Annamalai University

(Accredited with 'A' Grade by NAAC)

M.Sc. Biotechnology (Two-Year) Programme

Regulations & Curriculum-2019

UGC-SAP and DST-FIST Assisted

Department of Biochemistry and Biotechnology

ANNAMALAI UNIVERSITY

REGULATIONS FOR THE TWO-YEAR POST GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

These Regulations are common to all the students admitted to the Two-Year Master's Programmes in the Faculties of Arts, Science, Indian Languages, Education, Marine Sciences, and Fine Arts from the academic year 2019-2020 onwards.

1. Definitions and Nomenclature

1.1 University refers to Annamalai University.

1.2 Department means any of the academic departments and academic centres at the University.

1.3 Discipline refers to the specialization or branch of knowledge taught and researched in higher education. For example, Botany is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

1.4 Programme encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

1.5 Course is an individual subject in a programme. Each course may consist of Lectures/Tutorials/Laboratory work/Seminar/Project work/Experiential learning/ Report writing/viva-voce etc. Each course has a course title and is identified by a course code.

1.6 Curriculum encompasses the totality of student experiences that occur during the educational process.

1.7 Syllabus is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 Academic Year refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 Semester is a half-year term that lasts for a minimum duration of 90 days. Each academic year is divided into two semesters.

1.10 Choice Based Credit System A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 Core Course is mandatory and an essential requirement to qualify for the Degree.

1.12 Elective Course is a course that a student can choose from a range of alternatives.

1.13 Value-added Courses are optional courses that complement the students' knowledge and skills and enhance their employability.

1.14 Credit refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.15 Credit Hour refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.16 Programme Outcomes (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.17 Programme Specific Outcomes (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.18 Learning Objectives also known as Course Objectives are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student as a result of instruction.

1.19 Course Outcomes (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives. The relationship between PO and CO is mentioned as- 3-substantial/high, 2- medium and 1-low.

1.20 Grade Point Average (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.21 Cumulative Grade Point Average (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.

1.22 Letter Grade is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2. Programmes Offered and Eligibility Criteria

The PG Programmes offered by the Department of Biochemistry and Biotechnology and the eligibility criteria for each of these programmes are as follows:

S.No.	Programme	Eligibility Criteria
1.	M.Sc. Biochemistry	A pass in B.Sc. Biochemistry / Biotechnology / Microbiology / Chemistry / Botany / Zoology with not less than 50% of marks in Part–III.
2.	M.Sc. Biotechnology	A pass in B.Sc. Biotechnology / Biochemistry / Microbiology / Botany / Zoology with not less than 50% of marks in Part–III.

2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for all the above Programmes.

3. Reservation Policy

Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Two Year Master's Programmes consist of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5 Programme Structure

5.1 The Two Year Master's Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental), and Project.

5.2 Core courses

5.2.1 These are a set of compulsory courses essential for each programme.

5.2.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 Elective courses

5.3.1 **Departmental Electives (DEs)** are the Electives that students can choose from a range of Electives offered within the Department.

5.3.2 **Interdepartmental Electives (IDEs)** are Electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties.

5.3.3 Students shall take a combination of both DEs and IDEs.

5.4 Experiential Learning

5.4.1 Experiential learning provides opportunities to students to connect principles of the discipline with real-life situations.

5.4.2 In-plant training/field trips/internships/industrial visits (as applicable) fall under this category.

5.4.3 Experiential learning is categorised as Core.

5.5 Project

5.5.1 Each student shall undertake a Project in the final semester.

5.5.2 The Head of the Department shall assign a Research Supervisor to the student.

5.5.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.5.4 Students who wish to undertake project work in recognised institutions/industry shall obtain prior permission from the University. The Research Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

5.6 Value added Courses (VACs)

5.6.1 Students may also opt to take Value added Courses beyond the minimum credits required for award of the Degree. VACs are outside the normal credit paradigm.

5.6.2 These courses impart employable and life skills. VACs are listed in the University website and in the Handbook on Interdepartmental Electives and VACs.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction, of which 60% (18 hours) shall be Theory and 40% (12 hours) Practical.

5.6.4 Classes for a VAC are conducted beyond the regular class hours and preferably in the II and III Semesters.

5.7 Online Courses

5.7.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.7.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.8 Credit Distribution

The credit distribution is organised as follows:

	Credits
Core Courses	65-75
Elective Courses	15
Project	6-8
Total (Minimum requirement for award of Degree)	90-95

5.9 Credit Assignment

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour per week over a semester

1 Tutorial period of one hour per week over a semester

1 Practical/Project period of two or three hours (depending on the discipline) per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of *Attendance and Assessment Record* for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organisation of lesson plan of the Course Instructor.

6.3 The record shall be submitted to the Head of the Department once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be duly signed by the Course Instructor and the Head of the Department and placed in safe custody for any future verification.

6.5 The Course Instructor shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments, seminars, and viva-voce that would be suitable to the course. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Test-I will cover the syllabus of the first two units while CIA Test-II will cover the last three units.

8.4.5 CIA Tests will be for two to three hours duration depending on the quantum of syllabus.

8.4.6 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first/third semester will be conducted in November and for the second/fourth semester in May.

8.5.2 A candidate who does not pass the examination in any course(s) of the first, second and third semesters will be permitted to reappear in such course(s) that will be held in April and November in the subsequent semester/year.

8.5.3 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1. Each course, both Theory and Practical as well as Project/Internship/Field work/In-plant training shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will constitute 40% and the ESE 60% of the marks.

9.2. Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Instructor

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

	Marks
Test-I & Test-II	15
Seminar	05
Assignment	05
Total	25

9.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

	Marks
Test-I	15
Test-II	15
Viva-voce and Record	10
Total	40

9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by both External and Internal examiners (Double Evaluation).

9.3.2 In case of a discrepancy of more than 10% between the two examiners in awarding marks, third evaluation will be resorted to.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines laid down by the University.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		End Semester Examination (75 Marks)	
Review-I 10	Review-II: 15	Project / Dissertation Evaluation	Viva-voce
		50	25

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal.

9.5.2 Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.3 A committee consisting of the Head of the Department, faculty handling the course and a senior faculty member shall monitor the evaluation process.

9.5.4 The grades obtained in VACs will not be included for calculating the GPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than 40% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.4 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed from the first semester to the current semester.

11.3 The GPA is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

11.4 **CGPA** is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$CGPA = \frac{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

m is the number of semesters

11.5 Evaluation of the performance of the student will be rated as shown in the Table.

Letter Grade	Grade Points	Marks %
S	10	90 and above
A	9	80-89
B	8	70-79
C	7	60-69
D	6	55-59
E	5	50-54
RA	0	Less than 50
W	0	Withdrawn from the examination

11.6 Classification of Results. The successful candidates are classified as follows:

11.6.1 For **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme *in the first attempt* with a CGPA of 8.25 or above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (*See Section 12 for details*).

11.6.2 For **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 or above.

11.6.3 For **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11. 6.4 Candidates who obtain highest marks in all examinations at the first appearance alone will be considered for University Rank.

11.7 Course-Wise Letter Grades

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point.

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for Withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in **ANY ONE** of the semesters **ONLY** for exigencies deemed valid by the University authorities.

12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.

12.4 Application for withdrawal shall be considered **only** if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal is **not** granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. Academic misconduct

Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitised on issues of academic integrity and ethics.

14. Transitory Regulations

Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. *Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.*

Annamalai University

Department of Biochemistry & Biotechnology

M.Sc. Biotechnology (Two Year) Programme
Programme Code: SBIO22

Programme Structure
(For students admitted from the academic year 2019-2020)

Course Code	Course Title	Hours/Week		C	Marks		
		L	P		CIA	ESE	Total
Semester - I							
19BITC101	Core 1: Biomolecules and Metabolism	4	-	4	25	75	100
19BITC102	Core 2: Molecular Cell Biology	4	-	4	25	75	100
19BITC103	Core 3: Enzyme Technology	4	-	4	25	75	100
19BITP104	Core 4: Practical I - Biomolecules, Cell Biology and Enzymes	-	12	6	40	60	100
	Elective 1: Interdepartmental Elective	3	-	3	25	75	100
				21			
Semester - II							
19BITC201	Core 5: Applied Microbiology and Immunotechnology	4	-	4	25	75	100
19BITC202	Core 6: Advanced Molecular Biology	4	-	4	25	75	100
19BITC203	Core 7: Genetic Engineering	4	-	4	25	75	100
19BITP204	Core 8: Practical II – Immunotechnology, Molecular Biology and Genetic Engineering	-	12	6	40	60	100
	Elective 2: Interdepartmental Elective	3	-	3	25	75	100
	Elective 3: Department Elective	3	-	3	25	75	100
				24			
Semester - III							
19BITC301	Core 9: Analytical Techniques and Nanobiotechnology	4	-	4	25	75	100
19BITC302	Core 10: Industrial and Environmental Biotechnology	4	-	4	25	75	100
19BITC303	Core 11: Plant Biotechnology	4	-	4	25	75	100
19BITC304	Core 12: Animal Biotechnology	4	-	4	25	75	100
19BITP305	Core 13: Practical III -Analytical Techniques, Nanobiotechnology, Industrial and Environmental Biotechnology and Animal Biotechnology	-	12	6	40	60	100
	Elective 4: Interdepartmental Elective	3	-	3	25	75	100
	Elective 5: Department Elective	3	-	3	25	75	100
				28			
Semester - IV							
19BITC401	Core 14: Food and Medical Biotechnology	4	-	4	25	75	100
19BITC402	Core 15: Genomics, Proteomics and Bioinformatics	4	-	4	25	75	100
19BITP403	Core 16: Practical IV – Bioinformatics, Food and Medical Biotechnology	-	12	6	25	75	100
19BITPJ404	Project Work / Inplant training	-	10	6	25	75	100
				20			
	Total Credits			**93**			
	Value Added Courses						

L- Lectures; P- Practical; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

Note:

1. **Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.**
2. **Students may opt for any Value-added Courses listed in the University website.**

Elective Courses

Department Elective (DE)

S.No.	Course Code	Course Title	Hours/Week		C	Marks		
			L	P		CIA	ESE	Total
1.	19BITE205.1	Developmental Biology	3	-	3	25	75	100
2.	19BITE205.2	Clinical Biochemistry	3	-	3	25	75	100
3.	19BITE205.3	Basic Endocrinology	3	-	3	25	75	100
4.	19BITE306.1	Biotechnology Management	3	-	3	25	75	100
5.	19BITE306.2	Medical Laboratory Technology	3	-	3	25	75	100
6.	19BITE306.3	Drug Design and Drug Development	3	-	3	25	75	100

Interdepartment Elective (IDE)

S.No.	Course Code	Course Title	Department	Hours/Week		C	Marks		
				L	P		CIA	ESE	Total
1.	19 SOSX 115.1	Soft Skills	English	3	-	3	25	75	100
2.	19 ATX 215.1	Discrete Mathematics	Mathematics	3	-	3	25	75	100
3.	19MATX 215.2	Numerical Methods		3	-	3	25	75	100
4.	19MATX 315.1	Differential Equations		3	-	3	25	75	100
5.	19 STSX 215.1	Statistical Methods	Statistics	3	-	3	25	75	100
6.	19 STSX 215.2	Mathematical Statistics		3	-	3	25	75	100
7.	19 STSX 315.1	Bio-Statistics		3	-	3	25	75	100
8.	19 PHYX 215.1	Classical Mechanics and Special Theory of Relativity	Physics	3	-	3	25	75	100
9.	19 PHYX 215.2	Physics of the Earth		3	-	3	25	75	100
10.	19 PHYX 315.1	Bio-Medical Instrumentation		3	-	3	25	75	100
11.	19 PHYX 315.2	Energy Physics		3	-	3	25	75	100
12	19 CHEX 215.1	Applied Chemistry	Chemistry	3	-	3	25	75	100
13	19 CHEX 315.1	Basic Chemistry		3	-	3	25	75	100
14	19 CHEE 315.2	Instrumental Methods of Analysis		3	-	3	25	75	100
15	19 BOTX 215.1	Plant Tissue Culture	Botany	3	-	3	25	75	100
16	19 BOTX 215.2	Plant Science – I		3	-	3	25	75	100
17	19 BOTX 315.1	Gardening and Horticulture		3	-	3	25	75	100
18	19 BOTX 315.2	Plant Science – II		3	-	3	25	75	100
19	19 ZOOX 215.1	Animal Culture Techniques	Zoology	3	-	3	25	75	100
20	19 ZOOX 315.1	Environmental Science		3	-	3	25	75	100
21	19 GEOX 215.1	Environmental Geosciences	Earth Sciences	3	-	3	25	75	100

22	19 GEOX 315.1	Applied Geophysics		3	-	3	25	75	100
23	19 MIBX 315.1	Microbiology	Microbiology	3	-	3	25	75	100
24.	19 CISX 215.1	R Programming	Computer & Information Science	3	-	3	25	75	100

Interdepartment Elective Offered to Other Departments

Course Code	Course Title	Hours/Week		C	Marks		
		L	P		CIA	ESE	Total
19BIOX215.1	Basic Biochemistry	3	-	3	25	75	100
19BIOX215.2	Basic Biotechnology	3	-	3	25	75	100
19BIOX315.1	Biochemical Techniques	3	-	3	25	75	100
19BIOX315.2	Immunology	3	-	3	25	75	100

Value Added Course

Course code	Course title	Hours/Week		C	Marks		
		L	P		CIA	ESE	Total
CHEA415	Phytochemistry and Biological Activities of Medicinal Plants	3	-	-	25	75	100

Programme Outcomes

PO1: **Domain Knowledge:** Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.

PO2: **Resource Utilisation:** Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.

PO3: **Analytical and Technical Skills:** Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.

PO4: **Critical Thinking and Problem Solving:** Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.

PO5: **Project Management:** Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources.

PO6: **Individual and Team Work:** Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.

PO7: **Effective Communication:** Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.

PO8: **Environment and Society:** Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.

PO9: **Ethics:** Commitment to professional ethics and responsibilities.

PO10: **Life-long Learning:** Ability to engage in life-long learning in the context of the rapid developments in the discipline.

Programme Specific Outcomes

At the end of the programme, the student will be able to

PSO1: Demonstrate an understanding of biological principles and processes occurring in living systems.

PSO2: Apply the knowledge in biotechnology for industrial, pharmaceutical, medical and agricultural applications and find solutions for biotechnological problems.

PSO3: Use current biochemical and molecular techniques to undertake experiments, interpret results and draw conclusions.

PSO4: Use software tools for sequence alignment and structure prediction and data Acquisition for genome and proteome analysis.

PSO5: Understand personal and social responsibilities related to modern biotechnological research and be aware of the ethical issues in biotechnology and intellectual property rights and take up entrepreneurial ventures.

Semester-I **19BITC 101: Biomolecules and Metabolism** **Credits: 4**
Hours: 4

Learning Objective (LO): To comprehend the structure-function relationship of various biomolecules and understand the principles of energy production in cells in relation to metabolic pathways.

Unit-1 Proteins-I

Amino acids - structure and properties. Primary structure - determination of amino acid sequence of proteins. The peptide bond: The Ramachandran plot.
Secondary structures - α-helix, β-sheet and β-turns. Pauling and Corey model of fibrous proteins.
Supersecondary structure - helix-loop-helix, hairpin β-motif, Greek key motif and β-α-β motif. Structural classification of proteins.

Unit–2 Proteins-II

Tertiary structure - all α, all β, α/β, α+β domains. Structural motifs - protein family and superfamily. Quarternary structure - protomers, multimers - rotational and helical symmetry. Collagen triple helix. The structure of haemoglobin. Binding of oxygen to haemoglobin. Hill equation, Bohr effect, changes in conformation on O_2 binding. Role of 2, 3-BPG. Models for haemoglobin allostery. Collagen triple helix.

Unit-3 Nucleic Acids

DNA double helical structure - Watson and Crick model. A, B and Z forms of DNA. Unusual structures - palindrome, inverted repeats, cruciform and hairpins. Triple and quadruple structures. DNA supercoiling. Properties of DNA: buoyant density, viscosity, UV absorption, denaturation, the cot curve. Differences between DNA and RNA. Major classes of RNA -mRNA, rRNA, tRNA: structure and biological functions. Minor classes of RNA. DNA-protein interaction- HTH, HLH, Zinc finger, Leucine Zipper motifs.

Unit-4 Glycosaminoglycans, Glycoconjugates and Lipids.

Glycosaminoglycans - location and biological role of hyaluronic acid, chondroitin sulfate, keratin sulfate, heparin, dermatan sulfate. Sialic acid - significance. Proteoglycans. Glycoproteins and their biological importance. Lectins -function and applications. O-linked and N-linked glycoproteins, GPI linked oligosaccharides. Carbohydrates as information molecules- the sugar code. Blood group antigens and bacterial cell wall polysaccharides.
Fatty acids - saturated, unsaturated and hydroxyl fatty acids. Eicosanoids - biological actions of prostaglandins, thromoxanes, leukotrienes and lipoxins. Phospholipids and glycoshingolipids - biological functions. Steroids - plant and animal sterols, structure, properties and functions of cholesterol. Lipoproteins -classification and composition. Micelles, emulsions and liposomes. Novel role of lipids as signals, cofactors and pigments (an overview).

Unit-5 Metabolism

Bioenergetics: High energy phosphate compounds. Electron transport chain: Oxidative phosphorylation. Anabolism and catabolism. Carbohydrate metabolism (Structure not required) – Brief outline of glycolysis and citric acid cycle. Lipid metabolism (Structure not required): Brief outline of fatty acid oxidation and lipogenesis. Catabolism of amino acid nitrogen and urea cycle. Catabolism of carbon skeleton (Structure not required).

Current Streams of Thought

The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman, 7th ed. 2017.
2. Voet and Voet. Fundamentals of Biochemistry. Wiley. 5th ed. 2018.
3. Rodwell et al. Harper's Illustrated Biochemistry. McGraw Hill. 31th ed. 2018.
4. Berg, Tymoczko. Stryer Biochemistry. Freeman. 8th ed. 2015.

Supplementary Reading

Blackburn et al. Nucleic acids in Chemistry and Biology. Royal Soc Chem. 3rd ed. 2006.

Course Outcomes:
At the end of the course, the student will be able to:

CO1: Know the structural organization of proteins and understand the terms domains and motifs in describing protein structure.

CO2: Understand the basic and alternate structural forms of DNA, types of RNA and their functions.

CO3: Identify the motifs by which proteins interact with DNA

CO4: Apprehend the significance of major glycoconjugates, the biological functions of lipids and the composition of lipoproteins.

CO5: Describe the anabolic and catabolic reactions of major biomolecules.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	3	2	3	3	2	3	3	3	3	2	2	3
CO2	3	3	3	3	3	3	2	3	2	3	3	3	2	3	2
CO3	3	3	2	3	2	3	3	2	3	3	3	3	3	2	3
CO4	3	3	1	3	3	2	2	3	2	3	3	3	2	3	2
CO5	3	3	2	3	3	2	2	3	2	3	3	3	3	3	2

Semester-I **19BITC 102: Molecular Cell Biology** **Credits: 4**
Hours: 4

Learning Objective (LO): To learn in detail about the molecular organization of cells, cell division, membrane transport and cellular response to external stimuli.

Unit-1 Cell and Tissue Organization
Molecular organization of prokaryotic and eukaryotic cells. Structure and functions of subcellular organelles, nucleus and nucleolus. Mitochondrial biogenesis. Cell motility and shape of the cells - the actin, myosin, dynamics of actin assembly, microtubules and intermediate filaments, microtubule dynamics and associated proteins, kinesin, dynein and intracellular transport. Types of tissues - Epithelium – organization and types, Connective tissue. The basement membrane.

Unit-2 Membrane Composition and Transport
Composition of membranes - the lipid bilayer, peripheral and integral proteins. The fluid mosaic model. Brief account of membrane rafts. Endocytosis and exocytosis.
Membrane transport: types. Diffusion - passive and facilitated. General classes of transport systems - uniport, symport, antiport. Active transport - primary and secondary. The P-type ATPases (Na^+-K^+ ATPase), F-type ATPases (ATP synthases), ABC transporters, ionophores, aquaporins, ion-channels (ligand-gated and voltage-gated). Signal mediated transport through nuclear pore complexes.

Unit-3 Cell-cell Adhesion and Secretory Pathway
Major classes of cell junctions - anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs) - cadherins, integrins. Collagen and noncollagen components (laminin, fibronectins, proteoglycans and hyaluronan) of extracellular matrix. Cell-matrix adhesion and communication.
Overview of secretory pathway, Translocation of secretory proteins across the ER Membrane. Golgi and Post-Golgi Protein Sorting and Proteolytic Processing. Receptor-Mediated Endocytosis and the Sorting of Internalized Proteins. Molecular Mechanisms of Vesicular Traffic.

Unit-4 Cell Division, Differentiation, Cell Cycle and Cell Death
Molecular events of mitosis and meiosis. Cell differentiation. The cell cycle: phases, regulation by cyclins and cyclin-dependent kinases, checkpoints. Cell cycle control in mammalian cells. Role of multiple Cdks and cyclins in mammalian cell cycle.
Cell death: types – Necrosis - causes and mechanism. Apoptosis: morphology, mitochondrial and death receptor pathways. Differences between apoptosis and necrosis. Autophagic cell death.

Unit-5 Cell Signaling
Fundamental concepts and general features of cell signaling. Endocrine, paracrine, autocrine signaling and juxtacrine signaling. Types of receptors. Nuclear, cytosolic and transmembrane receptors. G-protein coupled receptors. Second messengers: cAMP, cGMP, diacylglycerol, inositol triphosphate and Ca^{2+}. Receptor tyrosine kinases - ras-raf-MAP kinase and JAK-STAT pathways .Ataxia Telengiectasia Mutated (ATM) signaling.

Current Streams of Thought
The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Karp. Cell and Molecular Biology. Wiley. 8th ed. 2016
2. Lodish et al. Molecular Cell Biology. Freeman. 8th ed. 2017
3. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman. 7th ed. 2017
4. De Robertis, E.D.P. and De Robertis, E.M.F, Cell and Molecular Biology Lippicott Williams & Wilkins. 8th ed. 2016.

Supplementary Reading

Alberts et al. Molecular Biology of the Cell. Garland Sci. 6th ed. 2014.

Course Outcomes

At the end of the course, the student will be able to

CO1: Differentiate prokaryotic and eukaryotic cells.
CO2: Understand the organizational and functional aspects of cells and organelles.
CO3: Learn cell-cell communication as well as interaction with outside environment through transport of molecules.
CO4: Learn how cells respond to external stimuli through the signal transduction mechanisms.
CO5: Appreciate the molecular events involved in cell division, cell cycle and cell death.

Outcome Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	2	3	2	2	3	3	2	3	3	3	2	3	2	2	3
CO2	3	3	2	3	3	2	3	3	2	3	3	3	2	3	3	2
CO3	3	2	1	2	2	3	3	2	3	3	3	2	3	2	2	3
CO4	3	3	2	2	3	2	3	3	2	3	3	3	2	2	3	2
CO5	3	3	2	3	3	2	3	3	2	3	3	3	2	3	3	2

Semester-I **19BITC 103: Enzyme Technology** **Credits: 4**
Hours: 4

Learning Objective (LO): To understand the basic concepts of enzyme action, kinetics, and use of enzymes in industry and medicine.

Unit-1 Enzymes-Classification, Kinetics and Inhibition
Enzymes - Classification and IUB nomenclature. Enzyme kinetics steady state kinetics. Effect of pH, temperature, enzyme and substrate concentration. Michaelis-Menten plot, Lineweaver-Burk plot, significance of Km and Vmax. Kinetics of allosteric enzymes, positive and negative cooperativity. MWC and KNF models. Sequential and nonsequential bisubstrate reactions. Reversible and irreversible inhibition. Effect of competitive, non-competitive and un-competitive inhibitors on Km and Vmax. Brief account on non-protein enzymes and extremozymes.

Unit-2 Functional Forms of Enzymes and Enzymic Regulation
Coenzymes - coenzymic role of thiamine pyrophosphate, FAD, NAD, pyridoxal phosphate, coenzyme A, biotin, folic acid and cobalamine. Multienzyme complexes (PDH). Metal-dependent and metalloenzymes. Isoenzymes (LDH).
Enzyme regulation: feedback inhibition and feedforward stimulation. Enzyme repression, induction and degradation. Zymogen activation. Covalent modification of enzymes - phosphorylation. Compartmentation.

Unit-3 Enzyme Reactors, Engineering and Production
Enzyme reactors: types (stirred tank, continuous flow), Immobilization of enzymes: principles, parameters, carriers (inorganic, polysaccharides, polymers), binding methods (adsorption, covalent), applications. Enzyme engineering: principles, steps, enzyme engineering with reference to lysozyme. Enzyme production and purification: enzyme sources (plant, animal, wild type and recombinant microorganisms), processes to improve enzyme yield. Downstream processing of enzymes and chromatographic purification (brief account).

Unit-4 Industrial Applications of Enzymes
Enzyme electrodes. Biosensors: components, types, (calorimetric, potentiometric, amperometric), applications. Enzymes of industrial significance: use of enzymes in detergents, textiles, and leather industry, production of glucose syrup, cheese production.

Unit-5 Therapeutic uses of Enzymes
Synzymes and solvent engineering. Soluble enzymes - introduction and applications in food, starch processing and detergents. Enzymes as diagnostic aids. Therapeutic uses of enzymes: enzymes as thrombolytic agents and digestive aids. Regulations and safety criteria for production of enzymes and their use. Regulations governing use of enzymes produced in wild-type or recombinant organisms.

Current Streams of Thought
The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Palmer T. Understanding enzymes. Prentice Hall. 2004.
2. Buchholz et al Biocatalysts and Enzyme Technology. Wiley-Blackwell. 2nd ed. 2012.
3. Pandey et al. Enzyme Technology. Springer. 2010.
4. Nelson, Cox. Lehninger Biochemistry. Freeman. 7th ed. 2017.
5. Balasubramanian et al. Concepts in Biotechnology. Univ Press 2007.

Supplementary Reading

1. Dixon and Webb. Enzymes. Elsevier. 2rd ed. 2014.
2. John E. Smith. Biotechnology. Cambridge university press, 5th ed. 2009.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the basic concepts, kinetics and regulatory role of enzymes.
CO2: Comprehend the methods for enzyme production and immobilization
CO3: Design the strategies of enzyme engineering
CO4: Apply the methods for large scale isolation, purification and downstream processing of enzymes
CO5: Apprehend the applications of enzymes as tools in industry and as therapeutics in medicine.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	3	3	2	3	2	3	3	3	3	3	2	3
CO2	3	3	3	3	2	3	3	3	2	3	3	3	2	3	2
CO3	3	3	3	3	3	2	3	2	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	1	3	2	3	3	2	2	3	3	3	3	3	3

Semester-I **19BITP 104: Core Practical - 1** **Credits: 6**

Practicals in Biomolecules, Cell Biology and Enzyme Technology **Hours: 12**

Learning Objectives (LO): To quantitate biomolecules, determine the kinetic parameters of enzymes and to identify cells and tissue types.

1. Qualitative analysis of amino acids
2. Quantitative estimation of amino acids by ninhydrin method
3. Estimation of DNA by diphenylamine method.
4. Estimation of RNA by orcinol method.
5. Identification of tissue types, phases of cell division.
6. Microscopic examination of epithelial cells, plant cells.
7. Isolation of mitochondria from cells
8. Effect of pH on enzyme activity (amylase).
9. Effect of temperature on enzyme activity (amylase).
10. Effect of substrate concentration on enzyme activity (amylase) and determination of Km value.
11. Enzyme immobilization using alginate beads
12. Effect of an inhibitor on enzyme activity.

Text Books

1. Nigam. Lab Manual of Biochemistry. Tata McGraw-Hill Education, New Delhi, India. 2008.
2. Becker WM Kleinsmit, LJ, Hardin J, and Bertoni GP. The World of the Cell, seventh edition. Pearson/Benjamin-Cummings, Boston, MA. 2009.
3. Alan H. Gowenlock. Varley's Practical Clinical Biochemistry. CBS. 6th ed. 2006

Course Outcomes

At the end of the course, the student will be able to

CO1: Analyze amino acids by qualitative and quantitative methods.
CO2: Estimate nucleic acid by chemical methods.
CO3 : Identify and examine plant cells
CO4: Examine different tissue types and the phases of cell division.
CO5 : Evaluate the factors affecting enzyme activity
CO6: Examine the effect of inhibitor on enzyme activity and immobilize enzymes.

Outcome Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	3	3	3	3	2	1	3	3	3	2	1	2	1
CO2	3	3	3	3	3	3	3	1	2	3	3	3	1	2	1	2
CO3	3	3	3	3	3	3	3	2	1	3	3	3	2	2	2	1
CO4	3	3	3	3	3	3	3	1	1	3	3	3	2	1	1	1
CO5	3	3	3	3	3	3	3	2	2	3	3	3	1	3	2	2
CO6	3	3	3	3	3	3	3	2	1	3	3	3	2	3	2	1

Semester-II **19BITC 201: Applied Microbiology and Immunology** **Credits: 4**
Hours: 4

Learning Objective (LO): To learn the classification of microorganisms, mechanism of infection and their role in food borne diseases. Also, to know in detail about immune mechanisms, advances in immunization practices and immunotechniques.

Unit-1 Introduction

Microbiology – classification of microbes. Ultrastructure of bacteria, cell envelope, cell wall – Difference between Gram positive and Gram negative bacteria, slime, flagella, capsule, pili. Microbial staining principle and types. Viruses Classification, ultrastructure plant, animal and bacterial. Life cycle of bacteriophage- Lytic and Lysogeny.

Unit-2 Food and Medical Microbiology

Infectious diseases- Methods of transmission. Host pathogen interactions and establishment of disease. Antibiotics mode of action. Antibiotic resistance. Antimicrobial agents.

Food poisoning - food borne diseases – bacterial and non-bacterial. Investigation of food borne diseases. Microbial quality and safety. Determination of microorganisms in food – culture, microscopy and sampling methods. Microbiology in food sanitation.

Unit-3 Immunity

Innate and adaptive immunity - Lymphoid organs and cells of immune system. Complement classical and alternate pathways. T-cells and B-cell receptors. Effector mechanisms- phagocytosis, cell mediated immunity- antibody-dependent cellular cytotoxicity (ADCC), MHC proteins – Antigen processing and presentation. Inflammatory response to infection. Transplantaion types. Graft Vs host reaction.

Unit-4 Immunization Practices and Immune Disorders

Immunization practices - active and passive immunization. Vaccines- killed, attenuated- toxoids. Recombinant vector vaccines - DNA vaccines, synthetic peptide vaccines. Production and applications of polyclonal and monoclonal antibodies. Genetically engineered antibodies. AIDS – pathogenesis. Tumor immunology - tumor antigens, cancer immunotherapy

Unit-5 Immunotechniques

Agglutination and precipitation techniques. Immunodiffusion techniques, Immunoelectrophoresis, RIA, Immunoblotting, Avidin-biotin mediated immunoassay. Immunohistochemistry, immunofluorescence. Complement fixation test. HLA typing. ELISA- principle and applications. Flow cytometry.

Current Streams of Thought

The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Doyle M.P. and Buchanan R.L. (Ed.) Food Microbiology: Fundamentals and Frontiers. ASM press. 4th ed. 2013
2. Greenwood D et al. Medical Microbiology. Elsevier Churchill Livingstone. 18th ed. 2012
3. Jenni Punt, Sharon Stranford et al. Kuby Immunology. WH Freeman & Co. 8th ed. 2018.
4. Abbas et al. Cellular and Molecular Immunology. Elsevier. 9th ed. 2018.
5. Janeway, C. (Ed), Paul Travers. Immunobiology. Garland Publ. 8^{9h} ed. 2017.

Supplementary Reading

Roitt et al. Roitt's Essential Immunology. Wiley-Blackwell Sci. 13th ed. 2017.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the classification of microorganisms and principles of staining.

CO2: To know about disease transmission, antimicrobial agents and food sanitation

CO3: Apprehend the importance of immunization practices and the development of novel vaccines.

CO4: Interpret the association of immune system with cancer, AIDS, autoimmunity and transplantation.

CO5 Demonstrate techniques involving antigen-antibody reactions and learn their biological applications.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	3	2	3	3	2	3	3	2	2	2	3
CO2	3	3	2	3	2	3	3	3	3	3	3	3	3	3	2
CO3	3	3	3	2	3	2	3	3	2	3	3	3	2	2	3
CO4	3	3	2	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	2	3	3	2	2	3	3	3	3	2	2

Semester-II **19BITC 202: Advanced Molecular Biology** **Credits: 4**
Hours: 4

Learning Objective (LO): To gain an insight into the storage, transfer and translation of genetic information at molecular level in prokaryotic and eukaryotic systems and understand the intricate molecular mechanisms of gene expression regulation.

Unit-1 Genome Complexity and DNA Replication
DNA sequence elements: unique sequence DNA, repetitive DNA - SINEs, LINEs, satellite, minisatellite and microsatellite DNA. C-value paradox. Structure of protein coding genes. Brief account of gene families, pseudogenes. DNA replication. Meselson and Stahl experiment. Enzymes and proteins involved in replication: helicases, SSB, topoisomerases, DNA polymerases, DNA ligase. DNA replication in bacteria and eukaryotes: initiation, elongation, termination. The end-replication problem and telomerase. Inhibitors of replication.

Unit-2 Mutations and Recombination
DNA damage by physical and chemical agents. DNA repair - photoreactivation, excision repair, mismatch repair, SOS response, double strand break repair.
Mutations: types. Point mutations, frameshift mutations and Suppressor mutations- nonsense and missense suppression. Recombination: Homologous recombination- the Holliday model, molecular basis. Site-specific recombination - generation of immunoglobulin receptor diversity. Transposition -transposons. Mechanism of transposition in bacteria and eukaryotes. Consequences and applications of transposition.

Unit -3 Transcription and Post-transcriptional Processing
Transcription in *E. coli:* RNA polymerase subunit structure, promoter sequence steps in transcription-template recognition, initiation, elongation and termination (intrinsic, rho-dependent). Transcription in eukaryotes: RNA pol I, II and III: subunit structure, transcription factors, promoters, inhibitors. Mechanism of RNA pol II transcription: preinitiation complex formation, transcription initiation (activator proteins, mediator, chromatin recruitment), elongation, termination.
Classes of introns. Post-transcriptional processing of prokaryotic and eukaryotic rRNA, tRNA. and eukaryotic mRNA. Brief account of ribozymes, RNA editing and Reverse transcription.

Unit -4 Genetic Code and Translation
The genetic code: general features. Mitochondrial genetic code. Mutations: point mutations and frameshift mutations. Suppressor mutations- nonsense and missense suppression.
Mechanism of protein synthesis in bacteria and eukaryotes: amino acid activation, initiation, elongation and termination. Inhibitors of protein synthesis. Post-translational modifications. Protein targeting to nucleus and subcellular organelles (mitochondria and lysosomes), secretory proteins (the signal sequence hypothesis). Protein degradation: the ubiquitin pathway. Protein folding-models, molecular chaperones.

Unit-5 Regulation of Gene Expression in Prokaryotes and Eukaryotes
Basic principles of gene regulation- levels of gene expression, definition of housekeeping genes, upregulation and downregulation.
Regulation of gene expression in prokaryotes: The *lac* operon. Attenuation and the *trp* operon. Regulation of r-protein operons. Regulation of gene expression by eukaryotes- Transcriptional regulation by steroid hormone receptors, phosphorylation (STAT proteins). Translational-regulation of GAL genes transcription in yeast- Gene silencing - RNA interference. Epigenetic regulation: DNA methylation, HATs and HDACs.

Current Streams of Thought
The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman. 7th ed. 2017.
2. Krebs JE et al. Lewin's. Genes XII. Jones & Bartlett Pub. 2017.
3. Alberts et al Molecular Biology of the Cell. Garland Sci. 6th ed. 2014.
4. Watson. Molecular Biology of the Gene. Pearson Edu. 7th ed. 2017.

Supplementary Reading

1. James D. Watson et al. Recombinant DNA: Genes and Genomes- A short course. Freeman. 3rd ed. 2006.
2. Richard Twyman. Advanced Molecular Biology. Gardlend Science. 2018

Course Outcomes

At the end of the course, the student will be able to

CO1: Comprehend genome complexity and the steps in replication

CO2: Appreciate repair mechanisms and the consequences of DNA mutations and recombination.

CO3: Figure out the steps in transcription and the significance of post transcriptional processing

CO4: Gain in-depth knowledge on genetic code, mechanism of protein synthesis and protein sorting.

CO5: Understand the mechanisms involved in gene expression regulation at transcriptional, translational and epigenetic levels.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	2	3	2	1	3	2	1	3	3	3	2	3	2
CO2	3	2	3	2	3	3	3	3	2	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	2	3	3	3	3	2	3	3
CO4	3	2	2	2	2	2	3	3	3	3	3	3	3	3	2
CO5	3	2	2	2	2	2	3	2	2	3	3	3	2	2	3

Semester-II **19BITC 203: Genetic Engineering** **Credits: 4**
Hours: 4

Learning Objective (LO): To acquire knowledge on cloning strategies, gene expression analysis, genetic engineering techniques and protein and metabolic engineering.

Unit-1 Cloning Strategies
Restriction endonucleases- nomenclature and action. Cloning vectors: Cloning in plasmid vectors (pBR322, pUC18). Bacteriophage lambda vectors- lambda biology, *in vitro* packaging, insertion and replacement vectors. M13 vectors. Cosmids. Expression vectors. BACs and YACs. Methods of ligation of insert and vector- host-organisms for cloning. Genomic and cDNA cloning. Screening methods for recombinants. Genomic libraries: construction, evaluation, growing and storing a genomic library. cDNA libraries: mRNA isolation, cDNA synthesis, construction of a cDNA library.

Unit-2 Expression of Cloned Genes
Factors affecting expression of cloned genes. Expression of cloned genes in bacteria. Fusion proteins, increasing protein stability and secretion. Expression in eukaryotic cells: Expression in yeast- yeast vectors. The GAL system, overexpression and secretion of heterologous proteins in yeast. Expression in insect cells: baculovirus system. Mammalian cell expression systems. Tagged proteins and secretion signals. Identify different host for cloned gene expression and factors affecting it.

Unit-3 Gene Expression Analysis
Analysis of transcription by northern, RNase protection, RT-PCR, *in situ* hybridization, and primer extension assays. Comparison of transcriptomes by differential screening, subtractive hybridization, differential display, array-based methods and microarray. Reporter genes- types and uses. Translational analysis by western, immunocytochemistry, immunohistochemistry, and 2-D electrophoresis.

Unit-4 Techniques
Extraction and purification of nucleic acids- cell lysis, extraction, precipitation, centrifugation, denaturation, purification, detection and quantification. Probe preparation and screening libraries with gene probes, antibodies, rescreening, subcloning. PCR: basic principles, optimization, applications. Reverse Transcriptase (RT)-PCR, real-time PCR, RACE, RAPD, inverse PCR, ligase chain reaction. Gene knock-in and knock-out technology. Characterization of DNA-protein interaction- Gel retardation assay, DNase I foot printing.

Unit-5 Site-Directed Mutagenesis (SDM), Protein and Metabolic Engineering
SDM-Cassette, oligonucleotide-directed mutagenesis, PCR-based methods. Use of SDM for protein engineering to improve enzymes and therapeutic proteins. Protein engineering by directed evolution and DNA shuffling. Metabolic engineering: designed overproduction of phenylalanine, novel routes to small molecules. Combinatorial biosynthesis. Synthetic biology (Brief outline). Hazards and safety aspects of genetic engineering.

Current Streams of Thought
The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Glick and Pasternak. Molecular Biotechnology: Principles and Applications of Recombinant DNA ASM Press. 4th ed. 2010.
2. Dale and von Schantz. From Genes to Genomes: Concepts and applications of DNA technology. Wiley-Interscience. 3rd ed. 2011.
3. Sandy Primrose and Richard Twyman and Bob Old. Principles of Gene Manipulation. Wiley Blackwell. 6th ed. 2002.

Supplementary Reading

1. Winnacker EL. From Genes to Clones. VCH Publ. 1987.
2. Sandy Primrose, and Richard Twyman. Principles of Gene Manipulation and Genomics. Wiley-Blackwell. 7th ed. 2006
3. Watson et al. Recombinant DNA: Genes and Genomes-A Short Course. 3rd ed. Freeman. 2006.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the concept of cloning, expression of desired genes, and construction of genomic library.
CO2: Apply genetic engineering principles to perform gene expression analysis and gene manipulation.
CO3: Understand the principles and applications of RACE, RAPD and PCR
CO4: Apply the knowledge on expression of cloned genes for basic and applied research.
CO5: Comprehend the steps and applications of protein and metabolic engineering

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	3	2	3	3	3	2	3	3	3	3	3	2
CO2	3	2	1	2	3	2	3	2	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	2	2	2	2	3	2	2	3	3	3	3	2	2
CO5	3	2	2	2	2	2	3	2	2	3	3	3	3	2	3

Semester-II **19BITP 204: Core Practical** **Credits: 6**

Practicals in Immunotechnology, Molecular Biology and Genetic Engineering **Hours: 12**

Learning Objective (LO): To isolate and analyze nucleic acids and proteins by molecular biology techniques and perform antigen - antibody reaction *in vitro.*

1. Identification of blood groups and Rh typing.
2. Radial Immunodiffusion.
3. Double diffusion.
4. Agglutination, rosette formation, complement fixation.
5. Immunoelectrophoresis.
6. Isolation of DNA.
7. Isolation of RNA from yeast.
8. Thermal denaturation of DNA.
9. UV absorption spectrum of proteins and nucleic acids- Demonstration.
10. Isolation of bacterial chromosomal and plasmid DNA and characterization by electrophoresis.
11. DNA electrophoresis in agarose gel and southern hybridization
12. SDS-PAGE of proteins and Western hybridization.
13. RNA isolation and cDNA synthesis.
14. RT-PCR
15. Real-time qPCR (Demonstration)

Text Books

1. J Sambrook & D.W.Russell. Molecular cloning: a laboratory manual Vol 1,2 & 3, CSHL Press. 2006.
2. G.K.Pal & P. Pal. Textbook of Practical Physiology. Orient Blackswan. 2nd Ed., 2006.
3. T S Work and E Work. Laboratory techniques in biochemistry and molecular biology. Amsterdam, North-Holland Pub. Co. 2009.

Course Outcomes

At the end of the course, the student will be able to

CO1: Perform and interpret immunodiffusion and immuno electrophoresis.

CO2: Isolate and analyze nucleic acids from various sources.

CO3: Separate proteins in biological samples by SDS-PAGE and study protein abundance by western blotting.

CO4: Identify blood groups and Rh factor

CO5: Undertake PCR analysis and know about real time qPCR

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	2	2	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3	2	2	3	3	3	3	2	3

Semester-III **19BITC 301: Analytical Techniques and Nanobiotechnology** **Credits: 4**
Hours: 4

Learning Objective (LO): To learn the principle, operation, and applications of bioanalytical instruments and understand the principles of nanobiotechnology.

Unit-1 Spectroscopic and Microscopic Techniques

Laws of absorption. Absorption spectrum. Principle, instrumentation and applications of UV-visible spectrophotometry, spectrofluorimetry and luminometry. Atomic emission and absorption spectroscopy. Brief outline of the principles and applications of NMR, ESR, ORD, and CD.

Basic principles and components of light, bright field, phase contrast, fluorescence microscopy. Principles and applications of TEM, SEM and confocal microscopy.

Unit-2 Chromatographic Techniques

General principles of partition and adsorption chromatography. Principle, instrumentation and applications of paper, thin layer and gas chromatography. Column chromatography - packing, loading, eluting and detection.

Principle, procedure, and applications of ion-exchange, molecular exclusion, and affinity chromatography. HPLC, HPTLC - principle, instrumentation and applications.

Unit-3 Electrophoresis and Blotting Techniques

Electrophoresis: General principles. SDS-PAGE, isoelectric focusing and 2-D PAGE. Agarose gel electrophoresis, Detection, estimation and recovery of proteins in gels. Pulsed field gel electrophoresis.

Hybridization techniques: Southern, Northern, Western and Southwestern.

Unit-4 Centrifugation and Radioisotopes Techniques

Basic principles of sedimentation. Low-speed and high-speed centrifuges. Ultracentrifuges. Analytical and preparative ultracentrifuge- instrumentation and applications. Basic principle and technique of subcellular fractionation by differential centrifugation. Density-gradient centrifugation-rate zonal and isopycnic.

Nature and units of radioactivity. Measurement of radioactivity. Solid and liquid scintillation - Scintillation cocktails. Counting, quenching, autoradiograhy. Applications of radioisotopes in biology. Radiation hazards.

Unit-5 Nanobiotechnology

Nanobiology - concepts, definitions. Bionanoparticles - basics of nanobiotechnology. Techniques for visualization of biomolecules at nanoscale - atomic force microscopy, optical microscopy TEM,SEM, FRET, magnetic resonance microscopy. Production of nanoparticles: collision/coalescence mechanism. Nanoparticle agglomerates and aerogels. Biological synthesis of nanoparticles by fungi, bacteria, yeast and actinomycetes. DNA based artificial nanostructures. Nanorobots. Applications of nanotechnology in life sciences and medicine. Nanomolecular diagnostics – use of nanoparticles as molecular imaging probes. Nanoparticles for drug delivery, gene delivery.

Current Streams of Thought

The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text books

1. Andreas Hofmann and Samuel Clokie. Wilson and Walker's Principles and techniques of Biochemistry and Molecular Biology. Cambridge University Press. 8th ed. 2018.
2. Upadhyay, Upadhyay and Nath. Biophysical Chemistry Principles and Techniques. Himalaya Publ. 2010.
3. Goodsell G S. Bionanotechnology: Lessons from nature. John Wiley. 2006.
4. Dinh V. Nanotechnology in Biology and Medicine: Methods, Devices and Applications. CRC Press. 2007

Supplementary Reading

1. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory. 4th ed. 2012.
2. Sambrook and Russell. The Condensed Protocols from Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory. 2006.
3. Pavia, Lampman, Kriz, Vyvyan. Introduction to spectroscopy. Cengage Learning. 5th ed. 2015.
4. Rodney Boyer, Modern Experimental Biochemistry. Pearson Education, Inc. 3rd ed. 2000.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the principle, components and applications of spectroscopic and radioisotope techniques.
CO2: Learn the principle, procedure and applications of different chromatographic techniques.
CO3: Apply electrophoretic and hybridization techniques for biomolecule separation.
CO4: Apply the techniques of sedimentation and microscopy for research.
CO5: Understand the concept of nanobiotechnology and apply the scientific knowledge for solving problems in biology and medicine.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	3	3	3	3	2	2	3	2	3	3	3	3
CO2	3	3	3	3	3	2	3	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3	2	2	3	2	3	3	2	3
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3	2	2	3	3	3	3	3	3

Semester-III **19BITC 302: Industrial and Environmental Biotechnology** **Credits: 4**
Hours: 4

Learning Objective (LO): To gain knowledge on the principles and techniques of bioprocessing, downstream processing, and to learn the role of biotechnology for environmental management and energy production.

Unit–1 Bioprocessing and Bioreactors

Fermentation - Introduction and types. Isolation and screening of industrially important microbes. Maintenance of strains. Strain improvement - mutant selection, recombination, metabolite production by rDNA technology. Inoculum source - seed culture; development of inocula for yeast, bacteria and fungi. Process development. Bioreactors - design, function and types. Aerobic and anaerobic fermentation. Essential criteria for culture media, media components, media formulation, media optimization. Antifoaming devices. Analysis of batch, fed-batch and continuous bioreactors.

Unit–2 Downstream Processing

Downstream processing: Stages: separation of microbial cells and solid matter, solid-liquid separation, release of intracellular compartments, concentration of biological products, purification-membrane filtration, precipitation, adsorption and chromatography, process centrifugation, dialysis, reverse osmosis, ultrafiltration, preservation and stabilization, crystallization and drying. Product formulation. Monitoring of downstream processing.

Industrial production, harvest and uses of enzymes, antibiotics (tetracycline, streptomycin), vitamins (B_2, B_{12}), amino acids (glutamic acid, threonine), organic acid (acetic acid) and organic solvents (acetone, butanol and glycerol).

Unit–3 Pollution and Control

Environmental pollution - types, methods for measurement, biosensors to detect environmental pollutants, hazards from wastes and pollutants. Air pollution and its control through biotechnology. Water pollution and control. Wastewater treatment - physical, chemical and biological. Activated sludge - oxidation ditches and ponds, trickling filter, towers, rotating discs and drums. Anaerobic processes: anaerobic digestion and filters. Effluent treatment: B.O.D and C.O.D Treatment for wastewaters of distillery, dairy, and tannery industries.

Unit–4 Soil and Agricultural Biotechnology

Soil microbiota. Growth, ecological adaptations, interactions among soil microorganisms, biogeochemical role of soil microorganisms. Microorganisms and soil fertility. Microbial degradation of xenobiotics in the environment. Oil spill clean-up. Bioremediation of contaminated soil and waste land. Biofertilisers - Definition - types and application methods. Biopesticides in integrated pest management- *Bacillus* and baculoviruses as biocontrol agents. Biodegradable plastics. Biofilms.

Unit–5 Alternative Energy Sources and Green Technology

Renewable sources of energy (solar, wind, biogas, energy crops, cellulose); Biogas production-hydrogen production using hydrogenase and nitrogenase. Conservation of energy. Bioleaching- use of microorganisms in mining of gold and uranium. Global environmental problems; Ozone depletion, greenhouse effect, impact and management. Mass production of blue green algae. Reforestation through micropropagation- use of *Casuarina,* and mycorrhizae. Development of stress resistant plants. Biodiversity- Alpha and beta diversity. Extinction and endangered species. Conservation of biodiversity. *In situ* and *ex situ*- gene banks, species conservation.

Current Streams of Thought

The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Ratledge and Kristiansen. Basic Biotechnology. Cambridge Univ. Press. 3rd ed. 2006.
2. Gupta PK. Elements of Biotechnology. Rastogi Publication. 2nd ed. 2010.
3. Scragg A. Environmental Microbiology. Am Society for Microbiology. 2nd ed. 2005.
4. Ahmed N. Industrial and Environmental Biotechnology. Horizon Scientific Press. 2014.
5. Primrose, Twyman and Old. Principles of Gene Manipulation. Blackwell Sci. 6th ed. 2002.

Supplementary Reading

Flickinger and Drew (eds). Encyclopedia of Bioprocess Technology. 5 vol. John Wiley & Sons, 1999.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand types of bioreactors, fermentation process and bioprocessing.

CO2: Know the requirements for successful operation of downstream processes for production of biopharmaceuticals.

CO3: Apprehend the harmful effects of pollution and biotechnological measures for pollution control.

CO4: Apply biotechnological process in waste management, cleanup of environment and agricultural improvement.

CO5: Comprehend the fundamentals of biodegradation, biotransformation and bioremediation and apply biotechnological innovation in conservation.

CO6: Recognize the importance of renewable energy sources and green technology.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	1	2	2	3	3	3	1	3	2	1	2	2	3
CO2	3	1	2	1	1	3	3	3	2	3	1	2	1	1	3
CO3	3	2	2	3	2	3	3	3	2	3	2	2	3	2	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	2	3	3
CO5	3	2	3	2	2	3	3	3	3	3	2	3	3	2	3
CO6	3	3	2	3	3	3	3	3	2	3	3	3	3	3	3

Semester-III **19BITC 303 Plant Biotechnology** **Credits: 4**
Hours: 4

Learning Objective (LO): To learn about fundamentals of plant tissue culture, and acquire knowledge on recombinant DNA technology to produce genetically modified plants as well as to understand the right to protect intellectual property and patenting.

Unit-1 Plant Tissue Culture

Plant tissue culture-Scope and importance in crop improvement in crop improvement. Totipotency and morphogenesis. Use of growth regulators. Callus and suspension cultures. Regeneration. Organogenesis and somatic embryogenesis- techniques and applications. Anther, ovary, embryo and meristem culture. Somatic hybridization. In vitro pollination and fertilization. Synseed production. Large-scale culture of plant cells. Production of biochemicals from cultured plant cells. Micropropagation. Somaclonal and Gametoclonal variation. Cryopreservation and ex situ conservation of germplasm. Production of haploid plants and uses of haploids in plant breeding. Protoplast isolation, culture and fusion.

Unit-2 Gene Delivery Methods

Gene delivery methods in plants- *Agrobacterium tumefaciens* mediated transformation- Ti plasmids (cointegrate and binary vectors), direct nuclear transformation (protoplast transformation, particle bombardment), Ri plasmids, viral vectors (CaMV, gemini, TMV), chloroplast transformation and its advantages. Use of reporter genes in transformed plant cells. *Arabidopsis* floral tip transformation.

Unit-3 Techniques in Transgenesis

Selectable markers for plants- drug resistance and herbicide resistance markers. DNA markers in plant genome analysis. RFLPs, RAPDs, DNA fingerprinting - general principles and applications in plant biotechnology. Insect resistance plants - *cry* genes of *B.t.* their proteins and target insects, *cry* gene expression in plants, insect resistance to Cry proteins. Strategies to obtain virus resistant transgenic plants. Herbicide resistance and stress- and senescence - tolerant and disease-resistant plants.

Unit-4 Gene Manipulation

Modification of seed protein quality. Long shelf life of flowers. Suppression of endogenous genes by antisense (delayed ripening) and ribozyme approaches. Cytoplasmic male sterility. Genetic modification of flower pigmentation. Modification of chloroplast and mitochondrial function. Integration and inheritance of transgenes. Terminator technology. Precise genome editing in plants - CRISPR/cas 9 system.

Unit-5 Advantages of Transgenic Plants and IPR

Production of biochemicals and vaccines by transgenic plants. Plant secondary metabolites. Regulatory mechanisms and manipulation of phenylproponoid pathway, shikimate pathway, production of alkaloids. Purification strategies. Problems in gene transfer in plants.

Intellectual Property Rights (IPR) - Legal protection of biotechnological invention- World Intellectual Property rights Organisation (WIPO).Types of IPR- Benefits of IPR system- patents, trade secrets, copyright, trademark, TRIPS. Patent application procedure in India.

Current Streams of Thought

The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Smith RH. Plant Tissue Culture. Elsevier. 3rd ed. 2013.
2. Sandy Primrose, Richard Twyman and Bob Old. Principles of Gene Manipulation and Genomics. Blackwell Sci. 8th ed. 2016.
3. Glick and Pasternak. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press. 4th ed. 2010.
4. James D. Watson et al. Recombinant DNA: Genes and Genomes-A short course. Freeman. 3rd ed. 2006.

Supplementary Reading

Slater A.Plant Biotechnology: The Genetic Manipulation of Plants. Oxford Univ Press. 2nd ed. 2008.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand and learn the techniques for culturing tissues, single cell, protoplast and anther culture and adopt methods of sterilization and cryopreservation

CO2: Learn gene transfer methods and molecular marker assisted selection.

CO3: Evaluate the production and benefits of genetically modified plants.

CO4: Apply rDNA technology for crop improvement.

CO5: Recognize the importance of protection of new knowledge and patenting of innovations in research.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	3	2	3	2	3	3	2	3	3	3	3	2	3
CO2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	2	3	3	3	3	2	3
CO4	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
CO5	3	2	3	2	3	2	3	3	2	3	3	3	3	2	3

Semester-III **19BITC 304 Animal Biotechnology** **Credits: 4**
Hours: 4

Learning Objective (LO): To gain knowledge on animal cell culture, gene manipulation, principles of cloning and transgenic animal technology and safety. Also, to know the ethical principles underlying biotechnology research and develop entrepreneurship skills.

Unit-1 Animal Cell Culture

Advantages and limitations of animal cell culture. Biology of cultured cells - cell adhesion, proliferation, morphology. Basic equipments and culture procedures - preparation, sterilization, disaggregation of tissue (mechanical and enzymatic), subculture, contamination. Primary culture, secondary culture and continuous cell lines. Cell based assays- cell viability and cytotoxicity testing. Monolayer, suspension and immobilized cultures.

Organ and histotypic culture - advantages, limitations, applications. Cell lines development - stages. 3D cultures. Whole embryo culture. Somatic cell hybridization. stem cells: types (embryonic and adult), isolation, identification, differentiation and uses, stem cell engineering. Commercial applications of animal tissue culture.

Unit-2 Manipulation of Reproduction in Animals

Artificial insemination, embryo transfer, *in vitro* fertilization. Composition of IVF media - steps in IVF - micro insemination - PZD, ICSI, SUZI, MESA. Embryo transfer in cattle and applications. Somatic cell cloning- cloning of Dolly. Ethical issues. Production of recombinant vaccine for foot and mouth disease.

Unit-3 Gene Transfer Methods

Vectors for gene transfer in animals: retrovirus. Gene constructs- promoter/enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase, dihydrofolate reductase, CAT. Transfection of animal cells - calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, viral vectors, microinjection.

Unit-4 Transgenic Animal Technology

Methods for producing transgenic animals- retroviral, microinjection, engineered stem cell. Targeted gene transfer. Transgene integration and identification methods. Transgenic cattle, sheep, fish and pigs. Uses of transgenic animals. Transgenic animals as models of human disease.

Unit-5 Biosafety, Bioethics and Entrepreneurship

Biosafety - definition. Biological safety cabinets. Recommended biosafety levels for infectious agents and infected animals. Biosafety regulation in India. Bioethics - definition. Ethical criteria in biotechnology. Ethics of genetically engineered crops. Ethical issues in animal biotechnology. Hazards and safety aspects of tissue culture. Guidelines for use of lab animals in research. Entrepreneurship - definition, needs and importance. Factors necessary for entrepreneurship. Promoting bio-entrepreneurship. Bio-entrepreneurship in India.

Current Streams of Thought

The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Glick and Pasternak. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press. 4th ed. 2010.
2. Primrose Twyman and Old. Principles of Gene Manipulation. Blackwell Sci. 8th ed. 2016.
3. James D. Watson et al. Recombinant DNA. Genes and Genomes–A Short Course. W.H. Freeman. 3rd ed. 2006.
4. Andreas Hofmann and Samuel Clokie. Wilson and Walker's Principles and techniques of Biochemistry and Molecular Biology. Cambridge University Press. 8th ed. 2018.
5. Singh B.D. Biotechnology. Expanding horizons. Kalyani Publ. 2012.

Supplementary Reading

1. Sandy Primrose and Richard Twyman. Principles of Gene Manipulation and Genomics. Wiley-Blackwell. 7th ed. 2006.
2. Freshney RI. Culture of animal cells: A Manual of Basic Technique. Wiley-Liss. 6th ed. 2010.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the fundamental principles that underlie cell culture and carryout cell based assays.

CO2: Comprehend the steps in manipulation of reproduction and acquire knowledge in animal cloning.

CO3: Understand the methods of gene transfer in animals.

CO4: Comprehend the methods of producing transgenic animals and benefits of transgenesis and related issues.

CO5: Recognize the importance of biosafety practices, ethical guidelines for research and entrepreneurship skill development.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	3	3	**3**	2	3	3	3	3	3	2	3
CO2	3	3	3	3	3	2	**3**	3	3	3	3	3	3	3	3
CO3	3	3	3	2	3	3	**3**	3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	**3**	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	**3**	3	3	3	3	3	3	2	3

Semester-III **19BITP 305 Core Practical - 3** **Credits: 6**
Hours: 12

Practicals in Analytical Techniques, Nanobiotechnology, Industrial and Environmental Biotechnology, and Animal Biotechnology

Learning Objective (LO): To learn tissue culture techniques, perform cell based assays, synthesise nanoparticles and analyze water quality.

1. Separation of proteins by SDS-PAGE.
2. GC and HPLC- Demonstration.
3. Preparation of nanoparticles (silver, zinc or chitosan)
4. Microbial production of citric acid using *Aspergillus niger*.
5. Determination of total dissolved solids in water.
6. Determination of D.O. concentration of water sample.
7. Determination B.O.D. of sewage sample.
8. Determination C.O.D. of sewage sample.
9. Estimation of nitrate in drinking water.
10. Immobilization of yeast/microbe
11. Plant tissue culture techniques: preparation of stock solutions of MS basal medium and plant growth regulator stocks.
12. Effect of plant growth regulators on various explants for callus induction.
13. Steps in micro propagation (demonstration)
14. Protoplast isolation and culture.
15. Isolation of lymphocytes and viability testing by trypan blue dye exclusion test.
16. Animal cell culture techniques: Surface sterilization techniques, media preparation and storage, membrane filtration, serum inactivation.
17. Estimation of protein, DNA and RNA from cultured cells.
18. MTT assay for cell viability
19. Preparation of metaphase chromosomes from cultured cells
20. Demonstration of apoptosis in cultured cell
21. Educational visit to biotechnology industries.

Text books

1. Joseph Sambrook, David William Russell. Molecular cloning: A laboratory manual CSHL Press. New York. 3rd ed., 2001.
2. John R.W Masters. Animal Cell Culture: a practical approach. 3rd ed. 2000.

Supplementary Reading

H.N. Thatoi , Supriya, Dash, Swagat Kumar Das. Practical Biotechnology: Principles and Protocols. 2017.

Course Outcomes

At the end of the course, the student will be able to

CO1: Learn the separation of proteins and biological compounds using electrophoresis and chromatography.
CO2: Assess drinking water purity and microbial abundance in sewage samples.
CO3: Synthesize nanoparticles and immobilize microbial cells.
CO4: Undertake chromosomal studies and test viability of lymphocyte preparation.
CO5: Culture cells *in vitro* and perform cell based assays.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	2	3	3	2	3
CO3	3	3	3	3	3	3	3	3	2	3	3	3	3	2	3
CO4	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
CO5	3	3	3	3	3	3	3	3	2	3	3	3	3	2	3

Semester-IV **19BITC 401 Food and Medical Biotechnology** **Credits: 4**
Hours: 4

Learning Objective (LO): To acquire knowledge on food biotechnology, the use of enzymes in food industry and to understand the molecular basis of diseases, diagnosis and therapy.

Unit - 1 Food Spoilage and Preservation
Types and sources of microorganisms associated with food. Conditions influencing microbial growth in food. Composition and spoilage of food, meat, fish, milk and milk products, cereals, pulses, nuts and oil seeds, fruits and fruit products, vegetable and vegetable products. Methods of food preservation. Control of microorganisms by retarding growth - low temperature, drying, intermediate moisture, chemicals. Control of microorganisms by destruction - gas treatments, heat, ionization radiation, ultraviolet radiation. canning and packing (Elementary idea).

Unit - 2 Fermented Foods and Enzymes in Food Industry
Basic principles of food fermentation. Fermented foods : fermented milk- yoghurt, cheese, bread; fermented vegetables- sauerkraut, olives. Fermented meats and fish. Production of beer, wine, and vinegar. Pro-, pre- and synbiotics. Mushroom farming. Use of enzymes in food industry- proteases in food processing, enzymes in baking and dairy industry, enzymes in fruit juice and brewing industry. Pickling and curing.

Unit - 3 Molecular Basis of Diabetes, Atherosclerosis & Cancer
Role of tissues and hormones in blood sugar homeostasis. Diabetes mellitus: classification, diagnosis, management, complications. Atherosclerosis: risk factors and management. Cancer- differences between benign and malignant tumours, growth characteristics of cancer cells, mechanism of radiation, virus and chemical carcinogenesis. Oncogenes and tumor suppressor genes (brief account).

Unit - 4 Molecular Diagnostics
Diagnostic kits - AIDS. Tumor markers - oncofetal proteins, hormones, enzymes, tumor - associated antigens. Prenatal & neonatal screening for genetic disorders. DNA diagnostic systems- probes. RFLP & PCR in disease diagnosis. Histocompatibility testing: cross matching. Viral diagnostics: immunodiagnosis, molecular diagnosis. SNP-based diagnosis.

Unit - 5 Molecular Therapeutics
Mabs, growth factors and interferons as therapeutic agents. Therapeutic agents from nonrecombinant and recombinant organisms. Antivirals and antiretrovirals. Drug delivery and targeting. Gene therapy: gene delivery systems, *ex vivo* and *in vivo* strategies, gene therapy for single-gene disorders, cancer and AIDS. Antisense and siRNA therapy. Nanotherapy. Stem cell therapy. Bioethics - Food and drug safety. Ethical issues in human gene therapy, human genome analysis and human cloning.

Current Streams of Thought
The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Mathews & Montville et al. Food Microbiology: An introduction. ASM Press. 4th ed. 2017.
2. Borem et al Understanding Biotechnology. Pearson 2011.
3. Adams and Moss. Food Microbiology. Royal SocChem. 4th ed. 2015.
4. Glick and Pasternak. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press. 4th ed. 2010.
5. Singh BD. Biotechnology. Kalyani Publ. 2012.

Supplementary Reading

1. Ward OP. Fermentation Biotechnology. John Wiley 1991.
2. Maulik and Patel Molecular Biotechnology Wiley-Liss. 1997.
3. James D. Watson et al. Recombinant DNA: Genes and Genomes - A short course. 3rd ed. Freeman. 2006.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the factors influencing food spoilage and apply traditional and modern methods of food preservation.

CO2: Apprehend the uses of fermented foods, enzymes in food industries and concepts in food safety laws and standards.

CO3: Understand the risk factors and molecular aspects of human diseases.

CO4: Use diagnostic kits for screening diseases and understand recent molecular diagnostic methods.

CO5: Know the new therapeutic approaches like nanotherapy, gene therapy and stem cell therapy and related ethical issues

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	3	2	2	3	3	3	3	2	3	2	3	3
CO2	3	3	3	2	3	3	3	3	2	3	3	3	3	2	3
CO3	3	3	2	2	3	2	3	3	2	3	2	3	2	2	2
CO4	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3
CO5	3	3	2	3	2	2	3	3	3	3	2	3	3	2	3

Semester-IV **19BITC 402 Genomics, Proteomics and Bioinformatics** **Credits: 4**
Hours: 4

Learning Objective (LO): To learn the principles of genome mapping, sequencing and analysis, structural and functional proteomics and basic concepts of sequence, structural alignment, database searching and protein structure prediction.

Unit–1 Genome Mapping and Sequencing
Definition of genome and genomics. Types of gene map-genetic, cytogenetic and physical. Molecular markers for mapping - RFLPs, microsatellites and SNPs. Physical mapping - *in situ* hybridization, STG mapping. Chromosome walking and jumping. Genome sequencing approaches: whole-genome shotgun, hierarchical shotgun.

Unit–2 NGS, Genome Projects, Post-Genome Analysis
Next-Generation Sequencing. Exome sequencing. Genome annotation - ORF scanning, Tilign array, Similarity searchers. Genome projects - Sequence data of *E.coli* and *D.melanogaster*. The Human Genome Project: goals, sequencing technologies, results, potential benefits, ethical, legal and social issues (ELSI).Post-genome analysis- microarrays, transcriptome, ChIPs, knock-out analysis, genome editing - CRISPR/Cas9

Unit–3 Protein Separation, Identification and Quantitation
Proteomics-introduction. Protein separation-general principles. 2D-gel electrophoresis, liquid-liquid chromatography. Protein identification by antibodies, Edman degradation, mass spectrometry - basic principle and instrumentation, ESI, MALDI-TOF, SELDI-TOF, tandem MS. Peptide mass fingerprinting (elementary details).

Unit–4 Structural & Functional Proteomics & Applications
Structural proteomics: X-ray and NMR for protein structure analysis. Comparative and homology modeling, secondary structure prediction, fold recognition and *ab initio* prediction. SCOP. Protein sequence analysis: substitution score matrices, pairwise similarity search, pattern recognition.
Protein function determination: database search for homology. Protein-protein interactions: yeast 2-hybrid system. Protein arrays and chips (concept and applications). Applications of proteomics - protein mining, protein expression profiling, mapping protein-network, co-immunoprecipitation, pull down assay, drug diagnostics, and drug discovery.

Unit–5 Bioinformatics
Useful search engines. File formats. PubMed. Bioinformatics workstation, Unix. Biological databases (primary, secondary, organism-specific, miscellaneous). Data submission and retrieval. Sequence alignment: substitution scores and gap penalties. Database similarity searching: BLAST, FASTA. Multiple sequence alignments: CLUSTAL. Gene discovery and prediction. Molecular phylogenetics: phylogenetic tree construction and analysis. Identification of orthologs and paralogs. Protein structure database-protein structure visualization, comparison and classification. Protein motifs and domain prediction. NGS data analysis.

Current Streams of Thought
The faculty will impart knowledge on the current developments in the subject of study to the students and this component will not be covered in the examinations.

Text Books

1. Lesk A Introduction to Bioinformatics. OUP. 4th ed. 2014.
2. Primrose. Principles of Genome Analysis and Genomes. Wiley-Blackwell. 3rd ed. 2006.
3. Brown. Genomes. Wiley. 5th ed. 2006
4. Hartwell etal. Genetics: From Genes to Genomes. 5th ed. 2014.
5. Twyman. Principles of Proteomics. 2nd ed. 2013

Supplementary Reading

1. Gibas and Per Jambeck. Developing Bioinformatics Computer Skills. O'Reilly Associates. 2nd ed. 2013.
2. Baxevanis, Ouellette. Bioinformatics. A Practical Guide to the Analysis of Genes and Proteins. Wiley Interscience. 3rd ed. 2004.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand types of gene map, molecular markers and classical and new generation genome sequencing approaches.

CO2: Comprehend genome projects, post-genome analysis and ELSI

CO3: Apply the modern methods for separation, identification ,quantitation and structural analysis of proteins

CO4: Apply structural bioinformatics tools to predict and elucidate protein structures and map protein interactions.

CO5: Retrieve, align, analyze and interpret sequences and structural data from databases.

CO6: Construct phylogenetic tree of different sequences and apply database information for molecular modelling.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	2	1	2	3	2	3	3	2	3	3	3	3
CO2	3	3	3	3	2	3	3	3	2	3	3	3	2	3	3
CO3	3	3	3	2	2	3	3	2	2	3	2	3	3	3	3
CO4	3	3	2	3	3	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	2	3	2	3	3	2	3	2	3	3
CO6	3	3	3	3	2	3	3	3	2	3	3	3	3	3	3

Semester-IV **19BITP 403 Core Practical – 4** **Credits: 6**

Practicals in Bioinformatics, Food and Medical Biotechnology **Hours: 12**

Learning Objective (LO): To learn and use bioinformatics tools, acquire skills in food microbiology and analyze blood parameters for clinical relevance.

1. Nucleotide and protein databases - Sequence alignment and searching
2. Multiple sequence alignment
3. Phylogenetic analysis
4. Protein sequence analysis, structure prediction
5. Primer designing
6. SNP and ORF finding in DNA sequence
7. Visualization tools.
8. Molecular modeling.
9. Dehydration of fruits and vegetables. Preparation of fruit juice powders.
10. Isolation of microbes from spoiled vegetables.
11. Preparation of fruit juice concentrates and use of enzymes for clarity.
12. Identification & characterization of proteins resolved on 2D PAGE (Demonstration).
13. HPTLC and GC-MS - (Demonstration).
14. Structure determination of proteins and nucleic acids by NMR & XRD- (Demonstration).
15. Aseptic packaging, freeze preservation, drying and dehydration, food fermentation, pickling and curing.
16. Preservation of food products using chemical preservatives.
17. Tissue collection, formalin fixation, sectioning, and staining.
18. Determination of biochemical analytes by autoanalyser (Demonstration).
19. Kit based detection of cholesterol and blood glucose
20. Use of ELISA for disease diagnosis- (Demonstration).

Text Books

1. Michael Agostino. Practical Bioinformatics,1st ed. Garland science
2. Ashish S Verma. Laboratory Manual for Biotechnology Paperback. 2014 ,Sultan chand and Company

Course Outcomes

At the end of the course, the student will be able to

CO1: Retrieve, align and analyze protein and nucleic acid sequences and structures
CO2: Adopt appropriate tools to model and visualize proteins
CO3: Acquire skills for preservation of foods and to check food quality
CO4: Quantitatively analyze blood parameters of clinical importance and acquire skills in histology
CO5: Understand the handling of ELISA, HPTLC, autoanalyser, 2D-PAGE, NMR and XRD.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	3	3	2	3	2	2	3	2	3	2	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	2	3	2	3	2	3	3	3	3
CO4	3	3	3	3	3	3	3	2	1	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3	2	2	3	2	3	3	3	3

Department Electives (DE)

19BITE 205.1 Developmental Biology

Credits: 3
Hours: 3

Learning Objective (LO): To learn the different phases of embryo development and associated medical implications.

Unit -1 Basic Concepts of Development

History and the origin of developmental biology - cell theory, mosaic and regulative development, discovery of induction, basic concepts of developmental biology- cell division, cell differentiation, signaling, patterning; model systems: vertebrates model organism - *Xenopus laevis*, chicken, mammals, zebrafish; invertebrate model organism- *Drosophila melanogaster*, *Caenorhabditis elegans.*

Unit-2 Early Embryonic Development

Early embryonic development of vertebrates and invertebrates: structure of the gametes - the sperm, the egg; cleavage and gastrulation; axes and germ layers; morphogenesis - cell adhesion, cleavage and formation of blastula, gastrulation, neural tube formation, cell migration; Axis specification in *Drosophila*; origin of anteriorposterior and dorsal - ventral patterning- role of maternal genes, patterning of early embryo by zygotic genes; segmentation genes - the gap genes, the pair - rule genes, the segment polarity genes, the homeotic selector genes - bithorax and antennapedia complex.

Unit-3 Organogenesis

General concepts of organogenesis: development of chick limb- development and patterning of vertebrate limb, proximal - distal and dorso - ventral axis formation, homeobox genes in patterning, insect imaginal disc - determination of wing and leg imaginal discs, organizing center in patterning of the wing, butterfly wing development, the homeotic selector genes for segmental identity; insect compound eye - morphogenetic furrow, ommatidia, signaling, eyeless gene; kidney development - development of ureteric bud and mesenchymal tubules.

Unit-4 Postembryonic Development

Postembryonic development: growth - cell proliferation, growth hormones; ageing - genes involved in alteration in timing of senescence; regeneration - epimorphic regeneration of reptile (salamander) limb, requirement of nerves for the proliferation of blastema cells; embryonic stem cells and their applications.

Unit-5 Medical Implications of Developmental Biology

Medical implications of developmental biology: genetic errors of human development - the nature of human syndromes - pleiotropy, genetic heterogeneity, phenotypic variability, mechanism of dominance; gene expression and human disease - inborn errors of nuclear RNA processing, inborn errors of translation; teratogenesis - environmental assaults on human development - teratogenic agents like alcohol, retinoic acid etc.

Text Books

1. Jonathan Slack. Essential Developmental Biology. Wiley-Blackwell. 3rd ed. 2012
2. Lewis Wolpert. Principles of Development. Oxford University Press.4th ed. 2012
3. Werner A Muller. Developmental Biology. Springer. 2012
4. Scott F. Gilbert. Developmental Biology. Sinauer Associates Inc., 10th ed. 2013
5. Klaus Kalthoff. Analysis of Biological Development. McGraw-Hill. 2nd ed. 2000.

Online Resource

6. Website: virtual embryo- http://people.ucalgary.ca/~browder/virtualembryo/dev_biol.html

Course Outcomes

On Successful completion of the course, the students will be able to

CO1: Understand the basics of embryo development in vertebrates and invertebrates.
CO2: Learn the events in the early embryonic development.
CO3: Understand the development of organs and developmental pattern
CO4: Understand the events taking place during post - embryonic development.
CO5: Understand the medical implications of developmental biology.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	3	2	2	3	3	2	3	3	3	2	3	2	2
CO2	3	3	2	3	3	2	3	3	3	3	3	3	2	3	3
CO3	3	2	2	3	2	2	3	2	3	3	3	2	2	3	2
CO4	3	3	3	2	3	3	3	3	3	3	3	3	3	2	3
CO5	3	2	3	2	2	3	3	2	3	3	3	2	3	2	2

19BITE 205.2 Clinical Biochemistry

Credits: 3
Hours: 3

Learning Objective (LO): This course will enable students to understand the biochemical basis of diseases.

Unit–1 Genetic Diseases

Genetic diseases: Patterns of inheritance. Chromosomal disorders: Brief account of Down syndrome. Monogenic disorders (autosomal dominant, autosomal recessive, sex-linked). Prenatal and neonatal screening for inborn errors. Treatment strategies for inborn errors. Collection of blood and urine samples for analysis: precautions and changes on keeping.

Unit–2 Liver and Kidney Disorders

Structure and functions of the liver. Composition and functions of bile. Jaundice: classification, causes and biochemical findings.
Normal and abnormal constituents of urine. Pathogenesis, biochemical findings and management of nephrotic syndrome.

Unit–3 Diabetes Mellitus

Diabetes mellitus - classification, diagnosis and management. Acute complication - diabetic ketoacidosis. Long-term complications - retinopathy, neuropathy, nephropathy and diabetic foot. Atherosclerosis: Risk factors and management.

Unit–4 Cancer

Differences between benign and malignant tumors. Growth characteristics of cancer cells, Morphological changes in tumor cells. Invasion and metastasis. Agents causing cancer - radiation, viruses, chemicals. Oncogenes and tumor suppressor genes (brief account only).

Unit–5 AIDS, Obesity and Malnutrition Disorders.

AIDS - Incidence and clinical diagnosis. The HIV genome, HIV life cycle. Brief account on treatment strategies.
Protein Energy Malnutrition: Marasmus and Kwashiorkor: clinical features and biochemical findings. Obesity: Causes, consequences and management (brief account only).

Text Books

1. Rodwell et al. Harper's. Biochemistry. McGraw-Hill. 31th ed. 2018.
2. Varley. Practical Clinical Biochemistry. CBS Publ. 6th ed. 2006
3. Mayne. Clinical Chemistry in Diagnosis and Treatment. 6th ed. ELBS. 1994
4. Marshall et al. Clinical Chemistry. Mosby. 8th ed. 2016.

Supplementary Reading

Tietz. Textbook of Clinical Chemistry and Molecular Diagnostics. Saunders. 8th ed. 2018

Course Outcomes

On Successful completion of the course, the students will be able to

CO1: Comprehend the genetic diseases
CO2: Understand the complications and treatment of liver and pancreatic disorders
CO3: Appreciate the biochemical and molecular basis of cancer and AIDS.
CO4: Gain knowledge on protein energy malnutrition and obesity

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	3	2	3	2	3	2	3	3	3	2	3	2	2
CO2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3
CO3	3	2	3	2	2	3	3	2	3	3	3	2	3	3	2
CO4	3	3	3	3	3	2	3	3	3	3	3	3	3	2	3

19BITE 205.3 Basic Endocrinology

Credits: 3
Hours: 3

Learning Objective (LO): To understand the general features of hormone action, physiological and biochemical effects of hormones and to learn about the disorders related to hormonal action.

Unit–1 Hypothalamic and Pituitary Hormones

Definition, classification of hormones, hormone receptor interaction and general mechanism of action. Hypothalamic and pituitary hormones. HPA axis, Hypothalamic releasing factors. Anterior pituitary hormones: growth hormone, ACTH, thyrotrophins, gonadotropins and prolactin. - Biosynthesis and secretion, POMC peptide, biological actions. Neuroendocrine hormones - endorphins, enkephalins, leptin .

Posterior pituitary hormones - biological actions of vasopressin and oxytocin. Hypo and hyper pituitarism - Gigantism, Acromegaly, Cushing syndrome, dwarfism, diabetes insipidus and syndrome of inappropriate ADH secretion (SIADH)

Unit–2 Thyroid and Parathyroid Hormones

Thyroid hormones - synthesis, secretion, regulation, transport, metabolic fate and biological actions. Antithyroid agents. Thyroid function tests. Abnormalities of thyroid function.

Hormonal regulation of calcium and phosphate metabolism - PTH, calcitonin and calcitriol secretion and biological actions. Hypo and hyper parathyroidism, Hypo and hypercalcemia - Rickets and osteomalacia.

Unit–3 Adrenal Hormones

Adrenal cortical hormones - Synthesis, regulation, transport, metabolism and biological effects of glucocorticoids, mineralocorticoids and sex steroids. Hypo and hyper function - Cushing's syndrome, aldosteronism, CAH, aderenal cortical insufficiency, Addison's disease.

Adrenal medullary hormones - Epinephrine and nor epinephrine - synthesis, secretion, metabolism, regulation and biological effects. Pheochromocytoma.

Unit–4 Pancreatic Hormones and Gastrointestinal Hormones

Pancreatic islets - Biosynthesis, metabolic and biological effects and mechanism of action of insulin, glucagon, somatostatin and pancreatic polypetide. Regulation of insulin secretion, Insulin receptor. Hypo and hyperglycaemia - Type I and type II diabetes.

Gastrointestinal hormones - Actions of major GI hormones- Gastrin, secretin, cholecystokinin (CCK) and others - gastro inhibitory polypeptide (GIP), glucagon-like peptide -1 (GLP-1) and ghrelin

Unit–5 Gonadal Hormones

Biosynthesis, regulation, transport, metabolism and biological actions of male sex hormones - androgen and testosterone. Hypogonadism and gynecomastia.

Biosynthesis, regulation, transport, metabolism and biological effects of female sex hormones oestrogen and progesterone. The menstrual cycle. Synthetic estrogens

Text Books

1. S. Melmed et al Saunders. Williams Text Book of Endocrinology. 13th ed. 2015
2. Mayne. Clinical Chemistry in Diagnosis and Treatment. ELBS. 6th ed. 1994
3. W.J. Marshall, S. K. Bengert, M. Lapsley. Clinical Chemistry. Mosby. 8th ed. 2016
4. Robert K Murray et al. Harper's. Biochemistry. Appeleton & Lange. 25th ed. 1999.
5. Prakash S Lohar. Endocrinology Hormones and Human Health. MJP publishers. 2005.

Course Outcomes

On Successful completion of the course, the students will be able to

CO1: Understand the general characteristics of hormone and hypothalamic and pituitary hormone

CO2: Learn the functions of thyroid and parathyroid secretions and disorders associated with hypo and hyper secretions.

CO3: Gain an understanding of the biological effects of adrenal hormones.

CO4: Know the hormones of the pancreas and clinical conditions associated with pancreatic insufficiency as well as about GI tract hormones.

CO5: Understand the gonadal hormone functions and associated clinical conditions.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	3	3	2	3	3	3	3	3	3	2	3	2	3
CO2	3	3	2	2	3	3	3	3	3	3	3	3	2	3	2
CO3	3	2	3	3	2	3	3	3	3	3	3	2	3	2	3
CO4	3	3	2	2	3	3	3	3	3	3	3	3	2	3	2
CO5	3	2	2	2	2	3	3	3	3	3	3	2	2	2	2

19BITE 306.1 Biotechnology Management

Credits: 3
Hours: 3

Learning Objective (LO): To learn different aspects of management pertaining to biotechnology industry in addition to principles of economics and accountancy.

Unit -1 Principles of Management

Concepts of Management: Administrative Management (Planning, Organizing, Staffing, Directing and Controlling), policy formulation, Operative Management (Personnel, Materials, Production, Financial, Marketing, Time/space, Margin/Morale). Motivation, Communication, Decision-making, leadership, Innovation, Creativity, Delegation, Responsibility, Record keeping.

Unit- 2 Economics & Accountancy

Economics: Principles of economics with special reference to the laws of demand and supply, demand schedule, demand curves, labour welfare, general principles of insurance and inland and foreign trade, procedure of exporting and importing goods.

Accountancy: Principles of Accountancy, Ledger posting and book entries, preparation of trial balance, columns of a cash book, Bank reconciliation statement, rectification of errors, Profits and loss account, balance sheet. Structure of Indian financial systems.

Unit -3 Portfolio and Project Management

Portfolio Management in the Biotechnology Industry - Balancing corporate need with product delivery to the market, impact of organizational size. Feasibility study. Project Management in Biotechnology Industry Sectors - objectives, sociotechnical considerations, insurance for projects, developing program strategy, risk assessment and management, tracking process, resources planning, management of uncertainty and safety issues. Clinical trials - introduction, organization, investigation, ethics. Regulatory affairs - Regulatory bodies for biotechnology products and compliance. Quality systems and control.

Unit -4 Production and Materials Management

Production Management: Concepts, Visible and Invisible inputs, Methodology of Activities, Performance Evaluation Technique, Process-Flow, Process Knowhow, Product development planning- rationale, targeted product profile, product development plan (clinical, project management, regulatory, nonclinical, quality control). Developing products with added value. Supply chain management - strategy, process.

Materials Management: Basic principles of materials management, major areas, scope, purchase, stores, inventory control and evaluation of materials management. TQM, quality systems and control.

Unit -5 Marketing Management & Entrepreneurship

Principles of marketing, The Product Concept, Brand, Product positioning, Product strategy. Marketing communication, new product launching/development, Principles of advertising. Market Research: Measuring & Forecasting Market Demands, Estimating current demand, Estimating industry sales, Market share & Future demand. Distribution: Channels of distribution, wholesale, retail, departmental store, Chain stores. Transportation and storage. Copyrights, patents.

Entrepreneurship - Entrepreneurial traits, self-appraisals, sources of funds. Business planning in Biotechnology.

Text Books

1. Harpum P. Portfolio, Program and Project Management in the pharmaceutical and biotechnology industries. 2010.
2. M.J. Roy. Biotechnology operations: Principles & Practices. CRC Press. 2011.
3. Biren N Shah, Bhavesh S Nayak, Vineet C Jain; Textbook Of Pharmaceutical Industrial Management; 2010; 1st ed; Elsevier India; ISBN: 9788131225394.

Course Outcomes

On Successful completion of the course, the students will be able to

CO1: Develop an understanding of the fundamental topics on management.
CO2: Gain knowledge on business economics and project management.
CO3 Get a strong foundation on commercialization of biotechnology products.
CO4: Get the required knowledge to lead and administer biotechnology companies.
CO5: Undertake entrepreneurship ventures.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3
CO2	3	3	3	3	3	3	3	3	3	3	2	3	2	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3
CO4	3	3	3	3	3	3	3	3	3	3	2	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3	2	2	2	2	3

19BITE 306.2 Medical Laboratory Technology

Credits: 3
Hours: 3

Learning Objective (LO): To understand the basic concepts and to learn the techniques essential for clinical laboratory

Unit-1 Basic Haematology and Biochemistry

Specimen collection and handling, transportation of specimens, disposal of specimen after laboratory use.

Composition of blood. Methods of estimation of Haemoglobin, PCV, total and differential count of WBC, platelet count, clotting, bleeding and prothrombin time. Blood Group - methods of grouping and Rh factor. Determination of proteins in serum and plasma. Determination of glucose, glycated hemoglobin, triglycerides, cholesterol, lipoproteins. Examination of body fluids - ascitic fluid, pleural fluid, synovial fluid, pericardial fluid, CSF and amniotic fluid. Urine analysis, abnormal constituents. Faecal specimen - Macroscopic and microscopic examinations - detection of occult blood, Semen analysis.

Unit-2 Microbiology

Microscopic examination, Gram staining, Acid-fast staining, Laboratory Culture - culture media, preparation of culture media, pH adjustment of culture media, Making of culture plates, techniques of aseptic transfer, blood and urine culture. Antibiotic sensitivity tests. Laboratory analysis of throat swab, sputum specimens, purulent exudates - Tuberculosis, Vibrio infections and Cholera, Gonorrhea, Leprosy

Unit-3 Histopathology

Tissue reception, labeling, fixation and section cutting, Preparation of paraffin blocks (Dehydration, clearing, embedding, blocking). Handling and care of microtome, types of microtome, sharpening of knives, and section cutting. Frozen section techniques - CO_2 freezing, cryostat. Preparation of common stains. H & E, Congo red, methyl violet, Leishman stain, Giesma and staining techniques. Mounting of specimens, record keeping, indexing of slides. Molecular analysis of chromosomal aberrations in leukemias and lymphomas. Molecular diagnosis of genetic diseases.

Unit-4 Laboratory Immunology

Agglutination tests, Haemagglutination tests, Precipitation tests and Flocculation tests, Tests for RA factor, CRP, ASO, VDRL, Widal, TORCH, Auto-Antibodies, Hepatitis, HIV testing and EBV. Aldehyde test ELISA test, serum electrophoresis. Preparation of slides of LE cell phenomenon and identification. Immuno -histochemical staining methods for auto-antibodies and tumour markers. Cutaneous sensitivity test.

Unit-5 Laboratory Automation and Quality Control

Functional components of clinical laboratories. Basic requirements of clinical laboratory technician. Maintenance of glassware and equipments. Quality assurance in clinical laboratory. External QC and internal QC – Assessment - Corrective and preventive actions. Clinical validation and accreditation. Equipment calibration. Automation - advantages over manual methods. Automated analyzers. Lab informatics and scientific data management system - record keeping, coding and indexing.

Text Books

1. Praful. B. Godkar, Darshan. P. Godkar, Text book of Medical Laboratory Technology. Bhalani Publishing House. 2014
2. F.J. Baker, R.E. Silverton, Butterworth - Heinemann. Introduction to Medical Laboratory Technology. Butterworth- Heinemann. 2014.
3. Mayne. Clinical Chemistry in Diagnosis and Treatment. ELBS. 6th ed. 1994
4. Harold Varley. Practical clinical biochemistry. CBS Publisher. 6th ed. 2002,
5. Todd & Stanford. Clinical Diagnosis and Management by Laboratory Methods. 16th ed. 2016

Course Outcomes

On Successful completion of the course, the students will be able to

CO1: Perform the basic haematology techniques and undertake biochemical analysis of clinical samples
CO2: Understand the tests performed in clinical microbiology lab
CO3: Undertake histological analysis of samples.
CO4: Comprehend the basic techniques performed in clinical immunology laboratory.
CO5: Know about quality control, lab accredition and automation.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	3	2	3	3	3	3	2	3	3	2	3
CO2	3	2	3	3	2	3	3	2	3	3	3	2	3	3	2
CO3	3	2	3	2	3	2	3	3	3	3	2	3	3	2	3
CO4	3	3	3	3	2	3	3	2	3	3	3	2	3	3	2
CO5	3	3	3	2	2	2	3	2	3	3	2	2	3	2	2

19BITE 306.3 Drug Design and Drug Development

Credits: 3
Hours: 3

Learning Objective (LO): To impart knowledge on drug metabolism, mechanism of action, drug design and development.

Unit-1 Pharmacokinetics

Introduction to drugs, routes of drug administration, absorption of drugs. Bioavailability: factors influencing absorption and bioavailability, drug distribution – plasma protein binding, placental transfer, blood brain barrier. Drug metabolism: Phase I & Phase II reactions. Excretion of drugs.

Unit- 2 Drug Metabolism

Physiochemical properties, mechanism of drug action. Drug receptors: Structure, types of receptors, second messengers, ligand gated ion channel, G - protein coupled receptor. Tyrosine kinase enzyme coupled receptors, steroid receptors. Dose - response relationship. Therapeutic Index. Adverse drug reactions.

Factors affecting drug action: drug – drug interaction, synergism, antagonism, additive effects. Drug tolerance and dependence.

Unit -3 Drug Designing

Drug design: lead discovery, lead modification, bioisosterism. Lipinski's rule. Quantitive structure – activity relationship: Physiochemical and electronic parameters used for quantifying drug action. Enzyme inhibition as a tool for drug design.

Drug stereochemistry: basic concepts, chirality and drug action, influence of geometric isomerism on drug action. Conformational flexibility and multiple modes of action. Applications of NMR spectroscopy and X – ray crystallography in drug design.

Unit -4 Biopharmaceuticals

Modern vaccine technologies. Recombinant proteins as pharmaceutical drugs. Protein engineering, peptide chemistry and peptidomimetics. Catalytic antibodies. Monoclonal antibody based pharmaceuticals. Hematopoietic growth factors. Nucleic acid therapy in development. Pharmaceutical enzymes. Development of adhesion molecules. Glycoprotein and carbohydrate based pharmaceuticals (Elementary details only).

Unit -5 Drug Development and Approval

Strategies for new drug discovery, lead compound, combinatorial approaches to drug discovery, pre-clinical and clinical trials- Phase 1, II and III.

Regulatory authorities - Food and Drug Administration (USA), European regulations- National security authorities, European medicine agency and new EU drug approval system.

Text Books

1. Patrick GLAn. Introduction to Medical Chemistry. Oxford University press. 5th ed. 2013.
2. Smith and William's. Introduction to the principles of Drug Design and Action. Taylor and Francis. 4th ed. 2005.
3. Thomas G. Fundamentals of Medical Chemistry. John Wiley & Sons. 2003.
4. Gareth Thomas. Medicinal Chemistry and Introduction. John Wiley & Sons. 2nd ed. 2008.
5. Gilman *et al.* Goodman & Gilman's The Pharmacological basis of therapeutics. 12th ed. 2011

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the basic concepts of pharmacokinetics
CO2: Know about mechanism of drug action
CO3: Gain knowledge concepts on drug designing
CO4: Understand the technologies used in drug development.
CO5: Understand the strategies for new drug discovery and regulatory bodies concerned with drug approval

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	2	3	2	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	3	3	3	3	2	3	2	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	2	3	3	3	3

Interdepartment Electives Offered to Other Departments

19BIOX 215.1 Basic Biochemistry

Credits: 3
Hours: 3

Learning Objective (LO): To understand the structure, functions and metabolism of major biomolecules.

Unit–1 Carbohydrates

Classification of carbohydrates. Functions of biologically important monosaccharides, disaccharides, homopolysaccharides, and heteropolysaccharides. Carbohydrate metabolism: glycolysis, citric acid cycle, gluconeogenesis, glycogen metabolism (overview only, structures not required). Diabetes mellitus (elementary details).

Unit–2 Amino Acids and Proteins

Amino acids: classification and acid-base properties. Biologically important peptides. Proteins - classification, functions, denaturation and renaturation. Orders of protein structure: Primary, secondary (α-helix, β-pleated sheet), supersecondary, tertiary, and quaternary structures. Urea cycle, (overview only, structures not required).

Unit–3 Lipids

Classification of lipids. Structure and functions of cholesterol. Lipid metabolism: β-oxidation of fatty acids, biosynthesis of fatty acids (overview only, structures not required). Coronary heart disease (elementary details).

Unit–4 Enzymes

Enzymes: Classification and nomenclature. Specificity, factors affecting enzyme activity - substrate, pH and temperature. Michaelis-Menten equation and L-B plot. Coenzymes and Isoenzymes (brief account only). Allosteric enzymes. Applications of enzymes in clinical diagnosis, therapeutics and industry.

Unit–6 Nucleic acids

DNA structure - Watson and Crick model. A, B, and Z forms of DNA. DNA denaturation. Differences between DNA and RNA. Major classes of RNA- structure and biological functions.

Text books

1. Nelson and Cox. Lehninger Principles of Biochemistry. Freeman. 7th ed. 2017.
2. Rodwell et al. Harper's Illustrated Biochemistry. McGraw Hill. 31th ed. 2018.
3. Satyanarayana U. Biochemistry. Books and Allied Publ. 5th ed. 2017.

Supplementary Reading

Voet and Voet. Fundamentals of Biochemistry. Wiley. 5th ed. 2018.

Course Outcomes

At the end of the course, the student will be able to

CO1: Understand the structure, classification and properties of carbohydrates and amino acids
CO2: Gain knowledge on the hierarchical organisation and properties of proteins, structure and properties of lipids and nucleic acids
CO3: Comprehend the functions and kinetic characteristics of enzymes
CO4: Understand the major metabolic pathways of biomolecules

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	3	3	3	3	3
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	2	3	2	3	3	3	3	3	3
CO4	3	3	3	2	3	2	3	3	2	3

19BIOX 215.2 Basic Biotechnology

Credits: 3
Hours: 3

Learning Objective (LO): To master the basic principles and applications of biotechnology.

Unit–1 Bioprocess Engineering and Downstream Processing
Bioprocess engineering: Isolation and screening of industrially important microbes. Bioreactors - fermentation media. Downstream processing: solid-liquid separation, release of intracellular compartments, concentration of biological products, purification, preservation and stabilization. Industrial production of ethanol.

Unit–2 Environmental and Energy Biotechnology
Wastewater treatment - physical, chemical and biological treatment processes. Effluent treatment. Bioremediation, oil spill cleanup. Biodegradable plastics. Bioleaching- use of microorganisms in mining. Renewable sources of energy, biogas production.

Unit–3 Enzyme and Food Technology
Immobilization of enzymes: methods, and applications. Biosensors. Use of enzymes in detergents, textiles, leather and food industry. Production of glucose syrup. Methods of food preservation. Elementary idea of canning and packing. Basic principles of food fermentation. Production of beer.

Unit–4 Recombinant DNA Technology
Basic steps in cloning. Restriction endonucleases, cloning vectors e.g. pBR322. Introduction of rDNA into host cells by calcium phosphate coprecipitation, electroporation, lipofection, microinjection. Screening of recombinants by marker inactivation. Applications of rDNA technology.

Unit–5 Plant, Animal, and Medical Biotechnology
Biofertilisers. Biopesticides (*Bacillus thuringiensis*). Transgenic plant technology: gene transfer by *Agrobacterium*-mediated method, development and uses of transgenic plants. Development and uses of transgenic animals. Gene therapy - basic principles. The human genome project (elementary details). Hazards and safety aspects of biotechnology.

Text Books

1. John E. Smith. Biotechnology. Cambridge Univ Press. 5th ed. 2009.
2. Singh B.D. Biotechnology. Expanding Horizons. Kalyani Publ. 3rd ed. 2010
3. Nicholls DTS. Genetic Engineering. Cambridge Univ Press. 3rd ed. 2008.
4. Ratledge and Kristiansen. Basic Biotechnology. Cambridge Univ. Press. 3rd ed. 2006.

Supplementary Reading

Watson at al. Recombinant DNA. Sci Am Publ. 3rd ed. 2006.

Course Outcomes
On Successful completion of the course, the students will be able to
- CO1: Know the principles of bioprocess engineering and downstream processing,
- CO2: Understand the methods applied for waste water treatment and uses of enzymes in industries
- CO3: Learn the steps involved in cloning and the importance of biofertilizers and biopesticides.
- CO4: Know the basics of food biotechnology and applications of enzymes in food industry.
- CO5: Learn about the production of transgenic plants and animals.

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	2	1	2	3	3	1	3
CO2	3	3	2	1	1	1	3	3	2	3
CO3	3	3	2	2	2	1	3	3	2	3
CO4	3	3	1	2	2	1	3	3	1	3
CO5	3	3	2	1	1	2	3	3	1	3

19BIOX 315.1 Biochemical Techniques

Credits: 3
Hours: 3

Learning Objective (LO): To learn the principle, operation, and applications of various techniques for analyzing biomolecules.

Unit–1 Spectroscopic Techniques
Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV-visible spectrophotometry, spectrofluorimetry and atomic spectroscopy.

Unit–2 Radioisotope Techniques
Nature and units of radioactivity. Detection and measurement of radioactivity - Geiger-Muller counter, solid and liquid scintillation counting. Autoradiography. Applications of radioisotopes in biology. Radiation hazards.

Unit–3 Electrophoresis and Blotting Techniques
Principle, technique and applications of PAGE, SDS-PAGE, agarose gel electrophoresis and isoelectric focusing. Blotting techniques: Southern and Western.

Unit–4 Chromatography
General principles of partition and adsorption chromatography. Principle, operation and applications of thin layer, ion-exchange, molecular exclusion, and affinity chromatography. HPLC - principle, instrumentation and applications.

Unit–5 Centrifugation
Basic principles. Types of centrifugation: analytical and preparative. Subcellular fractionation. Ultracentrifugation.

Text Books
1. Andreas Hofmann and Samuel Clokie. Wilson and Walker. Principles and Techniques of Biochemistry and Molecular biology. Cambridge University Press. 8th ed. 2018.
2. Upadhyay, Upadhyay and Nath. Biophysical Chemistry Principles and Techniques. Himalaya Publ. 2010.

Supplementary Reading
Rodney. F. Boyer. Modern Experimental Biochemistry. Pearson Education. Inc. 3rd ed. 2000.

Course Outcomes
On Successful completion of the course, the students will be able to

CO1: Understand the basic principle, instrumentation and applications of spectroscopy and
CO2: Comprehend the principle and application of radioisotope techniques
CO3: Understand the principle, instrumentation and applications of electrophoresis and blotting
CO4: Appreciate the principles and applications of chromatography and centrifugation Technique

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	2	3	3	3	3
CO2	3	3	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	2	3	3	3	3
CO4	3	3	3	3	3	3	3	2	2	3

19BIOX 315.2 Immunology

Credits: 3
Hours: 3

Learning Objective (LO): To acquire knowledge on immunological mechanism and immunotechniques.

Unit–1
Types of immunity - innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs. Cells of the immune system - lymphocytes, mononuclear phagocytes-dendritic cells, granulocytes, NK cells and mast cells. Antigens - antigenicity, epitopes, haptens. Immunoglobulins - structure, classification and functions.

Unit–2
T-cell, B-cell receptors, Antigen recognition - processing and presentation to T-cells. Immunological memory. Effector mechanisms - macrophage activation. Complement activation. Organization and expression of immunoglobulin genes. Generation of antibody diversity.

Unit–3
Transplantation types. MHC antigens in transplantation. Immunodeficiency disorders - AIDS: The HIV genome and life cycle. Autoimmunity and elementary details of autoimmune disorders (systemic lupus erythematosus).

Unit–4
Immunization practices - active and passive immunization. Vaccines - killed, and attenuated. Recombinant vaccines - DNA vaccines, synthetic peptide vaccines. Production of applications of polyclonal and monoclonal antibodies.

Unit-5
Agglutination and precipitation techniques. Immunoelectrophoresis, RIA, Immunoblotting, Avidin-biotin mediated immunoassay. Immunohistochemistry, immunofluorescence. ELISA - principle and applications.

Text Books

1. Jenni Punt, Sharon Stranford et al. Kuby Immunology. WH Freeman & Co. 8th ed. 2018.
2. Abbas et al. Cellular and Molecular Immunology. Elsevier. 9th ed. 2018.
3. Janeway, C. (Ed), Paul Travers. Immunobiology. Garland Publ. 9th ed. 2016.
4. Coico and Sunshine. Immunology: A short course. Wiley. 7th ed. 2015.

Supplementary Reading

Roitt et al. Essential Immunology. Willey-Blackwell Sci. 13th ed. 2017.

Course Outcomes
On Successful completion of the course, the students will be able to

CO1: Know the cells and organs of the immune system and about antigens and antibodies
CO2: Appreciate complement system and types of immunity.
CO3: Understand vaccination, antibody diversity and transplantation
CO4: Gain knowledge on immunochemical techniques

Outcome Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	3	2	3	2	3	3
CO2	3	3	2	3	2	3	3	3	2	3
CO3	3	2	3	2	3	2	3	2	3	3
CO4	3	3	2	3	2	3	3	3	2	3

Value Added Course

(*Offered to Other Faculties Except Faculty of Science*)

Phytochemistry and Biological Activities of Medicinal Plants

Unit-1

Extraction – purification of bio-active compounds from plants - cold & hot extract extraction- Soxhlet extraction - crude extracts purification by various solvents.

Unit-2

Isolation of bioactive compounds- chromatographic techniques - thin layer chromatography- liquid chromatography - HPLC and UPLC.

Unit-3

Structural analysis of bioactive compounds - IR spectroscopy - Mass spectroscopy - NMR spectroscopy.

Unit-4

Herbal medicine - History of herbal medicine - different types of herbal medicine - Ayurveda, Siddha and Unani - Pharmacological action - clinical research and traditional uses of Indian medicinal plants - *Eclipta alba, Gymnema sylvestre, Ocimum sanctum, Curcuma longa*.

Unit-5

Phytopharmaceuticals and their health benefits - anthocyanins, carotenoids, lycopene, isoflavones, polyphenols, omega 3 - fatty acids, biological effects of resveratrol.

Activity

1. Extraction of active ingredients from medicinal plants.
2. Demonstration of *in vitro* antioxidant activity of phytochemicals.

Text Books

1. Harbone, J.B. Phytochemical Methods: A guide to modern techniques of plant analysis, Springer (India) Private Limited, 3rd ed. New Delhi. 1998.
2. Silverstein R. M., Wester F. X. - Spectroscopic identification of organic compounds. John-Wiley. 1998.
3. Willard H.H., Merrit L. L., Dean J. A.. Instrumental Methods of Analysis, 1987.
4. Godte V. M.. Ayurvedic pharmacology and therapeutic uses of medicinal plants. Bharathiya Vidya Bhavan, Mumbai. 2000.
5. Grewal R.C. Medicinal Plants. Campus Books International, New Delhi. 2000.