Natural selection , Genetic Drift, Genetic variation	1	14
5.9	Allele frequencies and its changes, Mutation gene flow, Random mating.	1	14
5.10	Inbreeding, outbreeding, Assortive mating and Hybrid vigour	1	14

Reference :

1. Principles of Genetics, Snustad , Simmons and Jenkins, John Wiley And Sons Inc
2. Genetics, Robert Weaver and Philip Hendricks, WHC Brown Publishers, Iowa
3. Introduction to Genetic Analysis, Griffiths, Wesseler, Lewontin , Gelbart, Suzuki and Miller, Freeman's and Co, New York
4. Principles of Genetics : A.G. Gardner, John Wiley and Sons
5. Cell and Molecular Biology by Gerald Karp, Academic Press
6. Cell and Molecular Biology Cooper, Hausman, ASM Press
7. World of the Cell, Becker, Reece, Poenie, The Benjamin/Cummings's Pub
8. Cell Biology, Lodish et al, W H Freeman and Co, New York
9. Cell Biology, Thomas D Pollard and W.C Earnshaw, Saunder'sPublishers

Course	Details			
Code	BT1921103			
Title	**BIOPHYSICS AND INSTRUMENTATION**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	1/I			
Type	Core Course			
Credits	3	Hrs/wk	3	Total hrs: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Acquire basic concepts and principles of thermodynamics and bioenergetics	**U**	1,9
2	Explain and compare the biophysical chemistry of macromolecules and their interactions	**U**	1,9
3	Discuss the working principle and applications of various types of microscopic techniques	**U**	2,8
4	Differentiate the working principle and applications of various types of spectroscopic techniques	**An**	2,8
5	Acquire basic knowledge and applications of polarimetry and refractometry	**U**	2,8
6	Acquire knowledge of circular dichroism (CD)and optical rotatory dispersion (ORD)	**U**	2,8
7	Describe the technique and applications of flow cytometry	**U**	2,8
8	Discuss the technique of X-ray diffraction by crystals and its applications	**U**	2,8
9	Distinguish the working principle and applications of various chromatographic techniques	**An**	2,8
10	Explain the working principle and compare the types and applications of centrifugation techniques	**U**	2,8
11	Compare and contrast the working principle and compare the types and applications different electrophoretic techniques	**An**	2,8
12	Describe the origin and properties of radiations and discuss the measurement and applications of radioactivity	**U**	2,8

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Fundamentals of Bioenergetics**	**6**	
1.1	Laws of thermodynamics	1	1
1.2	The concept of enthalpy, entropy and free energy	1	1
1.3	Thermodynamic equilibrium and Redox potential	1	1
1.4	High energy molecules	1	1
1.5	Membrane potential and its significances	1	1
1.6	Bioenergetics: ATP synthesis	1	1
2.0	**Biophysical Chemistry of Macromolecules and their Interactions**	**14**	
2.1	Amino acids and the primary structure of proteins- Peptide bond	1	2
2.2	Primary, secondary and tertiary structure of proteins	1	2
2.3	Alpha domains, beta domains, alpha- beta domains	1	2
2.4	Quaternary structure and Virus structure	1	2
2.5	Structural implication of peptide bond**:** Ramachandran plot	1	2
2.6	The chemical structure of nucleic acids	1	2
2.7	DNA supercoiling and unusual DNA structures	2	2
2.8	GC content and denaturation kinetics, Cot curve	1	2
2.9	DNA-Protein interaction: Lambda repressor and cro binding to DNA	1	2
2.10	Interactions of transcription factors, Leucine Zipper, Cys-His, Zinc fingers	1	2
2.11	Histone-DNA interaction	1	2
2.12	RNA protein interactions	1	2
2.13	DNA-drug interaction	1	2
3.0	**Physico-Chemical Techniques**	**17**	
3.1	***Microscopy***: Fundamentals; Bright field and dark field microscopy; Staining techniques	1	3
3.2	Phase contrast and confocal microscopy	1	3
3.3	Polarization and interference microscopy	1	3
3.4	Electron microscopy: Basic principle	1	3
3.5	TEM: working principle, Instrumentation, sample preparation and applications	1	3
3.6	SEM: working principle, Instrumentation, sample preparation and applications	1	3
3.7	Atomic force microscopy: working principle, Instrumentation, and applications	1	3
3.8	***Spectroscopy***: Absorption and Emission Spectroscopy; Beer-Lamberts law	1	4

3.9	UV-Visible spectroscopy: working principle, Instrumentation, and applications	1	4
3.10	IR spectroscopy: working principle, Instrumentation, and applications	1	4
3.11	Light scattering, Raman Spectra: working principle and applications	1	4
3.12	NMR and ESR spectroscopy : working principle and applications	1	4
3.13	Fluorescence spectroscopy	1	4
3.14	Polarimetry and Refractometry	1	5
3.15	circular dichroism (CD)and optical rotatory dispersion (ORD)	1	6
3.16	Flowcytometry	1	7
3.17	X-ray diffraction by crystals; working principle and applications	1	8
4. 0	**Separation Techniques**	**13**	
4.1	***Chromatography****:* Basic concepts and principle	1	9
4.2	Planar Chromatography: Paper and Thin layer; HPTLC	1	9
4.3	Column Chromatography: reverse phase and normal phase	1	9
4.4	GC and HPLC	1	9
4.5	Ion exchange chromatography	1	9
4.6	Size exclusion (GPC) and affinity chromatography	1	9
4.7	***Centrifugation***: working principle	1	10
4.8	Types of centrifuges: Preparative and Analytical	1	10
4.9	Differential and Density gradient centrifugation; Cellular fractionation	1	10
4.10	***Electrophoresis****:* Workingprinciple	1	11
4.11	AGE; PAGE and SDS PAGE: Working principle, instrumentation and applications	1	11
4.12	Capillary Electrophoresis and isoelectric focusing	1	11
4.13	Ultra filtration and dialysis	1	11
5.0	**Radioactivity**	**4**	
5.1	Basic concepts of Atomic structure and radioactivity	1	12
5.2	Radioactive disintegration; half life period	1	12
5.3	Measurement of radioactivity: GM counter, Liquid scintillation counting, autoradiography	1	12
5.4	Applications of radioactivity	1	12

Reference:

- Introduction to protein structure: Branden and Tooze, Garland Science Pub.
- Introduction to Biophysics-Rodney Cotterill, Wiley
- Molecular Biophysics- Volkenstain M.V, Academic Press

- DNA topology- Andrew D Bates, Maxwell, Oxford University Press
- Introduction to Biophysics-Sokal R.R & Rohlf. F.J, Freeman & Co.
- Practical biochemistry Keith Wilson and John Walker Cambridge edn.
- Modern experimental Biochemistry- Rodney Boyer, Pearson education

Course	Details			
Code	BT1921104			
Title	**MICROBIOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	1/I			
Type	Core Course			
Credits	4	Hrs/week	4	Total hours: 72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Discuss the fundamental aspects of microbiology	U	1
2	Explain the structural and functional diversity of prokaryotic and eukaryotic systems	E	1,7
3	Illustrate the structural and physiological aspects of viruses	Ap	1,7
4	Describe the characterization and identification techniques and tests of microbes	U	1,7
5	Demonstrate the techniques of microbial isolation, culture and maintenance as well as the measurement of bacterial growth	Ap	1
6	Recognize the economic importance of microbes	U	7,8,9
7	Examine the suitability and efficacy of various sterilization and disinfection techniques	An	7,8
8	Express various aspects of microbial genetics	U	1
9	Distinguish mutagenic agents and experiment on in vitro mutagenesis	An	2,8
10	Interpret microbial physiology and metabolism	Ap	1,7

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**INTRODUCTION TO MICROBIOLOGY**	**23**	
1.1	The Historical foundation and development of microbiology	1	1, 2
1.2	Microbial diversity : Prokaryotic diversity	1	1, 2
1.3	Microbial diversity: Eukaryotic diversity	1	1, 2
1.4	Morphology and structure of bacterial cells	1	1, 2
1.5	Virus – Morphology, structure and replication	1	3

1.6	Classification of viruses	1	3
1.7	Viral diversity – Bacterial, Plant and Animal	1	3
1.8	Infectivity Assays (Plaque and end-point)	1	3
1.9	Isolation, culture and identification of viruses	1	3
1.10	Bacteria: Structure, diversity and economic importance	1	3
1.11	Microbial classification: Thermophiles, mesophiles, psychrophiles, halophiles and acidophiles	1	1, 2
1.12	Bacterial cell wall: structure and synthesis of peptidoglycan	1	1, 2
1.13	Morphological features of colony and cell	1	1, 4
1.14	Staining methods: Simple staining and differential staining- Gram staining and acid fast staining	1	1, 4
1.15	Special staining: Flagella, endospore and negative staining	1	1, 4
1.16	Bacterial identification: Cultural, Physiological and Biochemical characteristics of Microorganisms	2	1,4
1.17	Bergey's manual: Principles of bacterial taxonomy	1	1, 4
1.18	Molecular taxonomy: (16S rDNA)	1	1, 4
1.19	Fungi – Microscopic and macroscopic fungi- features and staining of fungal cells	1	1, 4
1.20	Economic importance Fungi	1	6
1.21	Fungal characterization and identification techniques	1	1, 4
1.22	Molecular taxonomy: ITS sequence	1	1, 4
2.0	**MICROBIAL CULTURE AND GROWTH KINETICS**	**13**	
2.1	Types of media (Selective, Enrichment and Transport media)	1	5
2.2	Bacterial culture techniques: Pour plate, spread plate and streak plating; Pure culture and streaking techniques (Quadrant, Radiant and Continuous)	2	5
2.3	Measurement of bacterial growth: Direct microscopic count and turbidometric method	1	5
2.4	Microbial Growth curve, Doubling time, factors affecting microbial growth: Environmental and nutritional factors	2	5
2.5	Most Probable Number (MPN)	1	5
2.6	Bacterial reproduction	1	5
2.7	Biofilm formation	1	5
2.8	Microbial locomotion : Flagellar, gliding motility and amoeboid motion	1	5
2.9	Bacterial swarming and Quorum sensing	2	5
2.10	Long term preservation, maintenance and transport of cultures	1	5
3.0	**STERILIZATION AND DISINFECTION**	**13**	
3.1	Principle of sterilization, Types of sterilization (Dry heat, moist heat, Pasteurization)	1	7
3.2	Physical methods of sterilization- Principle of autoclaving	1	7
3.3	Principle of Filtration: Membrane filters	1	7

3.4	Principle of Laminar Air Flow	1	7
3.5	Radiation as a sterilization agent – mechanism of action	1	7
3.6	Chemical methods of sterilization	1	7
3.7	Disinfectants and its types: Mode of action	1	7
3.8	Testing of disinfectants	1	7
3.9	Antibiotics sources, types and mechanism of action	2	7
3.10	Drug resistance in bacteria	1	7
3.11	Antibiotic sensitivity tests	1	7
3.12	Tyndallization and pasteurization	1	7
4.0	**MICROBIAL GENETICS**	**11**	
4.1	Genetic materials in bacteria: Bacterial chromosome	1	8
4.2	Plasmids: Types of plasmids (F, Col, R and degradative)	1	8
4.3	Properties of plasmids – sex factors, drug resistant, colicinogenic, Agrobacterium Ti and broad host range plasmid	2	8
4.4	Replication of plasmid; Control of copy number, plasmid amplification	1	8
4.5	Mechanism of Genetic recombination methods: Conjugation, transformation and transduction	1	8
4.6	Mutation: Mutagenesis and mutagenic agents	1	9
4.7	Molecular basis of mutation	1	9
4.8	in vitro mutagenesis; Detection of mutagen - ames test	2	9
4.9	Mutant selection	1	9
5.0	**MICROBIAL PHYSIOLOGY**	**12**	
5.1	Bacterial metabolism: catabolism and anabolism	1	10
5.2	Bacterial Photosynthesis	1	
5.3	Bacterial respiration: Aerobic and anaerobic	2	10
5.4	Fermentation	1	10
5.5	Major glycolytic pathways found in bacteria (Glycolysis)	2	10
5.6	Anaplerotic reaction	1	10
5.7	Catalase, super oxide dismutase, mechanism of oxygen toxicity.	1	10
5.8	Bacterial Chemolithotrophy: Physiological groups of chemolithotrophs	2	10
5.9	Microbial secondary metabolites	1	10

Text Books for Reference

1. Principles and practice of disinfection, preservation and sterilization – Russel AD et al, Blackwell Scientific Publications
2. Antimicrobial drug resistance , Bryan LE (Ed)., Academic press
3. Toplely and Wilsons, Principles of bacteriology, virology and immunology – Arnold – Heinemann
4. Microbiology, Bernard D. Davis et al., Harper International Edition
5. Zinsser Microbiology. Printice Hall International Inc

6. Manual of methods for General Bacteriology. Gerhadt P et al., (ED). American Society for Microbiology
7. Microbiology concepts and applications. Pelczer Jr. Chan. Creig. Mc Graw Hill, Inc
8. Microbiology, Prescott, Harley and Klein wim C Brown publishers.

Course	Details		
Code	BT1921601		
Title	**LABORATORY COURSE 1**		
Degree	M.Sc.		
Branch(s)	BIOTECHNOLOGY		
Year/Semester	1/1		
Type	Core – Practical		
Credits	4	Hrs/wk = 10	Total hrs: 180

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Evaluate the validity of Beer-Lambert's Law	**E**	2,9
2	Compare the lambda max values of various samples	**An**	2,9
3	Demonstrate and compare spectroscopic and colorimetric methods for the determination of bio-molecules	**An**	2,9
4	Demonstrate and formulate chromatographic experiments for the separation and identification of amino acids and plant pigments	**C**	2,9
7	Estimate bacteria and fungi in a given sample	**U**	2,9
8	Compare the staining techniques used for bacteria	**An**	2,9
9	Compare the efficacy and suitability of sterilization methods employed in microbiology	**Ap**	2,9
10	Determine the effect of disinfectants	**E**	2,9
11	Evaluate the effect of various antibiotics by sensitivity test	**E**	2,9
12	Demonstrate different biochemical test for the identification of microorganisms	**Ap**	2,9
13	Demonstrate the stages of mitosis and meiosis	**An**	1,2,9
14	Compare and correlate basic concepts of genetics	**Ap**	1,2,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Instrumentation , Biophysics, Biochemistry**	**60**	
1.1	***Spectrophotometric Experiments***	**40**	
1.1.1	Verification of Beer Lambert's law	5	1
1.1.2	Determination of Lamda max. for a given sample	5	2
1.1.3	Quantitative estimation of reducing sugars by Dinitrosalicylic acid method	5	3
1.1.4	Estimation of protein by Biuret, Lowry and Bradford Method	10	3

1.1.5	Estimation of Cholesterol by Zak's method	5	3
1.1.6	Estimation of DNA and RNA by UV-Visible spectroscopy	5	3
1.1.7	Determination of purity of DNA sample by UV-Visible spectroscopy	5	3
1.2	***Chromatographic Experiments***	**20**	
1.2.1	Separation of amino acids by paper chromatography	5	4
1.2.2	Separation of plant pigments by thin layer chromatography	5	4
1.2.3	Separation of plant pigments by column chromatography	5	4
1.2.4	Demonstration of HPLC, HPTLC and GC	5	4
2.0	**MICROBIOLOGY**	**70**	
2.1	**Isolation and Enumeration of Microbes**	**14**	
2.1.1	Serial dilution	5	7
2.1.2	Pour Plate method	3	7
2.1.3	Spread plate method	3	7
2.1.4	Maintenance by sub-culturing and storage	3	7
2.2	**Staining procedures**	**10**	
2.2.1	Simple stain and Differential staining	2	8
2.2.2	Gram staining	2	8
2.2.3	Flagellar Staining	2	8
2.2.4	Endospore staining	2	8
2.2.5	Acid fast staining	2	8
2.3	Sterilization methods (Dry heat, Moist heat, Filtration). Principle of Laminar Air Flow (LAF), Principle of Autoclaving	**5**	9
2.4	Testing of disinfectants	**10**	10
2.5	Antibiotic Sensitivity tests	**11**	11
2.6	Measurement of size of microorganism / spore	**2**	12
2.7	Study of cultural characteristics and biochemical test of bacteria	**18**	12
3.0	**CELL BIOLOGY**	**20**	
3.1	Identification of mitotic cell cycle stages	10	13
3.2	Identify the stages of meiosis	10	13
4.0	**GENETICS**	**30**	
4.1	Solving Genetic problems which obey Mendelian laws	10	14
4.2	Demonstration of Punnett square	5	14
4.3	Problems related multiple alleles, epistasis and linkage	10	14
4.4	Analysis of human pedigree for the charts	5	14

References

- Principles of Instrumental Analysis; D.A. Skoog and J. J. Leary, Saunders College Publishing, New York, 1992.
- Instrumental Methods of Analysis; H. H. Willard et. al.; 6th edition, Wadsworth.
- Chromatography Today, C.F. Poole and S.K.Poole, Elsevier, 1991
- Introduction to Modern Liquid Chromatography; L. R. Snyder and J. J. Kirkland, 2nd Ed. 1980, John Wiley and Sons, New York.
- Handbook of Analytical Techniques edited by Helmut Giinzler and Alex Williams; WILEY-VCH.
- Harry Nickla. How to Solve Genetics Problems. Benjamin Cummings, 2010
- Monroe W. Strickberger. Genetics, Third Edition
- Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi, ISBN 81-88237-41-8, p 13-17, p 39-43.
- Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p 1- 15, 195-303.
- Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5, p 12 – 18.
- Practical Biochemistry, R.C. Gupta & S. Bhargava (eds) CBS Publishers and Distributors, New Delhi, ISBN 81-239-0124-0 p 9 – 27.
- Laboratory Manual in General Microbiology by Kannan. N (2002) Panima Publishing Corporation.
- Laboratory Manual of Microbiology, Biochemistry and Molecular Biology (2012) Saxena, Baunthiya & Ravi. Scientific Publishers (India)
- Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja

SEMESTER II

Course	Details			
Code	BT1922105			
Title	**MOLECULAR BIOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	1/II			
Type	Core Course			
Credits	4	Hrs/week	4	Total hours: 72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Explain the structural organization of genes and repetitive sequences	U	1,8,9
2	Describe the mechanism of DNA replication of prokaryotes & eukaryotes	An	1,8,9
3	Discuss various DNA repair mechanisms	E	1,8,9
4	Explain the process of transcription in prokaryotes and eukaryotes	U	1,8,9
5	Examine post transcriptional modifications	An	1,8,9
6	Compare & contrast mechanisms of translation in prokaryotes & eukaryotes	An	1,8,9
7	Describe gene regulation and operon concept in prokaryotes	U	1,8,9
8	Explain gene regulation in eukaryotes	U	1,8,9
9	Discuss the methods of Gene Silencing	E	7,8,9
10	Debate and apply advanced tools and techniques of molecular biology in day to day life	C	7,8,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**ORGANIZATION OF GENOME**	**9**	
1.1	Chromatin structure: nucleosome morphology and histones	1	1
1.2	Higher level organization of genome	1	1
1.3	Heterochromatin and Euchromatin	1	1
1.4	Genes: split gene concept, exons and introns	1	1
1.5	DNA reassociation kinetics (Cot curve analysis)	1	1
16	Repetitive DNA- Tandem repeats microsatellites and minisatellites	1	1

1.7	Interspersed repeated DNAs: SINES, LINES	1	1
1.8	Transposons- types of IS elements	1	1
1.9	Replicative transposons and retroposons	1	1
2.0	**DNA REPLICATION**	**15**	
2.1	Models of DNA Replication: Conservative Semiconservative and discontinuous, Messelson and Stahl experiment	1	2
2.2	DNA replication in prokaryotes - Steps in initiation of replication, Ori site	1	2
2.3	Enzymatic factors involved in DNA replication	1	2
2.4	DNA polymerases in prokaryotes, Klenow fragment	1	2
2.5	Primosome, SSB, β clamp, progress of replication fork	1	2
2.6	Termination of replication in prokaryotes	1	2
2.7	DNA replication in eukaryotes : DNA polymerases in eukaryotes	1	2
2.8	Initiation of replication in eukaryotes	1	2
2.9	Elongation and termination of replication	1	2
2.10	Role of telomerases in replication of eukaryotic chromosomes.	1	2
2.11	Modes of replication, theta, rolling circle, d-loop replication	1	2
2.12	Inhibition of replication.	1	2
2.13	Role of enzymes in proof reading	1	3
2.14	DNA repair mechanisms ineukaryotes and prokaryotes: photoreactivation, Excision Repair, BER and NER	1	3
2.15	DNA repair mechanisms: mismatch repair, SOS repair, Recombination repair systems	1	3
3.0	**TRANSCRIPTION AND TRANSLATION**	**25**	
3.1	Process of transcription, Transcription unit	1	4
3.2	promoters, Enhancers, regulatory elements	1	4
3.3	RNA polymerases in prokaryotes and eukaryotes	1	4
3.4	Prokaryotic transcription: sigma factor in prokaryotes	1	4
3.5	Transcriptional elongation		4
3.6	Rho dependant and Rho independent termination	1	4
3.7	Transcription factors in Eukaryotes, CpG islands	1	4
3.8	Differences in transcription between prokaryotes and Eukaryotes	1	4
3.9	Monocisrtonic and polysistronic m-RNA.	1	4
3.10	Post transcriptional modifications - r-RNA and t-RNA processing	1	5
3.11	m-RNA processing- Polyadenylation, capping,	1	5
3.12	Splicing-Spliceosome, lariat structure	1	5
3.13	Group I, II and III Introns	1	5
3.14	Catalytic RNA Importance of ribozyme, properties,	1	5

	application, RNase P, RNAse III, RNAse H		
3.15	Transplicing, alternate splicing	1	5
3.16	Inhibitors of Transcription	1	4
3.17	mRNA stability and degradation	1	5
3.18	Process of translation.: Stages in translation	1	6
3.19	Genetic code, properties, wobble hypothesis	1	6
3.20	Eukaryotic and prokaryotic ribosomes	1	6
3.21	m-RNAs, t-RNAs, aminoacyl t-RNA synthatases	1	6
3.22	Protein factors initiation complex	1	6
3.23	Peptidyl transferase, releasing factors	1	6
3.24	Differences between prokaryotic and eukaryotic systems	1	6
3.25	Inhibition of translation	1	6
4.0	**GENE REGULATION**	**15**	
4.1	Molecular mechanism of gene regulation in prokaryote: Transcriptional regulation in prokaryotes	1	7
4.2	Inducible & repressible system,+ & -ve regulation	1	7
4.3	Operon concept, structure of operon	1	7
4.4	Lac operon	1	7
4.5	Trp operon	1	7
4.6	Ara operon	1	7
4.7	Catabolic repression, transcriptional atteunation	1	7
4.8	Multiple levels of eukaryotic gene regulation: Histone acetylation and deacetylation	1	8
4.9	Histone methylation and demethylation	1	8
4.10	chromosome remodeling complex	1	8
4.11	Transcription level gene amplification	1	8
4.12	Differential transcription	1	8
4.13	Translational control	1	8
4.14	Intein splicing	1	8
4.15	Role of Hormones in gene regulation	1	8
5.0	**ADVANCED MOLECULAR BIOLOGY**	**8**	
5.1	RNA interference, Antisense RNA	1	9
5.2	SiRNA,	1	9
5.3	MicroRNA	1	9
5.4	Gene silencing in prion disease– CJD, scrapie	1	9
5.5	Genome editing- CRISPR-Cas9 technology	1	9
5.6	Ribozwitches & their applications	1	9
5.7	Nucleic acid as therapeutic agent	1	10
5.8	Human genome project and its implications	1	10

Text Books for Reference

- Molecular Biology of the Cell by Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K and Walter P (2014) 6th edition, Garland Science, New York.
- Karp's Cell and molecular biology: Concepts and experiments by Iwasa J, Marshall W F and Karp G. (2016) John Wiley and Sons, Inc
- Gene XI by Krebs J E, Goldstein E S, Kilpatrick S T and Lewin B (2014), 11th Edition, Burlington, MA : Jones & Bartlett Learning.
- Molecular Biology of the Gene by Watson J D, Hopkins N H, Roberts, R W, Seitz J A and Weiner A M (2007) 6th Edition, Benjamin Cummings Publishing Company Inc.

Text Books for Enrichment

- Molecular biology by Weaver R F (2012) 5th edition McGraw Hill, New York
- Molecular cell biology by Lodish, H F (2013) New York: W.H. Freeman and Co.
- The cell: A molecular approach by Cooper G M and Hausman R E (2009) 6th Edition, Washington, D.C: ASM Press.

Course	Details			
Code	BT1922106			
Title	**IMMUNOLOGY AND IMMUNOTECHNOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	1/II			
Type	Core Course			
Credits	4	Hrs/week	4	Total hours: 72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Compare and contrast the mechanism of innate and adaptive immunity	An	1,7,8
2	Explain the overall organization of the immune system	U	1,7,8
3	Describe the structure and genetic basis of immunoglobin	R	1,7,8
4	Summarize different types of infection	U	1,7,8
5	Evaluate how the humoral and cell mediated immune responses co-ordinate to fight invading pathogens	E	1,7,8
6	Describe differentiation and maturation of lymphocytes	U	1,7,8
7	Outline major components of complement system and their activation pathways	U	1,7,8
8	Analyze the role of MHC antigen in immune response	An	1,7,8
9	Distinguish between tolerance and autoimmunity	An	1,7,8
10	Deduce the difference between immunodeficiency and immunosuppression.	E	1,7,8
11	Discuss the immune responses of transplantation	U	7,8,9
12	Describe ABO blood grouping	U	1,8,9
13	Explain the production and types various vaccines	U	7,8,9
14	Investigate the adverse effects of the immune system including allergy and hypersensitivity	E	1,7,8
15	Describe the mechanism of cancer immunology	U	7,8,9
16	Describe recent advances in antibody engineering and various immunological tests	An	7,8,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**INTRODUCTION TO IMMUNOLOGY**	**14**	
1.1	Types of immunity: Innate and acquired	1	1
1.2	Mechanisms of innate immunity	1	1
1.3	Organs with immune functions- primary lymphoid organs	1	2
1.4	Secondary lymphoid organs	1	2
1.5	Cells involved in immune response	1	2
1.6	Antigens, Antigenicity and Epitopes	1	2
1.7	Antibodies: Immunoglobulin – structure	1	2
1.8	Immunoglobulin – classes and functions	1	3
1.9	Genetic basis of antibody diversity	1	3
1.10	Organization and Expression of Immunoglobulin Genes	1	3
1.11	V(D)J rearrangements	1	3
1.12	Somatic hypermutation and affinity maturation	1	3
1.13	Inflammation	1	1
1.14	Mechanism of inflammation	1	1
2.0	**IMMUNE RESPONSES**	**21**	
2.1	Immune responses- Humoral	1	5
2.2	Immune responses- Cell mediated	1	5
2.3	Receptors on T and B cells	1	5
2.4	Antibody production	1	5
2.5	Primary and secondary immune modulation	1	6
2.6	Clonal selection theory	1	6
2.7	Antigen processing and presentation	1	6
2.8	Differentiation of Lymphocytes –T cells	1	6
2.9	Differentiation of Lymphocytes- B cells	1	6
2.10	Maturation of Lymphocytes- T cells	1	6
2.11	Maturation of Lymphocytes- B cells	1	6
2.12	Activation of T-cells, T-cell function	1	6
2.13	Complement system	1	7
2.14	Complement activation and pathways	1	7
2.15	Biological effects of complements	1	7
2.16	Role of MHC antigen in immune response and in transplantation	1	8
2.17	Cytokines	1	8
2.18	CTL mediated immune response	1	8
2.19	Function of phagocytes, mast cells, basophils and eosinophils	1	8
2.20	NK cells, ADCC-Antigen dependent cell cytotoxicity	1	8
2. 21	Types of infections	1	4
3.0	**CLINICAL IMMUNOLOGY**	**19**	

3.1	Immunology of organ and tissue transplantation	1	11
3.2	Allograft reaction	1	11
3.3	GVH reaction	1	11
3.4	Factors influencing allograft survival	1	12
3.5	ABO and Rh blood group system	1	12
3.6	Immunology of blood transfusion	1	12
3.7	Immunological Tolerance	1	9
3.8	Autoimmunity	1	9
3.9	Mechanisms of autoimmunization	1	9
3.10	Autoimmune diseases-I	1	9
3.11	Autoimmune diseases-II	1	9
3.12	Hypersensitivity – immediate and delayed reactions	1	14
3.13	Types of hypersensitivity-I and II	1	14
3.14	Types of hypersensitivity-III and IV	1	14
3.15	Immunodeficiency diseases	1	10
3.16	Immunoprophylaxis	1	10
3.17	Vaccines	1	13
3.18	Types of vaccines	1	13
3.19	Recent trends in vaccine development	1	13
4.0	**CANCER IMMUNOLOGY**	**5**	
4.1	Types and causes of cancer	1	15
4.2	Immunology of malignancy	1	15
4.3	Tumor antigens	1	15
4.4	Immune response in malignancy	1	15
4.5	Immunotherapy of cancer	1	15
5.0	**IMMUNOLOGICAL TECHNIQUES**	**13**	
5.1	Antigen- antibody interactions	1	16
5.2	Agglutination, Precipitation,	1	16
5.3	Immunodiffusion	1	16
5.4	Immunoflourescence	1	16
5.5	Complement fixation	1	16
5.6	Radioimmuno assay	1	16
5.7	ELISA technique	1	16
5.8	Western blotting	1	16
5.9	Immunoelectrophoresis	1	16
5.10	Immunohistochemistry techniques	1	16
5.11	Monoclonal antibodies – production	1	16
5.12	Monoclonal antibodies –application	1	16
5.12	Antibody engineering	1	16

Text Books for Reference

- Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, and Janis Kuby,Immunology, W H Freeman and Co.
- Ivan M. Roitt and Peter J delves, Essential Immunology, Blackwell Publishing..
- John W, Kimball Maxwell, Introduction to Immunology, Mac Millan International Edition.

Text Books for Enrichment

- Charles A. Janeway Jr., Paul Travers, Mark Walport and Mark J. Shlomchik, Immunobiology, Garland Publishing.
- Helen Chappel and Mansel Haeney, Essential Clinical Immunology, ELBS/Blackwell Scientific Publications

Course	Details			
Code	BT1922107			
Title	**BIOINFORMATICS AND BIOSTATISTICS**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	1/II			
Type	CORE			
Credits	4	Hrs/week	4	Total hours: 72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1.	Utilize online resources and database to gain access to biological data and literature information	Ap	1,9
2.	Explain different methods used in protein and nucleic acid sequence analysis using bioinformatics software	E	1,9
3.	Predict the structure for given protein sequence using software	C	1,9
4.	Identify recent trends in proteomics, genomics, toxico-genomics and systems biology.	Ap	1
5.	Describe the basic concepts of Next Generation Sequencing	U	1
6.	Debate the modern discoveries of bioinformatics which relates to today's healthcare and future trends in modern drug discovery globally.	E	1,9
7	Describe various applications of biostatistics	U	1,5
8	Recall the characteristics of probability distribution	R	1
9	Recognize the importance of data collection and its types	R	1,6
10	Interpret measures of central tendency and variability of given statistical data	Ap	1,9
11	Interpret the result of correlation and regression analysis	E	1,9
12	Determine the significant value and evaluate the significance of a given data or observation	E	1,6
13	Explain the use of statistical packages	U	1,9
14	Predict suitable experimental design for biological experiment and interpret the output adequately	C	1,6,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Introduction to Bioinformatics and Sequence Analysis**	**12**	
1.1	Biological data bases, data organization and search tools.	1	1
1.2	Biological data format	1	1
1.3	Structural data bases	1	1
1.4	Sequence data bases	1	1
1.5	Genomic sequence databases	1	1
1.6	Bibliographic data bases (History, FSTA, INSPEC, Pubmed, Scifinder)	1	1
1.7	Specialized databases- MALDI-TOF and MASCOT database	1	1
1.8	Introduction to Sequence Analysis, Scoring Matrices, Pairwise alignment	1	2
1.9	Tool for pairwise alignment-FASTA and BLAST (Basic types)	1	2
1.10	BLAST Parser, BLAST compressor along with blastp, blastx (BlastBlast extractor) and tblastx from BLAST+ 2.2.25 package	1	2
1.11	Multiple Sequence Alignmet	1	2
1.12	Tool for MSA-CLUSTAL	1	2
2.0	**Phylogenetic Analysis and CADD**	**13**	
2.1	Phylogenetic analysis-Significance,distance based method	1	2
2.2	Cladistics methods	1	2
2.3	Construction of phylogenetic tree and Tree evaluation methods.	1	2
2.4	Software for phylogenetic analysis-PHYLIP and MEGA,	1	2
2.5	Protein structure prediction	1	3
2.6	Homology modeling	1	3
2.7	Molecular visualization tool:-Rasmol and Pymol	1	3
2.8	Molecular modeling	1	3
2.9	Energy minimization and docking studies	1	3
2.10	Computer Aided Drug designing	1	3
2.11	Tool for docking studies:-Argus Lab, Autodock and GOLD,	1	3
2.12	DNA-drug interaction	1	3
2.13	Protein-drug interaction	1	3
3.0	**Application and Advanced topics in Bioinformatics**	**15**	
3.1	Applications of Bioinformatics: pharmaceutical industry, immunology	1	4
3.2	Applications of Bioinformatics: agriculture, forestry	1	4
3.3	Applications of Bioinformatics: chemiinformatics, geoinformatics; legal ethical and commercial considerations	1	4

3.4	Genetic algorithms	1	4
3.5	Artificial neural networks in modeling	1	4
3.6	Primer designing for PCR studies	1	4
3.7	Fundamental concepts and application of proteomics	1	4
3.8	Genomics	1	4
3.9	Metabolomics	1	4
3.10	Toxicogenomics	1	4
3.11	systems biology	1	4
3.12	Next Generation Sequencing methods	1	5
3.13	Debate/seminars on current drug-related discoveries	3	6
4.0	**Introduction to Biostatistics**	**16**	
4.1	Scope of Biostatistics and variables in biostatistics	1	7
4.2	Probability and probability distribution analysis	1	8
4.3	Collection of data	1	9
4.4	Classification of data	1	9
4.5	Tabulation of data	1	9
4.6	Graphical representation of data	1	9
4.7	Diagrammatic representation of data	1	9
4.8	Measures of central tendency-Arithmetic mean	1	10
4.9	Measures of central tendency –median	1	10
4.10	Measures of central tendency –mode	1	10
4.11	Measures of dispersion-standard deviation	1	10
4.12	Measures of dispersion-Standard error	1	10
4.13	Measures of dispersion-variance	1	10
4.14	Measures of dispersion-coefficient of variation	1	10
4.15	Correlation	1	11
4.16	Regression	1	11
5.0	**Test of significance**	**16**	
5.1	Basic idea of significance of test	1	12
5.2	Hypothesis testing	1	12
5.3	Levels of significance	1	12
5.4	Type I and Type II error	1	12
5.5	Large sample and small sample test	1	12
5.6	Testing the quality of single mean and double mean	1	12
5.7	Single proportion and double proportion in large sample test.	1	12
5.8	Small sample test statistic using ‘t’ distribution for single, double mean and paired test	1	12
5.9	Chi-square test and goodness of fit- Definition and significance	1	12
5.10	Chi-square test and goodness of fit-Problems	1	12
5.11	One way ANOVA- Definition and significance	1	12

5.12	One way ANOVA-Problems	1	12
5.13	Fundamentals of Experimental design	1	14
5.14	CRD and RBD	1	14
5.15	Introduction to Statistical packages	1	13
5.16	Statistical software-SPSS package	1	13

References

- Statistical methods in Biology- Briley N.J.T
- Biostatistics PN Arora and P K Malhan Himalaya Pub.
- Bioinformatics: Sequence and Genome analysis- David Mount, Cold Spring Harbour Lab Press, New York.
- Bionformatics and Molecular evolution: Paul G Higgs, Teresa K Attwood. Blackwell pub.
- Bioinformatics: A Beginner's Guide. Wiley India Pvt. Limited. Claverie,J.,M., Notredame,C.(2003).
- Understanding bioinformatics. Garland Science. Zvelebil, M. J., & Baum, J. O. (2008).
- Bioinformatics: Databases and Algorithms. Alpha Science Int'l Ltd. Gautham, N. (2006).
- Bioinformatics with Fundamentals of Genomics and Proteomics. Tata McGraw Hill Education Pvt. Ltd. Lesk, A. (2013). Introduction to bioinformatics. Oxford University Press.

Additional References

- Bioinformatics: introduction and method, conducted by Peking University. https://www.coursera.org/course/pkubioinfo
- Bioinformatics: life sciences on your computer, conducted by Johns Hopkins. University. https://www.coursera.org/course/bioinform
- Current drug-related debate (eg.CDRH Tweaks Guidance on Medical Devices Containing Animal-Derived Materials, Posted 14 March 2019 | By Ana Mulero).
- AP® Statistics, conducted by The Tennessee Board of Regents. https://www.edx. org/ course/tennessee-board-regents/tennessee-board-regents-statx-apr-3541
- www. conferencealerts.com
- http://www.ncbi.nlm.nih.gov/education/tutorials/
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- Mehdi Pirooznia, Edward J Perkins,2andYouping Deng, Batch Blast Extractor: an automated blastx parser application BMC Genomics. 2008; 9(Suppl 2): S10. , doi: 10.1186/1471-2164-9-S2-S10)
- Voit EO, Almeida J. Decoupling dynamical systems for pathway identification from metabolic profiles. Bioinformatics, 2004;20:1670–1681.

Course	Details			
Code	BT1922108			
Title	**BIOCHEMISTRY - II – METABOLISM AND ENZYMOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	1/II			
Type	Core Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Evaluate the structural and functional aspects of enzymes.	E	1,8,9
2	Differentiate various classes of enzymes	U	1,8,9
3	Discuss the isolation, purification and characterization of enzymes.	U	1,8,9
4	Examine the factors affecting the velocity of enzyme catalyzed reaction.	An	1,8,9
5	Deduce Michaelis-Menten equation	E	1,8,9
6	Interpret Lineweaver-Burk plot	U	1,8,9
7	Explain the mechanisms of enzyme regulation	U	1,8,9
8	Identify the metabolic pathways of carbohydrates, proteins, nucleic acids, fatty acids and cholesterol.	An	1,8,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**ENZYMES**	**9**	
1.1	Holoenzyme, apoenzyme and prosthetic group.	1	1
1.2	Enzyme specificity – Substrate (Absolute), Bond (Linkage) and Group Optical, Geometric and Co-factor specificity.	1	1
1.3	Mechanism of enzyme catalysis – Acid-base catalysis, Covalent catalysis, Metal ion catalysis.	1	1
1.4	Mechanism of enzyme catalysis – Orientation / Proximity effects, Preferential binding of the transition state complex.	1	1
1.5	Features of active site, activation energy, rate enhancement through transition state stabilization.	1	1
1.6	Enzyme Commission system classification of enzymes.	1	2
1.7	Enzyme Commission system nomenclature of enzymes.	1	2
1.8	Measurement and expression of enzyme activity – IU, katal, enzyme turnover number.	1	1

1.9	Isolation, purification and characterization of enzymes.	1	3
2.0	**ENZYME KINETICS**	**10**	
2.1	Factors affecting the velocity of enzyme catalyzed reaction – Effect of enzyme, substrate and product concentrations on enzyme activity.	1	4
2.2	Factors affecting the velocity of enzyme catalyzed reaction – Effect of temperature, p^H, ions and inhibitors on enzyme activity.	1	4
2.3	Derivation of Michaelis-Menten equation. Vmax value, Km value – Definition and significance.	1	5
2.4	Lineweaver-Burk plot.	1	6
2.5	Reversible enzyme inhibition – competitive, non-competitive and uncompetitive enzyme inhibition with examples.	1	7
2.6	Irreversible enzyme inhibition – active site directed inhibition (affinity labels) and suicide inhibition with examples.	1	7
2.7	Inhibitor design - Tight binding inhibition with examples. Time dependent inhibition with examples.	1	7
2.8	Zymogen forms of enzymes and zymogen activation.	1	7
2.9	Allosteric regulation – Aspartate transcarbamoylase	1	7
2.10	Isoenzymes – Lactate dehydrogenase and Creatine phosphokinase.	1	7
3.0	**METABOLISM OF CARBOHYDRATES**	**11**	
3.1	Glycolysis	1	8
3.2	Substrate level phosphorylation and Oxidative phosphorylation	1	8
3.3	Fate of Pyruvate – Alcoholic fermentation, Lactic acid fermentation	1	8
3.4	Citric acid cycle	1	8
3.5	Electron transport chain – structural components of ETC complexes: I, II, III, IV	1	8
3.6	Electron transport chain – structural components of ETC complexes: ATP Synthase	1	8
3.7	Chemiosmotic hypothesis of ATP synthesis.	1	8
3.8	Energetics of Glycolysis and Citric acid cycle	1	8
3.9	Gluconeogenesis	1	8
3.10	Glycogenesis and Glycogenolysis	1	8
3.11	Regulation of Carbohydrate metabolism	1	8
4.0	**METABOLISM OF PROTEINS AND NUCLEIC ACIDS**	**11**	
4.1	Synthesis of aminoacids – α-KG family, 3-PG family.	1	8
4.2	Synthesis of aminoacids – OAA family, Pyruvate family, PEP and E-4-P family, R-5-P family.	1	8
4.3	Degradation of aminoacids.	1	8
4.4	Deamination and Transmination of aminoacids.	1	8
4.5	Urea cycle.	1	8
4.6	Regulation of aminoacid metabolism.	1	8
4.7	De-novo synthesis of Purines.	1	8

4.8	De-novo synthesis of Pyrimidines.	1	8
4.9	Salvage pathway of nucleotide biosynthesis.	1	8
4.10	Degradation of purines and pyrimidines.	1	8
4.11	Regulation of nucleic acid metabolism.	1	8
5.0	**METABOLISM OF LIPIDS**	**13**	
5.1	β-oxidation of fatty acids – Activation of Fatty acids, Carnitine shuttle	1	8
5.2	β-oxidation of fatty acids – Actual steps of β-oxidation	1	8
5.3	Energetics of the β-oxidation of Palmitic acid.	1	8
5.4	Regulation of β-oxidation of fatty acids.	1	8
5.5	α-oxidation of fatty acids	1	8
5.6	ω-oxidation of fatty acids	1	8
5.7	Oxidation of odd chain fatty acids	1	8
5.8	Synthesis of fatty acids - Fatty acid synthase reactions	1	8
5.9	Regulation of synthesis of fatty acids.	1	8
5.10	Synthesis of Cholesterol – Stage 1 and Stage 2	1	8
5.11	Synthesis of Cholesterol – Stage 3	1	8
5.12	Regulation of synthesis of Cholesterol.	1	8
5.13	Degradation of cholesterol – Formation of bile acid, bile salt and steroid hormones	1	8

Text Books for Reference

- Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis Stevens (2000) Publisher:Oxford University Press, USA
- Enzyme Kinetics and Mechanisms by Taylor Publisher:Spring
- Enzyme Mechanism by P.K. Shivraj Kumar (2007) Publisher:RBSA Publishers
- Biochemistry by Donald Voet, Judith G. Voet Publisher: John Wiley &Sons Inc (2004)
- Principles of Biochemistry by Geoffrey L Zubay, William W Parson, Dennis E Vance Publisher: Mcgraw-hill Book Company – Koga (1995)
- Principles of Biochemistry, 4/e by Robert Horton H , Laurence A Moran, Gray Scrimgeour K Publisher: Pearsarson (2006)
- Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain and Nitin Jain, (2008) Publishers: S. Chand &Co Ltd

Text Books for Enrichment :

- Lehninger Principles of Biochemistry by Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008) 5thEdition, ISBN: 978-0-230-22699-9, Publisher: W. H. Freeman and, Company, New York p: 239-255.
- Biochemistry (6thEdition) by Jeremy M. Berg, John L. Tymoczko Lubert Stryer Publisher: B.I publications Pvt.Ltd (2007)
- A Text Book of Biochemistry by E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, Oxford and IBH Publishing Co., New Delhi, 1974.

- Principles Of Biochemistry, 4/e (2006) by Robert Horton H , Laurence A Moran, Gray Scrimgeour K **Publisher:**Pearson
- Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (second Edition) by Trevor Palmer, Philip Bonner (2007) Publisher:Horwood Publishing Limited

Course	Details			
Code	BT1922602			
Title	**LABORATORY COURSE 2**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	1/II			
Type	Core Course			
Credits	10	Hrs/week	10	Total hours: 180

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Estimate the activity of enzymes.	**E**	2,9
2	Determine the Km and Vmax values of an enzyme	**E**	2,9
3	Investigate the effect of pH and Temperature on Enzyme activity.	**An**	2,9
4	Assess the Ki of enzymes.	**E**	2,9
5	Apply enzyme purification method.	**Ap**	2,9
6	Separate and characterize proteins by SDS-PAGE.	**An**	2,9
7	Predict the significance of experiment using statistical methods	**C**	1,5,9
8	Use statistical software for manipulating biological data.	**Ap**	1,6,9
9	Use bioinformatics databases and sequence analysis tool for mining data.	**An**	1,9
10	Construct an Evolutionary tree for different species	**C**	1,9
11	Predict the interaction of molecules in different biological mechanism and visualize that in visualizing tool	**C**	1,9
12	Design a primer for given sequence	**C**	1,9
13	Demonstrate the use of docking softwares	**Ap**	1,9
14	Identify the principles of antigen antibody reactions by immunological laboratory tests and techniques	**Ap**	2,8,9
15	Demonstrate ELISA and Western Blotting technique	**Ap**	2,8,9
16	Analyze cellular components of leucocytes	**An**	2,8,9
17	Apply different immunological test to detect infection or analysis of antigen or antibody	**Ap**	2,8,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**METABOLISM AND ENZYMOLOGY**	**60**	
1.1	Estimation of the activity of ALP	6	1
1.2	Estimation of the activity of SGOT	6	1
1.3	Estimation of the activity of SGPT	6	1
1.4	Determination of Km and Vmax of enzymes	6	2
1.5	Effect of pH on enzyme activity	6	3
1.6	Effect of temperature on enzyme activity	6	3
1.7	Enzyme inhibition studies – Estimation of Ki	6	4
1.8	Purification of the enzyme – Ammonium sulphate precipitation	6	5
1.9	SDS-PAGE	12	6
2.0	**BIOSTATISTICS AND BIOINFORMATICS**	**60**	
2.1	**Biostatistics**	**20**	
2.1.1	Test of significance of given data	5	7
2.1.2	Chi-square Test & Student's t-test	5	7
2.1.3	ANNOVA	5	7
2.1.4	Analysis of data with statistical packages	5	8
2.2	**Bioinformatics**	**40**	
2.2.1	Retrieval of biological data from databases	5	9
2.2.2	Demonstration of molecular visualizing tool: Rasmol or Pymol	5	11
2.2.3	Analysis of sequence with BLAST tool	5	9
2.2.4	Find evolutionary relationship of given data with phylogenetic tool	5	10
2.2.5	Design and validate primers for a given genome sequence	10	12
2.2.6	Use docking software to study molecular interaction in drug discovery	10	13
3.0	**IMMUNOLOGY**	**60**	
3.1	Agglutination and precipitation tests	10	14
3.2	ELISA	10	15
3.3	Western blotting	10	15
3.4	Differential Counting of leucocytes using Leishman Staining	4	16
3.5	Isolation of PBMC	4	16
3.6	Serological tests for the diagnosis of microbial infections-RPR, RF, ASO, Widal	12	17
3.7	Immunodiffusion in gel-ODD	10	17

Reference

- Manual of Clinical Laboratory Immunology byNoel R. Rose (2002)Washington, D.CASM Press.
- Practical immunology a laboratory manualby Balakrishnan S, Kaliaperumal K, Duraisamy S (2017) Lambert Academic Publishing.
- Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande, I.K International Pvt. LTD, New Delhi, ISBN 81-88237-41-8, p 13-

17, p 39-43.
- Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, p 1- 15, 195-303.
- Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5, p 12 – 18.
- Practical Biochemistry, R.C. Gupta & S. Bhargava (eds) CBS Publishers and Distributors, New Delhi, ISBN 81-239-0124-0 p 9 – 27.

- Claverie, J. M., & Notredame, C. (2011). Bioinformatics for dummies. John Wiley & Sons
- David Mount . Bioinformatics: Sequence and Genome analysis, Cold Spring Harbour Lab Press, New York.
- Rastogi et. al., Bioinformatics: Methods and Applications, Prentice Hall of India.
- Sundar Rao, P. S. S., & Richard, J. (1996). An introduction to biostatistics. New Delhi. PrenticeHall India,
- Pranab Kumar Banerjee, 2004. Introduction to Biostatistics. S. Chand and company Limited.
- Roland Ennos, 2006. Statistical and Data Handling Skills in Biology, 2nd Edition. Pearson Education.

SEMESTER III

Course	Details			
Code	BT1923109			
Title	**BIOPROCESS TECHNOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	2/III			
Type	Core Course			
Credits	4	Hrs/week	4	Total hours: 72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1.	Discuss the history and role of microbes in industrial production of biomolecules	U	7,8,9
2.	Evaluate various screening methodology, strain improvement methods and preservation techniques	E	7,8
3.	Outline the different types of fermentation technology and its application	U	7,8
4.	Discuss the working, configuration and types of bioreactors	U	7,8,9
5.	Apply the concept of fluid rheology and its dimensional less number in fluid mechanics	Ap	7,8
6.	Design and describe various control parameters in a bioreactor	C	7,8,9
7.	Examine the procedures and techniques used in downstream process for product recovery and purification	An	7,8,9
8.	Design the methods and improve the industrial production of microbial products	C	8,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Introduction to Bioprocess Technology**	**8**	
1.1	The Historical foundation and development. Importance of microbes in Industry, Microbial biomass.	1	1
1.2	Importance of Microbial enzymes	1	1
1.3	Isolation of Industrially important microorganisms	1	1
1.4	Primary and Secondary screening	1	2
1.5	SCP and its nutritional values and its different sources	1	1
1.6	SCP production: Bacterial protein, Yeast protein, actinomycetes, mycoproteins, algal proteins (spirulina cultivation)	1	1
1.7	Strain improvement and its methods	1	2

1.8	Preservation and Maintenance of strains	1	2
2.0	**Fermentation Technology**	**12**	
2.1	Primary and Secondary metabolites	1	3
2.2	Batch culture, Specific growth rate	1	3
2.3	Substrate saturation constant	1	3
2.4	Yield co-efficient and its types	1	3
2.5	Microbial growth curve with monad equation	1	3
2.6	Substrate affinity, Continuou sculture (Chemostat)	1	3
2.7	Continuous culture : Turbidostat	1	3
2.8	Dilution rate, Washing out	1	3
2.9	Fed batch culture, maintenance coefficient	1	3
2.10	Product Yield, Solid State Fermentation	1	3
2.11	Submerged Fermentation, Aerobic and Anerobic Fermentation	1	3
2.12	Media Formulation and its types.	1	3
3.0	**Bioreactor Design**	**16**	
3.1	Bioreactor configuration and its parts	1	4
3.2	Function of Probes and valves	1	4
3.3	Function of agitators and aerators	1	4
3.4	Types of Bioreactors: CSTR	1	4
3.5	Pneumatically driven fermentor	1	4
3.6	Air lift Fermentorand Packed Bed reactor	1	4
3.7	Fluidized Bed reactor	1	4
3.8	Reactor Performance	1	4
3.9	Oxygen transfer in reactor system	1	5
3.10	Resistances against oxygen transfer	1	5
3.11	KLa, Reynold's number	1	5
3.12	Types of Fluids	1	5
3.13	Instrumentation of bioreactor (Online and offline) control	1	5
3.14	pH, Temperature, DO probe	1	5
3.15	Tachometer, Load cells	1	5
3.16	Control of Bioreactor	1	6
4.0	**Downstream Process**	**18**	
4.1	Downstream processing: Selection of unit operation with due consideration of physical, chemical and biochemical aspect of biomolecules.	1	7
4.2	Basic review of bioprocess designing, Primary separation and recovery processes	1	7

4.3	Cell disruption methods for intracellular products	1	7
4.4	Removal of insoluble, biomass and particulate debris separation techniques	1	7
4.5	Theory and principle of flocculation and sedimentation	1	7
4.6	Theory and principle of centrifugation and filtration methods	1	7
4.7	Enrichment operations: Membrane – based separations (Micro and Ultra-filtration)	1	7
4.8	Precipitation methods, extractive separation	1	7
4.9	Aqueous two phase extraction	1	7
4.10	Supercritical extraction, *in situ* product removal	1	7
4.11	Integrated bioprocessing	1	7
4.12	Product resolution/fractionation: Adsorptive chromatographic separation processes	1	7
4.13	Electrophoretic separations	1	7
4.14	Hybrid separation technologies (Electro-chromatography).	1	7
4.15	Product finishing: Precipitation/crystallization	1	7
4.16	Mixing and dialysis	1	7
4.17	Distillation and drying	1	7
4.18	Ultracentrifugation as a separation technique for fractionation of cells and proteins.	1	7
5.0	**Industrial Bioprocess Technology**	**18**	
5.1	Current Bioprocess Technology, products: Biopharmaceuticals, specialty products and industrial chemicals.	1	8
5.2	Environmental – management aids: Good manufacturing practices.	1	8
5.3	Fermentative production of alcohol and acetone	1	8
5.4	Fermentative production of butanol and citric acid	1	8
5.5	Fermentative production of acetic acid	1	8
5.6	Fermentative production of lactic acid	1	8
5.7	Fermentative production of amino acids	1	8
5.8	Fermentative production of water soluble vitamins	1	8
5.9	Fermentative production of Fat soluble vitamins	1	8
5.10	Synthesis of Penicillin	1	8
5.11	Synthesis of streptomycin	1	8
5.12	Synthesis of cephalosporin and Tetracycline	1	8
5.13	Microbial production of enzymes: amylase, protease	1	8
5.14	Microbial production of cellulose and pectinase	1	8
5.15	Bread, beer and cheese manufacturing.	1	8

5.16	Rennet preparation	1	8
5.17	Fermented dairy products	1	8
5.18	Fermentation of distilled beverages	1	8

References

- Principles of Fermentation Technology, P.F. Stanbury, A Whitaker and S.J. Hall , 2008, Elsevier
- Bioprocess Technology, P.T. Kalichelvan and Arul Pandi, 2009, MJP Publishers, Chennai
- Bioprocess Engineering, M. Shuler and F.Kargi (2002). Prentice Hall (I) Ltd., N. Delhi
- Bioprocess Technology – Kinetics and reactors , Antan Moser and Philip Manor., 1998, Springer
- Fermentation Microbiology and Biotechnology, E.M.T Mansi, C.F. Bryee A.L. Dmain, A.R. Alliman, 2009, Taylor and Francis, New York
- Comprehensive Biotechnology, Second edition, Elsevier, 2011, Murray Mor. Young (Editor in chief). ISBN -978-0-08-088504-9)
- Industrial Microbiology, Cassida L.E.1968. John Wiley and Sons Publishers.

Course	Details			
Code	BT1923110			
Title	**RECOMBINANT DNA TECHNOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	2/III			
Type	Core Course			
Credits	4	Hrs/week	4	Total hours: 72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	describe the function and applications of DNA editing enzymes	**U**	1
2	recall the methods of DNA ligation and related techniques	**R**	1,8
3	acquire the knowledge of DNA labeling	**U**	1
4	explain the techniques and applications of hybridization techniques	**U**	1,8
5	discuss DNA-Protein Interactions and its detection	**U**	1,6
6	explain the techniques involved in chromosome walking and chromosome jumping	**U**	1
7	differentiate the structure and applications of different cloning and expression vectors	**An**	1,8
8	explain the methods of transformation and cloning	**U**	1,8
9	explain the steps involved in construction of gene libraries and its application	**U**	1
10	describe the strategies for control of gene expression	**U**	1,8
11	compare and contrast different types blotting techniques	**An**	1,8
12	describe the types and application PCR based techniques	**U**	1,7,8
13	explain mutagenesis and methods for the detection of mutation	**U**	1,8
14	explain the technique and applications of various molecular markers	**An**	1,7
15	compare and contrast different types DNA sequencing methods	**An**	1,8
16	explain the steps involved in chemical synthesis of oligonucleotides	**U**	1,2,8
17	explain the applications of recombinant DNA technology	**U**	1,8
18	describe the bioethics: laws, possible dangers to society or nature by recombinant DNA technology	**U**	3,7

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Basics Concepts: Tools and Techniques**	**13**	
1.1	Restriction Enzymes	1	1
1.2	DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase	2	1
1.3	Cohesive and blunt end ligation; Linkers; Adaptors	2	2
1.4	Homopolymeric tailing	1	2
1.5	Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes	2	3
1.6	Hybridization techniques: Northern, Southern and colony hybridization, fluorescence in situ hybridization	2	4
1.7	DNA-Protein Interactions; electro-mobility shift assay; DNaseI foot printing	2	5
1.8	Chromosome walking and chromosome jumping	1	6
2.0	**Cloning Vectors**	**18**	
2.1	Cloning vectors; plasmid vectors: general characteristics and examples	2	7
2.2	Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors	2	7
2.3	Insertion and Replacement vectors; Cosmids	2	7
2.4	Artificial chromosome vectors (YACs; BACs)	2	7
2.5	Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors	2	7
2.6	Expression vectors; pMal; GST; pET-based vectors	1	7
2.7	Protein purification; His-tag; GST-tag; MBP-tag etc.	2	7
2.8	Intein-based vectors	1	7
2.9	Plant based vectors: Ti and Ri plasmids as vectors	2	7
2.10	Yeast vectors and Shuttle vectors	2	7
3.0	**Cloning Methodologies**	**11**	
3.1	Transformation- Insertion of foreign DNA into host cells-methods	2	8
3.2	Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries	2	9
3.3	cDNA and genomic cloning; Expression cloning; jumping and hopping libraries	2	8
3.4	Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display	2	8
3.5	Inducible expression system and control of transgene	2	10

	expression through naturally inducible promoters – lac and trp operons		
3.6	Principles in maximizing gene expression	1	10
4.0	**Molecular Techniques**	**19**	
4.1	Blotting techniques: southern, northern, southwestern	2	11
4.2	PCR and its applications: Primer design; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR and colony PCR	2	12
4.3	proofreading enzymes in pcr	1	12
4.4	cloning of PCR products; PCR in gene recombination; Deletion; addition; Overlap extension	2	12
4.5	Site specific mutagenesis	1	12
4.6	PCR in molecular diagnostics; Viral and bacterial detection	2	12
4.7	PCR based mutagenesis	1	13
4.8	Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)	3	13
4.9	Molecular markers	2	14
4.10	Sequencing methods	2	15
4.11	Chemical Synthesis of oligonucleotides	1	16
5.0	**Applications of Recombinant DNA Technology**	**11**	
5.1	Recombinant hormones	1	17
5.2	Gene therapy	2	17
5.3	Metabolite engineering	1	17
5.4	Imparting new agronomic traits to plants – resistance to abiotic and biotic stress, improving quality and quantity	2	17
5.5	Gene Silencing: RNA interference, antisense technology	2	17
5.6	Gene Knockout: Technique and applications	1	17
5.7	Animal pharming- Principle and applications	1	17
5.8	Bioethics: laws, possible dangers to society or nature	1	18

Reference

1. S.B. Primrose, R.M. Twyman and R.W. Old; Principles of Gene Manipulation. 6th Edition, S.B. University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.
5. Bernard J. Glick, Jack J. Pasternak, Cheryl L. Patten. Molecular Biotechnology – Glick and Pasternac, American Society for Microbiology 4th edition 2010

Course	Details			
Code	BT1923111			
Title	**PLANT AND ANIMAL BIOTECHNOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	2/III			
Type	Core Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Describe the basic procedure and requirements for the development of animal cell culture	**U**	1,2
2	Recall types of stem cells and its significances	**R**	1,7
3	Summarize the knowledge of characterization and maintenance of cell lines	**U**	1,2
4	Explain the applications of animal cell culture and hybridoma technology	**U**	1,7
5	Discuss the steps involved in transgenesis and *in vitro* fertilization	**U**	1,7,8
6	Explain the applications of transgenic animals and cloning	**U**	1,7,8
7	Examine the ethical issues in animal biotechnology	**An**	4
8	Explain the basic requirements, steps involved and applications of plant tissue culture	**U**	1,2,8
9	Explain *Agrobacterium* mediated DNA transfer and significances of Ti and Ri plasmid	**U**	2,8
10	Compare and Contrast the different types of vectors, promoter sequences, reporter genes, methods of gene transfer and consequences	**An**	1,7,8
11	Describe the application of plant transformation for productivity and performance	**U**	1,7,8

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	CO No.
1.0	**Animal Cell Culture**	**11**	
1.1	Brief history of animal cell culture	1	1
1.2	Different type of cell culture media, growth supplements, serum free media, balanced salt solution, other cell culture reagents	1	1
1.3	culture of mammalian cells, tissues and organs	1	1
1.4	primary culture, secondary culture, continuous cell lines, suspension	1	1

	cultures		
1.5	Cell cloning and selection; Cell synchronization	1	1
1.6	embryonic and adult stem cell culture; its applications	1	2
1.7	Characterization and maintenance of cell lines	1	3
1.8	application of animal cell culture for virus isolation and in vitro testing of drugs, production of human and animal vaccines and pharmaceutical proteins	1	4
1.9	measurement of viability & cytotoxicity; testing of toxicity of environmental pollutants in cell culture	1	4
1.10	Hybridoma technology and its applications	1	4
1.11	Three dimensional culture and tissue engineering	1	5
2.0	**Transgenesis and cloning**	**9**	
2.1	Transgenesis: transfection and Transformation of cell, Vectors for animal cells: SV40, adenovirus vectors, baculovirus, lenti virus, poxyvirus	2	5
2.2	Super ovulation, artificial insemination; in vitro fertilization; embryo recovery and culture of embryos	1	5
2.3	Cryopreservation of embryos; embryo transfer technology	1	5
2.4	transgenic manipulation of animal embryos	1	5
2.5	Applications of transgenic animal technology	1	6
2.6	transgenic mice, fish and cattle	1	6
2.7	animal cloning - basic concepts	1	6
2.8	Ethical issues in animal biotechnology	1	7
3.0	**Plant tissue culture**	**12**	
3.1	Plant tissue culture: historical perspective; totipotency	1	8
3.2	media preparation – nutrients and plant hormones; sterilization techniques	1	8
3.3	establishment of cultures – callus culture, cell suspension culture	1	8
3.4	organogenesis; Somatic embryogenesis	1	8
3.5	protoplast culture and somatic hybridization- methods and applications; cybrids and hybrids	2	8
3.6	Applications of tissue culture - micropropagation; somaclonal variation	1	8
3.7	haploid plants and its applications in genetics and plant breeding	1	8
3.8	production of virus free plants	1	8
3.9	germplasm conservation and cryopreservation	1	8
3.10	synthetic seed production	1	8
3.11	plant cell cultures for secondary metabolite production	1	8
4.0	**Transgenic techniques in plants**	**15**	
4.1	Basis of tumour and hairy root formation; role of virulence genes	2	9
4.2	*Agrobacterium* mediated DNA transfer	1	9
4.3	Features and Use of Ti and Ri plasmids: Mechanisms of DNA transfer	2	9
4.4	Binary vectors and triparental mating	2	10
4.5	Use of 35S and other promoters	1	10
4.6	Genetic markers; reporter genes	2	10

4.7	Methods of nuclear transformation; Viral vectors and their applications	2	10
4.8	Multiple gene transfers, Vector-less or direct DNA transfer	2	10
4.9	Transgene stability and gene silencing	1	10
5.0	**Genetically modified crops**	**7**	
5.1	*Application of plant transformation for productivity and performance*: herbicide resistance, insect resistance, Bt genes, Non Bt like protease inhibitors, alpha amylase inhibitor	2	11
5.2	virus resistance, coat protein mediated disease resistance	2	11
5.3	antifungal proteins, PR proteins, nematode resistance	1	11
5.4	marker-assisted selection - strategies for introducing genes of biotic and abiotic stress resistance in plants	2	11

Reference

- Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
- Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.
- Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons.
- Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
- Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell Pub.
- Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
- Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
- Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
- Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker.

Course	Details			
Code	BT1923112			
Title	**ENVIRONMENTAL BIOTECHNOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	2/III			
Type	Core Course			
Credits	4	Hrs/week	4	Total hours: 72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Describe the concepts of ecology; types and components of ecosystem	U	4
2	Explain the trophic structure, energy flow and nutrient cycling in an ecosystem	U	4
3	Discuss global environmental issues, mitigation and biodiversity conservation	An	4
4	Examine various aspects and prospects of biodegradation and bioremediation strategies of xenobiotics/pollutants	An	7,8
5	Compare the level and design effective methods for reduction, treatment and management of waste water	C	7,8
6	Evaluate and suggest effective methods for solid and biomedical waste management	C	7
7	Appraise the use of biofuels as alternatives to fossil fuels	U	7
8	Examine the types, advantages and applications of biofertilizers	An	7
9	Discuss the applications of microbial and environmental biotechnology	An	7,8
10	Discuss the applications of biosensors in environmental pollution detection and monitoring	U	7,8
11	Analyze the environmental risks and benefits of GMOs	An	4

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Environment and Biodiversity**	**16**	
1.1	Principles and concepts of ecosystem; Types of ecosystem	1	1
1.2	Components of ecosystem- abiotic and biotic factors	1	1
1.3	Energy flow and trophic structure (food chain, food web) in an ecosystem	1	2
1.4	Ecological efficiencies & Ecological pyramids	1	2
1.5	Biogeochemical cycles -Nitrogen and Carbon cycle	1	2
1.6	Biogeochemical cycles - P, S & Ca cycles	1	2
1.7	Autecology- Population ecology	1	1
1.8	Synecology-Community ecology	1	1
1.9	Global Environmental problems-Water, air and soil pollution	1	3
1.10	Global Environmental problems-Green house effect, global warming, Climate change, ozone depletion, Land degradation & desertification.	1	3
1.11	Biodiversity: Definition; Types of diversity- Genetic diversity; Species diversity and Ecosystem diversity;	1	3
1.12	Biodiversity hot spots, Endemism and Red data book	1	3
1.13	Biodiversity threats; vulnerability and extinction of biodiversity.	1	3
1.14	Methods of biodiversity conservation; In situ and Ex situ (Gene banks, Cryopreservation, Seed bank).	1	3
1.15	Formative assessment : Interactive writing - Climate change and species extinction risk	1	3
1.16	Formative assessment :Group discussion- International efforts to curb global environmental problems	1	3
2.0	**Xenobiotics, Biodegradation & Bioremediation**	**14**	
2.1	Xenobiotics- definition , Properties & recalcitrance	1	4
2.2	Xenobiotic categories-polychlorinated biphenyls and dioxins, synthetic polymers, alkylbenzyl sulphonates - Source, properties &biological effects	1	4
2.3	Xenobiotic categories- hydrocarbons, chlorinated pesticides, heavy metals-Source, properties& biological effects	1	4
2.4	Biodegradation- Microbial infallibility principle ; types of biodegradation	1	4
2.5	Factors affecting process of biodegradation	1	4
2.6	Use of microbes in biodegradation and biotransformation	1	4
2.7	Enzymes involved in biodegradation, molecular approaches & catabolic plasmids	1	4
2.8	Biodegradation of hydrocarbons	1	4
2.9	Biodegradation of cellulose, lignin & pesticides	1	4
2.10	Microbial transformation, accumulation and biosorption of heavy metals	1	4
2.11	Bioremediation; In situ and Ex situ bioremediation	1	4
2.12	Factors affecting bioremediation; Evaluating Bioremediation	1	4
2.13	Phytoremediation methods.	1	4
2.14	Case study-Oil spill bioremediation	1	4

3.0	**Water pollution monitoring and Waste water treatment**	**13**	
3.1	Overview of standards of water in relation to public health - Potable and non potable water	1	5
3.2	Physical and chemical parameters of water quality.-, pH,Total organic carbon, Nitrogen& Phosphate contents, Suspended solids, salinity & hardness	1	5
3.3	Chemical Oxygen Demand& Biological OxygenDemand	1	5
3.4	Bacteriological quality of water-Total heterotrophic count and MPN method for detecting coliforms -Presumptive, completed, and confirmed test.	1	5
3.5	Types of industrial effluents, characterization of the wastewater.	1	5
3.6	Treatment strategies for waste water- primary treatment	1	5
3.7	Biological treatment-Aerobic and anaerobic methods; Floc based and biofilm based.	1	5
3.8	Secondary treatment technologies- Oxidation ponds, Activated sludge process,	1	5
3.9	Secondary treatment - Trickling filter process, Rotating Biological contactor	1	5
3.10	Secondary treatment technologies- UASB, Submerged aerobic filters, Fluidized Bed Reactor & Packed bed reactor	1	5
3.11	Tertiary treatment methods-Disinfection, ozonation and Chlorination	1	5
3.12	Advanced tertiary treatment methods- Air stripping, Membrane process(Micro, Ultra, Nano filtration; reverse osmosis); Ion exchange process - (Brief notes)	1	5
3.13	Formative assessment: Group discussion - BIS water quality standards	1	5
4.0	**Management of municipal and biomedical waste**	**13**	
4.1	Solid wastes - types & basic aspects of solid waste management;	1	6
4.2	Aerobic and anaerobic treatments of solid wastes	1	6
4.3	Composting of organic wastes & different types of composting methods	1	6
4.4	Vermicomposting- method, organisms used & advantages	1	6
4.5	Anaerobic digestion process, role of microbes &stages of anaerobic digestion	1	6
4.6	Anaerobic digesters, design and biogas generation	1	6
4. 7	Comparison of aerobic and anaerobic methods	1	6
4.8	Review of current MSW management practices in India	1	6
4.9	Hazardous wastes- properties & types and treatment options	1	6
4.10	Sanitary and Secure landfills for MSW and hazardous waste management	1	6
4.11	Biomedical wastes- types & hazards caused by biomedical wastes;	1	6
4.12	Biomedical Handling rules and Treatment strategies for biomedical wastes.	1	6

4.13	Formative assessment: Writing task: Municipal solid waste management issues in Kerala and recommend suggestions to solve the problem	1	6
5.0	**Applications of Environmental Biotechnology**	**16**	
5.1	Biofuel production as an alternative energy resource	1	7
5.2	Biological nitrogen fixation; Phosphate solubilization by microbes or mycorrhizae	1	8,9
5.3	Microbial biofertilizers- types and uses and advantages	1	8
5.4	Algal & other biofertilizers-types and uses and advantages	1	8
5.5	Integrated Nutrient Management Approach	1	8
5.6	Biopesticides -Microbial pesticides and control of insect pests	1	9
5.7	Viral- biopesticides and control of insect pests	1	9
5.8	Biological control of plant pathogens	1	9
5.9	Integrated pest management approaches	1	9
5.10	Bioleaching and metal recovery	1	9
5.11	Biofilms and applications	1	9
5.12	Microbial biosurfactants, types and uses	1	9
5.13	Extremophiles and their applications	1	9
5.14	Biosensors - types and applications in environmental pollution detection and monitoring	1	10
5.15	GMOs and Environmental risk	1	11
5.16	Case study- India's experience with Bt Cotton	1	11

Text Books for Reference

- Bruce Rittman, Perry L. McCarty, Environmental Biotechnology: Principles and Applications, 2nd edition, McGraw-Hill, 2012. ISBN 13:9781259002885.
- Milton Wainwright, An Introduction to Environmental Biotechnology, Kluwer Academic Publishers, Boston. Hardbound, 1999.
- Microbial Ecology. Fundamentals and Applications. Atlas and Bartha, Pearson Education, Benjamin Cummings publishing company. Inc. New Jersy
- Waste water Microbiology, Gabriel Bitton, 2005, John Wiley and Sons, Wiley series in Ecological and Applied Microbiology.
- Environmental Biotechnology, Handbook of Environmental Engineering. Vol.10.Wang, L.K., Ivanov V., Tayi,J.H and Hung Y.T (eds), 2010, Humana Press.

Course	Details			
Code	BT1923603			
Title	**LABORATORY COURSE 3**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	2/III			
Type	Core Course			
Credits	4	Hrs/week	4	Total hours: 180

CO No	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Demonstrate the steps involved in preparation and sterilization of plant tissue culture media	**U**	2
2	Demonstrate and develop callus culture and perform organogenesis	**C**	2,5,8
3	Demonstrate and develop anther and embryo culture	**C**	2,5,8
4	Demonstrate protoplast isolation and perform somatic hybridization	**Ap**	2,5,8
5	Develop hairy root cultures	**C**	2,5,8
6	Demonstrate various methods of plant transformation	**Ap**	2,5,8
7	Demonstrate the steps involved in preparation and sterilization of animal cell culture media	**Ap**	2,5,8
8	Demonstrate the steps involved in the development of primary cell culture	**Ap**	2,5,8
9	Demonstrate the steps involved in passaging and explain the process of evaluation of contamination	**Ap**	2,5,8
10	Demonstrate experiments related to cell viability and cytotoxic assays	**Ap**	2,5,7
11	Analyze the quality of food and milk samples	**An**	2,5,7
12	Explain fermentation technology with models	**An**	2,5,8
13	Prepare immobilised microbial cells for enzyme production	**Ap**	2,8
14	Demonstrate the steps involved in mushroom cultivation	**An**	2,7,8
15	Analyse oxygen demand of waste water	**An**	2,7
16	Discuss the role of bioreactors for waste management & explain prospectus of biogas production	**U**	2,5,7
17	Develop a plan for organic waste composting	**C**	2,5,8
18	Examine bacteriological quality of water	**An**	2,5,7

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Plant Biotechnology**	**70**	
1.1	Plant tissue culture media preparation and sterilization	10	1
1.2	Surface sterilization and inoculation of explants	8	1
1.3	Callus induction and Micro-propagation	10	2
1.4	Anther culture	5	3
1.5	Embryo culture	5	3
1.6	Protoplast isolation- Mechanical & Enzymatic methods	10	4
1.7	Somatic Hybridization	6	4
1.8	Hairy root culture	6	5
1.9	Plant transformation	10	6
2.0	**Animal Biotechnology**	**40**	
2.1	Animal cell culture media preparation and sterilization	10	7
2.2	Development of primary cell culture	10	8
2.3	Passaging and cell counting	5	9
2.4	Cell viability assays	5	9
2.5	Cytotoxic assays	10	10
3.0	**Bioprocess Engineering**	**35**	
3.1	Bacteriological examination of food and milk sample	10	11
3.2	Fermentative production of wine and estimation of alcohol content	5	12
3.3	Fermentative production through solid state fermentation	5	12
3.4	Fermentative production of industrially useful enzyme	5	12
3.5	Immobilisation of microbial cells for enzyme production	6	13
3.6	Mushroom cultivation	4	14
4.0	**Environmental Biotechnology**	**35**	
4.1	Estimation of COD	5	15
4.2	Estimation of BOD	5	15
4.3	Bioreactor studies for waste management	2	16
4.4	Sketch anaerobic digester &Biogas production	3	16
4.5	Categorize Composting techniques	5	17
4.6	Bacteriological examination of water. MPN Method	15	18

References

- Roberta H. Smith (2012). Plant Tissue Culture: Techniques and Experiments. Academic Press; 3rd edition
- Reinert, J., Yeoman, M.M; Plant Cell and Tissue Culture: A Laboratory Manual. Springer-Verlag Berlin Heidelberg
- Neumann, Karl-Hermann, Kumar, Ashwani, Imani, Jafargholi (2009) Plant Cell and Tissue Culture - A Tool in Biotechnology.Springer-Verlag Berlin Heidelberg
- John Masters (2000). Animal Cell Culture: A Practical Approach (Practical Approach Series)OUP Oxford; 3 edition
- R. Ian Freshney (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell; 6th edition.
- Kulandeivelu,S (2012)Practical Manual on Fermentation Technology,I.K. International Publishing House Pvt. Ltd.Delhi

- P T Kalaiselvan&I Arul Pandi(2007) Bioprocess Technology,1st edition, MJP Publishers
- National Engineering Handbook, Part637Environmental engineering, USDA.
- Pepper I. L (1995). Environmental microbiology: a laboratory manual.Academic Press, San Diego, US.
- American Public Health Association (APHA), (1998); Standard methods for the examination of water and waste water; 20th edition, Washington.

SEMESTER IV

Course	Details			
Code	BT1924301			
Title	**CANCER BIOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	2/IV			
Type	Elective			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Explain the fundamental aspects and patho-physiology of cancer	U	1,7
2	Identify the tools and techniques used in cancer detection	U	7
3	Discuss principles of carcinogenesis	U	1,7
4	Explain molecular-cell biology of cancer	U	7
5	Identify the role and molecular basis of metastasis in cancer	U	1,7
6	Discuss the routine and advanced techniques used in the diagnosis and treatment of cancer	U	1,7,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Fundamentals of cancer biology**	**10**	
1.1	Introduction to Cancer Biology	1	1
1.2	Modulation of cell cycle in cancer	2	1
1.3	Different forms of cancers	2	1
1.4	Cancer screening and early detection	1	2
1.5	Detection using biochemical assays	1	2
1.6	tumor markers	2	2
1.7	molecular tools for early diagnosis of cancer	1	2
2.0	**Principles of carcinogenesis**	**7**	
2.1	Theory of Carcinogenesis	1	3
2.2	Chemical carcinogenesis	2	3
2.3	Principles of physical carcinogenesis	2	3
2.4	Mechanisms of radiation carcinogenesis	1	3
2.5	Nutrition and cancer	1	3
3.0	**Principles of molecular cell biology of cancer**	**17**	
3.1	Signal targets and cancer	2	4
3.2	Activation of kinases	1	4

3.3	Proto oncogenes and oncogenes activity	2	4
3.4	Identification of oncogenes	1	4
3.5	Retroviruses and oncogenes	2	4
3.6	Detection of oncogenes	2	4
3.7	Growth factors related to transformation	1	4
3.8	Telomerases	1	4
3.9	Tumor suppressor genes	2	4
3.10	Single Nucleotide Polymorphism (SNP) in cancer	1	4
3.11	Molecular tools for identifying cancer genes	2	4
4.0	**Principles of cancer metastasis**	**7**	
4.1	Clinical significances of invasion	2	5
4.2	Metastatic cascade	2	5
4.3	Basement membrane disruption	1	5
4.4	Proteinase and tumor cell invasion	2	5
5.0	**New molecules for cancer therapy**	**13**	
5.1	Diagnosis of cancers	2	6
5.2	Prediction of aggressiveness of cancer	1	6
5.3	Different forms of therapy	2	6
5.4	Advances in cancer detection	2	6
5.5	Chemotherapy	2	6
5.6	Radiation therapy	2	6
5.7	Use of signal targets towards cancer therapy	1	6
5.8	Gene therapy	1	6

Text Books for Reference:

1. Dunmock N.J And Primrose S.B., “Introduction to Modern Virology”, Blackwell Scientific Publications, Oxford, 1988.
2. Biotechnology- Applying genetic revolution. David P Clark , Nanette J Pazdernik.Elsevier, New York
3. Lewin’s Cells. Lynne Cassimeris,Viswanath R, Lingappa, George Plopper Jones . Bartlett Publishers, London
4. The Cell – A molecular Approach. Geoffrey M Cooper, Robert E Hausman, ASM Press, Washington.

Course	Details			
Code	BT1924302			
Title	**IPR, BIOSAFETY AND BIODIVERSITY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	2/IV			
Type	Elective Theory			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the concepts, criteria, and importance of IPR	U	1,3,9
2	Analyze the basic principles and legal framework of intellectual property rights and its application to biotechnology	An	1,3,9
3	Understand regulatory guidelines and steps involved in protection of intellectual property rights	U	1,3,9
4	Create awareness on the Biosafety, Bioethics and patenting of biotechnological processes and products	U	1,3,9
5	Discuss the pros and cons of transgenic plants and animals	U	1,8,9
6	Identiy good laboratory procedures and practices, describe the standard operating procedures for biotechnology research	An	1,8,9
7	Understand legal, ethical and social impacts of biotechnology research	U	1,8,9
8	Gain a general understanding of the importance of biodiversity and practice of biodiversity conservation	U	1,9
9	Apply the knowledge to our daily life to solve various environmental problems	Ap	8,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**INTELLECTUAL PROPERTY RIGHTS**	**9**	
1.1	Introduction and the need for intellectual property right (IPR)	1	1
1.2	IPR in India – Genesis and Development	1	1
1.3	IPR in other countries	1	1
1.4	Types of IP - Patents, Trademarks, Copyright & Related Rights	1	1
1.5	Types of IP - Industrial Design, Traditional Knowledge and Geographical Indications	1	1

1.6	Importance of IPR – patentable and non patentables; patenting life	1	1
1.7	Legal protection of Biotechnological inventions.	1	2
1.8	Agreements and Treaties - History of GATT & TRIPS Agreement	1	2
1.9	IPR and WTO regime - Consumer protection and plant genetic resources.	1	1
2.0	**PATENTS**	**11**	
2.1	Patent and kind of inventions protected by a patent	1	3
2.2	Indian Patent Act 1970 and Recent amendments	1	3
2.3	Filing of a patent application- precautions before patenting- disclosure/non-disclosure	1	3
2.4	Patent application- forms and guidelines, fee structure, time frames	1	3
2.5	Ownership of patent, Rights of patent holder and co-owner	1	3, 4
2.6	Transfer of patent Rights- Limitations of patent Rights	1	3, 4
2.7	The different layers of the international patent system (national, regional and international options)	1	3, 4
2.8	Plant variety protection and Farmers' Right Act	1	3, 4
2.9	Biopiracy and Bioprospecting	1	3, 4
2.10	Commercializing Biotechnology inventions	1	4, 7
2.11	Case studies on Basmati rice, Turmeric, and Neem patents	1	4, 7
3.0	**BIOSAFETY**	**10**	
3.1	Introduction and Historical backround of biosafety	1	4
3.2	Risk assessment- Primary Containment for Biohazards	1	4
3.3	Biological Safety Cabinets	1	4
3.4	Biosafety Levels of Specific Microorganisms	1	4
3.5	Recommended Biosafety Levels for Infectious Agents and Infected Animals	1	4
3.6	Biosafety guidelines - Government of India	1	4
3.7	GMOs and LMOs: Concerns and challenges	1	5
3.8	Environmental release of GMOs - Risk - Analysis, Assessment, management and communication	1	5
3.9	Roles of Institutional Biosafety Committee	1	5
3.10	Relevant International Agreements including Cartagena Protocol.	1	5
4.0	**BIOETHICS AND BIOSAETY STANDARDS**	**9**	
4.1	Guidelines for research in transgenic plants	1	5
4.2	General issues related to the release of transgenic plants, animals and microorganisms	1	5,7
4.3	General good laboratory practices	1	6
4.4	Importance of good laboratory practices	1	6

4.5	Bioethics and animal rights	1	7
4.6	human cloning- ethical issues	1	7
4.7	Designer babies- Ethical social implications	1	7
4.8	Biowarfare	1	7
4.9	Green peace - Human Rights and Responsibilities	1	7
5.0	**BIODIVERSITY**	**15**	
5.1	Introduction to biodiversity	1	8
5.2	Biodiversity Legislation in India; Indian Biodiversity Act and provisions on crop genetic resources.	1	8
5.3	Convention on Biological Diversity (CBD)	1	8
5.4	Biodiversity Act 2002	1	8
5.5	International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA)	1	8
5.6	Agricultural biodiversity	1	8
5.7	Strategies on PVFR and Biodiversity Acts	1	9
5.8	Conservation strategies for seed gene bank;	1	9
5.9	Climate change and conservation of plant genetic resources	1	9
5.10	Global efforts for management of crop genetic resources	1	9
5.11	Impact of GE crops on Biodiversity.	1	9
5.12	Functions of International union for the protection of new varieties of plants (UPOV)	1	9
5.13	International treaties relating to Biodiversity	1	9
5.14	Seminars on related topics	1	9
5.15	Group Discussions based on recent case studies	1	9

References

- P. Narayanan, Intellectual Property Laws, Eastern Law House.2001
- Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.2009
- John E. Smith, Biotechnology, 3rd Ed.Cambridge University Press.
- Prithipal Singh, an Introduction to Biodiversity, Ane Books India, 2007.
- B R Goel, An Introduction to Biodiversity, Arise Pub, 2006.
- Nirmal Chandra Pradhan, Basics of Biodiversity, Anmol, 2008.
- Padmanabh Dwivedi; S K Dwivedi and M C Kalita, Biodiversity and Environmental Biotechnology, Scientific, 2007.

Important Links

http://www.w3.org/IPR/
http://www.wipo.int/portal/index.html.en
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

Course	Details			
Code	BT1924303			
Title	**BIOPHARMACEUTICALS AND APPLIED NANOTECHNOLOGY**			
Degree	M.Sc.			
Branch(s)	BIOTECHNOLOGY			
Year/Semester	2/IV			
Type	Elective Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Acquire basic concepts of biopharmaceuticals	**U**	1,7,8
2	Recall various sources of drugs	**R**	1,7,8
3	Discuss the routes of drug administration	**U**	1,7,8
4	Explain the factors involved in pharmacodynamics and pharmacokinetics	**U**	1,7,8
5	Describe the concepts of GMP and GLP	**U**	1,7,8
6	Explain the steps involved in modern drug discovery process and clinical trials	**U**	1,7,8
7	Recall drug formulations, dosage forms and therapeutics of biological origin	**R**	1,7,8
8	Discuss various methods of nanoparticle synthesis and their characterization	**U**	1,7,8
9	Describe applications of nanotechnology in human health and evaluation of toxicity of nanomaterials	**U**	1,7,8

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Introduction to Bio-pharmaceutics**	**11**	
1.1	Introduction to bio-pharmaceutics	2	1
1.2	sources of drugs	2	2
1.3	routes of drug administration	2	3
1.4	Pharmacodynamics and Pharmacokinetics: absorption, distribution, metabolism and excretion of drugs	3	4
1.5	GMP and GLP	2	5
2.0	**Drug discovery**	**13**	
2.1	Overview of the drug discovery process- various phases of Drug discovery	2	6
2.2	Modern methods of drug discovery- Computer aided drug	2	6

	design		
2.3	Drug-receptor interactions	2	6
2.4	Clinical trial phases and design	3	6
2.5	Clinical data management- brief introduction	2	6
2.6	Concept of pharmacovigilance	2	6
3.0	**Drug formulations and Novel drug delivery systems**	**10**	
3.1	Dosage forms: solid/tablet, liquid; semisolid and aerosol forms	3	7
3.2	Various categories of therapeutics of biological origin	2	7
3.3	Vitamins	1	7
3.4	Antibiotics	1	7
3.5	hormones	1	7
3.6	vaccines	2	7
4. 0	**Introduction to Nanotechnology**	**9**	
4.1	Physical and chemical properties of nanoparticles	2	8
4.2	Production of nanoparticles: physical, chemical and biological methods	2	8
4.3	Characterization of nanoparticles: spectroscopic studies	2	8
4.4	Microscopic studies: AFM, SEM and TEM	3	8
5.0	**Applications of Nanotechnology**	**11**	
5.1	Nano-biotechnology for human health	2	9
5.2	liposomes and nanoparticles for drug delivery, gene delivery, etc.	3	9
5.3	Nanomaterial - Protein Interactions	2	9
5.4	Use of nanoparticles as molecular imaging probes	2	9
5.5	Toxicity evaluation of nanomaterials	2	9

Reference

- Brahmankar, D.M., "Biopharmaceutical and Pharmacokinetics: A Treatise", Vallabh Prakashan, 1995.
- Notari, R.E., "Biopharmaceutics and Clinical Pharmacokinetics: An Introduction", 4th edition, Marcell Deckker, 2005
- Oliver Kayser, Rainer H. Müller, "Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications", Wiley-VCH Publication, 2004
- Gary Walsh (2003) Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition, John Wiley & Sons, Inc.
- Rodney J. Y. Ho (2013) Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2nd Edition, John Wiley & Sons, Inc.
- Nanobiotechnology: Concepts, Applications and Perspectives (2004), Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
- Nanobiotechnology - II more concepts and applications (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH

Course	Details			
Code	BT1924304			
Title	**RESEARCH METHODOLOGY IN BIOTECHNOLOGY**			
Degree	M.Sc.			
Branch(s)	BIOTECHNOLOGY			
Year/Semester	2/IV			
Type	Elective Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Compare the research process and types of research	**U**	5
2	Understand the concepts and methods of literature survey and data collection	**U**	5,7
3	Make use of computer based tools and techniques in research and analysis	**Ap**	2,5,7
4	design and developing a research plan and able to find the use of computational techniques	**C**	2,5,6
5	Apply the knowledge of Biotechnology research planning, execution and result analysis	**Ap**	2,5,6
6	Compile and correlate the observations and results for publication and gains the technical writing skills	**C**	2,5,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**RESEARCH AND ITS METHODOLOGIES**	**8**	
1.1	Motivation – Objective and significance of research	1	1
1.2	Research process – Observation – Axiom – Theory – Experimentation	2	1
1.3	Types of research (basic, applied, qualitative, quantitative, analytical etc)	2	1
1.4	Features of translational research – Concept of laboratory to market (bench to public) – Industrial R&D	2	1
1.5	Definition of Research Problem and Problem Formulation	1	1
2.0	**LITERATURE SURVEY AND DATA COLLECTION**	**13**	
2.1	Literature Survey: Importance of Literature Survey	2	2
2.2	Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet.	2	2
2.3	Literature Review: Guidelines for Review, Record of Research Review	2	2
2.4	Data Collection: Collection of primary data, Secondary data	1	2

2.5	Data organization: Methods of data grouping	1	2
2.6	Role of Statistics for Data Analysis	2	2
2.7	Diagrammatic representation of data, Graphic representation of data.	1	2
2.8	Sample Design, Need for sampling, some important sampling definitions.	2	2
3.0	**APPLICATION OF COMPUTER IN RESEARCH**	**5**	
3.1	MS office and its application in Research – MS Word, MS Power point and MS Excel	2	3
3.2	Basic principles of Statistical Computation using SPSS	2	3
3.3	Use of Internet in Research – Websites, search Engines, E-journal and E-Library – INFLIBNET.	1	3
4.0	**RESEARCH DESIGN**	**16**	
4.1	Meaning of Research Design, Need of Research Design	2	4
4.2	Feature of a Good Design Important Concepts Related to Research Design	2	4
4.3	Different Research Designs	2	4
4.4	Basic Principles of Experimental Design	2	4
4.5	Developing a Research Plan	2	4
4.6	Design of Experimental Set-up	1	4
4.7	Selecting an experimental design – Sample size – Enzymes and enzymatic analysis	2	4
4.8	Instrumental methods	1	4
4.9	Correlation with published results – Discussion and representation of results	2	4,5
5.0	**PUBLISHING SCIENTIFIC AND TECHNICAL PAPERS**	**12**	
5.1	Types of research report: Dissertation and Thesis, research paper, review article, short communication, conference presentation etc.,	2	5, 6
5.2	Referencing and referencing styles	1	6
5.3	Research Journals, Indexing and citation of Journals- – Importance of impact factor and citation index.	2	6
5.4	Guide to publishing scientific papers	1	6
5.5	Ways to protect intellectual property – Patents- Technology and product transfer research	2	6
5.6	Technical writing skills	2	6
5.7	Plagiarism	1	6
5.8	Research Proposal Preparation	1	6

References :

- Haaland, P.D., "Experimental Design in Biotechnology", Marcel Dekker, 1989.
- Korner, A.M., "Guide to Publishing a Scientific paper", Taylor & Francis group, 2008.
- Kothari, C.R., "Research Methodology: Methods and Techniques", New Age Publications, 2008.
- Malinowski, M.J. and Arnold, B.E., "Biotechnology: Law, Business and Regulation", Aspen Publishers, 2004.
- Marczyk, G.R., DeMatteo, D. and Festinger, D., "Essentials of Research Design and Methodology", John Wiley & Sons Publishers, Inc., 2005
- Ranjit Kumar, Research Methodology: A Step- by- Step Guide for Beginners, 2nd Edition, SAGE, 2005
- Creswell, John W. Research design: Qualitative, quantitative and mixed methods approach. Sage publications, 2013

Course	Details			
Code	BT1924305			
Title	**NUTRITIONAL BIOCHEMISTRY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	2/IV			
Type	Elective Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the basic concepts of nutrition and energy content	U	1,7,8,9
2	Distinguish the role of nutrients in diet	An	1,7,8,9
3	Discuss the nutritional requirements of different age group in the life cycle.	U	1,7,8,9
4	Evaluate the role of nutrition in prevention and treatment of diseases.	E	1,7,8,9
5	Identify and adapt novel trends in nutritional science	C	1,7,8,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**BASIC CONCEPTS**	**5**	
1.1	Energy content and thermogenic effect of foods.	1	1
1.2	Measurement of energy expenditure; direct and indirect calorimetry.	1	1
1.3	Factors affecting energy expenditure and requirements, Energy imbalance.	1	1
1.4	Calorific value, definition of BMR and SDA and their affecting factors.	1	1
1.5	Respiratory quotient, RDA, thermal equivalent of oxygen, calorigenic action of the foods.	1	1
2.0	**NUTRIENTS**	**17**	
2.1	**Role of Carbohydrates in diet**	**3**	
2.1.1	Dietary types, requirements, physiological action, non-starch polysaccharides, Resistant starch, Fructose oligosaccharides (FOS)	1	2
2.1.2	Glycemic index: Factors affecting GI of foods and GI in chronic diseases.	1	2

2.1.3	Dietary fiber, Physiological effects and Potential health benefits.	1	2
2.2	**Role of lipids in diet**	**3**	
2.2.1	Dietary types, dietary needs of lipids; essential fatty acids Tran's fatty acids	1	2
2.2.2	Role of omega 3 and omega 6 fatty acids.	1	2
2.2.3	Deriving nutritional requirements of fats and oils for different age groups.	1	2
2.3	**Role of proteins in diet**	**5**	
2.3.1	Nutritive value of proteins and the methods for its determination.	1	2
2.3.2	Protein reserves of human body; nitrogen balance studies and factors influencing nitrogen balance;	1	2
2.3.3	Essential amino acids and concepts of protein quality; cereal proteins and their limiting amino acids	1	2
2.3.4	Improvement of quality of protein in diet, amino acid imbalance	1	2
2.3.5	Methods of estimating and assessing protein requirements.	1	2
2.4	**Role of vitamins, minerals, water and electrolytes in diet**	**3**	
2.4.1	Role of Fat soluble vitamins in diet	1	2
2.4.2	Role of Water soluble vitamins in diet	1	2
2.4.3	Role of minerals, water and electrolytes in diet	1	2
2.5	**Food components other than essential nutrients**	**3**	
2.5.1	Functional food- Probiotics, prebiotics, GM food, organic foods, Therapeutic foods, Neutraceuticals.	1	2
2.5.2	Bioactive substances from protein foods, Non glycerides in edible oils. Phytoestrogens. Dietary sources and physiological effects.	1	2
2.5.3	Brief introduction to Nutritional supplements, food additives, artificial sweeteners and fat replacers.	1	2
3.0	**NUTRITIONAL REQUIREMENTS OF DIFFERENT AGE GROUP IN THE LIFE CYCLE**	**11**	
3.1	**Balanced diet**- Definition, Recommended dietary allowances for different categories of the human beings.	**1**	3
3.2	**Nutrition in Pregnancy& lactation**	**3**	3
3.2.1	Importance of nutrition prior to (pre maternal period) and during pregnancy (pre natal period).	1	3
3.2.2	Intra-uterine growth retardation, Congenital malformation and gestational diabetes mellitus.	1	3
3.2.3	Factors affecting breastfeeding and fertility.	1	3
3.3	**Nutrition in Infancy**	**4**	3
3.3.1	Nutritional requirements, Breast feeding - Reasons for	1	3

	encouraging breast feeding, artificial feeding.		
3.3.2	Comparative composition of human & bovine milk, humanization of bovine milk.	1	
3.3.3	Formula foods, Weaning and supplementary feeding.	1	3
3.3.4	Feeding of premature and immature babies, feeding problems.	1	
3.4	**Nutrition in school children and Adolescents:** Nutritional requirements, Nutritional issues, problems and common diseases.	**1**	3
3.5	**Geriatric Nutrition*:*** Nutritional requirements of the elderly & dietary management to meet nutritional needs.	**1**	3
3.6	**Vegetarianism:** Importance of vegetarian diet, Principles of planning nutritionally adequate vegetarian diet, Role of vegetarian food in health & diseases.	**1**	3
4.0	**NUTRITION IN PREVENTION AND TREATMENT OF DISEASES**	**13**	
4.1	**Disorders related to nutrition**.	**2**	
4.1.1	Starvation, underweight, obesity, genetic and environmental factors leading to obesity. Management of obesity.	1	4
4.1.2	Malnutrition- Causes, Measure to combat malnutrition.	1	4
4.2	**Role of nutrition in the prevention and treatment of diseases**	**11**	
4.2.1	Diabetes: metabolism, factors affecting blood sugar levels,	1	4
4.2.2	Diabetes: meal management, dietary treatment, oral hypoglycemic drugs, sweeteners- nutritive and non-nutritive.	1	4
4.2.3	Prevention of diabetes.	1	4
4.2.4	Dietary management in acute renal diseases.	1	4
4.2.5	Dietary management in chronic renal diseases.	1	4
4.2.6	Diet in cardiovascular diseases.	1	4
4.2.7	Cardiovascular risk factors - dyslipidemia, atherosclerosis,	1	4
4.2.8	Cardiovascular risk factors - angina pectoris, myocardial infarction, rheumatic heart disease.	1	4
4.2.9	Prevention of CVD.	1	4
4.2.10	Diet for hypertension.	1	4
4.2.11	Diet and cancer.	1	4
5.0	**TRENDS IN NUTRITION SCIENCE**	**8**	
5.1	Nutrigenetics - aims and advantages.	1	5
5.2	Nutrigenomics - aims and advantages.	1	5
5.3	Nutrient-gene interactions.	1	5
5.4	Nutrigenomics and personalized nutrition	1	5
5.5	The effect of nutrients in genetic and epigenetic events.	1	5
5.6	The challenges in applying nutrigenomic data to nutrition.	1	5
5.7	Nutrition and metabolomics.	1	5
5.8	Ayurvedic nutrition.	1	5

Reference

- A Text Book of Medical Biochemistry- M.N.Chatterjee and R.Shindea, Jaypee pub.
- Harper's Illustrated Biochemistry- R.K.Murray, D.K.Grannes and V.W.Rodwell, McGraw Hill
- Medical Physiology- A.C.Guyton and J. E. Hall, Saunders pub.
- Human Physiology- C. C. Chatterjee, Medical Allied Agency
- Nutritional Biochemistry- Swaminathan
- Life span nutrition: Conception through life – S R Rolfes, L K DeBruyne and E N Whitney
- Understanding normal and clinical nutrition – E N Whitney C B Cataldo and S R Rolfes

Course	Details			
Code	BT1924306			
Title	**PHYSIOLOGY**			
Degree	M.Sc.			
Branch(s)	Biotechnology			
Year/Semester	2/IV			
Type	Elective Course			
Credits	3	Hrs/week	3	Total hours: 54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the physiology of circulatory system, respiratory system and excretory system	U	1,8,9
2	Discuss the physiological processes involved nervous and hormonal coordination.	U	1,8,9
3	Identify the physiology of reproductive System	Ap	1,8,9
4	Assess the mechanisms of Photosynthesis and Respiration	E	1,8,9
5	Interpret plant physiological processes	Ap	1,8,9
6	Describe the mechanisms in microbial physiology	U	1,8,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**CIRCULATORY SYSTEM, RESPIRATORY SYSTEM AND EXCRETORY SYSTEM**	**15**	
1.1	**Circulatory System**	**7**	
1.1.1	Circulation. Composition and functions of blood.	1	1
1.1.2	Haemopoiesis and formed elements. Haemoglobin.	1	1
1.1.3	Plasma - function, Blood volume, Blood volume regulation.	1	1
1.1.4	Homeostasis – mechanisms.	1	1
1.1.5	Blood groups: ABO system, determination, importance, Rh.	1	1
1.1.6	Structure of Heart, Myogenic heart, Specialized tissue, ECG – its principle and significance, Cardiac cycle, blood pressure	1	1
1.1.7	Neural and chemical regulation of circulation.	1	1
1.2	**Respiratory System**	**4**	

1.2.1	Functional anatomy, Phases of respiration.	1	1
1.2.2	Transport of gases.	1	1
1.2.3	Exchange of gases.	1	1
1.2.4	Neural and chemical regulation of respiration.	1	1
1.3	**Excretory System**	**4**	
1.3.1	Physiology of excretion, Kidney, Urine formation, Urine concentration, Micturition	1	1
1.3.2	Regulation of water balance.	1	1
1.3.3	Regulation of electrolyte balance.	1	1
1.3.4	Regulation of acid-base balance.	1	1
2.0	**NERVOUS AND HORMONAL COORDINATION, REPRODUCTIVE SYSTEM**	**8**	
2.1	**Nervous system**	**4**	
2.1.1	Neurons, Action potential	1	2
2.1.2	Gross neuro – anatomy of the brain and spinal cord, Central and peripheral nervous system.	1	2
2.1.3	Neural control of muscle tone and posture	1	2
2.1.4	Sense organs - Vision, Hearing, Smell, Taste and Tactile response	1	2
2.2	**Endocrinology**	**2**	
2.2.1	Endocrine glands, Basic mechanism of hormone action	1	2
2.2.2	Hormones and diseases	1	2
2.3	**Reproductive System**	**2**	
2.3.1	Reproductive processes, Gametogenesis, Ovulation	1	3
2.3.2	Neuroendocrine regulation of reproduction.	1	3
3.0	**PHOTOSYNTHESIS AND RESPIRATION**	**11**	
3.1	**Photosynthesis**	**6**	
3.1.1	Light harvesting complexes	1	4
3.1.2	Mechanisms of electron transport	1	4
3.1.3	Photo protective mechanisms.	1	4
3.1.4	CO_2 fixation-C3 pathway	1	4
3.1.5	CO_2 fixation-C4 pathway	1	4
3.1.6	CO_2 fixation-CAM pathway	1	4
3.2	**Respiration**	**5**	
3.2.1	Glycolysis.	1	4
3.2.2	Citric acid cycle.	1	4
3.2.3	Plant mitochondrial electron transport and ATP synthesis.	1	4
3.2.4	Photorespiration.	1	4
3.2.5	Transpiration.	1	4
4.0	**Plant Physiology**	**10**	
4.1	Absorption of water	1	5
4.2	Transport of water	1	5

4.3	Macro nutrients	1	5
4.4	Micro nutrients	1	5
4.5	Plant hormones	1	5
4.6	Plant movements	1	5
4.7	Photoperiodism	1	5
4.8	Vernalization	1	5
4.9	Responses of plants to biotic (pathogen and insects) stresses.	1	5
4.10	Responses of plants to abiotic (water, temperature and salt) stresses.	1	5
5.0	**Microbial Physiology**	**10**	
5.1	Microbial Nutrition	1	6
5.2	Growth yield and characteristics.	1	6
5.3	Strategies of cell division.	1	6
5.4	Stress response.	1	6
5.5	Biochemical Pathways in Microbial Metabolism – Aerobic respiration, Fermentation, Oxidation-Reduction Reactions.	2	6
5.6	Biochemical Pathways in Microbial Metabolism – Fermentation.	2	6
5.7	Biochemical Pathways in Microbial Metabolism – Oxidation-Reduction Reactions.	2	6

Reference

- Vander's Human Physiology- The Mechanism of Body function. Widmaier, Raff, Strang
- Text book of Medical Physiology. Arthur. C. Guyton & John. E. Hall
- Physiological basis of Medical Practice. John. B. west
- Review of Medical Physiology. William. F. Ganong
- Essentials of Medical Physiology. K. Sembulingam & Prema Sembulingam
- Text book of plant physiology. V. Verma
- Plant Physiology. S. Mukherji., A.K. Gosh.
- Microbial Physiology. Albert G Moat, John W. Foster., Michael P. Spector.
- Microbial Physiology. S Meena Kumari.
- Microbial Physiology and Metabolism. Daniel R Caldwell.

Course	Details		
Code	BT1924604		
Title	**LABORATORY COURSE 4**		
Degree	M.Sc.		
Branch(s)	BIOTECHNOLOGY		
Year/Semester	2/IV		
Type	Practical Course- Core		
Credits	4	Hrs/wk=10	Total Hrs: 180

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	demonstrate the steps involved in nucleic acid isolation and evaluation of isolated product	**Ap**	2,5
2	design PCR protocols or related experiments	**C**	2,5,7
3	explain bacterial conjugation	**U**	2,5
4	explain the steps involved in cDNA preparation	**U**	2,5
5	demonstrate pattern of DNA digestion by restriction enzymes and relate its application in recombinant DNA technology such as RFLP	**Ap**	2,5
6	demonstrate the steps involved in DNA ligation	**Ap**	2,5
7	Design and demonstrate experiments involving bacterial transformation, screening for transformed cells and purification of recombinant proteins	**C**	2,5,8
8	explain the steps involved in blotting techniques and its applications	**U**	2,5,8
9	demonstrate experiments related to molecular markers such as RFLP, RAPD/AFLP; SCAR or SNPs	**Ap**	2,5,7
10	Make use of various softwares such as MS office and others	**Ap**	6,9

PSO – Programme Specific Outcome; CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create**.**

Module	Course Description	Hrs	CO. No.
1.0	**Molecular Biology**	**45**	
1.1	DNA isolation from bacterial cells: isolation and evaluation by electrophoresis	10	1
1.2	DNA isolation from plant/animal tissues : isolation and evaluation by electrophoresis	10	1
1.3	Isolation of plasmids: isolation and evaluation by electrophoresis	10	1
1.4	Isolation of RNA: isolation and evaluation by electrophoresis	10	1
1.5	Determination of purity of isolated DNA/RNA- UV/Vis. Analysis	5	1
2.0	**Recombinant DNA Technology**	**115**	
2.1	Amplification of selective gene by PCR: Amplification and product evaluation by electrophoresis	5	2
2.2	Conjugation	5	3
2.3	cDNA preparation	5	4
2.4	Restriction enzyme digestion: digestion & evaluation by electrophoresis	5	5
2.5	Ligation: Ligation and result evaluation by electrophoresis	5	6
2.6	Competent cell preparation	10	7
2.7	Transformation of bacterial cells : $CaCl_2$ mediated heat-shock	10	7
2.8	Screening of recombinants: Blue-white screening	10	7
2.9	Expression and purification of recombinant proteins	10	7
2.10	Blotting techniques: Southern/western	5	8
2.11	Molecular marker studies: • RFLP • RAPD • SCAR • AFLP • SNP	 10 10 10 10 5	9
3.0	**Familiarization of computer based tools and softwares used in research and report preparation**	**20**	10

References

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