Syllabus and Evaluation Scheme

for

M.Sc. BIOTECHNOLOGY
(2 years, Semester I to IV)
(In accordance with NEP-2020)

IKS ≥ 5%.

Department of Biotechnology
Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

June 18, 2026

(2026-27)

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

About the Biotechnology Department

The Department of Biotechnology, Chaudhary Bansi Lal University, was established in the year 2014 under the faculty of Life Sciences. The Department of Biotechnology offers programs at the undergraduate (B.Sc. Biotechnology Honors), postgraduate (M.Sc. Biotechnology), and doctoral (Ph.D) levels. The Department provides academic knowledge and research skills in the field of biotechnology, with the goal of strengthening the entrepreneurial potential of students.

The department's goal is to inspire students to excel in science and contribute to the betterment of society. The Department's educational environment provides an ideal platform for students' progress and enhances their association with skilled and devoted teaching faculty. It also combines classroom instruction with extracurricular activities that allow pupils to showcase their talents and grow as individuals. Furthermore, it is held accountable for the quality of its research and hands-on training provided to students in well-equipped laboratories. Students choose a research dissertation/study and perform research in a variety of biotechnology disciplines. The department invites famous scientists and academicians to deliver talks on current themes of national importance regularly in order to keep students and faculty members up to date on recent achievements in the field of biotechnology. Students have qualified for various National-level exams and are well-positioned in various institutions/industries. All faculty members conduct advanced research and have publications in prestigious international and national journals.

The department's mission is to produce Biotechnologists who are skilled in technology, creativity, innovation, and entrepreneurship. The Department of Biotechnology maintains illustrious standards of teaching and research with distinguished and dedicated faculty members. It encourages high-quality research in biotechnology/biological sciences for the benefit of society and humanity. The research focuses on malaria vector biology, immunology, parasitology, plant molecular signaling, plant stress biology, bioinformatics, computational drug design, bioremediation, plant-microbe interactions, and Nano-biotechnology.

1. Future Vision of the department

The Department strives to provide high-quality courses that include strong vocational elements and professional skill development across the curriculum. It also intends to train people in biotechnology-related fields such as biochemistry, molecular biology, genetic engineering, plant biotechnology, microbiology, animal cell technology, developmental biology, bioinformatics, and bioprocess technology.

Biotechnology is a cutting-edge scientific field with enormous promise for human benefit. The Department will devote itself to establishing excellence in biotechnology promotion in the country. The Department will improve course content and practical facilities, as well as build the University's core lab facility, for the benefit of everyone. It will provide research services, encourage industries, and establish a centre of excellence. The Department would like to foster joint research projects by establishing Memoranda of Understanding (MOUs) with surrounding institutions, nationally/internationally. It also plans to run biotechnology-based programmes for societal welfare. The Department also supports significant investment in the generation of products, processes, and technologies, as well as a strong infrastructure for research and commercialization; expanding the knowledge base, nurturing potential utility leads, and bringing bioproducts to market by promoting the biotech industry.

2. Objectives of the Department

- To ignite the minds of the new generation and create leadership qualities so that they can thrive in the realm of science.

- To provide academic knowledge and research abilities in the field of biotechnology.
- To foster entrepreneurial skills to drive societal growth and development.

3. Biotechnology curriculum development strategy

In anticipation of permission from the Academic Council/Executive Council, the Department of Biotechnology was established in the Faculty of Life Sciences in the year 2014. Initially, the State Government permitted Chaudhary Bansi Lal University, Bhiwani, to accept the M.D. University, Rohtak's curriculum (as per letter no. 20/09-2014 UNP (1) dated nil from the Director General Higher Education, Haryana) until the same is framed by the University. The issue was settled at the first meeting of the Executive Council on 07.05.2015 and the M.D. University, Rohtak syllabus was implemented in the Department of Biotechnology as such. Following that, the Adhoc Postgraduate Board of Studies was formed at the fourth meeting of the Executive Council on July 25, 2015, to modify the syllabi from the session 2015-16. During the Academic Session 2015-16, University implemented the *Choice-Based Credit System* (CBCS). In the Academic Council meeting on December 3, 2018, almost half of the department's syllabus was revised and approved. The entire course was revised and approved by the Academic Council on August 14, 2019. New courses were added, while current courses were revised after two years, and over 20% of the syllabus was updated (as per Haryana State Higher Education Council letter no. 1/20-2020 ADV-HSHEC, 26-05-2020) and accepted in the Academic Council on October 6, 2020. In the year 2022, two more adjustments were made: the syllabus of the communication skills course was entirely revised, and the hobby club structure and syllabi were modified. In years 2023 and 2025, the syllabus was further revised following NEP2020 guidelines.

Thus, curriculum planning, design, development, and implementation based on local, national, regional, and global demands are critical to the department's teaching and knowledge-providing processes. It is part of the department's ongoing methodical approach.

4. Curriculum development and implementation

The concept of launching a new Program/course is conceived at the departmental level, followed by a feasibility study after consulting with various stakeholders such as students, alumni, faculty, industry experts, and academic quality regulatory bodies such as UGC and DHE. The Department's proposed curriculum is presented to the Post Graduate Board of Studies for additional consideration in the presence of two domain experts, one industry professional, and one alumni member. The Board of Studies proposes the syllabus to the relevant faculty, who then forward it to the Academic Council. Any deficiencies/suggestions in the curriculum are forwarded to lower academic bodies for further improvement. The University modifies the curricula of its various programmes in response to national/international developments and industry demand.

Students gain a strong theoretical foundation as well as the required skills and techniques in biological sciences, and they can apply these tools in the industry, healthcare, community, institutes, or other professions that they desire to follow. Given global scientific breakthroughs in the field of biotechnology, it was highly desirable to update and modify the current course to fulfill the goals of both research and industry. Some of the more prominent components of the Department of Biotechnology's curriculum are as follows:

a. The curriculum adheres to UGC requirements, giving students more options from intra-disciplinary (Core and Elective) and inter-disciplinary (Open Electives). In response to national/international advancements and industry demand, the University adjusts the curricula of its numerous programmes.

b. After completing a postgraduate degree in Biotechnology, the student is expected to enter the employment market as a trained biotechnologist wherever needed in academia and industry or to launch and develop a start-up into a commercial enterprise.

c. The programme is organized such that students are introduced to the essential foundation courses in the first semester. Core Courses are required to be studied by a student in order to complete the requirements of a programme. Overall, skills enhancement courses are also included, specifically to familiarize students with good personality traits.

d. Following that, as a basic element of the programme, they are required to learn the advanced courses as well as skill enhancement courses from the second semester onwards. Students are also encouraged to select elective courses from a pool of MOOC courses to enhance their knowledge. Students are also permitted to select any one course from the University's open electives that are offered by the other teaching departments.

e. Research dissertation is also included, where students are required to perform the research on a selected topic that exposes them to the topic of choice in research. Students take some of the industry- and entrepreneur-oriented courses such as Bioprocess Technology, IPR and Biosafety, and Biotech Management and Entrepreneurship to excel in these areas.

f. Entrepreneurship classes introduce pupils to concepts such as recognizing a winning business opportunity, obtaining money and launching a business, growing and nurturing the organization, and reaping the benefits. This semester also includes a Research Report to help students strengthen their research skills. Students, with the assistance of their mentor, identify a problem and research to discover a solution.

g. Students are encouraged to take MOOCs through SWAYAM or any other relevant portal to earn extra credits, according to MHRD requirements, from the existing MOOC courses. In case of the addition of other new courses to the SWAYAM platform can also be adopted. The procedure for taking the MOOC course will be in consultation with the MOOC Coordinator of the department.

Biotechnologists are in high demand in a wide range of industries and sectors, including agriculture, animal husbandry, environmental conservation, ecology, genetic engineering, healthcare, pharmaceuticals, medicine, academia, industrial research, and development. The department strongly believes that the current curriculum is on par with the modern demands of society and industry.

5. Program learning outcomes (PLOs)

The students on completion of the Master's programme will be able to:-

PLO 1: Demonstrate advanced knowledge about biotechnology with a critical understanding of the emerging developments and issues relating to the learner's domain area.

PLO 2: Demonstrate advanced knowledge and understanding of principles, methods, and techniques applicable to the chosen field of study.

PLO 3: Demonstrate the capacity to extrapolate the acquired knowledge and skills to real-life situations and apply acquired competencies in new/unfamiliar contexts.

PLO 4: Demonstrate the ability to apply the acquired conceptual, operational, or technical knowledge and a range of cognitive and practical skills to identify and address problems related to the chosen field of learning.

PLO 5: Demonstrate advanced knowledge relating to research methods to carry out research and investigations to formulate evidence-based solutions to complex and unpredictable problems in the field of biotechnology.

PLO 6: Demonstrate the ability to communicate, in a well-structured manner, the findings/results of the research studies undertaken in the field of biotechnology.

PLO 7: Pursue self-paced and self-directed learning to upgrade knowledge and skills, including research-related skills, while avoiding unethical practices.

Course mapping with PLO for PG Programme

Course code	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
26BT101	√	√	√	√	√	√	√
26BT102	√	√	√	√	√	√	√
26BT103	√	√	√	√	√	√	√
26BT104	√	√	√	√	√	√	√
26BT105	√	√	√	√	√	√	√
26BT106	√	√	√	√	√	√	√
26BT201	√	√	√	√	√	√	√
26BT202	√	√	√	√	√	X	√
26BT203	√	√	√	√	√	√	√
26BT204	√	√	X	√	√	X	√
26BT205	√	√	√	√	√	√	√
26BT206	√	√	√	√	√	√	√
26BT207	√	√	√	√	√	√	√
26BT208	√	√	√	√	√	√	√
26BT209	√	√	√	√	√	√	√
26BT210	√	√	√	√	√	√	√
26BT211	√	√	√	√	√	√	√
26BT301	√	√	√	√	√	√	√
26BT302	√	√	√	√	√	√	√
26BT303	√	√	√	√	√	√	√
26BT304	√	√	√	√	√	√	√
26BT305	√	√	√	√	√	√	√
26BT306	√	√	√	√	√	√	√
26BT307	√	√	√	√	√	√	√
26BT308	√	√	√	√	√	√	√
26BT309	√	√	√	√	√	√	X
26BT310	√	√	X	√	√	√	X
26BT320	√	√	√	√	√	√	√
26BT330	√	√	√	√	√	√	√
26BT401	√	√	√	√	√	√	√
26BT402	√	√	√	√	√	√	√
26BT403	√	√	√	X	√	√	√
26BT404	√	√	√	√	√	√	√
26BT405	√	√	√	√	√	√	√
26BT406	√	√	√	√	√	X	√
26BT407	√	√	√	X	√	√	√
26BT408	√	√	√	X	√	√	√
26BT409	√	√	√	√	√	√	√
26BT430	√	√	√	√	√	√	√
26BT440	√	√	√	√	√	√	√

M.Sc. in Biotechnology Evaluation Scheme

Summary

Program	:	**M.Sc. Biotechnology**
Duration	:	Two years (Four Semesters)
Minimum Attendance Required	:	**75% Mandatory**
Total Credits	:	**100***
Total Marks	:	**2500**

* Exit might be taken by the student may exit to receive a PG Diploma in Biotechnology after completing 50 credits (total marks 1350) that include the credits for semesters I and II. In addition, the student will also undergo an internship. Only the grade for internship will be mentioned in the transcript [for details, see the Multiple exit/entry options at PG level (One Year PG Diploma in Biotechnology)].

Assessment/Evaluation of Theory examination:

Internal Marks	Major Test (End Semester Exam) Marks	Total Marks
30	70	100
15	35	50

Internal Evaluation:

Minor Test Marks	Attendance Marks	Assignment/ Quizzes/seminar, etc, Marks	Total Marks
15	5	10	30
7	4	4	15

Duration of Examination:

Minor Test	Major Test (End Semester Exam)
1 h	2 to 3 h

To qualify for the course, a student is required to secure a minimum of 40% marks in aggregate including the internal evaluation and Major Test (End Semester Examination).

Education/Teaching policies and Assessments: Lectures will be delivered using livelihood methods wherever required for the subject concerned. The syllabus will be covered by different modes such as Digital aided learning (DAL), Digital and classroom learning (DCL), Classroom and lab learning (CLL), and Digital Self-Learning (DSL). Topics related to Digital self-learning (DSL) and classroom and lab learning (CLL) have been mentioned exclusively in the syllabus. The blending of the curriculum with the Indian knowledge system has also been considered while designing the curriculum. Students should opt for MOOC or related online courses from the SWAYAM portal as per UGC guidelines or other sources in any semester.

The NEP 2020 emphasizes formative and continuous assessment rather than summative assessment. Therefore, the scheme of assessment should have components of these two types of assessments. Assessment should have correlations with the learning outcomes that are achieved by a student after

completion of the course. The process of assessment is dealt with by the Ordinance for PG Programs and suggested to include quizzes, assignments, declamation, debate and discussion, problems based on the real situation, oral presentation and viva, publication, theoretical/experimental design, internal and external examination, and not limited to.

Multiple exit/entry options at PG level (One Year PG Diploma in Biotechnology)

- The department has a provision to allow an exit after completing 1 year (2 semesters) of M.Sc. Biotechnology and the student will be awarded a PG Diploma in Biotechnology. The student must complete the minimum required credits during this period.
- The student must complete the PG diploma within 1 year of admission. The student with an exit to PG Diploma may be further allowed to complete the PG degree within 5 years of first-year admission (*e.g., A student is admitted in 2025 and taking an exit with PG Diploma in 2026 should complete the PG degree by 2030*).
- M.Sc. degree in Biotechnology will be awarded after completing 2 years (4 semesters) of study. The degree will be provided to the student only after completing the minimum credits for the particular course. The student can also choose the additional course(s) to complete the credits or can acquire additional credits.
- A four-week training is compulsory for completing the PG Diploma. The student will undergo a work-based training in a firm, industry, or organization, or labs with faculty and researchers/experts in their own or other Institutions/research organizations during the summer term. Students will be provided with opportunities for internships with local industry, business organizations, health, and allied areas, local governments, Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations to provide opportunities to actively engage in on-site experiential/practical learning and, as a by-product, further improve their employability. The curricular component of 'community engagement and service, or the socioeconomic development' seeks to expose students to the socioeconomic issues in society so that theoretical learning can be supplemented by actual life experiences to generate solutions to real-life problems. Students will also be given opportunities to gain a first-hand understanding of the policies, regulations, organizational structures, processes, and programs that guide the development process. The study areas mentioned above are not limited to these lines; departments may also explore further.
- The training should be equivalent to 4 credits with a structured internship, where one credit is equivalent to two hours of engagement (in other words, at least 8h/week).
- Up to 20% of students can be allowed to take the exit with a PG diploma on a first-come first-served basis.
- Before the commencement of the 2nd semester, the students must disclose their exit to the Head of the department in advance.
- A supervisor should be appointed by the department, and a minimum of three members committee (Training Monitoring Committee, TMT), duly assigned by the chairperson, will monitor and evaluate the process of assignment.
- The supervisor and student will decide the topic and area of the training. A supervisor should have a minimum of three years of research /teaching experience.
- At the end of the training student will submit the report (within a week) in the format as provided in **Annex I**. Total marks remain 100, and the evaluation will be based on – Report submission (60% weightage) and Seminar/Presentation/viva-voce (40% weightage).
- To qualify for the PG Diploma, the student should secure at least a 'satisfactory or grade D', which will be reflected in the result. No marks will be mentioned in the transcript. The grades

will be awarded as: Grade A- 80% marks or more, Grade B-70% marks or more and less than 80%, Grade C-60% marks or more and less than 70%, Grade C-60% marks or more and less than 70%, and Grade D-50% marks or more and less than 60% marks.

- A copy of the final report and marks must be submitted to the examination branch of the University within the stipulated time frame.
- Grades should be adjusted by the Examination Branch during reentry.
- Lateral entry of students in the 2nd year from another University should be allowed. The degree will be provided to the student only after completing the minimum credits for the particular course. In case the student taking lateral transfer has unmatched credits in the first year, then he/she might choose an additional course(s) to complete the credits.

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Semester-I — Credits-24 — Marks-600

SN	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	26BT101	Cell Biology	CC1	04	-	04	04	-	04	70	30	-	100
2	26BT102	Biochemistry	CC2	04	-	04	04	-	04	70	30	-	100
3	26BT103	Microbiology	CC3	04	-	04	04	-	04	70	30	-	100
4	26BT104	Biotech Lab 1.1	CC4 (PC-1.1)		08	08	-	04	04	-	-	100	100
5	26BT105	Biotech Lab 1.2	PC-1.2	-	08	08	-	04	04	-	-	100	100
6	26BT106	Molecular Biology	DEC1	04	-	04	04	-	04	70	30	-	100
		Total		**16**	**16**	**32**	**16**	**08**	**24**	**280**	**120**	**200**	**600**

For details, go through the ordinance available on University website
T= Theory **P**=Practical **Int**=Internal assessment
CC= Core Course **DEC**= Discipline Elective Course
MOOC courses might also be adopted after discussion with the MOOC coordinator of the department.
Tutorials or other components implemented at the departmental level will be mentioned in the timetable.
Topics based on the Indian Knowledge System (IKS) are listed in Annex II
The Students from Non-Biology background should take the course Introductory Biology (26-BT-100)

Semester-II — Credits-26 — Marks-650

SN	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	26BT201	Molecular Immunology	CC5	04	-	04	04	-	04	70	30	-	100
2	26BT202	Developmental Biology	CC6	04	-	04	04	-	04	70	30	-	100
3	26BT203	Genetic Engineering	CC7	04	-	04	04	-	04	70	30	-	100
4	26BT204	Biotech Lab 2.1	CC8 (PC-2.1)		08	08	-	04	04	-	-	100	100
5	26BT205	Biotech Lab 2.2	PC-2.2	-	08	08	-	04	04	-	-	100	100
	26BT206	Bioinformatics	DEC2 (any one#)	04	-	04	04	-	04	70	30	-	100
7	26BT207	Metabolic Engineering											
8	26BT208	Biology of Infectious Diseases											
9	26BT209	Environmental Studies and Sustainable Development	VAC/IKS (any one*#)	02	-	02	02	-	02	-	50	-	50
10	26BT210	Indian Knowledge Systems in Biotechnology - I											
11	26BT211	Indian Knowledge Systems in Biotechnology - II											
		Total		**18**	**16**	**34**	**18**	**08**	**26**	**280**	**170**	**200**	**650**

For details, go through the ordinance available on University website
T= Theory **P**=Practical **Int**=Internal assessment
CC= Core Course **DEC**= Discipline Elective Course **VAC**= Value Added Course
These courses will be offered exclusively when at least five students are registered for the particular course.
*These courses will be based on the Indian Knowledge System and Modern sciences.
MOOC courses might also be adopted after discussion with the MOOC coordinator of the department.
Topics based on the Indian Knowledge System (IKS) are listed in Annex II
Note: Exit might be taken by the student after completing 50 credits (total marks 1050), which include the credits for semesters I and II. In addition, the student will also undergo an internship to receive a PG Diploma in Biotechnology [for details, see the Multiple exit/entry options at PG level (One Year PG Diploma in Biotechnology)].

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Semester-III (Option 1 and 2) Credits-26 Marks-650

SN	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	26BT301	Plant Biotechnology	CC9	04	-	04	04	-	04	70	30	-	100
2	26BT302	Animal Cell Technology	CC10	04	-	04	04	-	04	70	30	-	100
3	26BT303	Environmental Biotechnology	CC11	04	-	04	04	-	04	70	30	-	100
4	26BT304	Biotech Lab-3	PC-3	-	08	08	-	04	04	-	-	100	100
5	26BT305	Enzyme Technology	DEC3 and DEC4 (any two#)	04	-	4x2=8	04	-	4x2=8	70x2=140	30x2=60	-	100x2=200
7	26BT306	Cancer Biology											
8	26BT307	microRNA Technology											
9	26BT308	Research Orientation*											
10	26BT309	Biotech Management and Entrepreneurship											
11	26BT310	Bioethics and Biosafety	EEC**	02	-	02	02	-	02	35	15	-	50
		Total		22	08	30	22	04	26	385	165	100	650

For details, go through the ordinance available on the University website
T= Theory **P**=Practical **Int**=Internal assessment
CC= Core Course **DEC**= Discipline Elective Course **EEC**= Employability Enhancement Course
These courses will be offered exclusively when at least five students are registered for the particular course.
* It is mandatory for the students who adopt Option 2 in the fourth semester.
**EEC can also be adopted from the university pool
MOOC courses might also be adopted after discussion with the MOOC coordinator of the department.
Tutorials or other components implemented at the departmental level will be mentioned in the timetable.
Topics based on the Indian Knowledge System (IKS) are listed in Annex II

(After completing Semester III, option 1 and 2 students may opt for either Option 1 or Option 2 in Semester IV)

Semester-IV (Option 1) Credits-24 Marks-600

SN	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	26BT401	Bioprocess Technology	CC12	04	-	04	04	-	04	70	30	-	100
2	26BT402	Biotechniques	CC13	04	-	04	04	-	04	70	30	-	100
3	26BT403	Biotech Lab-4	PC-4	-	08	08	-	04	04	-	-	100	100
4	26BT404	Stem Cell and Regenerative Biology	DEC5, DEC6, DEC7 (any three#)	04	-	4x3=12	04	-	4x3=12	70x3=210	30x3=90	-	100x3=300
5	26BT405	Molecular Modelling											
6	26BT406	Study Oriented Project*											
7	26BT407	Systems Biology											
8	26BT408	Tissue Engineering											
9	26BT409	Gene Editing											
		Total		20	08	28	20	04	24	350	150	100	600

For details, go through the ordinance available on the University website
T= Theory **P**=Practical **Int**=Internal assessment
CC= Core Course **DEC**= Discipline Elective Course **MOOC**= Massive Open Online Course
These courses will be offered exclusively when at least five students are registered for the particular course.
*Mandatory for the students who adopt option 1 in the fourth semester. The evaluation will be internal based on the report and seminar.
MOOC courses might also be adopted after discussion with the MOOC coordinator of the department.
Tutorials or other components implemented at the departmental level will be mentioned in the timetable.
Topics based on the Indian Knowledge System (IKS) are listed in Annex II

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Semester-IV (Option 2) **Credits-24** **Marks-600**

S No	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	26BT401	Bioprocess Technology	DEC5, DEC6 (any two#)	04	-	4x2=8	04	-	4x2=8	70x2=140	30x2=60	-	100x2=200
2	26BT402	Developmental Biology											
3	26BT404	Stem Cell and Regenerative Biology											
4	26BT405	Molecular Modelling											
5	26BT406	Study Oriented Project											
6	26BT407	Systems Biology											
7	26BT408	Tissue Engineering											
8	26BT409	Gene Editing											
9	26BT403	Biotech Lab-4	PC-4	-	08	08	-	04	04	-	-	100	100
10	25BT430	Dissertation	Project work/Internship/apprentice	-	16	16		12	12	-	90	210	300
			Total	**08**	**24**	**32**	**08**	**16**	**24**	**140**	**150**	**310**	**600**

For details, go through the ordinance available on the University website
T= Theory **P**=Practical **Int**=Internal assessment
DEC= Discipline Elective Course **MOOC**= Massive Open Online Course
These courses will be offered exclusively when at least five students are registered for the particular course.
MOOC courses might also be adopted after discussion with the MOOC coordinator of the department.
Tutorials or other components implemented at the departmental level will be mentioned in the timetable.
Topics based on the Indian Knowledge System (IKS) are listed in Annex II

Semester-III (Option 3) **Credits-26** **Marks-650**

SN	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	26BT310	Bioethics and Biosafety	EEC*	02	-	02	02	-	02	35	15	-	50
2	26BT320	Research Report**	PC-3		04	04		04			100		100
3	26BT330	Dissertation	Project work/Internship/apprentice	-	26	26	-	20	20	-	150	350	500
			Total	**02**	**30**	**32**	**02**	**24**	**26**	**35**	**265**	**350**	**650**

For details, go through the ordinance available on University website
MOOC courses might also be adopted after discussion with the MOOC coordinator of the department.
Topics based on the Indian Knowledge System (IKS) are listed in Annex II
*EEC can also be adopted from the university pool
**The evaluation will be internal based on the report and seminar in a way similar to 25BT406 Study Oriented Project. Student can also adopt an online MOOC course in place of this course.

(The combination of Semester III option 3 and Semester IV option 3 can be opted by the students who have completed 4-year UG Honors with research, and subject to the future prospects of research)

Semester-IV (Option 3) **Credits-24** **Marks-600**

SN	Paper Code	Subject	Course Type	Weekly contact hours			Credits			Examination Scheme			
				T	P	Total	T	P	Total	T	Int	P	Total
1	26BT440	Dissertation	Project work/Internship/apprentice	-	32	32	-	20	20	-	150	350	500
2	-	Mooc Course	PC-4	-	-	-	04	-	04	-	-	-	100
			Total	**-**	**32**	**32**	**04**	**20**	**24**	**-**	**150**	**350**	**600**

For details, go through the ordinance available on the University website
MOOC course for all students as per their choice in consultation with the MOOC coordinator of the department.
Tutorials or other components implemented at the departmental level will be mentioned in the timetable.
Topics based on the Indian Knowledge System (IKS) are listed in Annex II

M.Sc. Biotechnology (Semester I)

Bridge course for students of non-biological background

25-BT-100 **Maximum Marks :50**

Introductory Biology **Internal Assessment: 50**

Note: *This course is designed exclusively* ***for the students with non-biology background*** *in their UG. It will be evaluated entirely through internal assessment. The evaluation may be based on assignments, quizzes, class tests, presentations, or any other mode decided by the instructor. The course shall be qualifying in nature and students will be given two chances to score minimum passing marks (20 out of 50). The grade awarded shall be reported as "Pass" only in the academic transcript and shall not be included in the calculation of SGPA/CGPA.*

Objectives

To provide basic concepts of biology and biotechnology required for pursuing a M.Sc. Biotechnology to the students from Mathematics or other non-Biology background. The course introduces the concept of living systems, biomolecules, cell biology, molecular biology, immunology, ecology, and the importance of biotechnology

Course outcomes

CO1: Understand the characteristics and organization of living systems.
CO2: Explain the structure and functions of cell and biomolecules.
CO3: Understand the basic concepts of molecular biology, genetics, immunology, and recombinant DNA technology.
CO4: Explain ecological principles, Evolution and gene technology.

Unit-I

Characteristics of Prokaryotes, Eukaryotes and Viruses, Ecology; Populations and communities; Biosphere. Ultra structure of cell, cell organelles and their functions. Concept of cell division.

Unit-II

Biomolecules: Structure and importance of biomolecules. Concept of enzymes, cofactors, and coenzymes; Basics of metabolism including glycolysis, Krebs cycle, and electron transport chain.

Unit-III

Molecular Biology and Immunology: Concept of gene, DNA replication, transcription, and translation; Immune cells, innate immunity, adaptive immunity, and immune responses.

Unit- IV

Genetic Engineering and Biotechnology: Introduction to genetic engineering and recombinant DNA technology; Restriction enzymes, vectors, and gene cloning; Applications of biotechnology in agriculture, medicine, industry, and environmental management.

Suggested readings

1. Campbell Biology – Urry et al.
2. Life: The Science of Biology – Sadava et al.
3. Essential Cell Biology – Bruce Alberts et al.
4. Molecular Biology of the Cell – Bruce Alberts et al.
5. Biotechnology – U. Satyanarayana.
6. Principles of Genetics – Snustad & Simmons.
7. Kuby Immunology.
8. Fundamentals of Ecology – Odum.

Note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester I)

26BT101
Cell Biology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks*

Objectives: This course will provide the fundamental knowledge of cells, which is a biochemical system to maintain the structure, metabolism, and reproduction in living organisms.

Course learning outcomes:
CLO1: The students will understand cell organelles, division, regulation, and their interactions with the environment.
CLO2: This course will prepare the students to develop their queries into life processes.
CLO3: Enable the students to seek a career in the field of medical sciences with a specific focus on the treatment of cell-related diseases, neuroscience, chromatin biology, and stem cell therapy.
CLO4: The course will open avenues in research as a cell biologist.

Unit I

Introduction to cell biology: Preface of cell biology; ultrastructure of a typical animal, plant, and bacterial cell. Structural organization and functions of the Endomembrane system, peroxisomes and their roles; Cell organelles and human diseases.

Membrane structure and function: Molecular composition of the cell membrane; Fluid-mosaic model of the membrane; importance of membrane fluidity and lipid asymmetry. Membrane transport system: Passive and active transports, membrane pumps, and electrical properties of the membrane. Ion channel blockers and diseases.

Unit II

Cytoskeleton and cell motility: Structure, dynamic organization and importance of cytoskeleton; microtubule motors and movement; cell adhesion; extracellular matrix; mechanism of protein sorting and transport.

Genomic organization: Chromatin organization; heterochromatin and euchromatin.

Unit III

Cell Cycle: Steps in the cell cycle, regulation of the cell cycle.

Cell signaling and communication: General principles of cell communication; second messengers; signaling through G-protein coupled receptors; two-component systems; bacterial chemotaxis and quorum sensing.

Unit IV

Cell death and cell renewal: Biology of aging; apoptosis and necrosis; mechanisms of programmed cell death; stem cells and their clinical applications[DSL]; cell cloning.

Biology of cancer cell: Biology of cancer; virus-induced cancer; proto-oncogenes, oncogenes and tumor suppressor genes; metastasis; molecular approaches for cancer treatment.

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Molecular Biology of the Cell by Bruce Alberts *et al.*, Garland Science.
2. Cell Biology by C B Powar, Himalayan Publishing House.
3. Essential Cell Biology by Bruce Albert et al., Garland Science.
4. Molecular Cell Biology by Harvey Lodish et al., W H Freeman & Co, New York.
5. Becker's World of the Cell by W.M Becker et al., Pearson Education.
6. Cell and Molecular Biology by Gerald Karp, John Wiley and Sons, Inc.
7. Cell Biology by P S Verma and V K Agarwal, S Chand Publishing

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester I)

25BT102
Biochemistry

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main aim of this course is to consolidate the knowledge of students about the basic molecules of life and their metabolism. This knowledge will help to explore the area of human physiology and health.

Course learning outcomes:

CLO1: The course will develop the principles of chemistry in life.

CLO2: Career opportunities in this study can be in government agencies, private research institutions, hospitals, and social and non-profit organizations to conduct research, clinical trials, and to find out cures for various diseases, particularly metabolic diseases.

Unit I

Preface of Biochemistry: Principles of biophysical chemistry (pH[CLL], buffer[CLL], reaction kinetics, thermodynamics, and colligative properties); stabilizing interactions (Van der Waals, hydrogen bonding, hydrophobic interaction, etc.) [DSL]; water and its properties.

Carbohydrates: Importance of carbohydrate, Structure and function of biologically important mono, di and polysaccharides, Glycoproteins & glycolipids; Carbohydrate metabolism. Glycolysis, Citric acid cycle, Glycogenolysis, and Pentose phosphate pathway and their regulations.

Unit II

Proteins: Structure, classifications and properties of amino acids and proteins[CLL]; an overview of amino acid biosynthesis (Proline, Arginine), stability and degradation [DSL]; Ramachandran plot. Mechanism of protein folding, factors affecting protein folding, Protein misfolding, and diseases.

Enzymes: Types and classification of enzymes; concept of cofactors and coenzymes [DSL]; enzyme kinetics (Michaelis-Menten equation[CLL], Km, Vmax, turnover number); Lineweaver–Burk plot[CLL]; enzyme inhibition; allosteric enzymes; immobilized enzymes [DSL].

Unit III

Lipids: Structure of fatty acids and lipids; classification of lipids; functions of major lipid subclasses-acyl glycerols, phospholipids, glycolipids, sphingolipids; waxes, terpenes, and sterols[DSL].

Lipid metabolism: Fatty acids biosynthesis, degradation and their regulations; ketone bodies synthesis; biosynthesis of TAG, cholesterol, phospholipids, and glycolipids; inborn errors of metabolism [DSL].

Unit IV

Nucleic acids: Structure and properties of nucleic acid bases[DSL], nucleosides, and nucleotides; biosynthesis and degradation of purines and pyrimidines; Salvage pathway.

Vitamins: Structure and biochemical roles of fat and water-soluble vitamins; roles of vitamins as coenzymes[DSL].

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Lehninger Principles of Biochemistry by Nelson DL and Cox MM, Freeman and Company, New York
2. Outlines of Biochemistry by Conn EE et al., John Willey and Sons Inc. New York & Toronto.
3. Principle of Biochemistry by Voet D, Voet JG and Pratt CW, John Wiley and Sons Inc. NY.
4. Biochemistry and Molecular Biology by Elliott WH and Elliot DC, Oxford University press Inc. New York
5. Biochemistry by Metzler D.E, Academic Press, London and New York.
6. Biochemistry by Berg JM et al., WH Freeman Publishers, New York
7. Biochemistry by Garret RH et al., Boston

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester I)

26BT103
Microbiology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course will provide an understanding of the structure, nutrition, metabolism, growth, classification, and identification of microorganisms.

Course learning outcomes:

CLO1: Students will get knowledge of basic microbiological techniques and applications of microbes in the food industry and medical sciences.

CLO2: The course will enable students to learn basic techniques in the field of microbiology, which has various career opportunities as clinical, agricultural, and industrial microbiologists.

Unit-I

Introduction to Microbiology: Introduction, branches and applications of microbiology; characteristic features of bacteria, archaea, viruses, fungi, protozoa and algae[DSL]; concept of viroids and prions.

Microbial taxonomy, metabolism, and diversity: Microbial classification and taxonomy; conventional and molecular approaches for identification of microorganisms; Bergey's manual of bacteriology; nutritional categories of microbes.

Unit II

Methods in Microbiology: Isolation of microbes from natural and artificial sources[CLL]; various techniques to establish a pure culture[CLL]; different methods of sterilization.

Microbial growth and culturing: Mathematical expression of growth; methods of growth measurement; types and formulation of aerobic & anaerobic culture; types of culture techniques (batch, semi-continuous, continuous, synchronous, enrichment, special)[CLL]; Procedure of microbial culture preservation and submission to repository[DSL].

Unit III

Morphological and metabolic characteristics of specialized microbes: Nitrogen fixing bacteria[CLL], nitrifying and denitrifying bacteria[CLL], acetic acid bacteria, sulphur oxidizing & reducing bacteria, iron-oxidizing bacteria, hydrogen bacteria, carboxydobacteria, and photosynthetic bacteria[DSL].

Unit IV

Genetic variations and mutagenesis: Mechanism of transformation, conjugation and transduction in bacteria; types of mutations; Ames test for mutagenesis[CLL].

Food and medical microbiology: Food preservation by different methods (high and low temperature, chemical additives, and irradiation); basic concept of D-value, Z-value, 12-D and F-value; microbial toxins and food poisoning caused by *Clostridium botulinum, Salmonella sp., Yersinia enterolitica, Vibrio sp., and Bacillus sp.*; Characteristics of disease-causing microbes with special emphasis on mycoplasma, rickettsias, and chlamydias[DSL].

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Microbiology by Pelczar Jr MJ, Chan ECS, and Krieg NR, Tata McGraw Hill.
2. General Microbiology by Stanier RY, Ingraham JL, Wheelis ML and Painter PR, 5th edition, McMillan.
3. Prescott Microbiology by Willey JM, Sherwood LM, and Woolverton CJ, McGraw Hill Higher Education.
4. Microbiology: An Introduction by Gerard J Tortora et al., Pearson publications.
5. Microbiology: With Diseases by Body System by Robert W Bauman, Pearson publications.
6. Microbiology: With Diseases by Taxonomy by Robert W Bauman, Pearson publications.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester-I)

25BT104
Biotech Lab 1.1

Maximum Marks: 100
Duration of Exam: 08 h

Objectives and Course learning outcomes:
We seek to train the next generation of researchers in cell biology and biochemistry with a deep understanding of core disciplines and the ability to plan important and incisive research and execute their ideas with appropriate technology and methodology, from the classic to the cutting edge.

Practical:

1. Ultrastructure of the cell
2. Cell staining and visualization under a microscope.
3. Mitotic division in root tip cells.
4. Preparation of chromosomes.
5. Effect of different factors on cell membrane permeability.
6. Effect of tonicity on animal and plant cells
7. Reactions of amino acids, sugars, and lipids
8. Quantitation of Proteins and Sugars
9. UV, Visible, Fluorescence, and IR spectroscopy, Absorption spectra
10. Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC, etc.)

Note: This is the list of suggested practical. The final list of practicals will be declared in the running semester.

M.Sc. Biotechnology (Semester-I)

25BT105
Biotech Lab 1.2

Maximum Marks: 100
Duration of Exam: 08 h

Objectives and Course learning outcomes:
We seek to train the next generation of researchers in Microbiology and molecular biology with a deep understanding of core disciplines and the ability to plan important and incisive research and execute their ideas with appropriate technology and methodology, from the classic to the cutting edge.

Practical:

1. Isolation of pure culture
2. Staining and microscopic examination of stained preparations
3. Measurement of microbial growth. Analyzing the effect of temperature, pH, and carbon and nitrogen sources on microbial growth.
4. Morphological and Biochemical characterization of the microbe
5. Enrichment culture technique
6. Isolation of genomic DNA from animal tissue
7. Agarose gel electrophoresis
8. Quantitative analysis of DNA
9. RFLP analysis

Note: This is the list of suggested practical. The final list of practicals will be declared in the running semester.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester I)

26BT106
Molecular Biology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: It focuses on the interactions between the various systems of a cell, including the interrelationships of DNA, RNA, and protein synthesis and their regulations.

Course learning outcomes:
CLO1: Students will learn the most significant molecular mechanisms that are used in living organisms.
CLO2: This course will prepare students to seek careers in molecular laboratories, as molecular biologists in research institutions, and in major diagnostic centers.

Unit I

Replication of genetic material: Introduction of molecular biology; identification of DNA as the genetic material[DSL]; viral genome; bacterial genome; eukaryotic chromosome.

DNA replication: Replicon, enzymes and accessory proteins involved in DNA replication. Mechanism of DNA replication in prokaryotes & eukaryotes.

Unit II

Gene transcription and RNA modification: Prokaryotic & eukaryotic transcription: RNA polymerase, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation[CLL]; RNA modification: processing, splicing, 5'Capping, 3'Poly A tailing, RNA editing, base modification[CLL].

Translation: The genetic code[DSL], prokaryotic and eukaryotic translation.

Unit III

Mechanisms of DNA Repair: Photo reactivation[DSL], base excision repair, nucleotide excision repair, mismatch excision repair, recombination repair, non-homologous end joining[CLL], translesion/error-prone repair; SOS response.

Recombination & transposition: Homologous recombination and Holliday junction model of recombination[CLL], site-specific recombination; illegitimate recombination; Cre-lox recombination[CLL]. Bacterial transposons, P elements in *Drosophila*; transposable elements in human[DSL]. Recombination errors and human diseases.

Unit IV

Gene regulation in prokaryotes: Transcriptional regulation: inducible and repressible controls[DSL], lac and tryptophan operons; post transcriptional regulations: leader sequences, attenuators; Co- and post-translational regulation: repressor proteins, antisense RNA, feedback inhibition and allosteric control[DSL].

Gene regulation in eukaryotes: Alternative splicing, RNA stability, DNA methylation, histone modification, riboswitches[CLL].

DSL=Digital Self Learning
CLL=Classroom and Lal Learning

Suggested readings:

1. Lewin Genes by Jocelyn E Krebs et al., Jones & Bartlett Learning.
2. Essentials of Molecular Biology by Friefelder D et al., Boston.
3. Genetics: Analysis and Principles by Brooker, Robert J, McGraw-Hill Education.
4. Concepts of genetics by William S Klug et al., Pearson NY.
5. Genetics: A molecular approach by Brown TA, Chapman and Hall, London.
6. Gene Regulation by Gurbachan S, Narosa Publishers.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester II)

26BT201
Molecular Immunology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The objective of this course is to provide information regarding cells, molecules, and processes associated with the immune system and their role in health & diseases. In addition, exposure to the recent developments in immunology will also be an integral part of the subject.

Course learning outcomes:

CLO1: The subject will emphasize developing students' understanding of molecular, cellular, and clinical perspectives in the area of immunology.

CLO2: This course will prepare students to seek a career in the field of immunological diagnosis, vaccine development, and numerous other clinical studies.

Unit I

Preface of immunology: Primitive and advanced immunity, anatomical barriers in innate immunity, cardinal features of acquired immune system[DSL]. Internal structure and organization of the thymus, spleen, and lymph nodes.

Cellular and humoral immunity: Concept of antigen, super antigen, immunogen, epitopes and hapten carrier system. Factors affecting immunogenicity. Molecular structure of antibodies and their functions. Complement system and its evasion by microbes[DSL]. Complement deficiencies and diseases.

Unit II

Immune receptors and their diversity: Structure and functions of Toll receptor, TCR, BCR, MHC; somatic recombination and generation of antibody diversity.

Antigen presentation and tolerance: Antigen processing and presentation, self-MHC restriction[DSL]. Immunological tolerance.

Unit III

Activation of immune cells and cytotoxicity: T cell activation, negative regulation of T cell activation. Mechanism of T cell and NK cell mediated target cell lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity[DSL]. Inflammatory bowel diseases.

Regulation of the immune system: Cytokines and their role in immune regulation.

Unit IV

Transplantation and disorders of immune response: Transplantation and its rejection, autoimmunity, hypersensitivity, immunodeficiencies[DSL].

Immunotechnology: Antigen-antibody interactions, agglutination[CLL], immunoelectrophoresis[CLL], immunoblotting[CLL], ELISA[CLL], surface plasmon resonance. Abzymes, antibody engineering[DSL]. Vaccines.

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Immunology by Kuby J. W.H. Freeman & Co., New York.
2. Cellular and Molecular Immunology by Abul K Abbas et al., Elsevier, Inc.
3. Immunology: A Short Course by Coico, Richard and Sunshine, Geoffrey. Willey-Blackwell Press.
4. Essential Immunology by Roitt, I.M. Oxford Black Well Science, London.
5. Immunology by Raj Khanna, Oxford Press.
6. Immunology and Immunotechnology by Chakravarty AK, Oxford press.
7. The Elements of Immunology by Fahim Halim Khan, Pearson Education

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester II)

26BT202
Developmental Biology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: In this course, students will study the genetic control of cell growth, differentiation, and morphogenesis that give rise to tissues, organs, and organisms.

Course learning outcomes:

CLO1: This course will impart vast knowledge of developmental processes to pursue our inquiry into the fundamentals of life.

CLO2: There are a variety of options for students, including a career as a researcher in a stem cell laboratory, developmental biologist, and stem cell banking.

Unit I

Basic concepts of development: Life cycle of *Xenopus, Drosophila, C. elegans* and mouse; embryonic development and potency, commitment, specification, induction, competence, determination and differentiation [DSL]; formation and differentiation of germ cells; structure, chemistry, dynamics and regulation of sperm locomotion, capacitation and egg-surface targeting; hormonal control of ovulation in mammals[DSL].

Unit II

Fertilization: Molecular and cellular biology of fertilization: acrosome reaction and signal transduction, monospermy and species-specificity[DSL], egg activation, early cleavages and blastocyst formation in mammals, biochemical and cellular changes during the passage down the oviduct to the uterus.

Unit III

Embryonic development: Implantation and formation of the placenta in mammals; gastrulation in mammals: formation of primitive streak, morphogenetic movements and neural induction; organogenesis and fetus development; pattern forming genes and expression in *Drosophila*; Mammalian brain and lens development[DSL].

Growth factors: Growth factors and signal cascades for BMP, Wnt, and notch during gastrulation.

Unit IV

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem[CLL]; leaf and floral development in *Arabidopsis.*

Introduction to stem cells: Molecular basis of pluripotency and its applications; stem cell niches; stem cell renewal[DSL]; epigenetic mechanism of cellular memory[DSL]; nuclear cloning and epigenetic reprogramming.

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Developmental Biology by Gilbert SF, Sinauer Asso.
2. Principles of Development by Wolpert L *et al.*, Oxford University Press
3. The Art of the Genes- How Organisms Make Themselves by Coen E, Oxford University Press
4. Genetic Analysis of Animal Development by Wilkins AS, Wiley-Liss
5. Biological Physics of the Developing Embryo by Forgacs G & Newman SA, Cambridge University Press.
6. Handbook of Stem Cells by R Lanza, I Weissman, J Thomson, and R Pedersen, Academic Press.
7. Essentials of Stem Cell Biology by R Lanza, J Gearhart *et al.*, Elsevier Academic press.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester II)

26BT203
Genetic Engineering

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The course also commonly known as recombinant DNA technology, is the set of molecular tools and techniques that are used for the manipulation of genes. The course also emphasizes the applications of genetic engineering, such as gene editing and gene therapy.

Course learning outcomes:

CLO1: This course will train the students for the use of molecular tools such as enzymes, various cloning vectors, library preparation, and suitable methods for the manipulation of animals and plants. Also learning strategies to study gene expression and recombinant protein production.

CLO2: Being the core area of biotechnology, this subject enables students to learn the basics of genetic manipulation tools and well-trained students can find career options in biotechnological and R&D units.

Unit I

Introduction and scope: Scope of genetic engineering; tools for genetic engineering: restriction and other modifying enzymes; vectors: basic biology of plasmids, bacteriophage vectors, cosmids, phasmids, YAC, BAC and M13; expression vectors[CLL].

Gene cloning strategies: preparation and screening of genomic and cDNA library, mRNA enrichment; PCR based cloning[CLL].

Unit II

Genetic manipulation of animals: Gene knockout and knock-in technologies; gene transfer methods to animal cells; transgenic mice and *Drosophila*; Genetic manipulation of plants: strategies for gene transfer to plants including *Agrobacterium-mediated* transformation; selectable markers for plants[DSL]; mapping the RNA by primer extension, S1 nuclease, and RNase protection methods; t-DNA and transposon tagging[DSL].

Unit III

Regulation of transgene expression: inducible expression systems; gene silencing by RNAi; strategies for heterologous gene expression in bacteria, yeast, insect, mammals, and plant cells; Gene probes: generation, labeling and usage; reporter genes[CLL].

Unit IV

Processing of recombinant proteins: *In vitro* translation; purification, refolding, characterization and stabilization of recombinant proteins; site-directed mutagenesis and protein engineering[DSL]. Analysis of protein-protein interactions by yeast two-hybrid system.

Genome editing using engineered nucleases: Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALEN) and clustered regularly interspaced short palindromic repeats (CRISPR); gene therapy: types and methods.

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Principles of gene manipulation and genomics by Primose SB and Twyman RM, Blackwell publishing.
2. Gene cloning and DNA analysis–An introduction by Brown TA, Blackwell publisher
3. Biotechnology: expanding horizons by BD Singh, Kalyani Publishers
4. Molecular cloning: A laboratory manual by J Sambrook and Michael R Green.
5. Essential genes by Benzamin Lewin, Pearson education international.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

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M.Sc. Biotechnology (Semester II)

26BT204
Biotech Lab 2.1

Maximum Marks: 100
Duration of Exam: 08 hrs.

Objectives and Course learning outcomes:
The course is aimed to promote the confluence of areas such as Immunology and Developmental Biology at one forum. It is also to promote and integrate research and development in the above-mentioned field. Also, to organize periodic experiments either exclusive to our lab or jointly with other organizations.

Practical:

1. Blood film preparation and identification of immune cells
2. Lymphoid organs and their microscopic organization
3. Immunization of animals
4. Separation of serum
5. Double diffusion and Immune-electrophoresis
6. Separation of mononuclear cells by Ficol1-Hypaque
7. Heamagglutination assay
8. ELISA
9. Immunoblotting
10. Immunodiagnostics (demonstration using commercial kits)
11. To study the different stages of development in frog and chick through permanent slides.
12. To study the spermatogenesis of rat and grasshopper through slides.
13. To prepare the permanent stained slides of developing stages from fertilized egg of hen.
14. Study of sex-chromatin Bars body from human buccal mucosa.
15. Epitope mapping

Note: This is the list of suggested practical. The final list of practicals will be declared in the running semester.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester II)

26BT205
Biotech Lab 2.2

Maximum Marks: 100
Duration of Exam: 08 hrs.

Objectives and Course learning outcomes:
The course is aimed to promote the confluence of areas such as Genetic engineering, Bio-informatics and Biology of infectious diseases at one forum. It is also to promote and integrate research and development in the above-mentioned field. Also, to organize periodic experiments either exclusive to our lab or jointly with other organizations.

Practical:

1. Quantify DNA and RNA concentrations using UV-Vis spectroscopy and assess quality via agarose gel electrophoresis.
2. Analyze gene expression data from DNA microarrays and interpret results using bioinformatics tools.
3. Isolation of plasmids and purification
4. Quantitation of nucleic acids.
5. Restriction analysis and construction of the restriction map of the plasmid
6. Preparation of competent bacterial cells
7. Genetic Transformation of bacteria with a recombinant plasmid
8. PCR amplification
9. Identification of disease vectors
10. Detection of different infectious diseases by commercially available kits
11. Detection of malaria parasite in Geimsa stained blood smear
12. Antibiotic sensitivity (bacterial)
13. Effect of hand hygiene on microbial growth

Note: This is the list of suggested practical. The final list of practicals will be declared in the running semester.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester II)

25BT206
Bioinformatics

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: It applies information technology and computer science to the area of biology for the purpose of studying, analyzing, and processing information related to genomics as well as other biological processes.

Course learning outcomes:

CLO1: Students will learn the integration of computers, software tools, and databases to address biological queries.

CLO2: This course will help students to work in all sectors of pharmaceutical, biomedical organizations, biotechnology, research institutions, hospitals, industry, and even NGOs.

CLO3: They can also be a part of the leading IT companies as "Bio-informationists" along with career areas such as database design & maintenance, pharmacology, sequence assembly analysis, informatics developer, etc.

Unit I

Introduction to bioinformatics: Branches, scope and research areas of bioinformatics; introduction to various sequence file formats; introduction to PERL: scalar variables, strings and numbers, arrays, hashes, operators, loops, regular expression[CLL]; applications of PERL in bioinformatics[DSL].

Introduction to databases: Classification scheme and features of biological databases; overview of various databases dealing with biological macromolecules[DSL].

Unit II

Major biological databases: Primary databases of nucleic acid and protein: NCBI-Genbank, EMBL, DDBJ; Swiss Prot, PIR[CLL].

Other databases: Secondary protein database Prosite and PRINTS[CLL]; secondary genomic database OMIM and OMIA, literature database Pub Med, metabolic database KEGG, *Plasmodium* database Plasmo DB, specialized databases including MIPS, TIGR, TAIR[CLL].

Unit III

Sequence comparison methods: Methods for the comparison of two sequences[CLL] viz., dot matrix plots, Needleman-Wunsch & Smith-Waterman algorithms; analysis of computational complexities and the relative merits and demerits of each method[CLL]; theory of scoring matrices and their use for sequence comparison; difference between PAM and BLOSUM[DSL]; sequence similarity tools: CLUSTAL X/W[CLL]; molecular phylogeny[DSL].

Unit IV

Database search algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms; BLAST and its types; PSI-BLAST and RPS-BLAST[CLL]; concept of position-specific weight matrices and their use in sequence analysis; theory of profiles and their use with special reference to PSI BLAST[CLL]; Markov chains and models; concept of HMMs[DSL], Viterbi algorithm; forward algorithm and Baum-Welch algorithm[CLL].

DSL=Digital Self Learning
CLL=Classroom and Lal Learning

Suggested readings:

1. Essential Bioinformatics by Jin Xiong, Cambridge publisher.
2. Bionformatics: Principles and Applications) by Zhumur Ghosh and Bibekanand Mallick, Oxford University Press.
3. Bioinformatics by Orpita Bosu and Simminder Kaur Thukral, Oxford University Press publisher
4. Introduction to Bioinformatics by M Lesk, Oxford University Press publisher.
5. Fundamental Concepts of Bioinformatics by Dan E Krane, Michael L Raymer, Michaeel L Raymer, Elaine Nicpon Marieb, Benjamin/Cummings.
6. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery by P Rastogi and N Mendiritta, Prentice-Hall of India Pvt. Ltd.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester II)

26BT207
Metabolic Engineering

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: A typical metabolic engineering syllabus covers the principles and applications of modifying cellular metabolism to enhance the production of desired compounds, including biofuels, pharmaceuticals, and chemicals. Key topics include cellular metabolism, metabolic pathways, metabolic flux analysis, and genetic tools used in metabolic engineering.

Course learning outcomes:
CLO1. Understanding the wealth of phytochemicals, often termed as natural products.
CLO2. Understanding the specific metabolic pathways of drugs, flavouring agents, and nutraceuticals.
CLO3. Advances in biosynthetic pathways through cloning of encoding genes.
CLO4. Biotechnological approaches to design strategies to alter biosynthetic routes leading to enhanced production of desired products of pharmaceutical importance, mainly through the application of metabolic engineering strategies.

Unit 1

Introduction to metabolic engineering: cellular metabolic pathways, promoter engineering, protein engineering, Biosynthesis of Secondary Metabolites. Synthetic biology. Metabolic flux, ^{13}C metabolic flux analysis principles and their applications. Application of in pharmaceuticals, chemical bioprocess, food technology, agriculture, bioremediation and biomass conversion.

Unit 2

Genome engineering: Introduction, CRISPR, combinational engineering, applications of combinational engineering. Regulation of secondary metabolite pathways, precursor effects, prophase, and idiophase relationship. Engineering tropane, morphine, and purine alkaloid pathways in plants. Manipulation of anthocyanin pathways and creation of a blue rose.

Unit 3

Metabolic pathway modeling: Metabolic engineering with Bioinformatics. Pathway manipulation for the production of phenolic esters. Metabolic engineering for vanillin biosynthesis. Genetic engineering of the shikonin pathway. Molecular pharming for human somatotropin production in transplastomic plants.

Unit 4

Bioconversions: Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Cometabolism, Mixed or sequential bioconversions, Conversion of insoluble substances, worked examples in metabolic engineering, including artemisinin and butanol.

Suggested readings:
1. Pharmacognosy Trease & Evans',
2. Biochemistry & Molecular Biology of Plants by Buchanan et al.
3. Chemicals from Plants by Walton & Brown,
4. Metabolic Engineering: Principles and Methodologies by Stephanopoulos G, Aristidou AA, and Nielsen J
5. Metabolic Engineering by Jens Nielsen
6. Metabolic Engineering (Biotechnology and Bioprocessing) by Sang Yup Lee and E Terry Papoutsakis
7. Metabolic Engineering by Ralph Becker
8. Metabolic Engineering for Bioactive Compounds by Vipin Chandra Kalia, Adesh Kumar Saini
9. Applications of Plant Metabolic Engineering. Robert Verpoorte, A.W. Alfermann, T.S. Johnson
10. Metabolic Engineering by Sang Yup Lee, E. Terry Papoutsakis
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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester II)

25BT208
Biology of Infectious Disease

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course deals with the medical and health aspects of microbes. Here, students will learn the outcomes of microbial diseases, their modes of transmission, and their impact on public health. In addition, diagnosis, therapy, and the challenges in this area will also be part of learning.

Course learning outcomes:
CLO1: Students will acquire knowledge about infectious diseases and their associated challenges.
CLO2: This course will prepare students to seek careers in the field of medical sciences, the pharma industry, disease diagnosis, and epidemiological studies

Unit I

Introduction to infectious diseases: Preface of infectious diseases; terminology and categories of diseases; normal and pathogenic microbiota; classification of infectious diseases[DSL]; reservoirs of infectious diseases; stages of infectious disease.

Host-pathogen interaction: Nature and manifestations of infectious diseases; portals of infectious agents entry and exit; virulence factors of infectious agents; pathogens mediated alteration of host cell behavior and damage.

Unit II

Symptoms, pathogenesis, diagnosis, treatment, and prevention for the representative infections[CLL]:
Bacteria: Tetanus, tuberculosis. Fungi: Superficial, subcutaneous, systemic and opportunistic mycoses. Viruses: Hepatitis, herpes simplex virus. Protozoa: Amoebiasis, plasmodiasis.

Unit III

Diagnosis of Infectious Diseases: Rationale behind the modern approaches for diagnosis of infectious diseases, basic concepts of gene probes, dot hybridization, and PCR assays.

Drug therapy and resistance: Action mechanisms of antibiotics, antivirals and antifungal agents; molecular mechanisms of drug resistance.

Unit IV

Vaccination against infectious diseases: Active and passive immunization; virus-like particles; edible vaccines; rational vaccine design based on clinical requirements and reverse vaccinology; role and properties of adjuvants; nanoparticles in vaccine delivery system[DSL].

Epidemiology of infectious diseases: Epidemiology and public health; disease burden; frequency of disease; investigation of epidemics; hospital-acquired (nosocomial) infections.

DSL= Digital Self Learning
CLL=Classroom and lab learning

Suggested readings:
1. Microbiology: An Introduction by Gerard J Tortora et al., Pearson publications.
2. Microbiology: With Diseases by Body System by Robert W Bauman, Pearson publications.
3. Microbiology: With Diseases by Taxonomy by Robert W Bauman, Pearson publications.
4. Prescott's Microbiology by Joanne M. Willey et al., McGraw-Hill publications.
5. Handbook of Disease-Causing Microbes by Paul, Jaishree, Ane Books.
6. Introduction to Molecular Vaccinology by Giese, Matthias, Springer
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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester II)

26BT209
Environmental Studies and Sustainable Development

Maximum Marks: 50
Total credits: 02

Note: The course will be evaluated based on the study report (30 marks) and seminars/presentations/viva, etc. (20 marks). The report will be focused on local studies that remain centered on the fieldwork/project work related to soil/air/water pollution/best out of waste theme-based work/bioremediation/or any other relevant topic related to the environment, including those mentioned below. In addition, students will also participate in environment-related activities through debate, declamation, group discussions, poster competition, seminars/ conferences/paper/poster presentation, and nukkad natak at the university/local/state/national levels. Paper/article publication in state/national/level journals, newspaper/conference/seminar proceedings is recommended.

Objectives: This course will provide fundamental knowledge about the environment and related issues that have a direct impact on the human population.

Course learning outcomes: The students will understand the environmental challenges, realize their role, and be motivated to protect the environment. This learning will prepare the students to develop their queries and ideas for a healthy environment.

CLO1. Understanding water resource management and the concept of green energy.
CLO2. Understanding the different types of waste and their management.
CLO3. To develop awareness of environmental laws and policies.
CLO4. Understanding wildlife protection and environmental impact assessment.

Unit-I

Water Resources Management: coordinated development and management of water, land, and related resources. Revival of Water Bodies: enumeration, protection, and management of water bodies in their respective States. Energy & Green Technologies: Renewable and Alternative energies such as Solar, Wind, Tidal, etc.

Unit-II

Waste Management: Solid/Liquid/Plastic/C&D/Electronic/Bio-medical/Hazardous wastes. Sanitation & Hygiene: Methods of Garbage collection, industrial/ hazardous waste management, Methods of wastewater treatment and disposal.

Unit-III

Environmental Laws & Policies and Legal Proceedings: Legislation, regulations, policies, and permits related to protecting the environment such as The National Green Tribunal Act, 2010, Water Prevention And Control of Pollution Act, 1974, Cess Act, 1974, Air Prevention And Control Of Pollution Act, 1977, Forest Conservation Act, 1980, Environmental Protection Act, 1986, Public Liability Insurance Act 1991, Government Missions for Environment Protection & Conservation (as per National Environment Policy NEP-2020) and Ministry of Environment and Forests (MoEF).

Unit-IV

Wildlife Protection & Conservation: habitat conservation, endangered and keystone species protection, ex-situ efforts, and poaching prevention. Environmental Impact Assessment: Water Environment, Biological Environment, Land Environment, Air Environment, Noise Environment, Socio-economic and Health Environment. Environment Management Plan.

Suggested readings:

1. Fundamentals of Ecology: E. P. Odum, W.B. Saunders Co
2. Concepts of Environmental Science. Sugandha Mishra, Dhirendra Kumar, Rajesh Publication.
3. Environmental Science. Jr. G. T. Mille R, Wadsworth Pub. Co
4. Fundamentals of Environmental Science: Dhaliwal GS, Sangha GS and Raina PK. Kalyani Publication
5. Environmental Science Systems & solutions, M.L. Mac-Kinney, & RM Schoch, Web-enhanced edition.
6. Environmental Chemistry: A. K. De, Wiley Eastern Ltd.
7. Journal publications

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester II)

25BT210
Indian Knowledge Systems in Biotechnology-I

Maximum Marks: 50
Total credits: 02

Note: *The course will be evaluated based on the study report (30 marks) and seminars/presentations/viva, etc. (20 marks). The report will be focused on studies that remain centered on the relevant topic related to the IKS, including those mentioned below. In addition, students will also participate in debate, declamation, group discussions, or poster competition.*

Objectives: This course introduces students to the integration of Indian Knowledge Systems (IKS) with modern biotechnology, focusing on Ayurvedic medicinal applications and biodiversity conservation. It aims to provide insights into traditional practices and their relevance to contemporary biotechnological advancements.

Course learning outcomes:
CLO1: Understand the application of Ayurvedic principles in modern biotechnology, particularly in drug discovery and bioprocessing.
CLO2: Gain knowledge of traditional ecological practices for biodiversity conservation and environmental biotechnology.
CLO3: Students will develop skills to apply IKS-based approaches in sustainable agriculture and ecological management.
CLO4: Students will be prepared for research careers integrating traditional and modern biotechnological methods.

Unit I

Ayurveda and Medicinal Biotechnology: Overview of Ayurvedic principles in biotechnology: Insights from ancient texts (Sushruta Samhita, Charaka Samhita) on plant and animal-based healing processes. Use of fermentation for herbal drugs and enzyme-based therapies. Case studies of traditional practices in modern medicinal contexts.

Unit II

Pharmacology and Bioprocessing in IKS: Pharmacology of bio-active compounds: Rasayana formulations and their relevance to drug discovery, bioprocessing, and secondary metabolite production. Integration of traditional fermentation (Asava-Arishta) with modern bioprocess technologies for producing antibiotics, vitamins, and enzymes.

Unit III

Ethno-biotechnology and Biodiversity: Ethno-biotechnology: Vrikshayurveda and its contributions to microbial diversity, biofertilizers (e.g., Rhizobium symbiosis), and sustainable crop improvement. Indigenous methods for genetic diversity in crops (e.g., Vavilov's centers in Indian contexts). Role of ethnozoology and ethnobotany in biodiversity conservation.

Unit IV

Sustainable Practices in Environmental Biotechnology: Traditional ecological knowledge in resource management: Bioremediation using herbs, vermicomposting, and phytoremediation for pollution control. Applications of IKS in sustainable agriculture and ecosystem management. Case studies on traditional practices for environmental sustainability.

Suggested Readings:

1. Sushruta Samhita, translated by Kaviraj Kunjalal Bhishagratna, Chowkhamba Sanskrit Series.
2. Charaka Samhita, translated by P.V. Sharma, Chaukhambha Orientalia.
3. Vrikshayurveda: The Science of Plant Life by Surapala, translated by Nalini Sadhale, Asian Agri-History Foundation.
4. Ethnomedicine and Pharmacognosy by V.K. Singh and J.N. Govil, Studium Press.
5. Biotechnology and Traditional Knowledge by S.K. Jain, Oxford & IBH Publishing.
6. Environmental Biotechnology by Bimal C. Bhattacharyya, Oxford University Press.
7. Indian Ethnobotany: Emerging Trends by A.K. Jain, Scientific Publishers.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester II)

26BT211
Indian Knowledge Systems in Biotechnology-II

Maximum Marks: 50
Total credits: 02

Note: The course will be evaluated based on the study report (30 marks) and seminars/presentations/viva, etc. (20 marks). The report will be focused on studies that remain centered on the relevant topic related to the IKS, including those mentioned below. In addition, students will also participate in debate, declamation, group discussions, or poster competition.

Objectives: This course explores the ethical, philosophical, and interdisciplinary dimensions of Indian Knowledge Systems (IKS) in biotechnology, emphasizing their relevance to sustainable development and modern challenges. It aims to foster a holistic approach to biotechnological innovation.

Course learning outcomes:
CLO1: Understand the ethical frameworks of IKS and their influence on modern biotechnological practices.
CLO2: Explore philosophical concepts of IKS and their application in drug design and regenerative medicine.
CLO3: Gain insights into sustainable biotechnology solutions inspired by IKS for addressing climate change and health challenges.
CLO4: Develop an interdisciplinary perspective, integrating IKS with fields like anthropology and agriculture for innovative research.

Unit I

Ethical Frameworks in IKS: Ethical principles in IKS: Ahimsa (non-violence) and its influence on genetic engineering, animal cell culture, and GM crops. Ethical considerations in modern biotechnology inspired by traditional practices. Case studies on ethical dilemmas in biotech research.

Unit II

Philosophical Dimensions of IKS: Concept of interconnectedness: Panchamahabhuta (five elements) and Tridosha (body balance) in understanding biological systems. Implications for gene editing and stem cell therapy. Samkhya philosophy and concepts of consciousness in guiding ethical biotech practices.

Unit III

Philosophy and Spirituality in Biotechnology: Integration of philosophical concepts of Prana (life force) and spiritual symbolism of plants/animals in drug design and regenerative medicine. Role of IKS in shaping holistic approaches to biotechnological research and innovation.

Unit IV

Interdisciplinary Applications and Modern Relevance: Sustainable development through IKS: Insights in pharmacognosy, bioenergy, and biodiversity for addressing climate change and health challenges. Interdisciplinary approaches: Integration of IKS with anthropology (ethnomedicine) and agriculture (sericulture/apiculture) for innovations in personalized medicine and environmental solutions.

Suggested Readings:

1. Sushruta Samhita, translated by Kaviraj Kunjalal Bhishagratna, Chowkhamba Sanskrit Series.
2. Charaka Samhita, translated by P.V. Sharma, Chaukhambha Orientalia.
3. Indian Philosophy by S. Radhakrishnan, Oxford University Press.
4. Ethnomedicine and Pharmacognosy by V.K. Singh and J.N. Govil, Studium Press.
5. Biotechnology and Traditional Knowledge by S.K. Jain, Oxford & IBH Publishing.
6. Environmental Biotechnology by Bimal C. Bhattacharyya, Oxford University Press.
7. Bioethics and Biosafety by M.K. Sateesh, I.K. International Publishing House.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester III)

26BT301
Plant Biotechnology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main objective of this course is to familiarize students with techniques of plant tissue culture, genetic manipulations of plants, and quality enhancement of plant products through biotechnological tools.

Course learning outcomes:

CLO1: Students' skills will develop in various aspects of plant tissue culture and transgenic plant generation.

CLO2: Plant biotechnologists have a huge demand in the plant- and seed-based industries that are continuously emerging for providing superior quality seeds and Genetically-modified (GM) plants.

CLO3: This course enables students to learn the basics of plant biotechnology and they can find career opportunities in government as well as private agricultural research institutions.

Unit I

Introduction to plant biotechnology: Concepts and scope of plant biotechnology in sustainable agriculture and food security; related tools of plant biotechnology; status of transgenic plant research in India[DSL]; terminator seed technology.

Plant tissue culture: Laboratory organization; media preparation and sterilization techniques[CLL]; concept of cellular differentiation and totipotency: regeneration and somatic embryogenesis; somaclonal and gametoclonal variations.

Unit II

Micropropagation: Methods, applications and limitations; haploid plant production through plant tissue culture[CLL].

Virus-free plants: Production of virus-free plants (VFP); applications of VFP[DSL].

Unit III

Biochemical productions and generation of hybrids: Biochemicals production from cultured plant cells; germplasm conservation: cryopreservation, slow growth cultures[DSL]; distant hybridization: embryo rescue and *in vitro* pollination; somatic hybridization: protoplast isolation, fusion, and regeneration of hybrids[CLL].

Unit IV

Gene transfer methods in plants: Plasmid-mediated, electroporation, cation precipitation, liposomes, microinjection and particle gum technology; molecular genetics of T-DNA transfer from *Agrobacterium* to plants[CLL].

Production of transgenic plants: Transgenic plants with herbicide resistance, resistance against biotic (insect, fungal and viral) and abiotic (salinity, drought, chill) factors. Nutritional quality improvement in plants for Starch, oil, and protein content; Golden rice and other developments[DSL].

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Plant biotechnology by BD Singh, Kalyanil Publishers.
2. Plant tissue culture: theory and practices by SS Bhojwani and MK Razdan, Elsevier Publishing.
3. Plant Biotechnology: The genetic manipulation of plants, Oxford press.
4. Plant Roots: the Hidden Half by Dekker. M, CRC press, New York.
5. Plant Physiology and Development by Taiz et al., Sinauer Associates, New York

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester III)

26BT302
Animal Cell Technology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course will emphasize the major areas of learning that will include the cell microenvironment, large-scale propagation, cryopreservation, stable transfection, bioengineering, and genetic manipulation of animal cells.

Course learning outcomes:

CLO1: This course will strengthen the knowledge and expertise of the students towards biotechnological applications of animal cell and tissue culture methodology.

CLO2: This course will enable the students to seek careers in the field of cell culture, tissue engineering, cell therapy, cell banking, instrument and lab designing, bioreactor industry, animal biotechnology, and GMO laboratories industries.

Unit I

Basics of cell culture and animal biotechnology: Introduction; types of cultures; advantages and disadvantages of cell culture; therapeutic implications of cell culture[DSL].

Cell culture laboratory and requirements: Equipment for cell culture laboratory[CLL]; cell culture vessels; aseptic techniques[CLL]; sterilization[CLL]; physicochemical properties of media[CLL]; constituents of culture medium and their importance[CLL]; serum-free medium[DSL]. Designing the cell culture laboratory[DSL],

Unit II

Cell culture and cloning: Primary cell cultures[CLL]; methods of cell disaggregation; subculture.

Cell characterization and transformation: Characterizing cells in the culture; cell immortalization and tumorigenicity[DSL].

Unit III

Viability and cytotoxicity: Markers and assays for cell viability and apoptosis; viable cell separation and quantitation[CLL].

Specialized cultures and contamination: Histotypic and organotypic cultures; monitoring and eradication of contamination.

Unit IV

Cryopreservation: Principles of cell cryopreservation; thawing and recovery of frozen cells.

Biotechnological advances in cell technology: Somatic cell fusion; producing genetically-engineered animals and their applications; basic concepts of tissue engineering; applications of tissue engineering[DSL].

DSL= Digital Self Learning
CLL=Classroom and Lab learning

Suggested readings:

1. Culture of animal cells by Freshney, R.I., Willey-Blackwell Press.
2. Animal cell technology by Ashok Mukhopadhyay. I. K. International Publishing House.
3. Gene transfer to animal cells by R. M. Twyman. Taylor & Francis group.
4. Animal cell culture & technology by Butler, M. Taylor & Francis.
5. Animal cell culture by John M. Davis. Willey-Blackwell Press.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester III)

26BT303
Environmental Biotechnology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course aims to equip the students with the scientific principles of treatment technologies to clean up contaminated environments and generate valuable resources for society.

Course learning outcomes:

CLO1: The students will become familiar with different types of biotechnological methods to improve the environment.

CLO2: Students can find positions in teaching, research and private industries, especially involved in developing bio-fertilizers, biopesticides, and biofuels and providing services such as environmental consultancy and protection agencies.

Unit I

Environmental pollution: Types and sources of environmental pollution; methods of monitoring and controlling the pollution[CLL]; toxic chemicals & their effects on the environment; pesticides in water;

Biochemical aspects of contaminants: biochemical aspects of arsenic, lead, carbon monoxide, ozone, peroxy-acylnitrate (PAN), and pesticides; concept of acid rain; greenhouse effect[DSL]; ozone depletion and heat island effect[DSL].

Unit II

Solid wastes management: Composition and properties of municipal solid wastes; storage and processing at source. Energy recovery from organic waste[DSL].

Specialized waste management: Hospital and hazardous waste management[DSL]; Disaster management; fly ash generation & utilization

Unit III

Effluent treatment: Effluent from organic and inorganic chemical industries; primary, secondary, and tertiary treatments of various effluents; pesticide manufacturing industries, pharmaceuticals, thermal power plants, food and dairy industries, iron and steel industries; effluent treatment for petrochemicals[DSL].

Unit IV

Technological advancement in pollution control: Advanced methods for the treatment of industrial effluents. integrated waste management; biofuels, biopesticides, biofertilizers, and phytoremediation.

DSL= Digital Self Learning
CLL=Classroom and Lab learning

Suggested readings:

1. Environmental Biotechnology: Principles and Applications by Bruce Rittman, Perry L. McCarty, McGraw-Hill.
2. Environmental Biotechnology: Concepts and Applications by Hans-Joachim Jordening, Josef Winter, John Wiley and Sons.
3. Environmental Biotechnology: Basic concepts and Applications by Indu Shekhar Thakur, IK Internationals Pvt. Ltd.
4. Environmental Microbiology by SK Agarwal, APH Publishing corporation, New Delhi
5. Introduction to Environmental biotechnology by AK Chatterji, PHI Learning private limited, New Delhi.

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M.Sc. Biotechnology (Semester III)

26BT304
Biotech Lab-3

Maximum Marks: 100
Duration of Exam. 08 hrs.

Objective and course learning outcome: Understand the Importance of Plant Biotechnology, Animal Cell Technology, and Environmental Biotech experiment in the curriculum. It will provide the Knowledge and Skill for the use of Basic and advanced technique in these areas.

Practical:

1. Preparation of plant tissue culture media
2. Surface sterilization of explants
3. Organ culture. Induction of callus, callus propagation, organogenesis
4. DNA isolation from plant tissues
5. PCR
6. Preparation of cell culture medium and sterilization
7. Heat inactivation of serum
8. Primary cell culture
9. Cell counting and cell viability
10. Subculture
11. Infinite cell culture
12. Cryopreservation of cells and thawing
13. Measurement of cell cytotoxicity
14. Analysis of miRNA sequences using bioinformatics tools (e.g., miRBase).
15. Simulation of miRNA target prediction using software (e.g., TargetScan).
16. In silico design and synthesis of guide RNA (gRNA) for CRISPR-Cas9 targeting a specific gene.
17. Simulate gene editing experiments using bioinformatics tools (e.g., Benchling).
18. Detection of coliforms to determine of the purify of potable water
19. Sampling techniques: wastewater analysis for physico-chemical characteristics such as pH, conductivity, TDS, DO, BOD, COD, alkalinity, nutrients, hardness, satiability of solids.
20. Estimation of nitrate in drinking water
21. Estimation of Cot and Ni^2 by colorimetry/spectrophotometry.
22. Estimation of sulphates by turbidometry.

Note: This is the list of suggested practical. The final list of practical will be declared in the running semester.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester III)

26BT305
Enzyme Technology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course on enzyme technology covers the classification, naming, isolation and purification of enzymes. It also includes the structure and general properties of enzymes, mechanisms of enzyme catalysis, Enzyme kinetics, different types of enzyme inhibition, regulation of enzymes and applications of enzymes.

Course learning outcomes:

CLO1. Explain principles underlying classification & nomenclature of enzymes and employ suitable methods for isolation and purification of enzymes from different sources.
CLO2. Compare the structure, general properties of enzymes to their mechanism of action
CLO3. Analyse the enzyme kinetics to study enzyme characteristics and analyze kinetic parameters to differentiate different types of enzyme inhibition.
CLO4. Explain and evaluate the role of regulatory enzymes in the regulation of metabolic pathways.
CLO5. Discuss the applications of enzymes in medicine, industry and genetic engineering and also to design synthetic enzymes.

Unit I

General properties of enzymes: Enzyme nomenclature and classification and their subclasses. Extraction and purification of soluble and membrane bound enzymes; Criteria and assay of enzyme purity. Mechanism of enzyme catalysis: Acid-base catalysis, covalent catalysis and metal ion catalysis; Enzyme activators, inhibitors and drug designing. Genetic improvement of enzymes.

Unit II

Kinetics of enzyme-catalysed reactions: Michaelis-Menten, and Eadie-Hofstee equations and their applications; Fast kinetics to elucidate the intermediates and rate-limiting steps; Determination of Km and Vmax in the presence and absence of inhibitor; Bisubstrate reactions- brief introduction to sequential and Ping-Pong mechanisms with examples.

Unit III

Enzymes and metabolic regulations: Metabolic pathways regulated by allosteric enzymes; Regulation of enzymes by covalent modification and zymogen activation. Investigations of active site structure: methods of active site mapping.

Unit IV

Enzyme applications: In diagnostics, therapeutics, environmental pollution, genetic engineering, gene editing, and industry such as textile, leather, detergent, beverage, and fruit processing. Synthetic Enzyme: DNAzymes, synzymes, enzyme reactors, Biosensors. Enzyme Immobilization. Generation of heat-stable and pH-stable enzymes, application in vaccine development and drug development.

Suggested readings:

1. Rosevear, A. et al. Immobilized enzymes and cells: Adam Higher imprint IOP Publishing.
2. Donald, F. C. Clinical Chemistry: A fundamental textbook. Saunders Company.
3. Uhlig, H. Industrial enzymes and their applications. John Wiley & Sons.
4. Palmer, T., & Bonner, P. L. Enzymes: biochemistry, biotechnology, clinical chemistry. Elsevier.
5. Chaplin, M.F.,Burke,C.Enzyme technology. Cambridge University Press.
6. Grundwald, D. Peter. Biocatalysis: Biochemical Fundamentals and Applications.Imperial College Press
7. Grunwald, P. Biocatalysis: biochemical fundamentals and applications. Imperial College Press.
8. Fundamentals of Enzymology: Nicholas Price & Lewis Stevens
9. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer
10. Enzyme Kinetics: Behavior and analysis of rapid equilibrium and steady state enzyme systems. Irwin H SEGEL.
11. Biochemistry. 5th edition, Berg JM, Tymoczko JL, Stryer L. Publisher: W H Freeman
12. Enzymes 2nd Edition Biochemistry, Biotechnology, Clinical Chemistry by T Palmer, P L Bonner

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester III)

26BT306
Cancer Biology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course will provide insight into the basic concepts as well as recent advances in the area of cancer biology at the molecular and cellular levels. The student will get knowledge of Cancer Immune System Interaction, environmental impact, and diagnosis.

Course learning outcomes:
CLO1: This course will impart vast knowledge of cancer and its molecular basis, Growth, Regulation and Metastasis.
CLO2: Provide preventive aspects of the disease and its epidemiology.

Unit I

Introduction to Cancer Biology: Nature, origin and types of Cancer Factors affecting cancer Association of Cancer with mutagen. Genetic & Molecular Basis of Cancer, Cellular Oncogenes, Receptors, Growth factors, Cytoplasmic Signaling. DNA defenses against mutation.

Unit II

Cancer Cell and Metabolism: Multi-Step Tumorigenesis. Inflammation, Genomic instability, Glycolysis, Glutaminolysis, Fatty Acid Synthesis, PPP, and MRP. Apoptosis, Necrosis, Necroptosis, Autophagy. Multi-Drug Resistance in Cancer.

Unit III

Tumor and immunity: Hypoxia, and Angiogenesis. EMT transition, Tumor Stroma Crosstalk. Immuno surveillance Theory, Immuno-editing, Types of Tumor. Antigens: TSTAs & TATAs, Cancer Immunotherapy

Unit IV

Cancer Treatment: Evolution of Drugs, Personalized Therapy, Potential Targets, Clinical Trials. Concept of cancer, Lifestyle, Environmental Toxicants, and Diet. Preventive measures.

Suggested readings:

1. The Biology of Cancer by Weinberg, R.A. Garland Science.
2. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics by Pecorino, L. Oxford University Press.
3. Cancer Biology by Ruddon, R.W. Oxford University Press.
4. Introduction to Cancer Biology by Robin Hesketh. Cambridge University Press.
5. Principles of Cancer Biology by Kleinsmith, L.J. Pearson Education.
6. The Biology of Cancer. Robert A. Weinberg, Garland Science.
7. Molecular Biology of the Cell. Bruce Alberts, Garland Science.
8. Recent review articles/Papers will be discussed/provided time to time.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester III)

26BT307
microRNA Technology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course will help to understand the biogenesis, function, and regulation of microRNAs (miRNAs). It will also help to develop skills in miRNA detection and analysis techniques and explore the role of miRNAs in gene regulation and disease, and therapeutic applications.

Course learning outcomes:
CLO1: Explain the biogenesis and regulatory roles of miRNAs in biological systems.
CLO2: Students will apply molecular techniques to detect and quantify miRNAs.
CLO3: Evaluate the role of miRNAs in disease, diagnostic potential, and miRNA-based therapeutics and associated challenges.

Unit I

Introduction to Micro (mi) RNAs: Definition and discovery of microRNAs (miRNAs). Biogenesis of miRNAs: Transcription, processing, and maturation. Structure and function of miRNAs in gene regulation. Comparison with other non-coding RNAs (e.g., siRNAs, lncRNAs).

Unit II

Role of miRNAs in Biological Processes: miRNAs in development: Embryonic and tissue-specific expression. miRNAs in cellular processes: Cell cycle, apoptosis, and differentiation. miRNAs in stress responses and environmental adaptation. Case studies: miRNAs in plant and animal systems.

Unit III

miRNAs in Disease and Diagnostics: miRNAs in cancer: Oncogenic and tumor-suppressor miRNAs. miRNAs in cardiovascular, neurological, and infectious diseases. miRNA profiling: Techniques for detection (qPCR, microarrays, NGS). Biomarker potential: Circulating miRNAs in diagnostics.

Unit IV

Therapeutic Applications and Challenges: miRNA-based therapeutics: Mimics and inhibitors (antagomirs). Delivery systems for miRNA therapeutics: Liposomes, nanoparticles. Challenges: Specificity, stability, and off-target effects. Emerging trends: miRNA editing and synthetic biology approaches.

Suggested readings:

1. MicroRNAs: Genomics, Biogenesis, Mechanism, and Function. Bartel, D. P. Cell Press.
2. Non-Coding RNAs: Molecular Biology and Applications. Ambros, V., & Ruvkun, G. Springer.
3. RNA Biology: An Introduction. Kim, V. N., et al. Wiley.
4. Nature Reviews Genetics and RNA journal on miRNA research articles.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester III)

26BT308
Research Orientation

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives and course learning outcomes:
This course will develop scientific aptitude in the students. Here the student will learn the ways to identify problems and, based on existing evidence they will be able to develop a hypothesis, designing a critical scientific methodology to find the solution and explanation to the problem.

Unit I

Identification and defining the research problem: Identification of research area, critical analyses of research problems; use of tools for searching literature through electronic databases; research design, sampling, and patent search. Meaning, objectives, types, and significance of research. necessity and techniques of defining a research problem.

Unit II

Experimental approaches and methodology: Formulation and objective of research problem. Features and types of good research design; basic principles of experimental designs, different types of sample designs; characteristics of good sample design; techniques of selecting a random sample.

Unit III

Ethics in biological research: Guidelines for biosafety and bioethics; handling of genetically modified organisms; copyright, royalty, intellectual property rights; plagiarism, citation and acknowledgements; disposal of bio-waste, radioactive material, and hazardous chemicals.

Unit IV

Presentation and publication skills: Skills for scientific writing and research presentation: term paper, research project, research report, thesis, research article, and review; Use of electronic tools for bibliographic formatting,and checking plagiarism; oral presentation skills.

Suggested readings:

1. Research Methodology: Methods and Techniques by Kothari, C.R., & Garg, G. New Age International Publishers.
2. Introduction to Research Methods by Burns, R.B., Sage Publications.
3. Research Methods in the Biosciences by Saunders, N. Oxford University Press.
4. Scientific Research Methodology by Kumar, R., Sage Publications.
5. Biostatistics and Research Methodology by Gupta, S.P. Sultan Chand & Sons.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester IV)

26BT309
Biotech Management and Entrepreneurship

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks*

Objectives: The main objective of this course is to motivate the students to develop the Biotech industry by applying their bench/lab knowledge to the field and generate job opportunities.

Course learning outcomes:
CLO1: Students will develop the quality talent and skills that help them to lead their lives as successful professionals.
CLO2: After completing the degree, students may start their businesses and become entrepreneurs in India or abroad.

Unit I

Taking a decision on starting a venture: statutory and legal requirements for starting a company/venture; budget planning and cash flow management; support mechanism for entrepreneurship in India[DSL].

Unit II

Assessment of market demand: changes and gaps for potential product(s) of interest; branding issues; pricing/policies/competition; overview of financing options (grants, loans, investors); use of IT in improving and upgrading business performance [CLL].

Unit III

Structure of a biotechnology company: scientific principles; start-up of the biotechnology company; legal and moral issues in biotechnology[DSL]; available software for better financial management; e-business setup[DSL]

Unit IV

Leadership skills: Managerial skills; organization structure, pros & cons of different structures; team building, teamwork [DSL]; appraisal; rewards in small-scale set up; managing technology transfer; regulations for transfer of foreign technologies; technology transfer agencies. Case study of successful bioenterpreneures[DSL]

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Principles of Management by PC Tripathi and PN Reddy, Tata McGraw-Hill
2. Management by Stephen Robbins, Pearson Education/PHI.
3. Management Fundamentals – Concepts, Application, Skill Development by Robert Lusier Thomson.
4. Dynamics of Entrepreneurial Development & Management by Vasant Desai – Himalaya Publishing House
5. Entrepreneurship Development by PM Charantimath, Small Business Enterprises: Pearson Education.
6. Entrepreneurship Development by SS Khanka, S Chand & Co.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester IV)

26BT310
Bioethics and Biosafety

Maximum Marks: 50
Theory Examination: 35
Internal Assessment: 15
Time: 2 hrs.

Note: *There shall be five questions in all. Question no. 1 shall be compulsory, consisting of fifteen (fifteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 10 marks) will be asked from each unit. Students will have to attempt one question from each unit.*

Objectives: To familiarize students with the ethical considerations surrounding biotechnological advancements such as genetically-modified organisms (GMOs), gene therapy, and human cloning. To provide students with an understanding of biosafety principles, including the containment of biohazards, regulatory frameworks for GMOs, and international biosafety guidelines.

Course learning outcomes:

CLO1. Students will develop a critical awareness of bioethical issues in modern biotechnology, enabling them to analyze and evaluate ethical dilemmas.

CLO2. Students will acquire the knowledge and skills necessary to implement biosafety measures effectively, ensuring the safe handling and containment of biological materials in research and industrial settings

Unit I

Introduction to bioethics and biosafety: Bioethical issues related to genetically-modified organisms and gene therapy/gene editing, international bioethics advisory committees and their tasks (IBC, IBA, IBS, etc.). Human cloning and ethical issues, ethics for using animals in research. Social and ethical implications of biological weapons.

Unit II

Biosafety regulations: Biosafety levels for microorganisms and biological safety cabinets, primary containment for biohazards. Biosafety guidelines of the Government of India. GMOs & LMOs, Indian regulations of GMOs: EPA Act and rules, roles of RCGM, GEAC, IBSC, etc.

Suggested readings:

1. Laws relating to Intellectual Property Rights by VK Ahuja, Lexis Nexis Publishers.
2. IPR, Biosafety and Bioethics by Deepa Goel and Somini Prashar, Pearson.
3. An Introduction to Ethical, Safety, and Intellectual Property Rights Issues in Biotechnology by Padma Nabisan, Elsevier Publishing.
4. Biotechnology and Intellectual Property Rights by Kshitij Kumar Singh, Springer.
5. A Guide to Biotechnology Law and Business by Robert A. Bohrer, Carolina Academic Press.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester IV)

26BT401
Bioprocess Technology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main objective of the course is to create a general understanding amongst the students about the basic principles of microbes-based commercial fermentations.

Couse learning outcomes:

CLO1: This course will provide knowledge to solve critical problems related to the process of fermentation.

CLO2: After this course, students can work in positions in teaching, research, and fermentation industries, especially involved in the preparation of microbial products such as pharmaceutical industries, food industries, chemical industries, etc.

Unit I

Introduction to fermentation technology: basic concepts of upstream and downstream processes; isolation, screening and maintenance of productive strains[DSL]; strain improvement; inoculum development; industrial media formulation and criteria for the selection of raw materials; sterilization of media and fermenter; process development; scale up of the process from lab to industry; extraction of fermented products[CLL].

Unit II

Fermenter design and control: Basic design of fermentor role and designing of individual parts: baffles, spargers, impellers, culture vessel, cooling and heating devices; designing reactors for specialized applications: airlift reactors and packed bed reactors; concept and utility of fluidized bed reactors and tube reactors[DSL]; computer control of fermentation process concerning pH, temperature, redox potential and oxygen; foam production and control.

Unit III

Applications of fermentation technology 1: Production of antibiotics (with special emphasis on penicillin), organic acids (citric acid), vitamins (Vit B12), amino acids (glutamic acid), anti-cancer agents, antioxidant drugs (Coenzyme Q10), industrial alcohol[DSL], exopolysaccharides (xanthan gum) [DSL]

Unit IV

Applications of fermentation technology 1: Food fermentations, production of cheese, beverages (beer and wine). Biotransformation of steroids; mineral recovery using microbes; production of single cell protein; [DSL]; methods for immobilization of enzymes and their applications in industry; enzyme engineering and its importance.

DSL= Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.
2. Fermentation Biotechnology: Industrial Perspectives by Chand.
3. Biochemical Engineering Fundamentals by Bailey and Ollis, Tata McGraw-Hill, N.Y.
4. Advances in Biochemical Engineering by TK Bhosh, A Fiechter and N Blakebrough. Springer Verlag Publications, New York.
5. Biotechnology- A textbook of Industrial Microbiology by Creuger and Creuger, Sinauer Associates.
6. Bioprocess Engineering Principles by Doran, Acad. Press, London.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester IV)

26BT 402
Biotechniques

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course aims to provide a broad understanding of principles, applications, and instrumentation related to biophysical and biochemical techniques to the students.

Course learning outcomes:
CLO1: Students will become capable of using techniques in various fields of research.
CLO2: The course enables students to make their careers as instrument experts in medical, chemical, and pharmaceutical sciences.

Unit I

Microscopy: Principles and applications of confocal, scanning, and transmission electron microscopy.

Cell separation and flow cytometry: Density gradient centrifugation; ultracentrifugation; $FACS_{CAN}$; cell sorter[DSL].

Unit II

Chromatography: Principles and applications of gas chromatography, high-pressure liquid chromatography (HPLC), and reversed-phase chromatography[CLL].

Electrophoresis: Principles and applications of 2D-PAGE[CLL]; Method of Coomassie and silver staining of gel; differential in gel electrophoresis (DIGE); electrophoretic mobility shift assay (EMSA)[CLL].

Unit III

Spectroscopy: Principles and applications of infrared, X-ray diffraction spectroscopy; NMR; mass spectrometry (LC-MS).

Unit IV

Blotting techniques: Southern[CLL], Northern[DSL] and Western blotting.

Applications of biotechniques: Quality measurement and quantitation of DNA and RNA[CLL]; microarrays (DNA and protein); comparative genome hybridization (CGH).

DSL=Digital Self Learning
CLL=Classroom and Lab Learning

Suggested readings:

1. Molecular Cloning: a Laboratory Manual by J sambrook, EF Fritsch and T Maniatis, Cold Spring Harbor Laboratory Press, New York.
2. Principal and Practice of Bioanalysis by Richard E Venn, Taylor and Francis.
3. Principles and Techniques-Practical Biochemistry by Walker J and Wilson K, Cambridge University Press, London.
4. Radioisotopes in Biology-A Practical Approach by Slater RJ, Oxford University Press, New York
5. Introductory Practical Biochemistry by Sawhney SK and Singh R, Alpha Science International.
6. Biophysical Chemistry : Principles & Techniques by Upadhayaye A, Upadhyaye K and Nath N, Himalaya Publication House, New Delhi.
7. Physical Biochemistry; Principles and applications by David Sheehan, Wiley Press.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester IV)

26BT403
Biotech Lab-4

Maximum Marks: 100
Duration of Exam. 08 hrs.

Objective and course learning outcome: Understand the Importance of Bioprocess Technology and Biotechnioques experiments in the curriculum. It will provide the Knowledge and Skill for the use of Basic and advanced technique in these areas.

Practical:

1. Isolation of industrially important microorganisms
2. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.
3. Determination of growth curve of a supplied microorganism and also determines substrate degradation profile.
4. Extraction of Citric acid/Lactic acid by salt precipitation.
5. Monitoring of dissolved oxygen during aerobic fermentation.
6. Preservation of industrially important bacteria by lyophilization.
7. Cell disruptions for endoenzymes by sonication.
8. Observe and compare cell structures using confocal microscopy and prepare slides for visualization.
9. Perform density gradient centrifugation to separate cell types from a mixed sample.
10. Analyze cell populations using flow cytometry (FACSCAN) and interpret fluorescence data.
11. Conduct high-pressure liquid chromatography (HPLC) to separate biomolecules and analyze elution profiles.
12. Perform 2D-PAGE electrophoresis and visualize protein separation using Coomassie and silver staining.
13. Execute electrophoretic mobility shift assay (EMSA) to study protein-DNA interactions.
14. Use infrared spectroscopy to analyze biomolecule functional groups and interpret spectra.
15. Perform Southern blotting to detect specific DNA sequences in a sample.
16. Conduct Western blotting to identify target proteins using antibodies.

Note: This is the list of suggested practical. The final list of practical will be declared in the running semester.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester IV)

26BT404
Stem Cell and Regenerative Biology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The objective of this paper is to familiarize the students with stem cell technology and its applications for the betterment of society. The course is designed to give a broad view of mammalian stem cells, reviewing where they are found in the body, the different types, and how they are cultured. The topics will cover the basic biology of these stem cells as well as bioengineering and the application of these stem cells to potential treatments of human diseases.

Course learning outcomes:

CLO1: Explain the definition, properties, proliferation, and culture techniques of stem cells, along with their medical applications and associated ethical/legal issues.

CLO2: Differentiate between embryonic and adult stem cells, describing their biology, culture methods, and potential benefits in therapeutic applications.

CLO3: Analyze the principles and methods of gene therapy, including viral and non-viral gene delivery vectors, and evaluate its successes, failures, and prospects.

CLO4: Evaluate the regulatory and ethical considerations in stem cell-based regenerative medicine and the safety of genetically modified stem cells in experimental gene therapies.

Unit I

Introduction to stem cells: Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in the use of stem cells. Principles of cell replacement therapy and application of pluripotent stem cells in cell replacement therapy.

Unit II

Types of stem cells: Stem Cell biology and therapy, types of embryonic stem cells, Adult stem cells, Stem Cell Biology and Therapy, Embryonic Stem Cells culture, and the potential benefits of stem cell technology

Unit III

Therapeutic applications of stem cells Gene Therapy: Introduction, History and evolution of Gene therapy, optimal disease targets, Failures and successes with gene therapy and prospects, Genetic Perspectives for Gene Therapy, Gene Delivery methods: Viral vectors and Non-viral Vectors. Application of pluripotent stem cells in neuronal disease management and cardiovascular diseases.

Unit IV

Ethical Issues: Issues associated with the stem cell-based regenerative medicine field, Regulatory and Ethical Considerations of stem cell and Gene Therapy, Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies. Case studies based on publications.

Suggested readings:

1. Stem Cell Biology by Marshak, D.R., Gardner, R.L., & Gottlieb, D. Cold Spring Harbor Laboratory Press.
2. Essentials of Stem Cell Biology by Lanza, R., & Atala, A., Academic Press.
3. Gene and Cell Therapy: Therapeutic Mechanisms and Strategies by Templeton, N.S. CRC Press.
4. Stem Cells: Scientific Facts and Fiction by Mummery, C., van de Stolpe, A., Roelen, B., & Clevers, H., Academic Press.
5. Molecular Biology of the Cell by Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P., Garland Science.

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Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester IV)

26BT405
Molecular Modeling

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: Molecular docking is one of the most frequently used methods in structure-based drug design, due to its ability to predict the binding conformation of small-molecule ligands to the appropriate target binding site. The drug designing software and programs are used to examine molecular modeling of genes, gene expression, gene sequence analysis, and the 3D structure of proteins.

Course learning outcome:

CLO1: Students will learn the use of drug designing software and programs to examine molecular modeling of genes, gene expression, gene sequence analysis, and 3D structure of proteins.

CLO2: This course will enable the students to seek careers in the field of teaching, research, and as Bioinformaticists in the health sector, Bioanalytics, Clinical Pharmacologists, Computational Biophysicists, and Pharmaceutical Scientists in different drug designing industries and Pharma companies.

Unit I

Protein and secondary structure prediction: Basic concept and types of secondary structure of protein and its conformational parameters; protein structure databases PDB and MMDB[CLL]; software for secondary structure prediction of proteins and visualization tools[CLL]; limitations of structure prediction[DSL].

Unit II

Molecular modeling: Methods of molecular modeling: homology modeling, model refinement, evaluation of the model[CLL]; applications of modeling[DSL]; overview of programs for comparative protein structure modeling[CLL], threading and its types, *Ab initio* method[CLL], its advantages, disadvantages and applications.

Unit III

Drug discovery: Technologies and strategies for drug discovery[CLL]; areas influencing the drug discovery[DSL]; concept of pharmacogenetics and pharmacogenomics; polymorphism of CP450 enzymes affecting drug response[CLL]; role of SNP in pharmacogenomics[CLL]; personalized medicine[CLL]; importance of personalized medicine[DSL].

Unit IV

Drug designing: Characteristics of a drug molecule; target identification and characterization; structure and ligand-based drug designing[CLL]; concept of pharmacophore, QSAR, and docking[CLL]; ADMET[DSL].

DSL=Digital Self Learning
CLL=Classroom and Lal Learning

Suggested readings:

1. Bioinformatics: Principles and Applications by Zhumur Ghosh and Bibekanand Mallick, Oxford University Press, publisher.
2. Drugs: From Discovery to Approval by Rick NG, Wiley Blackwell.
3. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery by P Rastogi and N Mendiratta, Prentice-Hall of India Pvt. Ltd.
4. Computational Drug Design: A guide for Computational and medicinal Chemists by David C. Young, Wiley.
5. Pharmacogenomics and Personalized Medicine by Nadine Cohne, Humana Press.

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M.Sc. Biotechnology (Semester IV)

26BT406
Study Oriented Project

Maximum Marks: 100
Internal Assessment: 100

Objective and course learning outcomes: Students adopt the study-oriented project based on the topic assigned by the teacher supervisor. At the end of the semester, the student will submit a "Report" based on his/her study (**Annex I**). Internal evaluation will be on the basis of pre-assigned seminar and continuous progress report to their respective supervisor. Final evaluation will be carried out by the team of internal examiners on the basis of presentation, viva-voce, and research report.

Topics for the research report: The teacher may assign research topics to the students in the following areas (may extend beyond, but not limited to):

i. Laboratory
ii. Computer and software
iii. Survey
iv. Research study
v. Combination of any of the above-mentioned areas

Criteria for Evaluation:

a. Attendance (Minimum attendance required 75%)

Total Attendance (%)	Marks Awarded (Max marks 10)
>75-80	4
>80-85	6
>85-90	8
>90	10

b. Internal Evaluation- 30 Marks
   i) Pre-study seminar - 10 Marks
   ii) Progress of the study - 10 Marks

c. External evaluation- 70 Marks
   i) Final seminar - 20 Marks
   ii) Viva-voce - 10 Marks
   iii) Research report - 40 Marks

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M.Sc. Biotechnology (Semester IV)

26BT407
Systems Biology

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: This course introduces systems biology principles and mathematical modeling to develop skills in analyzing biological networks using computational tools. It is also to provide hands-on training in MATLAB and Cytoscape.

Course learning outcomes:
CLO1: Explain systems biology principles and simulate models using MATLAB.
CLO2: Apply phase plane, stability, bifurcation, and sensitivity analyses in MATLAB.
CLO3: Analyze metabolic and signaling networks using graph theory and Cytoscape.
CLO4: Describe gene regulation, oscillators, and stochastic modeling.
CLO5: Visualize networks, simulate models, and present journal articles.

Unit 1

Introduction to systems biology: mathematical modeling fundamentals, mass-action kinetics, timescale separation, enzyme-catalyzed reactions, regulation of enzyme activity, cooperativity, alternative reaction mechanisms, plotting data in MATLAB, simulating systems biology models in MATLAB.

Unit 2

Analyses: Phase plane analysis, direction fields, nullclines, linear stability analysis, bifurcation analysis, sensitivity analysis, parameter estimation, and performing dynamic model analysis in MATLAB.

Unit 3

Metabolic networks: Graph theory, stoichiometric analysis, signaling systems, modeling metabolism, signaling motifs, signal amplification, ultrasensitivity, MAPK pathway modeling, visualizing and analyzing graphs using Cytoscape, evaluating and presenting journal articles.

Unit 4

Regulations: Simple gene regulation, autoregulation, feed-forward loops, regulatory motifs, oscillators, cell cycle control, stochastic modeling in biological systems, student-led discussions, and journal article presentations.

Suggested readings:

1. An Introduction to Systems Biology: Design Principles of Biological Circuits by Alon, U. Chapman and Hall/CRC.
2. Systems Biology: A Textbook by Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., & Herwig, R. Wiley-Blackwell.
3. Mathematical Modeling in Systems Biology: An Introduction by Ingalls, B.P. MIT Press.
4. Systems Biology: Simulation of Dynamic Network States by Palsson, B.O., Cambridge University Press.
5. Computational Systems Biology by Kriete, A., & Eils, R. Academic Press.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

M.Sc. Biotechnology (Semester IV)

26BT408
Tissue Engineering

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main objective of this course is to describe the basic principles involved in Tissue Engineering products. Finally, applying the tissue engineering principles to clinical problems, requiring tissue regeneration, and the use of tissue-engineered products

Course learning outcomes:
CLO1: Describe the basic principles involved in Tissue Engineering products.
CLO2: Details of Tissue Engineering products and their approach to regenerating a tissue or organ with selectivity.
CLO3: Understand the factors related to biomaterials, template architecture, polymer processing, cell/developmental biology, and the role of bioreactors in tissue-engineered products.

Unit I

Introduction to tissue engineering & regenerative medicine: Principles underlying tissue engineering strategies, key concepts of tissue engineering, its need, and current available technologies. Stem cell potency. Differentiation abilities of stem cells towards specific lineages. Concept of Cell-cell and cell-matrix interactions, extracellular matrices

Unit II

Biomaterials in tissue engineering & regenerative medicine: role of a biomaterial in tissue engineering, its properties; Natural and synthetic biomaterials, biodegradable polymers and 3D scaffold processing techniques; tissue repair and angiogenesis.

Unit III

Biocompatibility and immune rejection: biomaterial/graft compatibility, host acceptance and rejection. Drug, growth factor, and gene delivery: know-how and importance of sustained and controlled delivery, implications, and applications.

Unit IV

Transplantation of engineered cells and tissues: Tissue regeneration case studies on bone, blood vessel, cardiac muscles, skin, cornea, etc. Bioreactors in tissue engineering & regenerative medicine: know-how on bioreactors, tissue growth and maturation, implications and applications. Selected topics from recent research articles.

Suggested readings:
1. The Principles of Tissue Engineering by Robert Lanza, Robert Langer, and Joseph P. Vacanti.Academic Press
2. Essentials of Stem Cell Biology by Robert Lanza and Anthony Atala. Academic Press
3. Biomaterials Science: An Introduction to Materials and Medicine by Buddy D. Ratner, Allan S. Hoffman,Frederick J. Schoen, and Jack E. Lemons.Academic Press
4. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney.Wiley-Blackwell.
5. Biomaterials: Principles and Applications by B. Park and J.D. Bronzino. CRC Press.
6. An Introduction to Tissue-Biomaterial Interactions by K.C. Dee, D.A. Puleo, and R. Bizios. Wiley.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Chaudhary Bansi Lal University, Bhiwani
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M.Sc. Biotechnology (Semester IV)

26BT409
Gene Editing

Maximum Marks: 100
Theory Examination: 70
Internal Assessment: 30
Time: 3 hrs.

Note: *There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven (fourteen marks) short-answer type questions covering the entire syllabus. Two questions (each for 14 marks) will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.*

Objectives: The main objective of this course is to develop an understanding of the principles and techniques of gene editing. In addition, it will also help to explore the applications of gene editing in medicine, agriculture, and research, and to develop skills in gene editing technologies such as CRISPR-Cas9.

Course learning outcomes
CLO1: Students will demonstrate an understanding of gene editing principles and technologies.
CLO2: Learn to design and execute basic gene editing using CRISPR-Cas9.
CLO3: Evaluate the applications and limitations of gene editing in various fields.
CLO4: Critically analyze ethical and regulatory challenges in gene editing.

Unit I

Introduction to Gene Editing: Overview of gene editing: Definition, history, and significance. Molecular basis of gene editing: DNA repair mechanisms (NHEJ, HDR). Early gene editing technologies: Zinc Finger Nucleases (ZFNs), TALENs. Introduction to CRISPR-Cas systems: Components and mechanism.

Unit II

CRISPR-Cas9 Technology: Structure and function of the CRISPR-Cas9 system. Design of guide RNAs (gRNAs) for targeted gene editing. Delivery methods: Viral vectors, nanoparticles, and electroporation. Off-target effects and strategies to minimize them.

Unit III

Applications of Gene Editing: Gene editing in medicine: Gene therapy for genetic disorders (e.g., sickle cell anemia). Agricultural applications: Development of genetically modified crops. Industrial and environmental applications: Engineered microbes for bioremediation. Case studies: Successful gene editing projects (e.g., CAR-T therapy).

Unit IV

Ethical and Regulatory Issues: Ethical considerations in gene editing: Germline editing, designer babies. Regulatory frameworks: Global and national guidelines (e.g., FDA, WHO). Biosafety and risk assessment in gene editing experiments. Public perception and societal implications of gene editing.

Suggested Readings

1. *A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution*. Doudna, J. A., & Sternberg, S. H.. Houghton Mifflin Harcourt.
2. *Molecular Cell Biology*. Lodish, H., et al. W.H. Freeman.
3. *CRISPR-Cas Systems: Methods and Protocols*. Zhang, F., et al. Springer.
4. *Nature Biotechnology* and *Science* Journal articles on recent advancements in gene editing.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Internship
The Internship course will be governed by the Internship Guidelines of the University.

Dissertation/Project Work (As per point 19 of the PG Ordinance available online):
A student who opts for Dissertation/Project work of 12 credits in 4th / 2nd semester of 2-year / 1-year PG Programme will be required to do the research work based on systematic, scientific and rigorous investigations on the chosen and approved topic utilizing relevant research methods/techniques/innovations.

1. A student, who opts for Dissertation/Project work in 4th semester of 2 year PG Programme, shall submit a request for allotment of a supervisor mentioning her/his research areas of interest in order of preference to the Chairperson/Principal/Director during 3rd semester. The Department/College/Institute will allot a qualified supervisor to guide the student to do research for Dissertation/Project work. A regular full-time teacher of that Department/College/Institute, who has been approved to supervise Ph.D. scholars by the University, will be eligible to guide the students for Dissertation/Project work.

2. The student will submit the synopsis to the supervisor. In case of University Teaching Department (UTD), the synopsis will be approved by the Departmental Committee after recommendation of the supervisor.

3. In case of affiliated Colleges/Institutes, the Principal/Director shall constitute a committee of at least three members of the subject concerned for this purpose at the College/Institute level. The committee will consist of at least one subject expert from Chaudhary Bansi Lal University, Bhiwani to be nominated by the Chairperson/Director on the request of College/Institute. The request for external expert should reach to the Chairperson/Director before 30th November of the year concerned. The list of students, their approved topics, and names of supervisors along with their synopsis will have to be submitted by the College/Institute to the respective Chairperson/Director latest by 31st January of the concerned year.

4. The student shall be required to submit three hard copies of her/his dissertation or project report along with soft copy as PDF file to the Department/College/Institute by 31st May of the concerned year which will be forwarded to the Controller of Examinations for evaluation within a week.

5. The anti-plagiarism policy of the University will have to be strictly followed by the candidate and the supervisor for dissertation/project report. Similarity report certificate issued by the Librarian as per anti- plagiarism policy of the university is to be annexed with the dissertation/project report.

6. Evaluation of the dissertation/project report shall be done by an external examiner. The panel of examiners for evaluation of dissertations/project reports will be approved by the respective Board of Studies.

7. The schedule as specified above is to be strictly followed by the students and Department/College/Institute and any relaxation will not be allowed. However, in exceptional circumstances, late submission may be allowed with a late fee, as decided by the University authorities from time to time.

Annex I

Guidelines for the Preparation of Internship/Research Report

Objective:
The objective of these guidelines is to provide an idea to the students about the format of writing the internship/research report, dissertation, or any other related report that should be presented upon the completion of research work.

Features:

1. The dissertation is a formatted report of the student's research work. Hence, the utmost care is to be taken to make the work presentable to outsiders absolutely error-free.
2. The total number of pages should be reasonable with relevant content.
3. The dissertation shall be preferably printed on A4-size paper with a 1.5-inch margin on the binding edge and a 1.0-inch margin on all other sides.
4. The dissertation shall be typed in "Times New Roman" font with a size 12-point or 'Arial' font with a 10.5-point size with 1.5 spacing between the lines. The equation must be typed in single spacing in italics. Scientific names of the organisms should also be italicized (e.g. *Homo sapiens*).
5. The dissertation shall be printed on one side of the paper (A4). Photographs, tables, and other depictions should be in the appropriate colour and size.
6. Dissertation shall be written in English, in your own words, not just 'cut and paste'.
7. Mention (cite) references by name and year in parentheses in the text wherever applicable (e.g., Singh et al., 2020 for more than two authors, Singh and Kumar, 2020 for two authors, Singh, 2020 for the single author). Multiple references should be separated by ';' (e.g., Singh et al., 2020; Singh and Kumar, 2020).
   Some examples:
   Negotiation research spans many disciplines (Thompson, 1990).
   This result was later contradicted (Becker and Seligman, 1996).
   This effect has been widely studied (Abbott 1991; Barakat et al., 1995; Kelso and Smith, 1998; Medvec, 1993).
8. All the headings should have a font size of more than 12 points in bold.

The components of the report:

A. Cover page (also see the example Template-I at the end)
   i. The format of the cover pages shall be as per template I. The study/research title should be written clearly. Abbreviations should be avoided in the title, except the well-known abbreviations such as ATP, DNA, RNA, etc.
   ii. The spine of the dissertation should be provided with the University logo, the student's name, and the year of completion.

B. Declaration
This page should be similar to Template II.

C. Certificate
This page should be similar to the Template-III printed on the University Letterhead.

D. Acknowledgment

E. List of symbols and abbreviations

F. List of figure captions

G. List of tables

H. Abstract
   i. The abstract shall be preferably within one page of A4 size with the margin indicated earlier. The abstract shall be a concise summary of the research work.
   ii. A list of Keywords based on your study should be given.

I. Review of literature
It should have an extensive background of the research area with relevant references. The numbering of pages of the body of the text should start from the Review of Literature and be in Arabic numerals centered at the bottom of the page. Pages with Appendices, tables, maps, photographs, etc, are to be numbered as well.

J. Materials and Methods
All the materials you used and the methods you followed should be mentioned here with relevant references.

K. Results and discussion

1. Here, you mention your observations and their relevance in the form of a discussion. The results should be mentioned in the chapters if you have worked on more than one chapter. The chapter should have a number in Arabic numerals and shall be written as Chapter 1, Chapter 2, etc. This shall be followed by the title of the chapter.
2. Figures, tables, and graphs shall be positioned within the body of the text immediately after the citation and should not be positioned separately.

L. References

All the cited references should be listed here. Do not use footnotes or endnotes as a substitute for a reference list. Reference list entries should be alphabetized by the last names of the first author of each work.

Examples:

Journal article: Gamelin FX, Baquet G, Berthoin S, Thevenet D, Nourry C, Nottin S, Bosquet L. 2009. Effect of high-intensity intermittent training on heart rate variability in prepubescent children. Eur J Appl Physiol. 105:731-738. doi 10.1007/s00421-008-0955-8. Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations

Article by DOI: Slifka MK, Whitton JL. 2000. Clinical implications of dysregulated cytokine production. J Mol Med. doi:10.1007/s001090000086.

Books: South J, Blass B. 2001. The future of modern genomics. 4th Ed., Blackwell Press, London

Book chapter: Brown B, Aaron M. 2001. The politics of nature. In: Smith J (ed) The rise of modern genomics, 3rd Ed., Wiley Press, New York, pp 230-257.

Online document: Cartwright J (2007) Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1. Accessed on 26 June 2020.

Dissertation or thesis: Trent JW. 1975. Experimental acute renal failure. Dissertation/thesis, University of California.

M. Appendices

If any.

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

(Template-1: Cover Page)

TITLE.....

A
Research/Internship/Dissertation report
Submitted for the award of

M. Sc./PG Diploma in Biotechnology

By

Name of student (...Roll number...)

Under the Guidance of

Supervisor's Name

DEPARTMENT OF BIOTECHNOLOGY
CHAUDHARY BANSI LAL UNIVERSITY

Month, Year

(Template-2: Declaration by the student)

CHAUDHARY BANSI LAL UNIVERSITY
DEPARTMENT OF BIOTECHNOLOGY

DECLARATION

It is certified that

a. The work contained in this research dissertation/internship is original and has been carried out by me under the guidance of my supervisor.
b. The work has not been submitted to other University/Institute for any degree or diploma.
c. I have followed the University guidelines and ethics throughout the study.
d. Wherever I have used materials (data, theoretical analysis, figures, and text) from other sources, I have given due credit to them by citing them in the text of the dissertation and giving their details in the references. Further, I have taken permission from the copyright owners of the sources, wherever necessary.

Date:
Place:

Signature
(Name of the Student with Roll number)

चौधरी बंसी लाल विश्वविद्यालय, भिवानी
Chaudhary Bansi Lal University, Bhiwani
(A State University Established Under Haryana Act. 25 of 2014)

CERTIFICATE

This is to certify that the Dissertation/research/Internship report entitled ……., submitted by …….. to Chaudhary Bansi Lal University, Bhiwani, for the partial fulfillment of the award of……. **M.Sc./PG Diploma……** in Biotechnology, is a record of bona fide research work carried out by him/her under my supervision and has not been submitted to other University/Institute for any degree or diploma.

Signature

Name: ……
(Supervisor)

Signature

Name: ……
(Head of the Department)

Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

Annex II

M.Sc. Biotechnology
Topics based on Indian Knowledge System (IKS)

These topics — though not limited to the ones listed — are recommended for classroom teaching, oral or poster presentations, assignments, group discussions, debates, and declamations. Such activities aim to enhance students' scientific understanding of Indian Knowledge Systems (IKS) and their connections with modern biology. These practices will help cultivate interest in ancient Indian wisdom and uncover the scientific principles underlying these traditional concepts and practices.

Semester I

26BT101: Cell Biology

1. **Ayurvedic Sneha and membrane fluidity**: Integrate a session on Sneha (oily substances in Ayurveda, e.g., ghee) to explain lipid bilayer fluidity in cell membranes. Relates to lipid structures in membrane function.
2. **Herbal treatments for organelle health**: Add a case study on Ayurvedic herbs like Ashwagandha for mitochondrial and organelle health. Relates to therapeutic interventions for organelle dysfunction.
3. **Yogic Asanas and cytoskeletal dynamics**: Include a lecture on Yogic Asanas (postures) influencing cytoskeletal proteins and cell motility via physical movement. Relates to cytoskeleton structure and extracellular matrix interactions.
4. **Vata dosha and cell motility**: Include Vata dosha (Ayurvedic principle of movement) to discuss cytoskeletal dynamics and cellular migration. Relates to cytoskeleton-driven motility.
5. **Rasayana for cell cycle regulation**: Integrate a session on Rasayana (Ayurvedic rejuvenation therapies) to discuss cell cycle modulation using herbs. Relates to cell proliferation control.
6. **Vedic Mantras and cell communication**: Include a topic on Vedic Mantras (sound vibrations) as analogs to cellular signaling and gene expression regulation. Relates to intercellular communication.
7. **Ayurvedic herbs for signaling modulation**: Add a case study on herbs like Tulsi for modulating signaling pathways. Relates to signal transduction and receptor functions.
8. **Arbuda, cancer etiology, and Herbal interventions for cancer prevention**: Add a discussion on Arbuda (tumors in Ayurveda) to compare with modern cancer etiology and oncogenes. Relates to tumor formation mechanisms. Add a case study on Ayurvedic herbs like Turmeric for cancer prevention. Relates to oncogene suppression and chemotherapy.
9. **Vedic aging (Jara), cell death and Rasayana for stem cell renewal**: Include a topic on Vedic Jara (aging) to explore programmed cell death and senescence. Relates to cellular aging processes. Integrate a session on Rasayana therapies to discuss stem cell renewal and tissue regeneration. Relates to stem cell biology and repair.
10. **Cell staining with herbal dyes**: Include an experiment using turmeric (Ayurvedic dye) for cell microscopy, comparing with synthetic stains. Relates to cell visualization techniques.

26BT102: Biochemistry

1. **Tridosha and biochemical balance**: Include a lecture on Tridosha (Vata, Pitta, Kapha in Ayurveda) to explain pH and buffer systems in metabolism. Relates to biochemical homeostasis in Charaka Samhita.
2. **Traditional fermentation and Carbohydrate metabolism in Indian diets**: Add a discussion on traditional fermented foods (e.g., Idli, Dosa) to illustrate glycolysis and carbohydrate metabolism. Relates to carbohydrate breakdown pathways.
3. **Vedic Agni and energy metabolism**: Include a topic on Vedic Agni (digestive fire) as an analog to carbohydrate-based energy production. Relates to glycolysis and TCA cycle.
4. **Ayurvedic herbs for enzyme disorders**: Add a case study on herbs like Triphala for enzyme-related metabolic disorders. Relates to enzyme therapy in biochemistry.
5. **Sneha in therapeutic oils**: Include a lecture on Sneha (Ayurvedic fats, e.g., ghee, sesame oil) to discuss their roles in therapies like Abhyanga.
6. **Prameha and lipid metabolism**: Add a discussion on Prameha (Ayurvedic diabetes) to explore lipid metabolism disorders and ketone bodies. Relates to lipid metabolic pathways.
7. **Vedic elemental balance and lipids**: Integrate a session on Panchamahabhuta (five elements) to explain lipid functions in cellular membranes. Relates to lipid roles in membranes.
8. **Ayurvedic diet for lipid disorders**: Include a topic on Pathya-Apathya (Ayurvedic dietary rules) to address lipid metabolism imbalances. Relates to lipid disorder management.
9. **Aahar Vidhi, and herbal sources of vitamin**: Add a discussion on Ayurvedic Aahar Vidhi (nutrition principles) to explore vitamins as coenzymes in metabolism. Relates to vitamin biochemical roles. Add a case study on Ayurvedic herbs like Amla as natural vitamin sources. Relates to vitamin coenzyme functions.
10. **Prakriti-Purusha and genetic material**: Include a topic on Samkhya's Prakriti-Purusha duality as an analog to nucleic acid functions. Relates to genetic information flow.
11. **Protein/sugar quantification in herbs**: Add a practical on quantifying proteins/sugars in Ashwagandha extracts, linking to Ayurvedic nutrition. Relates to biochemical analysis.
12. **Chromatography of herbal extracts**: Add an experiment on separating compounds from Tulsi extracts using chromatography. Relates to biomolecule separation techniques.

25BT103: Microbiology

1. **Krimi in Charaka Samhita and Panchamahabhuta and microbes**: Include a lecture on Krimi (Ayurvedic pathogens, visible/invisible) to introduce microbes and their role in diseases. : Integrate a session on Vedic five elements (Panchamahabhuta) to discuss microbial taxonomy.
2. **Vrikshayurveda and microbial diversity**: Add a discussion on Vrikshayurveda's plant microbiology to explore microbial diversity in agriculture. Relates to microbial ecology.
3. **Vedic agriculture practices**: Add a case study on to illustrate soil microbe interactions. Relates to microbial diversity in ecosystems. Include a topic on Vrikshayurveda's use of microbes for soil health and crop growth.

4. **Shodhana and sterilization**: Include a lecture on Shodhana (Ayurvedic purification) to discuss sterilization techniques in microbiology. Relates to microbial control methods.
5. **Asava-Arishta and microbial growth**: Add a discussion on Ayurvedic Asava-Arishta (fermented medicines) to illustrate microbial culturing methods. Relates to microbial growth techniques.
6. **Vedic hygiene for microbial control**: Integrate a session on Vedic hygiene practices to explore microbial contamination prevention. Relates to aseptic techniques.
7. **Ayurvedic herbs and microbiome**: Add a case study on herbs like Neem to modulate microbial metabolic pathways. Relates to microbial metabolic regulation.
8. **Dosha imbalances and microbiome** Include a lecture on Ayurvedic Dosha (Vata, Pitta, Kapha) imbalances to discuss microbiome.
9. **Microbial toxins in Sushruta Samhita**: Integrate a session on Sushruta's toxin concepts to discuss food poisoning microbes. Relates to microbial pathogenesis.
10. **Microbial isolation from Panchagavya**: Integrate an experiment isolating microbes from Panchagavya (Ayurvedic fermented cow product). Relates to microbial culturing.

26BT106: Molecular Biology

1. **Vedic Prana and genetic material**: Integrate a session on Vedic Prana (life force) as an analog to DNA replication energy needs. Relates to replication energetics.
2. **Herbal support for DNA protection**: Include a topic on Ayurvedic herbs like Amla for protecting DNA metabolism.
3. **Mantras and transcription regulation**: Include a lecture on . Relates to transcription mechanisms.
4. **Mantras and Yogic sound therapies**: Integrate a session on Vedic Mantras (sound vibrations) as analogs to the regulation of replication, transcription, and gene expression. Yogic sound therapies influencing DNA/RNA modification and gene expression.
5. **Ayurvedic herbs for gene expression**: Include a topic on herbs like Brahmi for rejuvenation of genetic material, modulating gene transcription and translation.
6. **Vedic creation and translation**: Add a case study on Vedic creation theories to regulate replication, transcription, and gene expression.
7. **Rasayana and DNA repair**: Include a lecture on Rasayana (Ayurvedic rejuvenation) to discuss DNA repair mechanisms.
8. **Vedic Dosha and DNA damage**: Integrate a session on Dosha imbalances causing DNA damage, repair, and regulation.
9. **Herbal antioxidants for DNA repair**: Include a topic on Ayurvedic herbs like Tulsi for supporting DNA repair via antioxidants. Relates to oxidative damage repair.
10. **Role of Ayurvedic lifestyle and Yogic meditation in epigenetics**: Add a discussion on Yogic meditation influencing DNA methylation, chromatin modification, eukaryotic gene regulation and epigenetic modifications.

11. **Riboswitches in Vedic dietetics**: Include a topic on Vedic dietary principles to discuss riboswitches and gene regulation.
12. **Herbal gene regulation**: Add a case study on Ayurvedic herbs like Giloy for eukaryotic gene regulation, regulatory RNAs Relates to transcription factors and regulation.

Semester II

25BT201: Molecular Immunology

1. **Vyadhikshamatva and immunity**: Include a lecture on Vyadhikshamatva (Ayurvedic immunity) to discuss cellular and humoral immunity. Relates to innate and adaptive immunity.
2. **Ojas as vital essence**: Add a discussion on Ojas (Ayurvedic vital essence) as an analog to immune system strength. Relates to immune response in Charaka Samhita.
3. **Ayurvedic herbs for humoral immunity**: Integrate a session on herbs like Guduchi for enhancing humoral immunity. Relates to antibody production.
4. **Vedic anatomical barriers**: Include a topic on Vedic views of physical barriers to discuss innate immunity mechanisms. Relates to immune barriers.
5. **Herbal immunomodulators**: Include a topic on Ayurvedic herbs like Ashwagandha for immune receptor modulation. Relates to immune diversity.
6. **Traditional immune diversity**: Add a case study on Ayurvedic views of immunity to discuss receptor diversity and antigen recognition. Relates to immune specificity.
7. **Tridosha and cytokine regulation**: Add a discussion on Vedic principles of Tridosha balance to explore cytokine functions in immune regulation and homeostasis. Relates to immune signaling.
8. **Traditional anti-inflammatory remedies**: Add a case study on Ayurvedic anti-inflammatory herbs like Turmeric for immune regulation. Relates to inflammation control.
9. **Ayurvedic tissue regeneration and transplantation**: Include a lecture on Ayurvedic tissue regeneration to discuss transplantation immunology. Relates to transplant compatibility.
10. **Dosha imbalances and autoimmunity**: Add a discussion on Dosha imbalances causing autoimmune disorders, comparing to modern immunology. Relates to immune disorders.
11. **Herbal vaccines in Ayurveda**: Include a topic on traditional herbal formulations as vaccine analogs in Ayurveda. Relates to vaccine development.
12. **Traditional diagnostics for immune disorders**: Add a case study on Ayurvedic diagnostics (e.g., pulse diagnosis) for immune disorders. Relates to immunodiagnostics.

25BT202: Developmental Biology

1. **Traditional hormonal control**: Include a topic on Ayurvedic hormonal balance for ovulation and germ cell health. Relates to reproductive biology.
2. **Herbal germ cell therapies**: Add a case study on Ayurvedic herbs like Shatavari for germ cell health. Relates to reproductive health.

3. **Garbha Siddhanta and fertilization**: Include a lecture on Ayurvedic Garbha Siddhanta for fertilization processes. Relates to fertilization mechanisms.
4. **Herbal egg activation**: Integrate a session on herbs like Ashwagandha for egg activation in fertilization. Relates to reproductive biology.
5. **Charaka Samhita and embryonic development**: Include a lecture on Charaka's embryology for embryonic development stages. Relates to embryogenesis.
6. **Vedic neural induction**: Add a discussion on Vedic principles of neural development for neural induction. Relates to neurodevelopment.
7. **Herbal growth factors**: Integrate a session on Ayurvedic herbs like Brahmi as growth factors in development. Relates to growth signaling.
8. **Ayurvedic fetal development**: Add a case study on Ayurvedic therapies for fetal development support. Relates to embryonic growth.
9. **Vrikshayurveda and plant morphogenesis**: Include a lecture on Vrikshayurveda for plant morphogenesis and organogenesis. Relates to plant development.
10. **Rasayana and stem cells**: Add a discussion on Rasayana therapies for stem cell regeneration in plants and animals. Relates to stem cell biology.
11. **Herbal stem cell therapies**: Include a topic on Ayurvedic herbs like Aloe Vera for stem cell applications. Relates to regenerative biology.
12. **Traditional epigenetic reprogramming**: Add a case study on Ayurvedic epigenetic concepts for stem cell reprogramming. Relates to epigenetics.

26BT203: Genetic Engineering

1. **Vrikshayurveda and genetic engineering**: Include a lecture on Vrikshayurveda (Ayurvedic plant science) to discuss genetic engineering in agriculture. Relates to gene manipulation.
2. **Ayurvedic herbs as cloning vectors**: Integrate a session on using herbal compounds as potential cloning vectors in genetic engineering. Relates to vector design.
3. **Traditional genetic selection**: Include a topic on traditional plant breeding in Vrikshayurveda to discuss genetic selection. Relates to gene manipulation techniques.
4. **Ayurvedic gene stability**: Add a case study on Ayurvedic concepts of genetic stability.
5. **Gene therapy in Rasayana**: Add a discussion on Rasayana therapies to explore gene therapy applications in medicine. Relates to medical biotech.
6. **Vedic ethics in genetic modification**: Integrate a session on Vedic ethical principles (Dharma) for genetic engineering applications. Relates to biotech ethics.
7. **Biosafety in Vedic environmental ethics**: Include a lecture on Vedic environmental ethics to discuss biosafety in genetic engineering. Relates to regulatory frameworks.
8. **Ayurvedic ethics in gene editing**: Add a discussion on Ayurvedic or ancient indian ethical principles for gene editing technologies. Relates to ethical considerations.

9. **IKS trends in genetic engineering**: Add a case study on emerging IKS-based trends in genetic engineering, like herbal biotech. Relates to future trends.

26BT206: Bioinformatics

1. **Vedic classification of biological data**: Add a discussion on Vedic taxonomy to explore biological database structures. Relates to data categorization.
2. **Ayurvedic herb databases**: Integrate a session on creating databases for Ayurvedic herbs like Tulsi. Relates to biological data management.
3. **Traditional knowledge in databases**: Include a topic on incorporating IKS knowledge into modern biological databases. Relates to data integration.
4. **Vedic taxonomy and bioinformatics**: Add a case study on Vedic plant classification for bioinformatics database design. Relates to taxonomic databases.
5. **Vedic ancestry and phylogenetics**: Add a discussion on Vedic ancestry concepts to explore phylogenetic tree construction. Relates to evolutionary biology.
6. **Vedic medicine and functional genomics**: Add a discussion on Vedic medicinal principles to explore functional genomics applications. Relates to gene function analysis.
7. **Traditional views on gene function**: Include a topic on Ayurvedic concepts of gene function to discuss functional genomics. Relates to gene expression studies.
8. **Rasayana and drug discovery**: Include a lecture on Rasayana Shastra to discuss herbal drug discovery using bioinformatics. Relates to drug design.
9. **Tridosha and systems biology**: Add a discussion on Tridosha to explore systems biology modeling of biological networks. Relates to systems-level analysis.
10. **Vedic approaches to drug design**: Integrate a session on Vedic pharmacology for bioinformatics-based drug design. Relates to computational drug discovery.
11. **Traditional systems biology**: Add a case study on Ayurvedic systems biology (e.g., Tridosha networks) for modern applications. Relates to systems biology modeling.

26BT207: Metabolic Engineering

1. **Rasayana and metabolic engineering**: Include a lecture on Rasayana (Ayurvedic rejuvenation) to discuss metabolic pathway engineering. Relates to metabolic optimization.
2. **Vedic Agni and metabolic pathways**: Add a discussion on Vedic Agni (digestive fire) as an analog to metabolic pathways. Relates to biochemical pathways.
3. **Tridosha and metabolic balance**: Integrate a session on Tridosha to explore metabolic balance in engineering applications. Relates to metabolic regulation.
4. **Herbal modulation of metabolism**: Include a topic on Ayurvedic herbs like Ginger for modulating metabolic pathways. Relates to pathway engineering.
5. **Traditional fermentation for metabolism**: Add a case study on Ayurvedic fermentation (Asava-Arishta) for metabolic engineering. Relates to microbial metabolism.

6. **Ayurvedic diagnostics and pathway analysis**: Add a discussion on Ayurvedic diagnostics (e.g., pulse) for metabolic pathway analysis. Relates to pathway modeling.**Herbal pathway modulators**: Include a topic on Ayurvedic herbs like Triphala for metabolic pathway modulation. Relates to pathway regulation.
7. **Traditional metabolic engineering**: Add a case study on traditional dietary practices for metabolic engineering applications. Relates to pathway optimization.
8. **Herbal bioproducts in Ayurveda**: Include a topic on Ayurvedic herbs for bioproduct development, like antioxidants. Relates to bioproduct applications.
9. **Vedic creation and synthetic biology**: Include a lecture on Vedic creation theories to discuss synthetic biology principles. Relates to synthetic biology design.
10. **Traditional trends in metabolic engineering**: Add a case study on IKS-based trends in metabolic engineering, like herbal bioproducts. Relates to future trends.

26BT208: Biology of Infectious Diseases

1. **Krimi and pathogens**: Include a lecture on Krimi (Ayurvedic pathogens) to discuss microbial pathogens and their classification. Relates to pathogen biology.
2. **Herbal antimicrobials**: Include a topic on Ayurvedic herbs like Neem for antimicrobial action. Relates to pathogen control.
3. **Traditional disease causation**: Add a case study on Ayurvedic views of infection causes (e.g., Dosha imbalance). Relates to disease etiology.
4. **Ojas and host-pathogen interactions**: Include a lecture on Ojas (Ayurvedic vital essence) to discuss host-pathogen interactions. Relates to immune defense.
5. **Traditional pathogen neutralization**: Add a case study on Ayurvedic detoxification for pathogen neutralization. Relates to immune effector functions.
6. **Ayurvedic public health and epidemiology**: Include a lecture on Ayurvedic public health principles to discuss epidemiology. Relates to disease spread analysis.
7. **Vedic hygiene and disease control**: Add a discussion on Vedic hygiene practices for disease control strategies. Relates to infection control.
8. **Herbal epidemiology**: Integrate a session on Ayurvedic herbs and Vedic approaches for epidemic management (e.g. rituals, herbs). Relates to epidemiological interventions.
9. **Rasayana and vaccines**: Add a discussion on Rasayana therapies as analogs to vaccine-induced immunity. Relates to vaccine development.
10. **Herbal vaccines in Ayurveda**: Include a topic on Ayurvedic herbal formulations as vaccine analogs. Relates to immunotherapy.

26BT209: Environmental Studies and Sustainable Development

1. **Panchamahabhuta and ecosystems**: Include a lecture on Vedic Panchamahabhuta (five elements) to discuss ecosystem dynamics. Relates to ecosystem structure.

2. **Traditional ecological knowledge**: Include a topic on IKS-based ecological knowledge for ecosystem studies. Relates to the management of biodiversity and ecological diversity.
3. **Vrikshayurveda and resource management**: Include a lecture on Vrikshayurveda for sustainable natural resource management. Relates to resource conservation.
4. **Ayurvedic detoxification for pollution**: Add a discussion on Panchakarma for environmental pollution detoxification. Relates to pollution control.
5. **Vedic environmental purity**: Integrate a session on Vedic purity principles to discuss pollution mitigation. Relates to environmental health.
6. **Vrikshayurveda and conservation**: Add a discussion on Vrikshayurveda's plant conservation techniques. Relates to plant biodiversity.
7. **Ayurvedic herbs for biodiversity**: Integrate a session on herbs like Tulsi for supporting biodiversity. Relates to ecological health.
8. **Traditional conservation practices**: Include a topic on IKS-based conservation methods for biodiversity. Relates to conservation strategies.
9. **Vedic Dharma and sustainable development**: Include a lecture on Vedic Dharma for sustainable development principles. Relates to sustainability.
10. **Ayurvedic ecology and global issues**: Add a discussion on Ayurvedic ecology for addressing global environmental issues. Relates to environmental challenges.
11. **Traditional sustainable practices**: Include a topic on IKS-based sustainable agricultural practices and environmental management. Relates to sustainability strategies.
12. **Vedic solutions for climate change**: Add a case study on Vedic approaches to mitigate climate change impacts. Relates to global environmental solutions.

Semester III

25BT301: Plant Biotechnology

1. **Ayurvedic herbs in tissue culture**: Integrate a session on using herbs like Aloe Vera in plant tissue culture media. Relates to culture optimization.
2. **Traditional plant regeneration**: Include a topic on traditional plant regeneration methods in Vrikshayurveda. Relates to tissue culture regeneration.
3. **Herbal gene transformation**: Include a topic on transforming genes in medicinal plants like Tulsi. Relates to genetic engineering.
4. **Traditional marker-based selection**: Add a case study on Vrikshayurveda's marker-based plant selection. Relates to molecular breeding.
5. **Ayurvedic herbs for stress tolerance**: Add a discussion on herbs like Ashwagandha for plant stress tolerance. Relates to biotic/abiotic stress.
6. **Vedic plant ethics**: Include a lecture on Vedic Dharma for ethical issues in plant biotechnology. Relates to bioethics.

26BT302: Animal Cell Technology

1. **Traditional tissue preservation**: Include a topic on Ayurvedic tissue preservation methods for cell lines. Relates to cell storage.
2. **Vedic fermentation and bioreactors**: Add a discussion on Vedic fermentation for bioreactor design principles. Relates to bioreactor technology.
3. **Herbal media for cell culture**: Integrate a session on using Ayurvedic herbs in cell culture media. Relates to culture media design.
4. **Vedic cell growth concepts**: Add a case study on Vedic growth principles for cell culture in bioreactors. Relates to cell proliferation.
5. **Ayurvedic healing and medical applications**: Include a lecture on Ayurvedic healing for animal cell applications in medicine. Relates to regenerative medicine.
6. **Sushruta Samhita and tissue engineering**: Add a discussion on Sushruta's tissue regeneration for tissue engineering principles. Relates to tissue engineering.
7. **Vedic tissue regeneration**: Integrate a session on Vedic views of regeneration for tissue engineering applications. Relates to tissue repair.
8. **Traditional regenerative therapies**: Add a case study on Ayurvedic regenerative therapies for tissue engineering. Relates to regenerative medicine.
9. **Vedic animal ethics**: Include a lecture on Vedic Dharma for ethical issues in animal cell technology. Relates to bioethics.

26BT303: Environmental Biotechnology

1. **Vedic ecology and pollution control**: Include a lecture on Vedic Panchamahabhuta for pollution control strategies. Relates to environmental biotech.
2. **Ayurvedic detoxification for pollution**: Add a discussion on Panchakarma for environmental pollution detoxification. Relates to bioremediation.
3. **Vrikshayurveda and environmental health**: Integrate a session on Vrikshayurveda for managing environmental pollution. Relates to ecological biotech.
4. **Herbal bioremediation**: Add a case study on Ayurvedic herbs like Neem for bioremediation of pollutants. Relates to environmental cleanup.
5. **Ayurvedic hospital waste management**: Add a discussion on Ayurvedic principles for managing biomedical waste. Relates to specialized waste management.
6. **Ayurvedic pharmacy and effluent treatment**: Include a lecture on Ayurvedic pharmacy for effluent treatment methods. Relates to wastewater treatment.
7. **Vedic water purification**: Add a discussion on Vedic water purification rituals for effluent treatment. Relates to water treatment technologies.
8. **Herbal effluent treatment**: Integrate a session on herbs like Tulsi for effluent treatment in biotech. Relates to phytoremediation.

9. **Vedic biofuels**: Include a lecture on Vedic energy concepts for biofuel production in pollution control. Relates to bioenergy.
10. **Vrikshayurveda and biopesticides**: Add a discussion on Vrikshayurveda for biopesticide development. Relates to pest control biotech.
11. **Phytoremediation in Ayurvedic herbs**: Integrate a session on herbs like Neem for phytoremediation of pollutants. Relates to environmental cleanup.
12. **Traditional pollution control**: Include a topic on traditional pollution control methods in Ayurveda. Relates to pollution mitigation.
13. **Vedic sustainability in biotech**: Add a case study on Vedic sustainability principles for pollution control technologies. Relates to sustainable biotech.

25BT305: Enzyme Technology

1. **Rasa Shastra and enzyme properties**: Include a lecture on Rasa Shastra to discuss enzyme properties and catalysis. Relates to enzyme characteristics.
2. **Herbal enzyme activators**: Integrate a session on Ayurvedic herbs like Ginger as enzyme activators. Relates to enzyme function.**Ayurvedic enzyme action**: Add a case study on Ayurvedic concepts of enzyme action in metabolism. Relates to enzyme catalysis.
3. **Herbal enzyme modulators**: Integrate a session on herbs like Triphala for modulating enzyme kinetics. Relates to enzyme regulation.
4. **Ayurvedic enzyme inhibition**: Add a case study on Ayurvedic herbs for enzyme inhibition strategies. Relates to enzyme regulation.
5. **Tridosha and metabolic regulation**: Include a lecture on Tridosha for enzyme-mediated metabolic regulation. Relates to metabolic control.
6. **Herbal metabolic regulation**: Integrate a session on herbs like Ashwagandha for regulating metabolic enzymes. Relates to metabolic pathways.
7. **Ayurvedic enzyme applications**: Include a lecture on Ayurvedic enzyme use in medicine (e.g., digestive aids). Relates to enzyme applications.
8. **Rasa Shastra and synthetic enzymes**: Add a discussion on Rasa Shastra for designing synthetic enzymes. Relates to enzyme engineering.
9. **Herbal biosensors**: Include a topic on Ayurvedic herbs in enzyme-based biosensors. Relates to biotech applications.

25BT306: Cancer Biology

1. **Arbuda and cancer etiology**: Include a lecture on Arbuda (Ayurvedic tumors) to discuss cancer etiology. Relates to oncogenesis.
2. **Vedic cancer causation**: Add a discussion on Vedic views of disease causation for cancer biology. Relates to cancer initiation.

3. **Herbal anticancer agents**: Integrate a session on Ayurvedic herbs like Turmeric for cancer prevention. Relates to chemoprevention.
4. **Ayurvedic oncogene concepts**: Add a case study on Ayurvedic parallels to oncogenes in cancer biology. Relates to molecular oncology.
5. **Tridosha and cancer metabolism**: Include a lecture on Tridosha imbalances to discuss cancer cell metabolism. Relates to metabolic reprogramming.
6. **Vedic Marana and apoptosis**: Add a discussion on Vedic Marana (death) for apoptosis in cancer cells. Relates to programmed cell death.
7. **Herbal glycolysis inhibition**: Integrate a session on herbs like Guduchi for inhibiting cancer cell glycolysis. Relates to metabolic targeting.
8. **Ayurvedic metabolic balance**: Add a case study on Ayurvedic diet for cancer metabolic balance. Relates to cancer metabolism.
9. **Ojas and tumor immunity**: Include a lecture on Ojas (Ayurvedic vital essence) for tumor immunosurveillance. Relates to immune response to cancer.
10. **Herbal immunotherapy**: Integrate a session on Ayurvedic herbs like Ashwagandha for cancer immunotherapy. Relates to immune modulation.
11. **Rasayana and cancer treatment**: Include a lecture on Rasayana Shastra for cancer treatment strategies. Relates to chemotherapy.
12. **Vedic personalized therapy**: Add a discussion on Vedic personalized medicine for cancer treatment approaches. Relates to precision oncology.
13. **Traditional lifestyle for cancer**: Include a topic on Ayurvedic lifestyle (Dinacharya) for cancer prevention. Relates to preventive oncology.
14. **Ayurvedic diet for cancer**: Add a case study on Pathya-Apathya diet for cancer management. Relates to dietary therapy.

26BT307: microRNA Technology

1. **Ayurvedic gene regulation and miRNAs**: Include a lecture on Ayurvedic gene regulation for miRNA functions. Relates to miRNA biology.
2. **Vedic non-coding RNAs**: Add a discussion on Vedic subtle energy concepts for non-coding RNAs like miRNAs. Relates to RNA biology.
3. **Herbal miRNA biogenesis**: Integrate a session on herbs like Brahmi for miRNA biogenesis modulation. Relates to miRNA processing.
4. **Ayurvedic gene silencing**: Add a case study on Ayurvedic concepts of silencing for miRNA-mediated gene regulation. Relates to RNA interference.
5. **Yogic cellular processes and miRNAs**: Include a lecture on Yogic practices influencing miRNA-mediated cellular processes. Relates to cellular regulation.

6. **Vedic developmental miRNAs**: Add a discussion on Vedic embryology for miRNA roles in development. Relates to developmental biology.
7. **Herbal miRNAs in stress response**: Integrate a session on herbs like Ashwagandha for miRNA stress responses. Relates to stress biology.
8. **Ayurvedic cancer diagnostics and miRNAs**: Include a lecture on Ayurvedic diagnostics for miRNA-based cancer detection. Relates to diagnostic biomarkers.
9. **Traditional biomarkers**: Include a topic on Ayurvedic biomarkers (e.g., pulse diagnosis) for miRNA diagnostics. Relates to diagnostic techniques.
10. **Rasayana and miRNA therapeutics**: Include a lecture on Rasayana for miRNA-based therapeutic strategies. Relates to RNA therapeutics.
11. **Traditional off-target effects**: Include a topic on Ayurvedic views of unintended effects for miRNA therapy challenges. Relates to therapeutic safety.

25BT308: Research Orientation

1. **Ayurvedic research problems**: Include a lecture on identifying research problems using Ayurvedic texts like Charaka Samhita. Relates to research design.
2. **Traditional patent search**: Integrate a session on Ayurvedic patent systems for research problem identification. Relates to intellectual property.
3. **Vedic research design**: Include a topic on Vedic principles for designing research studies. Relates to research methodology.
4. **Herbal research areas**: Add a case study on Rasayana-based research problems in biotechnology. Relates to research focus areas.
5. **Vrikshayurveda and experimental design**: Include a lecture on Vrikshayurveda for experimental design in biotech research. Relates to experimental methodologies.
6. **Vedic Dharma and bioethics**: Include a lecture on Vedic Dharma for ethical considerations in biological research. Relates to research ethics.
7. **Vedic views on GMOs**: Integrate a session on Vedic perspectives on genetically modified organisms in research. Relates to biotech ethics.
8. **Ayurvedic bio-waste disposal**: Add a case study on Ayurvedic waste disposal methods for research labs. Relates to biosafety.

25BT309: Biotech Management and Entrepreneurship

1. **Vedic principles for biotech startups**: Include a lecture on Vedic Dharma (ethical duty) for decision-making in biotech ventures. Relates to entrepreneurial planning.
2. **Traditional entrepreneurial support**: Integrate a session on traditional Indian systems for supporting biotech entrepreneurship. Relates to startup ecosystems.
3. **Herbal venture ideas**: Include a topic on Ayurvedic herb-based business ideas for biotech ventures. Relates to entrepreneurial opportunities.

4. **Ayurvedic product market demand**: Include a lecture on assessing demand for Ayurvedic biotech products like herbal medicines. Relates to market analysis.
5. **Herbal market gap analysis**: Include a topic on identifying market gaps for Ayurvedic herb-based products. Relates to market research.
6. **Ayurvedic IT for business performance**: Add a case study on using IT tools for Ayurvedic biotech market analysis. Relates to business analytics.
7. **Vedic organizational structure**: Include a lecture on Vedic organizational principles (e.g., Arthashastra) for biotech company structure. Relates to organizational design.
8. **Ayurvedic company startups**: Add a discussion on Ayurvedic principles for starting biotech companies. Relates to business setup.
9. **Herbal e-business in Ayurveda**: Add a case study on e-commerce for Ayurvedic biotech products. Relates to digital business models.
10. **Herbal biotech entrepreneurship cases**: Add a case study on successful Ayurvedic biotech entrepreneurs. Relates to leadership case studies.

26BT310: Bioethics and Biosafety

1. **Vedic Dharma and bioethics**: Include a lecture on Vedic Dharma for bioethical principles in biotechnology. Relates to ethical frameworks.
2. **Ayurvedic views on GMOs**: Add a discussion on Ayurvedic perspectives on genetically modified organisms. Relates to biotech ethics.
3. **Vedic ethics in human cloning**: Integrate a session on Vedic ethical views on human cloning and biotech. Relates to cloning ethics.
4. **Traditional biological weapons**: Include a topic on Vedic views against biological weapons for biosafety. Relates to biosecurity.
5. **Herbal bioethics in Rasayana**: Add a case study on Rasayana-based ethical considerations in biotech. Relates to bioethical applications.
6. **Vedic biohazard containment**: Add a discussion on Vedic containment principles for biohazards. Relates to biosafety measures.

Semester IV

25BT401: Bioprocess Technology

1. **Asava-Arishta and fermentation**: Include a lecture on Asava-Arishta (Ayurvedic fermented medicines) to discuss fermentation technology principles. Relates to microbial fermentation processes.
2. **Vedic strain improvement**: Add a discussion on Vedic plant breeding (Vrikshayurveda) for microbial strain improvement in fermentation. Relates to strain optimization techniques.
3. **Traditional sterilization methods**: Include a topic on Shodhana (Ayurvedic purification) for sterilization in fermentation processes. Relates to microbial control methods.

4. **Vrikshayurveda for bioprocess scale-up**: Add a case study on Vrikshayurveda's agricultural scaling for bioprocess scale-up. Relates to industrial fermentation.
5. **Vedic engineering and fermenter design**: Include a lecture on Vedic engineering principles (e.g., Shilpa Shastra) for fermenter design. Relates to bioreactor technology.
6. **Herbal foam control**: Include a topic on Ayurvedic herbs like Neem for foam control in fermenters. Relates to bioprocess stability.
7. **Vedic bioreactor design concepts**: Add a case study on Vedic vessel designs as analogs to modern bioreactors. Relates to fermenter engineering.
8. **Antibiotic production in Rasayana Shastra**: Include a lecture on Rasayana (Ayurvedic rejuvenation) for antibiotic production via fermentation. Relates to bioproduct synthesis.
9. **Organic acids in Ayurvedic fermentation**: Add a discussion on Asava-Arishta for organic acid production in fermentation. Relates to metabolite production.
10. **Vedic views on vitamin production**: Integrate a session on Vedic nutrition for vitamin production via fermentation. Relates to bioproduct applications.
11. **Herbal antioxidants in bioprocesses**: Add a case study on herbs like Amla for antioxidant production in fermentation. Relates to industrial bioproducts.
12. **Food fermentation in Ayurvedic diets**: Include a lecture on Pathya-Apathya (Ayurvedic dietary rules) for food fermentation applications. Relates to food biotechnology.

26BT402: Biotechniques

1. **Ayurvedic fluid analysis and flow cytometry**: Include a topic on Ayurvedic fluid diagnostics (e.g., urine analysis) to explore flow cytometry. Relates to cell sorting.
2. **Traditional microscopy with natural dyes**: Add a case study on using natural dyes like turmeric for microscopy. Relates to staining techniques.
3. **Rasa Shastra and chromatography**: Include a lecture on Rasa Shastra (Ayurvedic alchemy) to discuss biomolecule separation via chromatography. Relates to separation techniques.
4. **Herbal spectroscopy in Rasayana**: Integrate a session on Rasayana herb analysis using spectroscopy for compound identification. Relates to analytical spectroscopy.
5. **Traditional color-based diagnostics**: Include a topic on Ayurvedic color diagnostics to discuss spectroscopic applications. Relates to diagnostic spectroscopy.
6. **NMR in Ayurvedic compound analysis**: Add a case study on NMR analysis of Ayurvedic compounds like Triphala. Relates to structural elucidation.
7. **Microarrays in traditional drug profiling**: Include a topic on Ayurvedic drug profiling to discuss microarray applications. Relates to high-throughput analysis.
8. **Ayurvedic quality control of biomolecules**: Add a case study on Ayurvedic quality control (e.g., for herbal extracts) using blotting. Relates to biotech applications.

26BT404: Stem Cell and Regenerative Biology

1. **Rasayana and stem cells**: Include a lecture on Rasayana (Ayurvedic rejuvenation) for stem cell biology and regeneration. Relates to stem cell properties.
2. **Vedic cell potency**: Add a discussion on Vedic Shakti (potency) as an analog to stem cell differentiation potential. Relates to cell pluripotency.
3. **Herbal stem cell therapies**: Integrate a session on Ayurvedic herbs like Ashwagandha for stem cell support. Relates to regenerative therapies.
4. **Garbha Siddhanta and embryonic stem cells**: Include a lecture on Garbha Siddhanta (Ayurvedic embryology) for embryonic stem cell studies. Relates to embryonic stem cells.
5. **Ayurvedic adult stem cells**: Add a discussion on Ayurvedic tissue regeneration for adult stem cell applications. Relates to adult stem cells.
6. **Traditional stem cell benefits**: Add a case study on Ayurvedic regenerative therapies for stem cell applications. Relates to regenerative medicine.
7. **Vedic genetic disease treatment**: Add a discussion on Vedic healing principles for gene therapy in genetic diseases. Relates to gene therapy applications.
8. **Ayurvedic cardiovascular stem cells**: Add a case study on Ayurvedic therapies for cardiovascular stem cell applications. Relates to regenerative cardiology.
9. **Vedic philosophy and stem cell ethics**: Include a lecture on Vedic Dharma for ethical issues in stem cell research. Relates to bioethics.

26BT405: Molecular Modeling

1. **Herbal protein modeling**: Integrate a session on modeling proteins from Ayurvedic herbs like Tulsi. Relates to computational modeling.
2. **Ayurvedic homology modeling**: Add a discussion on homology modeling of Ayurvedic herbal compounds. Relates to protein modeling.
3. **Vedic model refinement**: Integrate a session on Vedic refinement principles for molecular model optimization. Relates to model accuracy.
4. **Rasayana and drug discovery**: Include a lecture on Rasayana Shastra for bioinformatics-based drug discovery. Relates to drug design.
5. **Vedic pharmacogenetics**: Add a discussion on Vedic personalized medicine for pharmacogenetic drug discovery. Relates to pharmacogenomics.
6. **Traditional personalized medicine**: Include a topic on Ayurvedic personalized therapies for drug discovery. Relates to precision medicine.
7. **Ayurvedic drug discovery strategies**: Add a case study on Ayurvedic strategies for modern drug discovery. Relates to drug development.
8. **Herbal QSAR in Rasayana**: Integrate a session on quantitative structure-activity relationship (QSAR) for Ayurvedic herbs. Relates to drug optimization.

9. **Ayurvedic ADMET principles**: Add a case study on Ayurvedic ADMET (absorption, distribution, metabolism, excretion, toxicity) for drug design. Relates to pharmacokinetics.

25BT406: Study Oriented Project

1. **Ayurvedic herb genomics project**: Include a project on genomic analysis of Ayurvedic herbs like Tulsi. Relates to molecular biology research.
2. **Vedic ethics in biotech research**: Add a project incorporating Vedic ethical principles in biotech experiments. Relates to research ethics.
3. **Vrikshayurveda plant studies**: Integrate a project on Vrikshayurveda-based plant biotechnology studies. Relates to plant biotech research.
4. **Herbal drug development project**: Include a project on developing drugs from Ayurvedic herbs like Ashwagandha. Relates to pharmaceutical research.
5. **Traditional fermentation research**: Add a project on Ayurvedic fermentation (Asava-Arishta) for bioproduct development. Relates to bioprocess research.

25BT407: Systems Biology

1. **Tridosha and systems biology**: Include a lecture on Tridosha (Vata, Pitta, Kapha) for systems biology modeling of biological networks. Relates to systems-level analysis.
2. **Vedic biological modeling**: Add a discussion on Vedic principles of interconnectedness for systems biology models. Relates to network biology.
3. **Herbal systems biology**: Integrate a session on Ayurvedic herbs in systems biology for metabolic modeling. Relates to computational biology.
4. **Traditional mass-action kinetics**: Include a topic on Ayurvedic metabolic principles for mass-action kinetics in systems biology. Relates to kinetic modeling.
5. **Herbal bifurcation analysis**: Integrate a session on Ayurvedic herbs influencing bifurcation in biological systems. Relates to system dynamics.
6. **Ayurvedic metabolism and networks**: Include a lecture on Ayurvedic metabolic principles for modeling metabolic networks. Relates to metabolic pathways.
7. **Vedic graph theory in biology**: Add a discussion on Vedic interconnectedness for graph theory in metabolic networks. Relates to network analysis.
8. **Herbal oscillators in Rasayana**: Integrate a session on Rasayana herbs for oscillatory behavior in systems biology. Relates to dynamic regulation.
9. **Traditional stochastic modeling**: Include a topic on Ayurvedic variability concepts for stochastic modeling. Relates to probabilistic models.

25BT408: Tissue Engineering

1. **Sushruta Samhita and tissue engineering**: Include a lecture on Sushruta's tissue regeneration for tissue engineering principles. Relates to regenerative medicine.

2. **Vedic stem cell potency**: Add a discussion on Vedic Shakti (potency) for stem cell applications in tissue engineering. Relates to cell differentiation.
3. **Herbal tissue regeneration**: Integrate a session on Ayurvedic herbs like Aloe Vera for tissue regeneration. Relates to tissue engineering applications.
4. **Traditional cell-matrix interactions**: Include a topic on Ayurvedic tissue formation (Dhatu) for cell-matrix interactions. Relates to extracellular matrix.
5. **Ayurvedic Bhasma as biomaterials**: Include a lecture on Bhasma (calcined metals) as biomaterials in tissue engineering. Relates to biomaterial design.
6. **Vedic biodegradable polymers**: Add a discussion on Vedic material science for biodegradable polymers in tissue engineering. Relates to biomaterial properties.
7. **Ayurvedic angiogenesis therapies**: Add a case study on Ayurvedic herbs for angiogenesis in tissue engineering. Relates to vascularization.
8. **Traditional immune rejection therapies**: Include a topic on Ayurvedic therapies for managing immune rejection. Relates to immunosuppression.
9. **Rasayana and tissue regeneration**: Include a lecture on Rasayana for transplantation of engineered tissues. Relates to regenerative medicine.
10. **Herbal tissue growth**: Integrate a session on Ayurvedic herbs for supporting engineered tissue growth. Relates to tissue engineering.
11. **Ayurvedic skin regeneration**: Add a case study on Ayurvedic therapies for skin tissue regeneration. Relates to dermatological applications.

26BT409: Gene Editing

1. **Beeja Siddhanta and gene editing**: Include a lecture on Vedic Beeja (seed, hereditary unit) for gene editing concepts. Relates to genetic modification.
2. **Ayurvedic DNA repair**: Add a discussion on Ayurvedic rejuvenation for DNA repair in gene editing. Relates to DNA repair mechanisms.
3. **Herbal CRISPR delivery**: Integrate a session on Ayurvedic herbs for CRISPR delivery systems. Relates to delivery mechanisms.
4. **Ayurvedic CRISPR optimization**: Add a case study on Ayurvedic optimization methods for CRISPR technology. Relates to gene editing efficiency.
5. **Rasayana and gene therapy**: Include a lecture on Rasayana for gene editing applications in medicine. Relates to therapeutic gene editing.
6. **Vrikshayurveda and GM crops**: Add a discussion on Vrikshayurveda for genetically modified crop development. Relates to agricultural biotech.
7. **Vedic bioremediation**: Integrate a session on Vedic environmental principles for gene editing in bioremediation. Relates to environmental applications.
8. **Herbal safety in gene editing**: Add a case study on Ayurvedic herbs for ensuring safety in gene editing applications. Relates to therapeutic safety.