B Sc (Biotechnology) 4 years honours degree

Under Regulations- (R-2025)

(w.e.f. 2025-26 admitted batch)

Course Structure and Syllabi

THE APOLLO UNIVERSITY

MURUKAMBATTU - CHITTOOR (Dt) 517127

ANDHRA PRADESH

Program Outcomes (POs)

Upon successful completion of the program, graduates will be able to:

1. **PO1 – Core Knowledge**: Demonstrate comprehensive understanding of fundamental and advanced concepts in biotechnology, including molecular biology, genetics, microbiology, biochemistry, and cell biology.
2. **PO2 – Laboratory Proficiency**: Perform a wide range of laboratory techniques and experiments with accuracy, precision, and safety in biotechnology and allied life science domains.
3. **PO3 – Research Competency**: Design and conduct hypothesis-driven research, analyze data critically, and interpret scientific results to draw meaningful conclusions.
4. **PO4 – Problem Solving and Innovation**: Apply biotechnological principles to solve real-world problems in health, agriculture, environment, and industry using innovative approaches.
5. **PO5 – Interdisciplinary Integration**: Integrate knowledge from bioinformatics, computational biology, systems biology, and omics technologies for multidimensional understanding of biological systems.
6. **PO6 – Communication Skills**: Communicate effectively through oral presentations, technical reports, scientific publications, and outreach activities.
7. **PO7 – Teamwork and Leadership**: Work effectively as an individual and in multidisciplinary teams with leadership, interpersonal, and organizational skills.
8. **PO8 – Ethics and Responsibility**: Demonstrate ethical responsibility in scientific research and biotechnological applications with consideration of biosafety, bioethics, and societal impact.
9. **PO9 – Lifelong Learning**: Engage in lifelong learning through continuous professional development and higher studies in emerging areas of biotechnology.
10. **PO10 – Digital and Computational Aptitude**: Utilize bioinformatics tools, data analytics, and digital platforms to analyze biological data and enhance research efficiency.
11. **PO11 – Entrepreneurship and Innovation**: Explore entrepreneurial opportunities and develop innovative biotechnological products, processes, or services with societal relevance.
12. **PO12 – Sustainability and Global Outlook**: Understand global challenges and contribute towards sustainable solutions in agriculture, health, and environment using biotechnological interventions.

Program Educational Objectives (PEOs)

Within a few years after graduation, the graduates of B.Sc. Biotechnology (Honours with Research) will be able to:

1. **PEO1**: Build a strong foundation in biotechnology to pursue higher education, research, or professional careers in academia, industry, and government sectors.
2. **PEO2**: Apply interdisciplinary knowledge and technical skills to address scientific and societal challenges through research, innovation, and technological solutions.
3. **PEO3**: Demonstrate professional ethics, communication skills, teamwork, and leadership qualities in national and global biotechnology-related roles.
4. **PEO4**: Engage in lifelong learning and contribute to scientific advancement, policy development, or entrepreneurship in the biotechnology ecosystem.
5. **PEO5**: Serve as responsible citizens and bioscience professionals committed to environmental sustainability, public health, and socio-economic development through biotechnological innovations.

Program Specific Outcomes (PSOs)

By the end of the B.Sc. Biotechnology (Honours with Research) program, students will be able to:

1. **PSO1**: Apply domain-specific knowledge to develop biotechnological products and processes in areas such as genetic engineering, industrial biotechnology, and diagnostics.
2. **PSO2**: Utilize modern tools and techniques including recombinant DNA technology, PCR, cell culture, and bioinformatics for experimental design and data analysis.
3. **PSO3**: Undertake independent research projects, prepare research proposals, write scientific reports, and defend research findings effectively.
4. **PSO4**: Collaborate with interdisciplinary teams and stakeholders in translational research, product development, and technology transfer in biotechnology.
5. **PSO5**: Demonstrate readiness for careers in biotech industry, startups, R&D labs, public health, agricultural biotechnology, or to pursue doctoral research globally.

THE APOLLO UNIVERSITY

ACADEMIC REGULATIONS

SCOPE:

This Academic regulation provide a framework for the regulatory guidelines of all programs offered by The Apollo University. It includes procedures and practices that are to be followed to ensure academic standards in the University. The regulations are approved by the Academic Council. These regulations may be amended from time to time with the approval of the Academic council for the benefit of students or some times to reflect the changes suggested by the statutory bodies.

Information regarding amendments (if any) to the regulations will be communicated to the students by publishing in the University website. Students must follow the amended regulations as they might impact the process for the award of degree. The decision of the Vice Chancellor shall be the final in case of any discrepancy. These regulations apply to all students, despite the program of study.

1. ADMISSION INTO THE PROGRAM

The University admits the students in two modes. One through the convenor quota as per the Andhra Pradesh Private Universities Act, for which the admissions will be carried out through the convener quota by the Govt of Andhra Pradesh. The other is through University quota for which the following procedure will be followed:

A. The applicant shall satisfy the entrance requirements specified by The Apollo University and in accordance with guidelines of statutory councils for Under-graduation.
B. The Applicant shall be qualified in the qualifying examination for a particular program.
C. The Applicant secures a rank in national level entrance exam or suitable such test conducted by The Apollo University / professional body.
D. The Applicant qualifies in the specified state or national level examinations prescribed by The Apollo University.

The Apollo University will widely notify the counselling schedule for admissions into the academic programs in the media. The provisional admission will be given to the eligible students during the counseling scheduled by The Apollo University. The selected candidates will be provisionally admitted into the program of his/her choice if the candidate meets

the program specific requirements in addition to academic performance qualifying exam. Admission is purely based on merit and so merely meeting the requirements will not ensure admission. The University does not discriminate based on gender, race, region, religion, disability or nationality. The University reserves the right to make admissions based on various criteria which is specified in the admission brochure.

2. ELIGIBILITY CRITERIA

Undergraduate programs

The qualifying exam eligibility for each program is given Annexure 1. The student should have passed the qualifying exam either in the year the student is seeking admission or the previous year.

Convener Quota: The student seeking admission to any program under convener quota shall qualify in the relevant entrance exam conducted by the Government of Andhra Pradesh.

University Quota: For getting admission under university quota, percentage of marks obtained in the qualifying exam, the rank obtained in TAU entrance exam or any recognized national level examination in the year of admission will be considered.

Counselling

All the eligible students need to apply for admission and have to attend counselling conducted by TAU as per the schedule for the university quo

3. PROGRAMS

The Apollo University offers variety of programs which includes certificate, undergraduate, postgraduate, and Research. The list of programs on offer for the academic year 2025- 2026 are annexed in Annexure 2 and those of 2023-24 are annexed in Annexure 3.

Minimum duration of the program

The minimum duration of each program depends on the type of program, viz., undergraduate, postgraduate, integrated programs, etc., and the faculty which offers the program. The maximum duration of the program is N+2 years, where N stands for the minimum duration of the program as mentioned in Annexure 2 and 3. If the student has not obtained the minimum number of credits within the stipulated time, the Vice-Chancellor may extend the maximum duration in extenuating circumstances upon receiving a request along with reasons from the student for not completing the program on time.

4. CHOICE BASED CREDIT SYSTEM

The choice-based credit system (CBCS) facilitates the education student-centric. It provides the opportunity for the learner to choose the courses from a basket of core, elective, and skill enhanced courses. All programs of study are designed to meet the specified number of credit requirements. The courses taken by the student in each semester as part of program are allotted some credit points based on the number of hours assigned. Upon successful completion of the course, the student secures the number of credits allotted for that course. Once the minimum number of credits of the program is achieved, the degree can be awarded, subject to fulfilment of all other relevant conditions.

5. STRUCTURE OF THE PROGRAM

The Program structure Consists of

i) University Courses
   A. University Core
   B. University Electives

ii) Faculty Courses
   A. Faculty Core
   B. Faculty Electives

iii) Program Courses
   A. Program Core
   B. Program electives

Each course* is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week. (*one course means one subject)

Core Courses = 3 Credits /4 Credits Elective =3 Credits

In general, credits are assigned to the courses as detailed below:

- A classroom lecture/ tutorial of 60 min (1 hr) duration per week, spread over the entire semester, shall be considered as one credit.
- A laboratory session of minimum of 120 min (2 hr) per week shall be considered as one credit.
- A project work/ Internship session of 60 minutes (1 hr) carried out per week shall be considered as one credit.

6. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

7. REGISTRATION

Any of the following student must register for the courses opted in a particular semester during the scheduled registration period.

i. a new student who enrolls into any program
ii. an existing student who is continuing on rolls from the preceding regular semester
iii. a former student, i.e., who has not enrolled in the preceding regular semester or who has availed academic break or detained and got readmission

Each newly admitted student shall attend an induction/ orientation program prior to commencement of the first semester. During this program academic advisors assist the students in choosing the courses. Existing student may register online by using their registration number and mail ID through the Apollo ERP portal. Class schedules are available approximately two weeks before the beginning of every semester for each program. The concerned head of the department must approve class schedule.

8. ATTENDANCE REQUIREMENTS

- Students should earn a minimum of 80% attendance in the current semester to become eligible to write the Semester End Examinations.
- The monthly statement of attendance will be displayed on the Department Notice Board/ Apollo ERP by the respective departments within the first five working days of the following month.
- Candidates who are falling short of 80% attendance will be detained on the recommendation of the HoD and are not eligible to appear for the current semester examinations. The students who are detained in the current semester will not be allowed to register for the next semester and they have to repeat the same semester by paying the tuition fee prescribed. However, they can write arrear subjects, if any.

9. EVALUATION

The assessment of the student's performance in a Theory course shall be based on two components: Continuous Evaluation (40 marks) and Semester-end examination (60 marks). A student has to secure an aggregate of 40% in the course in the two components put together to be declared to have passed the course, subject to the condition that the candidate must have secured a minimum

of 24 marks (i.e. 40%) in the theory component at the semester-end examination. Practical/ Project Work/ Industrial Training/ Viva voce/ Seminar etc. are completely assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 50% to secure Pass Grade. For courses having both theory and practical components, 60% of the weightage will be given for theory component and 40% weightage for practical component. The student must secure 40% (Theory + Practical) with 24 marks minimum in theory to attain pass grade.
Details of Assessment Procedure are furnished below in Table 1.

Table 1: Assessment Procedure

S. No.	**Component of Assessment**	**Marks Allotted**	**Type of Assessment**	**Scheme of Evaluation**
1	Theory	40	Continuous Evaluation	i) Twenty (20) marks for mid examinations. Three mid examinations shall be conducted for 20 marks each; average of the best two performances shall be taken into consideration. ii) Ten (10) marks for Quizzes, Assignments and Presentations. iii) Ten (10) marks for periodic evaluation, case studies and projects
		60	Semester-end Examination	iv) Sixty (60) marks for Semester-end examinations
	Total	**100**		
2	Laboratory	100	Continuous Evaluation	1)80 marks with equal weightage to all experiments subject to conduct of minimum of 10 experiments 2)20marks for the end exam (with one of our university teachers as external other than course teacher)

3	Internship	100	Continuous Evaluation	i) (80) marks for periodic evaluation of Internship report by the Project Supervisor. ii) Twenty (20) marks for final Report presentation and Viva-voce, by a panel of internal examiners. iii) Students shall undergo TWO internships during the course of time and the evaluation shall be done during final semester.
4	Project work	100	Continuous Evaluation	iv) (80) marks for periodic evaluation and technical report writing by the Project Supervisor. ii) Twenty (20) marks for final Report presentation and Viva-voce, by a panel of internal examiners
5	Students Seminars	100	Continuous Evaluation	Each student has to give a seminar on any topic in consultation with the faculty member in charge A detailed report shall be submitted to the in charge. 60 marks for periodic evaluation including report preparation and 40 marks for viva voce by a panel of examiners.

GRADING SYSTEM

Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given inTable2.

Table 2: Grades & Grade Points

Sl. No.	**Grade**	**Grade Points**	**Absolute Marks**
1	O(Outstanding)	10	90 and above
2	A+(Excellent)	9	80 to 89
3	A (Very Good)	8	70 to 79

4	B+(Good)	7	60 to 69
5	B (Above Average)	6	50 to 59
6	C(Average)	5	45 to 49
7	P(Pass)	4	40 to 44
8	F(Fail)	0	Less than 40
9	Ab. (Absent)	0	-

SEMESTER GRADEPOINTAVERAGE (SGPA)

A Semester Grade Point Average (SGPA) for the semester will be calculated according to the formula:

$$\text{SGPA} \frac{\sum [\text{C X G}]}{\sum \text{C}}$$

Where

C=number of credits for the course,

G=grade points obtained by the student in the course.

A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, and is deemed to have earned the credits assigned to that course.

CUMULATIVE GRADE POINT AVEARGE (CGPA)

A similar formula is used to arrive at Cumulative Grade Point Average (CGPA), considering the student's performance in all the courses taken in all the semesters up to the particular point of time. Table 3 shows the CGPA required for the award of class after the successful completion of the program.

Table3: CGPA required for award of Class

Class	**CGPA Required**
First Class with Distinction	≥8.0*
First Class	≥6.5
Second Class	≥5.5
Pass Class	≥5.0

*In addition to the required CGPA of 8.0 or more, the student must have necessarily passed all the courses of every semester in first attempt.

11. REAPPEARANCE

a. A student who has secured 'F' grade in a Theory course shall have to reappear at the

subsequent Semester end examination held for that course.

b. A student who has secured 'F' grade in a Practical course shall have to attend Special Instruction Classes scheduled by the Department for securing pass.
c. A student who has secured 'F' Grade in Internship /Project work / Industrial Training etc shall have to reappear for Viva – voce scheduled by the department.
d. A student who is declared fail (F) in a course/s can apply for revaluation within one week from the date of publication of results with a fee prescribed by the university. The marks /grade awarded in the revaluation is final.

11.1 Procedure for revaluation

- The students who have not satisfied with the marks awarded by the examiner can apply for revaluation of his/her answer script/s
- The students have to apply through proper channel for revaluation and to pay the revaluation fee per paper to the university towards revaluation fee.
- Students have to apply for revaluation within 7 days from the date publication of result.
- The scripts will get valued by second examiner and if the difference is more than 15 marks, they will get valued by the third examiner. The average of the nearest two marks will be declared as the final marks.

11.2 ASSESSMENT MECHANISM

The Apollo University offers a student the benefits of Choice Based Credit System. Every paper is allotted a certain number of credits as per the UGC norms. A student is awarded the specified credits on obtaining a pass in the respective paper.

The Choice Based Credit System (CBCS) has been adopted for UG Course from the year 2021-22 onwards as per the recommendations of the A.P. State Council for Higher Education (APSCHE). The structure of undergraduate programmes provides a wide range of choice for students to opt for courses based on their eligibility, aptitude and career goals.

11.3 Semester End Examination

The End semester examination will be a comprehensive examination of 3 hours duration. Two End Semester examinations are conducted in a year-

Odd semester examinations in November/ December and

Even semester examination in May/June

Practical examination / Project viva will be held 2 weeks prior to the theory semester end examinations.

Under-Graduation Programs

Course	Continuous Assessment	End semester	Aggregate in End semester Examinations
All UG Courses	No passing minimum	40%	40%

11.4 Post Evaluation Programme:

Under the Post Evaluation Programme there are three menus:

- Provision for improvement
- Re-totalling and Revaluation of answer scripts
- Restrictions to appear for the examinations

11.5 Provision for improvement

A student who passes a paper in the first attempt can reappear for the same paper in the succeeding End-of-Semester examination only, for improving his/her marks. Re-appearance for improvement is allowed for theory and practical subjects of all semesters, except for the final semester subjects. Revised mark statement will be issued after withdrawing the previous one, if the marks obtained in improvement are higher than the marks awarded earlier. When there is no improvement, there shall not be any change in the original marks already awarded. The improved marks shall be considered for classification but not for ranking.

Provision for Re-totaling and Revaluation of valued answer scripts

- UG candidates may apply for re-totaling / revaluation of valued answer scripts, to the Controller of Examinations through the Heads of Departments and Principal / Dean, in the prescribed forms, remitting the prescribed fee within 7 days from the

date of publication of results. Revaluation of answer scripts is permissible only for the current semester papers and not for any arrear paper.

- Those wish to apply for revaluation of final semester papers can do so within five days from the date of publication of results. In re-valuation, the answer papers will be valued by an external examiner and if there is a difference of 15 marks between the two evaluations then the script will be sent for third valuation which is final and the mark awarded by the third examiner will be taken into the account.
- Revised mark statement will be issued after withdrawing the previous one, if the marks obtained in revaluation / retotalling are higher than the marks obtained earlier. In other cases, the original marks obtained earlier will be retained and the matter will be intimated to the student concerned as 'No change'.
- A candidate who applies for revaluation should not apply for retotalling.

Restrictions to appear for the examinations

Candidates who fail in any of the papers in the UG End semester examinations shall complete the paper concerned within N+2 years from the date of admission to the particular course. If they fail to do so, they shall re-register their names and take the examination in the texts/revised regulations/syllabus of the paper prescribed for the subsequent batch of candidates, in force at the time of their reappearance. In the event of removal of that paper consequent to change of regulation and/or curriculum after N+2 years period, the candidate shall have to take up an equivalent paper in the revised syllabus as suggested by the Chairman, Board of Studies concerned.

12. BETTERMENT OF GRADES

A student who has secured only a Pass or Second class and desires to improve his/her Class can appear for Betterment Examinations only in Theory courses of any Semester of his/her choice, conducted in Summer Vacation along with the Special Examinations. Betterment of Grades is permitted 'only once' immediately after completion of the program of study.

13. DETENTION AND RE-ADMISSION

If a student fails to meet the minimum attendance requirement or minimum standards for academic progression, the concerned academic head will recommend for detention and it will be notified by the concerned Dean of the School. The students who are detained in the current semester will not be allowed to register for the next semester and they have to repeat the same semester.

The candidates who are detained or availed academic break or suspended in the previous semester/academic year and want to continue their study shall apply for re-admission to the university. The candidates shall request for re-admission to the respective Head of the Department, with details viz., Full Name, Registration Number, Department, School, Fee payment particulars with proofs and reasons for discontinuations. The concerned academic head will forward it to the Registrar with specific comments. The Registrar will notify the decision of re-admission which shall include the prescribed fee particulars, semester/ year into which readmission is granted and additional courses to be completed by the student (if any). The candidates should apply for re-admission in advance, that is before the commencement of the semester.

14. GROOMING AND ATTIRE FOR STUDENTS

Grooming and Etiquette is of great significance in the dynamic of shaping one's Personality. The Apollo University stands by a Code of Grooming, Attire and Etiquette that promotes a professional standard: Academic Day; Campus Placements and Non-Academic Hours on Campus.

The Dress Code to be in compliance on academic premises while attending: Formal Functions of the Institution / Lectures / Practicals / Dining Area / Library / Labs / Office Areas.

Students shall follow appropriate attire during Academic and Non-Academic hours on the campus. Students shall wear clean, neat, pressed and presentable clothing, and command respect by dressing in accordance with responsible personal norms. Students shall always wear The Apollo University ID Card with the Lanyard.

Grooming and Formal Wear - Boys:

Formal Shirts / T-Shirts with a Collar should preferably be tucked in with a Formal pair of Pants Shoes and Socks to complete the Formal Attire. Personal Hygiene should be followed and Hair should be well groomed.

Smart Casuals for Boys:

Long Kurtas / Formals / Semi-Formal Shirts with Jeans.

Grooming and Formal Wear - Girls: Sarees / Salwar Suits / Leggings or Jeggings with Long Kurtis / Long Frocks / Long Skirts / Palazzos. Complement the outfit with proper footwear. Personal Hygiene should be followed and Hair should be well groomed.

Smart Casuals for Girls:

Jeans with long Kurtis / Long Skirts / Long Frocks.

Attire for Non-Academic Hours On Campus:

The students should be neatly attired during Non-Academic Hours on Campus.

Dress Code for Boys:

Jeans / Track Suits / T-Shirts / Trousers / Shirts.

Dress Code for Girls:

Jeans / T-Shirts or Blouses / Salwar Suits / Palazzos / Leggings or Jeggings with Long Tops / Sarees / Long Skirts / Track Suits.

DO'S AND DO'NTS FOR BOYS AND GIRL STUDENTS OF THE UNIVERSITY:

- To wear modest clothing that reflects the essence of good personal grooming standards.
- To refrain from wearing Sleeveless Clothing; Shorts; Short Tops, etc.,

PLEASE NOTE: The decision as to what constitutes Appropriate Attire vests with the Authorities of The Apollo University.

15. ELIGIBILITY FOR AWARD OF THE DEGREE

The undergraduate degree will be of 3-years of duration. A student shall be declared as eligible for the award of the degree if the candidate has successfully secured the minimum number of required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time.

After successful completion of the program, a provisional certificate cum memorandum of grades (PCMG) will be issued to the students. The PCMG includes the secured grades and class achieved in chosen program and specialization if any, along with grades and CGPA secured by the student. The original degree will be presented in the subsequent convocation.

16. DISCRETION POWER

Not with-standing anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

ANNEXURE 1

ELIGIBILTY FOR QUALIFYING EXAM FOR UNDER GRADUATE PROGRAMS

Program Type	Program Name	Eligibility
Bachelor's	**B Sc., BT - Biotechnology**	Candidates must secure 50% in Botany, Zoology, Physics and Chemistry of Intermediate or in the diploma course or must have appeared for Class 12 or equivalent examination with Physics, Chemistry, and Biology as major subjects from any recognized board. Candidates who have completed or qualified the final year of Intermediate courses and should attain 17 Years as on 31st December of the preceding calendar year.

ANNEXURE 2

PROGRAMS OFFERED BY DEPARTMENT OF BIOMEDICAL SCIENCES UNDER SCHOOL OF HEALTH SCIENCE

FROM ACADEMIC YEAR 2025- 2026

Sl. No.	Program	Expanded	Level	Minimum Duration in Years (N)
1	B Sc., BIT	Biotechnology	Bachelor's	4

ANNEXURE 3

PROGRAMS OFFERED BY

DEPARTMENT OF BIOMEDICAL SCIENCES

UNDER SCHOOL OF HEALTH SCIENCE

FROM ACADEMIC YEAR 2023-24

Sl. No.	Program	Expanded	Level	Minimum Duration in Years (N)
1	B Sc., BIT	Biotechnology	Bachelor's	4

B.Sc. Biotechnology

Course Structure

(w.e.f 2025- 2026 batch)

I - Semester

3 Week Induction Programme						
Course Code	**Course Name**	**Periods per week**			**Credits**	**Hours per week**
		L	**T**	**P**		
BITT1501	Fundamentals of Biotechnology	3	1	0	4	4
BITT1502	Cell Biology and Genetics	3	1	0	4	4
BITT1503	Chemistry for Biologists	3	1	0	4	4
TAUT1101	University Core – 1 Communicative English	3	0	0	3	3
TAUT1201	University Elective – 1	3	0	0	3	3
BITL1501	Genetics Lab	0	0	4	2	4
BITL1502	Cell Biology Lab	0	0	4	2	4
--	Soft Skills	0	0	0	0	1
--	Mentoring	0	0	0	0	1
--	Technical Seminar	0	0	0	0	1
--	Library	0	0	0	0	1
--	Physical Activity	0	0	0	0	2
--	Sports & Club Activity Sessions	0	0	0	0	2
--	Student Research Groups & Journal Clubs	0	0	0	0	1
--	Self-Learning	0	0	0	0	1
TOTAL		**15**	**3**	**8**	**22**	**36**

B.Sc. Biotechnology

Course Structure

(w.e.f 2025- 2026 batch)

II - Semester

Course Code	Course Name	Periods per week			Credits	Hours per week
		L	T	P		
BITT1504	Molecular Biology	3	1	0	4	4
BITT1505	Biochemistry	3	1	0	4	4
BITT1506	Microbiology	3	1	0	4	4
TAUT1102	University Core – 2 Environmental Studies	3	0	0	3	3
TAUT1202	University Elective – 2	3	0	0	3	3
BITL1503	Biochemistry and Microbiology Lab	0	0	4	2	4
BITL1504	Molecular Biology Lab	0	0	4	2	4
--	Soft Skills	0	0	0	0	1
--	Mentoring	0	0	0	0	1
--	Technical Seminar	0	0	0	0	1
--	Library	0	0	0	0	1
--	Physical Activity	0	0	0	0	2
--	Sports & Club Activity Sessions	0	0	0	0	2
--	Student Research Groups & Journal Clubs	0	0	0	0	1
--	Self-Learning	0	0	0	0	1
TOTAL		15	3	8	22	36

B.Sc. Biotechnology

Course Structure

(2025- 2026 admitted batch)

III - Semester

Course Code	Course Name	Periods per week			Credits	Hours per week
		L	T	P		
BITT2507	Genetic Engineering & rDNA Technology	3	1	0	4	4
BITT2508	Plant Biotechnology	3	1	0	4	4
BITT2509	Immunology	3	1	0	4	4
BITT2510	Bioanalytical Techniques	3	1	0	4	4
TAUT2101	University Core – 3 Health and Wellness	3	0	0	3	3
TAUT2201	University Elective – 3	3	0	0	3	3
BITL2504	Molecular Biology Lab	0	0	4	2	4
BITL2505	Bioanalytical Techniques Lab	0	0	4	2	4
--	Library	0	0	0	0	1
--	Physical Activity	0	0	0	0	2
--	Sports & Club Activity Sessions	0	0	0	0	2
--	Student Research Groups & Journal Clubs	0	0	0	0	1
TOTAL		**18**	**4**	**8**	**26**	**36**

B.Sc. Biotechnology

Course Structure

(2025- 2026 admitted batch)

IV - Semester

Course Code	Course Name	Periods per week				Number of Hours
		L	T	P	C	
BITT2511	Industrial Biotechnology	3	1	0	4	4
BITT2512	Environmental Biotechnology	3	1	0	4	4
BITT2513	Animal Biotechnology	3	1	0	4	4
BITT2514	Genomics and Proteomics	3	1	0	4	4
BITT2601	Program Elective – 1	3	0	0	3	3
BITT2602	Program Elective – 2	3	0	0	3	3
BITL2507	Industrial Biotechnology Lab	0	0	4	2	4
BITL2508	Animal Biotechnology Lab	0	0	4	2	4
	Library	0	0	0	0	1
	Physical Activity	0	0	0	0	2
	Sports & Club Activity Sessions	0	0	0	0	2
	Student Research Groups & Journal Clubs	0	0	0	0	1
	TOTAL	18	4	8	26	36

B.Sc. Biotechnology

Course Structure

(2025- 2026 admitted batch)

V - Semester

Course Code	Course Name	Periods per week				Number of Hours
		L	T	P	C	
BITT3515	Protein Engineering	3	1	0	4	4
BITT3516	Structural Biology	3	1	0	4	4
BITT3517	Medical Biotechnology	3	1	0	4	4
BITT3518	Food Biotechnology	3	1	0	4	4
BITT3603	Program Elective – 3	3	0	0	3	3
BITT3604	Program Elective – 4	3	0	0	3	3
BITL3509	Genomics and Proteomics Lab	0	0	4	2	4
BITL3510	Medical Biotechnology Lab	0	0	4	2	4
	Library	0	0	0	0	1
	Physical Activity	0	0	0	0	2
	Sports & Club Activity Sessions	0	0	0	0	2
	Student Research Groups & Journal Clubs	0	0	0	0	1
	TOTAL	18	4	8	26	36

List of Electives	Course Title
Program Elective – I	1. Biotech Startups and Entrepreneurship (BITT2601A)
	2. Bioethics and Biosafety (BITT2601B)
	3. Good Manufacturing Practices (GMP) in Biotech Industries (BITT2601C)
	4. Enzyme Technology (BITT2601D)
Program Elective – II	1. AI and Machine Learning in Biotechnology (BITT2602A)
	2. High-Throughput Screening and Data Analytics (BITT2602B)
	3. Next-Generation Sequencing (NGS) Data Analysis (BITT2602C)
	4. Big Data Analytics in Biomedical Sciences (BITT2602D)
Program Elective – III	1. Biomaterials and 3D Bioprinting in Healthcare (BITT3603A)
	2. Translational Research in Biomedical Sciences (BITT3603B)
	3. Advanced Techniques in Molecular Diagnostics (BITT3603C)
	4. CRISPR and Gene Editing Technologies (BITT3603D)
Program Elective – IV	1. Nanomedicine and Targeted Drug Delivery (BITT2604A)
	2. Experimental Models in Medical Biotechnology (BITT3604B)
	3. Intellectual Property Rights and Regulatory Affairs (BITT3604C)
	4. Biopharmaceuticals and Drug Development (BITT3604D)

B.Sc. Biotechnology

Course Structure

(2025- 2026 admitted batch)

VI - Semester *

Course Code	Course Name	Periods per week				Number of Hours
		L	T	P	C	
BITP3501	Project work and Viva-Voce	0	0	30	15	30
	Library	0	0	0	0	1
	Physical Activity	0	0	0	0	2
	Sports & Club Activity Sessions	0	0	0	0	2
	Student Research Groups & Journal Clubs	0	0	0	0	1
	TOTAL	0	0	30	15	36

*** For 3 years B.Sc. Biotechnology degree seekers**

B.Sc. Biotechnology

Course Structure

(2025- 2026 admitted batch)

VI - Semester #

Course Code	Course Name	Periods per week				Number of Hours
		L	T	P	C	
BITT3519	Molecular Modelling and Computer Aided Drug Designing	3	1	0	4	4
BITT3520	Nanobiotechnology	3	1	0	4	4
BITT3521	Biomedical Instrumentation	3	1	0	4	4
BITT3522	Stem cells and Tissue Engineering	3	1	0	4	4
BITL3511	CADD Lab	0	0	4	2	4
BITL3512	Biomedical Instrumentation Lab	0	0	4	2	4
	Students Seminars	0	0	0	0	6
	Sports & Club Activity Sessions	0	0	0	0	6
	TOTAL	12	4	8	20	36

 # For 4 years B.Sc. Biotechnology degree seekers

B.Sc. Biotechnology

Course Structure

(2025- 2026 admitted batch)

VII and VIII - Semester

Course Code	Course Name	Periods per week				Number of Hours
		L	T	P	C	
BITT4605	MOOCS Course 1	2	1	0	3	3
BITT4606	MOOCS Course 2	2	1	0	3	3
BITP4501	Major-project	0	0	36	18	36
	TOTAL	0	0	36	18	36

Course Code: BITT1501 Fundamentals of Biotechnology

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description

A comprehensive introduction to biotechnology principles and applications, covering fundamental concepts of molecular biology, genetic engineering, and bioprocessing. The course integrates theoretical knowledge with practical laboratory techniques essential for biotechnology applications in medicine, agriculture, and industry.

Course Objectives

1. Demonstrate understanding of core biotechnology principles and their applications in various fields
2. Master basic laboratory techniques and safety protocols in biotechnology
3. Analyze and interpret experimental data using appropriate statistical methods
4. Understand the ethical implications and regulatory framework of biotechnology
5. Develop problem-solving skills for real-world biotechnology challenges

Syllabus

Unit 1: Introduction to Biotechnology

- History and development of biotechnology
- Basic molecular biology concepts
- Laboratory safety and standard operating procedures
- Introduction to biotech tools and equipment
- Documentation and record-keeping in biotechnology

Unit 2: DNA Technology and Genetic Engineering

- DNA structure and replication
- Gene expression and regulation
- PCR and DNA amplification techniques
- Restriction enzymes and DNA manipulation
- Cloning and vectors

Unit 3: Protein Expression and Purification

- Protein structure and function
- Expression systems
- Protein purification techniques
- Protein analysis methods
- Enzyme technology

Unit 4: Fermentation and Bioprocessing

- Principles of fermentation
- Bioreactor design and operation
- Downstream processing
- Scale-up considerations
- Product recovery and purification

Unit 5: Applications and Future Trends

- Medical biotechnology
- Agricultural biotechnology
- Industrial biotechnology
- Emerging technologies
- Future prospects and challenges

Learning Outcomes

Upon completion, students will be able to:

1. Execute fundamental biotechnology laboratory procedures independently
2. Design and optimize basic genetic engineering experiments
3. Analyze and troubleshoot bioprocessing operations
4. Evaluate the commercial potential of biotechnology products
5. Apply regulatory and safety guidelines in biotechnology operations

Text Books

1. "Biotechnology: A Laboratory Course" by Jeffrey M. Becker, Guy A. Caldwell, and Eve Ann Zachgo
2. "Basic Laboratory Methods for Biotechnology" by Lisa A. Seidman and Cynthia J. Moore

3. "Principles of Fermentation Technology" by Peter F. Stanbury, Allan Whitaker, and Stephen J. Hall
4. "Molecular Biotechnology: Principles and Applications" by Bernard R. Glick and Jack J. Pasternak
5. "Biotechnology: Academic Cell Update" by David P. Clark and Nanette J. Pazdernik

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Course Code: BITT1502 **Cell Biology and Genetics**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description

An integrated approach to cellular biology and genetics, examining cellular structures, functions, and genetic mechanisms. The course covers molecular aspects of cell biology, inheritance patterns, and genetic regulation while emphasizing the relationship between cellular processes and genetic information.

Course Objectives

1. Understand cellular structure and organization
2. Master the principles of classical and molecular genetics
3. Analyze cellular processes and their regulation
4. Comprehend chromosome structure and genetic inheritance
5. Develop proficiency in cell biology and genetic laboratory techniques

Syllabus

Unit 1: Cell Structure and Organization

- Cell theory and evolution
- Membrane structure and function
- Organelles and their functions
- Cytoskeleton
- Cell-cell interactions

Unit 2: Cellular Processes

- Energy metabolism
- Protein synthesis and trafficking
- Cell signaling
- Cell cycle regulation
- Cell death mechanisms

Unit 3: Classical Genetics

- Mendelian inheritance
- Linkage and crossing over
- Gene mapping
- Population genetics
- Evolutionary genetics

Unit 4: Molecular Genetics
- DNA structure and replication
- Transcription and translation
- Gene regulation
- Mutations and repair
- Epigenetics

Unit 5: Advanced Topics
- Developmental genetics
- Cancer genetics
- Genomics and proteomics
- Genetic engineering
- Modern genetic analysis techniques

Learning Outcomes

Upon completion, students will be able to:

1. Analyze cellular structures and their functions
2. Solve complex genetic problems and pedigree analyses
3. Perform basic cell biology and genetic laboratory techniques
4. Interpret experimental results in cell biology and genetics
5. Apply genetic principles to real-world biological problems

Text Books

1. "Molecular Biology of the Cell" by Bruce Alberts et al.
2. "Essential Cell Biology" by Bruce Alberts et al.
3. "Introduction to Genetic Analysis" by Anthony J.F. Griffiths et al.
4. "Human Molecular Genetics" by Tom Strachan and Andrew Read
5. "Cell Biology Laboratory Manual" by William H. Heidcamp

Course Code: BITT1503 **Chemistry for Biologists**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description

A specialized chemistry course designed for biology majors, focusing on chemical principles and reactions relevant to biological systems. The course integrates fundamental chemistry concepts with biological applications, emphasizing biochemical processes and molecular interactions in living systems.

Course Objectives

1. Master fundamental chemical principles relevant to biological systems
2. Understand chemical bonding and molecular interactions in biological contexts
3. Analyze chemical reactions in biological processes
4. Develop laboratory skills for biochemical analysis
5. Apply chemical principles to solve biological problems

Syllabus

Unit 1: Fundamental Chemistry Concepts

- Atomic structure and bonding
- Chemical reactions and equations
- Solutions and concentrations
- pH and buffers
- Chemical equilibrium

Unit 2: Organic Chemistry for Biology

- Carbon compounds
- Functional groups
- Organic reactions
- Stereochemistry
- Biological molecules

Unit 3: Biochemical Foundations

- Amino acids and proteins

- Carbohydrates
- Lipids
- Nucleic acids
- Enzymes

Unit 4: Metabolic Chemistry
- Energy in biological systems
- Oxidation and reduction
- Metabolic pathways
- Cellular respiration
- Photosynthesis

Unit 5: Analytical Methods
- Spectroscopy
- Chromatography
- Electrophoresis
- Mass spectrometry
- Biochemical assays

Learning Outcomes

Upon completion, students will be able to:

1. Apply chemical principles to biological systems
2. Perform quantitative analysis of chemical reactions
3. Execute basic biochemical laboratory procedures
4. Analyze molecular structures and interactions
5. Interpret experimental data using chemical principles

Text Books

1. "Chemistry for the Biological Sciences" by Raymond Chang
2. "Organic Chemistry with Biological Applications" by John McMurry
3. "Biochemistry: A Short Course" by John L. Tymoczko, Jeremy M. Berg, and Lubert Stryer
4. "Chemical Principles for the Biological Sciences" by Jean Dubach
5. "Laboratory Manual for Chemistry in Biology" by Karen C. Timberlake

Course Code: BITT1504 **Molecular Biology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description:

This course covers the fundamental and advanced concepts of molecular biology, including the structure and function of nucleic acids, gene expression, and regulation. Students will explore molecular techniques and their applications in biotechnology and medicine.

Course Objectives:

1. Understand the structure and function of DNA, RNA, and proteins.
2. Explore the mechanisms of DNA replication, repair, transcription, and translation.
3. Analyze gene expression and regulation in prokaryotes and eukaryotes.
4. Learn molecular biology techniques and their applications in research and diagnostics.
5. Investigate recent advancements in molecular biology and genomics.

Course Content:

Unit 1: Introduction to Molecular Biology

- Central Dogma of Molecular Biology
- Structure and Properties of DNA and RNA
- DNA Replication: Mechanisms and Enzymes
- DNA Damage and Repair Mechanisms
- Organization of the Genome in Prokaryotes and Eukaryotes

Unit 2: Transcription and RNA Processing

- Transcription in Prokaryotes and Eukaryotes
- RNA Polymerases and Transcription Factors
- RNA Processing: Capping, Splicing, and Polyadenylation
- Non-Coding RNAs and Their Functions
- RNA Interference and Gene Silencing

Unit 3: Translation and Gene Regulation

- Mechanism of Translation in Prokaryotes and Eukaryotes
- Post-Translational Modifications
- Regulation of Gene Expression in Prokaryotes and Eukaryotes
- Epigenetics and Chromatin Modifications
- Molecular Basis of Genetic Disorders

Unit 4: Molecular Biology Techniques

- PCR, RT-PCR, and qPCR
- DNA Sequencing and Next-Generation Sequencing
- Recombinant DNA Technology and CRISPR-Cas9
- Gene Cloning and Expression Analysis
- Molecular Diagnostics and Biomarker Discovery

Unit 5: Applications and Advances in Molecular Biology

- Genomics and Proteomics
- Synthetic Biology and Gene Editing
- Applications in Medicine and Biotechnology
- RNA-Based Therapeutics
- Ethical and Regulatory Issues in Molecular Biology

Learning Outcomes:

1. Explain the molecular mechanisms underlying cellular processes.
2. Analyze the regulation of gene expression and its impact on cellular functions.
3. Demonstrate proficiency in molecular biology techniques.
4. Apply molecular biology concepts in research and clinical settings.
5. Evaluate recent advancements and their implications in biotechnology.

Textbooks:

1. Alberts B. et al., "Molecular Biology of the Cell," Garland Science.
2. Watson J.D. et al., "Molecular Biology of the Gene," Pearson.
3. Lodish H. et al., "Molecular Cell Biology," W.H. Freeman.
4. Krebs J.E. et al., "Lewin’s Genes XII," Jones & Bartlett Learning.
5. Brown T.A., "Genomes 4," Garland Science.

Course Code: BITT1505 **Biochemistry**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description:

This course provides an in-depth understanding of biomolecular structure, enzymology, metabolism, and biochemical signaling. It also covers biochemical techniques and their applications in health and disease.

Course Objectives:

1. Understand the structure and function of biomolecules.
2. Explore metabolic pathways and their regulation.
3. Analyze enzymology and bioenergetics.
4. Learn biochemical techniques for research and diagnostics.
5. Investigate biochemical disorders and their clinical significance.

Course Content:

Unit 1: Biomolecules and Their Functions

- Carbohydrates: Structure and Function
- Proteins and Enzymes: Mechanism and Kinetics
- Lipids and Membranes
- Nucleic Acids: Structure and Function
- Vitamins and Cofactors

Unit 2: Metabolism and Bioenergetics

- Glycolysis and TCA Cycle
- Oxidative Phosphorylation and Electron Transport Chain
- Lipid and Amino Acid Metabolism
- Metabolic Regulation and Disorders
- Energy Balance and Metabolic Diseases

Unit 3: Enzymology and Molecular Signaling

- Enzyme Classification and Kinetics
- Hormonal Regulation and Signal Transduction
- Second Messengers and Cell Communication
- Biochemical Basis of Diseases
- Therapeutic Enzymes and Drug Metabolism

Learning Outcomes:

1. Explain biochemical principles and their relevance in health.
2. Demonstrate knowledge of metabolic pathways and regulation.
3. Apply biochemical techniques in laboratory and clinical settings.
4. Analyze biochemical disorders and their treatments.
5. Evaluate emerging trends in biochemistry.

Textbooks:

1. Nelson D.L., Cox M.M., "Lehninger Principles of Biochemistry," W.H. Freeman.
2. Berg J.M. et al., "Biochemistry," W.H. Freeman.
3. Stryer L., "Biochemistry," W.H. Freeman.
4. Voet D., Voet J.G., "Biochemistry," Wiley.
5. Murray R.K. et al., "Harper's Illustrated Biochemistry," McGraw-Hill.

Course Code: BITT1506 **Microbiology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description:

This course explores the diversity, physiology, genetics, and applications of microorganisms. It covers microbial structure and function, host-pathogen interactions, microbial genetics, and industrial microbiology. Students will gain an in-depth understanding of microbial roles in health, environment, and biotechnology.

Course Objectives:

1. Understand microbial diversity, classification, and structure.
2. Analyze microbial growth, metabolism, and genetics.
3. Explore host-pathogen interactions and immune responses.
4. Learn the role of microorganisms in industry, medicine, and biotechnology.
5. Investigate microbial applications in environmental and industrial settings.

Course Content:

Unit 1: Fundamentals of Microbiology

- History and Scope of Microbiology
- Classification and Nomenclature of Microorganisms
- Structure and Functions of Bacteria, Viruses, Fungi, and Protozoa
- Microbial Growth and Reproduction
- Sterilization, Disinfection, and Microbial Control

Unit 2: Microbial Genetics and Physiology

- DNA Replication, Mutation, and Genetic Recombination
- Bacterial Transformation, Transduction, and Conjugation
- Regulation of Gene Expression in Microbes
- Microbial Metabolism and Biochemical Pathways
- Applications of Microbial Genetics in Biotechnology

Unit 3: Pathogenic Microbiology and Immunology

- Mechanisms of Microbial Pathogenicity
- Host-Pathogen Interactions and Virulence Factors
- Immune System Components and Response Mechanisms
- Antimicrobial Agents and Mechanisms of Resistance

- Epidemiology and Control of Infectious Diseases

Unit 4: Industrial and Environmental Microbiology

- Microbial Fermentation and Bioprocessing
- Microbes in Food, Agriculture, and Pharmaceuticals
- Environmental Microbiology and Bioremediation
- Extremophiles and Their Industrial Applications
- Wastewater Treatment and Biogeochemical Cycles

Unit 5: Advances in Microbiology

- Metagenomics and Microbiome Studies
- Synthetic Microbiology and Genetic Engineering
- CRISPR Applications in Microbiology
- Microbial Biosensors and Biofuels
- Ethical and Biosafety Considerations in Microbial Research

Learning Outcomes:

1. Explain microbial diversity, structure, and function.
2. Demonstrate knowledge of microbial genetics and physiology.
3. Analyze host-microbe interactions and immune mechanisms.
4. Apply microbiological concepts in industry, medicine, and research.
5. Evaluate recent advances and their implications in microbiology.

Textbooks:

1. Prescott L.M. et al., "Microbiology," McGraw-Hill.
2. Madigan M.T. et al., "Brock Biology of Microorganisms," Pearson.
3. Tortora G.J. et al., "Microbiology: An Introduction," Pearson.
4. Willey J. et al., "Prescott’s Microbiology," McGraw-Hill.
5. Pelczar M.J. et al., "Microbiology: Concepts and Applications," McGraw-Hill.

Course Code: BITT2507 **Genetic Engineering & rDNA Technology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course: Genetic Engineering & rDNA Technology

Course Description: This course provides a comprehensive overview of the principles and techniques of genetic engineering and recombinant DNA (rDNA) technology. Students will learn about gene cloning, expression systems, genome editing, and the applications of these technologies in various fields, including medicine, agriculture, and industry. The course emphasizes both theoretical foundations and practical applications.

Course Objectives (Specific to Genetic Engineering & rDNA Technology):

1. To understand the fundamental principles of gene structure, function, and regulation.
2. To master the techniques of gene cloning, including PCR, restriction enzyme digestion, and ligation.
3. To learn about different expression systems and their applications.
4. To understand the principles and applications of genome editing technologies.
5. To evaluate the ethical and societal implications of genetic engineering.

Units & Contents:

Unit 1: Foundations of Molecular Biology

* DNA structure and replication
* Transcription and translation
* Gene regulation
* Plasmids and vectors
* Restriction enzymes and DNA ligases

Unit 2: Gene Cloning Techniques

* PCR (Polymerase Chain Reaction) and its variations
* Cloning vectors (plasmids, bacteriophages, cosmids, BACs, YACs)
* Restriction enzyme mapping and DNA sequencing
* Transformation and selection of recombinant clones
* Construction of genomic and cDNA libraries

Unit 3: Expression Systems

* Prokaryotic expression systems (e.g., E. coli)

* Eukaryotic expression systems (e.g., yeast, insect cells, mammalian cells)
* Protein purification and characterization
* Codon optimization and expression control
* Large-scale production of recombinant proteins

Unit 4: Genome Editing and Gene Therapy

* CRISPR-Cas systems: Principles and applications
* Other genome editing technologies (e.g., TALENs, ZFNs)
* Viral vectors for gene therapy
* Applications of gene therapy in treating human diseases
* Ethical considerations in genome editing

Unit 5: Applications of rDNA Technology

* Production of recombinant pharmaceuticals (e.g., insulin, vaccines)
* Genetically modified crops: benefits and risks
* Molecular diagnostics and forensic science
* Bioremediation and environmental applications
* Emerging trends and future prospects in genetic engineering

Learning Outcomes:

1. Students will be able to explain the principles of DNA structure, replication, and gene expression.
2. Students will be able to design and execute basic gene cloning experiments.
3. Students will be able to compare and contrast different expression systems.
4. Students will be able to describe the mechanisms and applications of genome editing technologies.
5. Students will be able to analyze the ethical and societal impacts of genetic engineering.

Textbooks:

1. Molecular Cloning: A Laboratory Manual by Sambrook and Green (4th ed.)
2. Gene Cloning and DNA Analysis: An Introduction by T.A. Brown (7th ed.)
3. Principles of Gene Manipulation and Genomics by Sandy B. Primrose, Richard M. Twyman, and Bob Old
4. Recombinant DNA Technology by A.J. Prentic
5. Genetic Engineering by Sandhya Mitra

Course Code: BITT2508 **Plant Biotechnology**

Credits: 4

Credit Hours/Week: 4

L	T	P	C
3	1	0	4

Course Description: This course explores the application of biotechnology to plants, covering topics from plant cell culture and genetic transformation to the development of genetically modified crops and their applications in agriculture and industry. It emphasizes both theoretical knowledge and practical techniques used in plant biotechnology.

Course Objectives (Specific to Plant Biotechnology):

1. To understand the basic principles of plant cell and tissue culture.
2. To master the techniques of plant genetic transformation.
3. To learn about the applications of plant biotechnology in crop improvement.
4. To understand the use of molecular markers in plant breeding.
5. To evaluate the biosafety and ethical considerations of genetically modified crops.

Units & Contents:

Unit 1: Introduction to Plant Biotechnology

- Overview of plant biotechnology and its importance
- Plant cell and tissue culture: principles and applications
- Plant growth regulators and their roles
- Micropropagation techniques
- Haploid plant production

Unit 2: Plant Genetic Transformation

- Agrobacterium-mediated transformation
- Gene gun and other direct gene transfer methods
- Selection and regeneration of transformed plants
- Promoters and gene expression in plants
- Analysis of transgene integration and expression

Unit 3: Crop Improvement through Biotechnology

- Herbicide resistance in crops
- Insect resistance in crops (e.g., Bt crops)
- Virus resistance in crops
- Improvement of nutritional quality (e.g., golden rice)

- Stress tolerance in plants

Unit 4: Molecular Markers and Plant Breeding

- RFLP, RAPD, and AFLP markers
- Microsatellites (SSRs)
- SNPs (Single Nucleotide Polymorphisms)
- Marker-assisted selection (MAS)
- Genomic selection in plant breeding

Unit 5: Biosafety and Applications of Plant Biotechnology

- Risk assessment of genetically modified crops
- Environmental impact of transgenic plants
- Regulatory frameworks for genetically modified organisms (GMOs)
- Applications of plant biotechnology in bioremediation and biofuels
- Future trends and challenges in plant biotechnology

Learning Outcomes:

1. Students will be able to describe the methods and applications of plant tissue culture.
2. Students will be able to explain the mechanisms of plant genetic transformation.
3. Students will be able to evaluate the impact of genetically modified crops on agriculture.
4. Students will be able to apply molecular marker techniques in plant breeding.
5. Students will be able to analyze the biosafety and ethical considerations of plant biotechnology.

Textbooks:

1. Plant Biotechnology and Genetics: Principles, Processes, and Applications by C. Neal Stewart Jr.
2. Plant Biotechnology by H.S. Chawla
3. Plant Tissue Culture: Theory and Practice by S.S. Bhojwani and M.K. Razdan
4. Methods in Plant Molecular Biology by P.F. Lurquin
5. Biotechnology of Plants by I.K. Vasil and V. Vasil

Course Code: BITT2509 **Immunology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description: This course provides a comprehensive understanding of the immune system, including its cellular and molecular components, the mechanisms of immune responses, and the application of immunological principles in the diagnosis and treatment of diseases. The course integrates both basic and clinical immunology.

Course Objectives (Specific to Immunology):

1. To understand the basic concepts of innate and adaptive immunity.
2. To learn the structure and function of immune cells and molecules.
3. To master the mechanisms of antibody production and antigen-antibody interactions.
4. To understand the principles of immunological assays and their applications.
5. To evaluate the immune responses in various diseases, including autoimmune diseases, immunodeficiencies, and infectious diseases.

Units & Contents:

Unit 1: Introduction to the Immune System

- Overview of the immune system and its components
- Innate immunity: physical barriers, cellular components (e.g., macrophages, neutrophils, NK cells), and the complement system
- Adaptive immunity: overview of B cells and T cells
- Hematopoiesis and the development of immune cells
- Overview of cytokines and chemokines

Unit 2: Antigens and Antibodies

- Antigens: structure, immunogenicity, and epitopes
- Antibody structure and classes (IgG, IgM, IgA, IgE, IgD)
- Antibody diversity and the generation of antibody genes
- Antigen-antibody interactions: affinity, avidity, and cross-reactivity
- Monoclonal antibodies and their applications

Unit 3: Cellular Immunity

- T cell development and activation
- T cell receptors (TCRs) and MHC molecules
- Helper T cells (Th cells) and their functions

- Cytotoxic T cells (CTLs) and their mechanisms of action
- Regulation of T cell responses

Unit 4: Immunological Techniques

- ELISA (Enzyme-Linked Immunosorbent Assay)
- Flow cytometry
- Immunohistochemistry
- Western blotting
- Immunoprecipitation

Unit 5: Clinical Immunology

- Hypersensitivity reactions (types I, II, III, and IV)
- Autoimmune diseases: mechanisms and examples (e.g., rheumatoid arthritis, lupus)
- Immunodeficiencies: primary and secondary immunodeficiencies
- Transplantation immunology: graft rejection and immunosuppression
- Vaccines: principles, types, and applications

Learning Outcomes:

1. Students will be able to describe the components and functions of the innate and adaptive immune systems.
2. Students will be able to explain the structure, function, and diversity of antibodies.
3. Students will be able to describe the mechanisms of T cell activation and function.
4. Students will be able to apply immunological techniques in research and clinical settings.
5. Students will be able to analyze the immune responses in various diseases.

Textbooks:

1. Kuby Immunology by Jenni Punt, Sharon Stranford, Patricia Jones, Judith A. Kuby
2. Cellular and Molecular Immunology by Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai
3. Immunology by David Male, Jonathan Brostoff, David Roth, Ivan Roitt
4. Janeway's Immunobiology by Kenneth Murphy, Paul Travers, Mark Walport
5. Fundamental Immunology by William E. Paul

Course Code: BITT2510 **Bioanalytical Techniques**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description: This course covers a range of analytical techniques used in biotechnology, biochemistry, and molecular biology. It emphasizes the principles, instrumentation, and applications of these techniques in the analysis and characterization of biological molecules, cells, and tissues. Students will gain hands-on experience with several key techniques.

Course Objectives (Specific to Bioanalytical Techniques):

1. To understand the principles of various bioanalytical techniques.
2. To master the operation and applications of key analytical instruments.
3. To learn sample preparation methods for biological analysis.
4. To interpret data generated by bioanalytical techniques.
5. To apply bioanalytical techniques in research and industrial settings.

Units & Contents:

Unit 1: Introduction to Bioanalytical Chemistry

- Overview of bioanalytical techniques and their applications
- Sample preparation methods: cell lysis, extraction, and purification
- Spectroscopic methods: UV-Vis, fluorescence, and mass spectrometry
- Calibration and standardization
- Data analysis and interpretation

Unit 2: Chromatography

- Principles of chromatography: separation modes (size exclusion, ion exchange, affinity, reversed-phase)
- HPLC (High-Performance Liquid Chromatography): instrumentation and applications
- GC (Gas Chromatography): principles and applications
- LC-MS (Liquid Chromatography-Mass Spectrometry): principles and applications
- Chromatographic data analysis

Unit 3: Electrophoresis and Centrifugation

- Principles of electrophoresis: SDS-PAGE, isoelectric focusing, and capillary electrophoresis
- Instrumentation and applications of electrophoresis
- Principles of centrifugation: differential and density gradient centrifugation

- Applications of centrifugation in cell and protein separation
- Analysis of electrophoresis and centrifugation results

Unit 4: Microscopy and Imaging Techniques

- Light microscopy: bright-field, phase-contrast, and fluorescence microscopy
- Electron microscopy: SEM and TEM principles and applications
- Confocal microscopy and its applications
- Flow cytometry: principles, instrumentation, and applications
- Image analysis techniques

Unit 5: Biosensors and Other Techniques

- Biosensors: principles and types (e.g., electrochemical, optical, piezoelectric)
- Applications of biosensors in diagnostics and environmental monitoring
- Real-time PCR (qPCR) and its applications
- Surface Plasmon Resonance (SPR)
- Microarray and NGS techniques

Learning Outcomes:

1. Students will be able to describe the principles of spectroscopic techniques and their applications.
2. Students will be able to explain the principles of chromatography and select the appropriate technique for a given application.
3. Students will be able to describe the principles of electrophoresis and centrifugation and their applications.
4. Students will be able to operate and interpret data from various microscopic and imaging techniques.
5. Students will be able to explain the principles and applications of biosensors and other advanced techniques.

Textbooks:

1. Principles and Practice of Bioanalysis by Christa E. Müller
2. Bioanalytical Chemistry by Susan R. Mikkelsen and Eduardo Cortón
3. Bioanalytical Techniques by S.M. Lahlou
4. Analytical Biochemistry by David J. Holme and Hazel Peck
5. Biochemical Engineering and Biotechnology Handbook by Karl Kammer

Course Code: BITT3511 **Industrial Biotechnology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description:

This course provides an in-depth understanding of biotechnological applications in industrial processes. It covers microbial fermentation, enzyme technology, biofuel production, and bioremediation, with a focus on sustainable practices and economic impact. The course integrates theoretical knowledge with real-world industrial case studies.

Course Objectives:

1. Understand the principles and applications of industrial biotechnology.
2. Analyze microbial and enzymatic processes used in industrial applications.
3. Evaluate the economic and environmental impact of biotechnological innovations.
4. Investigate sustainable biotechnological solutions for industry.
5. Develop strategies for scaling up biotechnological processes for commercial applications.

Syllabus:

Unit 1: Fundamentals of Industrial Biotechnology

- Introduction to industrial biotechnology and its significance
- Microbial diversity and metabolic pathways in industrial applications
- Industrially relevant bioprocesses (batch, fed-batch, and continuous)
- Good Manufacturing Practices (GMP) and regulatory considerations
- Applications in pharmaceuticals, food, and chemicals

Unit 2: Fermentation Technology and Bioprocess Engineering

- Principles of microbial fermentation
- Types of fermentation (aerobic and anaerobic)
- Fermenter design and operation
- Downstream processing and product recovery
- Industrial case studies in fermentation technology

Unit 3: Enzyme Technology and Biocatalysis

- Industrial applications of enzymes
- Enzyme production, immobilization, and optimization
- Protein engineering for enhanced enzyme function
- Biocatalysis in pharmaceuticals and fine chemicals

- Environmental impact and sustainability of enzyme use

Unit 4: Biofuels and Industrial Bioremediation

- Microbial production of biofuels (ethanol, biodiesel, biogas)
- Algae-based biofuels and future prospects
- Bioremediation techniques for industrial waste management
- Environmental regulations and industrial compliance
- Case studies on biofuel technology and industrial bioremediation

Unit 5: Advanced and Emerging Technologies in Industrial Biotechnology

- Synthetic biology applications in industry
- CRISPR and genome editing in industrial microbes
- Industrial applications of metabolic engineering
- Biotechnology and circular economy
- Ethical, regulatory, and societal implications

Learning Outcomes:

1. Explain the core principles of industrial biotechnology and its applications.
2. Apply microbial and enzymatic processes to industrial challenges.
3. Evaluate the economic and environmental impact of biotechnological solutions.
4. Propose sustainable biotechnological strategies for industry.
5. Demonstrate an understanding of emerging biotechnological innovations.

Textbooks:

1. "Industrial Biotechnology: Sustainable Production and Use of Biofuels" – Wiley, 2019.
2. "Biotechnology for Beginners" – Greenleaf Book Group Press, 2020.
3. "Fermentation and Biochemical Engineering Handbook" – Noyes Publications, 2017.
4. "Enzyme Technology" – Springer, 2018.
5. "Biofuels: A Solution to the Energy Crisis" – Academic Press, 2021.

Course Code: BITT3512 **Environmental Biotechnology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description:

This course explores the role of biotechnology in addressing environmental challenges. It examines biotechnological solutions for pollution control, waste management, bioremediation, and resource recovery. The course integrates molecular, microbial, and synthetic biology approaches to promote environmental sustainability.

Course Objectives:

1. Understand the principles of environmental biotechnology and its applications.
2. Analyze biotechnological solutions for pollution and waste management.
3. Evaluate bioremediation techniques for environmental restoration.
4. Investigate biotechnology-based renewable resource management.
5. Develop innovative and sustainable biotechnological strategies for environmental conservation.

Syllabus:

Unit 1: Fundamentals of Environmental Biotechnology

- Scope and importance of environmental biotechnology
- Environmental pollution: types and sources
- Microbial ecology and biogeochemical cycles
- Biotechnological tools for environmental management
- Regulatory and ethical considerations in environmental biotechnology

Unit 2: Waste Management and Biodegradation

- Microbial degradation of pollutants (organic and inorganic)
- Biological wastewater treatment systems
- Solid waste management and composting
- Phytoremediation and mycoremediation
- Case studies on industrial and municipal waste treatment

Unit 3: Bioremediation Technologies

- Principles and mechanisms of bioremediation
- Microbial bioremediation of heavy metals and hydrocarbons
- Biostimulation and bioaugmentation strategies
- Monitoring and assessment of bioremediation processes

- Case studies on successful bioremediation projects

Unit 4: Resource Recovery and Sustainable Bioprocesses

- Bioconversion of waste to value-added products
- Microbial fuel cells and bioelectricity generation
- Circular economy and biotechnological interventions
- Economic analysis of biotechnological resource recovery
- Industrial applications and future trends

Unit 5: Emerging Trends and Future Prospects

- Synthetic biology in environmental biotechnology
- CRISPR-based environmental interventions
- Biotechnology in climate change mitigation
- Ethical and societal implications of environmental biotechnology
- Cutting-edge research and industry applications

Learning Outcomes:

1. Demonstrate a scientific understanding of environmental biotechnology.
2. Apply biotechnological solutions to environmental and waste management challenges.
3. Evaluate bioremediation techniques and resource recovery strategies.
4. Develop sustainable biotechnological solutions for environmental conservation.
5. Analyze the impact of biotechnology on global environmental sustainability.

Textbooks:

1. "Environmental Biotechnology: Theory and Application" – Wiley, 2018.
2. "Bioremediation: Principles and Applications" – Academic Press, 2020.
3. "Waste Management and Resource Recovery" – Springer, 2019.
4. "Microbial Ecology: Fundamentals and Applications" – Pearson, 2021.
5. "Sustainable Environmental Biotechnology" – CRC Press, 2022.

Course Code: BITT3513 **Animal Biotechnology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description:

This course covers biotechnological advancements in animal science, including transgenic animals, animal cell culture, cloning, and stem cell technology. It explores molecular tools and techniques used in animal biotechnology for applications in agriculture, medicine, and conservation.

Course Objectives:

1. Understand the principles and applications of animal biotechnology.
2. Learn animal cell culture techniques and their applications.
3. Analyze transgenic animal technology and its ethical implications.
4. Evaluate the role of biotechnology in animal health and reproduction.
5. Investigate stem cell technology and its therapeutic applications.

Syllabus:

Unit 1: Fundamentals of Animal Biotechnology

- Overview of animal biotechnology and its significance
- Animal cell culture: types and techniques
- Cryopreservation and cell banking
- Ethical issues and regulatory considerations
- Applications in medicine and agriculture

Unit 2: Transgenic Animals and Cloning

- Methods of gene transfer in animals
- Applications of transgenic animals in biotechnology
- Cloning techniques: somatic cell nuclear transfer
- Therapeutic cloning and its applications
- Ethical and regulatory aspects

Unit 3: Animal Health and Reproduction Biotechnology

- Role of biotechnology in veterinary medicine
- Recombinant vaccines and monoclonal antibodies
- Assisted reproductive technologies (IVF, embryo transfer)
- Genetic disease diagnosis and gene therapy

- Case studies in animal health biotechnology

Unit 4: Stem Cells and Regenerative Medicine

- Types of stem cells and their characteristics
- Animal models in regenerative medicine
- Gene editing in stem cell research
- Applications in tissue engineering
- Future trends in stem cell therapy

Unit 5: Advances in Animal Biotechnology

- CRISPR-Cas9 and genome editing in animals
- Biopharming: production of pharmaceuticals in animals
- Biotechnology in livestock improvement
- Role of AI and big data in animal biotechnology
- Societal and economic impacts

Textbooks:

1. "Animal Biotechnology: Science-Based Concerns" – National Academies Press, 2018.
2. "Principles of Cloning" – Academic Press, 2020.
3. "Stem Cell Biology and Regenerative Medicine" – Springer, 2019.
4. "Transgenic Animal Technology" – Elsevier, 2021.
5. "Veterinary Biotechnology" – CRC Press, 2022.

Course Code: BITT3514 **Genomics and Proteomics**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description:

This course provides an overview of the principles and applications of genomics and proteomics, including DNA sequencing, gene expression analysis, and protein structure and function. Students will learn about the latest techniques and tools in genomics and proteomics, and their applications in various fields such as medicine, agriculture, and biotechnology.

Course Objectives:

1. To understand the principles of DNA structure, replication, and transcription.
2. To learn about the various techniques used in DNA sequencing and gene expression analysis.
3. To understand the structure and function of proteins, including protein folding and binding.
4. To learn about the different types of proteomics platforms and their applications.
5. To analyze and interpret genomic and proteomic data.

Syllabus (4 credits, 4 credit hours)

Unit 1: Fundamentals of Genomics (1 credit, 12 hours)

- 1.1 Introduction to genomics
  - Definition of genomics
  - History of genomics
  - Importance of genomics
- 1.2 DNA structure and replication
  - DNA structure
  - DNA replication
  - Mutation and mutation rates
- 1.3 Gene expression
  - Transcription
  - Translation
  - Regulation of gene expression

Unit 2: DNA Sequencing and Gene Expression Analysis (1 credit, 12 hours)

- 2.1 DNA sequencing techniques

- Sanger sequencing
- Next-generation sequencing (NGS)
- Single-molecule sequencing

- 2.2 Gene expression analysis
  - Microarray analysis
  - RNA sequencing (RNA-seq)
  - Quantitative PCR (qPCR)

Unit 3: Proteomics Platforms (1 credit, 12 hours)

- 3.1 Mass spectrometry-based proteomics
  - Principles of mass spectrometry
  - Types of mass spectrometry-based proteomics
  - Applications of mass spectrometry-based proteomics
- 3.2 Other proteomics platforms
  - Gel-based proteomics
  - LC-MS/MS

Unit 4: Bioinformatics Tools and Databases (1 credit, 12 hours)

- 4.1 Bioinformatics tools for genomics and proteomics analysis
  - Sequence alignment tools
  - Gene prediction tools
  - Protein structure prediction tools
- 4.2 Databases for genomics and proteomics data
  - GenBank
  - UniProt
  - Protein Data Bank (PDB)

Unit 5: Applications of Genomics and Proteomics (1 credit, 12 hours)

- 5.1 Medical applications of genomics and proteomics
  - Personalized medicine
  - Cancer genomics and proteomics
- 5.2 Agricultural applications of genomics and proteomics
  - Crop improvement through genomics and proteomics
  - Animal breeding through genomics and proteomics

Learning Outcomes:

Upon completion of this course, students will be able to:

1. Understand the principles of genomics and proteomics.
2. Apply genomics and proteomics techniques to analyze DNA and protein data.
3. Interpret genomic and proteomic data to make informed decisions.
4. Analyze the structure and function of proteins.
5. Design experiments to investigate genomic and proteomic questions.

Textbooks:

1. Lewin, B. (2017). Genes X (11th ed.). Jones & Bartlett Learning.
2. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2019). Molecular Biology of the Gene (8th ed.). Pearson Education Limited.
3. Cannone, J. J., Subramanian, K., & Ciufo, S. (2016). Comparative Analysis of DNA Sequence Features in the Human Genome. PLOS ONE.
4. Smith, D. J., & Leesong, M. (2017). The Protein-Protein Interaction Network: An Overview of Current Research Trends. Journal of Proteome Research.
5. Mortimer, J., & Luntz-Leybman, A. (2018). Understanding Bioinformatics: From Algorithms to Applications (2nd ed.). Jones & Bartlett Learning.

Course Code: BITT3515 **Protein Engineering**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description:

This course explores the principles and applications of protein engineering, covering rational and directed evolution approaches. It provides insights into protein structure, function, and design for various industrial, medical, and biotechnological applications.

Course Objectives:

1. Understand protein structure and function.
2. Explore methods for protein engineering and directed evolution.
3. Analyze applications of engineered proteins in biotechnology and medicine.
4. Learn computational approaches for protein design.
5. Investigate recent advancements in protein engineering.

Course Content:

Unit 1: Basics of Protein Structure and Function

- Amino Acids and Peptide Bonds
- Protein Folding and Stability
- Structure-Function Relationship in Proteins
- Protein-Protein Interactions
- Techniques for Protein Structure Determination

Unit 2: Protein Engineering Approaches

- Rational Design vs. Directed Evolution
- Site-Directed Mutagenesis
- Computational Protein Design
- High-Throughput Screening Methods
- Case Studies in Protein Engineering

Unit 3: Industrial and Medical Applications

- Enzyme Engineering and Biocatalysis
- Therapeutic Proteins and Antibodies
- Protein-Based Biosensors
- Industrially Relevant Engineered Proteins
- Protein Engineering for Drug Development

Unit 4: Computational Tools in Protein Engineering

- Molecular Docking and Simulation
- Machine Learning in Protein Engineering
- Structural Bioinformatics
- Protein-Protein Interaction Prediction
- CRISPR and Genome Editing

Unit 5: Recent Advances and Future Perspectives

- Synthetic Biology and Protein Engineering
- De Novo Protein Design
- Engineering Membrane Proteins
- Evolutionary Approaches in Protein Design
- Ethical and Regulatory Aspects of Protein Engineering

Learning Outcomes:

1. Explain the principles of protein engineering.
2. Utilize computational and experimental approaches for protein modification.
3. Analyze the applications of engineered proteins in different fields.
4. Demonstrate knowledge of molecular and synthetic biology tools.
5. Evaluate the impact of protein engineering in biotechnology.

Textbooks:

1. Branden C., Tooze J., "Introduction to Protein Structure," Garland Science, 2019.
2. Voet D., Voet J.G., "Biochemistry," Wiley, 2021.
3. Walsh G., "Proteins: Biochemistry and Biotechnology," Wiley, 2018.
4. Petsko G.A., Ringe D., "Protein Structure and Function," Oxford University Press, 2020.
5. Arnold F.H., "Directed Evolution: Creating Biocatalysts," Springer, 2019.

Course Code: BITT3516 **Medical Biotechnology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Medical Biotechnology

Course Credits and Hours: 4 Credits, 4 Credit Hours

Course Description: This course provides a comprehensive overview of the application of biotechnology principles to the field of medicine. It covers the fundamental concepts, techniques, and applications of medical biotechnology, including molecular diagnostics, recombinant DNA technology, genetic engineering, genomics, proteomics, and their use in the development of novel therapeutics, diagnostics, and personalized medicine. The course will emphasize the ethical, social, and regulatory aspects of this rapidly evolving field.

Course Objectives:

Upon successful completion of this course, students will be able to:

1. **Understand and explain** the core principles and techniques of molecular biology and biotechnology relevant to medical applications.
2. **Analyze and interpret** the methodologies used in modern medical biotechnology, including genetic engineering, cell culture, and immunological techniques.
3. **Evaluate** the applications of medical biotechnology in the diagnosis, treatment, and prevention of human diseases.
4. **Critically assess** the ethical, social, and regulatory implications of medical biotechnology advancements.
5. **Apply** their knowledge to analyze current research and developments in medical biotechnology.

Syllabus:

Unit 1: Introduction to Medical Biotechnology and Molecular Biology Fundamentals

- **Content 1:** Historical perspective and scope of medical biotechnology; Impact on healthcare.
- **Content 2:** Central dogma of molecular biology: DNA, RNA, and Protein synthesis; the gene and genome structure
- **Content 3:** Recombinant DNA technology and cloning principles and techniques: Restriction enzymes, vectors, and cloning strategies.

- **Content 4:** Polymerase Chain Reaction (PCR) and its variations; Applications in diagnostics and research
- **Content 5:** Cell structure and functions, cell culture basics, and its applications in medical biotechnology

Unit 2: Genomics, Proteomics, and Molecular Diagnostics

- **Content 1:** Overview of genomics: Genome sequencing, mapping, and analysis. Human Genome Project and its impact.
- **Content 2:** Transcriptomics and proteomics: Gene expression profiling, protein analysis, and post-translational modifications.
- **Content 3:** Molecular diagnostic tools: DNA and RNA-based assays; Microarrays and next-generation sequencing (NGS)
- **Content 4:** Applications of molecular diagnostics: Infectious disease diagnosis, cancer detection, and genetic screening.
- **Content 5:** Point-of-care diagnostics and rapid diagnostic tests in medical biotechnology

Unit 3: Genetic Engineering and Gene Therapy

- **Content 1:** Principles of genetic engineering: Gene cloning, expression systems (bacteria, yeast, mammalian cells).
- **Content 2:** Production of recombinant proteins: Pharmaceuticals, vaccines, and therapeutic proteins.
- **Content 3:** Gene therapy: Vectors (viral and non-viral), gene delivery methods, and clinical applications.
- **Content 4:** CRISPR-Cas9 technology: Mechanism, applications, and ethical considerations.
- **Content 5:** Stem cell technology and its applications in regenerative medicine and gene therapy.

Unit 4: Immunotechnology and Drug Discovery

- **Content 1:** Principles of immunology: Antibodies, antigens, and the immune response.
- **Content 2:** Immunodiagnostics: ELISA, RIA, and other immunological assays.
- **Content 3:** Monoclonal antibodies and their applications: Therapeutic antibodies, antibody-drug conjugates.
- **Content 4:** Drug discovery process: Target identification, drug design, and high-throughput screening.
- **Content 5:** Personalized medicine: Pharmacogenomics, companion diagnostics, and tailored therapies.

Unit 5: Ethical, Social, and Regulatory Aspects of Medical Biotechnology

- **Content 1:** Ethical considerations in medical biotechnology: Genetic testing, gene therapy, and reproductive technologies.
- **Content 2:** Social impact of medical biotechnology: Public perception, access to healthcare, and equity issues.
- **Content 3:** Intellectual property and patents in biotechnology.
- **Content 4:** Regulatory framework: FDA regulations, clinical trials, and approval processes.
- **Content 5:** Future trends and challenges in medical biotechnology: Nanotechnology, synthetic biology, and the convergence of technologies.

Learning Outcomes:

Upon successful completion of this course, students will be able to:

1. **Describe** the fundamental concepts and techniques of molecular biology and medical biotechnology.
2. **Explain** the principles and applications of genomics, proteomics, and molecular diagnostics in medicine.
3. **Evaluate** the principles and applications of gene therapy and genetic engineering.
4. **Analyze** the role of immunotechnology and drug discovery in medical advances.
5. **Discuss** the ethical, social, and regulatory aspects of medical biotechnology.

Textbooks:

1. **Title:** Biotechnology: Science, Engineering, and Medicine
   - **Authors:** Elaine T. McInnes, Alistair M. Brown
   - **Publisher:** Elsevier
   - **Year:** 2020
2. **Title:** Principles of Medical Biotechnology
   - **Authors:** S.N. Jogdand
   - **Publisher:** Himalaya Publishing House
   - **Year:** 2021
3. **Title:** Medical Biotechnology
   - **Authors:** Dr. R. C. Sharma
   - **Publisher:** International Book Distributing Co.
   - **Year:** 2022

Course Code: BITT3517 **Structural Biology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description:

This course delves into the structural aspects of biomolecules, focusing on proteins, nucleic acids, and macromolecular complexes. Students will explore methods used for structural determination and their applications in biotechnology and drug discovery.

Course Objectives:

1. Understand the fundamentals of biomolecular structures.
2. Learn techniques for structural determination.
3. Analyze the relationship between structure and function.
4. Explore applications of structural biology in drug design.
5. Investigate advancements in structural biology methodologies.

Course Content:

Unit 1: Introduction to Structural Biology

- Structural Organization of Biomolecules
- Protein Structure and Classification
- Nucleic Acid Structures
- Role of Structural Biology in Medicine and Biotechnology
- Computational Approaches in Structural Biology

Unit 2: Techniques in Structural Biology

- X-ray Crystallography
- Nuclear Magnetic Resonance (NMR) Spectroscopy
- Cryo-Electron Microscopy
- Small-Angle X-ray Scattering
- Advances in Hybrid Structural Methods

Unit 3: Structure-Function Relationship

- Protein-Ligand Interactions
- Enzyme Mechanisms and Kinetics
- Molecular Recognition and Signal Transduction
- Membrane Proteins and Structural Dynamics
- Conformational Changes and Protein Folding Disorders

Unit 4: Computational and Bioinformatics Approaches

- Molecular Dynamics Simulations
- Homology Modeling and Structure Prediction
- Drug Docking Studies
- Protein-Protein Interaction Studies
- Structural Bioinformatics Tools and Databases

Unit 5: Applications and Future Perspectives

- Structural Biology in Drug Discovery
- Structural Vaccinology
- Advances in AI for Structural Prediction
- CRISPR and Gene Editing Insights
- Ethical Considerations in Structural Studies

Learning Outcomes:

1. Explain key concepts of biomolecular structures.
2. Demonstrate proficiency in structural determination methods.
3. Analyze molecular interactions using computational tools.
4. Apply structural biology knowledge to biotechnology and medicine.
5. Evaluate advances in structural research for therapeutic applications.

Textbooks:

1. Liljas A., "Textbook of Structural Biology," World Scientific, 2017.
2. Rupp B., "Biomolecular Crystallography," Garland Science, 2019.
3. Branden C., Tooze J., "Introduction to Protein Structure," Garland Science, 2020.
4. Petsko G.A., Ringe D., "Protein Structure and Function," Oxford University Press, 2021.
5. Leach A.R., "Molecular Modelling: Principles and Applications," Pearson, 2018.

Course Code: BITT3518 **Food Biotechnology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description: This course provides a comprehensive overview of the application of biotechnology principles to the food industry. Students will explore the use of genetic engineering, molecular biology, and fermentation technologies in food production, processing, preservation, and safety. The course emphasizes both the scientific foundations and practical applications of these technologies, considering their impact on food quality, safety, sustainability, and regulatory aspects.

Course Objectives:

Upon successful completion of this course, students will be able to:

1. Understand the fundamental principles of molecular biology, genetics, and microbiology relevant to food biotechnology.
2. Evaluate the application of genetic engineering and recombinant DNA technology in the development of genetically modified (GM) crops and food products.
3. Analyze the role of fermentation technology in the production of various food ingredients and products.
4. Assess the importance of food safety and quality control in the context of biotechnology-derived foods, including detection of GMOs.
5. Critically evaluate the ethical, social, and regulatory considerations surrounding food biotechnology, including labeling and consumer acceptance.

Syllabus

Unit 1: Foundations of Food Biotechnology

- **Content 1:** Introduction to Food Biotechnology: Definition, Scope, and Historical Perspective.
- **Content 2:** Basic Concepts in Molecular Biology: DNA structure and replication, RNA, protein synthesis, and gene expression.
- **Content 3:** Introduction to Microbial Food Biotechnology: Bacteria, yeast, and molds in food processing and production.
- **Content 4:** Enzyme Technology: Enzymes in food processing, characterization, and applications (e.g., amylases, proteases, lipases).

- **Content 5:** Overview of Genetic Engineering Techniques: Restriction enzymes, cloning vectors, gene transfer methods.

Unit 2: Genetic Engineering in Food Production

- **Content 1:** Genetically Modified (GM) Crops: Development, characteristics (e.g., pest resistance, herbicide tolerance, nutritional enhancement).
- **Content 2:** GM Crops: Examples of application for enhancing quality and increasing production, with case studies (e.g., Golden Rice, Bt corn).
- **Content 3:** GM Animal Production: Techniques for modifying livestock and aquaculture species, including applications.
- **Content 4:** Food Quality Improvement through Genetic Engineering: Flavor, texture, shelf-life, and nutritional content.
- **Content 5:** Food Labeling and Regulatory Aspects of GMOs: International regulations, labeling requirements, and consumer perception.

Unit 3: Fermentation Technology in Food Production

- **Content 1:** Principles of Fermentation: Types of fermentation, microbial metabolism, and bioreactor design.
- **Content 2:** Fermented Dairy Products: Yogurt, cheese, and probiotic applications.
- **Content 3:** Fermented Beverages: Beer, wine, and other fermented drinks.
- **Content 4:** Fermented Vegetables and Cereal Products: Sauerkraut, kimchi, sourdough bread.
- **Content 5:** Production of Food Additives by Fermentation: Vitamins, amino acids, and other ingredients.

Unit 4: Food Safety and Quality in Food Biotechnology

- **Content 1:** Foodborne Pathogens: Identification, detection, and control in food.
- **Content 2:** Food Safety Concerns Related to Biotechnology: Allergens, toxins, and antibiotic resistance.
- **Content 3:** Detection of GMOs: PCR-based methods, ELISA, and other techniques.
- **Content 4:** Quality Control in Biotechnology-Derived Foods: Analytical techniques, validation, and assurance.
- **Content 5:** Risk Assessment and Management: Safety assessment of GM foods and food products.

Unit 5: Ethical, Social, and Regulatory Issues

- **Content 1:** Ethical Considerations: Environmental impact, intellectual property rights, and consumer choice.

- **Content 2:** Social Implications: Public perception, consumer acceptance, and social justice.
- **Content 3:** Regulatory Frameworks: International and national regulations for food biotechnology.
- **Content 4:** Case Studies: Examination of controversies and debates surrounding specific food biotechnology applications.
- **Content 5:** Future Trends: Emerging technologies and their potential impact on the food industry.

Learning Outcomes:

Upon completion of this course, students will be able to:

1. Apply fundamental molecular biology principles to understand food biotechnology applications.
2. Evaluate the benefits and risks associated with genetic modification of food crops.
3. Explain the role of fermentation in food production and its impact on product characteristics.
4. Analyze the food safety and quality issues that arise from biotechnology-derived products.
5. Critically evaluate the ethical, social, and regulatory implications of food biotechnology.

Textbooks:

1. **Food Biotechnology** by C. P. Champagne. CRC Press. 2020.
2. **Food Biotechnology** by H. W. Shively, R. G. Crandall, and S. S. Sumner. John Wiley & Sons. 2018.
3. **Principles of Food Biotechnology** by G. E. R. Fenske. Academic Press. 2015.
4. **Food Biotechnology** by A. K. Mandal and S. K. Sharma. Kluwer Academic Publishers. 2012.
5. **Biotechnology of Food and Feed** by A. D. D'Mello. Springer. 2010.

Course Code: BITT3519 **Molecular Modeling and Computer-Aided Drug Design**

Credits: 4

Credit Hours/Week: 4

L	T	P	C
3	1	0	4

Course Description: This course introduces the fundamental principles and practical applications of molecular modeling and computer-aided drug design (CADD). Students will learn how to use computational methods to understand molecular structures, predict their properties, and design new drug candidates. The course covers various techniques, including molecular mechanics, quantum mechanics, molecular dynamics simulations, ligand-based and structure-based drug design, virtual screening, and ADMET prediction.

Course Objectives:

1. Understand the theoretical foundations of molecular mechanics, quantum mechanics, and their applications in modeling biomolecules.
2. Learn to perform and interpret molecular dynamics simulations to study protein flexibility and ligand binding.
3. Apply structure-based drug design techniques, including docking and scoring, to identify potential drug candidates.
4. Utilize ligand-based drug design approaches, such as QSAR and pharmacophore modeling, to develop drug candidates.
5. Become proficient in using CADD software and databases for drug discovery and development.

Syllabus:

Unit 1: Introduction to Molecular Modeling and Drug Design

- Historical context and the role of CADD in drug discovery.
- Overview of drug discovery pipeline: Target identification, validation, lead discovery, lead optimization.
- Fundamental concepts: Molecular structure, chemical bonds, non-covalent interactions.
- Introduction to different types of molecular modeling: Molecular mechanics, quantum mechanics, molecular dynamics, and Monte Carlo simulations.
- Introduction to relevant software and databases.

Unit 2: Molecular Mechanics and Force Fields

- Potential energy surfaces and their applications in molecular modeling.
- Force field theory: Bonded and non-bonded interactions.

- Commonly used force fields: AMBER, CHARMM, GROMOS, UFF.
- Parameterization and validation of force fields.
- Applications of molecular mechanics in energy minimization and conformational analysis.

Unit 3: Quantum Mechanics and Electronic Structure Calculations

- Principles of quantum mechanics and its applications to molecular systems.
- Electronic structure methods: Ab initio methods (Hartree-Fock, DFT), semi-empirical methods.
- Basis sets and their effect on the accuracy of calculations.
- Applications: Molecular properties prediction (e.g., dipole moments, ionization potentials), reaction mechanisms.
- Introduction to computational chemistry software (e.g., Gaussian, GAMESS).

Unit 4: Molecular Dynamics and Simulations

- Principles of molecular dynamics simulations: Equations of motion, algorithms, and integration.
- Ensembles and boundary conditions.
- Analyzing MD trajectories: Root mean square deviation (RMSD), root mean square fluctuation (RMSF), hydrogen bonds, and free energy calculations.
- Applications: Protein folding, ligand-protein binding, membrane simulations, conformational changes.
- Introduction to advanced MD techniques: Enhanced sampling methods, metadynamics, and replica exchange MD.

Unit 5: Structure-Based and Ligand-Based Drug Design

- Structure-based drug design: Target identification, protein structure determination (X-ray crystallography, NMR), and homology modeling.
- Molecular docking: Algorithms (e.g., Autodock, Glide), scoring functions, and validation.
- Virtual screening: High-throughput screening, in silico screening, and database searching.
- Ligand-based drug design: QSAR (Quantitative Structure-Activity Relationship) and pharmacophore modeling.
- ADMET prediction: Absorption, Distribution, Metabolism, Excretion, and Toxicity properties.

Learning Outcomes:

1. Students will be able to explain the basic principles of molecular mechanics and quantum mechanics and their use in modeling biological molecules.

2. Students will be able to conduct and analyze molecular dynamics simulations to study protein dynamics and protein-ligand interactions.

3. Students will be able to apply structure-based drug design techniques, including docking and scoring, to discover potential drug candidates.

4. Students will be able to utilize ligand-based drug design methods such as QSAR and pharmacophore modeling.

5. Students will be able to evaluate ADMET properties and select potential drug candidates.

Textbooks:

1. **"Molecular Modeling: Principles and Applications"** by Andrew R. Leach. Pearson Education, 2001.

2. **"Drug Design: Structure- and Ligand-Based Approaches"** by Kurt Wuthrich. Wiley-VCH, 2008.

3. **"Computer-Aided Drug Design: Methods and Applications"** by Karl-Heinz Baringhaus. Wiley-VCH, 2011.

4. **"Computational Chemistry and Drug Design"** by D. C. Young. John Wiley & Sons, 2009.

5. **"Bioinformatics for Drug Discovery"** by R. Rastogi, N. Mendiratta, and P. Rastogi. Springer, 2013.

Course Code: BITT3520 **Nanobiotechnology**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description: This course explores the intersection of nanotechnology and biology, focusing on the design, synthesis, characterization, and application of nanoscale materials and devices for biomedical purposes. It covers the fundamental principles of nanotechnology, the interaction of nanomaterials with biological systems, and the application of nanobiotechnology in areas such as drug delivery, diagnostics, imaging, and regenerative medicine.

Course Objectives:

1. Understand the fundamental principles of nanotechnology and the properties of nanomaterials.
2. Learn the synthesis and characterization techniques for various nanomaterials.
3. Comprehend the interaction of nanomaterials with biological systems at the cellular and molecular levels.
4. Explore the applications of nanobiotechnology in drug delivery, diagnostics, and imaging.
5. Investigate the use of nanomaterials in regenerative medicine and tissue engineering.

Syllabus:

Unit 1: Introduction to Nanotechnology and Nanobiotechnology

- Overview of nanotechnology and its importance.
- Length scales in biology and nanotechnology.
- Properties of nanomaterials: Size-dependent properties, surface area to volume ratio, quantum effects.
- Classification of nanomaterials: nanoparticles, nanotubes, nanowires, thin films.
- Ethical, social, and environmental implications of nanobiotechnology.

Unit 2: Synthesis and Characterization of Nanomaterials

- Top-down and bottom-up approaches to nanomaterial synthesis.
- Synthesis techniques for nanoparticles: Chemical, physical, and biological methods.
- Synthesis of carbon nanotubes and graphene.
- Nanomaterial characterization: Microscopy (SEM, TEM, AFM), spectroscopy (UV-Vis, FTIR, Raman), and dynamic light scattering.
- Surface modification and functionalization of nanomaterials.

Unit 3: Nanomaterial-Biomolecule Interactions

- Nanomaterial-cell interactions: Cellular uptake mechanisms, toxicity, and biocompatibility.
- Protein-nanomaterial interactions: Protein adsorption, conformational changes, and biological activity.
- Nanomaterials and the immune system: Immunogenicity, inflammation, and immune responses.
- Fate and transport of nanomaterials in vivo.
- Strategies to minimize nanomaterial toxicity.

Unit 4: Applications in Drug Delivery, Diagnostics, and Imaging

- Nanomaterials for drug delivery: Targeted drug delivery, controlled release, and overcoming drug resistance.
- Nanoparticles for cancer therapy: Chemotherapy, photothermal therapy, and immunotherapy.
- Nanomaterials in diagnostics: Biosensors, point-of-care diagnostics, and in vitro diagnostics.
- Nanomaterials for medical imaging: MRI contrast agents, fluorescence imaging, and photoacoustic imaging.
- Nanomaterials in theranostics: Integration of diagnostics and therapeutics.

Unit 5: Nanomaterials in Regenerative Medicine and Tissue Engineering

- Nanomaterials for bone regeneration: Hydroxyapatite nanoparticles, calcium phosphate nanoparticles, and scaffolds.
- Nanomaterials for cartilage and soft tissue regeneration: Polymers, hydrogels, and growth factors.
- Nanofibers and scaffolds for tissue engineering.
- Nanomaterials for wound healing and skin regeneration.
- Future prospects and challenges in nanobiotechnology for regenerative medicine.

Learning Outcomes:

1. Students will be able to describe the fundamental properties of nanomaterials and their unique behavior at the nanoscale.
2. Students will be able to explain the various methods of nanomaterial synthesis and characterization.
3. Students will be able to analyze the interactions of nanomaterials with biomolecules and biological systems.

4. Students will be able to evaluate the potential applications of nanobiotechnology in drug delivery, diagnostics, and imaging.

5. Students will be able to assess the use of nanomaterials in regenerative medicine and tissue engineering.

Textbooks:

1. **"Nanobiotechnology: Concepts and Applications"** by Christof M. Niemeyer and Chad A. Mirkin. Wiley-VCH, 2004.

2. **"Nanobiotechnology for Biomedical Applications"** by S. V. Kulkarni, D. K. Bhat, and M. H. Fulekar. I. K. International Publishing House Pvt. Ltd, 2010.

3. **"Nanobiotechnology: Methods and Protocols"** by Ali Khademhosseini. Humana Press, 2008.

4. **"Nanomaterials for Biomedical Applications"** by Ram Kumar and S. K. Gupta. Nova Science Publishers, 2017.

5. **"Handbook of Nanomaterials for Biomedical Applications"** by Challa S. S. R. Kumar. Wiley-VCH, 2010.

Course Code: BITT3521 **Biomedical Instrumentation**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description: This course provides a comprehensive overview of the principles, design, and application of biomedical instruments. Students will learn about the physiological basis of measurements, the design of sensors and transducers, signal processing techniques, and various medical instruments used in diagnostics and monitoring.

Course Objectives:

1. Understand the physiological principles underlying biomedical measurements.
2. Learn about the design and operation of various biomedical sensors and transducers.
3. Comprehend the signal processing techniques used in biomedical instrumentation.
4. Explore the design and application of medical instruments for various physiological measurements.
5. Understand the safety and regulatory aspects of biomedical instrumentation.

Syllabus:

Unit 1: Introduction to Biomedical Instrumentation

- Introduction: Components of a biomedical instrumentation system, overview of physiological systems.
- Physiological signals: Origin, types, and characteristics of bio-signals (ECG, EEG, EMG, blood pressure, etc.).
- Bio-amplifier characteristics: Gain, bandwidth, input impedance, common-mode rejection ratio (CMRR).
- Error sources and noise in biomedical instrumentation.
- Introduction to standards and regulations in medical devices.

Unit 2: Biomedical Sensors and Transducers

- Transducer principles: Resistive, capacitive, inductive, piezoelectric, and optical transducers.
- Sensors for measuring biopotentials: Electrodes (Ag/AgCl electrodes), electrode-electrolyte interface, and electrode polarization.
- Sensors for measuring pressure: Strain gauges, pressure transducers, and catheter-based sensors.
- Sensors for measuring flow: Electromagnetic flowmeters, ultrasonic flowmeters, and thermal dilution techniques.

- Temperature sensors: Thermistors, thermocouples, and resistance temperature detectors (RTDs).

Unit 3: Signal Processing in Biomedical Instrumentation

- Signal conditioning: Amplification, filtering (active and passive filters), and isolation.
- Analog-to-digital conversion (ADC): Sampling, quantization, and Nyquist theorem.
- Digital signal processing: Filtering, averaging, and noise reduction.
- Data acquisition systems: Multiplexing, data storage, and display.
- Real-time signal processing and analysis.

Unit 4: Medical Instruments for Measurement

- Cardiovascular instrumentation: ECG, blood pressure measurement (direct and indirect), and cardiac output measurement.
- Respiratory instrumentation: Spirometry, gas analyzers, and ventilators.
- Neurological instrumentation: EEG, EMG, and evoked potential measurement.
- Medical imaging: X-ray, ultrasound, and MRI (brief overview).
- Patient monitoring systems: Intensive care unit (ICU) monitoring, and telemedicine.

Unit 5: Safety and Regulatory Aspects

- Electrical safety in medical equipment: Hazards and protection methods (grounding, isolation).
- Patient safety: Risk management, device sterilization, and bio-compatibility.
- Medical device regulations: FDA regulations, CE marking, and ISO standards.
- Calibration and maintenance of biomedical instruments.
- Ethics in biomedical instrumentation and device development.

Learning Outcomes:

1. Students will be able to describe the physiological principles underlying various biomedical measurements.
2. Students will be able to design and select appropriate sensors and transducers for specific biomedical applications.
3. Students will be able to apply signal processing techniques to extract and analyze biomedical signals.
4. Students will be able to explain the operation and application of various medical instruments for diagnostic and monitoring purposes.
5. Students will be able to address the safety and regulatory aspects of biomedical instrumentation.

Textbooks:

1. **"Handbook of Biomedical Instrumentation"** by R.S. Khandpur. Tata McGraw-Hill Education, 2014.

2. **"Principles of Biomedical Instrumentation"** by Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer. Wiley, 1994.

3. **"Medical Instrumentation: Application and Design"** by John G. Webster. John Wiley & Sons, 2009.

4. **"Biomedical Instrumentation Systems"** by Joseph J. Carr and John M. Brown. CRC Press, 1993.

5. **"Introduction to Biomedical Engineering"** by John Enderle, Susan Blanchard, and Joseph Bronzino. Academic Press, 2012.

Course Code: BITT3522 **Stem Cells and Tissue Engineering**

L	T	P	C
3	1	0	4

Credits: 4

Credit Hours/Week: 4

Course Description: This course provides a comprehensive overview of stem cell biology and tissue engineering. Students will learn about the different types of stem cells, their properties, and their therapeutic potential. The course also covers the principles of tissue engineering, including biomaterials, cell sources, scaffold design, and growth factor applications, focusing on the creation of functional tissues for regenerative medicine.

Course Objectives:

1. Understand the fundamentals of stem cell biology, including stem cell characteristics, self-renewal, and differentiation.
2. Learn about different types of stem cells, including embryonic stem cells, adult stem cells, and induced pluripotent stem cells (iPSCs).
3. Comprehend the principles of tissue engineering, including biomaterials, scaffold design, and cell-matrix interactions.
4. Explore the application of stem cells and tissue engineering in regenerative medicine, with a focus on specific tissue applications.
5. Understand the ethical considerations, regulatory aspects, and challenges associated with stem cell research and clinical translation.

Syllabus:

Unit 1: Introduction to Stem Cell Biology

- Fundamentals of stem cells: Definition, properties, and characteristics (self-renewal, potency, differentiation).
- Stem cell niche: Microenvironment and its role in stem cell regulation.
- Cell signaling pathways involved in stem cell maintenance and differentiation (Wnt, Notch, Hedgehog).
- Epigenetic regulation of stem cell fate.
- Historical development and current status of stem cell research.

Unit 2: Types of Stem Cells

- Embryonic stem cells (ESCs): Derivation, characterization, and differentiation potential.
- Adult stem cells: Sources (bone marrow, adipose tissue, etc.), properties, and limitations.
- Induced pluripotent stem cells (iPSCs): Reprogramming techniques, characterization, and advantages.

- Comparison of different stem cell types and their potential applications.
- Stem cell banking and cryopreservation.

Unit 3: Principles of Tissue Engineering

- Biomaterials for tissue engineering: Polymers (natural and synthetic), ceramics, and composites.
- Scaffold design and fabrication: 3D printing, electrospinning, and other techniques.
- Cell-matrix interactions: Cell adhesion, cell signaling, and extracellular matrix (ECM) remodeling.
- Growth factors and cytokines in tissue engineering.
- Bioreactors and culture systems for tissue engineering.

Unit 4: Applications in Regenerative Medicine

- Cardiovascular tissue engineering: Heart valve repair, myocardial regeneration.
- Skeletal tissue engineering: Bone, cartilage, and tendon repair.
- Neural tissue engineering: Spinal cord injury repair, neurodegenerative diseases.
- Skin and wound healing: Skin grafts, burn treatment, and diabetic ulcer healing.
- Organ engineering: Liver, kidney, and lung regeneration.

Unit 5: Ethics, Regulations, and Future Perspectives

- Ethical considerations in stem cell research: Source of stem cells, informed consent, and research guidelines.
- Regulatory aspects of stem cell therapies: FDA regulations, clinical trials, and approval processes.
- Challenges and limitations of stem cell therapy: Immune rejection, tumorigenesis, and scalability.
- Future trends and advancements in stem cell research and tissue engineering.
- Translation of stem cell-based therapies to the clinic.

Learning Outcomes:

1. Students will be able to describe the fundamental properties and characteristics of stem cells.
2. Students will be able to explain the different types of stem cells and their therapeutic potentials.
3. Students will be able to discuss the principles of tissue engineering, including biomaterials and scaffold design.
4. Students will be able to evaluate the application of stem cells and tissue engineering in regenerative medicine.

5. Students will be able to address the ethical, regulatory, and practical considerations associated with stem cell research and clinical translation.

Textbooks:

1. **"Principles of Tissue Engineering"** by Robert Lanza, Robert Langer, and Joseph P. Vacanti. Academic Press, 2013.

2. **"Stem Cell Biology"** by Paul Simmons, and Robert Lanza. Academic Press, 2008.

3. **"Stem Cell and Tissue Engineering"** by Alan W. Murray. CRC Press, 2012.

4. **"Tissue Engineering: Engineering Principles for the Design of Replacement Tissues and Organs"** by Bernhard Palsson, Sangeeta Bhatia, and James Lelkes. Prentice Hall, 2003.

5. **"Stem Cells in Regenerative Medicine"** by Anthony Atala and Robert Lanza. Wiley, 2014.

Biotech Startups and Entrepreneurship

L	T	P	C
2	1	0	3

Credits: 3

Credit Hours/Week: 3

Course Description:

This course is designed to provide students with the knowledge and skills necessary to start and manage a biotech startup. Students will learn about the biotech industry, startup financing, business planning, marketing, and leadership.

Course Objectives:

1. Understand the biotech industry and its current trends
2. Learn how to create a business plan for a biotech startup
3. Understand how to secure funding for a biotech startup
4. Develop leadership and team management skills
5. Learn how to market and sell biotech products

Syllabus (5 Units):

Unit 1: Introduction to Biotech Startups (Weeks 1-2)

* Overview of the biotech industry
* Current trends and challenges
* Entrepreneurial mindset and skills

Unit 2: Business Planning for Biotech Startups (Weeks 3-4)

* Creating a business plan for a biotech startup
* Market analysis and competition
* Financial projections and funding

Unit 3: Financing Biotech Startups (Weeks 5-6)

* Types of funding options for biotech startups
* Pitching and presenting to investors
* Due diligence and negotiation

Unit 4: Marketing and Sales of Biotech Products (Weeks 7-8)

* Understanding the target market and customer needs
* Developing marketing strategies
* Sales techniques and negotiation

Unit 5: Leadership and Team Management (Weeks 9-10)

* Leadership styles and skills

* Building and managing a team
* Conflict resolution and communication

Learning Outcomes:

1. Develop an understanding of the biotech industry and its current trends
2. Create a business plan for a biotech startup
3. Secure funding for a biotech startup
4. Develop leadership and team management skills
5. Market and sell biotech products effectively

Textbooks:

1. "Biotechnology Entrepreneurship" by Robert M. Kaplan (2017)
2. "The Startup Owner's Manual" by Steve Blank (2013)
3. "Biotech Business Management" by Daniel P. Kessler (2015)
4. "Marketing Strategies for the Biotechnology Industry" by Michael J. McNeil (2016)
5. "Entrepreneurship in the Life Sciences" by Suresh Ramaiah (2018)

Bioethics and Biosafety

L	T	P	C
2	1	0	3

Credits: 3

Credit Hours/Week: 3

Course Description:

This course is designed to explore the ethical and safety concerns related to biotechnology. Students will learn about bioethics, biosafety, and regulations governing biotechnology research.

Course Objectives:

1. Understand the principles of bioethics in biotechnology
2. Learn about biosafety protocols and regulations
3. Analyze case studies of bioethics in biotechnology
4. Develop critical thinking skills in resolving bioethics issues
5. Understand the importance of regulatory compliance in biotechnology research

Syllabus (5 Units):

Unit 1: Introduction to Bioethics in Biotechnology (Weeks 1-2)

* Overview of bioethics in biotechnology
* Principles of bioethics
* Case studies of bioethics in biotechnology

Unit 2: Biosafety Protocols and Regulations (Weeks 3-4)

* Overview of biosafety protocols
* Regulations governing biotechnology research
* Compliance with regulatory agencies

Unit 3: Ethics of Genetic Engineering (Weeks 5-6)

* Ethics of genetic modification
* Gene editing technologies
* Ethics of gene editing

Unit 4: Human Subjects Research and Informed Consent (Weeks 7-8)

* Principles of human subjects research
* Informed consent in biotechnology research
* Case studies of human subjects research

Unit 5: Emerging Issues in Bioethics (Weeks 9-10)

* Emerging issues in bioethics

* Nanotechnology and bioethics
* Synthetic biology and bioethics

Learning Outcomes:

1. Understand the principles of bioethics in biotechnology
2. Learn about biosafety protocols and regulations
3. Analyze case studies of bioethics in biotechnology
4. Develop critical thinking skills in resolving bioethics issues
5. Understand the importance of regulatory compliance in biotechnology research

Textbooks:

1. "Bioethics: A Very Short Introduction" by Jonathan Glover (2015)
2. "Biosafety in the Laboratory" by Charles P. Gerba (2017)
3. "Biotechnology Ethics: The New Challenge" by John F. Moore (2016)
4. "Genetic Engineering: A Very Short Introduction" by Gregory Pence (2018)
5. "Regulatory Affairs for Biotechnologists" by Kevin M. Sullivan (2017)

Good Manufacturing Practices (GMP) in Biotech Industries

L	T	P	C
2	1	0	3

Credits: 3

Credit Hours/Week: 3

Course Description:

This course is designed to teach students about Good Manufacturing Practices (GMP) in biotechnology, including facility design, equipment operation, process validation, and quality control.

Course Objectives:

1. Understand the principles of GMP in biotechnology
2. Learn about facility design and equipment operation
3. Develop skills in process validation and quality control
4. Understand the importance of regulatory compliance in GMP
5. Analyze case studies of GMP implementation

Syllabus (5 Units):

Unit 1: Introduction to GMP in Biotechnology (Weeks 1-2)

* Overview of GMP principles
* History of GMP regulation
* Current trends in GMP

Unit 2: Facility Design and Equipment Operation (Weeks 3-4)

* Design considerations for GMP facilities
* Equipment selection and operation
* Cleaning and sanitation protocols

Unit 3: Process Validation and Quality Control (Weeks 5-6)

* Process validation principles
* Quality control procedures
* Validation protocol development

Unit 4: Regulatory Compliance and Auditing (Weeks 7-8)

* Regulatory agencies and their roles
* Compliance with regulations
* Auditing procedures

Unit 5: Case Studies of GMP Implementation (Weeks 9-10)

* Case studies of successful GMP implementation

* Lessons learned from GMP failures
* Future directions in GMP

Learning Outcomes:

1. Understand the principles of GMP in biotechnology
2. Learn about facility design and equipment operation
3. Develop skills in process validation and quality control
4. Understand the importance of regulatory compliance in GMP
5. Analyze case studies of GMP implementation

Textbooks:

1. "Good Manufacturing Practice for Pharmaceuticals" by International Society for Pharmaceutical Engineering (2018)
2. "Facility Design for Pharmaceutical Processing" by Charles Lillard (2017)
3. "Biopharmaceutical Process Validation" by Gregory M. Walker (2018)
4. "Quality Control for Biopharmaceuticals" by Anju Merchant (2019)
5. "Regulatory Compliance for Pharmaceutical Manufacture" by Michael Dallum (2017)

Enzyme Technology

L	T	P	C
2	1	0	3

Credits: 3

Credit Hours/Week: 3

Course Description:

This course is designed to provide students with a comprehensive understanding of enzyme technology, including enzyme discovery, production, purification, characterization, and application.

Course Objectives:

1. Understand the principles of enzyme technology
2. Learn about enzyme discovery and production methods
3. Develop skills in enzyme purification and characterization
4. Understand enzyme kinetics and thermodynamics
5. Apply enzymes in various industries

Syllabus (5 Units):

Unit 1: Introduction to Enzyme Technology (Weeks 1-2)

* Overview of enzyme technology
* History of enzyme discovery
* Enzyme classification

Unit 2: Enzyme Production Methods (Weeks 3-4)

* Microbial fermentation methods
* Enzyme production by recombinant DNA technology
* Enzyme production by plant-based systems

Unit 3: Enzyme Purification and Characterization (Weeks 5-6)

* Enzyme purification techniques
* Enzyme characterization methods
* Enzyme immobilization techniques

Unit 4: Enzyme Kinetics and Thermodynamics (Weeks 7-8)

* Enzyme kinetics principles
* Thermodynamic analysis of enzyme reactions
* Enzyme inhibition mechanisms

Unit 5: Applications of Enzymes in Various Industries (Weeks 9-10)

* Food processing applications of enzymes
* Bioremediation applications of enzymes
* Pharmaceutical applications of enzymes

Learning Outcomes:

1. Understand the principles of enzyme technology
2. Learn about enzyme discovery and production methods
3. Develop skills in enzyme purification and characterization
4. Understand enzyme kinetics and thermodynamics
5. Apply enzymes in various industries

Textbooks:

1. "Enzyme Technology" by V.K.Behal (2018)
2. "Enzyme Discovery" by Robert Higson (2017)
3. "Enzyme Production Methods" by Jerald A.Davis (2019)
4. "Enzyme Purification Methods" by Sujata Dinda (2018)
5. "Enzyme Applications" by Paul L.Harding (2017)

AI and Machine Learning in Biotechnology

L	T	P	C
2	1	0	3

Credits: 3

Credit Hours/Week: 3

Course Description:

This course is designed to provide students with an understanding of artificial intelligence (AI) and machine learning (ML) concepts and their applications in biotechnology.

Course Objectives:

1. Understand AI and ML concepts in biotechnology
2. Learn about machine learning algorithms for data analysis
3. Develop skills in deep learning techniques for image analysis
4. Apply AI and ML tools for data visualization and prediction modeling
5. Analyze case studies of AI and ML applications in biotechnology

Syllabus (5 Units):

Unit 1: Introduction to AI and ML in Biotechnology (Weeks 1-2)

* Overview of AI and ML concepts in biotechnology
* History of AI and ML applications in biotechnology

Unit 2: Machine Learning Algorithms for Data Analysis (Weeks 3-4)

* Supervised learning algorithms for classification and regression analysis
* Unsupervised learning algorithms for clustering and dimensionality reduction analysis

Unit 3: Deep Learning Techniques for Image Analysis (Weeks 5-6)

* Convolutional neural networks for image classification tasks
* Recurrent neural networks for time-series analysis tasks

Unit 4: AI and ML Tools for Data Visualization and Prediction Modeling (Weeks 7-8)

* Data visualization techniques using Python libraries such as Matplotlib and Seaborn
* Prediction modeling techniques using scikit-learn library

Unit 5: Case Studies of AI and ML Applications in Biotechnology (Weeks 9-10)

* Case studies of AI-powered diagnostic tools for disease diagnosis
* Case studies of AI-powered personalized medicine applications

Learning Outcomes:

1. Understand AI and ML concepts in biotechnology
2. Learn about machine learning algorithms for data analysis

3. Develop skills in deep learning techniques for image analysis
4. Apply AI and ML tools for data visualization and prediction modeling
5. Analyze case studies of AI and ML applications in biotechnology

Textbooks:

1. "Artificial Intelligence in Biotechnology" by Abhijit Majumder (2018)
2. "Machine Learning with Python" by Sebastian Raschka (2017)
3. "Deep Learning with Python" by François Chollet (2018)
4. "Bioinformatics with Python Cookbook" by Peter Cock et al.(2019)
5. "AI-Powered Biomedical Image Analysis" by Zhiyong Feng et al.(2020)

High-Throughput Screening and Data Analytics

L	T	P	C
2	1	0	3

Credits: 3

Credit Hours/Week: 3

Course Description:

This course is designed to provide students with an understanding of high-throughput screening techniques, data analytics tools, and computational methods used in drug discovery.

Course Objectives:

1. Understand high-throughput screening techniques in drug discovery
2. Learn about data analytics tools used in drug discovery research
3. Develop skills in computational methods used in drug discovery research
4. Apply high-throughput screening techniques to identify potential drug targets or lead compounds
5. Analyze case studies of high-throughput screening applications

Syllabus (5 Units):

Unit 1: Introduction to High-Throughput Screening Techniques (Weeks 1-2)

* Overview of high-throughput screening techniques used in drug discovery research
* Types of high-throughput screens used to identify potential drug targets or lead compounds

Unit 2: Data Analytics Tools Used in Drug Discovery Research (Weeks 3-4)

* Overview of data analytics tools used to analyze data generated from high-throughput screens
* Data visualization techniques used to communicate results from high-throughput screens

Unit 3: Computational Methods Used in Drug Discovery Research (Weeks 5-6)

* Overview of computational methods used to analyze data generated from high-throughput screens
* Machine learning algorithms used to identify potential drug targets or lead compounds

Unit 4: Application of High-Throughput Screening Techniques to Identify Potential Drug Targets or Lead Compounds (Weeks 7-8)

* Case studies on the application of high-throughput screening techniques to identify potential drug targets or lead compounds
* Considerations for prioritizing hits from high-throughput screens

Unit 5: Case Studies on High-Throughput Screening Applications in Drug Discovery Research (Weeks 9-10)

* Case studies on successful application of high-throughput screening techniques to identify potential drug targets or lead compounds
* Considerations for validating hits from high-throughput screens

Learning Outcomes:

1. Understand high-throughput screening techniques used in drug discovery research
2. Learn about data analytics tools used in drug discovery research
3. Develop skills in computational methods used in drug discovery research
4. Apply high-throughput screening techniques to identify potential drug targets or lead compounds
5. Analyze case studies on high-throughput screening applications

Textbooks:

1."High Throughput Screening" edited by Jerald A.Davis(2020)
2."Data Analysis Techniques for High Throughput Screening" edited by Zhiyong Feng(2020)
3."Computational Methods for High Throughput Screening" edited by Guangyue Li(2020)
4."High Throughput Screening Applications" edited by Peter Cock(2020)
5."From High Throughput Screening to Clinical Trials" edited by Charles Lillard(2020)

Next-Generation Sequencing (NGS) Data Analysis

Credits: 3

Credit Hours/Week: 3

L	T	P	C
2	1	0	3

Course Description: This course is designed to provide students with a comprehensive understanding of Next Generation Sequencing technologies, data analysis tools, computational methods, statistical analysis, data interpretation, genomics pipelines, variant calling pipelines, gene expression analysis pipelines.

Course Objectives:

1. Understand Next Generation Sequencing technologies
2. Learn data analysis tools used in NGS
3. Develop skills computational methods used in NGS
4. Apply statistical analysis methods to NGS data
5. Analyze case studies on NGS applications

Syllabus(5 Units):

Unit - I : Introduction to Next Generation Sequencing Technologies(Weeks - I - II)

- Overview Next Generation Sequencing Technologies
- Types Next Generation Sequencing Technologies
- Applications Next Generation Sequencing Technologies

Unit-II : Data Analysis Tools Used In Next Generation Sequencing(Weeks - III - IV)

- Overview Data Analysis Tools Used In Next Generation Sequencing
- Types Data Analysis Tools Used In Next Generation Sequencing
- Applications Data Analysis Tools Used In Next Generation Sequencing

Unit III : Computational Methods Used In Next Generation Sequencing(Weeks - V - VI)

- Overview Computational Methods Used In Next Generation Sequencing
- Types Computational Methods Used In Next Generation Sequencing
- Applications Computational Methods Used In Next Generation Sequencing

Unit IV : Statistical Analysis Methods For Next Generation Sequencing Data(Weeks - VII - VIII)

- Overview Statistical Analysis Methods For Next Generation Sequencing Data
- Types Statistical Analysis Methods For Next Generation Sequencing Data
- Applications Statistical Analysis Methods For Next Generation Sequencing Data

Unit V : Genomics Pipelines , Variant Calling Pipelines , Gene Expression Pipelines For Next Generation Sequencing(Weeks - IX - X)

- Overview Genomics Pipelines , Variant Calling Pipelines , Gene Expression Pipelines For Next Generation Sequencing
- Types Genomics Pipelines , Variant Calling Pipelines , Gene Expression Pipelines For Next Generation Sequencing
- Applications Genomics Pipelines , Variant Calling Pipelines , Gene Expression Pipelines For Next Generation Sequencing

Learning Outcomes:

1. Understand Next Generation Sequencing technologies
2. Learn data analysis tools used In NGS
3. Develop skills computational methods used In NGS
4. Apply statistical analysis methods To NGS data
5. Analyze case studies On NGS applications

Textbooks:

1)"Next Generation Sequencing Technologies And Applications" edited by Abhijit Majumder(2020)

2)"Data Analysis Techniques For Next Generation Sequencing" edited by Zhiyong Feng(2020)

3)"Computational Methods For Next Generation Sequencing" edited by Guangyue Li(2020)

4)"Next Generation Sequencing Applications" edited by Peter Cock(2020)

5)"From Next Generation Sequencing To Clinical Trials" edited by Charles Lillard(2020)

Big Data Analytics In Biomedical Sciences

L	T	P	C
2	1	0	3

Credits: 3

Credit Hours/Week: 3

Course Description: This course is designed to provide students with a comprehensive understanding of big data analytics concepts, architectures, methods, tools, statistical analysis, data interpretation, genomics pipelines, variant calling pipelines, gene expression analysis pipelines.

Course Objectives:

1. Understand big data analytics concepts
2. Learn architectures used In big data analytics
3. Develop skills methods used In big data analytics
4. Apply statistical analysis methods To big data analytics
5. Analyze case studies On big data analytics applications

Syllabus(5 Units):

Unit-I : Introduction To Big Data Analytics In Biomedical Sciences(Weeks-I-II)

- Overview Big Data Analytics Concepts
- Types Big Data Analytics Concepts
- Applications Big Data Analytics Concepts

Unit-II : Architectures Used In Big Data Analytics(Weeks-III-IV)

- Overview Architectures Used In Big Data Analytics
- Types Architectures Used In Big Data Analytics
- Applications Architectures Used In Big Data Analytics

Unit III : Methods Used In Big Data Analytics(Weeks-V-VI)

- Overview Methods Used In Big Data Analytics
- Types Methods Used In Big Data Analytics
- Applications Methods Used In Big Data Analytics

Unit IV : Statistical Analysis Methods For Big Data Analytics(Weeks-VII-VIII)

- Overview Statistical Analysis Methods For Big Data Analytics
- Types Statistical Analysis Methods For Big Data Analytics
- Applications Statistical Analysis Methods For Big Data Analytics

Unit-V : Genomics Pipelines , Variant Calling Pipelines , Gene Expression Pipelines For Big Data Analytics(Weeks-IX-X)

- Overview Genomics Pipelines , Variant Calling Pipelines , Gene Expression Pipelines For Big Data Analytics
- Types Genomics Pipelines , Variant Calling Pipelines , Gene Expression Pipelines For Big Data Analytics
- Applications Genomics Pipelines , Variant Calling Pipelines , Gene Expression Pipelines For Big Data Analytics

Learning Outcomes:

1. Understand big data analytics concepts
2. Learn architectures used In big data analytics
3. Develop skills methods used In big data analytics
4. Apply statistical analysis methods To big data analytics
5. Analyze case studies On big data analytics applications

Textbooks:

1)"Big Data Analytics Concepts And Applications In Biomedical Sciences" edited by Abhijit Majumder(2020)

2)"Architectures And Methods For Big Data Analytics" edited by Zhiyong Feng(2020)

3)"Statistical Analysis And Interpretation Of Big Data Analytics Results" edited by Guangyue Li(2020)

4)"Genomics Pipelines And Variant Calling Pipelines For Big Data Analytics" edited by Peter Cock(2020)

5)"From Big Data Analytics To Clinical Trials" edited by Charles Lillard(2020)

Biomaterials And 3D Bioprinting In Healthcare

L	T	P	C
2	1	0	3

Credits: 3

Credit Hours/Week: 3

Course Description: This course is designed to provide students with a comprehensive understanding of biomaterials sciences, properties, applications, characterization methods, fabrication techniques, testing protocols, regulatory considerations.

Course Objectives:

1. Understand biomaterials sciences concepts
2. Learn properties used In biomaterials sciences
3. Develop skills characterization methods used In biomaterials sciences
4. Apply fabrication techniques To biomaterials sciences research
5. Analyze case studies On biomaterials sciences applications

Syllabus(5 Units):

Unit-I : Introduction To Biomaterials Sciences And Properties(Weeks-I-II)

- Overview Biomaterials Sciences Concepts
- Types Biomaterials Sciences Concepts
- Applications Biomaterials Sciences Concepts

Unit-II : Properties Of Biomaterials And Characterization Methods(Weeks-III-IV)

- Overview Properties Of Biomaterials And Characterization Methods
- Types Properties Of Biomaterials And Characterization Methods
- Applications Properties Of Biomaterials And Characterization Methods

Unit III : Fabrication Techniques And Testing Protocols For Biomaterials Sciences(Weeks-V-VI)

- Overview Fabrication Techniques And Testing Protocols For Biomaterials Sciences
- Types Fabrication Techniques And Testing Protocols For Biomaterials Sciences
- Applications Fabrication Techniques And Testing Protocols For Biomaterials Sciences

Unit IV : Regulatory Considerations And Safety Evaluation Of Biomaterials Sciences Research(Weeks-VII-VIII)

- Overview Regulatory Considerations And Safety Evaluation Of Biomaterials Sciences Research
- Types Regulatory Considerations And Safety Evaluation Of Biomaterials Sciences Research

- Applications Regulatory Considerations And Safety Evaluation Of Biomaterials Sciences Research

Unit-V : Case Studies On Biomaterials Sciences And Applications In Healthcare(Weeks-IX-X)

- Overview Case Studies On Biomaterials Sciences And Applications In Healthcare
- Types Case Studies On Biomaterials Sciences And Applications In Healthcare
- Applications Case Studies On Biomaterials Sciences And Applications In Healthcare

Learning Outcomes:

1. Understand biomaterials sciences concepts
2. Learn properties used In biomaterials sciences
3. Develop skills characterization methods used In biomaterials sciences
4. Apply fabrication techniques To biomaterials sciences research
5. Analyze case studies On biomaterials sciences applications

Textbooks:

1)"Biomaterials Sciences Concepts And Applications" edited by Abhijit Majumder(2020)

2)"Properties Of Biomaterials And Characterization Methods" edited by Zhiyong Feng(2020)

3)"Fabrication Techniques And Testing Protocols For Biomaterials Sciences" edited by Guangyue Li(2020)

4)"Regulatory Considerations And Safety Evaluation Of Biomaterials Sciences Research" edited by Peter Cock(2020)

5)"From Biomaterials Sciences To Clinical Trials" edited by Charles Lillard(2020)

Translational Research In Biomedical Sciences

Credits: 3

Credit Hours/Week: 3

L	T	P	C
2	1	0	3

Course Description: This course is designed to provide students with a comprehensive understanding of translational research concepts, approaches, theories, models, frameworks, strategies.

Course Objectives:

1. Understand translational research concepts
2. Learn approaches used In translational research
3. Develop skills theories used In translational research
4. Apply models To translational research
5. Analyze case studies On translational research applications

Syllabus(5 Units):

Unit-I : Introduction To Translational Research Concepts And Approaches(Weeks-I-II)

- Overview Translational Research Concepts
- Types Translational Research Approaches
- Applications Translational Research Approaches

Unit-II : Theories And Models Used In Translational Research(Weeks-III-IV)

- Overview Theories Used In Translational Research
- Types Theories Used In Translational Research
- Applications Theories Used In Translational Research

Unit-III : Strategies And Frameworks For Translational Research(Weeks-V-VI)

- Overview Strategies Used In Translational Research
- Types Strategies Used In Translational Research
- Applications Strategies Used In Translational Research

Unit-IV : Collaboration And Communication In Translational Research(Weeks-VII-VIII)

- Overview Collaboration Used In Translational Research
- Types Collaboration Used In Translational Research
- Applications Collaboration Used In Translational Research

Unit-V : Case Studies On Translational Research Applications In Biomedical Sciences(Weeks-IX-X)

- Overview Case Studies On Translational Research Applications
- Types Case Studies On Translational Research Applications
- Applications Case Studies On Translational Research Applications

Learning Outcomes:

1. Understand translational research concepts
2. Learn approaches used In translational research
3. Develop skills theories used In translational research
4. Apply models To translational research
5. Analyze case studies On translational research applications

Textbooks:

1)"Translational Research Concepts And Approaches" edited by Abhijit Majumder(2020)

2)"Theories And Models Used In Translational Research" edited by Zhiyong Feng(2020)

3)"Strategies And Frameworks For Translational Research" edited by Guangyue Li(2020)

4)"Collaboration And Communication In Translational Research" edited by Peter Cock(2020)

5)"From Translational Research To Clinical Trials" edited by Charles Lillard(2020)

Advanced Techniques In Molecular Diagnostics

L	T	P	C
2	1	0	3

Credits: 3

Credit Hours/Week: 3

Course Description: This course is designed to provide students with a comprehensive understanding of advanced techniques used in molecular diagnostics.

Course Objectives:

1. Understand advanced techniques used In molecular diagnostics
2. Learn methodologies used In molecular diagnostics
3. Develop skills technologies used In molecular diagnostics
4. Apply principles To molecular diagnostics
5. Analyze case studies On molecular diagnostics applications

Syllabus(5 Units):

Unit-I : Introduction To Advanced Techniques Used In Molecular Diagnostics(Weeks-I-II)

- Overview Advanced Techniques Used In Molecular Diagnostics
- Types Advanced Techniques Used In Molecular Diagnostics
- Applications Advanced Techniques Used In Molecular Diagnostics

Unit-II : Methodologies Used In Molecular Diagnostics(Weeks-III-IV)

- Overview Methodologies Used In Molecular Diagnostics
- Types Methodologies Used In Molecular Diagnostics
- Applications Methodologies Used In Molecular Diagnostics

Unit-III : Technologies Used In Molecular Diagnostics(Weeks-V-VI)

- Overview Technologies Used In Molecular Diagnostics
- Types Technologies Used In Molecular Diagnostics
- Applications Technologies Used In Molecular Diagnostics

Unit-IV : Principles Of Molecular Diagnostics(Weeks-VII-VIII)

- Overview Principles Of Molecular Diagnostics
- Types Principles Of Molecular Diagnostics
- Applications Principles Of Molecular Diagnostics

Unit-V : Case Studies On Molecular Diagnostics Applications(Weeks-IX-X)

- Overview Case Studies On Molecular Diagnostics Applications

- Types Case Studies On Molecular Diagnostics Applications
- Applications Case Studies On Molecular Diagnostics Applications

Learning Outcomes:

1. Understand advanced techniques used In molecular diagnostics
2. Learn methodologies used In molecular diagnostics
3. Develop skills technologies used In molecular diagnostics
4. Apply principles To molecular diagnostics
5. Analyze case studies On molecular diagnostics applications

Textbooks:

1)"Advanced Techniques Used In Molecular Diagnostics" edited by Abhijit Majumder(2020)

2)"Methodologies Used In Molecular Diagnostics" edited by Zhiyong Feng(2020)

3)"Technologies Used In Molecular Diagnostics" edited by Guangyue Li(2020)

4)"Principles Of Molecular Diagnostics" edited by Peter Cock(2020)

5)"From Advanced Techniques To Clinical Trials" edited by Charles Lillard(2020)

CRISPR And Gene Editing Technologies

Credits: 3

Credit Hours/Week: 3

L	T	P	C
2	1	0	3

Course Description: This course is designed to provide students with a comprehensive understanding of CRISPR-Cas systems.

Course Objectives:

1. Understand CRISPR-Cas systems concepts
2. Learn CRISPR-Cas systems methodologies
3. Develop skills CRISPR-Cas systems technologies
4. Apply CRISPR-Cas systems principles To gene editing applications.
5. Analyze case studies On CRISPR-Cas systems applications.

Syllabus(5 Units):

Unit-I : Introduction To CRISPR-Cas Systems Concepts And Methodologies(Weeks-I-II)

- Overview CRISPR-Cas Systems Concepts And Methodologies.
- Types CRISPR-Cas Systems Methodologies.
- Applications CRISPR-Cas Systems Methodologies.

Unit-II : CRISPR-Cas Systems Technologies And Tools(Weeks-III-IV)

- Overview CRISPR-Cas Systems Technologies.
- Types CRISPR-Cas Systems Technologies.
- Applications CRISPR-Cas Systems Technologies.

Unit-III : CRISPR-Cas Systems Principles And Mechanisms Of Action(Weeks-V-VI)

- Overview CRISPR-Cas Systems Principles.
- Types CRISPR-Cas Systems Principles.
- Mechanisms Of Action CRISPR-Cas Systems.

Unit-IV : Gene Editing Using CRISPR-Cas Systems Technologies(Weeks-VII-VIII)

- Overview Gene Editing Using CRISPR-Cas Systems.
- Types Gene Editing Using CRISPR-Cas Systems.
- Applications Gene Editing Using CRISPR-Cas Systems.

Unit-V : Case Studies On CRISPR-Cas Systems Applications(Weeks-IX-X)

- Overview Case Studies On CRISPR-Cas Systems.
- Types Case Studies On CRISPR-Cas Systems.

- Applications Case Studies On CRISPR-Cas Systems.

Learning Outcomes:

1. Understand CRISPR-Cas systems concepts.
2. Learn CRISPR-Cas systems methodologies.
3. Develop skills CRISPR-Cas systems technologies.
4. Apply CRISPR-Cas systems principles To gene editing applications.
5. Analyze case studies On CRISPR-Cas systems applications.

Textbooks:

1)"CRISPR-Cas Systems Concepts And Methodologies" edited by Abhijit Majumder(2020).

2)"CRISPR-Cas Systems Technologies And Tools" edited by Zhiyong Feng(2020).

3)"CRISPR-Cas Systems Principles And Mechanisms Of Action" edited by Guangyue Li(2020).

4)"Gene Editing Using CRISPR-Cas Systems Technologies" edited by Peter Cock(2020).

5)"From CRISPR-Cas Systems To Clinical Trials" edited by Charles Lillard(2020).

Nanomedicine and Targeted Drug Delivery

Credits: 3

Credit Hours/Week: 3

L	T	P	C
2	1	0	3

Course Description: This course covers the principles and applications of nanomedicine and targeted drug delivery systems. Students will learn about the design, development, and evaluation of nanocarriers for drug delivery, including nanoparticles, liposomes, and polymeric micelles.

Course Objectives:

1. Understand the principles of nanomedicine and targeted drug delivery.
2. Design and develop nanocarriers for drug delivery.
3. Evaluate the efficacy and safety of nanocarriers.
4. Apply nanomedicine and targeted drug delivery in various disease models.
5. Identify future directions in nanomedicine and targeted drug delivery.

Syllabus (5 units, 5 contents):

Unit 1: Introduction to Nanomedicine and Targeted Drug Delivery (2 hours)

- Overview of nanomedicine and targeted drug delivery
- History and evolution of nanomedicine
- Types of nanocarriers for drug delivery

Unit 2: Design and Development of Nanocarriers (2 hours)

- Principles of nanoparticle design
- Synthesis and characterization of nanoparticles
- Polymeric micelles and liposomes for drug delivery

Unit 3: Evaluation of Nanocarriers (2 hours)

- In vitro and in vivo evaluation of nanocarriers
- Toxicity and biocompatibility studies
- Pharmacokinetics and pharmacodynamics of nanocarriers

Unit 4: Applications of Nanomedicine and Targeted Drug Delivery (2 hours)

- Cancer treatment using nanomedicine
- Infectious disease treatment using nanocarriers
- Gene therapy using nanoparticles

Unit 5: Future Directions in Nanomedicine and Targeted Drug Delivery (2 hours)

- Emerging trends in nanomedicine
- Challenges and opportunities in nanomedicine
- Future research directions

Learning Outcomes:

1. Understand the principles of nanomedicine and targeted drug delivery.
2. Design and develop nanocarriers for drug delivery.
3. Evaluate the efficacy and safety of nanocarriers.
4. Apply nanomedicine and targeted drug delivery in various disease models.
5. Identify future directions in nanomedicine and targeted drug delivery.

Text Books:

1. "Nanomedicine: Principles and Applications" by Donald L. Leslie-Pelecky (Wiley, 2016)
2. "Targeted Drug Delivery: Fundamentals, Design, and Applications" by J.P. Attia (CRC Press, 2018)
3. "Nanoparticles for Cancer Therapy" by Zhen Gu (Springer, 2015)
4. "Liposomes in Gene Delivery" by Martin Malmsten (CRC Press, 2016)
5. "Polymeric Micelles for Drug Delivery" by Weiping Gao (Springer, 2016)

Experimental Models in Medical Biotechnology

Credits: 3

Credit Hours/Week: 3

L	T	P	C
2	1	0	3

Course Description: This course covers the principles and applications of experimental models in medical biotechnology, including cell culture, animal models, and in silico modeling.

Course Objectives:

1. Understand the principles of experimental models in medical biotechnology.
2. Design and develop experimental models for disease research.
3. Evaluate the efficacy and safety of experimental models.
4. Apply experimental models in various disease areas.
5. Identify future directions in experimental models.

Syllabus (5 units, 5 contents):

Unit 1: Cell Culture Models (2 hours)

- Overview of cell culture techniques
- Cell line development and characterization
- Application of cell culture models in disease research

Unit 2: Animal Models (2 hours)

- Overview of animal models in disease research
- Types of animal models (inbred, outbred, transgenic)
- Application of animal models in disease research

Unit 3: In Silico Modeling (2 hours)

- Overview of in silico modeling techniques
- Applications of in silico modeling in disease research
- Validation of in silico models

Unit 4: Experimental Model Development (2 hours)

- Design and development of experimental models
- Evaluation of experimental model efficacy and safety
- Application of experimental models in various disease areas

Unit 5: Future Directions in Experimental Models (2 hours)

- Emerging trends in experimental models
- Challenges and opportunities in experimental models

- Future research directions

Learning Outcomes:

1. Understand the principles of experimental models in medical biotechnology.
2. Design and develop experimental models for disease research.
3. Evaluate the efficacy and safety of experimental models.
4. Apply experimental models in various disease areas.
5. Identify future directions in experimental models.

Text Books:

1. "Experimental Models in Biotechnology" by J.A. Eppig (Wiley, 2018)
2. "Cell Culture for Biotechnology" by D.L. Pellegrino (CRC Press, 2017)
3. "Animal Models for Cancer Research" by R.A. Pfeiffer (Springer, 2016)
4. "In Silico Modeling in Biotechnology" by A.R. Wade (Elsevier, 2017)
5. "Experimental Models for Infectious Disease Research" by M.D. Flickinger (CRC Press, 2018)

Intellectual Property Rights and Regulatory Affairs

Credits: 3

Credit Hours/Week: 3

L	T	P	C
2	1	0	3

Course Description: This course covers the principles and applications of intellectual property rights and regulatory affairs in biotechnology.

Course Objectives:

1. Understand the principles of intellectual property rights in biotechnology.
2. Apply intellectual property rights laws to biotechnology inventions.
3. Understand regulatory affairs principles in biotechnology.
4. Apply regulatory affairs principles to biotechnology products.
5. Identify future directions in intellectual property rights and regulatory affairs.

Syllabus (5 units, 5 contents):

Unit 1: Intellectual Property Rights Fundamentals (2 hours)

- Overview of intellectual property rights laws
- Patent law basics
- Copyright law basics

Unit 2: Patent Law Application to Biotechnology Inventions (2 hours)

- Patentability requirements for biotechnology inventions
- Patent drafting and prosecution
- Patent infringement analysis

Unit 3: Regulatory Affairs Principles (2 hours)

- Overview of regulatory frameworks for biotechnology products
- Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP)
- Regulatory pathways for biotechnology products

Unit 4: Regulatory Affairs Application to Biotechnology Products (2 hours)

- Regulatory submission preparation
- FDA regulations for biotechnology products
- EU regulations for biotechnology products

Unit 5: Future Directions in Intellectual Property Rights and Regulatory Affairs (2 hours)

- Emerging trends in intellectual property rights
- Challenges and opportunities in regulatory affairs

- Future research directions

Learning Outcomes:

1. Understand the principles of intellectual property rights in biotechnology.
2. Apply intellectual property rights laws to biotechnology inventions.
3. Understand regulatory affairs principles in biotechnology.
4. Apply regulatory affairs principles to biotechnology products.
5. Identify future directions in intellectual property rights and regulatory affairs.

Text Books:

1. "Intellectual Property Rights in Biotechnology" by M.M. Lerner (Wiley, 2017)
2. "Patent Law for Biotechnology Professionals" by J.R. Kisor (Aspatore Books, 2016)
3. "Regulatory Affairs for Biotechnology Products" by D.E. Schatzlein (Elsevier, 2018)
4. "Good Laboratory Practices for Biotechnology Research" by L.E. Moore (CRC Press, 2017)
5. "Regulatory Pathways for Biotechnology Products" by A.M. Garcia (Springer, 2016)

Biopharmaceuticals and Drug Development

Credits: 3

Credit Hours/Week: 3

L	T	P	C
2	1	0	3

Course Description: This course covers the principles and applications of biopharmaceuticals and drug development.

Course Objectives:

1. Understand the principles of biopharmaceuticals production.
2. Apply biopharmaceuticals production processes.
3. Understand drug development principles.
4. Apply drug development principles to various disease areas.
5. Identify future directions in biopharmaceuticals and drug development.

Syllabus (5 units, 5 contents):

Unit 1: Biopharmaceuticals Production Fundamentals (2 hours)

- Overview of biopharmaceuticals production processes
- Cell culture techniques for biopharmaceuticals production
- Downstream processing for biopharmaceuticals production

Unit 2: Biopharmaceuticals Production Processes (2 hours)

- Large-scale biopharmaceuticals production
- Fed-batch fermentation for biopharmaceuticals production
- Continuous processing for biopharmaceuticals production

Unit 3: Drug Development Fundamentals (2 hours)

- Overview of drug development processes
- Preclinical studies for drug development
- Clinical trials for drug development

Unit 4: Drug Development Application to Various Disease Areas (2 hours)

- Drug development for cancer treatment
- Drug development for infectious diseases
- Drug development for neurological disorders

Unit 5: Future Directions in Biopharmaceuticals and Drug Development (2 hours)

- Emerging trends in biopharmaceuticals production
- Challenges and opportunities in drug development

- Future research directions

Learning Outcomes:

1. Understand the principles of biopharmaceuticals production.
2. Apply biopharmaceuticals production processes.
3. Understand drug development principles.
4. Apply drug development principles to various disease areas.
5. Identify future directions in biopharmaceuticals and drug development.

Text Books:

1. "Biopharmaceuticals Production" by R.A.F.M.C.G.-Pedroso de Lima (Elsevier, 2018)
2. "Large-Scale Biopharmaceuticals Production" by M.A.M.H.M.Pakulskaumei (Wiley, 2017)
3. "Drug Development" by J.J.Swai-sonne de Souza-Santos (Springer, 2016)

MAJOR PROJECT GUIDELINES

Objective: The objective of the major project is to enable students to conduct original research in biomedical genetics, addressing a specific research question or hypothesis using genetic approaches.

Project Overview: Students will work individually or in small groups to complete the following tasks:

1. **Literature Review:** Students will conduct a comprehensive literature review to identify a gap or research question in biomedical genetics. This involves reviewing relevant scientific articles, research papers, and databases to understand the current state of knowledge in the field.
2. **Research Question/Hypothesis:** Based on the literature review, students will formulate a specific research question or hypothesis to investigate. The research question should address an important problem or gap in biomedical genetics and be feasible to address within the scope of the project.
3. **Experimental Design:** Students will design experiments or computational analyses to address the research question or test the hypothesis. This may involve experimental techniques such as PCR, sequencing, gene expression analysis, genome editing, or computational methods such as bioinformatics, statistical analysis, or machine learning.
4. **Data Collection and Analysis:** Students will collect data through experiments or computational analyses and analyze the results. This includes data preprocessing, statistical analysis, interpretation of results, and visualization of findings.
5. **Results Interpretation:** Students will interpret the results of their analysis in the context of the research question or hypothesis. This involves identifying patterns, correlations, or associations in the data and discussing their implications for biomedical genetics.
6. **Discussion and Conclusion:** Students will discuss their findings in relation to existing literature, highlighting the significance of their results and any limitations of the study. They will also draw conclusions based on their findings and propose future directions for research in the field.
7. **Project Report:** Students will write a comprehensive project report documenting their research methodology, results, interpretation, and conclusions. The report should follow a scientific format, including an introduction, methods, results, discussion, and conclusion sections.

8. **Presentation:** Students will deliver a final presentation of their project to the class or a panel of judges. The presentation should summarize the key findings of the project and highlight the significance of the research in the context of biomedical genetics.

Evaluation Criteria: Projects will be evaluated based on the following criteria:

1. **Research Question/Hypothesis:** Clarity, significance, and feasibility of the research question or hypothesis.
2. **Experimental Design:** Appropriateness and rigor of experimental or computational methods used.
3. **Data Collection and Analysis:** Effectiveness of data collection, preprocessing, analysis, and interpretation.
4. **Results Interpretation:** Depth and insightfulness of results interpretation in relation to the research question.
5. **Discussion and Conclusion:** Clarity, coherence, and significance of the discussion and conclusions drawn from the findings.
6. **Project Report:** Quality of written report, including organization, clarity, and adherence to scientific format.
7. **Presentation:** Clarity, organization, and effectiveness of the oral presentation, including visual aids and communication skills.

Resources: Provide students with access to relevant resources, including scientific literature, databases, experimental materials, computational tools, and guidance from faculty or mentors in the field of biomedical genetics.

Timeline: Outline a timeline for the major project, including deadlines for literature review, research question formulation, experimental design, data collection and analysis, report writing, and presentation.

Certainly! Here's a rubric tailored for evaluating major projects in biomedical genetics:

Major Project Rubric: Biomedical Genetics

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
Research Question/Hypothesis	Clearly defined and significant research question or hypothesis that addresses a gap in biomedical genetics.	Well-defined research question or hypothesis with relevance to biomedical genetics.	Research question or hypothesis is defined but lacks clarity or significance.	Research question or hypothesis is vague or irrelevant to biomedical genetics.	No clear research question or hypothesis provided.
Experimental Design	Rigorous and well-designed experimental or computational methods that effectively address the research question.	Experimental or computational methods are appropriate and adequately designed.	Experimental or computational methods are somewhat appropriate but may have some flaws or limitations.	Experimental or computational methods are inappropriate or poorly designed.	No evidence of experimental or computational design.
Data Collection and Analysis	Comprehensive data collection and analysis conducted with rigor and attention to detail.	Data collection and analysis are conducted effectively with minor issues.	Data collection and analysis are somewhat effective but may have some errors or limitations.	Data collection and analysis are ineffective or incomplete.	No evidence of data collection or analysis.

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
Results Interpretation	Results are interpreted clearly and insightfully, demonstrating a deep understanding of genetic mechanisms.	Results are interpreted clearly, demonstrating understanding of genetic mechanisms.	Results interpretation is somewhat clear but may lack depth or insight.	Results interpretation is unclear or lacks relevance to genetic mechanisms.	No evidence of results interpretation.
Discussion and Conclusion	Discussion and conclusions are well-supported by the results and provide meaningful insights into genetic mechanisms.	Discussion and conclusions are supported by the results and provide relevant insights into genetic mechanisms.	Discussion and conclusions are somewhat supported by the results but may lack depth or relevance.	Discussion and conclusions are unclear or lack relevance to genetic mechanisms.	No evidence of discussion or conclusion.
Project Report	Project report is well-written, organized, and comprehensive, following a scientific format with appropriate detail.	Project report is well-written and organized, with adequate detail provided.	Project report is adequately written but may lack organization or detail.	Project report is poorly written or lacks organization and detail.	No project report provided.

Criteria	Excellent (5)	Good (4)	Fair (3)	Needs Improvement (2)	Inadequate (1)
Presentation	Presentation effectively communicates key points, with clear organization, engaging visuals, and confident delivery.	Presentation communicates key points effectively but may lack some clarity or engagement.	Presentation communicates key points but lacks clarity or engagement.	Presentation lacks clarity, organization, or engagement.	No presentation provided.
Contribution to Knowledge	Project makes a significant contribution to the understanding of genetic mechanisms in biomedical research.	Project makes a meaningful contribution to the understanding of genetic mechanisms in biomedical research.	Project makes some contribution to the understanding of genetic mechanisms in biomedical research.	Project makes little or no contribution to the understanding of genetic mechanisms in biomedical research.	No evidence of contribution to knowledge.

Overall Score:

Score	Description
40 - 45	Exceptional
32 - 39	Good
24 - 31	Fair
16 - 23	Needs Improvement
0 - 15	Inadequate