FACULTY OF ENGINEERING & TECHNOLOGY

RAMA UNIVERSITY UTTAR PRADESH KANPUR

Rama City, G.T. Road, Mandhana, Kanpur-209217

Ref No: FET/DO/2025/037 Date: 20.08.2025

NOTICE

This is to inform all concerned that the **Board of Studies (BOS) meeting** of the Department of Biotechnology, FET will be held on **21st August 2025** at 10:00 a.m in Dean Office, FET.

All members of the Board of Studies (BOS) are requested to kindly make it convenient to attend the meeting.

Regards,

Dr. Indrajeet Gupta
Convenor
Board of Studies
Faculty of Engineering & Engineering
Rama University, Kanpur

Copy to:

1. All members of the BOS through E-Mail
2. Vice Chancellor, Rama University Uttar Pradesh, Kanpur
3. Director, Rama University Uttar Pradesh, Kanpur
4. Registrar, Rama University Uttar Pradesh, Kanpur
5. Dean Academic & Planning

HOD BIO <hodbio.fet@ramauniversity.ac.in>

Revised-Regarding your valuable suggestions/input in upcoming Board of Studies (BoS) Biotechnology Meeting on 19th August 2025

3 messages

HOD BIO <hodbio.fet@ramauniversity.ac.in> Thu, Aug 14, 2025 a...
To: "lkumar@hbtu.ac.in" <lkumar@hbtu.ac.in>
Cc: Dean Engineering Rama University <deanengineering@ramauniversity.ac.in>, "Dr. Neeraj" <drneeraj.fet@ramauniversity.ac.in>, Ajay Kumar <drajay.fet@ramauniversity.ac.in>, Aman Pratap Singh <amanpratapsingh.fet@ramauniversity.ac.in>, "Dr. Shraddha Sahu" <drshraddha.fet@ramauniversity.ac.in>, "Dr. Samakshi Verma" <samakshiverma.fet@ramauniversity.ac.in>, "Dr. Renu Verma" <renuverma.fet@ramauniversity.ac.in>, "Dr. Deeksha Ranjan" <drdeeksha.fet@ramauniversity.ac.in>, "Dr. Vivek Srivastava FET" <drviveksrivastava.fet@ramauniversity.ac.in>

Dear Sir,

Greetings from the Department of Biotechnology, FET, Rama University!

It gives us great honor to invite you to serve as an esteemed member of the Board of Studies (BoS-Biotechnology) for upcoming meeting scheduled on 19th August 2025 (Tuesday) at 10:00 A.M, to be held at Dean Office, FET, Rama University.

The agenda for the meeting includes review and discussion of the following academic programs:

B.Tech (AICTE 2020): Curriculum restructuring in alignment with the latest AICTE Model Curriculum (2020) for Biotechnology. The syllabus and evaluation scheme of biotechnology core courses are attached for your reference. Your expertise in this updated framework will be useful in ensuring academic excellence and relevance and their open elective subject syllabus are under process, we will update you as early.

B.Sc. (NEP 2020): Newly designed Board of Studies (BoS) implemented from the academic year 2024-25. Revisions are limited to modifications in evaluation and assessment criteria as per NEP 2020 guidelines. Your validated assessment for quality assurance is required and the documents related are attached.

M.Sc. and M.Tech in Biotechnology: BoS implemented from the academic year 2023-24 academic year. Discussion will focus on minor updates and suggestions to further strengthen academic rigor and research integration in order to align programs more closely with industry trends and research advancements. PG Suggestions file is attached for your concern.

Your insights and domain expertise will play a crucial role in enhancing the quality and competitiveness of our academic programs.

We request you to kindly provide us with your recommendations for obtaining a refined and up to date curriculum that meet regulatory requirements, incorporate emerging trends, and enhance academic quality.

Looking forward to your kind acceptance and advantageous contributions.

With Regards

Vivek Srivastava

On Thu, Aug 14, 2025 at 5:03 PM HOD BIO <hodbio.fet@ramauniversity.ac.in> wrote:

Dear Sir,

Greetings from Department of Biotechnology, FET, Rama University!

It gives us great honor to invite you to serve as an esteemed member of the Board of Studies (BoS-Biotechnology) for our upcoming meeting scheduled on 19th August 2025 (Monday) at 10:00 A.M, to be held at Dean Office, FET, Rama University.

The agenda for the meeting includes review and discussion of the following academic programs:

B.Tech (AICTE 2020): Curriculum restructuring in alignment with the latest AICTE Model Curriculum (2020) for Biotechnology. The syllabus and evaluation scheme of biotechnology core courses are attached for your reference. Your expertise in this updated framework will be useful in ensuring academic excellence and relevance and their open elective subject syllabus are under process, we will update you as early.

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Looking forward to your kind acceptance and advantageous contributions.

4 attachments

- **B. Tech BT Evaluation Scheme RR25 BOS.xlsx** 29K
- **PG Suggestions.docx** 15K
- **SYLLABUS NEW B. Tech 2025-26.docx** 159K
- **B.Sc Biotechnology_Evaluation Scheme 2024-25(1).doc** 365K

Lalit Kumar <lkumar@hbtu.ac.in> Tue, Aug 19, 2025 at 7:43 AM
To: HOD BIO <hodbio.fet@ramauniversity.ac.in>
Cc: Dean Engineering Rama University <deanengineering@ramauniversity.ac.in>, "Dr. Neeraj" <drneeraj.fet@ramauniversity.ac.in>, Ajay Kumar <drajay.fet@ramauniversity.ac.in>, Aman Pratap Singh <amanpratapsingh.fet@ramauniversity.ac.in>, "Dr. Shraddha Sahu" <drshraddha.fet@ramauniversity.ac.in>, "Dr. Samakshi Verma" <samakshiverma.fet@ramauniversity.ac.in>, "Dr. Renu Verma" <renuverma.fet@ramauniversity.ac.in>, "Dr. Deeksha Ranjan" <drdeeksha.fet@ramauniversity.ac.in>, "Dr. Vivek Srivastava FET" <drviveksrivastava.fet@ramauniversity.ac.in>

Dear Sir,
This is to inform you that the Orientation program of newly admitted students is scheduled today i.e. on 19th August 2025 in our University. As Dean Academic Affairs, I have to be there in the program, therefore not able to join the BoS meeting today. It is requested to please reschedule it after a few days.

Hope you understand the situation.
Thanks and regards

Prof. Lalit Kumar Singh
HoD, Biochemical Engineering &
Dean of Academic Affairs
HBTU Kanpur-208002

[Quoted text hidden]

HOD BIO <hodbio.fet@ramauniversity.ac.in> Wed, Aug 20, 2025 at 5:13 PM
To: Lalit Kumar <lkumar@hbtu.ac.in>
Cc: Dean Engineering Rama University <deanengineering@ramauniversity.ac.in>, "Dr. Neeraj" <drneeraj.fet@ramauniversity.ac.in>, Ajay Kumar <drajay.fet@ramauniversity.ac.in>, Aman Pratap Singh <amanpratapsingh.fet@ramauniversity.ac.in>, "Dr. Shraddha Sahu" <drshraddha.fet@ramauniversity.ac.in>, "Dr. Samakshi Verma" <samakshiverma.fet@ramauniversity.ac.in>, "Dr. Renu Verma" <renuverma.fet@ramauniversity.ac.in>, "Dr. Deeksha Ranjan" <drdeeksha.fet@ramauniversity.ac.in>, "Dr. Vivek Srivastava FET" <drviveksrivastava.fet@ramauniversity.ac.in>

Dear Sir,

As per our telephonic discussion, this is to formally invite you to attend the Board of Studies (BOS) meeting scheduled of Department of Biotechnology on 21st August 2025 (Thursday) at 10:00 AM.

Your valuable presence and expert inputs will greatly contribute to the discussions and academic deliberations.

Meeting details:
Date: 21st August 2025
Time: 10:00 AM
Venue: Dean Office, FET, Rama University

We look forward to your participation in the meeting.

Best regards,
Dr. Vivek Srivastava

[Quoted text hidden]

Office of the
Dean-Academic Affairs

RAMA UNIVERSITY UTTAR PRADESH, KANPUR
(Vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f))
Rama City, G.T. Road (Near Mandhana Railway Station)
Mandhana, Kanpur

Ref.No.: RU/DA/2025/035

DATE: 25.08.2025

NOTICE

To,

The Dean's
Faculty of Engineering & Technology.
Faculty of Agricultural Sciences & Allied Industries.
Faculty of Commerce & Management.
Faculty of Juridical Sciences.
Faculty of Pharmaceutical Sciences.
Faculty of Professional Studies.

Subject: Marks Distribution Criteria Based on Attendance.

This notice is to inform you that if attendance is selected as an assessment component for any course, the following rubrics will be applied:

Attendance Percentage	Marks
96%-100%	100% of attendance marks
91%-95%	80% of attendance marks
86%-90%	60% of attendance marks
81%-85%	40% of attendance marks
75%-80%	20% of attendance marks
Below 70%	0 Marks

It is requested to you kindly disseminate this information to all faculty members and implement the same from the current academic session.

Prof. (Dr.) Indrajeet Gupta
Dean- Academic Affairs

Dean- Academic Affairs
Rama University Uttar Pradesh
Kanpur

Minutes of Meeting
Board of Study
Bachelor of Technology
(Biotechnology)

[Applicable w.e.f. Academic Session 2025-2026 till Revised]

FACULTY OF ENGINEERING & TECHNOLOGY
RAMA UNIVERSITY, UTTAR PRADESH, KANPUR

Website: www.ramauniversity.ac.in

Ref: RU/FET/BT/BOS/2025/001 **Dated: 21.08.2025**

Faculty of Engineering & Technology
Department of Biotechnology
Minutes of Meeting
Boards of Studies

The Board of Studies meetings of B. Tech. Biotechnology syllabus for coming session 2025-26 were held in the Dean's Office on 21.08.2025 at 10:00 a.m.

The following members were present:

1. Dr. Indrajeet Gupta - Convenor
2. Dr. Vivek Srivastava - Chairperson
3. Dr. Neeraj - Member
4. Dr. Ajay Kumar - Member
5. Dr. Deeksha Ranjan - Member
6. Dr. Shraddha Sahu - Member
7. Dr. Samakshi Verma - Member
8. Dr. Renu Verma - Member
9. Mr. Aman Pratap Singh - Member Absent (21/8/25)

The following members agreed to review the minutes.

1. Dr. Lalit Kumar Singh - External Member

Agenda:
Agenda Items:

1. **Proposed Change in the Scheme**
   Review and approval of modifications in the academic scheme for upcoming sessions.
2. **Proposed Change in the Credits and Course Nomenclature**
   Discussion on aligning course credits and titles as per updated academic and industry requirements.
3. **Proposed Change in Course Codes**
   Discussion on Standardization and modification of course codes to reflect curriculum restructuring and consistency for first year common subjects.

4. **Proposed Change in Syllabi and Introduction of New Evaluation Scheme**
   Examination and approval of revisions in existing syllabi to meet emerging technological trends.
   Introduction and implementation of a new evaluation scheme for better assessment of student learning.
5. **Incorporation of MOOCs in Syllabus**
   Integration of Massive Open Online Courses (MOOCs) into the curriculum to enhance learning outcomes.
6. **Incorporation of Flipped Classroom Approach**
   Adoption of flipped classroom methodology to improve student engagement and practical learning.
7. **Revision of External Examiner Panel**
   Review and update of the panel of external examiners for various courses and programs.

The BOS committee confirmed the minutes of the BOS meeting held on 21-Aug-2025

1. Action Taken Report (ATR) on Minutes of Previous Meeting.

The BOS committee reviewed and confirmed the minutes of the BOS meeting held on 27/06/2024.
The BOS Committee discussed on Action Taken Report on the basis of result analysis of session 2024-25 (Odd).

2. R-25 Scheme

R-25 scheme to meet industrial & academic requirements and align with AICTE 2020 guidelines.

3. To consider and approve new Evaluation Scheme and Syllabus.

S. No.	Item No.	Existing	Recommendation /Action Taken
1	**RU/FET/BT/BOS/2025/BTECH/001**	**Proposed Change in the Scheme** Students and faculty suggested revising the existing scheme to reduce redundancy, ensure better alignment with industry trends, and incorporate multidisciplinary flexibility as per AICTE 2020.	The Board of Studies (BOS) has accepted and recommended to revise the Syllabus and evaluation scheme possess 50:50 (50 marks Internal Assessment and 50 marks End Semester Examination) under R-25, restructuring the curriculum to ensure flexibility, skill-based learning, and alignment with AICTE 2020 provisions.
2	**RU/FET/BT/BOS/2025/BTECH/002**	**Proposed Change in the Credits and Course Nomenclature** Faculty emphasized rationalizing credits to balance workload; students requested clarity and uniformity in course titles to match industry standards.	The committee took the decision to rationalize credits as per AICTE 2020 guidelines and update course nomenclature to reflect industry relevance.

3	**RU/FET/BT/BOS/2025/BTECH/003**	**Proposed Change in Course Codes** Faculty suggested revising course codes to establish a systematic for easy identification reduce ambiguity across departments, to maintain common codes for first year engineering students and align with the revised scheme (R-25).	The Committee approved revision of course codes to ensure systematic classification and easy mapping with scheme and syllabus.
4	**RU/FET/BT/BOS/2025/BTECH/004**	**Proposed Change in Syllabi and Introduction of New Evaluation Scheme** Feedback indicated need for inclusion of modern subjects (Entreprenuership and Startups, Bioseparation Engineering, etc.) and more continuous assessment methods.	The committee took the decision to update the syllabi with industry-oriented courses **and** emerging technologies, and to introduce a new evaluation scheme with greater weightage for projects, assignments, and continuous assessment.
5	**RU/FET/BT/BOS/2025/BTECH/005** (In reference with Circular No: RU/DA/2025/020 Dated: 28 July 2025)	**Incorporation of MOOCs in Syllabus** Faculty and students requested flexibility to pursue online courses (SWAYAM, NPTEL, Coursera) for skill enhancement.	The committee took the decision to incorporate MOOCs in the curriculum, allowing credit transfer (up to 20%) as per AICTE norms.
6	**RU/FET/BT/BOS/2025/BTECH/006**	**Incorporation of Flipped Classroom Approach** Students preferred interactive and practice-oriented sessions; faculty supported blended learning to increase participation.	The committee took the decision to formally introduce the flipped classroom pedagogy and circulate guidelines to faculty for effective implementation as per requirement.
7	**RU/FET/BT/BOS/2025/BTECH/007**	**Course Bucket Structure under R-25** Students and faculty suggested increasing elective choices and introducing structured specialization options.	The committee took the decision to approve the following bucket structure under **R-25**: • **Professional Elective Bucket – 22 Courses** • **Open Elective Bucket – 5 Courses**

3. Revision of External Examiner Panel: Faculty recommended updating the panel to include experts from both academia and industry. The committee took the decision to revise the external examiner panel, including industry experts and academicians from reputed institutions.

4. Question Paper Format: The question paper format, as per NAAC/NBA requirements, includes a dedicated column for CO (Course Outcome) mapping against each question. This ensures clear alignment of assessment items with defined learning outcomes, facilitates transparent evaluation, and supports accreditation compliance through measurable and outcome-based education practices.

5. Result Analysis: Summary of Result Analysis of the student's performance in the semester examination 2024-25 was presented and it was suggested that the course instructors should conduct remedial classes for the students whose performance was not found satisfactory and the subjects where results are below standards. **(Annexure -1).**

6. Feedback Analysis: Analysis was performed based on summary of already collected feedback from students and the course instructors have been instructed for improvement in teaching pedagogy for better understanding of students in the cases where the feedback is below average.

7. Short term course: In upcoming session 2025-26, we have proposed short term course on **"Applied Microbiology and Molecular Biology"** which was approved previously will be continued in the upcoming session.

8. Any other issue with the permission of the Chair: No

The meeting concluded with a vote of thanks to the chair.

Date of the Next Meeting: to be decided and conveyed later

Convenor

Signature: .....

Name: Dr. Indrajeet Gupta

Chairperson

Signature: .....

Name: Dr. Vivek Srivastava

Internal Members

Signature: 1. .....

Name: Dr. Neeraj

Signature: 2..... 21/8/2025

Name: Dr. Ajay Kumar

Signature: 3.....

Name: Dr. Deeksha Ranjan

Signature: 4..... 21/08/2025

Name: Dr. Shraddha Sahu

Signature: 5..... 21/8/25

Name: Dr. Samakshi Verma

Signature: 6..... 21/08/25

Name: Dr. Renu Verma

Signature: 7... ABSENT (21/8/25)

Name: Mr. Aman Pratap Singh

External Members

Signature: 1..... 21/08/2025

Name: Dr. Lalit Kumar Singh

Date: 21/8/25

Encl.: Recommended Curricula attached for consideration and approval.

CC:

1. Dean
2. Registrar Office

B. Tech. (BT) 2025-26

Program Educational Objectives

At Rama University Biotechnology program will prepare its graduates to:

PEO 1: Work productively as successful Computer professionals in diverse career paths including supportive and leadership roles on multidisciplinary teams or be active in higher studies,

PEO 2: Communicate effectively, recognize and incorporate societal needs and constraints in their professional endeavors, and practice their profession with high regard to ethical responsibilities,

PEO 3: Engage in life-long learning and to remain current in their profession to foster personal and organizational growth.

Program Specific Outcomes

PSO 1: Apply standard biotechnological practices and interdisciplinary approaches in real-time research and industrial projects using modern tools and techniques to deliver sustainable and quality solutions in healthcare, agriculture, and environmental sectors.

PSO 2: Design and develop innovative biological processes, products, or systems in areas related to genetic engineering, molecular biology, bioinformatics, bioprocess technology, and industrial biotechnology with varying levels of complexity.

PSO 3: Acquaint with contemporary trends and advancements in biotechnology and related research or industrial domains, and thereby innovate novel and ethical solutions to address current and future global challenges.

Program Outcomes:

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society

and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions.

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modeling recognizing their limitations to solve complex engineering problems.

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws.

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.

Office of the Dean Academic		RAMA UNIVERSITY UTTAR PRADESH, KANPUR (Vide U.P. Act No. 1 of 2014 as passed by State Legislature and recognized by UGC U/s 2(f)) Rama City, G.T. Road (Near Mandhana Railway Station) Mandhana, Kanpur

Ref.No.: RU/DA/2025/020 **DATE: 28.07.2025**

To,

1. All Deans/Except (Medical, Dental, Nursing, Paramedical and Pharma)
2. C.O.E.

Subject: MOOC Credit Exemption for Graduating Students in 2024-25 and Revised MOOC Integration

Following discussions with the Controller of Examinations (COE) in the Deans Meeting on July 23, 2025, and in relaxation of the conditions stated in notice **Ref No. R.U./Reg./2021/10 dated January 6, 2021**, it is decided that students who have completed their academic requirements for the AY 2024-25 are exempted from the mandatory MOOC course requirement. This exemption applies only to students graduating in the 2024-25 academic year.

All currently enrolled students are required to complete MOOC courses as per their year of study, proportional to the total program credits. The revised structure is as follows:

UG/PG Program Duration	Required/Desirable Credit Score*
2 Years	8
3 Years	12
4 Years	16
5 Years	20

*Concerned faculty/institutes (FET, FCM, FASAI, FPS) may decide to incorporate various learning modes, the AICTE Model Curriculum 2022 may be referred.

This decision has been taken with the approval of the Competent Authority.

Copy to: -

1- Secretary to Hon'ble Chancellor.
2- Secretary to Hon'ble Vice Chancellor
3- Hon'ble Director
4- Controller of Examination (COE)
5- Registrar for the necessary approval in AC & EC
6- Deputy Registrar/A.R./C.O.E.

Dr. Indrajeet Gupta
Dean Academic Affairs

Dean- Academic Affairs
Rama University Uttar Pradesh
Kanpur

M

B.Tech (
2025

RAMA UNIVERSITY

Faculty of Engineering & Technology

ORDINANCE

For

PROGRAMME

B.Tech. (Biotechnology)

2025-26

1. Program Name & Code

- **Program Name:** Bachelor of Technology in Biotechnology (B. Tech. Biotechnology)
- **Program Code:** 508

2. Eligibility Criteria

2.1. Admission to B. Tech. Biotechnology First Year:

Candidates who have passed Intermediate (10+2) qualifying examination from U.P. Board or its equivalent from any other recognized Board/University with a minimum of five subjects in which Physics and Mathematics or Biology are compulsory subjects along with one of the subjects from Chemistry/ Biotechnology/ Computer Science/ Technical Vocational subject with min. 50% (45% for SC/ST/OBC-NCL/PwD) aggregate marks in above three subjects. Programme offered by Faculty of Engg. & Technology, Rama University, Kanpur.

2.2. Admission to B.Tech. Biotechnology Second Year through Lateral Entry Scheme:

Candidates who have passed 3/4-year Diploma (with minimum 50% marks) from institutions recognized by the Board of Technical Education in Biotechnology / Chemical Engineering/ Food Technology/ Pharmacy or other relevant/allied fields of Engineering & Technology

OR

Candidate with a B.Sc. degree in Biology / Physics / Mathematics Chemistry / Environmental Science / related subjects (with minimum 50% marks) from a recognized University may also be eligible for admission to Second year in B.Tech. Biotechnology

3. Admission Procedure

1. Admission shall be made **strictly on the basis of merit** in the qualifying examination/entrance test conducted by Rama University (RUET) or as per guidelines of statutory bodies.
2. Reservation policy as per Government of Uttar Pradesh/University norms will be followed.
3. Final selection will be subject to verification of original documents and fulfillment of eligibility criteria.

4. Duration of Program

(i) The program shall consist of regular study for a minimum period of 8 semesters in four academic years.

(ii) The program shall consist of regular study for a minimum period of 6 semesters in three academic years for lateral entry.

(iii) The 3rd, 5th, and 7th semesters shall ordinarily be from 1st July to 31stDecember; and the remaining semesters shall be from 1st January to till 30th June, Subject to change, if any notified by the Vice Chancellor and other competent authorities; from time to time. The periods are inclusive of the time for examinations.

(iv) Total duration of the B.Tech. Program shall be 4 years, each year comprising of two semesters. Each semester shall normally have teaching for the 90 working days or as prescribed by UGC from time to time.

(v) A candidate, who has failed twice in first year due to any reason (either due to his/her non-appearance or he/she being not permitted to appear in semester examinations) shall not be allowed to continue his/her studies further as per University Norms.

5. Maximum Duration

The maximum permissible period for completing a programme for which the prescribed programme duration is n semesters, shall be (n+2) semesters. All the programme requirements shall have to be completed in (n+2) semesters. Under very special circumstances the duration of the total period may further be extended by a maximum of two (2) semesters with the approval of the Vice Chancellor. This excludes the period of expulsion or suspension by the University / medical leave.

6. Medium of Instruction

1. The medium of instruction and examination shall be English.
2. Technical terms in Hindi may be used wherever necessary to enhance comprehension.

7. Number of seats

Number of students to be admitted each year and the number of batches shall be decided and notified by the University from time to time; based upon the Rules, instructions and Notifications issued by UGC/AICTE.

8. Fee

A student shall pay the fee prescribed by the University from time to time.

9. Curriculum

The 4 Year curriculum has been divided into 8 Semesters and shall include lectures, practical's, seminars and projects in addition to industrial training etc. as defined in the

scheme and executive instructions issued by the University from time to time. The curriculum will also include such other curricular, co-curricular and extra- curricular activities as may be prescribed by the University from time to time.

10. Change of Branch:

Change of branch may be allowed against the vacant seats in the following two stages, provided criteria at following points are satisfied:

(i) In first year, after the last date of admission to the B.Tech. I semester, on the basis of merit of (10+2) examination marks on vacant seat, student can change his/her branch.
(ii) After change of branch, number of students in branch(s) shall neither increase over the intake approved by UGC or AICTE. nor it will decrease below 75% of intake approved by UGC or AICTE.
(iii) Further change of branch shall not be permitted.

11. Structure of the Program

The program shall follow the model of AICTE curriculum (2020) for B.Tech. Biotechnology, comprising:

S. No.	Category	AICTE Credits	Credits Achieved by our department
1	BSC	19	16
2	HSC	15	10
3	ESC	16	15
4	BSE	19	23
5	MC	-	5
6	AUC	0	0
7	OEC	18	12
8	PCC	43	45
9	PRC	18	18
10	PEC	18	18
Total Credits		**163**	**162**

HSC: Humanities and Social Sciences including Management Courses
BSC: Basic Science Courses
ESC: Engineering Science Courses
PCC: Professional Core Courses
PEC: Professional Elective Courses
OEC: Open Elective Courses
PRC: Project Work, Seminar, Internship Courses

MC: Mandatory Courses
AUC: Audit Cources
BSE: : Biotechnology Science &Engineering

Credit requirement for award of degree: ~160 credits (as per UGC norms).

12. Marks/Credits Distribution

a. Sessional (Internal Assessment):

The internal assessment for each course will be based on the following components: **Continuous Assessment (CA):** 30 marks (includes class tests, assignments, attendance, participation, quizzes, etc.)
Mid-Term Examination/ Pre-University Test (MTE/PUT): 20 marks (conducted centrally during the semester)

Thus, the **total internal assessment = 50 marks (50% weightage)** for theory and practical courses.

For **Theory courses**, internal assessment shall be carried out through includes class tests, assignments, attendance, participation, quizzes, etc. with the same distribution (CA = 30, MTE = 20).

For **Laboratory/practical courses**, internal assessment shall be carried out through regular performance, records, assignments, and viva-voce examinations, with the same distribution (CA = 30, MTE = 20).

For **Project Work / Internships / Seminars**, evaluation will follow a specific pattern:

CA = 25/110* marks (Progress Evaluation, Attendance, Report Submission)

MTE = 25/90* marks (Mid-Term Presentation/Review)

*Those Students are engaged in Industrial Project/R&D Project/Industry Internship/Start-up/Externship after VI Semester.

b. Semester Examinations (External Evaluation):

End-Term Examination (ETE): 50 marks (50% weightage) for each course. The format of the question paper shall include Course Outcome (CO) mapping as per Outcome-Based Education (OBE).

Important Points:

(i) To qualify a subject a student is required to secure a minimum of 30% marks in both internal as well as external separately and grand total required for a subject is minimum

40%. A student who secure less than 50% of marks in aggregate in a semester shall be deemed to have failed in that semester.
(ii) The minimum pass marks in a project/practical subject (including sessional marks if any) shall be 50% (internal 50%, External 50% and aggregate 50%).
(iii) A candidate, in order to pass, must secure 50% marks in the aggregate in a particular academic year inclusive of each semesters of the academic year.
(iv)The minimum pass marks in Seminar, Industrial Training and Educational Tour, Viva-Voice etc shall be 50%.
(v) In Non-Credit Courses (Non grading courses) a student's must secure 40% marks to qualify the courses.

c. Credit Calculation:
1 Credit = 1 hour of theory per week OR 2 hours of practical/field work per week.
Example: L-T-P of 3-1-0 = 4 credits; L-T-P of 3-0-2 = 4 credits.
A "credit" is the academic unit measuring course workload and determines instructional hours required per week.

Internships and Industrial Training will be evaluated separately as per AICTE /University norms, with Pass/Fail or Grade status depending on the course design.

d. Cumulative Grade Point Average (CGPA): It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

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

13. Evaluation Procedure

a. **Sessional:** The laboratory course sessional evaluations shall be performed continuously based on practicalperformed by a student. Such evaluation may involve periodic assessment of documentation of the practical exercise/experiment, precision of experiment etc. In the case of Project /Dissertation the Internal Assessment may be based on periodical progress report.
b. **Semester Examination:** The Semester Examination shall commence during the first week of December/May for the Odd semester/Even semester courses, respectively.
c. **Appointment of Examiners:** Head of the department shall normally appoint the examiners for differentcourses, selecting at least two other than the concerned teachers, randomly for theory courses in each of the semesters. In case of Lab/Projects/Viva-Voce examinations there shall be one internal and one external examiner. A sizable panel of external examiners shall be approved by the BOS on annual basis to facilitate the appointment of external examiners.

d. **Moderation:** A committee duly constituted by BOS as follows, shall moderate the examination papers andshall have the right to improve / change the questions to a considerable extent:

i. Dean
ii. Head of the department
iii. Three Faculty Members nominated by the Dean

e. **Examination & Evaluation System:** All the evaluations shall be performed in terms of marks, adding finally for each course out of 100 marks. The marks obtained by each student in courses shall be converted to Grade-Points. Uniform Grading system to be followed with uniform CGPA requirements for award of degrees at all levels and uniform conversion formulae to be followed for declaration of I, II and III divisions, distinctions etc. Declaration of division in the degree certificate to be made compulsory.

f. **Examination:** Paper to be set by external: HOD shall ensure the coverage of syllabus. If needed moderation can be done. Evaluation to be done internally by the faculty other than the Course Instructor. Syllabus of the concerned course shall be sent to the external examiner, who shall prepare the question papers. For practical, it is recommended that examination shall be conducted by course instructor(s) and one teacher nominated by HOD.

i) Evaluation: Relative grading shall be adopted at the Faculty of Engineering & Technology, Rama University. The list of letter grades, the grade points associated with them are given below:

Degree	Grade	Grade Point
B.Tech Biotechnology	O	10
	A	9
	B	8
	C	7
	D	6
	E	5
	F	0

Conversion to Percentage

Percentage (%) equivalent to SGPA/CGPA/CPI earned by a candidate may be calculated using the following formula:

Percentage of Marks= SGPA/CGPA/CPI × 10 - 4.5

A student obtaining Grade F shall be considered failed and will be required to reappear in the examination.

ii) **Transcripts (Format):** Based on the above recommendations on Letter grades, grade points, SGPA and CGPA, the Higher Education Institutions may issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

g. MOOCs Courses: As per the mandates of UGC, the students have to register in the MOOCs online Courses. By keeping in the mind, the credits of B.Tech. Biotechnology Graduates, they have to complete at least 16 credits MOOCs courses in their entire degree program.

h. Division and Position: The division shall be awarded on the basis of final year result as given below in Table:

Percentage (%)	Division
Below 50%	Fail
50%-64.99%	II Division
65%-74.99%	I Division
75% & above	I Division with Honors

i. Review and Re-evaluation:

Review and re-evaluation of the answer sheets shall be as per the University rules.

j. Grade Card:

At the end of each semester, a student will be given a 'Grade Card' which will contain Course Code, Title, Credits, Grades Awarded, Earned Credits and Earned Point secured by him/her in each course, together with his/her SGPA in that semester. On the completion of the programme, a Final Grade Card will be issued to the student, giving full semester-wise details about the absolute marks and grades obtained by him/her in each course together with his/her SGPA and also the CGPA and Division awarded to him/her.

k. Equivalence:

20.2 Calculation System of Semester Grade Point Average:

Computation of the Semester Grade Point Average (SGPA) and Cumulative Performance Index (CPI):

Semester Grade Point Average (SGPA)

SGPA is the weighted average of grade points obtained in all courses of a semester.

$$SGPA = \Sigma(Ci \times Gi) / \Sigma Ci$$

Where:
Ci = Credit of the i-th course
Gi = Grade point obtained in the i-th course

Cumulative Performance Index (CPI)

CPI (sometimes called CGPA) is the weighted average of SGPA across all semesters completed.

$$CPI = \Sigma(SGPAj \times Tj) / \Sigma Tj$$

Where:
SGPAj = SGPA of j-th semester
Tj = Total credits of j-th semester

Conversion to Percentage

Percentage (%) equivalent to SGPA/CGPA/CPI earned by a candidate may be calculated using the following formula:

Percentage of Marks= SGPA/CGPA/CPI × 10 - 4.5

14. Rules for Backlogs / Supplementary Exams

1. A student failing in one or more courses may appear in the **supplementary examination** conducted by the University.
2. Supplementary exams will be held within the notified schedule and as per University rules.
3. Maximum permissible backlogs for promotion: As per University promotion rules.
4. Students failing to clear backlogs within the **maximum duration** will not be awarded the degree.

15. Special Academic Requirements

2. Internship is mandatory for degree award; absence or failure will require repetition in the next academic cycle.
3. Students must maintain **minimum 75%** attendance in each course to be eligible for appearing in examinations.

16. Other Specific Rules

1. Ragging in any form is strictly prohibited and punishable under University and State laws.
2. Students must adhere to the Code of Conduct prescribed by Rama University.
3. Wearing of prescribed Uniform during practical/field work is mandatory.
4. Use of unfair means in examination will lead to disciplinary action as per University Examination Ordinance.

17. Exit Options (in Line with NEP Guidelines)

Not Applicable

18. Promotion

A candidate satisfying all the criteria under headings 8 (Marks/Credit Distribution) and 9 (Evaluation Procedure) shall be promoted to the next academic year of study including following points as per requirements:

(i) He/ She should either completely clear all the subject of any of the semester of an academic year or earn the credit greater than or equal to the minimum credits of either of the semester of that academic year.
(ii) A candidate shall not be promoted to third year unless he/she passes all the subjects of first year. Similarly, a candidate shall not be promoted to fourth year unless he/she passes all the examinations of second year.
(iii) In yearly result, a student shall be declared PASS only of he/ she secures above grades in all the subjects and minimum Semester Grade Point Average (SGPA) of 5.0, in each semester of an academic year.
(iv) If a candidate satisfies the criteria of **Examination** (discussed in point 8) but fails to satisfy the requirement of securing 50% marks in the aggregate in a particular academic year inclusive of each semesters of the academic year (discussed in 12.b.iii) then, he/she shall be eligible for provisional promotion with carry over. He/she may choose up to a maximum of any four theory papers of that particular academic year as per his/her choice to pass the examination of that year.

19. Carryover System

(a) A candidate who satisfies the point 18 (i) and 18 (iii) will be required to appear in those theory papers / practicals in which he/she failed. However, a candidate of first year will be allowed to appear in the second semester examination in those theory/ practical subjects in which he/she failed in the first semester examination, provided examination of those theory/practical subjects are held in second semester.

(b) A candidate satisfying the point 18 (iv) shall be required to exercise his/her choice up to a maximum of Six theory papers in which he/she desires to appear in the examination to fulfill and satisfy the requirement of securing 50% marks in the aggregate in a particular academic year inclusive of each semesters of the academic year (discussed in 12.b.iii). He/she shall inform the college about his/her choice within 15 days after the start of new session.

The highest marks secured in any subject in various attempts (end semester and carryover examinations) shall be considered.

20. Ex-studentship

A candidate opting for ex-studentship shall be required to appear in all the theory & practical subjects in the end semester examinations of both semesters of the same academic year. However, the marks pertaining to Sessional, Industrial Training, and Seminar shall remain the same as those secured earlier.

A candidate opting for ex-studentship shall be required to apply to the FET by paying only examination fee within 15 days from the start of new session.

21. Re-admission

a. A candidate may be allowed for re-admission provided he/she satisfies one of the following conditions:
b. A candidate is declared fail.
c. A candidate did not appear in a semester examination / or he/she was not granted permission to appear in the examination.
d. A candidate has been detained by the department and subsequently has been permitted to take re-admission.
e. A candidate as an ex-student passed the examination of the academic year or qualified for carryover system.
f. A candidate promoted with carry over subjects and he/she opted for re- admission.

22. Results

The result of a candidate shall be declared on the basis of performance of both semesters of the same academic year. However, a final year student, who is not permitted in any one of the final year semester examinations due to shortage of attendance, will be permitted in that particular semester of the next academic session to study as a regular student and appear at that semester examination.

23. Scrutiny and Revaluation

a. Scrutiny shall be allowed in maximum three theory papers only as University norms.
b. Revaluation shall be allowed in maximum three theory papers only as University norms.

24. Unfair means

Cases of unfair means shall be dealt as per the rules of the University and The U.P. Public Examination (Prevention of Unfair means) Act if any in prevalence.

25. Cancellation of Admission

The admission of a student at any stage of study shall be cancelled if:

(i) He / She is not found qualified as per UGC/AICTE / State Government norms and guidelines or the eligibility criteria prescribed by the University.

or

(ii) He / She is found unable to complete the course within the stipulated time as discussed in point 4 (v).

or

(iii) He / She are found involved in creating indiscipline in the FET or in the University.

26. The Academic Council shall have the power to relax any provision provided in the ordinance in any specific matter/situation subject to the approval of Executive Council of the University & such decision(s) shall be reported to the Chancellor of the University.

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I SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**CA**	**MTE**	**ETE**	**Total**
1	BSC	BCN 1003/BCN 2007	Chemistry	3	0	0	3	30	20	50	100
2	BSC	BBT 1001	General Mathematics-I	3	1	0	4	30	20	50	100
3	HSC	BCN 1008/BCN 2004	Life Skills: Entrepreneurship, Language, Communication and Personality	3	0	0	3	30	20	50	100
4	ESC	BCN 1004	Problem Solving using Programming	3	0	0	3	30	20	50	100
5	BSE	BBT 1002	Exploring the Biotechnology	3	0	0	3	30	20	50	100
6	BSC	BCN 1053/BCN 2057	Chemistry Laboratory	0	0	2	1	30	20	50	100
7	ESC	BCN 1054	Problem Solving using Programming Laboratory	0	0	2	1	30	20	50	100
8	BSE	BBT 1051	Basic Biotechnology Laboratory	0	0	2	1	30	20	50	100
9	HSC	BCN 1058/BCN 2054	Life Skills: Entrepreneurship, Language, Communication and Personality Laboratory	0	0	2	1	30	20	50	100
			Total	**15**	**1**	**8**	**20**	**270**	**180**	**450**	**900**
Total Credits Up to 1st Semester				**20**							

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II SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**CA**	**MTE**	**ETE**	**Total**
1	BSC	BCN 2002/BCN 1007	Physics	3	0	0	3	30	20	50	100
2	BSC	BBT 2001	General Mathematics-II	3	1	0	4	30	20	50	100
3	MC	BCN 2005	Universal Human Values-II: Understanding Harmony And Ethical Human Conduct	2	1	0	3	30	20	50	100
4	BSE	BBT 2002	Remedial Biology	3	0	0	3	30	20	50	100
5	ESC	BCN 2008/BCN 1005	Mechanical Engineering and Robotics	3	0	0	3	30	20	50	100
6	AUC	BCN 2006	Hobbies, Co-Curricular and Extra-Curricular	2	0	0	0	30	20	50	100
7	BSC	BCN 2052/BCN 1057	Physics Laboratory	0	0	2	1	30	20	50	100
8	BSE	BBT 20052	Remedial Biology Laboratory	0	0	2	1	30	20	50	100
9	ESC	BCN 2058/BCN 1055	Workshop/Manufacturing Practices Laboratory	0	0	2	1	30	20	50	100
10	ESC	BCN 2059	Design thinking and innovation Laboratory	0	0	2	1	30	20	50	100
			Total	**16**	**2**	**8**	**20**	**300**	**200**	**500**	**1000**
Total Credits Up to 2nd Semester				**40**							

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III SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**CA**	**MTE**	**ETE**	**Total**
1	BSE	BBT 3001	Genetics	2	0	0	2	30	20	50	100
2	ESC	BBT 3002	Digital System	2	0	0	2	30	20	50	100
3	BSE	BBT 3003	Biostatistics	2	0	0	2	30	20	50	100
4	BSE	BBT 3004	Essential Microbiology	2	0	0	2	30	20	50	100
5	ESC	BBT 3005	Fluid Flow and Heat-Mass Transfer	3	0	0	3	30	20	50	100
6	BSE	BBT 3006	Biochemistry	3	0	0	3	30	20	50	100
7	PCC	BBT 3007	Analytical Techniques	3	0	0	3	30	20	50	100
8	PEC	BBTP 101-BBTP 122	Professional Electives-I	3	1	0	4	30	20	50	100
9	BSE	BBT 3051	Biochemistry Laboratory	0	0	2	1	30	20	50	100
10	BSE	BBT 3052	Microbiology Laboratory	0	0	2	1	30	20	50	100
11	ESC	BBT 3053	Fluid Flow and Heat-Mass Transfer Laboratory	0	0	2	1	30	20	50	100
12	PRC	BBT 3054	Technical Seminar	0	0	2	1	25	25	50	100
13	MC	BCN3007	Humanities-I	2	0	0	2	30	20	50	100
			Total	**22**	**1**	**8**	**27**	**385**	**265**	**650**	**1300**
			Total Credits Up to 3rd Semester	**67**							

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IV SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**CA**	**MTE**	**ETE**	**Total**
1	BSE	BBT 4001	Cell & Molecular Biology	3	0	0	3	30	20	50	100
2	PCC	BBT 4002	Plant and Animal Biotechnology	3	0	0	3	30	20	50	100
3	PEC	BBTP 101-BBTP 122	Professional Electives-II	2	0	0	2	30	20	50	100
4	OEC	BBTO 101-BBTO 105	Open Electives-I	3	0	0	3	30	20	50	100
5	PCC	BBT 4007	Immunology & Immunotechnology	3	0	0	3	30	20	50	100
6	PCC	BBT 4008	Enzyme Technology	3	0	0	3	30	20	50	100
7	HSC	BBT 4009	Engineering Economics	2	0	0	2	30	20	50	100
8	HSC	BBT 4010	Intellectual Property Rights (IPR) & Regulatory Affairs	1	1	0	2	30	20	50	100
9	PRC	BBT 4051	Comprehensive Viva-voce	0	0	2	1	25	25	50	100
10	BSE	BBT 4052	Cell & Molecular Biology Laboratory	0	0	2	1	30	20	50	100
11	PCC	BBT 4053	Immunotechnology Laboratory	0	0	2	1	30	20	50	100
12	PCC	BBT 4054	Enzyme Technology Laboratory	0	0	2	1	30	20	50	100
13	MC	BCS4007	Environmental Sciences	2	0	0	0	30	20	50	100
			Total	**22**	**1**	**8**	**25**	**385**	**265**	**650**	**1300**
Total Credits Up to 4th Semester				**92**							

 # Internship-I needs to be done in Summer Break after Semester-IV and will be considered for evaluation in Semester-V.

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V SEM											
S No	Course Category	Course Code	Course Name	L	T	P	C	CA	MTE	ETE	Total
1	HSC	BBT 5001	Entreprenuership and Startups	1	1	0	2	30	20	50	100
2	PCC	BBT 5002	Fermentation Technology	3	0	0	3	30	20	50	100
3	PCC	BBT 5003	rDNA Technology	3	0	0	3	30	20	50	100
4	PCC	BBT 5004	Bioinformatics-I	3	0	0	3	30	20	50	100
5	PCC	BBT 5005	Good Manufacturing and Laboratory Practice	3	0	0	3	30	20	50	100
6	PEC	BBTP 101-BBTP 122	Professional Elective-III*	3	1	0	4	30	20	50	100
7	PEC	BBTP 151-BBTP 155	Professional Elective-III* Laboratory	0	0	2	1	30	20	50	100
8	PCC	BBT 5051	Bioinformatics-I Laboratory	0	0	2	1	30	20	50	100
9	PCC	BBT 5052	rDNA Technology Laboratory	0	0	2	1	30	20	50	100
10	PCC	BBT 5053	Fermentation Technology Laboratory	0	0	2	1	30	20	50	100
11	PRC	BBT 5054	Summer Internship-I	0	0	4	2	25	25	50	100
12	MC	BCN5007	Essence of Indian Knowledge Tradition	2	0	0	0	30	20	50	100
			Total	**18**	**2**	**12**	**24**	**355**	**245**	**600**	**1200**
Total Credits Up to 5th Semester				**116**							

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VI SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**CA**	**MTE**	**ETE**	**Total**
1	PCC	BBT 6001	Bioprocess Engineering	3	0	0	3	30	20	50	100
2	PCC	BBT 6002	Metabolic Engineering	3	0	0	3	30	20	50	100
3	PCC	BBT 6003	Bioinformatics-II	3	0	0	3	30	20	50	100
4	PEC	BBTP 101-BBTP 122	Professional Electives-IV*	3	0	0	3	30	20	50	100
5	PEC	BBTP 101-BBTP 122	Professional Electives-V	2	1	0	3	30	20	50	100
6	OEC	BBTO 101-BBTO 105	Open Elective-II	3	0	0	3	30	20	50	100
7	PCC	BBT 6051	Bioprocess Engineering Laboratory	0	0	2	1	30	20	50	100
8	PCC	BBT 6052	Metabolic Engineering Laboratory	0	0	2	1	30	20	50	100
9	PCC	BBT 6053	Bioinformatics-II Laboratory	0	0	2	1	30	20	50	100
10	PEC	BBTP 151-BBTP 155	Professional Electives-IV* Laboratory	0	0	2	1	30	20	50	100
			Total	**17**	**1**	**8**	**22**	**300**	**200**	**500**	**1000**
Total Credits Up to 6th Semester				**138**							
*** Students have to Opt those PEC Theory Course having laboratory**											
# Internship-II needs to be done in Summer Break after Semester-VI and will be considered for evaluation in Semester-VII.											

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VII SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**CA**	**MTE**	**ETE**	**Total**
1	PCC	BBT 7001	Bioseparation Engineering	3	0	0	3	30	20	50	100
2	OEC	BBTO 101-BBTO 105	Open Electives-III	3	0	0	3	30	20	50	100
3	PRC	BBT 7051	Project-I	0	0	4	2	25	25	50	100
4	PRC	BBT 7052	Summer Internship-II	0	0	6	3	25	25	50	100
5	PCC	BBT 7053	Bioseparation Engineering Laboratory	0	0	2	1	30	20	50	100
			Total	**6**	**0**	**12**	**12**	**140**	**110**	**250**	**500**
*** Students have to Opt those PEC Theory Course having laboratory**											
or											
1	OEC	BBTO 101-BBTO 105	Open Elective-III	3	0	0	3	30	20	50	100
2	PRC	BBT 7054	Industrial Project/R&D Project/Industry Internship/Start-up/Externship	0	0	18	9	110	90	200	400
			Total	**3**	**0**	**18**	**12**	**140**	**110**	**250**	**500**
Total Credits Up to 7th Semester				**150**							

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VIII SEM											
S No	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**CA**	**MTE**	**ETE**	**Total**
1	OEC	BBTO 101-BBTO 105	Open Electives-IV	2	1	0	3	30	20	50	100
2	PRC	BBT 8051	Project-II (Biotech Industrial or Biotech In-house Project or Bio-Entrepreneurship)	0	0	18	9	25	25	50	100
			Total	**2**	**1**	**18**	**12**	**55**	**45**	**100**	**200**
			Total Credits Up to 8th Semester	**162**							

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Professional Electives											
S. No.	Course Category	Course Code	Course Name	L	T	P	Credit	CA	MTE	ETE	Total
1	PEC*	BBTP 101	Food Biotechnology	3	1	0	4	30	20	50	100
2	PEC*	BBTP 102	Stem Cell Technology	3	1	0	4	30	20	50	100
3	PEC*	BBTP 103	Gene Expression and Transgenics	3	1	0	4	30	20	50	100
4	PEC*	BBTP 104	Environmental Biotechnology	3	0	0	3	30	20	50	100
5	PEC*	BBTP 105	Molecular diagnostics and its applications	2	0	0	2	30	20	50	100
6	PEC	BBTP 106	Synthetic Biology	3	0	0	3	30	20	50	100
7	PEC	BBTP 107	Genome Editing	3	1	0	4	30	20	50	100
8	PEC	BBTP 108	Biosimilars Technology	3	1	0	4	30	20	50	100
9	PEC	BBTP 109	Applications of Natural Products	3	1	0	4	30	20	50	100
10	PEC	BBTP 110	Medical biotechnology	3	1	0	4	30	20	50	100
11	PEC	BBTP 111	Bioterrorism and National Security	2	0	0	2	30	20	50	100
12	PEC	BBTP 112	Tissue Engineering	2	0	0	2	30	20	50	100
13	PEC	BBTP 113	Rational Drug Discovery	2	0	0	2	30	20	50	100
14	PEC	BBTP 114	Precision Medicine & Wellness	3	0	0	3	30	20	50	100
15	PEC	BBTP 115	Nano Biotechnology	2	1	0	3	30	20	50	100
16	PEC	BBTP 116	Agro Biotechnology	2	1	0	3	30	20	50	100
17	PEC	BBTP 117	Food Safety and Quality Management	3	0	0	3	30	20	50	100
18	PEC	BBTP 118	Marine Biotechnology	2	1	0	3	30	20	50	100

19	PEC	BBTP 119	Pharmaceutical Biotechnology	3	0	0	3	30	20	50	100
20	PEC	BBTP 120	Genomics and Proteomics	2	1	0	3	30	20	50	100
21	PEC	BBTP 121	Cancer Biology	3	0	0	3	30	20	50	100
22	PEC	BBTP 122	Industrial Biotechnology	2	1	0	3	30	20	50	100
23	PEC*	BBTP 151	Food Biotechnology Laboratory	0	0	2	1	30	20	50	100
24	PEC*	BBTP 152	Stem Cell Technology Laboratory	0	0	2	1	30	20	50	100
25	PEC*	BBTP 153	Gene Expression and Transgenics Laboratory	0	0	2	1	30	20	50	100
26	PEC*	BBTP 154	Environmental Biotechnology Laboratory	0	0	2	1	30	20	50	100
27	PEC*	BBTP 155	Molecular diagnostics and its applications Laboratory	0	0	2	1	30	20	50	100

*** Students will have to opt from these Courses in PEC-III & PEC-IV only**

Open Electives											
S. No.	**Course Category**	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credit**	**CA**	**MTE**	**ETE**	**Total**
1	OEC	BBTO 101	Waste Management & Upcycling	3	0	0	3	30	20	50	100
2	OEC	BBTO 102	Food and Nutrition Technology	3	0	0	3	30	20	50	100
3	OEC	BBTO 103	Biotechnology for Forensics	3	0	0	3	30	20	50	100
4	OEC	BBTO 104	Drug Design & Discovery	3	0	0	3	30	20	50	100
5	OEC	BBTO 105	Biomaterials	2	1	0	3	30	20	50	100

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Terminology and Abbreviation
L-T-P: Lecture-Tutorial-Practical hours per week.
Credits: Calculated as per AICTE norms (1 credit per lecture/tutorial hour, 0.5 credits per practical hour).
HSC: Humanities and Social Sciences including Management Courses
BSC: Basic Science Courses
ESC: Engineering Science Courses
PCC: Professional Core Courses
PEC: Professional Elective Courses
OEC: Open Elective Courses
PRC: Project Work, Seminar, Internship Courses
MC: Mandatory Courses
AUC: Audit Cources
BCN: Bachelor Common Courses
BBTP: Biotechnology Professional Electives
BBTO: Biotechnology Open Electives
MOOC: As per page no 191 of AICTE Model Curriculum for UG Degree Course 2022

S. No.	Category	AICTE Credits	Credits Achieved by our department
1	BSC	19	16
2	HSC	15	10
3	ESC	16	15
4	BSE	19	23
5	MC	-	5
6	AUC	0	0
7	OEC	18	12
8	PCC	43	45
9	PRC	18	18
10	PEC	18	18
Total Credits		**163**	**162**

Bachelor of Technology (B. Tech): Syllabus

Biotechnology

Semester-I

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Chemistry (BCN 1003)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course examines biotechnology's history, genetic engineering, diagnostics, plant biotechnology, and food production, integrating interdisciplinary principles and ethical considerations to address health, agricultural, and sustainability challenges.

Course Outcomes (COs):

CO1: To enable the students to understand the Chemistry of Atomic and Molecular structure, band structure of solids, chemistry of advanced Materials like Liquid crystals, Nano materials and Graphite & fullerenes.

CO2: To enable the students to understand and apply the detailed concepts of spectroscopic techniques and stereochemistry to identify the compounds, element etc.

CO3: To enable students to understand the concept of organic reactions.

CO4: To enable the students to understand and apply concepts related to Electrochemistry, Corrosion and Chemical kinetics.

CO5: To enable the students to understand and apply detailed concepts of water impurities, hardness of water, as well as analysis of coal & determination of calorific values.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	-	1	2	3	2
CO2	3	3	2	2	3	1	1	-	1	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	2	1	3	3	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Atomic and Molecular Structure:Molecular orbitals of diatomic molecules, Bond Order, Magnetic characters and numerical problems; Band structure of solids: and the role of doping on band structures;Chemistry of Advanced Materials: *Liquid Crystals;* Introduction, Types and Applications of

liquid crystals, industrially important materials used as liquid crystals. *Graphite and Fullerene;* Introduction, Structure and applications, *Nanomaterials;* Introduction, Preparation, characteristics of nanomaterials and applications of nanomaterials, Carbon Nano Tubes (CNT),

UNIT–II

Spectroscopic Techniques and Applications: Principles of spectroscopy and selection rules. Elementary idea and simple applications of UV, IR and NMR, Numerical problems; Stereochemistry:Enantiomers, diastereomers, optical activity, absolute configurations, conformational analysis.

UNIT–III

Organic reactions:Introduction to reactions involving substitution, addition, elimination,cyclization and ring openings;Mechanism of Name reactions: (i) Aldol condensation (ii) Cannizzaro reaction (iii) Beckmann rearrangement. (iv) Hofmann rearrangement and (v) Diels-Alder reaction.

UNIT–IV

Electrochemistry: Basic concepts of electrochemistry. Nernst equation and applications; Corrosion:Introduction to corrosion, Types of corrosion, Cause of corrosion, Corrosion prevention and control, Corrosion issues in specific industries (Power generation, Chemical processing industry, Oil & gas industry and Pulp & paper industries). Chemical Kinetics:Rate, order and molecularity of reaction, Integrated rate equation of zero order, first order and second order reactions.

UNIT–V

Water Technology: Sources and impurities of water, Municipality waste water treatment, Hardness of water, Disadvantages of hard water, Techniques for water softening (Lime-Soda, Zeolite, Ion Exchange and Reverse Osmosis process), Numerical problems.

Fuels and Combustion: Definition, Classification, Characteristics of a good fuel, Calorific Values, Gross & Net calorific value, Determination of calorific value by Bomb Calorimeter, Theoretical calculation of calorific value by Dulong's method, Ranking of Coal, Analysis of coal by Proximate and Ultimate analysis method, Numerical problems.

Text/ Reference Books:

1. Atkins, P. W., & de Paula, J. (2014). *Physical Chemistry* (10th ed.). Oxford University Press.
2. McQuarrie, D. A., & Simon, J. D. (1997). *Physical Chemistry: A Molecular Approach* (1st ed.). University Science Books.
3. Solomons, T. W. G., & Fryhle, C. B. (2016). *Organic Chemistry* (11th ed.). Wiley.
4. Cotton, F. A., Wilkinson, G., & Gaus, P. L. (1995). *Basic Inorganic Chemistry* (3rd ed.). Wiley.
5. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). *Principles of Instrumental Analysis* (7th ed.). Cengage Learning.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	General Mathematics-I (BBT 1001)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	1	0	4
Pre-requisites/Exposure	-				

Course Description: This course explores calculus, sequences, series, multivariable differentiation, and matrices, emphasizing applications in bioprocess modeling, data analysis, and optimization for biotechnology research and industrial applications.

Course Outcomes (COs):

CO1: Apply calculus concepts, including integrals and theorems, to bioprocess modeling.

CO2: Analyze convergence of sequences, series, and Fourier series for biological data.

CO3: Evaluate multivariable differentiation for optimization in biotechnological systems.

CO4: Solve matrix-based problems and apply linear algebra in biological modeling.

CO5: Integrate mathematical techniques for data analysis and bioprocess optimization.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	3	1	1	-	-	1	2	3	2
CO2	3	2	2	1	3	1	1	-	1	1	2	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	3
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Calculus: Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and Minima.

UNIT–II

Sequences and Series: Convergence of sequences and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithmic functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

UNIT–III

Multivariable Calculus (Differentiation): Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

UNIT–IV

Matrices: Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigen values and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Text/ Reference Books:

1. AICTE's Prescribed Textbook: Mathematics-I (Calculus & Linear Algebra), Khanna Book Publishing Co.
2. Reena Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
4. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
5. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
7. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
8. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Life Skills: Entrepreneurship, Language, Communication and Personality (BCN 1008)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores grammar, reading skills, business communication, and presentation techniques, emphasizing effective verbal, non-verbal, and written communication for professional biotechnology contexts.

Course Outcomes (COs):

CO1: Apply grammar rules, including subject-verb agreement and article usage, in technical writing.

CO2: Analyze texts and employ summarization, paraphrasing, and précis writing for biotechnology reports.

CO3: Evaluate communication types, barriers, and remedies for effective professional interactions.

CO4: Develop and deliver impactful oral and written presentations for biotechnology contexts.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	2	1	3	1	-	1	2	3	3
CO2	1	1	2	1	3	1	3	1	1	1	2	3	3
CO3	1	2	2	1	3	2	3	2	2	2	2	3	3
CO4	1	2	3	1	3	2	3	2	2	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés

UNIT–II

Employing different reading skills,Comprehension passage – Understanding the author's point of View, The art of condensation- Summarization, paraphrasing, précis and abstract writing, Reading short stories (Rabindranath Tagore, MunsiPremchand, Mulk Raj Anand and James Joyce), Writing business letters and reports

UNIT–III

Process and principles of effective business communication, Types of Communication-(Verbal Communication, Non-verbal Communication, Interpersonal Communication, Extra personal Communication, Intrapersonal Communication, Mass Communication and Media Communication etc., Barriers to communication, Remedies to overcome from the barriers of Communication.

UNIT–IV

Oral and Written Presentations: Technical Communication, Essential Elements of Effective Presentations and Speaking as a Leader, Gaining Power and Influence: Building a Strong Power Base, Motivating Others and Diagnosing Work Performance Problems, Managing Conflict: Interpersonal and Collaborative Approaches, Case Studies and Practice Sessions.

Text/ Reference Books:

1. Gerson, S. J., & Gerson, S. M. (2017). *Technical Communication: Process and Product* (9th ed.). Pearson.
2. Anderson, P. V. (2017). *Technical Communication: A Reader-Centered Approach* (9th ed.). Cengage Learning.
3. Raman, M., & Sharma, S. (2015). *Technical Communication: Principles and Practice* (3rd ed.). Oxford University Press.
4. Lesikar, R. V., Flatley, M. E., & Rentz, K. (2015). *Business Communication: Connecting in a Digital World* (13th ed.). McGraw-Hill.
5. Bovee, C. L., & Thill, J. V. (2019). *Business Communication Today* (14th ed.). Pearson.
6. Markel, M. (2018). *Technical Communication* (11th ed.). Bedford/St. Martin's.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Problem Solving using Programming (BCN 1004)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores computer systems, Python programming, algorithms, data structures, and control flow, emphasizing applications in biotechnology for data analysis, simulation, and process automation.

Course Outcomes (COs):

CO1: Understand computer systems, number systems, and algorithm design for biotechnology.

CO2: Apply Python syntax, data types, and operators for biological data processing.

CO3: Implement conditional statements, loops, and string operations in Python programs.

CO4: Utilize functions, modules, lists, tuples, dictionaries, and sets for biotech applications.

CO5: Develop Python programs for data analysis and automation in bioprocesses.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	1	2	1	1	-	-	1	2	3	2
CO2	2	3	3	2	3	1	1	-	1	1	3	3	3
CO3	2	3	3	2	3	1	1	-	1	1	3	3	3
CO4	2	3	3	2	3	1	1	-	1	1	3	3	3
CO5	2	3	3	2	3	2	1	1	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Introduction to components of a computer system (disks,memory, processor, where a program is stored and executed, operating system, compilers etc.), Input/ Output Devices, Number System, Idea of Algorithm: steps to solve logical and numerical problems. Introduction to Programming. Representation of Algorithm:Flowchart/Pseudocode with examples.From algorithms to programs; source code, variables (with data types) variables and memorylocations, Syntax and Logical Errors in compilation, object and executable code.

UNIT–II

Features and Applications of Python, Setting up Python Development Environment, Keywords, Identifiers, Statements, Indentation, Comments, Variables Declaration, Assignment, Naming Conventions, Data Types: Integers, Floating-Point Numbers, Strings, Booleans. Input and output using print- and input- functions, Numbers and Arithmetic Operators - Addition, Subtraction, Multiplication, Division, Modulus, Exponentiation, Floor Division. Operator Precedence, Comparison Operators - Equal to, Not Equal to, Greater than, less than, Greater than or Equal to, less than or Equal to. Logical Operators: and, or, not, Type Conversion - Implicit and Explicit Type Conversion, Bitwise Operators, Assignment Operators

UNIT–III

Conditional Statements - if, else, elif statements, Nested Conditional Statements, Loops: while loop. Loop Control Statements: break, continue, and pass, for loop: Iterating over sequences - strings, lists, tuples for loop with range- function, Nested Loops, for-else and while-else constructs, Strings - Creating Strings, Accessing Characters, String Slicing. String Immutability, String Operations - Concatenation, Repetition. String Formatting - % operator and format- method, f-strings, Common String Methods: upper-, lower-, strip-, split-, join-, find-, replace-

UNIT–IV

Functions - Calling Functions, Return Values, Function Parameters - Positional Arguments, Keyword Arguments, Default Arguments, Scope of Variables - Local and Global Scope, Function Composition, Recursion: Factorial, Fibonacci sequence. Lambda Functions, UNITs, Importing UNITs - import, import as, Standard UNITs - math, random. Lists-Creating Lists, List Operations: Concatenation, Repetition, append-, insert-, remove-, pop-, index-, count-, sort-, reverse-. List Comprehension, Tuples: Creating Tuples, Tuple Operations: Concatenation, Repetition. Tuple Methods -count-, index-, Creating Dictionaries, Common Dictionary Methods: keys-, values-, items-, get-, update-, pop-, popitem-, clear-. Dictionary Comprehension, Creating Sets, Union, Intersection, Difference, Symmetric Difference. Set Methods -add, remove, discard, update, intersection update-

Text/ Reference Books:

1. *Sundarrajan M, Mani Deepak Choudhry, "Python Programming Beginners Guide", 2024.*
2. *Deepali Srivastava, "Ultimate Python Programming", BPB Online 2024.*
3. Dierbach, Charles. *Introduction to computer science using python: A computational problem-solving focus*. Wiley Publishing, 2012. ISBN 9789332584686.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Exploring the Biotechnology (BBT 1002)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course examines biotechnology's history, genetic engineering, diagnostics, plant biotechnology, and food production, integrating interdisciplinary principles and ethical considerations to address health, agricultural, and sustainability challenges.

Course Outcomes (COs):

CO1: Trace the evolution and interdisciplinary scope of biotechnology, highlighting contributions from genetics, microbiology, and biochemistry.

CO2: Explain the role of genetic engineering tools and evaluate their safety and ethical implications.

CO3: Analyze the application of PCR, DNA sequencing, and biotechnological innovations in diagnostics and vaccine development.

CO4: Assess the significance of plant biotechnology in agriculture and conservation, focusing on totipotency and micropropagation.

CO5: Evaluate the role of fermentation in producing food and feed, emphasizing sustainability and scalability.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	-	-	-	2	1	1	-	2	1	2	-
CO2	2	2	1	1	3	3	-	3	-	1	1	3	-
CO3	2	3	2	2	3	2	1	1	-	2	1	3	-
CO4	2	2	3	1	2	1	3	1	-	1	1	3	2
CO5	2	1	2	1	2	1	3	1	-	1	1	2	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

History and scope of Biotechnology. New vs old biotechnology, Interdisciplinary nature of Biotechnology, Importance of various biological disciplines e.g. Genetics, Cell and Molecular Biology, Microbiology, Biochemistry, Immunology etc.

UNIT–II

Introduction to Genetic Engineering, Restriction endonuclease. Ligases, Alkaline phosphatase, Reverse transcriptase, DNA polymerase, Cloning Vectors (plasmid-based). Biotechnology hazards and safety. Social, moral and ethical issues

UNIT–III

Biotechnology in diagnostics and therapeutics. Biotechnological innovations with vaccine development Introduction to PCR, DNA sequencing and fingerprinting

UNIT–IV

Introduction to plant biotechnology, importance, significance, applications Biotechnology in agriculture, Totipotency, Clonal propagation/micropropagation in vitro conservation of plant genetic resources, its applications and limitations.

UNIT–V

Biotechnology of food and feed. Introduction to fermentation; fermentation process and raw materials used for production of alcoholic beverages, cheese, SCP, bakery products and food additives.

Text/ Reference Books:

1. A textbook of Biotechnology; R.C. Dubey; S.Chand & Company Ltd.
2. Biotechnology- Expanding Horizons; B.D. Singh; Kalyani publishers
3. Gene Cloning & DNA Analysis- An Introduction; T.A. Brown; (6th Edition); Wiley Blackwell
4. Food Biotechnology by Foster GN, CBS publication, 2020

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Chemistry Laboratory (BCN 1053)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Determination of alkalinity in the given water sample.
2. Determination of Strength of strong acid using pH - Meter
3. Determination of Temporary and Permanent hardness in water sample using EDTA as standard solution.
4. Determination of available chlorine in bleaching powder.
5. Determination of chloride content in the given water sample by Mohr's method.
6. Determination of Iron content in the given Iron ore sample by using [K3Fe(CN)6] as an external indicator.
7. Determination of solubility of salt (NaCl) at room temperature.
8. Determine the viscosity of a given solution.
9. Element detection and Functional group identification in organic compounds.
10. Preparation of Bakelite & Urea Formaldehyde resin.
11. Verification of Beer's law.
12. Determination of surface tension of given liquid.
13. Determination of rate constant of hydrolysis of esters.
14. Determination of molecular weight of a polymer using Ostwald's viscometer
15. To determine moisture, volatile matter and ash content of a given coal sample

Recommended books:

1. Experiments in Applied Chemistry: Dr. Sunita Rattan, S.K. Kataria& Sons.
2. Laboratory Manual on Engineering Chemistry: S. K. Bhasin, Sudha Rani, Dhanpat Rai Publishing Company.
3. Advanced Inorganic Analysis: Agarwal & Keemti Lal, Pragati Prakashan.
4. Vogel's Textbook of Quantitative chemical analysis: J. Mendham et.al., Pearson Education.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Problem Solving using Programming Laboratory (BCN 1054)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Setting up Python environment, writing and running simple Python programs.
2. Laboratory exercises on if, else, and elif statements.
3. Implementing while loops and using break, continue, pass statements.
4. String manipulation exercises: indexing, slicing, concatenation, and repetition.
5. Implementing programs using various string methods.
6. Laboratory exercises on function parameters and scope of variables.
7. Implementing recursive functions and using lambda functions.
8. Working with Lists: creating, accessing, slicing, and operations.
9. Practicing List methods and List Comprehension.
10. Working with Tuples: creating, accessing, slicing, and operations.
11. Working with Dictionaries: creating, accessing, and modifying dictionaries.
12. Practicing Dictionary methods and Dictionary Comprehension. Sets and Set operations.

Recommended Books:

1. *Sundarrajan M, Mani Deepak Choudhry, "Python Programming Beginners Guide", 2024.*
2. *Deepali Srivastava, "Ultimate Python Programming", BPB Online 2024.*
3. Dierbach, Charles. *Introduction to computer science using python: A computational problem-solving focus*. Wiley Publishing, 2012. ISBN 9789332584686.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Basic Biotechnology Laboratory (BBT 1051)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Demonstration of instruments to be used in the Laboratory course
2. Buffer preparation, pH maintenance
3. Aseptic techniques for microbial culture
4. Isolation of pure microbial culture
5. Gram staining technique
6. Estimation of carbohydrates
7. Enzyme linked Immunoassay
8. Effect of temperature and pH on enzyme activity
9. Isolation of DNA
10. Detection of microorganisms in food and water samples

Recommended Books:

1. R. Boyer, Modern Experimental Biochemistry, 3rd Ed., Pearson Education (Singapore) Pvt. Ltd., 2001
2. R. L. Switzer and L. F. Garrity, Experimental Biochemistry, 3rd Ed., W. H. Freeman, 1999
3. S. J. Karcher, Molecular Biology: A Project Approach, Academic Press, 2001.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Life Skills: Entrepreneurship, Language, Communication and Personality Laboratory (BCN 1058)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Laboratory:

1. Group Discussion, Conversations and dialogue- Practical based on relevant Grammatical Patterns.
2. Practice of Communication Skills for Seminars/Conferences/Workshops with emphasis on Paralinguistic /Kinesics.
3. Presentation Skills for Technical Paper/Project Reports/ Professional Reports based on proper Stress and Intonation Mechanics
4. Public Speaking practice by conducting elocution, extempore, debate and speech competition
5. Theme Presentation/ Keynote Presentation based on correct methodologies
6. Individual Speech Delivery/Conferencing with skills to defend Interjections/Quizzes
7. Argumentative Skills/Role Play Presentation with Stress and Intonation.
8. Comprehension Skills based on Reading and Listening Practical's on a model Audio

Recommended Books:

1. Wood, F.T. *Remedial English Grammar*. Macmillan, 2007.
2. Kumar, Sanjay and PushpLata. *Communication Skills*. Oxford University Press, 2011.
3. Seely, John. *Oxford Guide to Effective Writing and Speaking*. Oxford University Press, 2013.
4. Sudharshana, N.P., and C. Savitha. *English for Engineers*. Cambridge University Press, 2018.
5. Joyce, James. *Dubliners (Modern Classics)*. Penguin Books, 2000.
6. Tagore, Rabindranath. *The Home-Coming*. CI Publisher, 2014.
7. Anand, Mulk Raj. *The Lost Child and Other Stories*. Orient Publishing, 2004.
8. McCarthy, Michael, and Felicity O'Dell. *English Vocabulary in Use (Intermediate)*. Cambridge University Press, 2002.

Semester-II

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Physics (BCN 1007)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores relativity, quantum mechanics, electromagnetic waves, interference, diffraction, and optical fibers, emphasizing applications in biotechnology, such as sensors, lasers, and imaging technologies.

Course Outcomes (COs):

CO1: Understand special relativity concepts and their implications in biotechnology.

CO2: Apply quantum mechanics principles to model biomolecular systems.

CO3: Analyze electromagnetic waves and their applications in biotech sensors.

CO4: Evaluate interference, diffraction, and optical systems for imaging applications.

CO5: Assess optical fibers and lasers for biotechnological sensing and diagnostics.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	-	1	2	3	2
CO2	3	2	2	1	3	1	1	-	1	1	2	3	2
CO3	3	3	2	2	3	1	1	-	1	1	3	3	3
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	2	3	2	1	1	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Inertial and non-inertial frames, Galilean vs Lorentz transformations, Postulates of Special Relativity, Time dilation, length contraction, Relativistic momentum and energy, Mass-energy equivalence: equivalence:$E=mc^2$

UNIT–II

Limitations of classical physics, de-Broglie hypothesis; Davisson-Germer experiment, Phase and group velocity, Schrödinger equation (time-dependent and time-independent), Wave function interpretation; particle in a dimensional box

UNIT–III

Continuity equation, displacement current, Maxwell's equations (differential & integral forms), Electromagnetic waves in vacuum and conductors; Poynting vector, Skin depth

UNIT–IV

Coherent sources, interference (thin films, Newton's rings), Diffraction: single slit, double slit, diffraction grating, absent spectra, dispersive and resolving power

UNIT–V

Total internal reflection, Step-index vs graded-index fibers, Numerical aperture, attenuation, dispersion, Applications in sensors, Spontaneous and stimulated emission, He-Ne and Ruby lasers, Laser applications

Text/ Reference Books:

1. Concepts of Modern Physics – Arthur Beiser
2. Introduction to Electrodynamics – David J. Griffiths
3. Optics – AjoyGhatakEngineering Physics – D.C. Tayal

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	General Mathematics-II (BBT 2001)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	1	0	4
Pre-requisites/Exposure	-				

Course Description: This course explores multivariable calculus, differential equations, and complex variables, emphasizing applications in bioprocess modeling, optimization, and analysis for biotechnology research and industrial processes.

Course Outcomes (COs):

CO1: Apply multivariable integration to compute areas, volumes, and bioprocess properties.

CO2: Solve first-order differential equations for modeling biological systems.

CO3: Analyze higher-order differential equations and special functions in biotech applications.

CO4: Evaluate complex differentiation and mappings for biomolecular modeling.

CO5: Utilize complex integration and residue theorems for biotechnological data analysis.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	3	1	1	-	-	1	2	3	2
CO2	3	2	3	1	3	1	1	-	1	1	2	3	3
CO3	3	3	3	2	3	1	1	-	1	1	3	3	3
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	2	3	2	1	1	1	2	3	3	3

Legend: 3: High correlation. 2: Moderate correlation. 1: Low correlation. -: No correlation

Syllabus:

UNIT–I

Multivariable Calculus (Integration): Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

UNIT–II

First order ordinary differential equations: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

UNIT–III

Ordinary differential equations of higher orders: Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

UNIT–IV

Complex Variable – Differentiation: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

UNIT–V

Complex Variable – Integration: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

Text/ Reference Books:

1. Chandrika Prasad &Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, 2018.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
3. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
4. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
5. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
6. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Universal Human Values-II: Understanding Harmony And Ethical Human Conduct (BCN 2005)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	1	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores holistic development, value education, harmony in self, family, society, and nature, emphasizing ethical conduct and strategies for value-based biotechnology professions.

Course Outcomes (COs):

CO1: Understand value education and holistic development for human aspirations.

CO2: Analyze harmony in self and body for personal well-being.

CO3: Evaluate trust, respect, and justice in family and societal relationships.

CO4: Assess interconnectedness and harmony in nature for sustainable practices.

CO5: Apply ethical conduct and holistic strategies in biotechnology professions.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	-	2	2	2	3	1	2	1	3	3
CO2	1	1	1	-	3	2	2	3	1	2	1	3	3
CO3	1	2	2	-	3	3	2	3	2	2	1	3	3
CO4	1	2	2	1	3	3	2	3	2	2	1	3	3
CO5	1	2	3	1	3	3	2	3	2	3	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Right Understanding, Relationship and Physical Facility (Holistic Developmentand the Role ofEducation), Understanding Value EducationSelf-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations.

UNIT–II

Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

UNIT–III

Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.

UNIT–IV

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four, Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence.

UNIT–V

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for, Humanistic Education, Humanistic Constitution and Universal, Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical, Case Studies, Strategies for Transition towards Value-based Life and Profession, Human Order

Tutorial:

1. Sharing about Oneself
2. Exploring Human Consciousness
3. Exploring Natural Acceptance
4. Exploring the difference of Needs of Self and Body
5. Exploring Sources of Imagination in the Self
6. Exploring Harmony of Self with the Body
7. Exploring the Feeling of Trust
8. Exploring the Feeling of Respect
9. Exploring Systems to fulfil Human Goal
10. Exploring the Four Orders of Nature
11. Exploring Co-existence in Existence
12. Exploring Ethical Human Conduct
13. Exploring Humanistic Models in Education
14. Exploring Steps of Transition towards Universal

Text/ Reference Books:

1. The Textbook - A Foundation Course in Human Values and Professional Ethics, R RGaur,R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values andProfessional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, NewDelhi, 2019. ISBN 978-93-87034-53.
3. Professional Ethics and Human Values, Premvir Kapoor, ISBN: 978-93-86173-652, KhannaBook Publishing Company, New Delhi, 2022.
4. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
5. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
6. The Story of Stuff (Book).
7. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
8. Small is Beautiful - E. F Schumacher.
9. Slow is Beautiful - Cecile Andrews
10. Economy of Permanence - J C Kumarappa
11. Bharat Mein Angreji Raj – PanditSunderlal

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Remedial Biology (BBT 2002)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course introduces students to the fundamentals of plant and animal biology, covering diversity in the living world, morphology, anatomy, physiology, and basic cellular processes. It emphasizes the role of plants and animals in ecosystems, nutrient cycles, and biotechnological applications, providing a foundation for understanding life sciences in biotechnology.

Course Outcomes (COs):

CO1: Understand the diversity of living organisms, classification systems, and morphological features of plants and animals.

CO2: Explain plant nutrition, photosynthesis, respiration, growth regulators, and mineral requirements.

CO3: Analyze cellular structures, tissues, and physiological processes in plants and animals.

CO4: Describe human physiological systems including circulation, digestion, respiration, excretion, and reproduction.

CO5: Apply knowledge of plant and animal biology to biotechnological contexts, such as conservation and genetic resources.

CO-PO-PSO Mapping Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PSO1	PSO2
CO1	3	2	1	-	2	2	1	-	-	1	-	3	-
CO2	3	3	2	1	2	2	1	-	-	1	1	3	-
CO3	3	3	2	1	2	1	1	-	-	1	1	3	-
CO4	3	3	2	1	2	-	1	-	-	1	1	-	3
CO5	3	3	2	1	2	-	1	1	-	1	1	-	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Living world: Definition and characters of living organisms, Diversity in the living world, Binomial nomenclature, Five kingdoms of life and basis of classification. Salient features of Monera, Potista, Fungi, Animalia and Plantae, Virus. Morphology of Flowering plants- Morphology of different parts of

flowering plants – Root, stem, inflorescence, flower, leaf, fruit, seed. General Anatomy of Root, stem, leaf of monocotyledons & Dicotylidones.

UNIT–II

Plants and mineral nutrition: Essential mineral, macro and micro nutrients, Nitrogen metabolism, Nitrogen cycle, biological nitrogen fixation. Photosynthesis- Autotrophic nutrition, photosynthesis, Photosynthetic pigments, Factors affecting photosynthesis.

UNIT–III

Plant respiration: Respiration, glycolysis, fermentation (anaerobic). Plant growth and development- Phases and rate of plant growth, Condition of growth, Introduction to plant growth regulators. Cell – The unit of life- Structure and functions of cell and cell organelles. Cell division. Tissues- Definition, types of tissues, location and functions.

UNIT–IV

Body fluids and circulation- Composition of blood, blood groups, Human circulatory system, Structure of human heart and blood vessels, Cardiac cycle, cardiac output and ECG. Digestion and Absorption- Human alimentary canal and digestive glands, Role of digestive enzymes, Digestion, absorption and assimilation of digested food. Breathing and respiration- Human respiratory system, Mechanism of breathing and its regulation, Exchange of gases, transport of gases and regulation of respiration, Respiratory volumes

UNIT–V

Excretory products and their elimination- Modes of excretion, Human excretory system- structure and function, Urine formation. Neural control and coordination- Definition and classification of nervous system, Structure of a neuron, Generation and conduction of nerve impulse, Structure of brain and spinal cord, Functions of cerebrum, cerebellum, hypothalamus and medulla oblongata. Chemical coordination and regulation- Endocrine glands and their secretions, Functions of hormones secreted by endocrine glands. Human reproduction- Parts of female reproductive system, Parts of male reproductive system, Spermatogenesis and Oogenesis, Menstrual cycle.

Text/ Reference Books:

1. Campbell, N. A., & Reece, J. B. (2014). "Biology" (10th ed.). Pearson Education.
2. Raven, P. H., Johnson, G. B., Mason, K. A., Losos, J. B., & Singer, S. R. (2017). Biology (10th ed.). McGraw-Hill Education.
3. Taiz, L., & Zeiger, E. (2015). "Plant Physiology and Development" (6th ed.). Sinauer Associates.
4. Tortora, G. J., & Derrickson, B. H. (2017). "Principles of Anatomy and Physiology" (15th ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Mechanical Engineering and Robotics (BCN 2008)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores material properties, fluid mechanics, thermodynamics, and robotics, emphasizing applications in biotechnology for bioprocess equipment, automation, and system optimization.

Course Outcomes (COs):

CO1: Understand engineering material properties and their biotechnological applications.

CO2: Apply measurement techniques and analyze fluid properties in bioprocesses.

CO3: Evaluate thermodynamic principles and cycles for biotech system efficiency.

CO4: Analyze fluid dynamics and machinery for bioprocess equipment design.

CO5: Design and assess robotic systems for automation in biotechnology.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	1	-	-	1	2	3	2
CO2	3	3	2	2	3	1	1	-	1	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	2
CO5	3	3	3	2	3	2	1	1	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Classification of engineering materials, composition of cast iron and carbon steels on iron-carbon diagram and their mechanical properties, alloy steel and their applications, stress-strain diagram, Hooks law and modulus of elasticity, tensile, shear, hardness and fatigue testing of materials.

UNIT–II

Temperature, pressure, velocity, flow, strain, force and torque measurement, concept of measurement error & uncertainty analysis, measurement by Vernier calliper, micrometer, dial gauges, slip gauges, sine-bar and combination set, introduction to lath, drilling, milling and shaping machines, various types of carbon steels, alloy steels and cast irons, its properties and uses.

UNIT–III

Fluid properties, pressure, density and viscosity, pressure variation with depth, static and kinetic energy, Bernoulli's equation for incompressible fluids, viscous and turbulent flow, working principle of fluid coupling, pumps, compressors, turbines, positive displacement machines and pneumatic machines, hydraulic power & pumped storage plants for peak load management as compared to base load plants.

UNIT–IV

First and second law of thermodynamics, steam properties, steam processes at constant pressure, volume, enthalpy & entropy, classification and working of boilers, efficiency & performance analysis, natural and induced draught, calculation of chimney height, refrigeration, vapor absorption & compression cycles, coefficient of perform (COP), refrigerant properties &ecofriendly refrigerants, working of two stroke, four stroke petrol & diesel engines, actual and hypothetical indicator diagram Steam engines.

UNIT–V

Introduction: Definition, Structure, Classification and Specifications of Robots, Industrial, Robot Elements and Control: Manipulators, Drives, Sensors, End Effectors, Configuration,Force/Torque Relationship, Trajectory Planning, Position Control, Feedback System, Digital Control,Modeling of Robots: Coordinate Frames, Mapping and Transformation; Direct KinematicModel; Inverse Kinematics; Manipulate or Differential Motion; Static Analysis; Jacobian

Text/ Reference Books:

1. Narula; Material Science; TMH
2. Agrawal B & CM; Basic Mechanical Engg. Wiley India
3. Nag PK, Tripathi et al; Basic Mechanical Engg; TMH
4. Rajput; Basic Mechanical Engg;
5. Sawhney GS; Fundamentals of Mechanical Engg; PHI
6. Nakra and Chaudhary; Instrumentation & measurement; TMH

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Hobbies, Co-Curricular and Extra-Curricular (BCN 2006)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: This course explores physical fitness, sports science, yoga, biomechanics, psychology, and doping, emphasizing applications in health, wellness, and performance optimization for biotechnology professionals.

Course Outcomes (COs):

CO1: Understand physical education principles and trends for wellness in biotechnology.

CO2: Analyze Olympic values, fitness components, and lifestyle changes for health.

CO3: Apply biomechanics, yoga, and sports psychology to enhance professional performance.

CO4: Evaluate sports injuries, doping, and corrective measures for health and ethics.

CO5: Design fitness and training programs for biotech professionals' holistic development.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	-	2	2	2	2	1	2	1	3	3
CO2	1	1	1	-	2	2	2	2	1	2	1	3	3
CO3	1	2	2	1	3	3	2	2	2	2	2	3	3
CO4	1	2	2	1	3	3	2	3	2	2	2	3	3
CO5	1	2	3	2	3	3	2	3	2	3	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Meaning & definition of Physical Education, Aims & Objectives of Physical Education, Changing trends in Physical Education

UNIT–II

Ancient & Modern Olympics (Summer & Winter), Olympic Symbols, Ideals, Objectives & Values, Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.)

UNIT–III

Meaning & Importance of Physical Fitness & Wellness, Components of Physical fitness, Components of Health related fitness, Components of wellness, Preventing Health Threats through Lifestyle Change, Concept of Positive Lifestyle, Define Anatomy, Physiology & Its Importance, effect of exercise on the functioning of Various Body Systems. (Circulatory System,Respiratory System, Neuro-Muscular System etc.). Meaning & Importance of Kinesiology & Biomechanics in Physical Edu. & Sports, Newton's Law of Motion & its application in sports, Friction and its effects in Sports.

UNIT–IV

Meaning and Concept of Postures, Causes of Bad Posture, Advantages & disadvantages of weight training, Concept & advantages of Correct Posture, Common Postural Deformities – Knock Knee; Flat Foot; Round Shoulders; Lordosis, Kyphosis, Bow Legs and Scoliosis, Corrective Measures for Postural Deformities

UNIT–V

Meaning & Importance of Yoga, Elements of Yoga, Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas, Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana&Shashankasana), Relaxation Techniques for improving concentration - Yog-nidra, First Aid – Definition, Aims & Objectives, Sports injuries: Classification, Causes & Prevention, management of Injuries: Soft Tissue Injuries and Bone & Joint Injuries

Text/ Reference Books:

1. Modern Trends and Physical Education by Prof. Ajmer Singh.
2. Light On Yoga by B.K.S. Iyengar.
3. Health and Physical Education – NCERT (11th and 12th Classes)

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Physics Laboratory (BCN 1057)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

Group A

1. To determine the wavelength of sodium light by Newton's ring experiment.
2. To determine the wavelength of different spectral lines of mercury light using plane transmission grating.
4. To determine the focal length of the combination of two lenses separated by a distance and verify the formula for the Focal length of combination of lenses.
5. To measure attenuation in an optical fiber.
6. To determine the wavelength of He-Ne laser light using single slit diffraction.
7. To study the polarization of light using He-Ne laser light.
8. To determine the wavelength of sodium light with the help of Fresnel's bi-prism.
9. To determine the coefficient of viscosity of a given liquid.
10. To determine the value of acceleration due to gravity (g) using compound pendulum.

Group B

1. To determine the energy band gap of a given semiconductor material.
2. To study Hall effect and determine Hall coefficient, carrier density and mobility of a given semiconductor Material using Hall Effect setup.
3. To determine the variation of magnetic field with the distance along the axis of a current carrying coil and estimate the radius of the coil.
4. To verify Stefan's law by electric method.
5. To determine resistance per unit length and specific resistance of a given resistance using Carey Fosters Bridge.
7. To determine the electrochemical equivalent (ECE) of copper.
8. To calibrate the given ammeter and voltmeter by potentiometer.
9. To draw hysteresis (B-H curve) of a specimen in the form of a transformer and to determine its Hysteresis loss.

Recommended Books:

1. Practical Physics- K. K. Dey& B. N. Dutta (Kalyani Publishers New Delhi)
2. Engineering Physics-Theory and Practical- Katiyar& Pandey (Wiley India)

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Remedial Biology Laboratory (BBT 2002)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Introduction to experiments in biology- Study of Microscope, Section cutting techniques, Mounting and staining, Permanent slide preparation.
2. Study of cell and its inclusions
3. Study of Stem, Root, Leaf, seed, fruit, flower and their modifications
4. Detailed study of frog by using computer models
5. Microscopic study and identification of tissues pertinent to Stem, Root Leaf, seed, fruit and flower
6. Identification of bones
7. Determination of blood group
8. Determination of blood pressure
9. Determination of tidal volume

Recommended Books:

1. Practical human anatomy and physiology. by S.R.Kale and R.R.Kale.
2. A Manual of pharmaceutical biology practical by S.B.Gokhale, C.K.Kokate and S.P.Shriwastava.
3. Biology practical manual according to National core curriculum. Biology forum of Karnataka. Prof .M.J.H.Shafi

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Workshop/Manufacturing Practices Laboratory (BCN 2058)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Course Description: This course explores casting, machining, CNC, additive manufacturing, fitting, electrical systems, carpentry, plastic moulding, and welding, emphasizing applications in biotechnology equipment fabrication and maintenance.

Course Outcomes (COs):

CO1: Understand manufacturing methods for biotech equipment fabrication.

CO2: Apply CNC machining and additive manufacturing in bioprocess systems.

CO3: Perform fitting operations and utilize power tools for biotech applications.

CO4: Analyze electrical, carpentry, moulding, and welding processes for equipment design.

CO5: Integrate manufacturing techniques for efficient biotechnology production systems.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	1	-	-	1	2	3	2
CO2	3	3	3	2	3	1	1	-	1	1	3	3	3
CO3	3	3	3	2	3	1	1	-	1	1	3	3	3
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	2	3	2	1	1	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Manufacturing Methods- casting, forming, machining, joining, advancedmanufacturing methods. CNC machining, Additive manufacturing. Fitting operations & power tools.

UNIT–II

Electrical & Electronics. Carpentry., Plastic moulding, glass cutting. Metal casting. Welding (arc welding & gas welding), brazing.

Laboratory:

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding + Gas welding)
6. Casting
7. Smithy
8. Plastic moulding & Glass Cutting

Text/ Reference Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Design Thinking and Innovation Laboratory(BCN 2059)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Course Contents:

Students are set to embark on a group project designed to foster a holistic understanding of the design thinking approach applied in project development. Continuous assessments will gauge their performance against various project-related criteria. The project entails the creation of a poster, video, blog, report, and presentation, enabling students to explore different deliverables and associated documentation. The focus is on tackling real-world problems and actionable issues, utilizing technology and improved design for effective solutions.

Studio Work / Laboratory Experiments:

The course will be taught using a combination of the best practices of teaching-learning. Multiple environments will be used to enhance the outcomes such as seminar; self-learning, MOOCs, group discussions and ICT based tools for class participation along with the classroom sessions. The teaching pedagogy being followed includes more exposure to hands-on experiment and practical implementations done in the Laboratory sessions. To make the students aware of the industry trends, one session of expert lecture will be organized to provide a platform to the students for understanding the relevant industry needs.

Text /Reference Books:

1. E Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna BookPublishing Company.

Semester-III

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Genetics (BBT 3001)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: This course provides an introduction to genetics, covering Mendelian inheritance, molecular basis of heredity, chromosome structure, population genetics, and modern applications in biotechnology. It emphasizes the role of genetics in disease, evolution, and genetic engineering.

Course Outcomes (COs):

CO1: Understand Mendelian laws, inheritance patterns, and non-Mendelian genetics through problem-solving.

CO2: Explain DNA structure, replication, transcription, translation, mutations, and repair mechanisms.

CO3: Analyze chromosome structure, sex determination, linkage, recombination, and cytogenetics.

CO4: Apply concepts of population genetics, Hardy-Weinberg equilibrium, and quantitative traits to genetic disorders.

CO5: Evaluate recombinant DNA technology, genomics, proteomics, gene editing, and ethical issues in modern genetics.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	1	3	-	1	-	-	1	-	3	1
CO2	3	3	2	1	2	-	1	-	-	1	1	3	2
CO3	3	3	2	1	2	-	1	-	-	1	1	3	2
CO4	3	2	3	1	3	1	1	1	-	1	1	2	3
CO5	3	3	2	2	2	2	1	3	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Mendel's experiments and laws of inheritance including law of dominance, law of segregation and law of independent assortment. Monohybrid and dihybrid crosses, back cross and test cross. Concept of probability in inheritance. Multiple alleles with examples such as the ABO blood group system.

UNIT-II

Concept of gene interaction beyond Mendelian ratios. Co-dominance and incomplete dominance. Complementary gene action, supplementary gene action, inhibitory factors, duplicate gene action and epistasis. Lethal genes with examples of dominant and recessive lethals.

UNIT-III

General features and classification of chromosomes. Chromosomal theory of inheritance. Mechanisms of sex determination, haplodiploidy and environmental sex determination. Patterns of inheritance such as sex-linked, sex-limited and sex-influenced traits. Variations in chromosome number including aneuploidy and polyploidy and structural changes such as deletions, duplications, inversions and translocations. Human genetic disorders including allosomal disorders such as Klinefelter syndrome and Turner's syndrome and autosomal disorders such as Down syndrome and Cri-du-chat syndrome.

UNIT- IV

Concept of genetic linkage and recombination. Crossing over, its mechanism, cytological proof and significance. Gene mapping and calculation of map distances. Cytogenetic techniques including karyotyping, chromosome banding and fluorescent in situ hybridization. Concepts of penetrance and expressivity. Pleiotropy, position effect and genomic imprinting.

UNIT-V

Population Genetics and Evolution: Allele frequencies and genotype frequencies, random mating and Hardy-Weinberg principle. Inbreeding. Genetics and evolution.

Text/ Reference Books:

1. Hartl, D. L., & Jones, E. W. (2018). Genetics: Analysis of Genes and Genomes (9th ed.). Jones & Bartlett Learning.
2. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2019). Concepts of Genetics (12th ed.). Pearson Education.
3. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. (2015). An Introduction to Genetic Analysis (11th ed.). W. H. Freeman.
4. Snustad, D. P., & Simmons, M. J. (2015). Principles of Genetics (7th ed.). Wiley.
5. Pierce, B. A. (2020). Genetics: A Conceptual Approach (7th ed.). W. H. Freeman.
6. Russell, P. J. (2013). iGenetics: A Molecular Approach (3rd ed.). Pearson Education.
7. Lewin, B., Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2014). Lewin's Genes XII (12th ed.). Jones & Bartlett Learning.
8. Strachan, T., & Read, A. P. (2018). Human Molecular Genetics (5th ed.). Garland Science.
9. Sadava, D., Hillis, D. M., Heller, H. C., & Berenbaum, M. R. (2014). Life: The Science of Biology (10th ed.). Sinauer Associates.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Digital System (BBT 3002)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: This course explores digital signals, logic gates, sensors, signal conditioning, microcontrollers, and consumer electronics, emphasizing their applications in biotechnology, communication systems, and industrial automation.

Course Outcomes (COs):

CO1: Understand digital systems, number systems, logic gates, and Boolean algebra.

CO2: Analyze sensors, transducers, and display systems for biotechnological applications.

CO3: Evaluate signal conditioning circuits, amplifiers, and A/D-D/A converters.

CO4: Apply microcontrollers and PLCs for bioprocess control and automation.

CO5: Assess consumer electronics and communication systems in biotechnology contexts.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	-	1	-	-	1	2	3	2
CO2	3	3	2	2	3	1	1	-	1	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	1	1	1	3	3	3
CO5	3	3	2	1	3	3	1	2	1	2	3	2	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Digital Systems: Analog & Digital signals - Need for digital instruments, Elements of digital instruments – Number systems: Binary, Hexadecimal, Logic gates, Boolean algebra (Identities and Properties), Digital controllers (ON-OFF), Combinational Circuits-Binary adder-subtractor, Multiplexers, Demultiplexers.

UNIT-II

Sensors and Displays: Sensors and Transducers, Classification, Potentiometer, Strain Gauge Piezoelectric Sensor, Linear Variable Differential Transformer, Resistance temperature detectors (RTD), Thermocouples, Tactile transducers – Displays, Light Emitting Diode (including OLED) displays

UNIT-III

Signal Conditioning Circuits, D.C. Bridge- Unbalanced, Push-Pull configuration, Operational amplifiers- Inverting, Non-Inverting, Instrumentation Amplifier, Active filters: - Low pass, High pass Analog to Digital Converter – Successive Approximation, Digital to Analog Converter - Weighted Resistor.

UNIT- IV

Introduction to Micro Controllers Introduction: Memory types, peripheral devices- Microcontroller (8 bit), Architecture, Graphics, Processing Unit (GPU) Applications: -Interfacing of Digital Input/Output, Analogue Input/Output Introduction to Programmable Logic Controller (PLC) and PID (Proportional + Integral + Derivative) Controller.

UNIT-V

Consumer Electronics and Communication System : Consumer Electronics: Television, Mobile Phones, Air conditioners Refrigerators, Washing Machine. (Block diagram approach only), Communication System: Satellite communication, Global Positioning Systems, Global System for Mobile. (Block diagram approach only)

Text/ Reference Books:

1. Floyd, T. L. (2017). *Digital Fundamentals* (11th ed.). Pearson.
2. Tocci, R. J., Widmer, N. S., & Moss, G. L. (2017). *Digital Systems: Principles and Applications* (12th ed.). Pearson.
3. Dorf, R. C., & Bishop, R. H. (2016). *Modern Control Systems* (13th ed.). Pearson.
4. Malvino, A. P., & Bates, D. J. (2015). *Electronic Principles* (8th ed.). McGraw-Hill.
5. Boylestad, R. L., & Nashelsky, L. (2012). *Electronic Devices and Circuit Theory* (11th ed.). Pearson.
6. Shuler, M. L., & Kargi, F. (2017). *Bioprocess Engineering: Basic Concepts* (3rd ed.). Pearson.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Biostatistics (BBT 3003)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: This course explores data classification, probability distributions, statistical tests, regression, ANOVA, and experimental designs, emphasizing applications in biotechnology for data analysis and quality control.

Course Outcomes (COs):

CO1: Understand data types, classification, and measures of central tendency and dispersion.

CO2: Analyze probability concepts, distributions, and random variables in biological data.

CO3: Evaluate correlation, regression models, and non-parametric tests for data analysis.

CO4: Apply hypothesis testing, t-tests, chi-square, F-tests, and ANOVA in experiments.

CO5: Design experiments and implement statistical quality control in biotechnology research.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	-	1	2	3	2
CO2	3	2	2	1	3	1	1	-	1	1	2	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	2	3	2	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Data and Classification: Data type, Classification and summarization of data. Diagrams and Graphs, Measures of central tendency, Measures of dispersion, Moments, Skewness, kurtosis

UNIT-II

Probability and Distributions: Introduction to probability, Laws of probability, Baye's theorem, Expectation and Random variable, Binomial distribution, Poison distribution, Normal distribution

UNIT-III

Correlation, Regression and Tests: Correlation, Pearson and Mathew correlation, Coefficient, Co-efficient of correlation, Rank Correlation, Lines of regression, Linear and Non linear regression, Multiple regression, Non-Parametric tests, Sign test, Mann-Whitene Wilcoxon test

UNIT- IV

Tests of Hypothesis and ANOVA: Hypothesis tests, Student's t-test, Chi squire test, F-test and ANOVA, One way and two way analysis of variants.

UNIT-V

Design and Quality Control: Principles of experimental design and analysis, Completely randomized design, Randomized block design, Latin square design, Statistical quality control, Types of quality control, Control chart for variables, Control chart for attributes.

Text/ Reference Books:

1. Montgomery, D. C., & Runger, G. C. (2019). *Applied Statistics and Probability for Engineers* (7th ed.). Wiley.
2. Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (2016). *Probability and Statistics for Engineers and Scientists* (9th ed.). Pearson.
3. Zar, J. H. (2009). *Biostatistical Analysis* (5th ed.). Pearson.
4. Sokal, R. R., & Rohlf, F. J. (2011). *Biometry: The Principles and Practice of Statistics in Biological Research* (4th ed.). W.H. Freeman.
5. Montgomery, D. C. (2017). *Design and Analysis of Experiments* (9th ed.). Wiley.
6. Cochran, W. G., & Cox, G. M. (1992). *Experimental Designs* (2nd ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Essential Microbiology (BBT 3004)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: This course provides an introduction to microbiology, focusing on microbial diversity, structure, growth, control methods, and applications in biotechnology. It covers sterilization, culture techniques, and microbial roles in diseases and industry.

Course Outcomes (COs):

CO1: Understand the historical development, microscopy, and classification of microorganisms.

CO2: Identify and describe bacteria, fungi, protozoa, algae, viruses, and their characteristics.

CO3: Explain nutritional requirements, culture media, and physical/chemical microbial control methods.

CO4: Demonstrate techniques for cultivation, maintenance, isolation, identification, and staining of microorganisms.

CO5: Evaluate microbial reproduction, growth kinetics, and roles in infectious diseases and biotechnology.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	-	1	2	3	-
CO2	3	3	1	1	2	1	1	-	-	1	1	3	2
CO3	3	3	2	2	2	2	1	1	-	1	2	3	2
CO4	3	2	2	3	2	-	1	1	1	1	3	3	2
CO5	3	3	2	2	3	2	1	2	-	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Introduction to the microbial world: Historical developments, Microscopes: Types and Uses, importance of electron microscopy.

UNIT–II

Brief introduction to bacteria, fungi, protozoa, algae and viruses. Methods of Sterilization and disinfection, Chemical methods of microbial control: disinfectants, types, and mode of action.

UNIT–III

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation

UNIT–IV

Cultivation and Maintenance of microorganisms: Types of culture media and their preparation; Methods of isolation, pure culture preparation and preservation of microorganisms. Methods of identification: staining techniques.

UNIT–V

Asexual methods of reproduction, Bacterial growth curve and Generation time, General account of Conjugation, Transformation and Transduction. Microorganisms as a causative agent of infectious diseases.

Text/ Reference Books:

1. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). Microbiology: An Introduction (13th ed.). Pearson Education.
2. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2021). Brock Biology of Microorganisms (16th ed.). Pearson Education.
3. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2019). Prescott's Microbiology (10th ed.). McGraw-Hill Education.
4. Black, J. G., & Black, L. L. (2018). Microbiology: Principles and Explorations (10th ed.). Wiley.
5. Cappuccino, J. G., & Sherman, N. (2019). Microbiology: A Laboratory Manual (11th ed.). Pearson Education.
6. Bauman, R. W. (2017). Microbiology with Diseases by Body System (5th ed.). Pearson Education.
7. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2015). Microbiology (7th ed.). McGraw-Hill Education.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Fluid Flow and Heat-Mass Transfer (BBT 3005)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores fluid properties, flow dynamics, mixing, heat transfer, distillation, and extraction, emphasizing applications in bioprocessing, bioreactor design, and equipment scale-up.

Course Outcomes (COs):

CO1: Understand fluid properties and statics for bioprocess design.

CO2: Apply fluid dynamics, mixing, and aeration in bioreactor systems.

CO3: Analyze heat conduction principles for biotechnological applications.

CO4: Evaluate convective heat transfer and heat exchanger designs.

CO5: Implement distillation and extraction techniques in bioprocessing.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	1	-	-	1	2	3	2
CO2	3	3	3	2	3	1	1	-	1	1	3	3	2
CO3	3	2	2	1	3	1	1	-	1	1	2	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	2
CO5	3	3	3	2	3	2	1	1	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Basic properties of fluids, Types of fluids, Fluid statics: Pressure, hydrostatic forces, and simple applications in bioprocessing. Basic concepts of fluid dynamics: Types of flows, and their relevance in biotechnology. Fluid Flow in Bioprocessing: Introduction to fluid flow through pipes: Laminar and turbulent flows with basic equations. Basic pressure drop and head loss in pipes, and their impact on bioprocess design. Introduction to pumps in biotechnology: Types and their applications in simple bioprocesses. Flow through packed beds and porous media: Basic concepts and applications in bioreactors. Basic understanding of fluidization and its importance in bioprocesses.

UNIT–II

Basic concepts of mixing and agitation in bioreactors and their significance in simple processes. Basic principles of aeration and agitation in fermentation processes and their importance. Simple introduction to sedimentation and centrifugation in bioprocessing. Importance of fluid mechanics in bioprocessing equipment and scale-up considerations. Viscosity and its importance in biotechnological processes. Basic flow properties of non-Newtonian fluids in bioreactors and pipelines. Basic mixing and flow considerations for non-Newtonian fluids in biotechnological applications.

UNIT–III

Heat transfer versus Thermodynamics, Modes of heat transfer, basic laws of heat transfer. Conduction: The Fourier heat conduction equation. One dimensional Steady state heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces.

UNIT–IV

Convective heat transfer, dimensionless numbers in heat transfer and their significance, application of dimensional analysis to heat transfer by convection, empirical equations for calculation of heat transfer coefficients in laminar, turbulent and transition region in forced convection, flow arrangements in heat exchangers, plate and frame heat exchanger, shell and tube heat exchanger.

UNIT–V

Distillation-Principles of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, enthalpy concentration diagrams, flash vaporization, differential distillation (Rayleigh equation), steam distillation, continuous distillation, McCabe-Thiele method. Liquid-liquid Extraction- Liquid-liquid equilibria, choice of solvent for extraction, analytical and graphical solutions for single and multistage operations, continuous counter current operation. Equipment: Mixer settler cascades, Rotating disc contactor, Scheibel extractor, Pulsed column, Centrifugal extractor.

Text/ Reference Books:

1. R. K. Bansal, Fluid Mechanics and Hydraulic Machines, Publisher: Laxmi Publications (India)
2. Modi & Seth, Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House (Delhi, India)
3. W.L. McCabe, J.C. Smith, and P. Harriot, Unit Operations of Chemical Engineering, 7/e, McGraw-Hill International Edition, 2017.
4. B.K. Dutta, Heat Transfer: Principles and Applications, Prentice Hall of India, 2000.
5. R.E. Treybal, Mass Transfer Operations, 3/e, McGraw Hill International Editions, 1981.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Biochemistry (BBT 3006)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores the biochemical foundations of life, including water, buffers, carbohydrates, lipids, amino acids, proteins, nucleotides, and their metabolism. It highlights disorders related to metabolic pathways and applications in biotechnology.

Course Outcomes (COs):

CO1: Understand water properties, ionization, pH, buffers, and their role in biological systems.

CO2: Explain carbohydrate structure, classification, and metabolic pathways like glycolysis and TCA cycle.

CO3: Analyze lipid types, synthesis, oxidation, and related metabolic disorders.

CO4: Describe amino acid classification, protein structure, biosynthesis, and degradation.

CO5: Evaluate nucleotide structure, metabolism, and disorders of purine/pyrimidine pathways.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	1	-	-	1	1	3	1
CO2	3	3	2	1	2	1	1	-	-	1	1	3	2
CO3	3	3	2	1	2	1	1	1	-	1	1	3	2
CO4	3	2	2	2	2	-	1	-	1	1	2	3	2
CO5	3	3	2	1	3	2	1	2	-	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Water - Structure, unusual properties, non-covalent interactions, role in biological processes. Ionization of Water, pH scale, Weak Acids, and Weak Bases. Buffers and buffering mechanism, Henderson Hasselbalch equation. Buffering against pH Changes in Biological Systems: Phosphate buffer, Bicarbonate buffer, Protein buffer, Amino acid Buffer & Hemoglobin Buffer System.

UNIT–II

Carbohydrates - classification, structure and functions of monosaccharides, disaccharides and polysaccharides. Ring structure and mutarotation, stereo isomers and structural isomers. Metabolism and Its regulation - Glycolysis & oxidation of Pyruvate, TCA cycle, Gluconeogenesis, Pentose Phosphate Pathway, Oxidative phosphorylation, Disorder/ diseases of carbohydrate metabolism.

UNIT–III

Fats and lipids - Classification, structure and function: Simple, Compound & Derived lipids, Essential fatty acids. Fatty acid synthesis and Its regulation, origin of acetyl-Co A for fat synthesis, Elongation & desaturation of Fatty Acids. Activation & transport of fatty acid from cytosol to mitochondria for oxidation. Oxidation of palmitic acid by β-oxidation and ATP generation. Disorder/ diseases of lipid metabolism

UNIT–IV

Amino acids and proteins - Classification & structure of amino acids. Essential amino acids. Peptide bond formation, Ramachandran plot, Primary, secondary, tertiary & quaternary structure of proteins. Overview of biosynthesis of amino acids from intermediates of glycolysis, Citric Acid Cycle & pentose phosphate pathway and Its regulation. Biodegradation of amino acids: Transdeamination. Urea Cycle. Disorder/ diseases of amino acids metabolism.

UNIT–V

Purines and pyrimidines - Structure and properties. Metabolism of Nucleotides: Purines & Pyrimidines synthesis: de Novo & salvage pathway, Conversion of nucleoside monophosphates to nucleoside triphosphates, Formation of deoxyribonucleotides. Catabolism & salvage of Purine and Pyrimidine nucleotides and its regulation. Disorder of purines and pyrimidines metabolism.

Text/ Reference Books:

1. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman.
2. Voet, D., Voet, J. G., & Pratt, C. W. (2019). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). Wiley.
3. Berg, J. M., Tymoczko, J. L., Gatto, G. J., & Stryer, L. (2019). Biochemistry (9th ed.). W. H. Freeman.
4. Garrett, R. H., & Grisham, C. M. (2016). Biochemistry (6th ed.). Cengage Learning.
5. Murray, R. K., Granner, D. K., Mayes, P. A., & Rodwell, V. W. (2018). Harper's Illustrated Biochemistry (31st ed.). McGraw-Hill Education.
6. Devlin, T. M. (2018). Textbook of Biochemistry with Clinical Correlations (7th ed.). Wiley.
7. Stryer, L., Berg, J. M., & Tymoczko, J. L. (2015). Biochemistry: A Short Course (3rd ed.). W. H. Freeman.
8. Zubay, G. L. (2017). Principles of Biochemistry (5th ed.). McGraw-Hill Education.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Analytical Techniques (BBT 3007)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: The course explores centrifugation, chromatography, spectroscopy, mass spectrometry, NMR, biosensors, microarrays, and microfluidics, emphasizing principles and applications for biomolecule analysis and diagnostic advancements.

Course Outcomes (COs):

CO1: Understand principles of centrifugation, chromatography, and electrophoresis for biomolecule separation.

CO2: Explain spectroscopic techniques (UV-Vis, fluorescence, NMR) and microscopy for biomolecule analysis.

CO3: Analyze mass spectrometry for determining empirical formulas, structures, and sequencing of biomolecules.

CO4: Evaluate NMR spectroscopy, chemical shift, and multidimensional NMR for structural determination.

CO5: Assess biosensors, microarrays, MEMS, and microfluidic systems for diagnostic applications.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	1	1	-	-	1	3	3	2
CO2	3	3	2	2	3	1	1	-	-	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	2
CO5	3	3	3	2	3	2	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Principles of Centrifugation, Analytical Centrifugation. Preparative centrifugation. Principles of Chromatography. Types of Chromatography. Principles of Electrophoresis, Gel Electrophoresis.

UNIT-II

UV-Visible spectroscopy. Vibrational spectroscopy. Fluorescence spectroscopy.

Refractometry, Polarimetry and Circular Dichroism. Microscopy: Confocal light microscopy.Cryo-electron microscopy. Determination of particle number and particle size from light scattering data. Structure determination of biomolecules and biomolecular assemblies from X-ray diffraction data.

UNIT-III

Principles and components of mass spectrometers. Ionization methods. Determination of empirical formula. Determination of structure of small organic molecules. Oligonucleotide sequencing. Peptide and protein sequencing. Mass spectroscopy for Metabolomics and Proteomics

UNIT-IV

Principles of Magnetic Resonance. Principles and components of Fourier Transform NMR spectrometer. Chemical shift, coupling constants and peak areas. Structure determination of small organic compounds using NMR spectroscopic data. Multidimensional NMR spectroscopy. Application of solution NMR spectroscopy for protein structure determination. NMR spectral fingerprinting. Principles of MRI.

UNIT-V

Principles, applications and types of Biosensors. Glucose Biosensors. Principles and applications of Microarrays. Microarray fabrication. Detectors for microarrays. Introduction to Micro Electro Mechanical systems. Fabrication of MEMS. Principles and applications of Microfluidic systems. Laboratory-on-a-chip devices exemplified with PCR-chips. Point of care devices for diagnostic applications.

Text/ Reference Books:

1. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). Principles of Instrumental Analysis (7th ed.). Cengage Learning.
2. Harris, D. C. (2015). Quantitative Chemical Analysis (9th ed.). W.H. Freeman.
3. Lakowicz, J. R. (2006). Principles of Fluorescence Spectroscopy (3rd ed.). Springer.
4. Wishart, D. S., & Sykes, B. D. (2019). NMR Spectroscopy in Drug Development and Analysis (2nd ed.). Wiley.
5. Aebersold, R., & Mann, M. (2016). Mass Spectrometry-Based Proteomics (1st ed.). Springer.
6. Mirkin, C. A., & Niemeyer, C. M. (2007). Nanobiotechnology II: More Concepts and Applications (1st ed.). Wiley-VCH.
7. Bhawani, S. A., & Mukherjee, P. K. (2019). Analytical Techniques in Biosciences (1st ed.). Elsevier.
8. Oberoi, H. S., & Sandhu, S. K. (2020). Biosensors and Their Applications in Healthcare (1st ed.). CRC Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Biochemistry Laboratory (BBT 3051)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Preparation of solutions:
   - Percentage solutions,
   - Molar solutions,
   - Normal solutions Buffer preparation, pH maintenance
2. To perform quantitative estimation of carbohydrates
3. To distinguish reducing and non-reducing sugars
4. To perform quantitative estimation of proteins
5. To estimate nucleic acids
6. To perform isoelectric precipitation
7. To separate sugars, fatty acids and amino acids by paper chromatography
8. To extract lipids from plant material
9. To perform thin layer chromatography

Recommended Books:

1. Wilson and Walker, "Principles and Techniques of Practical Biochemistry", 4 Edn., Cambridge Knew pros 1997.
2. Plummer DT, "An Introduction to Practical Biochemistry", Ill Edn., Tata McGraw hill.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Microbiology Laboratory (BBT 3004)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory
3. Sterilization Techniques
4. Preparation of different media: synthetic media CzapekDox media and /or BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
5. Isolation of pure cultures of bacteria by the streaking methods.
6. Pure culture through streak plate method
7. Simple and Negative staining
8. Differential Staining-Gram Staining
9. Estimation of CFU count by spread plate method/pour plate method.
10. Preservation of bacterial cultures by various techniques.

Recommended Books:

1. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp
2. Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett Pub..Sudburry, 835 pp
3. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.
4. Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9 th ed. Pearson Education Pte. Ltd., San Francisco. 958pp.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Fluid Flow and Heat-Mass Transfer Laboratory (BBT 3053)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Determination of venturimeter and orifice meter coefficient.
2. Deamination of major friction losses in fluid flow in pipes
3. Deamination of minor friction losses in fluid flow in pipes
4. Determination of pressure drops in a packed bed for different fluid velocities.
5. Determination of pressure drop and void fraction in a fluidized bed.
6. Determination of centrifugal pump efficiency
7. Sampling of materials (Riffle sampling and cone quartering sampling).
8. Determination of thermal conductivity using steady-state method.
9. Determination of convective heat transfer coefficient.
10. Evaluation of effectiveness and heat transfer coefficients of parallel and counter flow heat exchanger.

Recommended Books:

1. Laboratory manual of fluid mechanics

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Technical Seminar (BBT 3054)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Course Objective(s): Develop an ability to understand and present a seminar on the latest scientific and technological developments in the field of engineering and technology which enhances writing as well as oral communication skills.

Guidance / Remarks:

- Seminar in-charges shall highlight the significance of technical seminar in the first two sessions and enlighten the students on the utility of these seminars.
- The student has to identify the related topic.
- The slots, titles shall be decided upfront and seminar in charge shall take signatures.
- The same sheet shall be affixed in the respective classrooms and seminar register.
- If any student fails to present his/her seminar on the given slot, to genuine reasons, they may be asked to present in the subsequent slot/week.
- Progress of the seminars need to be reviewed by the concerned HOD once in 15 days.
- The evaluation for technical seminars has to be informed to students and displayed in the classrooms.
- Report and presentation must contain topic, introduction, explanation, diagrams, tables, applications and conclusions.

Semester-IV

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Cell & Molecular Biology (BBT 4001)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers the basics of cell and molecular biology, including cell structure, DNA/RNA functions, protein synthesis, genetics, and cell signaling. It emphasizes applications in biotechnology and provides a foundation for advanced studies.

Course Outcomes (COs):

CO1: Understand cell definitions, history, properties, and chemical foundations.

CO2: Explain DNA/RNA information flow, transcription, translation, and differences in prokaryotes/eukaryotes.

CO3: Analyze protein structure, pathways, synthesis control, and significance.

CO4: Apply genetics, transgenics, genomic analysis, cell cycle, mitosis/meiosis, and checkpoints.

CO5: Evaluate cell signals, receptors, pathways, misregulation, and protein kinases.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	-	1	1	3	1
CO2	3	3	2	1	2	-	1	-	-	1	1	3	2
CO3	3	3	2	1	2	-	1	-	-	1	1	3	2
CO4	3	2	3	2	2	1	1	1	1	1	2	3	3
CO5	3	3	2	1	3	2	1	2	-	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT- I

Cell Structure and Organization: Introduction to cell biology, cell theory, prokaryotic and eukaryotic cells. Structure and function of organelles – nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, chloroplast, lysosomes, and peroxisomes. Plasma membrane organization and transport mechanisms; cytoskeleton, cell junctions, extracellular matrix, and cell–cell communication.

UNIT-II

Cell Function and Regulation: Cell cycle: phases, mitosis and meiosis, and their regulation. Signal transduction pathways and secondary messengers; regulation of gene expression in eukaryotes. Programmed cell death (apoptosis), autophagy, stem cells – properties and applications. Cancer cell biology including oncogenes, tumor suppressor genes, and hallmarks of cancer.

UNIT-III

DNA Replication and Repair: Central dogma; structure and features of DNA related to replication. DNA replication in prokaryotes and eukaryotes – initiation, elongation, and termination. Enzymes and proteins involved: DNA polymerases, helicase, primase, ligase, topoisomerase, and SSB proteins. Concepts of origin of replication, replication fork, Okazaki fragments, and leading/lagging strand synthesis. Proofreading, fidelity, and error correction. DNA damage and repair mechanisms – mismatch repair, base excision repair, nucleotide excision repair, SOS repair, and photoreactivation.

UNIT-IV

Transcription: Overview of transcription. Prokaryotic transcription – RNA polymerase, promoters, initiation, elongation, and termination (rho-dependent and rho-independent). Eukaryotic transcription – RNA polymerases I, II, and III; promoters, enhancers, and transcription factors. Post-transcriptional modifications – 5' capping, splicing, polyadenylation, and RNA editing. Non-coding RNAs (microRNA, siRNA, lncRNA) and their role in gene regulation. Transport of mRNA from nucleus to cytoplasm and regulation of RNA stability.

UNIT- V

Translation and Protein Processing: Genetic code, features, degeneracy, start/stop codons, wobble hypothesis. Components of translation, ribosomes, tRNA, aminoacyl-tRNA synthetases, initiation and elongation factors. Mechanism of translation in prokaryotes and eukaryotes – initiation, elongation, and termination. Role of ribosome in protein synthesis. Post-translational modifications and protein maturation. Protein folding, role of chaperones, proteasome-mediated degradation. Protein targeting and trafficking to ER, Golgi, mitochondria, and chloroplast.

Text/ Reference Books:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). MolecularBiology of the Cell (6th ed.). Garland Science.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Amon, A. (2021). Molecular Cell Biology (9th ed.). W. H. Freeman.
3. Cooper, G. M., & Hausman, R. E. (2019). The Cell: A Molecular Approach (8th ed.). Sinauer Associates.
4. Karp, G. (2019). Cell and Molecular Biology: Concepts and Experiments (9th ed.). Wiley.
5. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). Molecular Biology of the Gene (7th ed.). Pearson Education.
6. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman.
7. Becker, W. M., Kleinsmith, L. J., Hardin, J., & Bertoni, G. P. (2017). The World of the Cell (9th ed.). Pearson Education.
8. Voet, D., Voet, J. G., & Pratt, C. W. (2019). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Plant & Animal Biotechnology (BBT 4002)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers plant and animal biotechnology techniques, including tissue culture, genetic transformation, animal cell culture, molecular farming, and omics technologies. It emphasizes applications in agriculture, medicine, and industry.

Course Outcomes (COs):

CO1: Understand plant tissue culture principles, media, regulators, regeneration, and applications.

CO2: Explain genetic transformation methods, vectors, transgenic plants, and regulatory issues.

CO3: Analyze animal cell culture history, media, scaling, and hybridoma technology.

CO4: Evaluate molecular farming, ethical considerations, biosafety, and transgenic animals.

CO5: Apply omics technologies and bioinformatics in plant and animal biotechnology.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	1	1	1	1	1	2	3	2
CO2	3	3	2	2	2	2	1	2	-	1	2	3	3
CO3	3	3	2	3	2	1	1	1	1	1	3	3	2
CO4	3	3	2	2	3	3	1	3	1	2	2	3	3
CO5	3	3	3	2	3	2	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Plant tissue culture and biotechnology-Introduction, significance, history, plant tissue culture media, plant growth regulators, In vitro plant regeneration- totipotency, cell differentiation. Organogenesis, somatic embryogenesis, Clonal (Micro) propagation. Applications of plant tissue culture technique, Haploid plant production, Protoplast technology- isolation, culture, somatic hybrids and cybrids production, Germplasms conservation- cryopreservation, Gene banks, Somaclonal variation.

UNIT-II

Scale-up propagation Callus and cell culture system- isolation, culture, growth, viability and applications, Secondary metabolite production, biotransformation, Bioreactor- design and models for mass cultivation of plant cells. Genetic Transformation-basic principles and applications Plant genetic transformation technology: Methods of gene transfer, Vectors of genetic transformation- Ti based vectors, T-DNA, mechanism of Agrobacterium gene transfer, viral vectors. Transgenic plants- (Golden Rice, etc.). Current global status and limitations of transgenic crops, Ethical and legal issues related to GM crops, Regulation of GM crops in India.

UNIT-III

Animal Cell Culture: History, characteristics, metabolism, nutritional requirements, culture media, growth conditions, primary culture, cell lines, suspension culture. Growth and Scale-Up: Scaling for vaccine/antigen/pharmaceutical protein production, hybridoma technology, cell culture reactors, scale-up (suspension/monolayer), growth factors, monitoring, mass transfer.

UNIT-IV

Molecular Farming: Transgenic crops for antibodies, viral antigens, peptide hormones, edible vaccines, nutraceuticals, biofuels. Ethical and Biosafety Considerations: Transgenic animals, transgene delivery (microinjection, stem cells), animal pharming, organ culture, regenerative medicine, human embryonic stem cell research, regulatory frameworks, risk assessment, public perception, environmental/social/legal issues.

UNIT-V

Omics Technologies and Bioinformatics in Plant and Animal Biotechnology – Introduction to genomics, transcriptomics, proteomics, and metabolomics; high-throughput sequencing and data analysis; marker-assisted selection; molecular markers (RFLP, AFLP, SSR, SNP) and their applications.

Text/ Reference Books:

1. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: The Genetic Manipulation of Plants (2nd ed.). Oxford University Press.
2. Bhojwani, S. S., & Razdan, M. K. (2016). Plant Tissue Culture: Theory and Practice (5th ed.). Elsevier.
3. Primrose, S. B., & Twyman, R. M. (2013). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell.
4. Freshney, R. I. (2015). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (7th ed.). Wiley-Blackwell.
5. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry and Molecular Biology of Plants (2nd ed.). Wiley.
6. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th ed.). ASM Press.
7. Walsh, G. (2018). Biopharmaceuticals: Biochemistry and Biotechnology (2nd ed.). Wiley.
8. Brazas, M., & Hancock, J. M. (2017). Bioinformatics: Methods and Applications (1st ed.). Academic Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Immunology & Immunotechnology (BBT 4007)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course introduces immunology principles, immune system components, antigen-antibody interactions, and immunotechniques. It covers transplantation, autoimmunity, cancer immunology, and vaccine development.

Course Outcomes (COs):

CO1: Understand immune system history, types of immunity, cells, and organs.

CO2: Analyze antigens, immunoglobulins, MHC, complement, cytokines, and hypersensitivity.

CO3: Apply immunotechniques like ELISA, RIA, immunodiffusion, and vaccines.

CO4: Evaluate transplantation, autoimmunity, immunodeficiencies, and AIDS.

CO5: Assess cancer immunology, immune surveillance, antigens, and immunotherapy.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	-	1	1	3	1
CO2	3	3	2	1	2	1	1	-	-	1	1	3	2
CO3	3	2	3	3	2	1	1	1	1	1	3	3	3
CO4	3	3	2	1	3	2	1	2	-	2	1	3	3
CO5	3	3	2	1	3	2	1	2	-	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT- I

Cells and Organs of the Immune System: History of Immunology. Types of Immunity: Innate and Adaptive immunity. Primary & Secondary immune response. B lymphocytes – Humoral immunity. T lymphocytes – Cell-mediated immunity. Antigen-Presenting Cells (APCs). Immunization & Memory. Organs: Thymus, Bone marrow, Spleen, Lymph nodes, Peripheral lymphoid organs

UNIT-II

Molecules of the Immune System: Antigens, Haptens & Adjuvants– Properties (foreignness, molecular

size, heterogeneity). Antigen Types – Iso- & Allo-antigens. Antigenicity & Immunogenicity. Affinity & Avidity. B & T cell epitopes, Superantigens. Immunoglobulins – Classification, Structure, Function. Major Histocompatibility Complex (MHC) – Classification, Structure, Function. Antigen Processing Pathways – Cytosolic & Endocytic. Complement Pathways. Cytokines – Classification & Function. Hypersensitivity – Types I, II, III. Delayed Type Hypersensitive Response.

UNIT-III

Immunotechniques and Vaccines: Antigen specificity, Cross-reactivity. Precipitation & Immunodiffusion reactions – Radial, Ouchterlony double diffusion. Agglutination reactions -ELISA, RIA. Fluorescent Techniques- flowcytometry. Immunoelectrophoresis – Types. Vaccines – Conventional, Peptide, Subunit, DNA vaccines

UNIT-IV

Transplantation, Autoimmunity, and Immunodeficiencies: Transplantation Immunology – Phases in graft rejection. Immunosuppressive agents. Autoimmune Disorders – Systemic & Organ-specific (examples). Primary & Secondary Immunodeficiencies. AIDS – Cause, Symptoms, Effects on immune system

UNIT-V

Immunology in Disease and Cancer: Cancer and the Immune System – Immune surveillance, Immunological escape. Cancer antigens. Cancer immunotherapy

Text/ Reference Books:

1. Kuby, J., Owen, J. A., Punt, J., Stranford, S. A., & Jones, P. P. (2018). Kuby Immunology (8th ed.). W. H. Freeman.
2. Abbas, A. K., Lichtman, A. H., & Pillai, S. (2021). Cellular and Molecular Immunology (10th ed.). Elsevier.
3. Murphy, K., & Weaver, C. (2016). Janeway's Immunobiology (9th ed.). Garland Science.
4. Roitt, I. M., Delves, P. J., Martin, S. J., & Burton, D. R. (2017). Roitt's Essential Immunology (13th ed.). Wiley-Blackwell.
5. Kindt, T. J., Goldsby, R. A., & Osborne, B. A. (2013). Kuby Immunology (7th ed.). W. H. Freeman.
6. Sompayrac, L. (2019). How the Immune System Works (6th ed.). Wiley-Blackwell.
7. Playfair, J. H. L., & Chain, B. M. (2016). Immunology at a Glance (10th ed.). Wiley-Blackwell.
8. Coico, R., & Sunshine, G. (2015). Immunology: A Short Course (7th ed.). Wiley-Blackwell.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Enzyme Technology (BBT 4008)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers enzyme classification, catalysis, kinetics, regulation, and industrial applications. It includes enzyme immobilization, engineering, and roles in clinical and food industries.

Course Outcomes (COs):

CO1: Understand enzyme history, nomenclature, classification, and chemical nature.

CO2: Explain catalysis models, inhibition types, and mechanisms.

CO3: Analyze enzyme regulation, localization, degradation, and cellular organization.

CO4: Apply enzyme kinetics, factors affecting activity, and Michaelis-Menten equation.

CO5: Evaluate industrial and clinical enzyme uses, immobilization, engineering, and biosensors.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	-	1	-	-	1	1	3	1
CO2	3	3	2	1	2	-	1	-	-	1	1	3	1
CO3	3	3	2	1	2	1	1	-	-	1	1	3	2
CO4	3	2	3	2	3	-	1	-	1	1	2	3	2
CO5	3	3	2	2	3	2	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

General introduction and historical background - Terminology, Nomenclature and Classification of Enzymes. Criteria for purity of enzymes- Specific activity and Enzyme activity, Enzyme units- Katal and IU. Chemical nature of enzymes- Proteinaceous nature of enzymes, Non protein enzymes- Ribozymes and DNAzymes. Metalloenzymes. Cofactors, Coenzymes, Prosthetic groups, coenzymes involved in different metabolic pathways.

UNIT-II

Lock and key model, Induced fit model and Transition state Hypothesis. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis. Mechanism of enzyme action - Chymotryspin, Carboxypeptidase-A and Ribonuclease, Proenzymes (Zymogens). Reversible Enzyme Inhibition- Competitive, Non-Competitive, Uncompetitive, Allosteric Inhibition. Irreversible Inhibition, Suicide inhibition. Examples and Mechanism of various Inhibitions like Penicillin, Iodoacetamide.

UNIT-III

Feedback Regulation, Allosteric Regulation, Covalent Modification and Proteolytic Activation. Organisation of enzymes in the cell- Cellular localization, compartmentalization of metabolic pathways, enzymes in membranes, concentrations. Mechanisms of enzyme degradation, lysosomal and non-lysosomal pathways, examples.

UNIT-IV

Factors affecting the enzyme activity- Enzyme Concentration and Substrate Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, Lineweaver Burk Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition.

UNIT-V

Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry. Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflamatory agents, Asparaginase, Isoenzymes- LDH, Transaminases, Amylases, Phosphatases. ELISA, Abzymes Immobilization of enzymes and types, Enzyme Engineering and site directed mutagenesis, Synzymes, Enzyme biosensors.

Text/ Reference Books:

1. Palmer, T., & Bonner, P. L. (2011). Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (2nd ed.). Woodhead Publishing.
2. Fersht, A. (2017). Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding (4th ed.). World Scientific.
3. Copeland, R. A. (2013). Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis (2nd ed.). Wiley.
4. Bisswanger, H. (2017). Enzyme Kinetics: Principles and Methods (3rd ed.). Wiley-VCH.
5. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman.
6. Voet, D., Voet, J. G., & Pratt, C. W. (2019). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). Wiley.
7. Price, N. C., & Stevens, L. (2015). Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins (3rd ed.). Oxford University Press.
8. Buchholz, K., Kasche, V., & Bornscheuer, U. T. (2012). Biocatalysts and Enzyme Technology (2nd ed.). Wiley-VCH.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Engineering Economics (BBT 4051)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: This course explores economic principles, cost analysis, project evaluation, and decision-making, emphasizing applications in bioprocess optimization, resource allocation, and financial planning in biotechnology industries.

Course Outcomes (COs):

CO1: Understand economic principles and their application in biotechnology.

CO2: Analyze costs and benefits for bioprocess project planning.

CO3: Apply time value of money in biotech investment decisions.

CO4: Evaluate project feasibility using economic analysis techniques.

CO5: Make informed decisions for resource optimization in biotechnology.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	1	2	2	1	1	-	1	1	3	2
CO2	2	3	3	2	3	2	1	1	1	1	2	3	3
CO3	2	3	3	2	3	1	1	1	1	1	2	3	3
CO4	2	3	3	2	3	2	1	1	1	1	2	3	3
CO5	2	3	3	2	3	3	1	2	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Engineering Economics: Definition and scope of engineering economics in biotechnology. Basic economic concepts: Supply, demand, market structures. Role of economics in bioprocess design and optimization. Cost concepts: Fixed, variable, marginal, and opportunity costs. Economic decision-making in biotech industries.

UNIT-II

Cost Estimation and Analysis: Types of costs: Capital, operating, direct, and indirect costs. Cost estimation techniques: Order-of-magnitude, detailed estimates. Cost indices and scaling factors in bioprocess equipment. Break-even analysis: Applications in biotech production. Cost-benefit analysis for biotech projects.

UNIT-III

Time Value of Money: Time value of money: Present value, future value, annuities. Interest rates: Simple, compound, nominal, and effective. Cash flow analysis: Cash flow diagrams in biotech projects. Discounted cash flow methods: Net present value (NPV), internal rate of return (IRR).

UNIT-IV

Project Evaluation and Selection: Project evaluation techniques: Payback period, benefit-cost ratio. Depreciation: Straight-line, declining balance, sum-of-years-digits. Sensitivity and risk analysis in biotech projects. Capital budgeting: Evaluating biotech equipment investments. Replacement analysis: Upgrading bioprocess systems.

UNIT-V

Decision-Making and Optimization: Decision-making models: Decision trees, expected value analysis. Optimization techniques: Linear programming for resource allocation. Economic considerations in bioprocess scale-up and sustainability. Ethical and environmental factors in economic decisions.

Text/ Reference Books:

1. Sullivan, W. G., Wicks, E. M., & Koelling, C. P. (2020). *Engineering Economy* (17th ed.). Pearson.
2. Park, C. S. (2018). *Fundamentals of Engineering Economics* (4th ed.). Pearson.
3. Blank, L., & Tarquin, A. (2017). *Engineering Economy* (8th ed.). McGraw-Hill.
4. Newnan, D. G., Eschenbach, T. G., & Lavelle, J. P. (2020). *Engineering Economic Analysis* (14th ed.). Oxford University Press.
5. Riggs, J. L., Bedworth, D. D., & Randhawa, S. U. (1996). *Engineering Economics* (4th ed.). McGraw-Hill.
6. White, J. A., Case, K. E., & Pratt, D. B. (2019). *Principles of Engineering Economic Analysis* (6th ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Intellectual property Rights & Regulatory Affairs (BBT 4010)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	1	1	0	2
Pre-requisites/Exposure	-				

Course Description: This course is designed to make students learn about the legal, safety and public policy issues raised due to the rapid progress in Biotechnology and development of new products.

Course Outcomes (COs):

CO1: Understand biosafety principles, levels, Laboratory requirements, and waste management practices.

CO2: Analyze risks, biosafety for genetically engineered organisms, and environmental protection.

CO3: Evaluate ethical issues in genetic engineering, cloning, and human genome research.

CO4: Explain types of intellectual property rights, including patents, copyrights, and trademarks.

CO5: Assess IPR applications in biotechnology, patenting transgenic organisms, and Indian regulations.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	2	2	1	2	-	1	2	3	2
CO2	3	3	2	2	3	3	1	2	1	1	2	3	2
CO3	3	2	2	1	3	3	1	3	1	2	1	3	2
CO4	3	2	2	1	2	2	1	2	-	1	1	2	3
CO5	3	2	2	1	3	3	1	3	1	2	2	2	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction and Development of Biosafety Practices and Principles, General Laboratory requirements, Definitions and Biosafety levels: 1,2,3,4, Biological safety cabinets: centrifuges, Shipment of biological specimens, Biological waste management, Decontamination, Biosafety manuals, Medical surveillance, Emergency response

UNIT -II

Risks and Assessment of Risks, Biosafety at small scale and large-scale processes Biosafety for genetically engineered microbes, plants and animals, National biosafety committees, Biosafety and environment protection International conventions

UNIT-III

History and Introduction, Ethics and genetic engineering, Genetic Privacy Patent of genes, Human races, Human Cloning Stem Cells, Eugenics, Christian faith, Human genome and religious considerations Case Studies and Final Considerations

UNIT-IV

Introduction and Types of Intellectual Property Rights Patents, Copyrights, Trademarks, Industrial designs, Trade secrets, Geographical Indications and Farmers rights & Plant variety Protection.

UNIT-V

IPR for Biotechnology, Patenting of transgenic organisms and isolated genes, microbes international conventions and cooperation Current status of IPR in India

Text/ Reference Books:

1. Traynor, P. L., & Frederick, R. J. (2002). *Biosafety and Risk Assessment in Agricultural Biotechnology* (1st ed.). Michigan State University Press.
2. Fleming, D. O., & Hunt, D. L. (2006). *Biological Safety: Principles and Practices* (4th ed.). ASM Press.
3. Ganguli, P. (2011). *Intellectual Property Rights: Unleashing the Knowledge Economy* (1st ed.). Tata McGraw-Hill.
4. Bains, W. (2004). *Biotechnology from A to Z* (3rd ed.). Oxford University Press.
5. Watal, J. (2001). *Intellectual Property Rights in the WTO and Developing Countries* (1st ed.). Oxford University Press.
6. Resnik, D. B. (2004). *The Ethics of Science: An Introduction* (1st ed.). Routledge.
7. Singh, K. (2016). *Intellectual Property Rights in Biotechnology* (1st ed.). Kalyani Publishers.
8. WHO Guidelines. (2020). *Laboratory Biosafety Manual* (4th ed.). World Health Organization. Available at: www.who.int

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Comprehensive Viva-Voce (BBT 4051)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Guidance/Remarks:

- There shall be comprehensive viva voce as stated above which will be evaluated for 100 marks. Out of 100 marks, 25 marks are internal and 75 marks are external.
- The evaluation of comprehensive viva-voce has to be carried out by two teachers independently and average be taken.
- The sessional marks awarded by the Department are not final. They are subject to scrutiny by a committee constituted by the college and scaling is done wherever necessary.
- The recommendations of the Committee are final and binding

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Cell & Molecular Biology Laboratory (BBT 4052)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Microscopy and Cell Observation

2. Mitotic Chromosomes from Onion Root Tips

3. DNA Extraction from Plant Tissue

4. Agarose Gel Electrophoresis of DNA

5. Bacterial Transformation with Plasmid DNA

6. Polymerase Chain Reaction (PCR) Amplification

7. Protein Extraction and Quantification

8. SDS-PAGE of Proteins

9. Cell Viability Using Trypan Blue

10. Enzyme Activity Assay (Catalase)

Recommended Books:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). Molecular Biology of the Cell (6th ed.). Garland Science.
2. Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual (3rd ed.). Cold Spring Harbor Laboratory Press.
3. Freshney, R. I. (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6th ed.). Wiley-Blackwell.
4. Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology (7th ed.). Cambridge University Press.
5. Brown, T. A. (2016). Gene Cloning and DNA Analysis: An Introduction (7th ed.). Wiley-Blackwell.
6. Karp, G. (2013). Cell and Molecular Biology: Concepts and Experiments (7th ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Immunotechnology Laboratory (BBT 4053)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Different types of antigen –antibody cross reaction
2. Identification of blood group antigens
3. Differential count of White blood cells by haemocytometer
4. Isolation, purification and identification of immunoglobulin from goat blood.
5. Widal test for identification of *Salmonella Typhi*
6. Double diffusion techniques for identification of antigen-antibody samples
7. Agglutination inhibition test to detect pregnancy
8. Immuno-electrophoresis techniques.
9. ELISA (Enzyme linked Immunosorbent Assay)

Recommended Books:

1. Immunology, The experimental Series – II by W. Luttmann, K. Bratke, M. Kupper, Myrtek, USA, Elsevier, Academic Press;2006
2. Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Enzyme Technology Laboratory (BBT 4054)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Isolation of enzyme from different microorganism.
2. Isolation of alpha amylase from plant source.
3. Determination of Enzyme activity.
4. Effect of pH on Enzyme kinetics.
5. Effect of temperature on Enzyme kinetics.
6. Identification of Enzyme by different assay.
7. Fractionation of protein using ammonium sulphate.

Recommended books:

1. Laboratory manual
2. Jakoby WB. [23] Crystallization as a purification technique. Methods in Enzymology. 1971 Dec 31; 22:248-52.
3. Bernfeld P. Amylases α and β. Methods in Enzymology Volume I. Elsevier, Science Direct. G; 1955, 149-158 p.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
BCN4007	Environmental Sciences	L	T	P	C
Owning School/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	0
Pre-requisites/Exposure	-				

Course Outcomes (COs)

CO1: Demonstrate analytical thinking skills concerning environmental topics.
CO2: Demonstrate an ability to combine the many disciplines and fields that intersect with environmental concerns.
CO3: Illustrate an integrative approach to environmental issues with a focus on sustainability.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	2	1	1	1	-	1	2	3	2
CO2	3	3	2	2	2	-	1	-	1	1	2	3	2
CO3	3	3	2	3	2	1	1	1	1	1	3	3	2

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT 1:
Environmental Sustainability, Ecosystems, and Climate Change: Overview of Environmental Sustainability, Sustainability and Population Growth, Exploration of Growth Curves, Way forward – Ecosystems and climate change introduction – Ecosystem dynamics –Tragedy of commons - Tragedy of commons solutions – Ecosystems and extinctions – Weather vs. Climate – Climate changes in the past – Climate change in the present – Climate processes.

UNIT 2:
Biodiversity and its conservation: Biodiversity – Value of biodiversity – Threats to biodiversity - Conservation of biodiversity – Case studies.

UNIT 3:
Natural resources: Natural Resources and Their Challenges, Renewable and Non-renewable Energy Sources, Water's Role in Agriculture, Agriculture's Connection to Food Production, Addressing Issues and Solutions in Agriculture and Food Production.

UNIT 4:
Environmental pollution: Causes, effects and control measures of various types of pollutions - Air pollution - Water pollution -Wastewater treatment - Soil pollution - Noise pollution - Thermal pollution - - Solid waste management - E-waste-Case studies on pollution.

UNIT 5:
Ethical Perspectives on the Environment, Global Environmental Policies, Environmental Legislation in India, Environmental Impact Assessment, Challenges Encountered in Enforcing Environmental Laws.

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UNIT 6:

Life cycle analysis and sustainability thinking: Introduction of LCA – Methodology of LCA – ISO 14044SignificanceofLCA–Case studies of LCA.

Text Books :

1. *Bharucha, Erach. Textbook of environmental studies for undergraduate courses. 2nd ed. Universities Press, 2013.ISBN978-8173718625.*

Semester-V

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Entreprenuership and Startups (BBT 5001)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	1	1	0	2
Pre-requisites/Exposure	-				

Course Description: This course explores entrepreneurial principles, startup strategies, business planning, and innovation, emphasizing applications in launching and managing biotech ventures for product development and commercialization.

Course Outcomes (COs):

CO1: Understand entrepreneurial principles and their role in biotechnology startups.

CO2: Identify and evaluate biotech business opportunities and market needs.

CO3: Develop business plans and models for biotech ventures.

CO4: Analyze funding strategies and regulatory requirements for startups.

CO5: Implement strategies for innovation and commercialization in biotech.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	1	2	2	2	2	1	2	1	3	2
CO2	2	3	3	2	3	2	2	2	2	2	2	3	3
CO3	2	3	3	2	3	2	2	2	2	2	2	3	3
CO4	2	3	3	2	3	2	2	3	2	2	2	3	3
CO5	2	3	3	2	3	3	2	3	2	3	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Entrepreneurship in Biotechnology: Definition and principles of entrepreneurship in biotech. Role of startups in advancing biotechnology innovation. Entrepreneurial mindset: Opportunity recognition, risk-taking. Biotech industry overview: Trends, challenges, and opportunities. Case study: Success stories of biotech startups (e.g., Moderna).

UNIT -II

Opportunity Identification and Market Analysis: Identifying biotech opportunities: Unmet needs in healthcare, agriculture, environment. Market analysis: Customer segments, competitors, and market

size. Tools: SWOT analysis, Porter's Five Forces for biotech markets. Intellectual property: Patents, trademarks in biotech.

UNIT-III

Business Planning and Models: Components of a biotech business plan: Vision, mission, strategy. Business models: B2B, B2C, licensing in biotech. Lean startup methodology: Minimum Viable Product (MVP) for biotech. Financial projections: Revenue, costs, break-even analysis.

UNIT-IV

Funding and Regulatory Navigation: Funding sources: Venture capital, angel investors, grants, crowdfunding. Pitching to investors: Crafting a biotech pitch deck. Regulatory requirements: FDA, EMA approvals for biotech products. Risk management: Financial, regulatory, and market risks.

UNIT-V

Innovation and Commercialization: Innovation strategies: R&D, open innovation in biotech. Product development: From lab to market in biotechnology. Commercialization: Go-to-market strategies, scaling up. Ethical considerations: Responsible innovation in biotech.

Text/ Reference Books:

2. Blank, S., & Dorf, B. (2020). *The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company*. K&S Ranch.
3. Ries, E. (2011). *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. Crown Business.
4. Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Wiley.
5. Aulet, B. (2013). *Disciplined Entrepreneurship: 24 Steps to a Successful Startup*. Wiley.
6. Kawasaki, G. (2015). *The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything*. Portfolio.
7. Byers, T. H., Dorf, R. C., & Nelson, A. J. (2019). *Technology Ventures: From Idea to Enterprise* (5th ed.). McGraw-Hill.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Fermentation Technology (BBT 5002)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course introduces fermentation principles, microbial kinetics, media, sterilization, and industrial applications like antibiotics, solvents, and enzymes.

Course Outcomes (COs):

CO1: Understand fermentation history, industry development, strain selection, and preservation.

CO2: Explain inoculum development, microbial kinetics, batch/continuous/fed-batch cultures.

CO3: Analyze media formulation, optimization, sterilization methods, and antifoams.

CO4: Evaluate regulatory mechanisms, repression, inhibition, and metabolite overproduction.

CO5: Assess industrial processes for antibiotics, solvents, amino acids, acids, alcohols, enzymes, and biopharmaceuticals.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	2	1	1	1	-	1	2	3	2
CO2	3	3	2	2	2	-	1	-	1	1	2	3	2
CO3	3	3	2	3	2	1	1	1	1	1	3	3	2
CO4	3	3	2	1	3	1	1	-	-	1	1	3	2
CO5	3	3	3	2	3	2	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction & Historical Background : Interaction between biochemical engineering, microbiology, and biochemistry in fermentation technology. History and development of the fermentation industry. Selection of microbial cultures for fermentation processes. Strain development strategies: mutation, selection, recombinant approaches. Preservation and improvement of industrially important microorganisms.

UNIT-II

Inoculum Development & Microbial Kinetics: Introduction to inoculum development and criteria for inoculum transfer. Development of inocula for bacterial, yeast, and mycelial processes. Inoculum preparation for plant fermenters. Aseptic inoculation methods and maintenance of aseptic conditions. Fermentation material and energy balances. Microbial growth kinetics: growth cycle, measurement of growth. Batch culture, continuous culture, fed-batch culture — principles and applications.

UNIT-III

Media & Sterilization Techniques: Media ingredients and formulation principles. Oxygen requirements in fermentation. Role and selection of antifoams. Medium optimization methods.

Media sterilization: Batch sterilization & thermal death kinetics. Continuous sterilization process. Sterilization of fermenter and ancillary equipment. Filter sterilization of air and media.

UNIT-IV

Regulatory Mechanisms & Metabolic Control: Regulatory mechanisms in catabolic and anabolic processes. Induction and nutritional repression. Carbon catabolite repression & Crabtree effect. Feedback inhibition and feedback repression. Strategies for overproduction of primary and secondary metabolites.

UNIT-V

Industrial Applications & Case Studies Process details, parameters, and raw materials for: Antibiotics: β-lactam (e.g., penicillin), Solvents: Acetone, Amino acids: Lysine, Organic acids: Citric acid, Alcohols: Ethanol, Industrial enzymes: Protease, Amylase, Biopharmaceuticals: Insulin, Interferon, Microbial transformations in industry. Microbial leaching (bio-mining).

Text/ Reference Books:

1. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). Principles of Fermentation Technology (3rd ed.). Elsevier.
2. Crueger, W., & Crueger, A. (2017). Biotechnology: A Textbook of Industrial Microbiology (3rd ed.). Sinauer Associates.
3. El-Mansi, E. M. T., Bryce, C. F. A., Demain, A. L., & Allman, A. R. (2011). Fermentation Microbiology and Biotechnology (3rd ed.). CRC Press.
4. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). Industrial Microbiology: An Introduction (1st ed.). Wiley-Blackwell.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	rDNA Technology (BBT 5003)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers recombinant DNA principles, cloning vectors, enzymes, gene transfer, PCR, and applications in agriculture and medicine.

Course Outcomes (COs):

CO1: Understand rDNA history, DNA purification, manipulation, and introduction into cells.

CO2: Explain cloning vectors, genomic/cDNA libraries, and gene editing techniques.

CO3: Analyze enzymes in molecular cloning and their mechanisms.

CO4: Apply gene recombination, transfer, silencing, mutagenesis, knock-in/knock-out.

CO5: Evaluate PCR, qPCR, blotting, sequencing, fingerprinting, and rDNA applications.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	2	1	1	-	-	1	2	3	1
CO2	3	3	2	2	2	1	1	1	-	1	2	3	2
CO3	3	3	2	2	2	-	1	-	-	1	2	3	1
CO4	3	3	3	2	3	1	1	1	1	1	2	3	2
CO5	3	3	3	2	3	2	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

The Basic Principles of Gene Cloning and DNA Analysis: Introduction and history of gene cloning. Advent and importance of gene cloning and the polymerase chain reaction (PCR). Purification of DNA from living cells. Manipulation of purified DNA. Introduction of DNA into living cells. Plasmids

UNIT-II

DNA Libraries, Gene Editing & Strain Improvement: Vectors for Cloning: pBR322, bacteriophage, cosmid, phagemid, shuttle vectors, Cloning vectors for *E. coli* and other high-capacity vectors, Cloning vectors for eukaryotes, Genomic and cDNA libraries.

UNIT-III

Enzymology of Genetic Manipulation: Enzymes useful in molecular cloning: Restriction endonucleases, Klenow enzyme, DNA polymerases, Terminal nucleotidyl transferase, DNA ligases, Polynucleotide kinase, Reverse transcriptase, Alkaline phosphatase

UNIT-IV

Gene Editing: Gene recombination and gene transfer. Bacterial conjugation, transformation, transduction. Gene transfer techniques. Approaches to gene silencing. Mutagenesis: random and site-directed. Knock-in and knock-out techniques

UNIT-V

Applications and Techniques of Gene Cloning: Polymerase Chain Reaction (PCR) and quantitative PCR (qPCR). Labeling nucleic acids and blotting techniques (Southern, Northern, Western, Zoo blot). DNA sequencing. DNA fingerprinting. Applications of recombinant DNA technologies in agriculture, medicine, and health

Text/ Reference Books:

1. Primrose, S. B., & Twyman, R. M. (2013). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell.
2. Sambrook, J., & Russell, D. W. (2012). Molecular Cloning: A Laboratory Manual (4th ed.). Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2016). Gene Cloning and DNA Analysis: An Introduction (7th ed.). Wiley-Blackwell.
4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). Molecular Biology of the Gene (7th ed.). Pearson Education.
5. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual (3rd ed.). Cold Spring Harbor Laboratory Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Bioinformatics- I (BBT 5004)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course introduces bioinformatics, biological databases, sequence analysis, alignment, phylogeny, and scoring matrices for biotechnology applications.

Course Outcomes (COs):

CO1: Understand bioinformatics definition, scope, history, and applications in biotechnology.

CO2: Explain biological databases, types, submission/retrieval, and formats like FASTA.

CO3: Analyze sequence similarity, homology, alignment methods, and algorithms.

CO4: Apply evolutionary analysis, phylogeny, tree construction, and software like PHYLIP.

CO5: Evaluate database searches, scoring matrices, and predictive methods for sequences.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	3	3	2
CO3	3	3	3	2	3	-	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	2	3	3	2
CO5	3	3	3	2	3	2	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Bioinformatics– Definition, Scope, and Importance, Objectives and areas of Bioinformatics History of Bioinformatics, Applications of Bioinformatics, Central Dogma, Human Genome Project, NCBI, EMBL, DDBJ, -Techniques and Insights.

UNIT-II

Introduction to Biological Database: Overview, Types of biological databases, Nucleic acid and protein databases- GenBank, SWISS PROT. Structural databases - PDB, etc; Motifs and Pattern Databases - PROSITE, Pfam, etc. Data submission & Data retrieval system - SRS, Entrez, Bankit, Seqin.etc., Protein Databases, Literature Databases- PUBMED, MEDLINE Composite Databases, Sample Sequence Data File, Representation of sequence, GenBank, EMBL, FASTA, GCG, MSF, NBRF-PIR.

UNIT-III

Basic sequence similarity concepts: identity vs. homology, Homologues, orthologues, and paralogues – definitions, Sequence Analysis & Alignment: Statistical significance of alignment; Sequence assembly Analysis; Global & Local Alignment and their algorithms, Pair-wise and Multiple sequence alignment: Methods for sequence alignment. Dot plots, Dynamic programming algorithms, Heuristics - FASTA, BLAST, Gaps & gap penalties, Sequence patterns, profiles, and motifs.

UNIT-IV

Introduction to sequence alignment and its evolutionary basis, Evolutionary analysis- Concept of phylogeny and trees, Phylogenetic prediction, evolutionary tree construction, tree building methods, rooted & unroofed trees, evolution tree & data phylogenetic software like PHYLIP, phylogenies from pairwise distance matrices (UPGMA and NJ algorithms) CLUSTAL W, T-coffee, Phylogenetics on the web, Sequence Homology, COGS (Cluster of Orthologous genes).

UNIT-V

Nature of data in taxonomy and phylogeny, Predictive methods using nucleotide sequence: Annotation of DNA and protein sequences, Database searches for homologous sequences- FASTA, BLAST, PSI-BLAST and PHI-BLAST, Scoring matrices - PAM, BLOSUM.

Text/ Reference Books:

1. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis (2nd ed.). Cold Spring Harbor Laboratory Press.
2. Lesk, A. M. (2019). Introduction to Bioinformatics (5th ed.). Oxford University Press.
3. Pevsner, J. (2015). Bioinformatics and Functional Genomics (3rd ed.). Wiley-Blackwell.
4. Baxevanis, A. D., Bader, G. D., & Wishart, D. S. (2020). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (4th ed.). Wiley.
5. Zvelebil, M., & Baum, J. O. (2007). Understanding Bioinformatics (1st ed.). Garland Science.
6. Krane, D. E., & Raymer, M. L. (2002). Fundamental Concepts of Bioinformatics (1st ed.). Pearson Education.
7. Attwood, T. K., & Parry-Smith, D. J. (1999). Introduction to Bioinformatics (1st ed.). Prentice Hall.
8. Higgs, P. G., & Attwood, T. K. (2005). Bioinformatics and Molecular Evolution (1st ed.). Blackwell Publishing.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Good Manufacturing and Laboratory Practice (BBT 5005)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores GMP and GLP principles, quality control, documentation, and regulatory compliance, emphasizing applications in bioprocessing, lab safety, and biotech product development.

Course Outcomes (COs):

CO1: Understand GMP and GLP principles for biotechnology applications.

CO2: Apply quality control and assurance in bioprocessing and labs.

CO3: Implement documentation and validation in biotech processes.

CO4: Evaluate regulatory compliance and safety protocols in labs.

CO5: Design GMP/GLP-compliant systems for biotech product development.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	1	2	2	1	2	-	1	1	3	3
CO2	2	3	2	2	3	1	1	2	1	1	2	3	3
CO3	2	3	2	2	3	1	2	2	1	1	2	3	3
CO4	2	2	2	2	3	2	1	3	1	1	2	3	3
CO5	2	3	3	2	3	2	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to GMP and GLP: Definitions and scope of GMP and GLP in biotechnology. Importance in bioprocessing and laboratory research. Regulatory bodies: FDA, EMA, WHO, and ICH guidelines. Principles of GMP: Quality, safety, efficacy in biotech products. Principles of GLP: Integrity, reproducibility in lab experiments.

UNIT-II

Quality Control and Assurance: Quality control (QC): Testing methods for biotech products. Quality assurance (QA): Systems for consistent quality. Standard Operating Procedures (SOPs): Development

and use. Analytical techniques: HPLC, PCR, ELISA in QC. Stability testing and shelf-life determination.

UNIT-III

Documentation and Validation: Documentation: Batch records, lab notebooks, protocols. Data integrity: ALCOA principles (Attributable, Legible, Contemporaneous, Original, Accurate). Validation: Equipment, process, and analytical method validation. Good Documentation Practices (GDP) in biotech labs.

UNIT-IV

Regulatory Compliance and Safety: Regulatory frameworks: cGMP, GLP, and ISO standards. Compliance with 21 CFR Part 11 (electronic records). Lab safety: Biosafety levels, chemical handling, PPE. Risk assessment and management in biotech labs. Audits and inspections: Preparation and response.

UNIT-V

GMP/GLP in Biotech Product Development: GMP in bioprocess scale-up: From lab to production. GLP in preclinical and analytical studies. Cleanroom design and environmental monitoring. Ethical considerations in GMP/GLP compliance. Strategies for implementing GMP/GLP in biotech startups.

Text/ Reference Books:

1. WHO. (2011). *WHO Good Manufacturing Practices for Pharmaceutical Products: Main Principles*. World Health Organization.
2. OECD. (1998). *OECD Principles of Good Laboratory Practice*. Organisation for Economic Co-operation and Development.
3. FDA. (2018). *Current Good Manufacturing Practice (cGMP) Regulations*. U.S. Food and Drug Administration.
4. Beaney, A. M. (2016). *Quality Assurance of Aseptic Preparation Services* (5th ed.). Pharmaceutical Press.
5. Nally, J. D. (2010). *Good Manufacturing Practices for Pharmaceuticals* (6th ed.). CRC Press.
6. Sharp, J. (2004). *Good Laboratory Practice: Standards, Compliance, and Issues* (2nd ed.). CRC Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Bioinformatics- I Laboratory (BBT 5004)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Explore NCBI.
2. Analysis of sequence alignment of any given protein sequence.
3. Analysis of sequence alignment of any given gene sequence.
4. Analysis of Multiple sequence alignment of given protein sequences.
5. Phylogenetic analysis of given protein sequences.
6. Annotation of any nucleotide sequence.

Recommended Books:

1. D.W. Mount Bioinformatics: Genome and Sequence Analysis: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
2. Ian Korf, Mark &Josaph: BLAST, Oreilly Publisher, 2003
3. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.
4. A.D. Baxevanis& B.F.F. OuletteBioinformatics – A practical guide to the Analysis of Genes and Proteins,2002, Willey International publishers.
5. M.J. Bishop and C.J. Rawlings (editors), DNA and Protein Sequence Analysis---A Practical Approach IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	rDNA Technology Laboratory (BBT 5052)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Isolation of plasmid DNA from E.coli culture
2. Separation of plasmid DNA on agarose gel electrophoresis
3. Restriction digestion of phage DNA
4. Ligation of the DNA digested by restriction endonucleases
5. Preparation of competent E.coli cells
6. Transformation of competent E.coli cells with ligated plasmid and selection of positive colonies through Blue-white screening method
7. Studying the expression of cloned genes (GFP).
8. PCR amplification of DNA using gene specific primers
9. DNA finger printing through RFLP and RAPD

Recommended Books:

1. Laboratory manual by Sambrook and Russel
2. T.A. Brown, Gene cloning and DNA analysis: an introduction, 6/e, Wiley- Blackwell, 2010.
3. D. S.T. Nicholl, An introduction to genetic engineering, 3/e, Cambridge University press, 2008.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Fermentation Technology Laboratory (BBT 5053)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Determine the growth patterns and specific growth rate of *E. coli*
2. Determine the effect of peptone concentration on *E .coli* growth
3. Fermentative production of Penicillin Antibiotics using *Penicilium chrysogenum.*
4. To study the induction effect of β-galactosidase enzyme in *E. coli*
5. Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger.*
6. Citric acid production from whey with glucose as supplementary carbon source by *Aspergillus niger*
7. Microbial production of citric acid by solid state fermentation process.
8. Microbial production of enzymes by (a) solid state and (b) submerged
9. Fermentative production of Ethanol using *Saccharomyces cerevisiae*

Recommended Books:

1. Fermentation Microbiology and Biotechnology, 3rd Edition by Bjorn Kristiansen, Joan Linden, Michael Mattey (CRC Press, 1998)
2. Principles of Fermentation Technology by P.F. Stansbury, A. Whitaker, Stephen J. Hall

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Summer Internship- I (BBT 5054)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	4	2
Pre-requisites/Exposure	-				

Objective: Minimum of six weeks in an Industry preferably in the area of Biotechnology. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report. This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.AICTE Internship Policy available on AICTE's website may be referred for more information regarding Internship.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
BCS5007	Essence of Indian Knowledge Tradition	L	T	P	C
Owning School/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	0
Pre-requisites/Exposure	-				

Course Outcomes (COs)

CO1: Understand the foundational concepts, sources, and transmission methods of Indian Knowledge Systems.
CO2: Analyze the contributions of Indian traditions in fields such as science, philosophy, health, governance, and education.
CO3: Evaluate the relevance and application of Indian knowledge traditions in contemporary society and interdisciplinary contexts.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	3	3	2
CO3	3	3	3	2	3	-	1	-	1	1	3	3	2

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Course Contents:

UNIT1: **05 lecture hours**

Understanding Indian Knowledge Systems, Modes of Knowledge Transmission in Ancient India, Vedic Corpus: Foundations of Indian Wisdom, Exploring Vedangas and Upavedas, Classical Indian Philosophical Traditions: An Overview

UNIT 2: **05 lecture hours**

Logic and Epistemology in Indian Philosophy, Indian Contributions to Mathematics: From Ancient to Medieval, Advancements in Astronomy and Cosmology in India, Ayurveda: Science of Life and Well-being, Traditional Indian Architecture and Town Planning

UNIT 3: **05 lecture hours**

Language and Knowledge: Role of Sanskrit, Indian Literature and Poetics: Exploring Aesthetics and Meaning, Indigenous Knowledge Systems, Indigenous Knowledge in Environment and Ecology: Practices and Wisdom

UNIT 4: **05 lecture hours**

Art, Music, and Dance in Indian Tradition, Governance and Administration in Ancient India, Ethical and Epistemological Concerns in IKS, Relevance and Future of Indian Knowledge Systems, Constitution of India

UNIT 5: **06 lecture hours**

Constitutionalism and Indian Context, Making of Indian Constitution: Constituent Assembly and Philosophical Foundations, Preamble: Ideals and Objectives of Constitution, Fundamental Rights: Right to Equality, Fundamental Rights: Freedoms and Other Rights

UNIT 6: **05 lecture hours**

Fundamental Rights: Cultural and Educational Rights and Constitutional Remedies, Directive Principles of State Policy: Guiding Principles for Governance, Fundamental Duties and Responsibilities of Citizens, Union Executive: President and Vice-President

UNIT 7: **05 lecture hours**

Union Executive: Prime Minister and Council of Ministers, Union Legislature: Parliament - Lok Sabha and Rajya Sabha, Judiciary: Supreme Court of India, Federalism and Center-State Relations in India State Government: Executive and Legislature

UNIT 8: **06 lecture hours**

State Government: Judiciary and Local Self-Government, Constitutional Amendments and Structure Doctrine, Emergency Provisions and Constitutional Governance, Contemporary Debates and Future of Indian Constitution

Text Books:

1. B. Madhavan, Vinayak Rajat Bhat, Nagendra Pavana R.N. "Introduction to Indian knowledge system", PHI Learning Private Limited, 2024.
2. Bhatt, S. R., and Anu Mehrotra. "Philosophy of Education: Indian Perspective", D. K. Print world,2018.

Semester-VI

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Bioprocess Engineering (BBT 6001)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course focuses on microbial growth, media preparation, sterilization, bioreactors, mass transfer, and control in bioprocessing.

Course Outcomes (COs):

CO1: Understand microbial growth, kinetics, and quantitative analysis methods.

CO2: Explain sterilization concepts, methods, and stoichiometric calculations.

CO3: Analyze reactor operations, kinetics, and substrate/product formation.

CO4: Evaluate diffusion, mass transfer, oxygen uptake, and transfer in bioreactors.

CO5: Assess bioreactor control, sensors, modeling, and optimization.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	1	1	-	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	2	3	2
CO3	3	3	3	2	3	-	1	-	1	1	2	3	3
CO4	3	3	2	2	3	1	1	-	-	1	3	3	3
CO5	3	3	3	2	3	2	1	1	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT–I

Media Preparation, Media design and optimization. Microbial growth patterns and kinetics in batch culture, Microbial growth parameters, Environmental conditions affect growth kinetics, Kinetics of thermal death of microorganisms, Heat Generation by microbial growth, Quantitative analysis of microbial growth by direct & indirect methods.

UNIT–II

Sterilization: concept and methods. Type of Sterilizations, Batch heat sterilization of liquids, Estimation of sterilizer efficiency, Continuous heat sterilization of liquids, Sterilization of air: Methods &Mechanism, Design of depth filter and estimation of its efficiency. Stoichiometric calculations,

Theoretical prediction of yield coefficients, Stoichiometry of growth and product formation, Maximum possible yield, Theoretical oxygen demand, Stoichiometry of single-cell protein synthesis.

UNIT–III

Ideal Reactor Operation: Batch, Fed Batch & Continuous operation of mixed bioreactors, Microbial pellet formation, Kinetics and dynamics of pallet formation. Chemostate with immobilized cells, Chemostate with cell recycle, substrate utilization and product formation in bioreactor.

UNIT–IV

Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures, Factor affecting cellular oxygen demand, Oxygen transfer in bioreactors, Measurement of volumetric oxygen transfer coefficient, Oxygen transfer in large Bioreactor

UNIT–V

Bioreactor control mechanism, Physical, Chemical and Biological environment of bioreactor, Manual control system, Role of physical, chemical & biological sensors, Advanced control strategies viz. PID controllers, Fuzzy logic based controllers and artificial neural network based Controllers. Basic concepts of computer modeling and optimization in bioprocess applications

Text/ Reference Books:

1. Shuler, M. L., & Kargi, F. (2017). Bioprocess Engineering: Basic Concepts (3rd ed.). Pearson Education.
2. Doran, P. M. (2012). Bioprocess Engineering Principles (2nd ed.). Academic Press.
3. Niazi, S. K., & Brown, J. L. (2015). Fundamentals of Modern Bioprocessing (1st ed.). CRC Press.
4. Clarke, K. G. (2013). Bioprocess Engineering: An Introductory Engineering and Life Science Approach (1st ed.). Woodhead Publishing.
5. Simpson, R., & Sastry, S. K. (2013). Chemical and Bioprocess Engineering: Fundamental Concepts for First-Year Students (1st ed.). Springer.
6. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). Principles of Fermentation Technology (3rd ed.). Butterworth-Heinemann.
7. Bailey, J. E., & Ollis, D. F. (2018). Biochemical Engineering Fundamentals (3rd ed.). McGraw-Hill Education.
8. Blanch, H. W., & Clark, D. S. (2017). Biochemical Engineering (2nd ed.). CRC Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Metabolic Engineering (BBT 6002)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores metabolic pathways, regulation, and engineering for biotechnological applications, including cellular metabolism and pathway optimization.

Course Outcomes (COs):

CO1: Understand metabolic engineering principles, cellular metabolism, and reaction types.

CO2: Analyze primary/secondary metabolite regulation and feedback mechanisms.

CO3: Explain metabolic flux analysis, control coefficients, and optimization methods.

CO4: Apply metabolic engineering strategies to microbial systems for product enhancement.

CO5: Evaluate case studies in biofuel, pharmaceutical, and chemical production.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	-	1	2	3	2
CO2	3	3	2	1	2	2	1	1	-	1	2	3	3
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Basics of Metabolism & Pathway: Introduction to Metabolic Engineering: Basic principles, scope, applications, and an overview of cellular metabolism (including cellular transport processes, fueling reactions, biosynthetic reactions, polymerization, growth energetics).

UNIT-II

Regulation of Metabolic Pathways: Primary Metabolite Synthesis & Regulation, Regulation at enzyme level and whole cell level. Alteration of feedback regulation. Secondary Metabolite Biosynthesis &

Regulation, Precursor effects. Prophase–idiophase relationship. Producers of secondary metabolites. Industrial applications of secondary metabolites. Application of metabolic engineering in pharmaceuticals, chemical bioprocesses, food technology, agriculture, environmental bioremediation, and biomass conversion.

UNIT-III

Advancement and Applications of Metabolic Engineering: CRISPR-Cas System in Metabolic Engineering: Application of the CRISPR-Cas system for manipulating genes in metabolic engineering. Metabolic pathway engineering: Strategies for enhancing the production of secondary metabolites in microorganisms and plants. Integration with Artificial Intelligence (AI): Using AI for efficient design of metabolic pathways.

UNIT-IV

Techniques and methodologies of Metabolic Engineering: Metabolic Flux Analysis (MFA): Flux Balance Analysis (FBA), Flux Variability Analysis, experimental determination of metabolic fluxes using isotope-labeled substrates. Bioinformatics in Metabolic Engineering: Utilizing bioinformatics tools for metabolic pathway modeling, analysis of metabolic control, and the structure of metabolic networks.

UNIT-V

Future Perspectives, Ethics, and Biosafety in Metabolic Engineering: Trends and future directions in metabolic engineering; synthetic biology approaches for pathway construction; genome-scale metabolic models; sustainability in industrial biotechnology. Ethical considerations, biosafety guidelines, risk assessment, and regulatory frameworks for genetically modified microorganisms and products at national and international levels.

Text/ Reference Books:

1. Stephanopoulos, G., Aristidou, A. A., & Nielsen, J. (1998). Metabolic Engineering: Principles and Methodologies (1st ed.). Academic Press.
2. Lee, S. Y., & Papoutsakis, E. T. (2012). Metabolic Engineering (1st ed.). CRC Press.
3. Smolke, C. D. (2010). The Metabolic Pathway Engineering Handbook: Fundamentals (1st ed.). CRC Press.
4. Nielsen, J., & Keasling, J. D. (2016). Engineering Cellular Metabolism (1st ed.). Elsevier.
5. Villadsen, J., Nielsen, J., & Lidén, G. (2011). Bioreaction Engineering Principles (3rd ed.). Springer.
6. Voit, E. O. (2017). A First Course in Systems Biology (2nd ed.). Garland Science.
7. Palsson, B. O. (2015). Systems Biology: Constraint-based Reconstruction and Analysis (2nd ed.). Cambridge University Press.
8. Cortassa, S., Aon, M. A., Iglesias, A. A., & Lloyd, D. (2002). An Introduction to Metabolic and Cellular Engineering (1st ed.). World Scientific.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Bioinfomatics-II (BBT 6003)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course introduces bioinformatics, biological databases, sequence analysis, alignment, phylogeny, and scoring matrices for biotechnology applications.

Course Outcomes (COs):

CO1: Understand bioinformatics definition, scope, history, and applications in biotechnology.

CO2: Explain biological databases, types, submission/retrieval, and formats like FASTA.

CO3: Analyze sequence similarity, homology, alignment methods, and algorithms.

CO4: Apply evolutionary analysis, phylogeny, tree construction, and software like PHYLIP.

CO5: Evaluate database searches, scoring matrices, and predictive methods for sequences.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	3	3	2
CO3	3	3	3	2	3	-	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	2	3	3	2
CO5	3	3	3	2	3	2	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT -I

Gene prediction: Gene prediction in prokaryotes & eukaryotes, Genomic sequence annotation, Basis of Gene Prediction, Pattern Recognition, Gene Prediction methods, Gene Prediction Tools, Gene expression informatics. Primer Design, ORF Finder.

UNIT-II

Protein structure prediction: Protein Identification and Characterization, Motif, Profiles, Patterns, Primary Structure Analysis and Prediction, Secondary Structure Analysis and Prediction, 3D proteins structure file formats: RASMOL, CHIME, PDB, CIF, MMDB; Tertiary structure predictions: Homology modeling, Threading, ab initio.

UNIT -III

Molecular modeling, Introduction to the concepts of molecular modeling, Conformational analysis, Use of molecular graphics packages (Rasmol, MOLMOL, Pymol etc.), Force field concepts and potential energy calculation, Introduction to computer simulation in biology, Types of simulations

UNIT -IV

Genomics, Proteomics, Comparative Genomics & Proteomics, Tools and Techniques in Genomics, Tools and Techniques in Proteomics, Protein-Protein Interaction, Post-translational Modifications, Machine Learning in Bioinformatics,

UNIT -V

In-silico Drug Design, Ligand-based & structure-based approaches, Protein-ligand docking, QSAR modelling, Pharmacodynamics (efficacy & potency), Pharmacokinetics (ADME), Lipinski's Rule of Five, Pharmacogenomics, Role of Bioinformatics in drug and Vaccine designing and development.

Text/ Reference Books:

1. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis (2nd ed.). Cold Spring Harbor Laboratory Press.
2. Lesk, A. M. (2019). Introduction to Bioinformatics (5th ed.). Oxford University Press.
3. Pevsner, J. (2015). Bioinformatics and Functional Genomics (3rd ed.). Wiley-Blackwell.
4. Baxevanis, A. D., Bader, G. D., & Wishart, D. S. (2020). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (4th ed.). Wiley.
5. Zvelebil, M., & Baum, J. O. (2007). Understanding Bioinformatics (1st ed.). Garland Science.
6. Krane, D. E., & Raymer, M. L. (2002). Fundamental Concepts of Bioinformatics (1st ed.). Pearson Education.
7. Attwood, T. K., & Parry-Smith, D. J. (1999). Introduction to Bioinformatics (1st ed.). Prentice Hall.
8. Higgs, P. G., & Attwood, T. K. (2005). Bioinformatics and Molecular Evolution (1st ed.). Blackwell Publishing.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Bioprocess Engineering Laboratory (BBT 6051)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Determine the growth patterns and specific growth rate of *E.coli*
2. Determine the effect of peptone concentration on *E.coli*. growth
3. Determination of specific thermal death rate constant (kd) for E.Coli
4. Determine the effects of temperature & pH on *Pseodomonas putida*
5. Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger*
6. Citric acid production from whey with glucose as supplementary carbon source by *Aspergillus niger*
7. Upstream and Downstream of bioprocess for the production of α-amylase by *Aspergillus nudulans*
8. Estimation of volumetric liquid mass transfer coefficient (KLa) using sodium sulphite method.
9. Preparation of immobilized enzymes & cells and evaluation of kinetic parameters.
10. Computational Design of Fermentative Process for l-Lysine production

Recommended Books:

Laboratory manual

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Metabolic Engineering Laboratory (BBT 6052)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Bacterial Growth Curve Analysis
2. Plasmid DNA Extraction from E. coli
3. Restriction Digestion of Plasmid DNA
4. Agarose Gel Electrophoresis for DNA Analysis
5. PCR Amplification of a Metabolic Gene
6. Cloning a Metabolic Gene into an Expression Vector
7. Transformation of E. coli with Recombinant Plasmid
8. Induction and Expression of a Metabolic Enzyme
9. Enzyme Activity Assay (e.g., β-galactosidase)
10. Quantification of Metabolite Production (e.g., Ethanol)

Recommended Books:

1. , E. T. (2012). *Metabolic Engineering* (1st ed.). CRC Press.
2. Sambrook, J., & Russell, D. W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
3. Nielsen, J., & Keasling, J. D. (2016). *Engineering Cellular Metabolism* (1st ed.). Elsevier.
4. Brown, T. A. (2016). *Gene Stephanopoulos, G., Aristidou, A. A., & Nielsen, J. (1998). *Metabolic Engineering: Principles and Methodologies* (1st ed.). Academic Press.
5. Lee, S. Y., & Papoutsakis Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular Biology of the Cell* (6th ed.). Garland Science.
7. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th ed.). Cambridge University Press.
8. Smolke, C. D. (2010). *The Metabolic Pathway Engineering Handbook: Fundamentals* (1st ed.). CRC Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Bioinfomatics-II Laboratory (BBT 6053)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Gene Prediction of any nucleotide sequence.
2. ORF prediction of any nucleotide sequence.
3. Secondary Structure prediction of any amino acid sequence.
4. Draw any drug molecule by chemsketch tool.
5. Visualize any protein molecule.
6. Homology modeling of any given protein sequence.

Text/Reference Books:

Sambrook et al, "Molecular Cloning-A laboratory Manual"

Semester-VII

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Bioseparation Engineering (BBT 7001)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: It explores principles and techniques for recovering, isolating, purifying, and polishing biomolecules, emphasizing process economics, industrial applications, and downstream processing for biotechnology products.

Course Outcomes (COs):

CO1: Understand the principles, importance, and process economics of bioseparation, including biomolecule properties and fermentation broth characteristics.

CO2: Explain methods for removing insoluble materials, including cell disruption, flocculation, sedimentation, centrifugation, and filtration techniques.

CO3: Analyze product isolation techniques such as adsorption, extraction, precipitation, and membrane separations, along with their design and applications.

CO4: Apply purification methods, including chromatography, electrophoresis, and hybrid techniques, for achieving high-purity biomolecules.

CO5: Evaluate product polishing techniques like crystallization and drying, and assess their application in producing commercial bioproducts such as ethanol, citric acid, and monoclonal antibodies.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	1	1	2	3	2
CO3	3	3	3	3	2	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	2	3	2	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction: Role and importance of bioseparation, RIPP scheme, purification requirements, properties of biomolecules, characteristics of fermentation broth, biological activity, purity analysis, process economics.

UNIT-II

Removal of Insoluble: Cell disruption (physical, chemical, mechanical), removal of biomass and debris, flocculation, sedimentation, centrifugation, filtration.

UNIT-III

Isolation of Products: Adsorption (Langmuir, Freundlich), extraction (batch, continuous, aqueous two-phase, supercritical, in situ removal), precipitation (salts, solvents, polymers), membrane separations (microfiltration, ultrafiltration, design and applications).

UNIT-IV

Purification: Chromatography (GC, HPLC, gel permeation, ion-exchange, affinity, reverse phase, hydrophobic interaction), electrophoresis (capillary, isoelectric focusing, 2D), hybrid techniques (GC-MS, LC-MS).

UNIT-V

Product Polishing & Commercial Bioproducts: Crystallization (principles, nucleation, growth, scale-up), drying (principles, equipment: vacuum shelf, rotary, freeze, spray), biomolecules: ethanol, citric acid, lysine, steroids, penicillin, dextran, trehalose, subtilisin, chymosin, vitamin B12, hepatitis B vaccine, insulin, erythropoietin, monoclonal antibodies.

Text/ Reference Books:

1. Harrison, R. G., Todd, P., Rudge, S. R., & Petrides, D. P. (2015). Bioseparations Science and Engineering (2nd ed.). Oxford University Press.
2. Ladisch, M. R. (2001). Bioseparations Engineering: Principles, Practice, and Economics (1st ed.). Wiley-Interscience.
3. Belter, P. A., Cussler, E. L., & Hu, W. S. (1988). Bioseparations: Downstream Processing for Biotechnology (1st ed.). Wiley.
4. Shuler, M. L., & Kargi, F. (2017). Bioprocess Engineering: Basic Concepts (3rd ed.). Pearson Education.
5. Garcia, A. A., & Bonen, M. R. (2010). Bioseparation Process Science (1st ed.). Blackwell Publishing.
6. Doran, P. M. (2012). Bioprocess Engineering Principles (2nd ed.). Academic Press.
7. Ghosh, R. (2006). Principles of Bioseparations Engineering (1st ed.). World Scientific Publishing.
8. Seader, J. D., Henley, E. J., & Roper, D. K. (2016). Separation Process Principles: Chemical and Biochemical Operations (3rd ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Project-I (BBT 7051)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	4	2
Pre-requisites/Exposure	-				

Objective: To synthesize and apply the knowledge gained over the engineering programme to solve real world problems.

Guidance/Remarks: Project-I can be done either during the Summer Break between Semester VI and Semester VII or during the Semester VII. It will be evaluated as part of Semester VII. It may either be a complete project related to the field of Biotechnology or it may be an initiation (Phase I) of Project-II present in Semester VIII, provided the "Project Work II" is expected to extend beyond the duration of 6 months.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Summer Internship-II (BBT 7052)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	6	3
Pre-requisites/Exposure	-				

Objective: Minimum of six weeks in an Industry preferably in the area of Biotechnology. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report. This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course. AICTE Internship Policy available on AICTE's website may be referred for more information regarding Internship.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Bioseparation Engineering Laboratory (BBT 7053)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Cell disruption by chemical method. (Demonstration/Laboratory)
2. Cell disruption by mechanical method. (Demonstration/Laboratory)
3. Product recovery by membrane filtration. (Demonstration/Laboratory)
4. Separation of product using rotary vacuum Evaporation(Demonstration/Laboratory)
5. Separation of bioproduct using adsorption. (Demonstration/Laboratory)
6. Biomass removal by flocculation / Centrifugation method. (Demonstration/Laboratory)
7. Purification of ethanol using distillation method. (Laboratory)
8. Purification of antibiotic using liquid-liquid extraction. (Demonstration/Laboratory)
9. Enzyme Purification using Dialysis method / Salting out method.

   (Demonstration/Laboratory)

Recommended Books:

1. Separation Process Principles – J.D. Seader, Ernest J. Henley, D. Keith Roper, Wiley.
2. Bioprocess Engineering: Basic Concepts – Michael L. Shuler, Fikret Kargi, Prentice Hall.
3. Bioprocess Technology: Fundamentals and Applications – K. G. Ramawat, Springer.
4. Introduction to Biochemical Engineering – D. G. Rao, Tata McGraw Hill.
5. Handbook of Bioseparations – Satinder Ahuja, Academic Press.

Semester-VIII

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Project- II (BBT 8051)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	18	9
Pre-requisites/Exposure	-				

Objective: To synthesize and apply the knowledge gained over the engineering programme to solve real world problems.

Guidance/Remarks: Project-II have to be done during the Semester VIII. It may be initiated in the break between Semester VII & VIII although it is not mandatory to initiate in the break. It will be evaluated as part of Semester VIII. It may either be a complete project related to the field of Biotechnology or it may be an extension (Phase II) of ProjectI present in Semester VII, provided the Project in charge agrees that "Project Work I" is worthy enough to extend across two semesters (i.e. VII & VIII). It may also be a startup in the field related to Biotechnology. In case of startups, substantial evidence has to be produced for evaluation of the work carried out as part of Project-II.

Professional Electives

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Food Biotechnology (BBTP 101)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	1	0	4
Pre-requisites/Exposure	-				

Course Description: This course explores food production, microbial applications, genetic engineering, safety, and regulations, emphasizing fermentation, nutraceuticals, GMO foods, and quality control for sustainable food systems and health benefits.

Course Outcomes (COs):

CO1: Understand food biotechnology principles, microbial roles, and fermentation processes.

CO2: Explain genetic engineering techniques and GMO applications in food production.

CO3: Analyze food processing, enzyme applications, and nutraceutical development.

CO4: Evaluate food safety hazards, quality control, and analytical techniques.

CO5: Assess food regulations, ethical issues, and sustainability in food biotechnology.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	2	1	1	-	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	2	2	1	3	3	1	3	1	2	2	2	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Definition, scope, and history of food biotechnology. Role of microorganisms in food production (e.g., bacteria, yeast, fungi). Fermentation processes: Principles and applications (e.g., lactic acid, alcohol). Traditional vs. modern biotechnological approaches in food production. Overview of food biotechnology in nutrition and health.

UNIT -II

Principles of genetic engineering in food crops and microorganisms. Genetically modified organisms (GMOs): Development and applications (e.g., Bt crops, golden rice). Techniques: Gene cloning,

CRISPR-Cas9, and transformation methods. Benefits and challenges of GM foods in agriculture. Case studies on GMO safety and consumer acceptance.

UNIT-III

Food processing techniques: Fermentation, pasteurization, and bioprocessing. Role of enzymes in food production (e.g., amylase, protease, lipase). Development of nutraceuticals and functional foods. Biotechnological approaches to improve food texture, flavor, and shelf life. Impact of processing on nutritional quality.

UNIT-IV

Food safety hazards: Microbial, chemical, and physical contaminants. Analytical techniques: PCR, ELISA, and HPLC for food quality assessment. Microbial safety in fermented and processed foods. Quality control methods: Sensory evaluation, proximate analysis. Case studies on foodborne illness prevention.

UNIT-V

National and international food regulations: FSSAI, Codex Alimentarius, FDA. Safety assessment of GMOs and biotechnologically derived foods. Ethical considerations: Consumer rights, labeling, and environmental impact. Sustainability in food biotechnology: Waste reduction and resource recovery. Emerging trends: Plant-based proteins, Laboratory-grown foods.

Text/ Reference Books:

1. Shetty, K., Paliyath, G., Pometto, A., & Levin, R. E. (2005). *Food Biotechnology* (2nd ed.). CRC Press.
2. Bains, W. (2004). *Biotechnology from A to Z* (3rd ed.). Oxford University Press.
3. Fellows, P. J. (2016). *Food Processing Technology: Principles and Practice* (4th ed.). Woodhead Publishing.
4. Mozumder, N. H., & Tamura, T. (2019). *Biotechnology in Food Processing* (1st ed.). Springer.
5. Clark, D. P., & Pazdernik, N. J. (2015). *Biotechnology: Applying the Genetic Revolution* (2nd ed.). Academic Press.
6. Belitz, H. D., Grosch, W., & Schieberle, P. (2009). *Food Chemistry* (4th ed.). Springer.
7. Aquino, D. B., & Persaud, N. (2020). *Genetically Modified Foods: Safety and Regulation* (1st ed.). Elsevier.
8. FSSAI Guidelines. (2025). *Food Safety and Standards Authority of India*. Available at: www.fssai.gov.in.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Stem Cell Technology (BBTP 102)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	1	0	4
Pre-requisites/Exposure	-				

Course Description: It explores stem cell properties, mechanisms, specialized types, clinical applications in tissue engineering, and ethical considerations for advancing regenerative medicine and biotechnology.

Course Outcomes (COs):

CO1: Understand stem cell properties, classification, sources, and their roles in embryogenesis and adult tissues.

CO2: Explain stem cell differentiation, potency, regulation, signaling pathways, nuclear reprogramming, and cryopreservation techniques.

CO3: Analyze specialized stem cells, including hematopoietic, mesenchymal, and primordial germ cells, and their plasticity and repopulating patterns.

CO4: Apply stem cell technologies in clinical treatments for neurological disorders, organ failure, and tissue engineering for cartilage, bone, neural, and cardiac regeneration.

CO5: Evaluate stem cell applications in developmental biology, drug screening, disease modeling, and address ethical considerations and research guidelines.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	-	1	2	3	1
CO2	3	3	2	2	2	1	1	-	-	1	2	3	2
CO3	3	3	2	2	3	1	1	-	1	1	2	3	2
CO4	3	3	3	3	3	2	1	1	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Fundamentals of Stem Cells: Properties, classification, and sources of stem cells, Embryonic stem cells: Blastocyst, inner cell mass, early embryogenesis. Adult stem cells: Hematopoietic, mesenchymal, epidermal, liver, pancreatic, intestinal.

UNIT-II

Stem Cell Mechanisms: Differentiation, potency, aging, nuclear reprogramming, gene editing, Checkpoints and signaling pathways in stem cell regulation. Cryopreservation: Techniques, cryoinjury, cord blood preservation.

UNIT-III

Specialized Stem Cells Primordial germ cells, embryonal carcinoma cells, trophoblast stem cells. Hematopoietic stem cells: Repopulating patterns, lymphopoiesis, plasticity. Hemangioblast, mesenchymal stem cells, neurogenesis.

UNIT-IV

Clinical and Tissue Engineering Applications: Immune barriers, engineering stem cell niches. Neurological disorders: Parkinson's, Alzheimer's, Huntington's, ALS, spinal cord injury. Tissue systems: Organ failure, diabetes, cardiomyopathy, hemophilia, cancer. Tissue engineering: Biomaterials, biomaterial-tissue interface, scaffolds, bioreactors. Applications in cartilage, bone, neural, and cardiac regeneration.

UNIT-V

Biomedical Applications and Ethics: Stem cells in developmental biology, drug screening, disease modeling. Genetically engineered stem cells, clinical trials. Ethical considerations, research guidelines, current challenges.

Text/ Reference Books:

1. Thomson, J. A., & Odorico, J. S. (2000). Human Embryonic Stem Cells (1st ed.). Academic Press.
2. Lanza, R., & Atala, A. (2014). Essentials of Stem Cell Biology (3rd ed.). Academic Press.
3. Blau, H. M., & Daley, G. Q. (2019). Stem Cells: Biology and Applications (1st ed.). CRC Press.
4. Mummery, C., van de Stolpe, A., Roelen, B. A. J., & Clevers, H. (2014). Stem Cells: Scientific Facts and Fiction (2nd ed.). Academic Press.
5. Freshney, R. I., Stacey, G. N., & Auerbach, J. M. (2007). Culture of Human Stem Cells (1st ed.). Wiley-Liss.
6. Bongso, A., & Lee, E. H. (2011). Stem Cells: From Bench to Bedside (2nd ed.). World Scientific Publishing.
7. Sell, S. (2013). Stem Cells Handbook (2nd ed.). Humana Press.
8. Turksen, K. (2018). Adult and Embryonic Stem Cells (1st ed.). Springer.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Gene Expression and Transgenics (BBTP 103)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	1	0	4
Pre-requisites/Exposure	-				

Course Description: The Course explores gene expression mechanisms, transgenic techniques, applications in plants/animals, and ethical/regulatory issues, fostering skills for biotechnology advancements in agriculture and medicine.

Course Outcomes (COs):

CO1: Understand the central dogma, gene structure, and differences in prokaryotic and eukaryotic gene expression.

CO2: Explain gene regulation mechanisms, including operons, transcription factors, epigenetic modifications, and post-transcriptional control.

CO3: Analyze transgenic concepts, gene delivery methods, and roles of selectable markers and reporter genes.

CO4: Apply transgenic technologies, including CRISPR-Cas9 and gene gun, in plant and animal systems for crop improvement and biomedical applications.

CO5: Evaluate ethical issues, biosafety protocols, and regulatory frameworks in transgenic research through case studies.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	-	1	-	-	1	2	3	1
CO2	3	3	2	2	2	1	1	-	-	1	2	3	2
CO3	3	3	2	2	2	1	1	1	-	1	2	3	2
CO4	3	3	3	3	3	2	1	1	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Basics of Gene Expression: Central dogma: Transcription, translation, Replication and genetic code. Gene structure: Promoters, enhancers, introns, exons, and regulatory elements. Overview of prokaryotic and eukaryotic gene expression.

UNIT-II

Regulation of Gene Expression: Prokaryotic regulation: Lac and trp operons, inducible/repressible systems. Eukaryotic regulation: Transcription factors, epigenetic modifications (DNA methylation, histone acetylation). Post-transcriptional control: mRNA splicing, miRNA, RNA interference.

UNIT-III

Principles of Transgenics: Introduction to transgenics: Concepts, history, and transgenic vs. GMO distinctions. Gene delivery methods: Plasmids, viral vectors, Agrobacterium-mediated transformation. Selectable markers, reporter genes, and their roles.

UNIT-IV

Transgenic Technologies and Applications: Transgenic plants: Gene gun, CRISPR-Cas9, applications in crop improvement (e.g., Bt crops). Transgenic animals: DNA microinjection, embryonic stem cells, knock-out/knock-in models. Biomedical applications: Gene therapy, disease modeling, drug discovery.

UNIT-V

Ethical and Regulatory Perspectives: Ethical issues: Safety, environmental impact, animal welfare in transgenic research. Regulatory guidelines: Biosafety protocols, clinical trial frameworks. Case studies: Golden rice, gene-edited therapies, and current challenges.

Text/ Reference Books:

1. Primrose, S. B., & Twyman, R. M. (2013). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell.
2. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th ed.). ASM Press.
3. Brown, T. A. (2016). Gene Cloning and DNA Analysis: An Introduction (7th ed.). Wiley-Blackwell.
4. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). Molecular Biology of the Gene (7th ed.). Pearson Education.
5. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Amon, A. (2021). Molecular Cell Biology (9th ed.). W. H. Freeman.
6. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: The Genetic Manipulation of Plants (2nd ed.). Oxford University Press.
7. Herring, R. J. (2015). The Oxford Handbook of Food, Politics, and Society (1st ed.). Oxford University Press.
8. Krimsky, S., & Gruber, J. (2013). Genetic Explanations: Sense and Nonsense (1st ed.). Harvard University Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Environmental Biotechnology (BBTP 104)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: The course explores microbial ecology, waste bioconversion, biofuels, bioremediation, and pollution management, emphasizing sustainable development, environmental laws, and microbial solutions for air, water, soil, and emerging pollutants.

Course Outcomes (COs):

CO1: Understand ecosystem concepts, microbial ecology, and sources, effects, and measurements of air, water, and soil pollution.
CO2: Explain bioconversion of organic wastes into biogas, H2, and biofuels, and evaluate their economic and social impacts.

CO3: Analyze biodegradation principles and bioremediation methods for xenobiotics, metals, and organic pollutants using in situ and ex situ technologies.

CO4: Apply microbial strategies for enhanced oil recovery, carbon capture, and degradation of plastics, antibiotics, and emerging pollutants.

CO5: Evaluate sustainable development, environmental impact assessment, and compliance with updated Indian (2024-2025) and international environmental laws.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	3	1	1	-	1	2	3	2
CO2	3	3	2	2	2	3	1	1	1	1	2	3	3
CO3	3	3	3	2	3	2	1	1	1	1	3	3	3
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	2	1	3	3	1	3	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Environmental Biotechnology: Basic components of environment: Ecosystem concepts, abiotic and biotic factors. Microbial ecology: Importance in environmental biotechnology. Environmental pollution: Air, water, and soil (sources, effects, measurements).

UNIT-II

Waste to Wealth and Biofuels: Bioconversion of organic wastes: Production of biogas, H2, celluloses, food/feed stocks. Biofuels from waste: Methods, processes, economic/social aspects. Community biogas plants and schemes: Scope for rural development.

UNIT-III

Biodegradation and Bioremediation: Principles of biodegradation: Xenobiotics (lignin, hydrocarbons, detergents, dyes, pesticides). Bioremediation fundamentals: Methods (biostimulation, bioaugmentation), examples. Remediation of metals (Cr, As, Se, Hg) and organics (PAHs, PCBs, pesticides); in situ/ex situ technologies.

UNIT-IV

Microbial Efficacy in Environmental Challenges: Microbial enhanced oil recovery; carbon storage/capture (sequestration, biopolymers). Aerobic/anaerobic degradation of aliphatic/aromatic compounds. Microbial interactions with plastics, antibiotics, and emerging pollutants.

UNIT-V

Environmental Impact Assessment and Laws: Development-environment relation: Sustainable development, carrying capacity. Key Indian laws (updated as of 2025): Environmental Protection Act, 1986 (with Sixth Amendment Rules, 2025); Water (Prevention and Control of Pollution) Act, 1974 (amended 2024); Water (Prevention and Control of Pollution) Cess Act, 1974; Air (Prevention and Control of Pollution) Act, 1981 (amended 2024); Hazardous and Other Wastes (Management and Transboundary Movement) Amendment Rules, 2025. International environmental laws.

Text/ Reference Books:

1. Atlas, R. M., & Bartha, R. (2000). Microbial Ecology: Fundamentals and Applications (4th ed.). Benjamin-Cummings.
2. Scragg, A. H. (2005). Environmental Biotechnology (2nd ed.). Oxford University Press.
3. Vallero, D. A. (2015). Environmental Biotechnology: A Biosystems Approach (2nd ed.). Academic Press.
4. Thakur, I. S. (2010). Environmental Biotechnology: Basic Concepts and Applications (1st ed.). I.K. International Publishing.
5. Jördening, H. J., & Winter, J. (2005). Environmental Biotechnology: Concepts and Applications (1st ed.). Wiley-VCH.
6. Rittmann, B. E., & McCarty, P. L. (2001). Environmental Biotechnology: Principles and Applications (1st ed.). McGraw-Hill Education.
7. Singh, R. L., & Singh, R. P. (2017). Advances in Environmental Biotechnology (1st ed.). Springer.
8. Evans, G. M., & Furlong, J. C. (2010). Environmental Biotechnology: Theory and Application (2nd ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Molecular Diagnostics and its Applications (BBTP 105)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: The course explores principles, techniques, and applications of nucleic acid, protein, and immuno-based diagnostics for diseases, integrating emerging technologies, ethical considerations, and regulatory frameworks for personalized medicine.

Course Outcomes (COs):

CO1: Understand the history, principles, scope, and biomarker discovery in molecular diagnostics, including the evolution of diagnostic platforms.

CO2: Explain nucleic acid-based techniques, including PCR variants, hybridization, and sequencing technologies for diagnostic applications.

CO3: Analyze protein and immuno-based diagnostics, including immunoassays, proteomics, and biosensors for point-of-care applications.

CO4: Apply molecular diagnostic techniques for infectious diseases, genetic disorders, cancer, and pharmacogenomics in personalized medicine.

CO5: Evaluate emerging trends (CRISPR, AI, microbiome), ethical issues, regulatory guidelines, and challenges in molecular diagnostics.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	3	3	2
CO3	3	3	2	3	2	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Molecular Diagnostics: History, principles, and scope of molecular diagnostics. Biomarkers: Types, discovery, and validation.

Overview of diagnostic platforms and their evolution.

UNIT-II

Nucleic Acid-Based Techniques: PCR and variants (qPCR, RT-PCR, digital PCR). Nucleic acid hybridization (Southern/Northern blot, microarrays). Sequencing technologies (Sanger, NGS) and their diagnostic roles.

UNIT-III

Protein and Immuno-Based Diagnostics: Immunoassays (ELISA, Western blot, flow cytometry). Protein profiling: Mass spectrometry, proteomics in diagnostics. Biosensors and point-of-care devices.

UNIT-IV

Applications in Disease Diagnosis: Infectious diseases: Viral/bacterial diagnostics (e.g., COVID-19, TB). Genetic disorders and cancer: Mutation analysis, liquid biopsies. Pharmacogenomics and personalized medicine applications.

UNIT-V

Advanced Trends, Ethics, and Regulations: Emerging technologies: CRISPR-based diagnostics, AI integration, microbiome analysis (as of 2025 trends). Ethical issues: Data privacy, access equity, regulatory guidelines (FDA, ICMR). Challenges: Validation, cost, and future directions like POC expansion.

Text/ Reference Books:

1. Nolte, F. S., & Wittwer, C. T. (2020). Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications (3rd ed.). F.A. Davis Company.
2. Buckingham, L. (2019). Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications (3rd ed.). F.A. Davis Company.
3. Patrinos, G. P., & Ansorge, W. J. (2010). Molecular Diagnostics (2nd ed.). Academic Press.
4. Coleman, W. B., & Tsongalis, G. J. (2016). Molecular Diagnostics: For the Clinical Laboratorian (3rd ed.). Humana Press.
5. Grody, W. W., Nakamura, R. M., Strom, C. M., & Kiechle, F. L. (2010). Molecular Diagnostics: Techniques and Applications for the Clinical Laboratory (1st ed.). Academic Press.
6. Persing, D. H., Tenover, F. C., Hayden, R. T., Ieven, M., Miller, M. B., Nolte, F. S., ... & van Belkum, A. (2016). Molecular Microbiology: Diagnostic Principles and Practice (3rd ed.). ASM Press.
7. Ladner, J. T. (2021). Next-Generation Sequencing in Molecular Diagnostics (1st ed.). Springer.
8. Strachan, T., & Read, A. P. (2018). Human Molecular Genetics (5th ed.). Garland Science.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Synthetic Biology (BBTP 106)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: The course xplores principles, genetic engineering, minimal genomes, and genome editing, emphasizing microbial cell factories, biomaterial/drug production, safety regulations, and intellectual property rights for sustainable biotechnological applications.

Course Outcomes (COs):

CO1: Understand synthetic biology concepts, minimal genomes, and synthetic genetic codes.

CO2: Explain minimal cells, microbes, and targeted deletion methods in synthetic systems.

CO3: Analyze genome design, building blocks, and synthetic biology design tools.

CO4: Evaluate genome synthesis, editing tools (CRISPR, TALENs), and sequencing methods.

CO5: Assess microbial cell factories, applications, safety regulations, and IPR in synthetic biology.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	1	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Synthetic Biology. Basic concepts of synthetic biology. Self-replicating systems. RNA dependent RNA polymerase. Synthetic genetic code. Minimal genetic code. Extended genetic code. Non- native nucleic bases. Non-native backbone.

UNIT-II

Minimal nucleic acid polymerases. Minimal ribosome. Minimal genome. Minimal cell. Minimal microbes (specific example E.coli and Mycobacteria). Targeted deletion methods. Semi-synthetic

systems. Semi-synthetic microbes.

UNIT-III

Genome design. Building blocks and structures. Temporal and spatial engineering. Design tools for synthetic biology. OPEN and CoDA selection systems.

UNIT-IV

Genome synthesis strategies. Genome editing tools - Zinc finger nucleases, TALENs, CRISPR- Cas9. Genome assembly methods. Genome sequencing. Measurement of genetic output.

UNIT-V

Microbial cell factories. Potential applications of synthetic biology for production of biomaterials, biofuels and drugs. Potential applications of synthetic biology in medicine, food production and bioremediation. Regulation of synthetic biology for safety. Intellectual property rights for synthetic organisms.

Text/ Reference Books:

1. Endy, D., & Myers, C. J. (2010). *Synthetic Biology: A Laboratory Manual* (1st ed.). World Scientific.
2. Voigt, C. A. (2011). *Synthetic Biology: Tools and Applications* (1st ed.). Academic Press.
3. Purnick, P. E. M., & Weiss, R. (2009). *The Principles of Synthetic Biology* (1st ed.). MIT Press.
4. Church, G. M., & Regis, E. (2014). *Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves* (1st ed.). Basic Books.
5. Smolke, C. D. (2010). *The Metabolic Pathway Engineering Handbook: Fundamentals* (1st ed.). CRC Press.
6. Fu, P., & Pitera, D. J. (2019). *Synthetic Biology: Methods and Protocols* (1st ed.). Humana Press.
7. Ganguli, P. (2011). *Intellectual Property Rights: Unleashing the Knowledge Economy* (1st ed.). Tata McGraw-Hill.
8. Keasling, J. D. (2015). *Synthetic Biology for Biotechnology* (1st ed.). Elsevier.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Genome Editing (BBTP 107)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	1	0	4
Pre-requisites/Exposure	-				

Course Description: The course explores genome organization, sequencing, editing technologies (ZFNs, TALENs, CRISPR), and applications in medicine, forensics, and synthetic biology, emphasizing ethical considerations and safety regulations.

Course Outcomes (COs):

CO1: Understand genome organization, mapping, polymorphism, and epigenomics.

CO2: Analyze genome sequencing and applications in predictive medicine and forensics.

CO3: Explain genome editing technologies (ZFNs, TALENs, CRISPR) and transfection methods.

CO4: Evaluate fluorescent tagging, CRISPR-based DNA tagging, and transcriptomics techniques.

CO5: Assess applications, ethical issues, and safety regulations in genome engineering.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	1	-	1	2	3	2
CO2	3	3	2	2	2	2	1	-	-	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	1	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation. 2: Moderate correlation. 1: Low correlation. -: No correlation

Syllabus:

UNIT-I

Organization of genomes. Genome maps. Data mining and sequence acquisition. Polymorphism and structural variations. Genome wide association studies (GWAS). Epigenomics and comparative genomics. Genome dynamics and cytogenomics.

UNIT-II

Genome sequence determination and genome analysis of E. coli, Saccharomyces cerevisiae, C. elegans,

Drosophila melanogaster, Arabidopsis thaliana and Homo sapiens. Applications of genomics in predictive medicine and forensics.

UNIT-III

Introduction to Genome Editing, DNA repair mechanisms, Methods used in genome editing technology ZFNs, TALENs, Introduction to CRISPR/ CAS technology and its applications, Transfection optimization for efficient gene editing

UNIT-IV

Fluorescent tagging of fixed and live cells, CRISPR-based DNA tagging, Quantitative and high-throughput single-cell image analysis, Chip-seq, RNA-seq, single-cell transcriptomics, guide RNA.

UNIT-V

Applications of genome engineering in therapy, synthetic, developmental biology, human genetics and disease phenotyping, Ethical aspects and safety of genome engineering technology.

Text/ Reference Books:

1. Brown, T. A. (2020). *Genomes 5* (5th ed.). Garland Science.
2. Green, E. D., Watson, J. D., & Myers, R. M. (2018). *Human Genome Editing: Science, Ethics, and Governance* (1st ed.). National Academies Press.
3. Joung, J. K., & Sander, J. D. (2013). *TALENs and ZFNs: Methods and Protocols* (1st ed.). Humana Press.
4. Doudna, J. A., & Sternberg, S. H. (2017). *A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution* (1st ed.). Houghton Mifflin Harcourt.
5. Pevsner, J. (2015). *Bioinformatics and Functional Genomics* (3rd ed.). Wiley-Blackwell.
6. Zhang, F. (2019). *CRISPR-Cas: A Laboratory Manual* (1st ed.). Cold Spring Harbor Laboratory Press.
7. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular Biology of the Cell* (6th ed.). Garland Science.
8. Resnik, D. B. (2004). *The Ethics of Science: An Introduction* (1st ed.). Routledge.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Biosimilars Technology (BBTP 108)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	1	0	4
Pre-requisites/Exposure	-				

Course Description: The Course explores Science and Market explores biosimilar development, regulatory frameworks, scientific principles, manufacturing processes, and market dynamics, equipping students for advancements in biopharmaceuticals and healthcare accessibility.

Course Outcomes (COs):

CO1: Understand the definition, characteristics, historical development, and healthcare significance of biosimilars.
CO2: Explain global regulatory frameworks, approval guidelines, and naming/labeling regulations for biosimilars.
CO3: Analyze structural/functional comparability, analytical techniques, and preclinical/clinical requirements for biosimilarity assessment.
CO4: Apply cell line development, upstream/downstream processing, and GMP in biosimilar manufacturing.
CO5: Evaluate market trends, pricing, reimbursement, market access strategies, and competition in the biosimilar industry.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	1	3	2
CO2	3	3	2	1	2	2	1	3	-	1	1	3	2
CO3	3	3	2	2	3	1	1	1	1	1	3	3	2
CO4	3	3	3	3	2	1	1	1	1	1	3	3	3
CO5	3	3	3	1	3	3	1	2	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Biosimilars: Definition and characteristics of Biosimilars. Historical development and evolution. Importance and significance in healthcare

UNIT-II

Regulatory Frameworks: Overview of global regulatory agencies (FDA, EMA, etc.). Guidelines and requirements for Biosimilar approval. Biosimilar naming and labeling regulations

UNIT-III

Scientific Principles: Structural and functional comparability. Analytical techniques for Biosimilarity assessment. Preclinical and clinical development requirements.

UNIT-IV

Manufacturing Processes: Cell line development. Upstream and downstream processing. Quality control measures and Good Manufacturing Practices (GMP)

UNIT-V

Market Dynamics and Access: Market overview and trends. Pricing, reimbursement, and market access strategies. Competition analysis and strategic considerations

Text/ Reference Books:

1. Declerck, P., & Simoens, S. (2017). Biosimilars: Science, Regulation, and Market Access (1st ed.). Springer.
2. Weise, M., & Bielsky, M. C. (2016). Biosimilars: Regulatory, Clinical, and Manufacturing Perspectives (1st ed.). Wiley.
3. Rader, R. A. (2013). Biosimilars: Strategic and Technical Challenges (1st ed.). CRC Press.
4. Sharma, A., & Reddy, V. (2019). Biosimilars: Development and Applications (1st ed.). Academic Press.
5. Gutka, H. J., Yang, H., & Kakar, S. (2018). Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development (1st ed.). Springer.
6. Crommelin, D. J. A., & Sindelar, R. D. (2013). Pharmaceutical Biotechnology: Fundamentals and Applications (4th ed.). Springer.
7. Walsh, G. (2018). Biopharmaceuticals: Biochemistry and Biotechnology (3rd ed.). Wiley.
8. Jagschies, G., Lindskog, E., Lacki, K., & Galliher, P. (2017). Biopharmaceutical Processing: Development, Design, and Implementation of Manufacturing Processes (1st ed.). Elsevier.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Applications of Natural Products (BBTP 109)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	1	0	4
Pre-requisites/Exposure	-				

Course Description: The Course explores sources, extraction, and screening of phytopharmaceuticals, herbal cosmetics, nutraceuticals, and quality control, emphasizing therapeutic applications and regulatory guidelines for natural products.

Course Outcomes (COs):

CO1: Understand sources of crude drugs and various methods for extraction and isolation of phytopharmaceuticals.

CO2: Analyze phytochemical screening techniques for alkaloids, flavonoids, glycosides, and other therapeutic classes.

CO3: Explain the role of herbal cosmetics and aromatic plant-derived products in healthcare and industry.

CO4: Apply knowledge of nutraceuticals and health foods, including their sources, uses, and commercial preparations.

CO5: Evaluate quality control methods for herbal drugs as per WHO, AYUSH, and pharmacopoeial guidelines.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	2	1	1	-	-	1	2	3	2
CO2	3	3	2	2	3	1	1	-	1	1	2	3	2
CO3	3	3	2	2	2	2	1	1	-	1	2	3	3
CO4	3	3	3	2	2	2	1	1	1	1	2	3	3
CO5	3	3	2	2	3	2	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Sources of crude drug: Biological, marine, Mineral and plant tissue culture as source of natural products.

Various methods of extraction and isolation of phytopharmaceuticals namely infusion, decoction,

maceration, percolation, hot continuous extraction, successive solvent extraction, supercritical fluid extraction, steam distillation, Counter-current Extraction, Ultrasound Extraction (Sonication). Parameters for selection of suitable extraction process.

UNIT-II

Phytochemical Screening: Screening of alkaloids, saponins, cardenolides and bufadienolides, flavonoids and leucoanthocyanidins, tannins and polyphenols, manthraquinones, cynogenetic glycosides, amino acids in plant extracts. Important therapeutic classes: antimicrobial, antidiabetics, hepatoprotectives, immmunomodulators, anti-cancer.

UNIT-III

Herbal cosmetics: Importance of herbals as shampoos (soapnut), conditioners and hair darkeners, (amla, henna, hibiscus, tea), skin care (aloe, turmeric, lemon peel, vetiver); Colouring and Flavouring agents from plants; Utilization of aromatic plants and derived products with special reference to sandalwood oil, mentha oil, lemon grass oil, vetiver oil, geranium oil and eucalyptus oil

UNIT-IV

Nutraceuticals and Health Foods: Classification of Nutraceuticals, Health foods: Source, Chemical constituents, uses, actions and commercial preparations of, following health foods, Alfalfa, Bran, Angelica, Chamomile, Corn oil, Fenugreek, Ferverfew, Garlic, Ginseng, Ginkgo, Honey, Hops, Safflower oil, Soyabean Oil,Turmeric. Concept and examples of Adaptogens .

UNIT-V

Quality control of herbal drugs as per WHO, AYUSH and Pharmacopoeial guidelines-Extractive values, ash values. Determination of heavy metals, insecticides, pesticides and microbial load in herbal preparations.

Text/ Reference Books:

1. Evans, W. C. (2009). Trease and Evans' Pharmacognosy (16th ed.). Saunders Elsevier.
2. Heinrich, M., Barnes, J., Gibbons, S., & Williamson, E. M. (2017). Fundamentals of Pharmacognosy and Phytotherapy (3rd ed.). Elsevier.
3. Mukherjee, P. K. (2019). Quality Control and Evaluation of Herbal Drugs (1st ed.). Elsevier.
4. Wink, M. (2015). Biochemistry of Plant Secondary Metabolism (2nd ed.). Wiley-Blackwell.
5. Harborne, J. B. (1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis (3rd ed.). Chapman & Hall.
6. Samuelsson, G., & Bohlin, L. (2015). Drugs of Natural Origin: A Textbook of Pharmacognosy (7th ed.). Swedish Pharmaceutical Press.
7. Dewick, P. M. (2009). Medicinal Natural Products: A Biosynthetic Approach (3rd ed.). Wiley.
8. Khandelwal, K. R. (2008). Practical Pharmacognosy: Techniques and Experiments (19th ed.). Nirali Prakashan.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Medical Biotechnology (BBTP 110)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	1	0	4
Pre-requisites/Exposure	-				

Course Description: The Course explores therapeutic peptides, oligonucleotides, cardiovascular drugs, chemotherapeutics, and organ-specific drug delivery, emphasizing immune responses, cancer therapies, and novel targeting strategies for medical applications.

Course Outcomes (COs):

CO1: Understand therapeutic biomacromolecules, immune responses, and cancer immunotherapy.

CO2: Explain oligonucleotides, gene therapy, and carbohydrate-based vaccine strategies.

CO3: Analyze cardiovascular drugs, radiological agents, and hematopoietic therapies.

CO4: Evaluate chemotherapeutic agents, antibiotics, and endocrine drugs.

CO5: Assess organ-specific drug targeting and novel delivery strategies.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	2	1	1	-	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	2
CO5	3	3	3	1	3	3	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Therapeutic Aspects of Bio-macromolecules: Introduction, Endogenous peptides and proteins, Modification of endogenous peptides and proteins. Immune System: Overview, Antibody-mediated response, Vaccines, Cell-mediated immune response, Cancer immunotherapy.

UNIT-II

Oligonucleotides: Overview, Gene therapy, Antisense therapy, Ribozymes. Oligosaccharides: Overview, Oligosaccharide synthesis. Heparin. Glycoproteins, Polysaccharide bacterial vaccines, Approaches to carbohydrate-based cancer vaccines.

UNIT-III

Radiological Agents: Radiosensitizers and Radioprotective agents. Cardiovascular Drugs: Myocardial infarction agents, Endogenous vasoactive peptides, Hematopoietic agents, Anticoagulants, anthrombotics and hemostatics.

UNIT-IV

Chemotherapeutic Agents: Synthetic antibacterial agents, Lactam antibiotics, Anthelminitic agents, Anthelmintic agents, Antiamebic agents, Antiviral agents. Endocrine Drugs: Female sex hormones and analogs, Agents affecting the immune Response.

UNIT-V

Drug Targeting Organ-Specific Strategies: Basic concepts and novel advances, Brain-specific drug targeting strategies, Pulmonary drug delivery, Cell specific drug delivery.

Text/ Reference Books:

1. Vyas, S. P., & Dixit, V. K. (2008). *Pharmaceutical Biotechnology* (1st ed.). CBS Publishers.
2. Walsh, G. (2014). *Biopharmaceuticals: Biochemistry and Biotechnology* (2nd ed.). Wiley.
3. Saltzman, W. M. (2015). *Drug Delivery: Engineering Principles for Drug Therapy* (2nd ed.). Oxford University Press.
4. Kuby, J., & Owen, J. A. (2018). *Kuby Immunology* (8th ed.). W.H. Freeman.
5. Ho, R. J. Y., & Gibaldi, M. (2007). *Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs* (2nd ed.). Wiley.
6. Crommelin, D. J. A., & Sindelar, R. D. (2013). *Pharmaceutical Biotechnology: Fundamentals and Applications* (4th ed.). Springer.
7. Kayser, O., & Warzecha, H. (2012). *Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications* (2nd ed.). Wiley-VCH.
8. Meibohm, B. (2013). *Pharmacokinetics and Pharmacodynamics of Biotech Drugs* (1st ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Bioterrorism & National Security (BBTP 111)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: The Course explores bioterrorism threats, biological agents, risk assessment, and response strategies, emphasizing biosecurity measures, national policies, and ethical considerations to safeguard public health and security.

Course Outcomes (COs):

CO1: Understand bioterrorism, biological agents, and their impact on national security.

CO2: Analyze risks and biosecurity measures for small- and large-scale bioterrorism events.

CO3: Evaluate response strategies, surveillance, and emergency preparedness protocols.

CO4: Assess national and international biosecurity policies and regulations.

CO5: Examine ethical issues and societal implications of bioterrorism preparedness.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	1	3	2
CO2	3	3	2	2	3	2	1	1	-	1	2	3	2
CO3	3	3	3	2	3	2	2	1	1	1	2	3	3
CO4	3	2	2	1	2	3	1	2	1	2	1	3	2
CO5	3	2	2	1	3	3	2	3	1	2	1	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Bioterrorism and Biological Agents: Definition and history of bioterrorism. Biological agents: Categories (A, B, C) and characteristics (e.g., anthrax, plague). Impact on national security: Public health and societal disruption. Modes of dissemination: Aerosols, food, and water contamination. Case study: 1984 Rajneesh Salmonella attack.

UNIT-II

Risk Assessment and Biosecurity Measures: Risks and risk assessment in bioterrorism: Small- and large-scale processes. Biosecurity for genetically engineered microbes and pathogens.

Biosafety levels (1–4) and biological safety cabinets. Decontamination and biological waste management.

UNIT-III

Response Strategies and Surveillance: Emergency response protocols: Identify, report, refer. Surveillance systems: Syndromic surveillance and early detection. Medical surveillance and treatment: Antibiotics and vaccines. Case study: 2001 anthrax attacks response.

UNIT-IV

National and International Biosecurity Policies: National biosecurity policies: U.S., UK, and India frameworks, International conventions: Cartagena Protocol, Biological Weapons Convention. Role of agencies: DHS, NBACC, WHO. Policy challenges: Antibiotic resistance and engineered pathogens.

UNIT-V

Ethical Issues and Societal Implications: Ethical considerations: Public fear, privacy, and resource allocation. Societal impacts: Panic, economic disruption, and trust in governance. Balancing security and civil liberties in bioterrorism response. Psychological consequences and public communication strategies.

Text/ Reference Books:

1. Fleming, D. O., & Hunt, D. L. (2006). *Biological Safety: Principles and Practices* (4th ed.). ASM Press.
2. Koblentz, G. D. (2010). *Living Weapons: Biological Warfare and International Security* (1st ed.). Cornell University Press.
3. Ryan, J. R. (2016). *Biosecurity and Bioterrorism: Containing and Preventing Biological Threats* (2nd ed.). Butterworth-Heinemann.
4. Traynor, P. L., & Frederick, R. J. (2002). *Biosafety and Risk Assessment in Agricultural Biotechnology* (1st ed.). Michigan State University Press.
5. Tucker, J. B. (2012). *Innovation, Dual Use, and Security: Managing the Risks of Emerging Biological and Chemical Technologies* (1st ed.). MIT Press.
6. WHO Guidelines. (2020). *Laboratory Biosafety Manual* (4th ed.). World Health Organization. Available at: www.who.int.
7. Gerstein, D. M. (2009). *Bioterror in the 21st Century: Emerging Threats in a New Global Environment* (1st ed.). Naval Institute Press.
8. Atlas, R. M., & Dando, M. (2006). *Bioterrorism: Confronting the Threat* (1st ed.). Lynne Rienner Publishers.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Tissue Engineering (BBTP 112)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: This course introduces tissue engineering principles, cell sources, biomaterials, scaffolds, bioreactors, and applications in regenerative medicine.

Course Outcomes (COs):

CO1: Understand tissue engineering definition, history, components, and organization.

CO2: Explain cell sources, isolation, expansion, signaling, and biocompatibility.

CO3: Analyze biomaterials classification, properties, fabrication, and degradation.

CO4: Evaluate bioreactors, culture control, perfusion, and tissue maturation.

CO5: Assess applications, challenges, ethics, regulations, and clinical translation.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	1	1	2	3	2
CO3	3	3	2	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Tissue Engineering: Definition, scope, history, and significance. Relationship with regenerative medicine. Key components: cells, scaffolds, and signalling molecules. Tissue organization and extracellular matrix.

UNIT-II

Cell Sources and Culture Techniques: Types of cells used: stem cells, primary cells, cell lines. Isolation and expansion of cells. Cell signaling in tissue development. Co-culture techniques. Biocompatibility considerations.

UNIT-III

Biomaterials and Scaffold Design: Classification of biomaterials: natural and synthetic polymers. Scaffold properties: mechanical, chemical, biological. Fabrication techniques: electrospinning, freeze-drying, 3D bioprinting. Degradation and remodeling of scaffolds.

UNIT-IV

Bioreactors and Tissue Growth: Types of bioreactors for tissue engineering. Control of culture environment: pH, temperature, oxygen. Perfusion and mechanical stimulation. Monitoring tissue maturation.

UNIT-V

Applications, Challenges, and Ethics: Applications in skin, bone, cartilage, cardiovascular and neural tissue engineering. Clinical translation and immunological considerations. Regulatory guidelines and commercialization. Ethical issues in human tissue engineering.

Text/ Reference Books:

1. Lanza, R., Langer, R., & Vacanti, J. (2020). Principles of Tissue Engineering (5th ed.). Academic Press.
2. Nerem, R. M., & Sambanis, A. (2014). Tissue Engineering: Principles and Practices (1st ed.). CRC Press.
3. Palsson, B. O., & Bhatia, S. N. (2004). Tissue Engineering (1st ed.). Pearson Education.
4. Clemens, R. A., & Hernandez, R. J. (2017). Tissue Engineering and Regenerative Medicine (1st ed.). Springer.
5. Laurencin, C. T., & Khan, Y. (2013). Tissue Engineering (1st ed.). Wiley.
6. Blitterswijk, C. V., & De Boer, J. (2014). Tissue Engineering (2nd ed.). Academic Press.
7. Fisher, J. P., Mikos, A. G., & Bronzino, J. D. (2012). Tissue Engineering: Principles and Applications (1st ed.). CRC Press.
8. Saltzman, W. M. (2004). Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues (1st ed.). Oxford University Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Rational Drug Discovery (BBTP 113)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	0	0	2
Pre-requisites/Exposure	-				

Course Description: This course covers rational drug discovery processes, target identification, lead optimization, computational methods, and preclinical/clinical development.

Course Outcomes (COs):

CO1: Understand rational drug discovery scope, history, and pipeline.

CO2: Explain target identification, validation, genomics, and biomarkers.

CO3: Analyze lead discovery, SAR, hit-to-lead, and prodrug design.

CO4: Apply computational approaches like SBDD, LBDD, docking, and AI.

CO5: Evaluate preclinical/clinical studies, regulations, ethics, and IP.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	1	3	2
CO2	3	3	2	2	2	1	1	-	-	1	2	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Rational Drug Discovery: Definition, scope, and importance. Historical development and shift from serendipitous to rational approaches. Drug discovery pipeline and timeline. Success stories and case studies.

UNIT-II

Target Identification and Validation: Molecular targets: receptors, enzymes, ion channels, nucleic acids. Genomics, proteomics, and metabolomics in target identification. Validation strategies: genetic, biochemical, and pharmacological. Biomarkers and their role in target validation.

UNIT-III

Lead Discovery and Optimization: High-throughput screening (HTS) and combinatorial chemistry. Structure-activity relationship (SAR) studies. Hit-to-lead optimization strategies. Prodrug design and analog development.

UNIT-IV

Computational Approaches in Drug Design: Structure-based drug design (SBDD) and ligand-based drug design (LBDD). Molecular docking, pharmacophore modeling, QSAR. Virtual screening and fragment-based drug discovery. Role of AI and machine learning in drug design.

UNIT-V

Preclinical and Clinical Development, Ethics: Preclinical studies: in vitro and in vivo models. Clinical trial phases and design. Regulatory guidelines (FDA, EMA, CDSCO). Intellectual property, patents, and ethical considerations.

Text/ Reference Books:

1. Patrick, G. L. (2021). An Introduction to Medicinal Chemistry (7th ed.). Oxford University Press.
2. Silverman, R. B., & Holladay, M. W. (2014). The Organic Chemistry of Drug Design and Drug Action (3rd ed.). Academic Press.
3. Wermuth, C. G., Aldous, D., Raboisson, P., & Rognan, D. (2015). The Practice of Medicinal Chemistry (4th ed.). Academic Press.
4. Nogrady, T., & Weaver, D. F. (2005). Medicinal Chemistry: A Molecular and Biochemical Approach (3rd ed.). Oxford University Press.
5. Vogel, H. G., Maas, J., & Gebauer, A. (2013). Drug Discovery and Evaluation: Pharmacological Assays (4th ed.). Springer.
6. Kubinyi, H. (2006). Chemogenomics in Drug Discovery: A Medicinal Chemistry Perspective (1st ed.). Wiley-VCH.
7. Anderson, A. C., & Wright, D. L. (2019). Computational Drug Design (1st ed.). Wiley.
8. Rankovic, Z., & Morphy, R. (2010). Lead Generation Approaches in Drug Discovery (1st ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Precision Medicine & Wellness (BBTP 114)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course introduces precision medicine, omics, diagnostics, digital health, and ethical issues in personalized wellness.

Course Outcomes (COs):

CO1: Understand precision medicine evolution and differences from personalized medicine.

CO2: Explain omics technologies, pharmacogenomics, and biomarkers.

CO3: Analyze molecular diagnostics, targeted therapy, gene therapy, and applications.

CO4: Evaluate digital health, wearables, AI, telemedicine, and lifestyle interventions.

CO5: Assess ethics, regulations, economics, and future trends in precision medicine.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	3	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	3	3	2
CO3	3	3	3	2	3	2	1	1	1	1	3	3	3
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	2	1	3	3	1	3	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Precision Medicine: Definition, scope, and evolution of precision medicine. Difference between personalized medicine and precision medicine. Role in healthcare transformation. Success stories and global initiatives.

UNIT-II

Omics in Precision Medicine: Genomics, transcriptomics, proteomics, metabolomics. Pharmacogenomics and pharmacogenetics. Biomarkers: discovery, validation, and clinical use. Systems biology approach to disease understanding.

UNIT-III

Molecular Diagnostics and Therapeutics: Next-generation sequencing (NGS) and bioinformatics applications. Companion diagnostics and targeted therapy. CRISPR-Cas9 and gene therapy in precision medicine. Cancer precision therapy and rare disease applications.

UNIT-IV

Digital Health and Wellness Technologies: Wearable devices and health monitoring. Artificial intelligence and big data in healthcare. Telemedicine and mobile health (mHealth). Lifestyle interventions: nutrition, exercise, mental health in precision wellness.

UNIT-V

Ethics, Regulation, and Future Trends: Ethical and privacy issues in genetic data use. Regulatory frameworks (FDA, EMA, ICMR). Economic challenges and market adoption. Future trends and opportunities in precision medicine and wellness.

Text/ Reference Books:

1. Collins, F. S., & Varmus, H. (2015). A New Initiative on Precision Medicine. New England Journal of Medicine.
2. Jameson, J. L., & Longo, D. L. (2018). Precision Medicine: Personalized, Problem-Based, and People-Centered (1st ed.). McGraw-Hill Education.
3. Khoury, M. J., & Galea, S. (2020). Precision Public Health for the Era of Precision Medicine (1st ed.). Springer.
4. Topol, E. J. (2019). Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again (1st ed.). Basic Books.
5. Dzau, V. J., & Ginsburg, G. S. (2016). Realizing the Full Potential of Precision Medicine in Health and Healthcare (1st ed.). National Academies Press.
6. Strachan, T., & Read, A. P. (2018). Human Molecular Genetics (5th ed.). Garland Science.
7. Lesko, L. J., & Schmidt, S. (2012). Clinical Pharmacogenomics: Applications in Pharmaceutical Development (1st ed.). Wiley.
8. Hedgecoe, A. (2004). The Politics of Personalized Medicine: Pharmacogenetics in the Clinic (1st ed.). Cambridge University Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Nano Biotechnology (BBTP 115)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	1	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers nanobiotechnology principles, nanomaterials, tools, applications in drug delivery and diagnostics, and safety/ethics.

Course Outcomes (COs):

CO1: Understand nanobiotechnology definition, history, properties, and biology applications.

CO2: Explain nanomaterials types, synthesis, modification, and biocompatibility.

CO3: Analyze tools like SEM, TEM, AFM, spectroscopy, and biosensing.

CO4: Apply nanocarriers, diagnostics, imaging, and antimicrobial nanomaterials.

CO5: Assess nanotoxicology, ethics, regulations, and future trends.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	3	3	2
CO3	3	3	2	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	2	1	3	3	1	3	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Nanobiotechnology: Definition, scope, and interdisciplinary nature. Historical development and milestones. Unique properties of nanomaterials in biology. Role in biotechnology, medicine, and agriculture.

UNIT-II

Nanomaterials in Biology: Types: nanoparticles, nanowires, nanotubes, quantum dots, dendrimers. Synthesis methods: top-down and bottom-up approaches. Surface modification and functionalization. Biocompatibility and toxicity considerations.

UNIT-III

Tools and Techniques: Imaging techniques: SEM, TEM, AFM, confocal microscopy. Spectroscopic techniques: UV-Vis, FTIR, Raman, fluorescence. Nanopatterning and nanofabrication methods. Biosensing principles and nanosensors.

UNIT-IV

Applications in Biotechnology and Medicine: Nanocarriers for drug delivery and targeted therapy. Nano-enabled diagnostics and imaging agents. Nanotechnology in regenerative medicine and tissue engineering. Nanovaccines and antimicrobial nanomaterials.

UNIT-V

Safety, Ethics, and Future Prospects: Nanotoxicology and risk assessment. Ethical issues in nanobiotechnology applications. Regulatory guidelines (FDA, EMA, OECD). Future trends: personalized nanomedicine, nanorobotics, smart nanomaterials.

Text/ Reference Books:

1. Niemeyer, C. M., & Mirkin, C. A. (2004). Nanobiotechnology: Concepts, Applications, and Perspectives (1st ed.). Wiley-VCH.
2. Jain, K. K. (2017). The Handbook of Nanomedicine (4th ed.). Humana Press.
3. Vo-Dinh, T. (2014). Nanotechnology in Biology and Medicine: Methods, Devices, and Applications (2nd ed.). CRC Press.
4. Mitragotri, S., Anderson, D. G., Chen, X., Chow, E. K., & Ho, D. (2018). Nanotechnology for Precision Medicine (1st ed.). Springer.
5. Gazit, E., & Nussinov, R. (2006). Nanobiotechnology: Bioinspired Devices and Materials of the Future (1st ed.). Humana Press.
6. Bhushan, B. (2017). Springer Handbook of Nanotechnology (4th ed.). Springer.
7. Saji, V. S., & Cook, R. (2013). Nanomaterials for Biomedical Applications (1st ed.). Elsevier.
8. Webster, T. J. (2012). Nanotechnology Enabled In Situ Sensors for Monitoring Health (1st ed.). Springer.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Agro Biotechnology (BBTP 116)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	1	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers agricultural biotechnology, including germplasm conservation, crop improvement, genetic engineering, molecular breeding, and biosafety.

Course Outcomes (COs):

CO1: Understand agriculture, germplasm conservation, micropropagation, and pathogen-free plants.
CO2: Explain biotechnology methods for crop improvement, gene transfer, and transgenics.

CO3: Analyze non-gel techniques, genotyping, molecular breeding, and MAS.

CO4: Apply in vitro production of secondary metabolites, molecular pharming, and biotransformation.

CO5: Evaluate biofertilizers, phytoremediation, biopesticides, hydroponics, and biosafety.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	2	2	1	-	-	1	2	3	2
CO2	3	3	2	2	2	2	1	-	1	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction: Agriculture and Agricultural Biotechnology, In vitro Germplasm Conservation Micro propagation, In vitro production of pathogen and/or disease-free plants

UNIT-II

Biotechnology- Methods of Crop Improvement, Genetic Engineering for Crop Plants Improvement. Methods of gene transfer in plants, Transgenic Plants for biotic and abiotic, stress resistance, In vitro induced mutagenesis, Role of antisense and RNAi in crop improvement, Regulated and tissue specific expression of transgenes for crop improvement, Terminator gene technology

UNIT-III

Recent advances – Non gel based techniques for plant, genotyping – Homogenous assays – Qualitative/Real Time assays; DNA Chip and its technology. Molecular breeding (MAS) Transgenic Plants, Molecular Markers, QTL.

UNIT-IV

Mapping In vitro Production of Secondary Metabolites Production of foreign compounds in transgenic plants Molecular Pharming, Production of Edible vaccines and other therapeutics, Biotransformation

UNIT -V

Biofertilizers and Phyto-remediation Biopesticides, Agricultural antibiotics Biotechnology in Agriculture, Hydroponics, Biosafety regulations, Ethical Aspects and Public Acceptance.

Text/ Reference Books:

1. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: The Genetic Manipulation of Plants (2nd ed.). Oxford University Press.
2. Chrispeels, M. J., & Sadava, D. E. (2003). Plants, Genes, and Crop Biotechnology (2nd ed.). Jones & Bartlett Learning.
3. Primrose, S. B., & Twyman, R. M. (2013). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell.
4. Halford, N. G. (2012). Genetically Modified Crops (2nd ed.). Imperial College Press.
5. Stewart, C. N. (2016). Plant Biotechnology and Genetics: Principles, Techniques, and Applications (2nd ed.). Wiley.
6. Altman, A., & Hasegawa, P. M. (2011). Plant Biotechnology and Agriculture: Prospects for the 21st Century (1st ed.). Academic Press.
7. Bhojwani, S. S., & Razdan, M. K. (2016). Plant Tissue Culture: Theory and Practice (Revised ed.). Elsevier.
8. Murphy, D. J. (2007). Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture (1st ed.). Cambridge University Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Food Safety and Quality Management (BBTP 117)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers material handling, packaging, storage, and quality control in food processing.

Course Outcomes (COs):

CO1: Understand solids/liquids handling, pumps, and filling machines.

CO2: Explain packaging materials for various food types.

CO3: Analyze storage requirements for cereals, meat, milk, vegetables, and beverages.

CO4: Evaluate storage principles, losses, and structures including cold storage.

CO5: Assess loss in cereal quality, insect/pest control, and storage design.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	1	1	-	-	1	2	3	2
CO2	3	3	2	1	2	2	1	-	-	1	2	3	2
CO3	3	3	2	2	3	2	1	-	1	1	2	3	3
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	3	2	3	3	1	2	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Material Handling: Solids and granular materials handling: elevators, conveyors; Pumps: centrifugal and positive displacement; Liquid filling machines: open vent, closed vent and piston fillers.

UNIT-II

Packaging Materials Polymer films, metal containers, flexible packages, special packing.

UNIT-III

Requirements for cereals, meat, poultry, fish, milk, vegetables, fruits, plantation crop-

based products and carbonated beverages.

UNIT-IV

Storage Principle and Practice: Storage losses and their estimation: Modified and control Atmosphere storage: Binandsilo storage force reals and pulses.

UNIT-V

Loss in cereal quality-insect and pest control. Design of storage structures and facilities including cold storage.

Text/ Reference Books:

1. Fellows, P. J. (2016). Food Processing Technology: Principles and Practice (4th ed.). Woodhead Publishing.
2. Robertson, G. L. (2012). Food Packaging: Principles and Practice (3rd ed.). CRC Press.
3. Paine, F. A., & Paine, H. Y. (2012). A Handbook of Food Packaging (2nd ed.). Springer.
4. Subramaniam, P. (2014). Food Storage and Preservation (1st ed.). New India Publishing Agency.
5. Rees, D. (2013). Insects of Stored Products (1st ed.). CSIRO Publishing.
6. Barbosa-Cánovas, G. V., Fontana, A. J., Schmidt, S. J., & Labuza, T. P. (2020). Water Activity in Foods: Fundamentals and Applications (2nd ed.). Wiley-Blackwell.
7. Saravacos, G. D., & Kostaropoulos, A. E. (2016). Handbook of Food Processing Equipment (2nd ed.). Springer.
8. Sinha, N. K., Hui, Y. H., Evranuz, E. Ö., Siddiq, M., & Ahmed, J. (2010). Handbook of Vegetables and Vegetable Processing (1st ed.). Wiley-Blackwell.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Marine Biotechnology (BBTP 118)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	1	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores marine ecosystems, biogeochemical cycles, natural products, aquaculture, and biotechnological applications.

Course Outcomes (COs):

CO1: Understand marine biotechnology status, ecosystems, and inhabitants.

CO2: Explain tides, currents, elements, cycles, and climate impacts.

CO3: Apply biology and policy in conservation, restoration, and food web dynamics.

CO4: Evaluate marine natural products, aquaculture, and bioactive compounds.

CO5: Assess biotechnology for economic development, bioremediation, and vaccines in aquaculture.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	3	1	1	-	1	2	3	2
CO2	3	3	2	1	2	3	1	-	-	1	2	3	2
CO3	3	3	3	2	3	3	1	1	1	1	2	3	3
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Overview of the present status of marine biotechnology, Marine ecosystems – intertidal zone, inhabitants and ecology of estuaries, salt marshes, mangrove swamps, coral reefs and the deep sea, Plankton, nekton and benthos.

UNIT-II

Introduction to tides and waves. Water currents and winds. Major and minor elements in the sea water and their importance, dissolved oxygen. Biogeochemical cycles (Carbon, Nitrogen, Sulphur and Phosphorus) in the ocean. Global climatic change and potential effects on coral bleaching,

eutrophication.

UNIT-III

Applications from both the biology and policy perspectives (e.g. endangered species, captive breeding, habitat fragmentation, ecosystem restoration, rehabilitation. Marine food web dynamics - primary, secondary and tertiary production.

UNIT-IV

Marine natural products, aquaculture, valuable chemicals, bioactive compounds from micro-algae, macro-algae and other marine organisms. Important enzymes from marine microorganisms and their applications: Xylanases, proteases, chitinases.

UNIT-V

Marine biotechnology for economic development and environmental problem solving. Aquaculture-fish, shrimp and pearl oyster culture. Transgenic marine organisms. Biofouling and prevention Bioremediation. Probiotic bacteria and their importance in aquaculture. PCR, molecular and immunological techniques for determination and identification of bacterial and viral pathogens in aquaculture. Vaccines for aquaculture.

Text/ Reference Books:

1. Borowitzka, M. A., & Moheimani, N. R. (2013). Algae for Biofuels and Energy (1st ed.). Springer.
2. Kathiresan, K., & Thiruneelakandan, G. (2019). Marine Biotechnology: Applications and Opportunities (1st ed.). CRC Press.
3. Kim, S. K. (2015). Handbook of Marine Biotechnology (1st ed.). Springer.
4. Yokoyama, H., & Takahashi, K. (2017). Marine Biotechnology for Sustainable Aquaculture (1st ed.). Wiley.
5. Smith, J. L., & Vignieri, S. N. (2020). Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity (2nd ed.). Island Press.
6. Raghukumar, C. (2012). Marine Biotechnology: Trends and Applications (1st ed.). Springer.
7. Blunt, J. W., & Munro, M. H. G. (2018). Dictionary of Marine Natural Products (2nd ed.). CRC Press.
8. Proksch, P., & Müller, W. E. G. (2014). Marine Pharmacology: Bioactive Molecules from the Sea (1st ed.). Academic Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Pharmaceutical Biotechnology (BBTP 119)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers pharmaceutical industry history, pharmacokinetics, dosage forms, bulk manufacturing, generics, biosimilars, and regulations.

Course Outcomes (COs):

CO1: Understand pharmaceutical history, drug discovery, pharmacokinetics, and adverse reactions.

CO2: Explain dosage forms, classification, and screening principles.

CO3: Analyze bulk manufacturing reactions, requirements, and case studies.

CO4: Evaluate generics, biosimilars, biopharmaceuticals, and marine products.

CO5: Assess GMP, GLP, purity, FSSA guidelines, and Drugs/Cosmetics Act

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	2	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	2	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction History of pharmaceutical industry, drug discovery and development phases; Introduction to pharmacokinetics and pharmacodynamics (factors affecting drug metabolism (ADME)), Dose effect relationship, adverse drug reactions (ADR), the role of patents in the drug industry.

UNIT-II

Dosage form, Drug screening principles; definition of dosage forms, classification of dosage forms (solid unit dosages – Tablets, capsules; liquids – solutions, lotions, suspension etc; semi-solid – ointments; Parenteral)

UNIT-III

Bulk drug manufacturing: Types of reactions in bulk manufacture and processing. Special Requirements for bulk drug manufacture. Case study: Unit process and unit operations of inulin production, purification, formulation, and packaging.

UNIT-IV

Generics and its advantages; bio-generics and biosimilar, protein-based. Biopharmaceuticals; Marine natural products, bioactive compounds from micro-algae, macro-algae, and other marine organisms.

UNIT-V

GMP, GLP, Purity determination as per ICH guidelines, FSSA guidelines, use of biochemical and molecular techniques in quality evaluation. Drugs and Cosmetics Act and regulatory aspects.

Text/ Reference Books:

1. Walsh, G. (2018). Biopharmaceuticals: Biochemistry and Biotechnology (3rd ed.). Wiley.
2. Patrick, G. L. (2021). An Introduction to Medicinal Chemistry (7th ed.). Oxford University Press.
3. Crommelin, D. J. A., & Sindelar, R. D. (2013). Pharmaceutical Biotechnology: Fundamentals and Applications (4th ed.). Springer.
4. Vyas, S. P., & Dixit, V. K. (2011). Pharmaceutical Biotechnology (1st ed.). CBS Publishers.
5. Ho, R. J. Y., & Gibaldi, M. (2013). Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs (2nd ed.). Wiley.
6. Gad, S. C. (2018). Handbook of Pharmaceutical Biotechnology (1st ed.). Wiley.
7. Sharma, A., & Reddy, V. (2019). Biosimilars: Development and Applications (1st ed.). Academic Press.
8. ICH Guidelines. (2025). International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use. Available at: www.ich.org.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Genomics & Proteomics (BBTP 120)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	2	1	0	3
Pre-requisites/Exposure	-				

Course Description: This course introduces genomics and proteomics, sequencing, analysis, protein interaction, and bioinformatics applications.

Course Outcomes (COs):

CO1: Understand genomics definition, types, and databases.
CO2: Explain genome sequencing, assembly, annotation, and applications.

CO3: Analyze proteomics types, separation, identification, and expression profiling.

CO4: Evaluate protein interactions, structural proteomics, and functional annotation.

CO5: Apply bioinformatics for data analysis, systems biology, and drug discovery.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	3	3	2
CO3	3	3	2	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	1	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Genomics: Definition, history, and scope of genomics. Types of genomics: structural, functional, and comparative. Model organisms in genomics research. Genome databases and resources.

UNIT-II

Genome Sequencing and Analysis: Genome mapping strategies. DNA sequencing methods: Sanger, NGS platforms, third-generation sequencing. Genome assembly and annotation. Applications of genomics in health and agriculture.

UNIT-III

Introduction to Proteomics: Definition, scope, and types of proteomics. Protein structure, folding, and post-translational modifications. Techniques for protein separation and identification: 2D-PAGE, mass spectrometry. Protein expression profiling.

UNIT-IV

Protein Interaction and Functional Proteomics: Protein-protein interaction mapping: yeast two-hybrid, co-immunoprecipitation. Structural proteomics: X-ray crystallography, NMR, cryo-EM. Functional annotation of proteins. Proteomics in biomarker discovery.

UNIT-V

Bioinformatics tools for genomics and proteomics data analysis. Systems biology approaches. Applications in drug discovery, diagnostics, and personalized medicine. Ethical and societal considerations.

Text/ Reference Books:

1. Brown, T. A. (2020). Genomes 5 (5th ed.). Garland Science.
2. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology (1st ed.). Humana Press.
3. Lesk, A. M. (2019). Introduction to Bioinformatics (5th ed.). Oxford University Press.
4. Twyman, R. M. (2013). Principles of Proteomics (2nd ed.). Garland Science.
5. Primrose, S. B., & Twyman, R. M. (2013). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell.
6. Westermeier, R., & Naven, T. (2002). Proteomics in Practice: A Guide to Successful Experimental Design (1st ed.). Wiley-VCH.
7. Pevsner, J. (2015). Bioinformatics and Functional Genomics (3rd ed.). Wiley-Blackwell.
8. Koonin, E. V., & Galperin, M. Y. (2003). Sequence - Evolution - Function: Computational Approaches in Comparative Genomics (1st ed.). Springer.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Cancer Biology (BBTP 121)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers cancer origins, genetics, causes, oncogenes, suppressors, metastasis, biomarkers, and therapies.

Course Outcomes (COs):

CO1: Understand cancer statistics, origins, genetic changes, hallmarks, and microenvironment.

CO2: Explain chemical carcinogenesis, mutagens, oncogenes, and viral roles.

CO3: Analyze oncogene families, tumor suppressors, and metastasis mechanisms.

CO4: Evaluate biomarkers, diagnostic options, and epigenetic markers.

CO5: Assess chemotherapy, radiotherapy, emerging therapies, and tumor immunology.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	2	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to cancer- Cancer statistics and problems at National and International perspectives. Origin of cancer cell, Genetic, molecular and epigenetic changes in cancer cells, Tumor hallmarks, Tumor microenvironment. Cancer progression Basis of tumour progression, Steps in tumor progression, Cancer stem cell theory for origin of cancer, Classifications, stages and grades of tumor

UNIT-II

Causes of cancer Chemical carcinogenesis Endogenous & exogenous mutagens, Identification of carcinogens, Tumour initiators & tumour promoters, Molecular basis of cancer- Aberrant signaling in cancer, Cellular and viral oncogenes (Gain of Function), Deregulated apoptotic genes (Loss of

functions), Genomic landscape of cancers, DNA repair response in cancer, Dysregulation of cell cycle and cell growth, mutation in apoptosis genes, The role of viral genes in cancer progression (DNA tumour virus (SV 40) and human papilloma virus (E6 and E7).

UNIT-III

Introduction to Oncogenes families Cell transforming ability of oncogene, Retrovirus as a source of cancer, Oncogenes: Ras, Myc, Src, Jun and Fos, Controlling factors of oncogene expressions Tumour suppressor genes Molecular basis of tumor suppressor genes including Retinoblastoma (Rb), p53, Adenomatous polyposis coli (APC) in the development and progression of tumor. Metastasis Molecular basis of metastasis, steps in cell invasion, intravasation, transport, colonization, angiogenesis.

UNIT-IV

Cancer biomarkers and diagnostic options, Expanded diagnostic technique, Tumour markers, Nucleic acid based markers and mitochondrial DNA mutation markers, Epigenetic markers including DNA methylation pattern and chromatin remodeling, mitochondrial DNA,

UNIT-V

Cancer therapy Contemporary chemotherapy, radiotherapy Emerging therapies (Targeted delivery & Synthetic lethal approaches) Inhibitors of oncogenic protein, tumour blood vessels as target for cancer therapy Tumor immunology and cancer immunotherapies

Text/ Reference Books:

1. Weinberg, R. A. (2013). The Biology of Cancer (2nd ed.). Garland Science.
2. Hanahan, D., & Weinberg, R. A. (2011). Hallmarks of Cancer: The Next Generation. Cell Press.
3. DeVita, V. T., Lawrence, T. S., & Rosenberg, S. A. (2020). Cancer: Principles & Practice of Oncology (11th ed.). Wolters Kluwer.
4. Pecorino, L. (2021). Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics (5th ed.). Oxford University Press.
5. Vogelstein, B., & Kinzler, K. W. (2002). The Genetic Basis of Human Cancer (2nd ed.). McGraw-Hill.
6. Mukherjee, S. (2010). The Emperor of All Maladies: A Biography of Cancer (1st ed.). Scribner.
7. Heng, H. H. Q. (2019). Genome Chaos: Rethinking Genetics, Evolution, and Molecular Medicine (1st ed.). Academic Press.
8. El-Deiry, W. S. (2016). Tumor Suppressor Genes: Methods and Protocols (2nd ed.). Humana Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Industrial Biotechnology (BBTP 122)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course explores microbial fermentation, enzyme technology, bioprocess engineering, and industrial applications, emphasizing sustainable production of biofuels, pharmaceuticals, and biomaterials, alongside regulatory and ethical considerations.

Course Outcomes (COs):

CO1: Understand principles of industrial biotechnology, fermentation, and enzyme applications.

CO2: Analyze microbial systems and bioprocess engineering for industrial production.

CO3: Evaluate production of biofuels, pharmaceuticals, and biomaterials using biotechnology.

CO4: Apply bioprocess optimization and scale-up techniques in industrial settings.

CO5: Assess regulatory frameworks, ethical issues, and sustainability in industrial biotechnology.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	1	-	1	2	3	2
CO2	3	3	2	2	3	1	1	-	1	1	3	3	2
CO3	3	3	3	2	3	2	1	-	1	1	3	3	3
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	2	2	1	3	3	1	3	1	2	2	2	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Industrial Biotechnology: Definition, scope, and history of industrial biotechnology. Role of microorganisms: Bacteria, yeast, and fungi in industrial processes. Fermentation processes: Batch, fed-batch, and continuous fermentation. Enzyme technology: Industrial enzymes (e.g., amylases, proteases). Applications in food, textile, and detergent industries.

UNIT-II

Microbial Systems and Bioprocess Engineering: Microbial strains: Selection and optimization (e.g., E. coli, Saccharomyces cerevisiae). Bioreactor design: Stirred-tank, air-lift, and packed-bed reactors. Bioprocess parameters: pH, temperature, aeration, and agitation. Downstream processing: Filtration,

centrifugation, and purification. Case study: Antibiotic production using microbial fermentation.

UNIT-III

Industrial Production of Biofuels and Pharmaceuticals: Biofuel production: Bioethanol, biodiesel, and biogas via microbial processes. Pharmaceutical production: Antibiotics, insulin, and therapeutic proteins. Metabolic engineering for enhanced product yield. Scale-up challenges in industrial biotechnology. Case study: Bioethanol production from lignocellulosic biomass.

UNIT-IV

Biomaterials and Bioprocess Optimization: Biomaterials: Bioplastics, biopolymers, and biodegradable materials. Enzyme immobilization techniques for industrial applications. Bioprocess optimization: Response surface methodology, DOE. High-throughput screening for strain improvement. Case study: Production of polyhydroxyalkanoates (PHA).

UNIT-V

Regulatory, Ethical, and Sustainability Issues: Regulatory frameworks: FDA, EMA, and Indian biotech regulations. Biosafety and environmental impact of industrial processes. Ethical considerations: GMO use, intellectual property rights. Sustainability: Waste reduction, circular bioeconomy. Emerging trends: Synthetic biology and green bioprocessing.

Text/ Reference Books:

1. Demain, A. L., & Davies, J. E. (1999). *Manual of Industrial Microbiology and Biotechnology* (2nd ed.). ASM Press.
2. Glazer, A. N., & Nikaido, H. (2007). *Microbial Biotechnology: Fundamentals of Applied Microbiology* (2nd ed.). Cambridge University Press.
3. Ratledge, C., & Kristiansen, B. (2006). *Basic Biotechnology* (3rd ed.). Cambridge University Press.
4. Lee, S. Y., & Papoutsakis, E. T. (2012). *Metabolic Engineering* (1st ed.). CRC Press.
5. Waites, M. J., Morgan, N. L., Rockey, J. S., & Higton, G. (2001). *Industrial Microbiology: An Introduction* (1st ed.). Wiley-Blackwell.
6. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2016). *Principles of Fermentation Technology* (3rd ed.). Elsevier.
7. El-Mansi, E. M. T., & Bryce, C. F. A. (2007). *Fermentation Microbiology and Biotechnology* (3rd ed.). CRC Press.
8. Crueger, W., & Crueger, A. (2000). *Biotechnology: A Textbook of Industrial Microbiology* (2nd ed.). Sinauer Associates.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Food Biotechnology Laboratory (BBTP 151)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Isolation and Identification of Lactic Acid Bacteria from Fermented Foods
2. Fermentation for Yogurt Production and pH Analysis
3. DNA Extraction from Genetically Modified (GM) Food Crops
4. PCR Detection of GMO Genes in Food Samples
5. Agarose Gel Electrophoresis for GMO Analysis
6. Enzyme Activity Assay for Amylase in Food Processing
7. Protein Extraction and Quantification from Plant-Based Foods
8. Microbial Analysis of Food Spoilage (Total Plate Count)
9. Proximate Analysis of Food Samples (Moisture, Ash, Fat)
10. Sensory Evaluation of Biotechnologically Processed Foods

Recommended Books:

1. Shetty, K., Paliyath, G., Pometto, A., & Levin, R. E. (2005). *Food Biotechnology* (2nd ed.). CRC Press.
2. Sambrook, J., & Russell, D. W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
3. Fellows, P. J. (2016). *Food Processing Technology: Principles and Practice* (4th ed.). Woodhead Publishing.
4. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th ed.). Cambridge University Press.
5. Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
6. Belitz, H. D., Grosch, W., & Schieberle, P. (2009). *Food Chemistry* (4th ed.). Springer.
7. Clark, D. P., & Pazdernik, N. J. (2015). *Biotechnology: Applying the Genetic Revolution* (2nd ed.). Academic Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Stem Cell Technology Laboratory (BBTP 152)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Sterilization techniques: Theory and Practical: Glassware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium.
5. Isolation of lymphocytes for culturing.
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

Recommended Book:

1. R.Ian Freshney, "Animal cell Culture"

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Gene Expression and Transgenics Laboratory (BBTP 153)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. RNA Extraction from Plant or Animal Tissue
2. cDNA Synthesis from Extracted RNA
3. RT-PCR for Gene Expression Analysis
4. Agarose Gel Electrophoresis of PCR Products
5. Cloning a Target Gene into an Expression Vector
6. Transformation of *E. coli* with Recombinant Plasmid
7. Agrobacterium-Mediated Transformation of Plant Cells
8. GFP Expression Analysis in Transformed Cells
9. Protein Expression and Detection via Western Blot
10. Quantitative PCR (qPCR) for Gene Expression Levels

Recommended Books:

1. Sambrook, J., & Russell, D. W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual* (4th ed.). Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
4. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2014). *Molecular Biology of the Cell* (6th ed.). Garland Science.
5. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th ed.). Cambridge University Press.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Environmental Biotechnology Laboratory (BBTP 154)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. Dissolved Oxygen in waste water
2. Biochemical oxygen demand in waste water
3. Chemical Oxygen demand in waste water
4. Hardness of water
5. Total, dissolved and suspended solid in waste water
6. Alkalinity of waste water
7. Acidity of waste water
8. Hexavalent chromium in waste water
9. Nitrate in waste water
10. Sulphate in waste water

Recommended Books:

1. Patra, J. K., Das, G., Das, S. K., & Thatoi, H. (2020). A Practical Guide to Environmental Biotechnology (1st ed.). Springer.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Molecular Diagnostics and its Applications Laboratory (BBTP 155)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	0	0	2	1
Pre-requisites/Exposure	-				

Experiments:

1. DNA Extraction from Human Blood or Saliva
2. PCR Amplification of a Disease-Associated Gene
3. Agarose Gel Electrophoresis for PCR Product Analysis
4. Real-Time PCR (qPCR) for Pathogen Detection
5. RNA Extraction and cDNA Synthesis for Gene Expression
6. ELISA for Detection of Disease Biomarkers
7. Restriction Fragment Length Polymorphism (RFLP) Analysis
8. DNA Sequencing for Mutation Detection
9. Multiplex PCR for Multiple Pathogen Detection
10. Fluorescent In Situ Hybridization (FISH) for Chromosomal Abnormalities

Recommended Books:

1. Buckingham, L. (2019). *Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications* (3rd ed.). F.A. Davis Company.
2. Sambrook, J., & Russell, D. W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
3. Coleman, W. B., & Tsongalis, G. J. (2016). *Molecular Diagnostics: For the Clinical Laboratorian* (2nd ed.). Humana Press.
4. Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell.
5. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th ed.). Cambridge University Press.

Open Electives

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Waste Management & Upcycling (BBTO 101)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: The course explores waste classification, industrial treatment, biotechnological minimization, resource recovery, and environmental regulations, emphasizing sustainable management of municipal, hazardous, and biomedical waste.

Course Outcomes (COs):

CO1: Understand classification, generation, and characterization of municipal, hazardous, and biomedical wastes.

CO2: Analyze industrial waste sources, properties, and treatment methods across various industries.

CO3: Evaluate biotechnological approaches for waste minimization and resource recovery.

CO4: Apply waste treatment techniques, including landfilling, incineration, composting, and bioremediation.

CO5: Assess environmental regulations and ethical considerations for waste management.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	3	1	1	-	1	2	3	2
CO2	3	3	3	2	3	2	1	-	1	1	2	3	2
CO3	3	3	3	2	3	3	1	1	1	1	3	3	3
CO4	3	3	3	2	3	2	1	1	1	1	3	3	3
CO5	3	2	2	1	3	3	1	3	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Waste Classification and Characterization: Classification of waste: Municipal solid waste (MSW), hazardous waste, biomedical waste. Sources and generation of MSW, hazardous, and biomedical wastes. Chemical and physical characterization: Proximate analysis, C/N ratio, energy content. Biomedical waste categories and their implications. Overview of waste management challenges and sustainability goals.

UNIT-II

Industrial Waste: Sources and Treatment: Sources of industrial pollution: Food (sugar, fermentation, meat, dairy, rice-milling), material (paper, steel, metal-plating, petroleum refineries), and miscellaneous industries (textile, tanning, fertilizers, atomic energy). Physical, chemical, organic, and biological properties of industrial waste. Manufacturing processes and flow sheets for waste generation. Waste reduction, treatment, and disposal methods specific to each industry.

UNIT-III

Waste Management and Disposal Techniques: Disposal methods for MSW: Landfilling, incineration, composting, vermicomposting. Principles of landfilling: Site selection, liners, gas collection. Incineration: Energy recovery, emission control. Composting and vermicomposting: Processes and applications. Hazardous and biomedical waste treatment: Chemical neutralization, autoclaving, secure disposal.

UNIT-IV

Biotechnology in Waste Minimization and Resource Recovery: Role of biotechnology in waste minimization: Microbial degradation, enzyme applications. Recovery of by-products: Biogas, biomass, proteins, carbohydrates, oils, and metals. Wastewater conversion: Anaerobic digestion, bioscrubbing, nutrient recovery. Reclamation: Groundwater recharge, agricultural reuse of effluents, sludge as fertilizer. Bioremediation techniques for hazardous waste management.

UNIT-V

Environmental Regulations and Ethical Considerations: Hazardous Waste (Management and Handling) Rules, 1989 (Amended 2000, 2003). Biomedical Waste (Management and Handling) Rules, 1998. Municipal Solid Waste (Management and Handling) Rules, 2000. Batteries (Management and Handling) Rules, 2001. Plastic Waste (Management and Recycling) Rules, 1999. Ethical aspects: Public health, environmental safety, and societal acceptance.

Text/ Reference Books:

1. Tchobanoglous, G., & Kreith, F. (2002). Handbook of Solid Waste Management (2nd ed.). McGraw-Hill.
2. Metcalf & Eddy, Inc. (2014). Wastewater Engineering: Treatment and Resource Recovery (5th ed.). McGraw-Hill.
3. Rao, C. S. (2006). Environmental Pollution Control Engineering (2nd ed.). New Age International.
4. LaGrega, M. D., Buckingham, P. L., & Evans, J. C. (2010). Hazardous Waste Management (2nd ed.). Waveland Press.
5. Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous, and Industrial (2nd ed.). CRC Press.
6. Cheremisinoff, N. P. (2003). Handbook of Solid Waste Management and Waste Minimization Technologies (1st ed.). Butterworth-Heinemann.
7. Kiely, G. (1996). Environmental Engineering (1st ed.). McGraw-Hill.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Food and Nutrition Technology (BBTO 102)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers nutrition basics, food composition, processing, preservation, functional foods, nutraceuticals, and safety regulations.

Course Outcomes (COs):

CO1: Understand nutrition, nutrients, RDA, macronutrients, micronutrients, and fiber.

CO2: Analyze food composition, analysis methods, and sensory evaluation.

CO3: Explain preservation principles, processing technologies, and nutrient effects.

CO4: Evaluate functional foods, probiotics, prebiotics, and disease prevention.

CO5: Assess safety hazards, HACCP, GMP, laws, and public health programs.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	1	3	2
CO2	3	3	2	2	3	1	1	-	-	1	3	3	2
CO3	3	3	2	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	2	1	1	1	1	2	3	3
CO5	3	3	3	2	3	3	1	3	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Food and Nutrition: Basic concepts: Food, nutrition, and health. Nutrients: Classification, functions, and recommended dietary allowances (RDA). Macronutrients: Carbohydrates, proteins, and fats – digestion, absorption, metabolism. Micronutrients: Vitamins and minerals – types, sources, deficiency disorders. Role of water and dietary fiber.

UNIT-II

Food Composition and Analysis: Food composition databases and food labeling. Methods of food analysis: Proximate composition, moisture content, ash, crude protein, fat, carbohydrates. Determination of vitamins and minerals. Sensory evaluation of food.

UNIT-III

Food Processing and Preservation: Principles of food preservation: Thermal, chemical, irradiation, dehydration. Food processing technologies: Pasteurization, sterilization, extrusion, freeze-drying, fermentation. Packaging materials and food shelf-life extension. Effect of processing on nutrient content.

UNIT-IV

Functional Foods and Nutraceuticals: Definition and classification of functional foods and nutraceuticals. Probiotics, prebiotics, and synbiotics. Bioactive compounds in foods – antioxidants, phytochemicals, omega-3 fatty acids. Role of nutraceuticals in prevention and management of chronic diseases (e.g., diabetes, CVD, cancer).

UNIT-V

Food Safety, Regulations, and Public Health Nutrition: Food safety hazards: Biological, chemical, and physical. HACCP and good manufacturing practices (GMP). National and international food laws and standards: FSSAI, Codex Alimentarius, WHO guidelines. Public health nutrition programs in India. Emerging trends in food and nutrition technology.

Text/ Reference Books:

1. Wardlaw, G. M., & Smith, A. M. (2017). Contemporary Nutrition: A Functional Approach (5th ed.). McGraw-Hill Education.
2. Fellows, P. J. (2016). Food Processing Technology: Principles and Practice (4th ed.). Woodhead Publishing.
3. Vaclavik, V. A., & Christian, E. W. (2014). Essentials of Food Science (4th ed.). Springer.
4. Shahidi, F., & Ho, C. T. (2007). Functional Foods and Nutraceuticals (1st ed.). CRC Press.
5. Potter, N. N., & Hotchkiss, J. H. (2012). Food Science (5th ed.). Springer.
6. Sun, D. W. (2014). Emerging Technologies for Food Processing (2nd ed.). Academic Press.
7. Belitz, H. D., Grosch, W., & Schieberle, P. (2009). Food Chemistry (4th ed.). Springer.
8. Manay, N. S., & Shadaksharaswamy, M. (2008). Foods: Facts and Principles (3rd ed.). New Age International.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Biotechnology for Forensics (BBTO 103)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: The course explores forensic science, DNA fingerprinting, genetics, and agricultural applications, emphasizing techniques like RFLP, RAPD, AFLP, microsatellites, PCR, and SNP analysis, alongside ethics and regulatory frameworks.

Course Outcomes (COs):

CO1: Understand forensic science, biotechnology, genetics, agriculture, and the history/ethics of DNA fingerprinting.

CO2: Explain DNA fingerprinting techniques: RFLP, RAPD, AFLP, microsatellites, and SNP analysis.

CO3: Analyze PCR amplifications, genetic linkage, and physical genome mapping methods.

CO4: Apply DNA extraction from blood/biological materials and utilize forensic testing tools/kits.

CO5: Evaluate ethical, legal, and procedural frameworks in forensic biotechnology and agriculture.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	3	1	2	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	3	3	1	1	-	1	1	3	3	3
CO5	3	2	2	1	3	3	1	3	1	2	2	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Forensic Science and Biotechnology: Overview of forensic science and forensic biotechnology. Introduction to forensic genetics and forensic agriculture. History of DNA fingerprinting: Development and milestones. Ethical considerations, rules, and procedures in forensic investigations. Role of forensic biotechnology in criminal justice and agriculture.

UNIT-II

DNA Fingerprinting Techniques: Principles of DNA fingerprinting/profiling/testing. Restriction Fragment Length Polymorphism (RFLP): Principles and applications. Random Amplified Polymorphic

DNA (RAPD): Methodology and uses. Amplified Fragment Length Polymorphism (AFLP): Techniques and forensic applications. Microsatellites: Structure, analysis, and significance in identification.

UNIT-III

Advanced DNA Analysis Methods: Single Nucleotide Polymorphisms (SNPs): Detection and applications in forensics. PCR amplifications: Principles, types, and role in DNA profiling. Genetic linkage mapping: Concepts and applications in forensic genetics. Physical mapping of the genome: Techniques and relevance. BAC end sequencing: Process and forensic/agricultural applications.

UNIT-IV

DNA Extraction and Forensic Tools: DNA extraction from blood and biological materials: Methods and protocols. Other tests for DNA analysis: STR analysis, mitochondrial DNA sequencing. Forensic DNA testing tools, kits, and equipment: Overview and applications. Quality control and standardization in DNA testing procedures.

UNIT-V

Applications and Regulatory Frameworks: Forensic biotechnology in criminal investigations: Case studies and applications. Forensic agriculture: Applications in crop identification, GMO testing, and biosecurity. Ethical issues in DNA profiling: Privacy, consent, and misuse concerns. Legal frameworks: Regulations governing DNA evidence and forensic practices. Future trends: Emerging technologies in forensic biotechnology and agriculture.

Text/ Reference Books:

1. Butler, J. M. (2014). Fundamentals of Forensic DNA Typing (1st ed.). Academic Press.
2. Goodwin, W., Linacre, A., & Hadi, S. (2011). An Introduction to Forensic Genetics (2nd ed.). Wiley.
3. Primrose, S. B., & Twyman, R. M. (2013). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell.
4. Inman, K., & Rudin, N. (2001). Principles and Practice of Criminalistics: The Profession of Forensic Science (1st ed.). CRC Press.
5. Jobling, M. A., & Gill, P. (2004). Encoded Evidence: DNA in Forensic Analysis. Nature Reviews Genetics.
6. Brown, T. A. (2020). Genomes 5 (5th ed.). Garland Science.
7. Hageman, R. H., & Bhatt, D. P. (2016). Forensic Science: Applications in Agriculture and Biotechnology (1st ed.). Springer.
8. Weir, B. S. (1996). Genetic Data Analysis II: Methods for Discrete Population Genetic Data (2nd ed.). Sinauer Associates.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Drug Design & Discovery (BBTO 104)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: The course explores drug discovery pipelines, target validation, lead optimization, computational design, and preclinical/clinical development, emphasizing regulatory, ethical, and technological aspects for biopharmaceutical innovation.

Course Outcomes (COs):

CO1: Understand drug discovery history, pipelines, pharmacokinetics, and pharmacodynamics.

CO2: Explain target identification, validation, genomics, and biomarker roles.

CO3: Analyze lead discovery, structure-activity relationships, and optimization strategies.

CO4: Apply computational methods, including SBDD, molecular docking, and AI in drug design.

CO5: Evaluate preclinical/clinical development, regulations, patents, and ethical issues.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	1	2	2	1	-	-	1	3	3	2
CO3	3	3	3	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	2	1	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Drug Discovery: Historical development and evolution of drug discovery. Drug discovery pipeline: Phases, timelines, and success rates. Introduction to pharmacokinetics (ADME) and pharmacodynamics. Dose-effect relationships and adverse drug reactions (ADR). Role of patents and intellectual property in drug development.

UNIT-II

Target Identification and Validation: Molecular targets: Receptors, enzymes, ion channels, nucleic acids. Genomics, proteomics, and metabolomics in target discovery. Validation strategies: Genetic,

biochemical, and pharmacological. Biomarkers: Discovery, validation, and clinical applications. Case studies in target-based drug discovery.

UNIT-III

Lead Discovery and Optimization: High-throughput screening (HTS) and combinatorial chemistry. Structure-activity relationship (SAR) studies. Hit-to-lead optimization and analog development. Prodrug design and strategies for improving drug efficacy. Fragment-based drug discovery.

UNIT-IV

Computational Approaches in Drug Design: Structure-based drug design (SBDD) and ligand-based drug design (LBDD). Molecular docking, pharmacophore modeling, and QSAR. Virtual screening and AI/machine learning in drug design. Role of bioinformatics and computational tools. Case studies in computer-aided drug discovery.

UNIT-V

Preclinical/Clinical Development and Regulations: Preclinical studies: In vitro/in vivo models and toxicity testing. Clinical trial phases, design, and ethical considerations. Regulatory guidelines: FDA, EMA, CDSCO. Intellectual property, patents, and commercialization. Challenges, future trends, and case studies.

Text/ Reference Books:

1. Patrick, G. L. (2021). An Introduction to Medicinal Chemistry (7th ed.). Oxford University Press.
2. Silverman, R. B., & Holladay, M. W. (2014). The Organic Chemistry of Drug Design and Drug Action (3rd ed.). Academic Press.
3. Wermuth, C. G., Aldous, D., Raboisson, P., & Rognan, D. (2015). The Practice of Medicinal Chemistry (4th ed.). Academic Press.
4. Nogrady, T., & Weaver, D. F. (2005). Medicinal Chemistry: A Molecular and Biochemical Approach (3rd ed.). Oxford University Press.
5. Vogel, H. G., Maas, J., & Gebauer, A. (2013). Drug Discovery and Evaluation: Pharmacological Assays (4th ed.). Springer.
6. Kubinyi, H. (2006). Chemogenomics in Drug Discovery: A Medicinal Chemistry Perspective (1st ed.). Wiley-VCH.
7. Anderson, A. C., & Wright, D. L. (2019). Computational Drug Design (1st ed.). Wiley.
8. Rankovic, Z., & Morphy, R. (2010). Lead Generation Approaches in Drug Discovery (1st ed.). Wiley.

RAMA UNIVERSITY UTTAR PRADESH, KANPUR

Name of Program	Bachelor of Technology (Biotechnology)				
Course Name	Biomaterials (BBTO 105)	L	T	P	C
Owning Faculty/Department	Faculty of Engineering & Tech. / Biotechnology	3	0	0	3
Pre-requisites/Exposure	-				

Course Description: This course covers biomaterial properties, types (metallic, ceramic, polymeric, composite), and applications in drug delivery and tissue engineering.

Course Outcomes (COs):

CO1: Understand biomaterials definition, classification, and biomedical applications.

CO2: Explain physical, chemical, mechanical, biological properties, and interactions.

CO3: Analyze metallic and ceramic biomaterials, advantages, and uses.

CO4: Evaluate polymeric and composite biomaterials, natural/synthetic, and biodegradation.

CO5: Assess applications in drug delivery, scaffolds, biosensors, ethics, and trends.

CO-PO-PSO Mapping Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	2	1	1	-	1	2	3	2
CO2	3	3	2	2	2	1	1	-	-	1	2	3	2
CO3	3	3	2	2	3	1	1	-	1	1	3	3	2
CO4	3	3	3	2	3	1	1	-	1	1	3	3	3
CO5	3	3	3	2	3	3	1	3	1	2	3	3	3

Legend: 3: High correlation, 2: Moderate correlation, 1: Low correlation, -: No correlation

Syllabus:

UNIT-I

Introduction to Biomaterials: Definition, classification, and types of biomaterials (natural and synthetic). Historical development and applications in biotechnology, medicine, and industry. Basic requirements of biomaterials for biomedical applications (biocompatibility, non-toxicity, mechanical strength).

UNIT-II

Properties of Biomaterials: Physical, chemical, mechanical, and biological properties of biomaterials. Degradation and corrosion of biomaterials. Surface properties and modification techniques. Interaction of biomaterials with biological systems.

UNIT-III

Metallic and Ceramic Biomaterials: Commonly used metals (stainless steel, titanium alloys, cobalt–chromium alloys). Advantages, limitations, and applications in implants and prosthetics. Ceramic biomaterials: alumina, zirconia, bioglass, hydroxyapatite. Applications in bone repair, dental implants, and tissue scaffolds.

UNIT-IV

Polymeric and Composite Biomaterials: Natural polymers (collagen, chitosan, alginate, silk fibroin). Synthetic polymers (PLA, PGA, PCL, PEG, PMMA) and their biomedical uses. Biodegradable vs. non-biodegradable polymers. Composite biomaterials and their role in tissue engineering.

UNIT-V

Applications and Future Trends: Biomaterials in drug delivery systems. Scaffolds for tissue engineering and regenerative medicine. Biosensors and diagnostic devices. Recent advances: smart biomaterials, nanostructured biomaterials, 3D bioprinting. Ethical, safety, and regulatory aspects of biomaterials.

Text/ Reference Books:

1. Ratner, B. D., Hoffman, A. S., Schoen, F. J., & Lemons, J. E. (2012). Biomaterials Science: An Introduction to Materials in Medicine (3rd ed.). Academic Press.
2. Park, J., & Lakes, R. S. (2007). Biomaterials: An Introduction (3rd ed.). Springer.
3. Hench, L. L., & Jones, J. R. (2015). Biomaterials, Artificial Organs and Tissue Engineering (2nd ed.). Woodhead Publishing.
4. Hollinger, J. O. (2011). An Introduction to Biomaterials (2nd ed.). CRC Press.
5. Temenoff, J. S., & Mikos, A. G. (2008). Biomaterials: The Intersection of Biology and Materials Science (1st ed.). Pearson.
6. Wnek, G. E., & Bowlin, G. L. (2008). Encyclopedia of Biomaterials and Biomedical Engineering (2nd ed.). CRC Press.
7. Williams, D. F. (2014). Essential Biomaterials Science (1st ed.). Cambridge University Press.
8. Lanza, R., Langer, R., & Vacanti, J. (2020). Principles of Tissue Engineering (5th ed.). Academic Press.

Annexure -1

Result Analysis

Bachelor of Technology (Biotechnology) First Semester **(I -Year)** Batch **(2024-25)**

S. No.	Paper Code	Name of Paper	No. of Students			Pass (%)
			Appeared	Pass	Fail	
1.	BTE-101	Cell Biology & Signalling	21	21	0	100
2.	BTE-102	Exploring the Biotechnology	21	21	0	100
3.	BSC-104	Applied Chemistry	21	21	0	100
4.	BSC-105	Fundamental Mathematics	21	14	07	67
5.	HSC-101	Communication Skills-I	21	21	0	100
6.	ESC-103	Computational Thinking and Programming	21	21	0	100
7.	BSC-154	Applied Chemistry Laboratory -I	21	21	0	100
8.	BTE-153	Cell Biology Laboratory	21	21	0	100
9.	HSC-151	Communication Skills-I Laboratory	21	21	0	100
10.	ESC-153	Computer Programming Laboratory	21	21	0	100

Main Result:

1.	No. of Students Appeared	21
2.	No. of Students Passed	14
General / Overall Pass %		**67**

Bachelor of Technology (Biotechnology) Third Semester **(II - Year)** Batch **(2024-25)**

S. No.	Paper Code	Subject Name	Appeared	Passed	Failed	Pass %
1.	BTE-301	Genetics	12	12	00	100
2.	BTE-302	Modern Techniques and Instrumentation	12	11	01	92
3.	BTE-303	Biostatistics	12	10	02	83
4.	BTE-304	Microbiology & Virology	12	11	01	92
5.	ESC-307	Fluid Mechanics & Mechanical Operations	12	11	01	92
6.	ESC-355	Fluid Mechanics & Mechanical Operations Laboratory	12	12	00	100
7.	HSC-301	Verbal Ability – I	12	12	00	100
8.	BTE-351	Genetics Laboratory	12	12	00	100
9.	BTE-352	Modern Techniques and Instrumentation Laboratory	12	12	00	100
10.	BTE-353	Microbiology & Virology Laboratory	12	12	00	100

Main Result:

1.	No. of Students Appeared	12
2.	No. of Students Passed	10
General / Overall Pass %		**83.00**

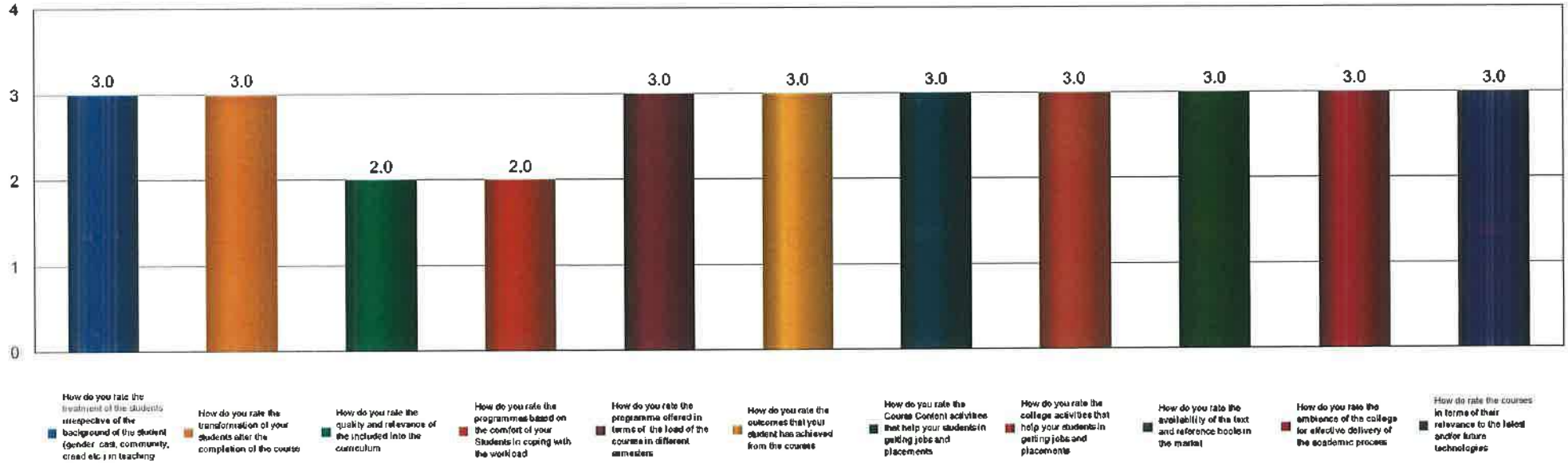
Bachelor of Technology (Biotechnology) Fifth Semester **(III - Year)** Batch **(2024-25)**

S. No.	Paper Code	Name of Paper	No. of Students			Pass (%)
			Appeared	Pass	Fail	
1.	EBT-504	Animal Biotechnology	17	17	0	100
2.	PBT-501	Bioinformatics-II	17	16	01	94
3.	PBT-502	Fermentation Technology	17	17	0	100
4.	PBT-512	Food Biotechnology	17	16	01	94
5.	ESC-501	Scientific Reading and Writing	17	17	0	100
6.	HSC-501	Reasoning Ability-I	17	14	03	83
7.	HU-003	Organizational Behaviour	17	17	0	100
8.	PBT-551	Fermentation Technology Laboratory	17	17	0	100
9.	PBT-552	Immunology Laboratory	17	17	0	100
10.	PBT-553	Molecular Biology Laboratory	17	17	0	100
11.	PBT-554	Bioinformatics Laboratory-II	17	17	0	100

Main Result:

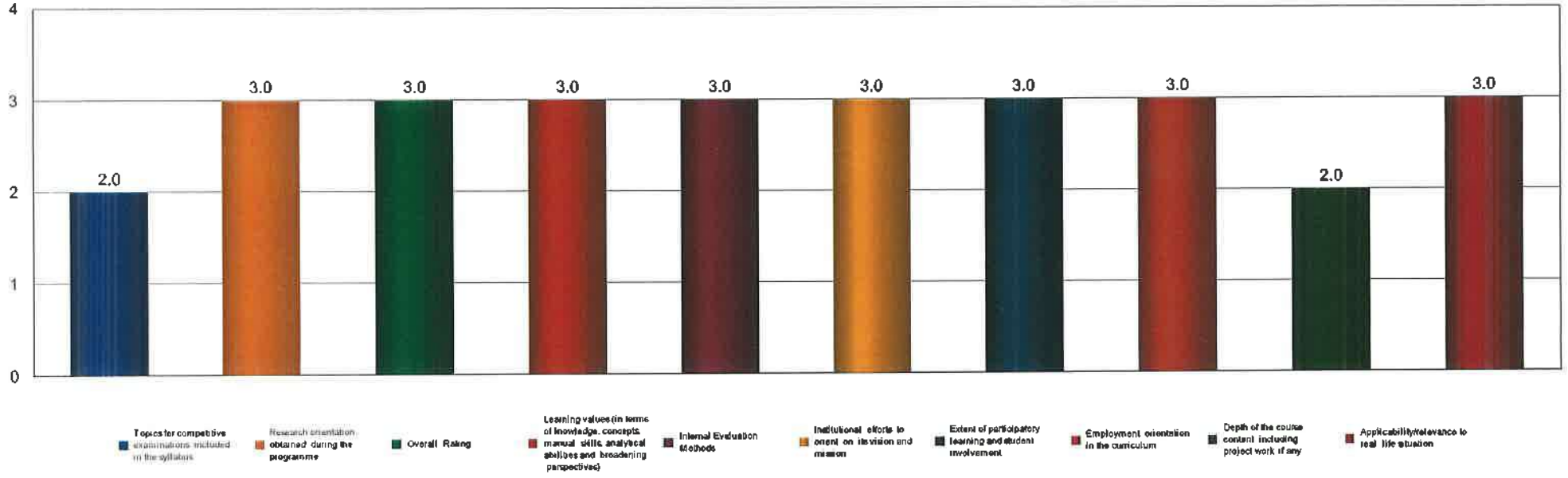
1.	No. of Students Appeared	17
2.	No. of Students Passed	10
General / Overall Pass %		**59**

Curriculum Program Feedback Analysis [Faculty], Session : 2024-2025



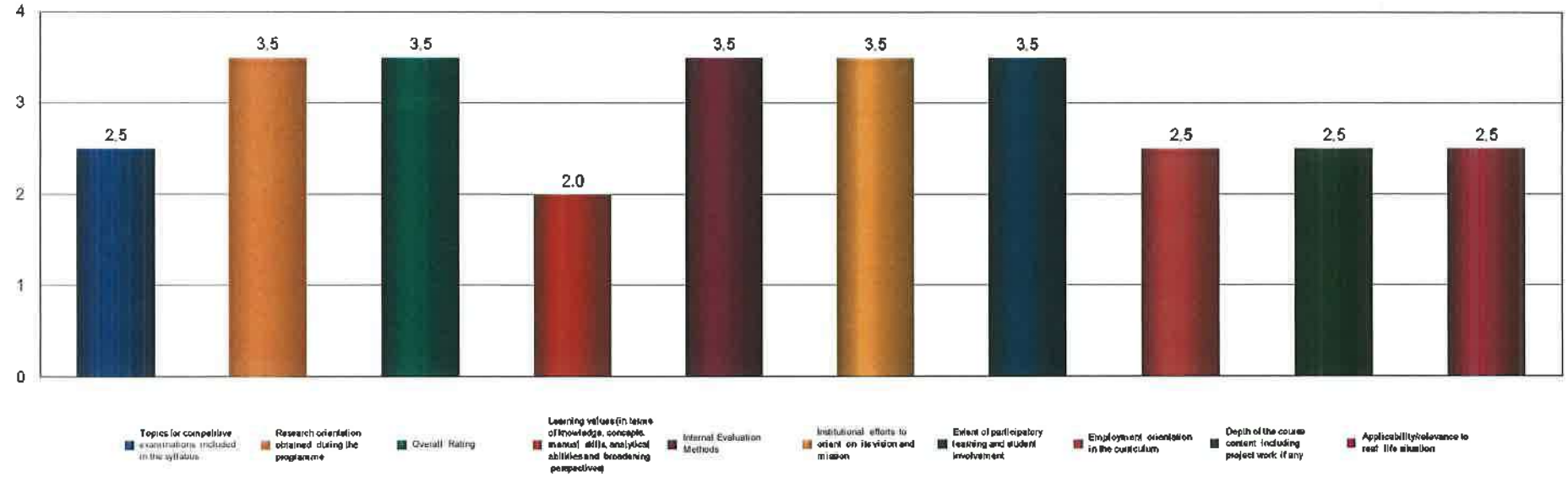
Department	Program	How do you rate the treatment of the students irrespective of the background of the student (gender, cast, community, creed etc.) in teaching and	How do you rate the transformation of your students after the completion of the course	How do you rate the quality and relevance of the included into the curriculum	How do you rate the programmes based on the comfort of your Students in coping with the workload	How do you rate the programme offered in terms of the load of the courses in different semesters	How do you rate the outcomes that your student has achieved from the courses	How do you rate the Course Content activities that help your students in getting jobs and placements	How do you rate the college activities that help your students in getting jobs and placements	How do you rate the availability of the text and reference books in the market	How do you rate the ambience of the college for effective delivery of the academic process	How do rate the courses in terms of their relevance to the latest and/or future technologies
DEPARTMENT OF BIOTECHNOLO	B.TECH	3.0	3.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

Curriculum Program Feedback Analysis [Student], Session : 2024-2025



Department	Program	Topics for competitive examinations included in the syllabus	Research orientation obtained during the programme	Overall Rating	Learning values (in terms of knowledge, concepts, manual skills, analytical abilities and broadening perspectives)	Internal Evaluation Methods	Institutional efforts to orient on its vision and mission	Extent of participatory learning and student involvement	Employment orientation in the curriculum	Depth of the course content including project work if any	Applicability/relevance to real life situation
DEPARTMENT OF BIOTECHNOLO	B.TECH	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0

Curriculum Program Feedback Analysis [Student], Session : 2024-2025



Department	Program	Topics for competitive examinations included in the syllabus	Research orientation obtained during the programme	Overall Rating	Learning values (in terms of knowledge, concepts, manual skills, analytical abilities and broadening perspectives)	Internal Evaluation Methods	Institutional efforts to orient on its vision and mission	Extent of participatory learning and student involvement	Employment orientation in the curriculum	Depth of the course content including project work if any	Applicability/relevance to real life situation
DEPARTMENT OF BIOTECHNOLOGY	B.SC(HONS.)	3.0	4.0	4.0	1.0	4.0	4.0	4.0	2.0	3.0	2.0
	B.TECH	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	3.0