Ref: RU/FET/B.Sc./BOS/2024 **Dated: 27.06.2024**

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

The Board of Studies meeting of B. Sc. Biotechnology syllabus for coming session 2024-25 as per NEP regulation and B. Sc. Biotechnology (H) 2nd and 3rd year were held in the Dean's Office on 27.06.2024. The following members were present:

1. Prof. (Dr.) C.S Raghuvanshi - Chairperson
2. Prof. (Dr.) Ajay Kumar - Convenor
3. Dr. Vivek Srivastava - Member
4. Dr. Samakshi Verma - Member

The following members agreed to review the minutes.

1. Dr. Lalit Kumar Singh - External Member

Agenda:

1. Action Taken Report (ATR) on the basis of feedback from Stack holder/External member.

The BOS committee confirmed the minutes of the BOS meeting held on 03/06/2023

2(a) To consider and approve new evaluation scheme of B.Sc. Biotechnology syllabus as per NEP regulation

S. No.	Item No.	Feedback from Faculty/Subject experts	Recommendation /Action Taken
1	To consider and approve the amendments in evaluation scheme, syllabus and ordinance in the existing CBCS Scheme B.Sc. (Hons.) according to the New Education policy (NEP-2020) to implement B.Sc. (Hons.) Biotechnology with	The existing curriculum of B.Sc Biotechnology is based on the CBCS system. The implementation of NEP 2020, offers an interdisciplinary approach and versatile curriculum. NEP 2020 emphasizes more on the value-added courses, ability enhancement courses, practical skills, internships	The applicability of courses in thoroughly discussed and approved by the BOS members. The detailed 4 years B.Sc (Hons.)/ Research syllabus and evaluation scheme are attached herewith. B.Sc contains Disciplinary Specific Core Courses (DSCCs), Disciplinary Specific Elective Courses (DSEs), Generic Elective Courses (GECs), Skill Enhancement Courses (SECs),

	Research for the students to be admitted in the new Academic Session 2024-2025.	and industrial projects, safeguarding a holistic education to for the fulfillment of the current industrial requirements and the government organization.	Ability Enhancement Compulsory Courses (AECCs) Value Addition Courses (VACs) and Dissertations (DST). The major recommendations featuring the syllabus of B.Sc. Biotechnology as per NEP regulation are as follows: • Facilitates the student to earn and own academic bank of credits (ABC) each year, providing flexibility in pursuing the particular curriculum from any institution in India. • Allows multiple exit options after the completion of each subsequent years: ➢ After the completion of 1st year (two semesters) with 42 credits will be awarded a *"Certificate of Cell Biology & Techniques in Biotechnology"* ***Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.*** ➢ After the completion of 2nd year (four semesters) with 89 credits will be awarded a *"Diploma in Biotechnology"* ***Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided***

			they secure additional 4 credit in skill based vocational courses offered during first year or second year summer term ➢ After the completion of 3rd year (six semesters) with 135 credits will be awarded the *"Bachelor's Degree of Science in Biotechnology"* ➢ After the completion of 4th year (eight semesters) with 180 credits will be awarded a *"Bachelor's of Science degree with Honours"* • The **B.Sc (Hons.) curriculum** consists of discipline specific elective subjects of 12 credits and the **B.Sc degree (Honour's) and Research** consists a mandatory **Project Work/ Research Work of 12 credits.**

2(b) To consider and approve existing evaluation scheme and syllabus for B.Sc. (Hons.) Biotechnology

S. No.	Item No.	Feedback from Faculty/Subject experts	Recommendation /Action Taken
1.	To consider and approve the existing Evaluation Scheme and Syllabus for B.Sc. (Hons.) Biotechnology students admitted in the Academic Session 2022-2023 and 2023-2024.	The existing Evaluation Scheme and Syllabus continued for the B.Sc IInd year and B.Sc IIIrd year students according to the UGC-CBCS scheme in the upcoming semesters.	The committee considered and approved the existing Evaluation Scheme and Syllabus based on the UGC-CBCS scheme and recommended for the B.Sc IInd year and B.Sc IIIrd year students admitted in the Academic Session 2022-2023 and 2023-2024.

3. Result Analysis: All of B.Sc. (Hons.) Ist Semester students have 78.94 % cleared pass their final exam with good. All B.Sc (Hons.) IIIrd Semester students have 77.77 % cleared pass their final exam with good. All B. Sc. (Hons.) Vth Semester students have 100 % cleared pass their final exam with honors. All students of B. Sc (Hons.) Ist, IIIrd and Vth Semester has to promote in next semester of the session 2023-24. **(Annexure -1).**

4. Feedback Analysis: Feedback from B.Sc. (Hons.) Ist, IIIrd and Vth Semester students of session 2023-24 were good for academic.

5. Short term course: In upcoming session 2024-25, we have proposed short term course on **"Applied Microbiology and Molecular Biology".**

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

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

Chairperson
Signature: .....
Name: Dr. C. S Raghuvanshi

Convenor
Signature: .....
Name: Dr. Ajay Kumar

Internal Members
Signature: 1. .....
Name: Dr. Vivek Srivastava

Signature: 2.....
Name: Dr. Samakshi Verma

External Members
Signature: 1.....
Name: Dr. Lalit Kumar Singh
Date:

Encl.: Recommended Curricula attached for consideration and approval.

CC:

1. Dean
2. Registrar Office

Annexure -1

Bachelor of Science (Biotechnology) First Semester (**I Year**) Batch (**2023-24**)

S. No.	Paper Code	Name of Paper	No. of Students			Pass (%)
			Appeared	Pass	Fail	
1.	BSBT-101	Cell Biology	19	17	2	89.47
2.	BSBT-102	Biochemistry	19	17	2	89.47
3.	BSBT-103	Chemistry-I	19	17	2	89.47
4.	BSGE-111	Biotechnology and Human Welfare	19	18	1	94.73
5.	BSTA-121	Communication Skill	19	18	1	100
6.	BSBT-151	Cell Biology Laboratory	19	19	0	100
7.	BSBT-152	Biochemistry Laboratory	19	19	0	100
8.	BSBT-153	Chemistry-I Laboratory	19	19	0	100

Main Result:

1.	No. of Students Appeared	19
2.	No. of Students Passed	15
General / Overall Pass %		**78.94**

Bachelor of Science (Biotechnology) Third Semester (**II Year**) Batch (**2023-24**)

S. No.	Paper Code	Name of Paper	No. of Students			Pass (%)
			Appeared	Pass	Fail	
1.	BHBT-301	Genetics	9	7	2	77.77
2.	BHBT-302	General Microbiology	9	7	2	77.77
3.	BHBT-303	Bioinformatics	9	8	1	88.88
4.	BBTS-001	Molecular Diagnostics	9	7	2	77.77
5.	BBTG-003	Bioethics & Biosafety	9	8	1	88.88
6.	MOOC-007	Introduction to Cell Biology/MOOC'S	1	1	0	100
7.	MOOC-022	Wildlide Ecology/MOOC'S	2	2	0	100
8.	MOOC-026	Animal Physiology/MOOC'S	2	2	0	100
9.	MOOC-027	Genetic Engineering: Theory & Application/MOOC'S	3	3	0	100
10.	BHBT-351	Bioinformatics Lab	9	9	0	100
11.	BHBT-352	Microbiology Lab	9	9	0	100
12.	BBTS-051	Molecular Diagnostics Lab	9	9	0	100

Main Result:

1.	No. of Students Appeared	9
2.	No. of Students Passed	7
General / Overall Pass %		77.77

Bachelor of Science (Biotechnology) Fifth Semester (**III Year**) Batch (**2023-24**)

S. No.	Paper Code	Name of Paper	No. of Students			Pass (%)
			Appeared	Pass	Fail	
1.	CBBS-501	Bioprocess Technology	3	3	0	100
2.	CBBS-502	Recombination DNA Technology	3	3	0	100
3.	CBBS-503	Food Biotechnology	3	3	0	100
4.	CBDE-502	Animal Biotechnology	3	3	0	100
5.	CBDE-508	Biostatistics	3	3	0	100
6.	CBBS-551	Food Biotechnology Lab	3	3	0	100
7.	CBBS-552	Seminar	3	3	0	100
8.	CBDE-552	Animal Biotechnology Lab	3	3	0	100

Main Result:

1.	No. of Students Appeared	3
2.	No. of Students Passed	3
General / Overall Pass %		**100**

RAMA UNIVERSITY, KANPUR

RAMA UNIVERSITY

ORDINANCE
(As per National Education Policy-2020)
FOR
THE UNDERGRADUATE PROGRAMMES
(Effective from Session 2024-2025)

ORDINANCE

(AS PER NEP-2020)

FOR

THE UNDERGRADUATE PROGRAMMES IN THE FACULTY OF ENGINEERING & TECHNOLOGY, 2024

In view of the National Educational Policy-2020 of the Government of India and the University Grants Commission's Guidelines for the Learning Outcomes-based Curriculum Framework (LOCF) under the Choice Based Credit System (CBCS), the Rama University has prepared this Ordinance for undergraduate academic programmes for the Faculties of Faculty of Engineering & Rama University.

1. **Short Title, Commencement and Scope:**
   The Ordinance shall be called as the Rama University Ordinance for the following Undergraduate Programmes in the Biotechnology. This Ordinance shall come into force from the Academic Session 2024-2025
2. **Scope and Coverage:**
   The students admitted until the session 2024-2025 and pursuing UG programs shall be governed with their existing ordinances. The undergraduate academic programme governed by this Ordinance shall be of four (3+1) years duration with multiple Entry-Exit options during the program with appropriate certifications namely,

(a) A **Certificate** in a Discipline upon successful completion of the **First Year** (Two Semesters);
(b) A **Diploma** in a Discipline upon successful completion of the **Second Year** (Four Semesters);
(c) A **Bachelor's Degree** in a Discipline at thesuccessful completion of the **Third Year** (Six Semesters);
(d) **Bachelor's Degree with Honours / Bachelor's Degree Honours with Research** in a Discipline at the successful completion ofthe **Four Year** (Eight Semesters).

This Ordinance shall be applicable to the students taking admission to the undergraduate programmes from the Academic Session 2024-2025 and onwards.

Those students who were admitted to the undergraduate /postgraduate programmes before the adoption of the instant Ordinance shall continue to be governed by the existing Ordinance.

The curriculum for the 4-year undergraduate programme shall be based on the LOCF-CBCS system of the UGC with value addition courses as envisaged in the NEP-2020.

3. **Definitions of Key Words:**

National Education Policy 2020 (NEP 2020): The NEP-2020 envisages a holistic and multidisciplinary education that aims to produce employable graduates with integrated

personality. The policy envisions the undergraduate degree to be of either 3- or 4-years duration, with multiple entry and exit options within this period and with appropriate certifications e.g. a certificate after 1 year of study or a diploma after 2 years of study or a Bachelor's degree after 3 years of study. The 4-year programme will lead to either aBachelor's degree with Honours in a discipline or a Bachelor's degree with Research, provided the student completes a rigorous research project in a major area of study as specified by the University.

Academic Bank for College and University Students Uttar Pradesh - (ABACUS-UP): Academic Bank for College and University Students of Uttar Pradesh (ABACUS-UP) is a student-centric academic service portal established and managed by Higher Education Department of Government of Uttar Pradesh. It paves the way for seamless student mobility amongst and within degree-granting Higher Education Institutions (HEIs) of U.P., through a formal system of credit recognition, credit accumulation, credit transfer and credit redemption, with the view to promote distributed and flexible teaching-learning.
Students can become its account holders and avail the options of multiple exits, entry and credit transfer, thereby facilitating their mobility across state's HEIs. ABACUS-UP is platform which also provides all the information about Infrastructure, Labs, Equipment's, Sports etc. as well as the teaching faculty of any HEI to the stakeholders so that students can explore and exercise informed choices before admission. ABACUS-UP provides login credentials to all the students, teachers and officials of HEIs for transparent and smooth information sharing. This facilitates information exchange and resource-sharing among various HEIs. The platform will be linked to Digilocker to enable the students to download their certificate, diploma and degree when required,

Multiple Entry and Exit Points: These are stages where the students may have options for entry and exit in the academic programmes in Higher Education Institutions to be facilitated through the facility created by the Academic Bank Credit scheme in the manner as provided in the UGC "Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions".

Learning Outcomes-based Curriculum Framework (LOCF): It is a framework initiated by the UGC in 2018 for updating CBCS curriculum so as to reflect the expected learning outcomes and academic standards that are expected to be attained by graduates of a programme of study and holder of a qualification.

Choice Based Credit System (CBCS): It is the system formulated by the UGC in 2015. The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses). Under the CBCS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of minimum number of credits to be completed by the students.

Academic Year: Two consecutive (one odd + one even) semesters constitute one academic year.

Semester: Each semester will consist of 15-16 weeks of academic work equivalent to 90 actual

teaching days. In a bi-semester system, an academic year consists of two semesters. The odd semesters may be scheduled from June/July to November/ December, and even semester from November/ December to April/May.

Programme: A programme, hereinafter, shall mean an academic programme leading to award of a degree, diploma or certificate. It comprises of a fixed set of core (compulsory) Courses and some choice based (optional) Courses with a minimum Credit requirement.

Course: A course, usually referred to as 'paper', is a component of a Programme, comprising one or a combination of some academic forms of instructions such as lectures, tutorials, laboratory work, field work, outreach activities, project work, vocational training, viva, seminars, term papers, assignments, presentations, self-study etc. or a combination of some of these. All courses should define learning objectives and students learning outcomes. Each course is to be identified by a unique course code and course title.

Credit: Credit defines the quantum of work-load for a course. Generally, one hour of theory or one hour of tutorial or two hours of laboratory work, per week for a duration of a semester result in the award of one credit. Credits for internship shall be one credit per one week of internship, subject to a maximum of six credits.

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

Letter Grade: It is an index of the performance of students in a course. Grades are denote by letters O, A, B, C, D, E, F and Ab.

Credit Point: It is the product of grade point and number of credits for a course.

Semester Grade Point Average (SGPA): It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registeredin a semester to the total course credits taken during that semester. It shall be expressed up to two decimal places.

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 to the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

Transcript or Grade Report or Certificate: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

4. Courses of Undergraduate Programmes:

The undergraduate programmes governed by this Ordinance contain the following course components:

Major Core Course: This is a course which is to be compulsorily studied by a student as a

core requirement to complete the requirement of a programme in a said discipline/subject of study. Each of the Core Courses shall contain two components: Theory and Practical. Theory Paper having Practical shall carry 4 Credits so that Practicalcarries 1 Credits. Theory Paper having Tutorial shall carry 5 Credits so that Tutorial carries 1Credit.

Minor Elective Course: Generally, an elective course is a course which can be chosen froma pool of courses which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill.

An elective course may be three types:

(a) **Discipline Specific Elective (DSE) Course**: Elective courses offered by the main discipline/subject of study are referred to as Discipline Specific Elective Courses. This course is to advance knowledge and skill in the core domain. Each of the DSE courses shall contain two components: Theory and Practical/Tutorial. Theory Paper having Practical shall carry 4 Credits so that Practical carries 1 Credits. Theory Paperhaving Tutorial shall carry 5 Credits so that Tutorial carries 1 Credit.

(b) **Generic Elective Course (GEC):** An elective course chosen generally from anunrelated discipline/subject, with an intention to seek a wide exposure is called a Generic Elective.

(c) **Dissertation/Project/Internship:** An elective course designed to acquire special/advanced knowledge is termed as dissertation/project. This is considered asa special course involving application of knowledge in solving/ analyzing/ exploring a real life situation/ difficult problem. Dissertation/Project Work/Internship is optionaland it may be offered in lieu of a discipline specific elective paper in 8th Semester.

(d) A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

Each of the GEC Courses shall contain two components: Theory and Practical/Tutorial. Theory Paper having Practical shall carry 4 Credits so that Practical carries 1 Credits.Theory Paper having Tutorial shall carry 5 Credits so that Tutorial carries 1 Credit.

Vocational/Skill development Course: These courses offered by the department in different faculties as value added courses to enhancing employability. They will be two types individual nature and progressive nature. There will be a capping on the maximum numberof students in a particular course as specified by the department.

Co-curricular Courses: These are courses that will help develop all capacities of human beings – intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner. It includes subjects like Yoga, Sports, Health Care, NCC, NSS, Ethics, Culture etc. Co-curricular courses may be chosen from a pool of courses. Each Co-curricular courses shall carry 2 Credits. They will be qualifying in nature and their grades will not be added in CGPA.

5. Course Structure:

The course structure for the UG programme shall be as under:

a. Certificate

The Certificate in a discipline is obtainable after 1 year (two semesters) of study. A Bachelor's Certificate in a discipline may be awarded if a student studies Maximum 12 (Theory & Practical) core papers in that discipline, 1 Minor elective paper, 2 Vocational/Skill Development Courses (SDC) and 2 Co-curricular courses with the completion of courses equal to a minimum of 42 Credits.

Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.

b. Diploma

The Diploma in a discipline is obtainable after 2 years (four semesters) of study. A Bachelor's Diploma in a discipline may be awarded if a student studies Maximum 24 (Theory & Practical) core papers in that discipline, 2 Minor elective paper, 4 Vocational/Skill Development Courses (SDC) and 4 Co-curricular courses with the completion of courses equal to a minimum of 89 Credits.

Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 4 credit in skill based vocational courses offered during first year or second year summer term

c. Bachelor's Degree/ Bachelor's Degree with Honours

The Bachelor's Degree in a discipline is obtainable after 3 years (six semesters) of study. A Bachelor's degree (i.e., B.Sc.) / Bachelor's degree with Honours in a discipline degree may be awarded if a student studies Maximum 44 (Theory & Practical) core papers in that discipline, 2 Minor elective paper, 4 Vocational/Skill Development Courses (SDC) and 6 Co-curricular courses and 2 industrial Training survey/Research Project with the completion of courses equal to a minimum of 135 Credits.

d. Bachelor's Degree with Research

The Bachelor's Degree with Research in a discipline is obtainable after 4 years (eight semesters) of study. A Bachelor's degree with Research (i.e. B.Sc. (Research in a discipline may be awarded if a student studies Maximum 54 (Theory & Practical) core papers in that discipline, 3 Minor elective papers, 4 Vocational/Skill Development Courses (SDC) and 6 Co-curricular courses and 4 industrial Training survey/Research

Project with the completion of courses equal to a minimum of 180 Credits.

6. SWAYAM Courses:

SWAYAM Courses: The University may allow up to 40% of the total courses being offered in a particular program in a Semester through the online learning courses offered through SWAYAM platform subject to the following conditions:

- The course contents are alike;
- The courses are not offered in the University/College;
- There is non-availability of suitable teaching staff to run the course in the University/College.

The University shall give the equivalent credit weightage to the student for the credits earned vide online learning credit courses through SWAYAM platform, in the credit plan of the programme.

7. Mechanism for Computation of Work-load:

The following mechanism shall be adopted for computation of work-load:

(a) 1Credit =1Theory period of one-hour duration/week/semester;
(b) 1Credit =1Tutorial period of one-hour duration/week/semester;
(c) 1Credit =1Practical period of two hours' duration/week/semester;
(d) 1Credit = Internship of 1 week/semester.

8. Course Curriculum and Syllabus:

The course curriculum and syllabus of every undergraduate programme shall be developed by the concerned Board of Studies of the University and shall be implemented after obtaining approval from the Academic Council.

The University may offer a number of choices for the papers under Generic Elective Courses (GEC), Discipline Specific Elective (DSE) courses, Skill Enhancement Courses (SEC) and Value Addition Courses (VAC), as per the availability of the courses and faculty.

The University may evolve a system/policy about Extra Curricular Activities/ General Interest and Hobby Courses/Sports/NCC/NSS/Vocational courses/related courses, for adding them under Value Addition Courses (VAC).

Dissertation/Project Work/Internship is optional and it may be offered in lieu of a discipline specific elective paper in 8th Semester.

Every course/paper offered in the University shall have a unique Course Code consisting of 06 (five) alphanumeric characters in the form of *"XYZpqr"* where triple

Sem.	DSCCs	DSECs	GECs	AECCs	SECs	VACs	Cr
I	CC-01 (4 + 1) CC-02 (4)	DSEC-1(4)		AECC-1 (2+ 1)	SEC-1 (3)	VAC-1 (2)	21
II	CC-03 (4+ 1) CC 04 (4+ 1) CC-05 (4)			AECC-2 (2)	SEC-2 (3)	VAC-2 (2)	21

Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.						VAC- 3* (2)	2
						VAC- 4* (2)	2
Students on exit shall be awarded Certificate in ***"Cell Biology Techniques in Biotechnology"*** **after securing the requisite 42 credits in Semester I & II**							
III	CC-06 (4 + 1) CC-07 (4 + 1)	DSEC-2 (4)		AECC-3 (2)	SEC-3 (4+1)	VAC-3 (2)	23
IV	CC-08 (4 + 1) CC-09 (4 + 1) CC-10 (4 + 1)	DSEC- 3 (4)			SEC-4 (3)	VAC-4 (2)	24
Students on exit shall be awarded *"Diploma in Biotechnology"* after securing the requisite 89 credits on completion of Semester IV							
Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 4 credit in skill based vocational courses offered during first year or second year summer term						VAC- 5* (2)	2
						VAC- 6* (2)	2
V	CC-11 (4) CC-12 (4 + 1) CC-13 (4 + 1) CC-14 (4)			AECC-4 (2)	SEC-4 (3)		23
VI	CC-15 (4) CC-16 (4) CC-17 (4 + 1) CC-18 (4 + 1) CC-19 (4 + 1)						19
Students on exit shall be awarded *"Bachelor Degree of Science in Biotechnology"* after securing the requisite 135 credits on completion of Semester VI							
VII	CC-20 (4) CC-21 (4) CC- 22 (4+1)				SEC-4 (4)	Dissertation/ Major Project DST-1 (6)	23
VIII	CC-23 (4) CC-24 (4) CC-25 (4) CC-26 (4)					Dissertation/ Major Project DST-2 (6)	22
Students on exit shall be awarded *"Bachelor of Biotechnology (Honours with Research)"* after securing the requisite 180 credits on completion of Semester VIII							
VII	CC-17 (4) CC-18 (4)	DSEC-6 (4+1) DSEC-7 (4) DSEC-11(4)			SEC-5 (2)		23
VIII	CC-19 (4+ 1)	DSEC-8(4) DSEC-9(4) DSEC-10(4) DSEC-12 (4 + 1))					22
Students on exit shall be awarded *"Bachelor of Biotechnology with Honours"* after securing the requisite 180 credits on completion of Semester VIII.							

alphabet characters *"XYZ"* shall identify the discipline/subject to which the Course/paper belongs, *p* isa numeric character specifying the qualification level and *"qr"* are numeric characters specifying the serial number of the Course/paper under that level.

The curriculum of every undergraduate programme shall be in conformity with the University Grants Commission's Guidelines for the Learning Outcomes- based Curriculum Framework

(LOCF) under the Choice Based Credit System (CBCS).

Every undergraduate programme shall conform with the common minimum curriculum and syllabi of the core papers as fixed by the UGC/UP Higher Education Council under the CBCS system. The allowed deviation from the syllabi is 30% at the maximum.

9. Multiple Entry and Exit Options:

The entry and exit options for students, who enter the undergraduate programme, shall be as follows:

1st YEAR

Entry 1: The entry requirement for Bachelor's certificate (Level 5) programme is Secondary School Leaving Certificate obtained after the successful completion of Grade 12. A programme of study leading to entry into the first year of the Bachelor's degree is open to those who have met the entrance requirements, including specified levels of attainment at the secondary level of education specified in the programme admission regulations. Admission to the Bachelor's degree programme of study is based on the evaluation of documentary evidence (including the academic record) of the applicant's ability to undertake and complete a Bachelor's degree programme.

Exit 1: Bachelor's certificate will be awarded when a student exits at the end of 1st year (Level 5). A Bachelor's certificate requires completion of courses equal to a minimum of 42 Credits at Level 5.

Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.

2nd YEAR

Entry 2. The entry requirement for Bachelor's diploma (Level 6) is a Bachelor's certificate obtained after completing the first year (two semesters) of the undergraduate programme. A programme of study leading to the second year of the Bachelor's degree is open to those who have met the entrance requirements, including specified levels of attainment, in the programme admission regulations. Admission to a programme of study is based on the evaluation of documentary evidence (including the academic record) of the applicant's ability to undertake and complete a Bachelor's degree programme.

Exit 2: At the end of the 2nd year (Level 6), if a student exits, a Bachelor's diploma shall be awarded. A Bachelor's Diploma requires completion of courses equal to a minimum of 89 Credits from Level 5 to Level 6.

Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 4 credit in skill based vocational courses offered during first year or second year summer term

3rd YEAR

Entry 3. The entry requirement for an undergraduate programme is a diploma obtained after completing two years (four semesters) of the undergraduate programme. A programme of study leading to the Bachelor's degree is open to those who have met the entrance requirements, including specified levels of attainment, in the programme admission regulations. Admission to a programme of study is based on the evaluation of documentary evidence (including the academic record) of the applicant's ability to undertake and complete a Bachelor's degree programme.

Exit 3: On successful completion of three years, the Bachelor's degree shall be awarded. A Bachelor's degree requires completion of courses equal to a minimum of 135 Credits from Level 5 to Level 7.

4th YEAR

Entry 4. An individual seeking admission to a Bachelor's degree (Honours) (Level 8) in a discipline would normally have completed all requirements of the relevant three-year bachelor degree (Level 7) in that discipline. After completing the requirements of a three- year Bachelor's degree, candidates who meet a minimum CGPA of 7.5 shall be allowed to continue studies in the fourth year of the undergraduate programme to pursue and complete the Bachelor's degree with Honours in the discipline.

Exit 4: On the successful completion of the fourth year, a student shall be awarded a Bachelor's degree with Honours in the concerned discipline. A Bachelor's degree with Honours requires completion of courses equal to a minimum of 180 Credits from Level 5 to Level 8.

10. Qualification Levels and Credit Requirements:

Following the UGC's nomenclature, qualification titles such as certificate, diploma and degree for the undergraduate programmes are organized in a series of levels in ascending order as under:

Level 5: Bachelor's certificate; Level 6: Bachelor's diploma; Level 7: Bachelor's degree/ Bachelor's degree with Honours; Level 8: Bachelor's degree with Research; Level 9: Master degree in any discipline

The minimum credit requirements for these qualification types shall be as under:

Levels	Qualification Title	Minimum Credit Requirements
Level-5	Certificate in a discipline	**42**
Level-6	Diploma in a discipline	**89**
Level-7	Bachelor's Degree	**135**
Level-8	Bachelor's Degree with Honoursin a discipline / Bachelor's Degree with Research in a discipline	**180**

11. Marks Distribution and Evaluation:

Total marks for each course shall be based on internal assessment/Continuous Assessment (CA) (25%) and semester end examination (75%). The Continuous Assessment of 25% shall be distributed as under:

(a) CA/Quiz/Assignment/Seminar/Field Work/Project Work/Case Study: 20%;
(b) Attendance: 5%.

12. Bloom Taxonomy and CO-PO:

(a) Exam /Continuous Assessment Test / Assignments questions should be mapped to Bloom's Taxonomy (BT) levels and CO-PO of the course of a program.

BT level	1	Remember
BT level	2	Understand
BT level	3	Apply
BT level	4	Analyze
BT level	5	Evaluate
BT level	6	Create

Each question of assessment activity should have mapping description displayed like mark of question. Example:

Q.1(a) …..Question Text…… [BT-2, CO-1, PO-1] [1]

Questions of assessment activities should broadly match to following structure (mix of BT levels) in individual activity or in complete activity set.
BT Level 1 and 2 questions- 25%
BT Level 3 and 4 questions- 25%
BT Level 4, 5 and 6 questions - 50%
Questions of assessment activities should appropriately cover each CO and PO as per CO-PO mapping.

13. Grading of Performance:

Letter Grade and Grade Point Allocation:

In every course, based on the combined performance in all assessments in a particular semester as per the curriculum/syllabus, the student is awarded a letter grade.
These letter grades not only indicate a qualitative assessment of the learner's performance but also carry a quantitative (numeric) equivalent called the Grade Point. The letter grades and their equivalent grade point applicable for undergraduate programmes are given below:

Grade	Grade Point
O	**10**
A	**9**
B	**8**
C	**7**
D	**6**

E	**5**
F	**0**

A learner who remains **absent** in any form of **evaluation/examination**, **letter grade** allocated to him/her should be **AB** and **corresponding grade point** is **zero**. She/he should reappear for the said evaluation/examination in due course. **Letter Grade** is used to signify the level of qualitative/quantitative academic achievement of a student in a Course, while the Grade Point is used to indicate the numerical weight of the Letter Grade on a 10-point scale. Letter Grades 'O' to 'E' indicate successful completion of a Course, while Letter Grades 'F' and 'Ab' indicate 'fail' and 'Absent' respectively. The 10-point grading system of the UGC, as described above, will be adopted for assessment and examination of the performance of students in various courses of the undergraduate programmes.

14. Award of Grades

14.1 In the qualifying paper Q grade will be given for qualified and NQ grade for not qualified.

14.2 In the above table, each course/paper (all theory and practical) of main and minor subjects is credit course all the pass percentage of all of them will be 33 percentages prevalent till now.

14.3 Six co-curricular courses and small projects in the third year are qualifying and their passing marks will be 40%.

14.4 Four skill development /Vocational courses are also credit courses and their passing marks will also be 40%. G.O 2058/70-3-2021-08(33)-2020 T.C dated 26 august 2021 Provided as skill in sequence/development/employment-oriented course/ paper will be Evaluated out of total score of 100. Out of which Internship/training/practical based work will be evaluated out of 60 marks and
theory based work will be evaluated out of 40 marks. The minimum pass marks in the skill development course/paper will be 40 out of the total score of 100. There will be no separate minimum pass marks for internship/training and theory.

14.5 Maximum Marks in each course (all theory and practical) main/minor/co-curricular/minor research, continuous internal evaluation of 25 marks out of 100 and 75 marks in university (external) examination. The number will be added up.

14.6 In order to pass each course/paper of main and minor subjects (passed in all theory and practical) it will be necessary (a) Score a minimum 25 marks (33 percent of 75) out of maximum of 75 marks in the university examination and (b)Internal and must have secured a minimum of 33 marks in aggregate in the external examination.

14.7 In order to pass each course/paper of co-curricular and minor research subject (passed in all theory and practical) it will be necessary (a) Score a minimum 30 marks (45 percent of 75) out of maximum of 75 marks in the university examination and (b) must have secured a minimum of 40 marks in internal and external examination.

14.8 There is no minimum pass percentage in the internal assessment of any course/ paper.

14.9 If a student gets zero marks in internal assessment and the minimum passing marks of 33 (main and minor subject) or 40 (co-curricular/minor research subject) in external examination, then he will still pass there will be zero marks even for complete absence in the internal assessment.

14.10 No grace marks will be given.

15. Computation of SGPA and CGPA

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

  The SGPA is an indicator of the overall academic performance of a student in all the courses he/she has registered during a given semester. It is computed as follows: If the grades awarded to a student are G_1, G_2 etc in courses with corresponding credits C_1, C_2 etc, the SGPA is given by:

$$SGPA = \frac{C_1 \times G_1 + C_2 \times G_2 + \cdots + C_n \times G_n}{C_1 + C_2 + \cdots + C_n}$$

- The CGPI indicates the overall academic performance of a student in all the courses registered up to and including the latest completed semester/summer term. It is computed in the same manner as the SGPA, considering all the courses (say, n) and is given by:

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

- Percentage conversion of CGPI :

$$\textbf{\textit{Percentage of marks}} = \textbf{\textit{CGPI}} \times \textbf{10-4.5}$$

- Students should get a minimum grade E in each subject with 5 CGPI to clear the semester.
- CGPI conversion

≥8 CGPI	**Ist division with honours**
≥6 CGPI	**Ist division**
≥5 CGPI	**IInd division**
<5 CGPI	**Fail**

If a candidate passes all examinations in first attempt without grace and secures 8CPI or more marks, he/she shall be placed in FIRST DIVISION WITH HONOURS and the candidates at first two top positions amongst First Div. with Honours only will be awarded medals viz. Gold and Silver respectively in order of merit.

Award of Sessional Marks:

Sessional marks for theory subjects, practicals and project shall be awarded as will be prescribed and at present the break-up of sessional marks shall be as follows:

Evaluation Scheme:

- **Course without practical components**

For Continuous Evaluation (CE) is such as: 20 Marks

1. Attendance: 5 Marks
2. Assignments/Quiz / Seminar/Term paper /Project :15Marks

MTE - Mid Term Examination: 20 Marks
a. First Mid Term Examination: 10 marks
b. Second Mid Term Examination: 10 marks

ETE - End Term Examination: 60 Marks

- **Course with practical components only**

For Continuous Evaluation (CE) is such as: 15 Marks
Conduct / Perform/Execution /Practical File/ Viva-Voice

ETE - End Term Examination: 25 Marks

Make-up test may be held only for those students who could not appear in any one of mid-term class tests due to genuine reasons for which the prior permission from the Head of Department was taken. Make up test shall ordinarily be held about two weeks before the semester examination. The syllabus for the make-up test shall be the whole syllabus covered by the subject teacher up to that time.

Award of Major Project-I & II, Industrial Training Marks at Department level:

The marks for B. Sc Hons. With Research shall be awarded on the following basis

Criteria	Internal	External	Total
Project Report	50	100	150
Viva Voce	50	100	150
Total	**100**	**200**	**300**

The marks in Major Project-I & II, Industrial Training and Educational Tour shall be awarded by a committee consisting of following members:

(i) Head of the Department or his/her nominee.

(ii) Concerned Officer – In-charge.

(iii) Senior Faculty Member of the department nominated by the Head of Department

16. Promotion of Students

16.1 A student will always be promoted from the current odd semester to the next even semester, irrespective of the result of the current odd semester.

16.2 Promotion from the current even semester to next odd semester i.e. from current year to next year subject to the following condition: -

16.2.1 The student must have passed at least 50% of the credit papers (theory and practical combined) of the total required credits for the current year (both semesters inclusive) and

16.2.2 The student has passed the Major for the current year (both semesters) Passed at least 50% of the credit papers in the subjects (three main subjects in the first and second year and two main subjects in third

year) of the total credits of all the paper (theory and practical together). The digit after the decimal point will be not counted in computing the 50% credit, as 27.6 and 27.3 will be treated as 27.

17. For promotion from the second year to the third year, it will be necessary to pass all the required (main/Minor/Skill etc.) papers of 46 credits and qualifying (co-curricular) papers of the first year.

18. Back paper or Improvement exam

- There will be no back paper or improvement examination in internal assessment. Internal assessment can be done along with university examination only in case the entire semester is re-appeared as a back paper examination. But a student will not be able to take the entire examination of two completed semesters simultaneously.
- The facility of back paper or improvement will be available to the student for the papers of even(odd) semesters only in the even(odd) semesters.\
- The course/paper and syllabus for the back paper or examination for improvement will be available to the student in the current semester in which he is appearing for the examination.
- A student can give back paper or any course/paper for improvement, any number of times, till the university(external) examination period is not interrupted. But this arrangement will be available only for the papers of 1 year prior to the current year.

19. Time duration:

The maximum period to complete any one year will be three years. Explanation: - If the student studies for all three years in continuity, then he will get maximum nine years. But if the student has got certificate/diploma of any one year if he leaves, he can come back anytime to resume the rest of the year's studies and he will get three years (one year of studies) to complete the further of studies.

20. SGPA/ CGPI Calculation:

Calculation of SGPA and CGPI will be calculated from the following formula CGPI will be converted into percentage marks according to the following formula:

$$\textbf{Equivalent percentage} = CGPI \times 10 - 4.5$$

The students will be given a division as per the following table:

21. Re-admission in the University:

A candidate who has failed and has not been promoted to the higher class will have to repeat the year as a regular student. He will be allowed for re-admission on payment of prescribed fees provided he/she satisfies one of the following conditions.

a. A candidate is declared failed.

b. A candidate did not appear in a semester examination and or he/she was granted permission for not to appear in the examination on his/her own request.

c. A candidate has been detained by the University and has also been permitted to take re-admission.

d. A candidate promoted with carry over subjects and he /she opted for re-admission.

23. Scrutiny:

Scrutiny shall be allowed in only theory papers for which the candidate has to apply within 15 days after declaration of semester result.

21. Cancellation of Admission:

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

a. He/She is not found qualified as per guidelines or the eligibility criteria prescribed by the University.

Or

b. He/She is found unable to complete the course within the stipulated time as prescribed in clause 4.

Or

c. He/She is found involved in creating indiscipline in the University.

Or

d. He/She is found involved in any criminal case/ has given any false statement.

22. Accumulation of Credits:

Every student shall open an account in the ABACUS-UP which will provide him/her with an unique ID and will allow access to the Standard Operating Procedure (SOP). The Credits awarded to a student for the courses pursued in the University shall be accumulated in the Academic Bank Account of the student. The procedure for accumulation of credits earned, shelf life, redemption of credits, would be as per the UGC (Establishment and Operation of Academic Bank of Credits in Higher Education) Regulations, 2021 and their subsequent amendments. The validity of credits earned will be to a maximum period of seven years or as specified by the ABACUS-UP.

23. Duration of the undergraduate programmes:

Every student admitted to an undergraduate programme for a qualification (Level 5 to Level 8) shall be required to complete the programme within a period of 2 (two) years from the date of admission to the programme of each qualification level.

24. Course Registration:

At the beginning of every Semester, all the students shall be required to register for the Courses specified for that Semester of the Programme in the Office of Controller of Examinations in the prescribed forms with payment of fees as prescribed by the University from time to time.

25. Admission and Examinations:

All matters pertaining to admission and examinations for the 4-year undergraduate programs shall be regulated by the Admission and Examination Regulations for the 4-Year Undergraduate Programmes of the Rama University.

26. Power to remove Difficulties:

If any difficulty arises in giving effect to the provisions of this Ordinance, the Vice- Chancellor may, by order, make such provisions not inconsistent with the Act, Statutes, Ordinances or other Regulations, as appears to be necessary or expedient to remove the difficulty, however subject to ratification of such order by the Statutory Bodies of the University

RAMA UNIVERSITY
DEPARTMENT OF BIOTECHOLOGY
FACULITY OF ENGINEERING AND TECHNOLOGY

COURSE STRUCTURE

B. Sc. (Hons with Research)

BIOTECHNOLOGY

(As per NEP regulation)

2024-25

Course Curriculum (w.e.f. Session 2024-25)
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National Education Policy 2020

Objectives: The proposed new structure for the undergraduate programs of the university aims to achieve the following key goals enunciated by the National Education Policy 2020 (NEP-2020:

- Multi-disciplinary and inter-disciplinary learning
- Holistic curriculum (including teaching of Indian and International languages, ethics and culture, social and emotional learning and co-curricular activities)
- Skill enhancement (including skills relating to information technology and data analysis)
- Research to be incorporated as a key component of the learning process
- Adoption of appropriate pedagogies to promote active student participation in the learning process so as to promote creativity and a spirit of exploration and adventure
- Capacity building for gaining as well as creating employment.
- Engagement with industry and society (including dissertations, projects and internships)
- Enhancing prospects for socially and economically disadvantaged and differently abled students.
- Provision for credit transfer in both national and international contexts

Bachelor of Science (Honors) in Biotechnology (Three Years / Four Years):

In the first three years of the new program, students shall study the following courses in addition to the courses that exist in the current B.Sc. Program:

Language and Literature -II: The current BSc Program includes only one language course (English/MIL) The new program structure would require students to study two 'Language and Literature' courses, of which at least one should be in an Indian Language (IL).

Social and Emotional Learning: An interdisciplinary course that promotes well-being and health.

Innovation and Entrepreneurship: An interdisciplinary course that helps students acquire skills relating to creative social and business entrepreneurship, and organizational skills.

Co-curricular: Co-scholastic activities such as music, art, gardening, sports.

Ethics and Culture: An interdisciplinary course that shall include experience of community service.

Multidisciplinary and Research: In the fourth year (semesters VII and VIII), students can choose one discipline out of the three disciplines that they have pursued in the first three years of study, and study six courses in this discipline. (The discipline courses offered will aim to strengthen fundamental knowledge in the discipline). Students would also be required to complete a research dissertation on the Major discipline of study, and an inter-disciplinary research dissertation on the Major and Minor disciplines of study

Introduction

The National Education Policy which was effective till now was formulated almost 34 years ago.A more felicitous vision was needed to meet the aspirations of the New India. The National Education Policy (NEP) 2020 is an ambitious and futuristic policy that strives to remove rigid boundaries and create new possibilities for students to choose and learn the subjects or courses of their choice.

The policy proposes a large number of changes that can transform higher education in India. One such change that has caught everyone's attention is changing the 3-year undergraduate course structure into a 4-year pattern with multiple entry and exit points to make higher education more suited to get jobs later. At present, students who leave the course in between are labelled as drop- outs and they get no qualification certificate or diploma for the credits earned during the period in the college.

NEP 2020 seeks to pave the way for flexible and lifelong learning and encourages students to choose their academic path leading to the award of certificate, diploma, and degree. Hence, Multiple Entry and Exit System (MEES) is the corner stone of the new National Education Policy in higher education. The system allows students to drop their course and resume it at a later stage as and when they desire or deem it worth pursuing. This arrangement will prove to be a boon for those

students who cannot continue their studies due to financial, social or any other reason and desire to resume their studies when the conditions become favorable in due course of time.

How the system will function?

As per the draft of the NEP 2020 the undergraduate degree will be of either 3 or 4-year duration with multiple entry and exit options within this period, with appropriate certifications : a certificate after completing 1 year in a discipline or field including vocational and professional areas, a diploma after 2 years of study, or a Bachelor's degree after a 3-year programme. The 4- year programme may also lead to a degree 'with Research' if the student completes a rigorous research project in the major area(s) of study as specified by the higher education institution.

NEP 2020 states that innovative and flexible curricular structure under multiple entry and exit points will abolish the currently prevalent rigid, uniform and mechanical structure to create new possibilities for students to choose and learn the subjects of their choice as per their preference, convenience, or necessity.

Major benefits associated with the NEP system can be outlined as under: Benefits of Multiple Entry and Exit System (MEES)

- This is a kind of stress-buster move. It is likely to reduce the pressure of pursuing a course with an opportunity of zero-year loss in the academic journey. The move is likely to become a big boon for the students as they do not need to fear about losing a year or two if they have been studying one course for two years already when they plan to move into a different one.
- A large number of undergraduates quit the course after one or two year with zero benefit after paying huge fee and spending their valuable time. Awarding certificate or diploma after completing 1 or 2 years will have some worth in the long run.

- Students will have the greater flexibility and liberty to join a course or leave a course as they like, and they shall be also provided the opportunities to change the courses if theywant to learn about a different sector as per their future career needs.
- Increasing Gross Enrolment Ratio at higher education is one of the objectives of NEP 2020.This move will reduce the drop-out rates of students especially for those who want to switch courses and desire to re-enter as and when they deem fit to resume their studies to earn full fledge college degree.
- The credits that the students obtain in their first and second year will be stored using the Academic Bank of Credits (ABC) system. So, at any point of time, if students want to take a break and continue their course within a fixed period, they can utilise these credits for further education.
- The system will allow students to take a sabbatical and then join back their studies without losing any credits. The move will allow students to build their own degrees. Students shall be granted more autonomy than before to decide what kind of major and minor courses they want to pursue.
- This is likely to revolutionize higher education system in India as only interested students will complete the degree through multiple entries and exit point system. Those who are notinterested to pursue the course shall have no compulsion to complete the same by all means.
- This path breaking move will make our higher education system more like the global format with continuous reforms in this direction.

Effectiveness of Multiple Entry and Exit System (MEES)

In the light of above stated facts, multiple entry and exit system seems to be a very positive change. However, a more in-depth analysis of the concept raises few practical hitches as well. Hence, following concerns need to be addressed for the effective implementation of Multiple Entry and Exit System (MEES). Concerns to be addressed.

- Students can exit after one year with a certificate, after two years with a diploma and a Bachelor's degree after three years and Bachelor's with research after 4 years. Curriculum construction is a big challenge in implementing this system. What type of proficiency will be attained by a student after one or two year of a degree course? Thus, curriculum needsto be reworked in order to incorporate the specialized competencies, knowledge and skills required in a particular subject area.
- In the absence of proper guidance, confusions and doubts can arise in the minds of the students leading to a state of chaos. Student support services need to be encouraged and developed at different levels for students who are more likely to drop out due to personal, social, emotional, cultural, and economic or any other reason.
- What type of opportunities will be available for the certificate and diploma holders in different sectors at the same time when degree holders are finding it hard to get jobs? Students may face difficulty to find employment on the basis of an early certificate or diploma unless it is technically specialized.
- Shall we be able to develop a pool of efficient entrepreneurs by awarding certificate and diploma after completing 1 or 2 years of a course through multiple entry and exit points? There is an apprehension of treating early exit certificates as a stamp of failure in the worldof work.
- Educational institutions are required to develop a hassle-free mechanism of admissions while implementing this system. The situation is likely to become critical, suppose when the total intake of a degree course is fixed in a particular institution. How to tackle the situation when under this system suppose 15 students decide to exit in the second semester and about 25 students who left years ago are in queue for entry? Obviously, it will disturb the required teacher-pupil ratio and other infrastructural facilities available in the institution.
- Another concern that is bothering everybody is that a large population of the students who will leave the courses in between may not return back due to some trivial reasons. It is tobe ensured that a large section of the students may not get deprived of higher education in the absence of strong motivation and proper guidance.
- The execution of this system in its true spirit needs to develop an impeccable mechanism of fees at the time of admission under multiple entry option. It is to be ensured that the system may not become a golden opportunity for private or other institutions to charge exorbitant fees from students who seek entry back to resume their studies.

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Sem.	DSCCs	DSECs	GECs	AECCs	SECs	VACs	Cr
I	CC-01 (4 + 1) CC-02 (4)	DSEC-1(4)		AECC-1 (2+ 1)	SEC-1 (3)	VAC-1 (2)	21
II	CC-03 (4+ 1) CC 04 (4+ 1) CC-05 (4)			AECC-2 (2)	SEC-2 (3)	VAC-2 (2)	21
Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.						VAC- 3* (2)	2
						VAC- 4* (2)	2
Students on exit shall be awarded Certificate in ***"Cell Biology Techniques in Biotechnology"*** **after securing the requisite 42 credits in Semester I & II**							
III	CC-06 (4 + 1) CC-07 (4 + 1)	DSEC-2 (4)		AECC-3 (2)	SEC-3 (4+1)	VAC-3 (2)	23
IV	CC-08 (4 + 1) CC-09 (4 + 1) CC-10 (4 + 1)	DSEC- 3 (4)			SEC-4 (3)	VAC-4 (2)	24
Students on exit shall be awarded ***"Diploma in Biotechnology"*** **after securing the requisite 89 credits on completion of Semester IV**							
Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 4 credit in skill based vocational courses offered during first year or second year summer term						VAC- 5* (2)	2
						VAC- 6* (2)	2
V	CC-11 (4) CC-12 (4 + 1) CC-13 (4 + 1) CC-14 (4)			AECC-4 (2)	SEC-4 (3)		23
VI	CC-15 (4) CC-16 (4) CC-17 (4 + 1) CC-18 (4 + 1) CC-19 (4 + 1)						19
Students on exit shall be awarded ***"Bachelor Degree of Science in Biotechnology"*** **after securing the requisite 135 credits on completion of Semester VI**							
VII	CC-20 (4) CC-21 (4) CC- 22 (4+1)				SEC-4 (4)	Dissertation/ Major Project DST-1 (6)	23

VIII	CC-23 (4) CC-24 (4) CC-25 (4) CC-26 (4)					Dissertation/ Major Project DST-2 (6)	22
Students on exit shall be awarded *"Bachelor of Biotechnology (Honours with Research)"* after securing the requisite 180 credits on completion of Semester VIII							
VII	CC-17 (4) CC-18 (4)	DSEC-6 (4+1) DSEC-7 (4) DSEC-11(4)			SEC-5 (2)		23
VIII	CC-19 (4+ 1)	DSEC-8(4) DSEC-9(4) DSEC-10(4) DSEC-12 (4 + 1))					22
Students on exit shall be awarded *"Bachelor of Biotechnology with Honours"* after securing the requisite 180 credits on completion of Semester VIII.							

Abbreviations: DSCCs: Discipline Specific Core Courses (5Cr or 4+1Cr); DSECs: Discipline Specific Elective Courses (4Cr); GECs: Generic Elective Courses (4Cr); AECCs: Ability Enhancement Compulsory Courses (2Cr); SECs: Skill Enhancement Courses (2Cr); VACs: Value Addition Courses (2Cr); DST: Dissertations (6Cr); Cr: Credits

05/10/2024

Assessment Method: Weightage for Assessment

Type of Course	Internal Assessment/ Formative assessment	Summative Assessment (End-term Examination)
Theory	40	60
Practical	25	25
Projects	100	200
Internship	40	60

Progressive certificate, diploma, Bachelor's Degree Bachelor' Degree with Honours and Research and Bachelor' Degree with Honours, provided at the ed of each year of exit of the four-years undergraduate programme

Qualification Types, Exit Option and Credit Requirement		
	Exit Options	**Credit Required**
1.	**"Certificate"** upon the successful completion of the first year (two semesters) of multidisciplinary four-year undergraduate programme.	36-40
2.	**"Diploma"** upon the successful completion of the first two year (Four semesters) of multidisciplinary four-year undergraduate programme.	72-80
3.	**"Bachelor's Degree"** at the successful completion of the third year (Six semesters) of the multidisciplinary four-year undergraduate programme.	108-120
4.	**"Bachelor' Degree with Honours and Research"** in a Discipline at successful completion of Four years (Eight semesters).	144-160 (12 credit mandatory for Project /Research work)
5.	**"Bachelor' Degree with Honours"** in a Discipline at successful completion of Four years (Eight semesters).	144-160 (12 credit for discipline specific subjects)

PEOs, POs & PSOs of B.Sc. Biotechnology Program

Program Educational Objectives (PEOs):

PEO1: To develop in our student competencies to pursue higher education and research in reputed institutes and industry at local and global level.

PEO2: To update, strengthen and deepen students 'knowledge using a flexible, research-intensive program in concord to academia and industry requirements.

PEO3: To develop a working knowledge of biotechnology product and processes

PEO4: To enable critical thinking and full-fledged grasp of essential aspects of bioethics inculcating a value system among students.

Program Outcomes / Program Specific Outcomes are attributes i.e. what students are expected to know or will be able to do when they graduate from a program.

Program Outcomes (POs): The POs of BSc Biotechnology are as follows:

PO1: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO2: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO3: Understand the impact of the professional biotechnological solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO4: Apply ethical principles and commit to professional ethics and responsibilities and norms of the science practice.

PO5: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change

Programme Specific Outcomes (PSOs):

PSO1: Students will be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek c) why to seek?

PSO2: Undergraduate students will be able to demonstrate and apply the principles of bioprocess engineering in the design, analysis, optimization and simulation of bioprocess operations.

PSO3: Empower the students to acquire technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology

PSO4: Detailed experience would enable them to begin a career in industry that engages in geneticengineering as well as in research laboratories conducting fundamental research.

PSO5: Recognize the importance of Bioethics, IPR, entrepreneurship, Communication andmanagement skills so as to usher next generation of Indian industrialists

PSO6: To impart in-depth practical oriented knowledge to students in various thrust areas ofbiotechnology, so as to meet the demands of industry and academia.

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1st Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major (Core) CC1	BBT111	Elementary Cell Biology	4	0	0	4	20	20	60	100
2	Major (Core) CC2	BBT112	Basics of Genetics	4	0	0	4	20	20	60	100
3	Multidisciplinary	BBT113	Chemistry for Biology	4	0	0	4	20	20	60	100
4	AEC1	BBT114	Computer and IT skill	2	0	0	2	20	20	60	100
5	SEC1	BBT115	Biotechnological Skills and Analytical Techniques	3	0	0	3	20	20	60	100
6	VAC1	VBT111	Indian Knowledge System	2	0	0	2	20	20	60	100
Practical											
7	Major (Core) CC1	BBT171	Elementary Cell Biology and Genetics Lab	0	0	2	1	15	10	25	50
8	AEC1	BBT172	Computer and IT skill Lab	0	0	2	1	15	10	25	50
				19	0	4	21	150	140	410	700

Contact Hr.	**23**		
Theory	**6**	**Lab**	**2**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

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2nd Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major (Core) CC3	BBT211	Biochemistry	4	0	0	4	20	20	60	100
2	Minor (Core) CC4	BBT212	Plant Physiology	4	0	0	4	20	20	60	100
3	Minor (Core) CC5	BBT213	Mammalian Physiology	4	0	0	4	20	20	60	100
4	AEC2	BBT214	Functional English -1	2	0	0	2	20	20	60	100
5	SEC2	BBT215	Application of Biotechnology in Agriculture	3	0	0	3	20	20	60	100
6	VAC2	VBT211	Ecology and Environmental Science	2	0	0	2	20	20	60	100
Practical											
7	Major (Core) CC3	BBT271	Biochemistry Lab	0	0	2	1	15	10	25	50
8	Minor (Core) CC4	BBT272	Physiology Lab	0	0	2	1	15	10	25	50
				19	0	4	21	150	140	410	700

Contact Hr.	**23**		
Theory	**6**	**Lab**	**2**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

*Students on exit shall be awarded Certificate in "Cell Biology &Techniques in Biotechnology" after securing the requisite 42 credits in Semester I & II

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Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.

I	VAC (Summer)	VBT212	Plant Biotechnology and Genetic Improvement	2	0	0	2	20	20	60	100

I	VAC (Summer)	VBT213	Genetic Engineering Techniques	2	0	0	2	20	20	60	100

Course Curriculum (w.e.f. Session 2024-25)
B.Sc. (Hons.) with Research Biotechnology
FET, Rama University

3rd Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major(Core) CC6	BBT311	General Microbiology	4	0	0	4	20	20	60	100
2	Major (Core) CC7	BBT312	Bioinstrumentation	4	0	0	4	20	20	60	100
3	SECs2	BBT313	Molecular Diagnostic Techniques	4	0	0	4	20	20	60	100
4	Multidisciplinary	BBT314	Developmental Biology	4	0	0	4	20	20	60	100
5	AEC3	BBT315	Communication Skill	2	0	0	2	20	20	60	100
6	VAC3	VBT311	Physical Education and Yoga	2	0	0	2	20	20	60	100
Practical											
7	Major(Core) CC6	BBT371	General Microbiology Lab	0	0	2	1	15	10	25	50
8	Major (Core) CC7	BBT372	Bioinstrumentation Lab	0	0	2	1	15	10	25	50
9	SECs2	BBT373	Molecular Diagnostic Techniques Lab	0	0	2	1	15	10	25	50
				20	0	6	23	165	150	435	750

Contact Hr.	**26**		
Theory	**6**	**Lab**	**3**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

4th Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major (Core) CC8	BBT411	Molecular Biology	4	0	0	4	20	20	60	100
2	Minor (Core)	BBT412	Enzymology	4	0	0	4	20	20	60	100
3	Major (Core) CC9	BBT413	Basic immunology	4	0	0	4	20	20	60	100
4	Multidisciplinary	BBT414	Role of Biotechnology in Forensic Science	4	0	0	4	20	20	60	100
5	SEC3	BBT415	Bio-safety and Ethics in Biological Sciences	3	0	0	3	20	20	60	100
6	VAC4	VBT411	Innovation and Entrepreneurship	2	0	0	2	20	20	60	100
Practical											
7	Major (Core) CC8	BBT471	Molecular Biology and RDT Lab	0	0	2	1	15	10	25	50
8	Minor (Core)	BBT472	Enzymology Lab	0	0	2	1	15	10	25	50
9	Major (Core) CC9	BBT473	Basic immunology Lab	0	0	2	1	15	10	25	50
				21	0	6	24	165	150	435	750

Contact Hr.	**27**		
Theory	**6**	**Lab**	**3**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

***Students on exit shall be awarded "Diploma in Biotechnology" after securing the requisite 89 credits on completion of Semester III and IV**

Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 4 credit in skill based vocational courses offered during first year or second year summer term.

II	VAC (Summer)	VBT412	Applied Microbiology in Industry	2	0	0	2	20	20	60	100
II	VAC (Summer)	VBT413	Industrial Enzyme Technology	2	0	0	2	20	20	60	100

Course Curriculum (w.e.f. Session 2024-25)
B.Sc. (Hons.) with Research Biotechnology
FET, Rama University
5th Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major (Core) CC10	BBT511	Recombinant DNA Technology	4	0	0	4	20	20	60	100
2	Major (Core) CC11	BBT512	Fermentation Technology	4	0	0	4	20	20	60	100
3	Minor (Core)	BBT513	Bioinformatics	4	0	0	4	20	20	60	100
4	Major (Core)	BBT514	Animal Biotechnology	4	0	0	4	20	20	60	100
5	AEC4	BBT515	Biostatistics	2	0	0	2	20	20	60	100
Practical											
6	Major (Core) CC11	BBT571	Fermentation Technology Lab	0	0	2	1	15	10	25	50
7	Minor (Core)	BBT572	Bioinformatics Lab	0	0	2	1	15	10	25	50
8	SEC4	BBT573	Industrial Internship	0	0	6	3	20	20	60	100
				18	0	10	23	150	140	410	700

Contact Hr.	**28**		
Theory	**5**	**Lab**	**3**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

Course Curriculum (w.e.f. Session 2024-25)
B.Sc. (Hons.) with Research Biotechnology
FET, Rama University

6th Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major (Core) CC12	BBT611	Bioprocess Technology	4	0	0	4	20	20	60	100
2	Minor (Core)	BBT612	Nanotechnology	4	0	0	4	20	20	60	100
3	Major (Core) CC13	BBT613	Environmental Biotechnology	4	0	0	4	20	20	60	100
4	Major (Core) CC14	BBT614	Plant Biotechnology	4	0	0	4	20	20	60	100
5	Major (Core) CC15	BBT615	Food Biotechnology	4	0	0	4	20	20	60	100
Practical											
7	Major (Core) CC13	BBT671	Environmental Biotechnology Lab	0	0	2	1	15	10	25	50
8	Major (Core) CC14	BBT672	Plant Biotechnology Lab	0	0	2	1	15	10	25	50
9	Major (Core) CC15	BBT673	Food Biotechnology Lab	0	0	2	1	15	10	25	50
				20	0	6	23	145	130	375	650

Contact Hr.	**26**		
Theory	**5**	**Lab**	**3**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

***Students on exit shall be awarded Degree in "Bachelor Degree of Science in Biotechnology" after securing the requisite 135 credits on completion of Semester VI**

Course Curriculum (w.e.f. Session 2024-25)
B.Sc. (Hons.) with Research Biotechnology
FET, Rama University
7th Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major (Core) CC16	BBT711	Stem Cell Engineering	4	0	0	4	20	20	60	100
2	Minor (Core)	BBT712	Medical Microbiology	4	0	0	4	20	20	60	100
3	Major (Core) CC17	BBT713	Genomics and Proteomics	4	0	0	4	20	20	60	100
4	SECs7	BBT714	Research Methodology	4	0	0	4	20	20	60	100
Practical											
5	DST1	BBT771	Major Project-I	0	0	12	6	50	50	200	300
6	Major (Core) CC17	BBT 772	Genomics and Proteomics Lab	0	0	2	1	15	10	25	50
				16	0	14	23	145	140	465	750

Contact Hr.	**30**		
Theory	**4**	**Lab**	**2**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

Course Curriculum (w.e.f. Session 2024-25)
B.Sc. (Hons.) with Research Biotechnology
FET, Rama University

8th Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major (Core) CC18	BBT811	Advance Cell Biology	4	0	0	4	20	20	60	100
2	Major (Core) CC19	BBT812	Fundamental of Biomedical Sciences	4	0	0	4	20	20	60	100
3	Major (Core) CC20	BBT813	Scientific Writing	4	0	0	4	20	20	60	100
4	Major (Core) CC21	BBT814	Intractual property rights	4	0	0	4	20	20	60	100
Practical											
5	DST2	BBT871	Major Project-II	0	0	12	6	50	50	200	300
				16	0	12	22	130	130	440	700

Contact Hr.	**28**		
Theory	**4**	**Lab**	**1**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

***Students on exit shall be awarded "Bachelor of Biotechnology (Honours with Research)" after securing the requisite 180 credits on completion of Semester VIII.**

For Bachelor' Degree with Honours only
7th Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major (Core) CC22	BBT711	Stem Cell Engineering	4	0	0	4	20	20	60	100
2	Major (Core) CC23	BBT712	Medical Microbiology	4	0	0	4	20	20	60	100
3	DSEs 6	BBT713	Genomics and Proteomics	4	0	0	4	20	20	60	100
4	DSEs7	BBT714	Research Methodology	4	0	0	4	20	20	60	100
5	SEC 5	BBT715	Application of Biosensor in Biotechnology	2	0	0	2	20	20	60	100
6	SECs 11	BBT716	Evolutionary Biology	4	0	0	4	20	20	60	100
Practical											
7	SECs 6	BBT 772	Genomics and Proteomics Lab	0	0	2	1	15	10	25	50
				22	0	2	23	135	130	385	650

Contact Hr.	**24**		
Theory	**6**	**Lab**	**1**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

8th Semester

S. No	Course Type	Course Code	Course Name	L	T	P	Cr	CA	MTE	ETE	Total
1	Major (Core) CC24	BBT811	Advance Cell Biology	4	0	0	4	20	20	60	100
2	SECs 8	BBT812	Fundamental of Biomedical Sciences	4	0	0	4	20	20	60	100
3	SECs 9	BBT813	Scientific Writing	4	0	0	4	20	20	60	100
4	SECs 10	BBT814	Intractual property rights	4	0	0	4	20	20	60	100
5	SECs 12	BBT815	Drug Design	4	0	0	4	20	20	60	100
Practical											
6	Major (Core) CC24	BBT872	Advance Cell Biology Lab	0	0	2	1	15	10	25	50
7	SECs 12	BBT873	Drug Design Lab	0	0	2	1	15	10	25	50
				20	0	4	22	130	120	350	600

Contact Hr.	**24**		
Theory	**5**	**Lab**	**2**

Abbreviations: CCs: Core Courses AECCs: Ability Enhancement Compulsory Courses; SECs: Skill Enhancement Courses; VACs: Value Addition Courses DST: Dissertations Cr: Credits

Students on exit shall be awarded "Bachelor of Biotechnology with Honours" after securing the requisite 180 credits on completion of Semester VIII

DEPARTMENT OF BIOTECHNOLOGY,
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RAMA UNIVERSITY, KANPUR, U.P (INDIA)

SYLLABUS

B. Sc. (Hons with Research)

BIOTECHNOLOGY

(As per NEP Regulation)

2024-25

DEPARTMENT OF BIOTECHNOLOGY,
FACULTY OF ENGINEERING & TECHNOLOGY
RAMA UNIVERSITY, KANPUR, U.P (INDIA)

SEMESTER I

(CORE COURSE-1)

ELEMETARY CELL BIOLOGY (BBT 111)

COURSE OBJECTIVES: Cell biology is the study of cell structure and function, and it revolves around the concept that the cell is the fundamental unit of life.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport; Symport, antiport, uniport, active and passive transport.	10
2	Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions.	10
3	Lysosomes: Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function, Mitochondria: Structure and function, Chloroplasts: Structure and function, Nucleus: Structure and function, chromosomes and their structure.	10
4	Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis.	10
5	Cell division - Cell cycle, mitosis and meiosis, regulations of cell cycle and check points and proteins involved in cell cycle check points. Basics in cell signaling-signaling molecules and receptors, G protein coupled receptors, Tyrosine kinase receptor, apoptosis and necrosis.	10

Text Books:

Jeff Hardin, Gregory Bertoni, Lewis J. Kleinsmith, Wayne M. Becker. Becker's World of the Cell, 8th edition. Benajmin Cummings, 9780321689634, 0321689631, (2012).

EDP De Robertis and EMF De Robertis. Cell and Molecular Biology. 8th edition. Lippincott Williams and

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Wilkins, 9780781734936, 0781734932, (2006)

Reference Books:

Gerald Karp, Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc, 9780470483374, 0470483377 (2010)

G.M. Cooper, and R.E. Hausman. The Cell: A Molecular Approach. 5th Edition. ASM Press 780878931064, 0878931066 (2009)

Online links for study and reference materials:

http://www.open2study.com/cellbiology

https://nptel.ac.in/courses/102103012/

Cell Biology - Course (swayam2.ac.in)

COURSE OUTCOME: On completion of this course, the students will be able to:

1. Acquire knowledge about the ultra-structural information of cell besides the detailed views of the cell interior.
2. Understand the complex molecular mechanisms occurring in the cell and regulation of gene expression.
3. Learn about the classical genetics and transmission of characters from one generation to the next which will make foundation for the advanced genetics.
4. Develop innovative research ideas for curing genetic disorders in humans

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	2	2	2
CO2	-	-	2	3	3
CO3	3	1	2	2	-
CO4	2	2	3	3	2

(CORE COURSE-1)

ELEMETARY CELL BIOLOGY & GENETICS LAB (BBT 171)

COURSE OBJECTIVES: The course describes the tissue level organization and related functions of animal and plant cells, different staining techniques, etc.

Credits: 01 L-T-P: 0-0-2

Module No	Content	Teaching Hours
1	1. Organization and working of optical microscope: Dissecting and compound microscopes. 2. To examine the phenomenon of cell permeability using hypotonic, isotonic and hypertonic solutions. 3. Demonstration of dialysis. 4. To study the prokaryotic (bacterial) and eukaryotic cell structures with the help of microscope. 5. To observe the different stages of mitosis and meiosis using permanent slides. 6. To study the mitosis cell division in onion root tips. 7. Mendalian Genetics Problem	20

SUGGESTED TEXTBOOKS:

1. Rastogi, V.B. (2010). Fundamental of Molecular Biology. New Delhi: ANE Books.
2. Rastogi, V.B. (2016). Introductory Cytology –Knrn. Meerut: Kedar Nath Ram Nath Publishers.
3. Tamarin, R.H. (2004). Principles of Genetics (7th ed.). USA: McGraw- Hill Higher Education.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Understand the structure of cells and its organelles with the help of permanent slides.
2. Gain hands-on training for operating microscope for cell analysis
3. Use relevant tools and techniques for the analysis of chromosomes, and cell size determination using micrometry.

(CORE COURSE-2)

BASICS Of GENETICS (BBT 112)

COURSE OBJECTIVES: The purpose of this course is to understand the genetic patterns of Mendelian inheritance and non-Mendelian inheritance.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Principles of Heredity and Variation: Mendel concept of genetics and his experiments, monohybrid crosses, dihybrid crosses, back cross and test cross. multiple alleles(blood group systems)	10
2	Gene Interaction: Concept of gene interaction, co-dominance and incomplete Dominance, Complementary factors, Supplementary factors, Inhibitory factors, Duplicate dominant factors, Lethal genes (dominant and recessive), Epistatis.	10
3	Genes and Chromosomes: General features of chromosomes. Chromosomal theory of inheritance, Sex determination. Sex-linked, Sex-limited and Sex-influenced inheritance. Variation in chromosome number and structure, Inherited disorders - Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down syndrome and cri-du-chat syndrome)	10
4	Gene Linkage and Chromosome Mapping: Linkage and recombination of genes in a chromosome, Crossing over and genetic mapping, Gene mapping. Cytogenetic techniques. Penetrance and expressivity, Pleiotropy. Position effect and genomic imprinting	10
5	Population Genetics and Evolution: Allele frequencies and genotype frequencies, random mating and Hardy-Weinberg principle. Inbreeding. Genetics and evolution.	10

SUGGESTED TEXT BOOKS:

1. Borem, A., Santos, F.R., & Bowen, D.E. (2003). Understanding Biotechnology (1st d.). USA: Prentice Hall.
2. Brown, T. (2011). Introduction to Genetics –A molecular approach (1st ed.). USA: Garland Science.
3. Brown, T.A. (2010). Gene Cloning and DNA Analysis: An Introduction (6th ed.). USA: Wiley-Blackwell.
4. Gardner, E.J., Simmons, M.J., & Snustad, D.P. (2005). Principles of Genetics (8th ed.). New Jersey,

USA: John Wiley & Sons Ltd.

5. Glick, B.R., & Patten, C.L. (2017). Molecular Biotechnology: Principles and Applications of Recombinant DNA (5th ed.). USA: American Society for Microbiology Press.

SUGGESTED REFERENCE BOOKS

Gardner EJ, Simmons MJ, Snustad DP. Principles of Genetics. 8th Ed. Wiley- India. 2008.

Snustad DP, Simmons MJ. Principles of Genetics. 6th Ed. John Wiley and Sons Inc. 2011.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Acquire knowledge of the structure and arrangement of the genome in living organisms.
2. Understand the biochemical nature of nucleic acids, their role in living systems.
3. Learn the basic genetic manipulation techniques and their application for human welfare.
4. Develop innovative research ideas for Plant Breeding and genetic disorders in humans to their own research.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	-	2
CO2	1	-	2	3	3
CO3	-	3	2	3	-
CO4	3	2	-	2	2

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-1)

CHEMISTRY FOR BIOLOGY(BBT 113)

OBJECTIVES: This course will enlighten students with basic knowledge of solutions, colloids and phase rules, chemical kinetics and electrochemistry. It will help students to understand about amino proteins and carbohydrates, basic nature and reactions of carboxylic acid and its derivatives, amine and diazonium salts and also about concept of coordination chemistry.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Solutions Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Colloidal solution and suspension, types and properties of colloidal system, coagulation of colloidal solution, protective colloids. Phase Equilibrium Phases, components, and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule. Phase diagram (one component system).	9
2	Rate, order and molecularity of reaction, Integrated rate equation of zero order, first order and second order reactions, activation energy. Electrolysis, electrochemical cells, electrode potential, electrochemical series, Nernst equation.	9
3	Carbohydrate: Introduction, occurrence, classification, constitution of glucose, osazone formation. Reaction of glucose and fructose, Mutarotation, cyclic structure-pyranose and furanose form. Epimerisation, Chain lengthening and shortening in aldose. Disaccharides and glycosidic bonds. Polysaccharides - Starch, Bacterial Peptidoglycan and Extracellular matrix (Glycosaminoglycans). Glycoconjugates	9
4	Amino acids, Peptides and Proteins: Amino acids (Strecker synthesis using Gabriel's phthalimide synthesis, proteogenic and non proteogenic aminoacids, unusual aminoacids, amphoteric nature, Zwitter ion, isoelectric point and pKa Value, Ramachandran plot for amino acids. Peptides (The Peptide Linkage, Peptide Synthesis, Structure of Polypeptides); Proteins (General Characteristics, Classification, Structure). Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins).	9
5	Nomenclature and Classification, Structure and function of storage lipids (Triacylglycerols), membrane lipids (Phospholipids, Glycolipids and Archeal ester lipids), Intracellular signals (Phosphatidyl inositol), Cofactors (Vitamins) and natural pigments (β- carotene).	9

SUGGESTED TEXT BOOKS:

1. Nelson and Cox, Lehninger. Principles of Biochemistry (7th Edition), W.H Freeman Publishers (2010).
2. Voet D. Biochemistry (4th Edition), Academic Press (2012).
3. Dubey R.C, A Textbook of Biotechnology (6th Edition), S. Chand Publishing, reprint, 2014.

SUGGESTED REFERECE BOOKS:

1. Zubey G. Principles of Biochemistry, Oscar Publication (2000).
2. Devlin T. M. Text Book of Biochemistry with Clinical Correlations (4th Edition) Wiley & Sons Publication (2005).
3. Roy Tasker, Carl Rhodes. Stryer's Biochemistry (7th Edition) W. H. Freeman publishers(2012).

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Know the chemical constituents of cells, the basic units of living organisms.
2. Explain various types of weak interactions between the biomolecules.
3. know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids.
4. Correlate the structure-function relationship in various biomolecules
5. Know the role of biomolecules for orderly structures of the cells/tissues.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	3	3	-
CO2	2	3	2	3	-
CO3	-	2	3	3	2
CO4	2	3	2	3	-
CO5	3	-	2	3	2

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(ABILITY ENHANCEMENT COMPULSORY COURSE-1)

COMPUTER & IT SKILL (BBT 114)

COURSE OBJECTIVES: The course is designed to aim at imparting a basic level appreciation program for biological science undergraduate students. After completing this course students are able to use the computer for basic purposes like making assignments, preparing projects, net surfing to retrieve the data related to their educational studies, reading books, preparing PPTs, etc. At the end of this course, students have basic knowledge about biological databases and their uses in their current course of study.

Credits: 02 L-T-P: 2-0-0

Module No	Content	Teaching Hours
1	**Introduction of Computer:** Fundamentals of Computer, Basic Applications of Computer;Components of Computer System, Central Processing Unit (CPU), VDU, Keyboard and Mouse, Other input/output Devices, Computer Memory, Concepts of Hardware and Software; Concept of Computing, Data, and Information; Applications of IECT; Connecting keyboard, mouse, monitor and printer to CPU and checking power supply.	10
2	**Operating Computer using GUI Based Operating System:** What is an Operating System; Basics of Popular Operating Systems; The User Interface, Using Mouse; Using right Button of the Mouse and Moving Icons on the screen, Use of Common Icons, Status Bar, Using Menu and Menu-selection, Running an Application, Viewing of File, Folders and Directories, Creating and Renaming of files and folders, Opening and closing of different Windows; Using help; Creating Short cuts, Basics of O.S Setup; Common utilities	10
3	**Introduction to Internet, WWW, and Web Browsers:** Basic of Computer networks; LAN, WAN; Concept of the Internet; Applications of the Internet; Connecting to the Internet; What is ISP; Knowing the Internet; Basics of Internet connectivity related troubleshooting, World Wide Web; Web Browsing software, Search Engines; Understanding URL; Domain name; IP Address; Using e-governance website	10
4	**Use of Microsoft Office:** Word Processing Basics; Opening and Closing of documents; Text creation and Manipulation; Formatting of text; Table handling; Spell check, language setting and thesaurus; Printing of word document. Basics of presentation software; Creating Presentation; Preparation and Presentation of Slides; Slide Show; Taking printouts of presentation/handouts.	10
5	**Biological databases and data search:** Introduction to NCBI, Blast, Uniprot, SCOP, PDB, Sequence alignment online software. Scientific Literature data search. How to download biological data from databases and their preliminary use in biological research.	10

Text Books and Reading Materials:

Basic Computer Course by April 2022, Pawan Gupta

https://www.computer-pdf.com/other/406-tutorial-basic-computer-course-book.html

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Understand the basic concept of computer
2. Understand the detailed concept of Operating systems and the use of various software.
3. Understand the basic use of internet surfing for academic uses.
4. Students can able to prepare documents, PPTs, Assignment, and their reports.
5. Understand about various biological databases and their use for research purposes.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	3	3	-
CO2	2	3	2	3	-
CO3	-	2	3	3	2
CO4	2	3	2	3	-
CO5	3	-	2	3	2

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(ABILITY ENHANCEMENT COMPULSORY COURSE-1)

COMPUTER & IT SKILL LAB (BBT 172)

COURSE OBJECTIVES: To provide practical knowledge about the Basics of Computers hardware and software, internet, email, and to solve exercises using the application tools like Word processor, Spread sheet and Presentation

L-T-P: 0-0-2

Credits: 01

Module No	Content	Teaching Hours
1	1. Computer basics 2. Brief Introduction of MS-Word which includes formatting, editing of a document. 3. Brief Introduction of MS-Power point which includes animated presentation for a seminar/report. 4. Sending letters to multiple recipients using Mail Merge 5. Creating Table and calculation of sum, average, percentage in MS-Excel 6. Preparing charts or graphs in MS-Excel 7. Introduction of Python	20

SUGGESTED READINGS:

Computer Fundamentals Concepts, Systems, Application by D. P. Nagapal, S. Chand Publications, RP-2014, ISBN: 81-219-2388-3.

Fundamentals of Computers by V. Rajaraman and Neeharika Adabala, PHI Publications, 2015 Edition.

http://www.tutorialsforopenoffice.org/

http://www.libreoffice.org/get-help/documentation/

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Identify Computer hardware parts and connect peripherals.
2. Install Operating Systems and Utility software.
3. Install and configure Printer and LAN card.
4. Use internet to search, download, and access email account.
5. Create documents on Word processor, Spread sheet, and Presentation applications.

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(SKILL ENHANCEMENT COURSES-1)

BIOTECHNOLOGICAL SKILLS AND ANALYTICAL TECHNIQUES (BBT 115)

COURSE OBJECTIVES: The course is designed to aim at skill enhancement as per National Occupational Standards (NOS) of "Lab Technician/ Assistant and knowledge about major activities of biotech industry, regulations, and compliance, environment, health, and safety. At the end of this course, students have skill about usage and maintenance of basic equipment of biotechnology lab and environmental lab.

Credits: 03 L-T-P: 3-0-0

Module No	Content	Teaching Hours
1	**CIP and SIP Fundamentals, Safety, and Documentation:** - Introduction to CIP and SIP: Industry standards and protocols for clean-in-place (CIP) and sterilize-in-place (SIP) procedures, Material Requirements for Cleaning: Guidelines for cleaning specific areas (lab benches, ventilation systems, equipment surfaces), selecting cleaning agents based on material properties (stainless steel, plastic, glass), Personal Protective Equipment (PPE) and Safety: Required PPE for handling cleaning and sterilization processes. Safety symbols, hazard signs, and proper usage, Methodology for Cleaning and Storage Areas: Cleaning protocols for various surfaces (metal, plastic, glass), best practices for material storage to avoid cross-contamination, Signage and Labeling: Do's and don'ts of labeling areas and equipment in the laboratory to ensure safety and compliance with standards, Documentation: Recording chemical and equipment usage. Maintaining cleaning records as per SOPs, logging cleaning/sterilization activities for traceability and audits.	10
2	**Equipment Safety, Chemical Handling, and Hazard Management:** Safety Protocols for Equipment and Chemicals: Handling and cleaning of critical lab equipment, focusing on safety protocols and maintenance procedures (e.g., autoclaves, incubators, pH meters, centrifuges), Chemical Safety: Proper storage, handling, and labeling of chemicals, including hazardous chemicals. Understanding Material Safety Data Sheets (MSDS) and safe disposal protocols, Inventory Management: Maintenance of chemical and equipment inventories. Procedures to maintain chemicals, stock updates, labeling and expiration tracking. Disposal of Hazardous Chemicals and Waste: Best practices for chemical disposal in compliance with environmental and safety regulations. Safe disposal of decontaminated media and materials, SOP Adherence: The importance of following Standard Operating Procedures (SOPs) in chemical handling, equipment cleaning, and labelling.	10
3	**Instrument Handling and Practical Applications:** Instrument Handling Practice: Understanding working principles, construction, and practical applications of laboratory equipment, including :Microscope, Weighing Scale, pH Meter, Autoclave, Hot Air Oven, BOD Incubator, Incubator Shaker, Centrifuge, Colony Counter, Water Bath, Double Distillation Unit, Hot Plate, Fermenter/Bioreactor, Microtome, Photoperiod Trolley (PTC Trolley), Dry Bath, Vortex Mixer, Calorimeter, Spectrophotometer, Gel Documentation, UV-Transilluminator, Semi-Dry Transblot System, Gel Electrophoresis, SDS-PAGE, PCR Analyzer, Operational Safety: Guidelines on equipment calibration, maintenance, and safety checks before and after use, Documentation of Instrument Use: Recordkeeping of instrument use and maintenance as per SOPs for research experiments and quality control.	10
4	**Solution Preparation, Media Handling, and Laboratory Reporting:** Preparation	10

	of Solutions and Standards: Molarity, Molality, Normality: Calculations and preparation of solutions. Understanding %w/w, %v/v, ppm, ppb, Dilution Techniques: Methods for diluting concentrated solutions, preparation of standard and stock solutions, Handling Acids and Reagents: Safe preparation and usage of acids and reagents. Reading reagent bottle labels and precautionary measures, Water Quality Management: Maintenance and storage of purified water for media preparation (plant tissue culture, microbiological, and animal cell culture media), Media Preparation and Sterilization: Procedures for media preparation, sterilization, and making cotton plugs for long-term and short-term use, Laboratory Record Writing: Method of Record Writing: Data collection, recording, and maintaining accurate research logs, Reporting and Analysis: Reporting of experimental results, discussion, summary writing, and creating effective PowerPoint presentations for research dissemination.	

SUGGESTED TEXT BOOKS:

Principles of Instrumental Analysis" by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch.

Microbiology: Laboratory Theory & Application" by Michael J. Leboffe and Burton E. Pierce.

REFERENCE BOOKS:

Handbook of Good Laboratory Practice (GLP), Second Edition" by Peter D. Kunder and Ray H. Liu.

Basic Laboratory Methods for Biotechnology" by Lisa A. Seidman and Cynthia J. Moore.

Online links for study & reference materials:

https://www.oecd.org/chemicalsafety/testing/good-laboratory-practiceglp.htm

https://practicalbiology.org/standard-techniques/aseptic-techniques

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Understand CIP/SIP protocols and select appropriate cleaning agents for different materials.
2. Apply safety protocols using PPE and safety signage for equipment and chemical handling.
3. Perform and document cleaning and sterilization processes per SOPs.
4. Manage chemical and equipment inventories, ensuring compliance with safety regulations.
5. Operate, maintain, and document the use of laboratory instruments safely.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	3	3	-
CO2	2	3	2	3	-
CO3	-	2	3	3	2
CO4	2	3	2	3	-
CO5	3	-	2	3	2

(VALUE ADDITION COURSE-1)
INDIAN KNOWLEDGE SYSTEM (VBT 111)

COURSE OBJECTIVES: This course introduces students to the rich and diverse Indian Knowledge Systems (IKS), covering key areas like ancient science, literature, philosophy, and environmental practices. The course aims to bridge the gap between traditional knowledge and modern education, highlighting India's contributions to various fields and their relevance in contemporary society.

L-T-P: 2-0-0

Credits: 02

Module No	Content	Teaching Hours
1	**Introduction to Indian Knowledge Systems:** Definition and scope of Indian Knowledge Systems, Historical development of IKS, Key sources of IKS: Vedas, Upanishads, Smritis, Puranas, Importance and relevance of IKS in modern education and science.	10
2	**Indian Philosophical Traditions:** Overview of Indian philosophical schools: Nyaya, Vaisheshika, Sankhya, Yoga, Mimamsa, Vedanta, Buddhist and Jain philosophies . , , The concept of knowledge (Pramana) in Indian philosophy, Indian approaches to logic, epistemology, and metaphysics.	10
3	**Indian Contributions to Science and Mathematics:** Development of mathematics in ancient India: concepts of zero, algebra, and calculus (Aryabhata, Brahmagupta, Bhaskara), Indian contributions to astronomy: Aryabhata, Varahamihira, and their works, Ayurveda and Siddha: indigenous systems of medicine, Metallurgy and chemistry in ancient India.	10
4	**Indian Literature and Linguistics:** Classical Sanskrit literature: Ramayana, Mahabharata, and the Puranas, Tamil Sangam literature and regional literary traditions, The development of linguistics in India: Panini's Ashtadhyayi, Impact of Indian literary works on modern thought and literature	10
5	**Indian Environmental Knowledge and Sustainable Practices:** Traditional environmental practices and ecological knowledge in ancient India, Sacred groves, water conservation, and sustainable agriculture, Traditional systems of animal care and biodiversity conservation, The relevance of ancient practices in modern environmental conservation.	10

SUGGESTED TEXT BOOKS:

1. "The Cultural Heritage of India" – The Ramakrishna Mission
2. "Ancient Indian Education" by Radha Kumud Mookerji
3. Indian Philosophy" by S. Radhakrishnan
4. A Concise History of Science in India" by D. M. Bose, S. N. Sen, and B. V. Subbarayappa
5. - "Ayurveda: Life, Health and Longevity" by Robert Svoboda
6. "The Ramayana" by Valmiki (Translation)
7. - "History of Indian Literature" by Maurice Winternitz
8. - "The Ashtadhyayi of Panini" by Panin

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Understand the Philosophical Foundations of Indian Knowledge
2. Analyze Traditional Indian Contributions to Science and Mathematics
3. Evaluate the Interconnectedness of Indian Art, Literature, and Spirituality
4. Apply Indian Ethical and Environmental Wisdom to Contemporary Issue

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	2	2	2
CO2	-	-	2	3	3
CO3	3	1	2	2	-
CO4	2	2	3	3	2

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SEMESTER-2

(CORE COURSE-3)

BIOCHEMISTRY(BBT 211)

OBJECTIVES: To consolidate students' training in chemistry, biology and other aspects of disciplines, and combining both to generate a better understanding of the principle of biochemistry and metabolism of biomolecules.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	**Bioenergetics:** Laws of thermodynamics, free energy change, enthalpy, entropy, equilibrium constant, flow of electrons, electron carriers, redox potential, redox coupling & ATP bioenergetics, High energy compounds.	10
2	**Introduction to Metabolism:** Anabolic, catabolic and amphibolic pathways. Enzymes in metabolism: Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, active site, allosteric site, apoenzyme, holoenzyme, substrate inhibitor, modulator. IUBMB classification of enzymes, Fischer's and Koshland's hypothesis.	10
3	**Metabolism in mitochondria:** Biological oxidation - enzymes involved in oxidation and reduction, reactions catalyzed by dehydrogenases, oxidases, peroxidases and oxygenases; removing of H2O2 from the biologic systems. Macroergic compounds. Respiratory chain, oxidative phosphorylation, inhibitors of the respiratory chain. The action of uncouplers; chemiosmotic theory. Glycolysis, Citric acid cycle, central role of Acetyl CoA, localization of TAC in the cell, Inborn errors: Type 1 Diabetes mellitus.	10
4	**Metabolism of lipids:** Biosynthesis of fatty acids, membrane phospholipids, fatty acid synthase complex, regulation, Microsomal & Mitochondrial system of chain elongation & synthesis of unsaturated fatty acids. β-oxidation of fatty acids, role of carnitine, oxidation of unsaturated fatty acids & odd carbon fatty acids. Inborn errors: Disorders of Fatty acid oxidation metabolism– Medium chain acyl coenzyme A dehydrogenase deficiency.	10
5.	**Metabolism of Nitrogenous Compounds**: Transamination (mechanism). Oxidative & Non-oxidative deamination. Urea cycle, linkage of urea & TCA cycle. Transmethylation & Decarboxylation, physiologically important products of decarboxylation. Synthesis and degradation of nucleotides (DNA). Disorders of Amino acid metabolism- Phenylketonuria, Disorders of Urea cycle– Carbamoyl phosphate synthetase I deficiency. Disorders of nucleotide metabolism – Lesch-Nyhan syndrome.	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Berg, J.M., Stryer, L., Tymoczko, J.L. and Gatto, G.J. (2015). Biochemistry (8th ed.). New York, USA: WH Freeman.

2. Conn, E.E., Stumpf, P.K., and Bruening, G. (2006). Outlines of Biochemistry (5th ed.). New Jersey: Wiley-Blackwell.
3. Copeland, R.A. (2008). Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis (2nd ed.). India: Wiley-VCH.
4. Gupta, S.N. (2015). Biochemistry (2nd ed.). Meerut: Rastogi Publication.
5. Jain, J.L., Jain, S., and Jain, N. (2016). Fundamentals of Biochemistry (7th ed.). New Delhi: S Chand

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Demonstrate broad knowledge of the biomolecules, machinery and information that flow within living cells and an appreciation of how these underpin all biological processes, in both normal and diseased states.
2. Demonstrate proficiency in core biochemical laboratory techniques, understanding both the principles and applications of these methods within the molecular biosciences.
3. Understand enzyme actions and kinetics

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	-	-	2
CO2	3	2	2	-	3
CO3	3	-	3	-	2

BIOCHEMISTRY LAB (BBT 271)

COURSE OBJECTIVES: This course will enable the students gain basic knowledge of biochemical methods and their application in biology. Better understand these theories, methods and its practical.

Credits: 01 L-T-P: 0-0-2

Module No	Content	Teaching Hours
1	1. Preparation of buffers. 2. Estimation of protein and to find out the λmax of protein (BSA). 3. Qualitative analysis of carbohydrates, lipids and proteins 4. Determination of iodine number. 5. Determination of the acid value of lipid. 6. Demonstration of saponification value of fats and oil. 7. Preparation and precipitation of casein from buffalo milk.	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Berg, J.M., Stryer, L., Tymoczko, J.L. and Gatto, G.J. (2015). Biochemistry (8th ed.). New York, USA: WH Freeman.
2. Conn, E.E., Stumpf, P.K., and Bruening, G. (2006). Outlines of Biochemistry (5th ed.). New Jersey: Wiley-Blackwell.
3. Copeland, R.A. (2008). Enzymes: A Practical Introduction to Structure, Mechanism and Data Analysis (2nd ed.). India: Wiley-VCH.
4. Gupta, S.N. (2015). Biochemistry (2nd ed.). Meerut: Rastogi Publication.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Apply various tools and techniques to understand different biochemical processes of experimentation and hypothesis testing.
2. Identify and distinguish the carbohydrates, proteins and lipids based on specific biochemical tests.
3. Apply the gained knowledge to develop entrepreneurship skills in both academics and industries.

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(CORE COURSE-4)

PLANT PHYSIOLOGY (BBT 212)

COURSE OBJECTIVES: Plant physiology explains the various tissue systems of plants and the physiochemical processes taking part in the plants for transport of water, minerals and ions.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	The shoot and root apical meristem and its histological organization, simple & complex permanent tissues, primary structure of shoot & root, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf).	10
2	Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport.	10
3	Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, Calvin cycle, CAM plants, photorespiration, compensation point. Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.	10
4	Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberellins, cytokinins, abscisic acid, ethylene). Physiological role and mode of action, seed dormancy and seed germination, concept of photo-periodism and vernalization.	10

SUGGESTED TEXTBOOKS:

1. Ambhast, R.S. (2008). Plant Ecology. New Delhi: CBS.
2. Dutta, S.C. (2012). Plant Physiology. New Delhi: New age International Publishers.
3. Hopkins, W.G., & Huner, N.P.A. (2008). Introduction to Plant Physiology. New Jersey: John Wiley and Sons Inc.

SUGGESTED REFERENCE BOOKS:

1. Narst, V., Devlin & Witham. (1974) Plant Physiology. New Delhi: East West Press.
2. Noggle, G.R., & Fritz, G.J. (1992). Introductory Plant Physiology. New Delhi: Prentice Hall of India.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Students will be able to understand the various physiological life processes in Plants
2. They will also gain about the various uptake and transport mechnisms in plants and are able to coordinate the various processes.
3. They understand the role of various harmones, signaling compounds, thermodynamics and enzyme kinetics.
4. students will gain knowledge about various mechanisms such as channel or transport proteins involved in nutrient uptake in plants

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	-	1
CO2	-	-	3	-	2
CO3	-	-	2	1	-

(CORE COURSE-5)

MAMMALIAN PHYSIOLOGY (BBT 213)

COURSE OBJECTIVES: The course will make the students understand regarding the mammalian physiology at the molecular, cellular, and system levels in integrative physiology.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice. Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.	10
2	Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.	10
3	Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.	10
4	Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Chaterjee, C.C. (2005). Human Physiology Vol-II (11th ed.).
2. Chaterjee, C.C. (2018). Human Physiology Vol-I (12th ed.). NewDelhi: CBS Publishers & Distributors.
3. Guyton, A.C., & Hall, J.E. (2015). Textbook of Medical Physiology (13th ed.). USA: Saunders.
4. Jurd, R.D. (2003). Instant notes in Animal Biology. New Delhi: Viva Books Pvt. Ltd.

COURSE LEARNING OUTCOME:

On completion of this course, the students will be able to:

1. Gain basic understanding of structure and functions of each physiological system of human.
2. Describe principles and pathway of metabolism of carbohydrate, protein and lipids.
3. Develop an understanding about principles of human anatomy and physiology.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	3
CO2	3	2	3	2	1
CO3	3	1	2	1	2

PHYSIOLOGY LAB (BBT 272)

COURSE OBJECTIVES: The course will make the students learn about various solution standardization, viscosity and basics of titration.

Credits: 01 L-T-P: 0-0-2

Module No	Content	Teaching Hours
1	1. Estimation of Haemoglobin percentage by Haemocytometer. 2. Enumeration of the total number of red blood corpuscles (R.B.C.) & (W.B.C.) 3. Determination of ABO blood groups and Rh factor. 4. Study of effect of isotonic, hypotonic and hypertonic solutions on R.B.C. 5. Determination of the presence of sugar and albumin in the urine sample. 6. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf. 7. Respiration: CO_2 is produced during respiration, Loss of dry weight in respiration, Anaerobic respiration. 8. Osmosis: Grapes and dried raisins, Potato osmoscope and semi permeable membrane, Plasmolysis and deplasmolysis. Demonstration of opening & closing of stomata 9. Separation of photosynthetic pigments by paper chromatography. 10. Isolation and osevation of stomatal density through leaf disc	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Chaterjee, C.C. (2018). Human Physiology Vol-I (12th ed.). NewDelhi: CBS Publishers & Distributors.
2. Guyton, A.C., & Hall, J.E. (2015). Textbook of Medical Physiology (13th ed.). USA: Saunders.
3. Jurd, R.D. (2003). Instant notes in Animal Biology. New Delhi: Viva Books Pvt. Ltd.
4. Dutta, S.C. (2012). Plant Physiology. New Delhi: New age International Publishers.
5. Hopkins, W.G., & Huner, N.P.A. (2008). Introduction to Plant Physiology. New Jersey: John Wiley and Sons Inc

COURSE LEARNING OUTCOME:

On completion of this course, the students will be able to:

1. Understand the estimation of Haemoglobin percentage

2. Handling for ABO blood groups determination

3. Understand the physiological details of photosynthesis and respiration.

4. Design experiments, collect and analyze data, critically evaluate, and present the data produced in physiology.

(ABILITY ENHANCEMENT COMPULSORY COURSE-2)

FUNCTIONAL ENGLISH -I (BBT 214)

COURSE OBJECTIVES: To introduce corrective measures to eliminate grammatical errors in speaking and writing.

Credits: 02 L-T-P: 2-0-0

Module No	Content	Teaching Hours
1	**Fundamentals of Grammar and Vocabulary:** Parts of speech: nouns, verbs, adjectives, adverbs, pronouns, prepositions, conjunctions, Sentence structure: subject-verb agreement, types of sentences (simple, compound, complex), Tenses and verb forms: past, present, and future tenses, Common errors in grammar: articles, prepositions, and word order, Vocabulary building: synonyms, antonyms, and contextual usage	8
2	**Reading and Comprehension Skills:** Skimming and scanning techniques, Identifying main ideas and supporting details, Understanding scientific and technical vocabulary, Reading comprehension of scientific articles and reports, Summarizing and paraphrasing academic texts	8
3	**Writing Skills:** Paragraph writing: topic sentences, coherence, and unity, Writing scientific essays and short reports, Drafting and editing academic papers, Writing formal letters, emails, and applications, Introduction to citation and referencing styles (APA/MLA)	8
4	**Speaking and Listening Skills:** Pronunciation, stress, and intonation for clear speech, Presenting scientific topics orally, Engaging in academic discussions and debates, Listening to lectures, academic talks, and scientific podcasts, Listening for specific information and note-taking techniques	8

SUGGESTED TEXTBOOKS & REFERENCES:

1. Leech, G. & J. Svartvik (2002) A Communicative Grammar of English. Pearson, India.
2. Pandey J. H. (2008) Complete Grammar, Shree Book Centre, Mumbai, India.
3. Murphy, R. (2009) Intermediate English Grammar. Cambridge Univ. Press, India.
4. Hewings, M. (2011) Advanced English Grammar. Cambridge Univ. Press, India.
5. Wren, P. C. & H. Martin (2000) High School English Grammar and Composition, S. Chand & Co, New Delhi.

COURSE OUTCOME: On completion of this course, the students will be able to:

1. Theoretical and conceptual understanding of the elements of grammar.
2. To enhance the learners' ability of communicating accurately and fluently.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	1	1	3
CO2	1	2	1	2	3

(SKILL ENHANCEMENT COURSES-2)

APPLICATION OF BIOTECHNOLOGY IN AGRICULTURE (BBT 215)

COURSE OBJECTIVES: This course is designed to impart knowledge and skill on understanding the Concepts of diversified Biotechnological application in the field of Agriculture,

Credits: 03 L-T-P: 3-0-0

Module No	Content	Teaching Hours
1	Principles of Biotechnological Application in Agriculture , Introduction to microbial world , Prokaryotic and eukaryotic microbes. Microbial growth in models of bacterial, yeast and mycelia growth curve	10
2	Role of microbes in soil fertility and crop production. Biological nitrogen fixation- symbiotic, associative and asymbiotic.Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere.	10
3	Microbes in human welfare and silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro-waste. Mushroom culture.	10
4	Applications of Plant Genetic Engineering – crop improvement, herbicide resistance,insect resistance, virus resistance, plants as bioreactors. Genetic modification in Agriculture –transgenic plants, genetically modified foods, application, future applications, ecological impact of transgenic plants.	10

SUGGESTED TEXTBOOKS

Naveen Kango , 2010, Text Book of Microbiology , I.K. International Publishing House Pvt.Ltd
G. Rangaswami, D.J. Bagyaraj , 2016 , Agricultural Microbiology, PHI Learning Pvt.Ltd
Shiva Aithal, Nikhilesh Kulkarni , 2010, Modern Approaches Soil Agriculture .
Environmental Microbiology , Himalaya Publishing House
Ahindra Nag , 2008 , Text Book Of Agricultural Biotechnology, PHI Learning

REFERENCE BOOKS

Microbiology. Pelczar, J.r.,M.J.E.C.S.Chan and Krieg, N.R, 2009, McGraw Hill Publishers
Microbiology. Prescott, L.M, Harley, J.P. and Klein, D.A., 2008, McGraw Hill Publishing Ltd

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Learn and gain knowledge about Concept of application of diversified biotechnological applications in the field of Agriculture
2. Learn and gain knowledge about Concept , types , components , production and application and impacts of Biofertilizers, Biopeticides , Mushrooms , GMOs , Genetic Engineering , Recombinant DNA Technology , Tissue culture , Biofuel etc.
3. Comprehend the systems , components , types , process of operation demands of the Agriculture Biotechnology Industry
4. Learn to apply technical knowledge and skills required for understanding and application of the Agriculture Biotechnology

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	3	3	2	2
CO3	3	2	2	1	1
CO4	3	3	2	2	2

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(VALUE ADDITION COURSE-2)

ECOLOGY AND ENVIRONMENTAL SCIENCE (VBT 211)

COURSE OBJECTIVES: Recognize major concepts in environmental sciences and demonstrate in depth understanding of the environment. The course deals with the components of environment, ecosystem, environmental pollution and health hazards and finally the protection and preservation of environment.

L-T-P: 2-0-0

Credits: 02

Module No.	Content	Teaching Hours
1	**Introduction to Environmental Science:** Definition and scope and need for public awareness; Ecosystem: Concept, Structure and Function of Ecosystem, Productivity and Food chain and Food web, Ecological Pyramids, Energy flow in Ecosystem, Restoration of Damaged Ecosystem.	10
2	**Biodiversity:** Definition, Description at National and Global level, Levels, Gradients and Use of Biodiversity, Hot Spots of Biodiversity, Threats and Conservation of Biodiversity. Extinction of species, Biodiversity assessment, Biosphere Reserves, International Efforts to conserve Biodiversity.	10
3	**Natural Resources:** Renewable and Non-renewable and their equitable use for sustainability, Material Cycles: Carbon, Nitrogen and Sulphur Cycle, Conventional and Non-Conventional Energy Resources – Fossils fuel based, Hydroelectric, Wind, Nuclear and Solar Energy, Biomass, Biodiesel, Hydrogen as an alternative fuel, Resettlement and Rehabilitation.	10
4	**Environmental Changes and Human Health:** Social issues related to environment – sustainable development, urban problems related to water and energy conservation and waste management, resettlement and rehabilitation, Environmental ethics. Environmental pollution – causes and effect, control measures for water, air and soil, marine, land, noise, thermal pollution, Climate change, green house effect, Global Warming Acid Rain, Ozone layer formation and depletion, Impact on human health	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House

COURSE OUTCOME:

By the end of this class, the student should be able to:

1. Integrate the various disciplines and fields related to the environment to solve the environmental issues
2. Create an awareness, knowledge, and appreciation of the intrinsic values of ecological processes and communities.
3. Adopt integrative approach towards the environmental issues with a special focus on sustainability.
4. Describe human population characteristics and growth, and recognize the impacts of human society on Earth's systems and resources
5. Describe ecosystems in terms of how they vary, are structured, and function both internally and as part of the larger biosphere.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	-	1
CO2	3	2	1	2	2
CO3	1	2	3	-	1
CO4	1	2	-	1	2
CO5	3	2	-	2	1

Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.

(VOCATIONAL COURSE 1)
PLANT BIOTECH & GENETIC IMPROVEMENT (VBT 212)

OBJECTIVES: The course focuses on the fundamental principles and applications of plant biotechnology for genetic improvement. Students will gain hands-on experience in techniques like plant tissue culture, transgenesis, and genetic engineering, which are crucial for developing genetically improved plant varieties.

L-T-P: 2-0-0
Credits: 02

Module No	Content	Teaching Hours
1	**Overview of Plant Biotechnology:** Importance of plant biotechnology in agriculture and food security, Key areas: tissue culture, genetic engineering, marker-assisted selection **Genetic Improvement in Plants:** Traditional plant breeding vs. biotechnological approaches, Role of genetic diversity, domestication, and hybridization in crop improvement	10
2	**Introduction to Plant Tissue Culture:** Principles of plant tissue culture, Types of cultures: callus culture, organ culture, cell suspension culture **Applications of Tissue Culture in Genetic Improvement:** Micropropagation, somatic embryogenesis, and clonal propagation, Production of disease-free and high-yielding plants	10
3	**Principles of Genetic Transformation:** Agrobacterium-mediated transformation: Ti plasmid, T-DNA integration, Direct gene transfer methods: gene gun, electroporation **Transgenic Plants and GM Crops:** Development of genetically modified crops (Bt crops, herbicide resistance), Ethical considerations and regulatory aspects of GM crops	10
4	**Molecular Markers in Plant Breeding:**Types of markers: RFLP, RAPD, SSR, SNP - Marker-assisted selection (MAS) and its role in plant breeding **CRISPR-Cas9 and Genome Editing in Plants:** Basics of CRISPR-Cas9 technology, Applications of genome editing in developing improved crops	10
5	**Successful Case Studies of Transgenic Crops:** Bt cotton, Golden Rice, drought-resistant crops, Applications in sustainable agriculture and food security **Challenges and Future Prospects:** Environmental and socio-economic impacts of GM crops, Innovations in plant biotechnology: synthetic biology, precision agriculture	10

SUGGESTED TEXT BOOKS:

1. "Plant Biotechnology: Principles and Applications" by Adrian Slater, Nigel Scott, and Mark Fowler
2. "Plant Tissue Culture: Theory and Practice" by S.S. Bhojwani and M.K. Razdan
3. "Transgenic Plants: Methods and Protocols" edited by Leandro Peña
4. Online resources: NCBI, TAIR, Phytozome, etc.

COURSE OUTCOME:

By the end of this class, the student should be able to:

1. Understand the basic principles of plant biotechnology and genetic improvement.
2. Gain practical experience in plant tissue culture and genetic transformation techniques.
3. Learn how to apply molecular markers and bioinformatics tools for plant genetic analysis.
4. Be able to critically evaluate the use of GM crops and their impact on agriculture.
5. Acquire the skills needed to pursue internships or careers in plant biotechnology and related industries.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	1	3	-
CO2	-	-	-	-	-
CO3	-	-	3	3	2
CO4	-	-	3	3	2
CO5	-	-	2	3	-

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(VOCATIONAL COURSE 2)
GENETIC ENGINEERING TECHNIQUES (VBT 213)

OBJECTIVES: This course aims to introduce students to essential genetic engineering techniques used in biotechnology research and industry. Students will gain hands-on experience in gene cloning, DNA manipulation, and the use of advanced molecular tools such as CRISPR-Cas9 for gene editing..

L-T-P: 2-0-0
Credits: 02

Module No	Content	Teaching Hours
1	**Overview of Genetic Engineering:** Definition, history, and applications in medicine, agriculture, and industry, Difference between genetic modification and genetic engineering **Basic Tools and Enzymes Used in Genetic Engineering:** DNA ligases, restriction enzymes, reverse transcriptase, and polymerases, Vectors: plasmids, viral vectors, cosmids, BACs, and YACs	10
2	**DNA Isolation from Various Sources:** Isolation of genomic DNA from bacteria, plant, or animal tissues, Extraction of plasmid DNA from bacterial cultures **DNA Purification and Quantification:** Techniques for purifying DNA: phenol-chloroform extraction, ethanol precipitation, Quantification of DNA using spectrophotometry (A260/A280 ratio)	10
3	**Introduction to Gene Cloning:** Basic steps: cutting, ligation, transformation, selection, and screening, Use of restriction enzymes and ligases for cloning **Transformation and Selection of Recombinant DNA:** Bacterial transformation methods: heat shock, electroporation, Screening methods: blue-white screening, antibiotic selection	10
4	**Principles and Types of PCR:** Components and steps in PCR: denaturation, annealing, extension, Variations: Reverse transcription PCR (RT-PCR), quantitative PCR (qPCR) **Applications of PCR in Genetic Engineering:** PCR-based cloning, gene amplification, mutation analysis, Diagnostic applications in detecting genetic disorders	10
5	**Applications of Genetic Engineering:** Production of recombinant proteins (e.g., insulin, growth hormones), Development of genetically modified organisms (GMOs) in agriculture (e.g., Bt crops) **Ethical Considerations in Genetic Engineering:** Bioethics in genetic engineering: GMOs, gene editing in humans, Regulatory frameworks: FDA, USDA, biosafety concerns	10

SUGGESTED TEXT BOOKS:

1. "Gene Cloning and DNA Analysis: An Introduction" by T.A. Brown
2. "Molecular Cloning: A Laboratory Manual" by Michael R. Green and Joseph Sambrook
3. "Genetic Engineering: Principles and Methods" edited by Jane K. Setlow
4. Online resources: NCBI, Addgene, CRISPR tools (CRISPR design websites), etc.

COURSE OUTCOME:

By the end of this class, the student should be able to:

1. Understand the principles and applications of genetic engineering techniques.
2. Gain practical skills in gene cloning, DNA isolation, and PCR-based methods.
3. Be familiar with advanced gene editing techniques like CRISPR-Cas9.

4. Critically evaluate the ethical and regulatory issues surrounding genetic engineering.
5. Be prepared for internships or research roles in molecular biology, genetic engineering, or biotechnology industries.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	1	3	-
CO2	-	-	-	-	-
CO3	-	-	3	3	2
CO4	-	-	3	3	2
CO5	-	-	2	3	-

05/10/2024

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SEMESTER-3

(CORE COURSE-6)

GENERAL MICROBIOLOGY (BBT 311)

OBJECTIVES: This course introduces students to the basic concepts of microbiology, the history and development of microbiology.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including Molecular approaches, Microbial phylogeny and current classification of bacteria.	10
2	Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.	
3	Cultivation and Maintenance of microorganisms: Nutritional categories of microorganisms, methods of isolation, Purification and preservation. Control of Microorganisms: By physical, chemical and chemotherapeutic agents.	10
4	Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways. Genetic recombination in bacteria: Transformation, Transduction and Conjugation.	10
5	Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods. Introduction to microbial ecology.	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition, CBS Publishers and Distributors, Delhi, India.
2. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
3. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings

4. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Understand the basic microbial structure, function and study the comparative characteristics of prokaryotes and eukaryotes.
2. Understand the structural similarities and differences among various physiological groups of bacteria/archaea.
3. General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	-	1
CO2	3	-	1	-	1
CO3	3	-	3	2	-

GENERAL MICROBIOLOGY LAB (BBT 371)

COURSE OBJECTIVES: The main purpose of this course is to master the students with practical knowledge of microbiology that they are being taught, and to provide practical technical training related to microbiology.

Credits: 01

Module No	Content	Teaching Hours
1	1. Study of different sterilization methods used in microbiology lab. 2. Preparation of various media for microbs. 3. Methods of isolation of bacteria from different sources. 4. Serial dilution analysis . 5. Isolation of bacteria and their biochemical characterization. 6. Determination of bacterial cell size by micrometry. 7. Enumeration of microorganism - total & viable count. 8. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition, CBS Publishers and Distributors, Delhi, India.
2. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
3. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Culture, isolate and purify microbes form various sites.
2. Learn various techniques of media preparation and sterilization method.
3. Observe the morphology by using different staining techniques.

(CORE COURSE-7)

BIOINSTRUMENTATION (BBT 312)

COURSE OBJECTIVES: The primary objectives of this course are to develop the skills to understand the theory and practice of bio analytical techniques.

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	**Biophysical methods:** Introduction of concept of pH, Measurement of pH, pOH, Buffer action.	10
2	**Separation & Identification of Materials**: Concept mechanism and applications of Chromatography (Partition Chromatography, Paper Chromatography, Adsorption Chromatography, TLC, GLC, Ion Exchange Chromatography, Gel Chromatography, HPLC, Affinity Chromatography); Electrophoresis (Gel Electrophoresis, Paper Electrophoresis), Isoelectric focussing	10
3	**Centrifugation**: Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical), Factors affecting Sedimentation velocity, Standard Sedimentation Coefficient, rotor types, Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation and its applications	10
4	**Microscopy:** Light microscopy, Bright & Dark Field microscopy, Fluorescence microscopy, Phase Contrast microscopy, Electron microscopy (TEM, SEM), **Spectroscopy:** Basic concepts, principle, working, care & maintenance of UV VIS and FT-IR Spectroscopy.	10
5	**X-Ray Crystallography:** Concept of X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal structure, determination of crystal structure (concept of rotating crystal method, powder method).	

SUGGESTED TEXTBOOKS:

1. Cromwell, L. and Weibell, F.J. and Pfeiffer, E.A., Biomedical Instrumentation and Measurement, Dorling Kingsley (2006) 2nd ed.
2. Carr, J.J. and Brown, J.M., Introduction to Biomedical Equipment Technology, Prentice Hall (2000) 4th ed.
3. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.

REFERENCE BOOKS:

1. Khandpur, R.S., Handbook of Biomedical Instrumentation, McGraw Hill (2003) 2nd ed.
2. Webster, J.G., Medical Instrumentation Application and Design, John Wiley (2007) 3rd ed.

Biophysical Techniques By Iain Campbell • 2012, 9780199642144, 0199642141, QUP Oxford.

Online links for study & reference materials:

https://microbenotes.com/category/instrumentation/
https://lecturenotes.in/download/material/18824-note-of-bioinstrumentation-by-nithya-biotech.
http://biomedikal.in/2009/12/lecture-notes-on-biomedical-instrumentation/

COURSE OUTCOME:

After completion of the Course, the student will be able to:

1. Enable the student to get sufficient knowledge in principles and applications of bio instruments.
2. To enable the students to learn the immuno techniques and radio labelling techniques.
3. To differentiate and analyze the biomedical signal sources.
4. Describe the Basic concept of various microscopic techniques
5. Understand the basic principle and application of X-Ray Crystallography and spectroscopy.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	-	2
CO2	3	-	2	1	3
CO3	3	1	2	1	-
CO4	3	-	3	1	2
CO5	3	1	2	-	-

BIOINSTRUMENTS LAB (BBT 372)

COURSE OBJECTIVES: This course contains bio analytical techniques along with their theory, working principal, common instrumentation and possible applications.

Credits: 01

Module No.	Contents	Lab Hours
I	1. Operation of shakers, incubators, pH meters and centrifuges 2. Buffer preparation- Phosphate/Acetate/Citrate 3. Demonstration of different types of centrifuges 4. Separation of amino acids by paper chromatography 5. Native gel electrophoresis of proteins 6. Agarose Gel Electrophoresis. 7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Wilson, K. and Walker, J. Practical Biochemistry – Principles and techniques 7th edition, 2010, Cambridge University Press,
2. Brawer, I M., Perce, A.M., Experimental techniques in Biochemistry. Prentice Hall Foundation, New York 2012.

Further Readings:

3. Joseph Sambrook and David. W. Russel, Molecular Cloning- A laboratory manual, 4th edition, 2012, Cold spring harbor press.

COURSE OUTCOME

After completion of the Course, the student will be able to:

1. The students will become familiar with working principals, tools and techniques of analytical techniques.
2. After completion students can get employment in academic and industrial research organization based on biotechnology, pharmacy, agriculture, and chemical.

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-2)

MOLECULAR DIAGNOSTICS TECHNIQUES (BBT 313)

COURSE OBJECTIVES: The course in skill enhancement provides an insight into different diagnostic techniques to the students.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes, immuno blotting. histochemical techniques. Paper based diagnosis (biosensor, colorimetric), Immunodiagnostic tests. Immuno florescence. Radioimmunoassay. Applications of enzyme immunoassays in disease diagnosis.	10
2	Applications of various kinds of PCR: qPCR, RTPCR. RFLP, RAPD, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures.	10
3	Automation in microbial diagnosis, standardization of antigen and specific antibodies, Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications.	10
4	Genetic testing: chromosome banding patters, banding techniques and their correlates, karyotyping; Ethical, Social and Legal Issues to Molecular -Genetic Testing.	10
5.	Cell sorting- Flow cytometry and FACS. Neonatal and prenatal diagnosis. Sex identification in forensics. Diagnostic Testing for Cystic Fibrosis. Molecular Testing for HIV-1.	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.

COURSE LEARNING OUTCOME:

On completion of this course, the students will be able to:

1. Knowledge of different diagnostic techniques.
2. Learn the concept of histochemical-immuno assay.
3. Know about the applications of molecular marker.
4. Know the applications and clinical role of the monoclonal and polyclonal antibodies.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	3
CO2	3	1	2	-	1
CO3	3	-	2	-	1
CO4	3	1	2	-	3

MOLECULAR DIAGNOSTICS TECHNIQUES LAB (BBT 373)

COURSE OBJECTIVES: The course in skill enhancement provides an insight into different diagnostic techniques practically to the students.

Credits: 01 L-T-P: 0-0-2

Module No	Content	Teaching Hours
I	Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.) 1. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture 2. A kit-based detection of a microbial infection (Widal test). 3. Demonstration of study of Electron micrographs. 4. Immuno-diagnostic test (Typhoid, Malaria, Dengue) (anyone) 5. PCR analysis/ demonstration. 6. Perform/demonstrate RAPD and its analysis.	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
4. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
5. Microscopic Techniques in Biotechnology, Michael Hoppert

Online:

https://microbiologyinfo.com/widal-test-introduction-principle-procedure-interpretation-and-limitation/

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Knowledge of detection methods of communicable diseases.
2. Knowledge of molecular marker analysis.

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(GENERIC ELECTIVE-1)

DEVELOPMENTAL BIOLOGY (BBT 314)

COURSE OBJECTIVE: The course in Developmental Biology provides an insight into the genetic and physiological control of animal development.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Gametogenesis: Definition, scope & historical perspective of development Biology, Gametogenesis – Spermatogenesis, Oogenesis. Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk	10
2	Early embryonic development: Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos	10
3	Embryonic Differentiation; Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level.	10
4	Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.	10
5	Organogenesis: Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals	10

SUGGESTED TEXTBOOKS:

1. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Gain expertise in explaining how a variety of interacting processes generate an organism's heterogeneous shapes, size and structural features that arise on the trajectory from embryo to adult or more generally throughout a life cycle.
2. Gain an understanding of systematic and organized learning about the knowledge and concepts of

growth and development of organisms.

3. Demonstrate a rich array of material and conceptual practices that could be analysed to better understand the scientific reasoning exhibited in experimental life sciences.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOME

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	-	1
CO2	3	-	-	2	2
CO3	3	1	2	-	-

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(ABILITY ENHANCEMENT COMPULSORY COURSE-3)

COMMUNICATION SKILL (BBT 315)

COURSE OBJECTIVE: This course will enhance the English communication, speaking, reading and writing skills of a student.

Credits: 02 L-T-P: 2-0-0

Module No	Content	Teaching Hours
1	**Introduction**: Theory of Communication, Types and modes of Communication	8
2	**Language of communication:** Verbal, and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication	8
3	**Speaking skills:** Monologue, Dialogue, Group Discussion, Effective Communication, / Mis Communication, Interview, Public speech.	8
4	**Reading and understanding:** Close reading comprehension, Summary paraphrasing analysis, & interpretation, translation, Literary knowledge text.	8
5	**Writing skills:** Documenting, report writing, making notes, Letter writing.	8

SUGGESTED TEXTBOOKS & REFERENCES:

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. To make students proficient in oral communication and writing.
2. Students should be able to write analytically in a variety of formats, including essays, reflective writing, and critical reviews of secondary sources.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	-	-	2
CO2	-	2	-	1	2

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(VALUE ADDITION COURSE-2)
PHYSICAL EDUCATION AND YOGA (VBT 311)

COURSE OBJECTIVES: This course is designed to impart knowledge on understanding the concepts of Physical Education and Yoga for Health fitness and wellness.

Credits: 02 L-T-P: 2-0-0

Module No	Content	Teaching Hours
1	**Physical Education:** Meaning, Definition, Aim and Objective, Misconception About Physical Education. Need, Importance and Scope of Physical Education in the Modern Society, Physical Education Relationship with General Education.	10
2	**Concept of Fitness and Wellness:** Meaning, Definition and Importance of Fitness and Wellness, Components of Fitness, Factor Affecting Fitness and **Wellness.** Weight Management: Meaning and Definition of Obesity, Causes of Obesity., Management of Obesity, Health problems due to Obesity. Lifestyle: Meaning, Definition, Importance of Lifestyle, Factor affecting Lifestyle, Role of Physical activity in the maintains of Healthy Lifestyle	10
3	**Yoga and Meditation**: Historical aspect of yoga. Definition, types scopes & importance of yoga, Yoga relation with mental health and value education, Yoga relation with Physical Education and sports, Definition of Asana, differences between asana and physical exercise, Definition and classification of pranayama, Difference between pranayama and deep breathing.**Practical:** Asana, Suraya-Namaskar, Bhujang Asana, Naukasana, Halasana,Vajrasan, Padmasana, Shavasana, Makrasana, Dhanurasana, Tad Asana. Pranayam: Anulom, Vilom.	10

SUGGESTED TEXTBOOKS

1. Singh, Ajmer, Physical Education and Olympic Abhiyan, "Kalayani Publishers", New Delhi, Revised Addition, 2006
2. Patel, Shri krishna, Physical Education, "Agrawal Publishers", Agra, 2014-15
3. Panday, Preeti, Sharirik Shiksha Sankalan, " Khel Sanskriti Prakashan, Kanpur

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Learn the introduction of Physical Education, Concept of fitness and wellness

2. Weight management and lifestyle of an individual.
3. Learn about the relation of Yoga with mental health and value Education.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	-	1	1
CO2	-	3	-	1	2
CO3	1	3	1	1	2

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SEMESTER-4

(CORE COURSE-8)

MOLECULAR BIOLOGY (BBT 411)

Objectives: This course aims to enable students to master the following knowledge about genetic material i.e., DNA, DNA transcripts, i.e., RNA and protein biosynthesis and their interrelationship.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Introduction to Molecular Biology, Types of genetic materials- Experiments of Griffith, Avery, MacLeod and McCarty, Hershey and chase, John Cairns experiment, Meselson- Stahl experiment, Central dogma of life.	8
2	Replication of DNA, Models of DNA replication, Mechanism of DNA replication in prokaryotes (initiation, elongation, replication fork, replication machinery, termination), Rolling Circle mechanism. Enzymes and proteins involved in DNA replication (nucleases, DNA polymerases, DNA helicases, gyrases, SSBP, topoisomerase, primase).	10
3	DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, non-homologous end joining. Homologous recombination:models and mechanism.	10
4	Mechanism of transcription in prokaryotes and eukaryotes. Enzymes and proteins involved in transcription, post transcriptional modifications. Inhibitors of transcription.	10
5	Genetic code - characteristics and properties, Wobble hypothesis. Protein biosynthesis in prokaryotes and eukaryotes, post translational modifications, protein degradation, Inhibitors of protein synthesis. Regulation of gene expression (lac, trp and gal operons).	10

SUGGESTED TEXT BOOK:

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

REFERENCE BOOKS

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

COURSE OUTCOMES:

On completion of this course, the students will be able to:

1. Learn DNA replication, transcription and translation
2. Understand the regulation of gene expression
3. Knowledge about DNA repair and damage

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	1	2
CO2	3	1	2	-	1
CO3	3	-	2	1	-

MOLECULAR BIOLOGY and RDT LAB (BBT 471)

COURSE OBJECTIVES: Provide hands on experiments in performing basic molecular biology techniques such as DNA isolation, gel electrophoresis

Credits: 01 L-T-P: 0-0-2

Module No	Content	Teaching Hours
I	Develop skills and understanding about different techniques used in Molecular Biology experiments. 1. Isolation of genomic DNA from bacterial cells. 2. Isolation of Plasmid DNA by *E.coli*. 3. Isolation of Plant DNA by CTAB method. 4. Agarose gel electrophoresis of genomic DNA & plasmid DNA. 5. Preparation of restriction enzyme digests of DNA samples. 6. Polymerase Chain Reaction 7. Restriction Analysis and Restriction digestion of pBR322	20

SUGGESTED TEXTBOOKS:

1. Brown T. A, Gene Cloning and DNA Analysis: An Introduction, (6th Edition) Wiley- Blackwell, 2010.
2. Winnacker L Ernst, From genes to clones -Introduction to gene technology (4th edition), Panima Publishing Corporation, 2003.

REFERENCE BOOKS:

1. Dubey R.C, Advanced Biotechnology (1st edition), Chand and Company, 2014.
2. Watson D James; et al Recombinant DNA: genes and genomes, (3rd edition), Basingstoke: Palgrave pacmillan, 2007.
3. Sathyanarayanan U, Biotechnology (2013) Books and allied (P) ltd.
4. Michael R. Green, Molecular Cloning: A Laboratory Manual (4th Edition), Cold Spring Harbor Laboratory Press.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Know about the isolation of chromosomal and plasmid DNA.
2. Perform application of PCR in rDNA technology.
3. Gain hands-on training in various molecular techniques for gene manipulation

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(CORE COURSE-9)

ENZYMOLOGY (BBT 412)

COURSE OBJECTIVES: This course has been designed to teach the student majoring in science all the major aspects of the study of enzymes.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Introduction to Enzymes: General introduction and historic background- General Terminology, Nomenclature and Classification of Enzymes. Criteria of purity of enzymes- Specific activity. Enzyme units-Katal and IU. Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNAzymes. Metalloenzymes and metal activated enzymes. Coenzymes and Cofactors- Prosthetic group.	10
2	Enzyme Catalysis: Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects etc. Mechanism of Serine proteases- Chymotryspin, Lysozyme, Carboxypeptidase A and Ribonuclease., Proenzymes (Zymogens).	10
3	Enzyme Kinetics and Inhibition: Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition. Kinetics Allosteric enzymes. Factors affecting the enzyme activity- Concentration, pH and temperature. Reversible Inhibition- Competitive, Non Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition.	10
4	Enzyme Regulation: Feedback Regulation, Allosteric Regulation, Reversible Covalent Modification and Proteolytic Activation. Enzymes in the cell, localization, compartmentation of metabolic pathways, enzymes in membranes, concentrations. Mechanisms of enzyme degradation, lysosomal and nonlysosomal pathways,examples.	10
5	Industrial Enzymes- Thermophilic enzymes, amylases, lipases, enzymes in industry, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes. Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflamatory agents, strptokinasae, asparaginase, Isoenzymes like CK and LDH, Transaminases (AST, ALT), Cholinesterases, Phosphatases.	10

SUGGESTED READIGS:

Text Books:

1. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, VEdition, W.H. Freeman and Co., New York.

Reference Books:

2. Voet D and Voet J (2012) Biochemistry . Fifth edition, Wiley.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009).
4. Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc. .

Online links for study & reference materials:

https://www.youtube.com/watch?v=ozdO1mLXBQE

https://www.youtube.com/watch?v=k5BFZ3_9MT8

https://courseware.cutm.ac.in/courses/enzymology/

COURSE OUTCOME: On completion of this course, the students will be able to:

1. To understand thebasic concepts of Enzyme
2. To learn about functioning and kinetics of several enzymes
3. To provide basic knowledge of enzyme use as a tools in industry, agriculture and medicine.
4. To study about the different applications of enzymes.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	1	2
CO2	2	-	2	1	2
CO3	1	3	2	1	-
CO4	2	-	3	2	1

05/01/2024

ENZYMOLOGY LAB (BBT 472)

COURSE OBJECTIVES: The course in skill enhancement provides an insight into enzymology and enzymes to the students

Module No	Content	Teaching Hours
1	1. Screening of microorganisms for enzyme production. 2. Effect of pH on enzyme activity. 3. Effect of Temperature on enzyme activity. 4. Ammonium sulphate precipitation of enzymes 5. Partial purification of enzymes by dialysis. 6. Colorimetric assay for enzyme activity 7. Quantitative estimation of proteins by Bradford/Lowry's method. 8. Effect of temperature on enzyme activity 9. Calculation of kinetic parameters such as Km, Vmax	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGraw Hill, 2009.
3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.
4. Practical Enzymology Hans Bisswanger Wiley–VCH 2004

COURSE OUTCOMES:

On completion of this course, the students will be able to:

1. know the principles of isolation and purification of enzymes from various sources.
2. comprehend various methods involved in enzyme technology and their commercial

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(CORE COURSE-10)

BASIC IMMUNOLOGY (BBT 413)

COURSE OBJECTIVES: To introduce the science of immunology and detailed study of various types of immune systems and their classification, structure and mechanism of immune activation

Credits: 4 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	Immunology - History & Milestones, Microbial infections and host resistance. Immune response: Innate & Adaptive responses, Humoral and cell mediated Immune Responses. Structures, composition and functions of cells and organs of immune system	**10**
2	Antigens & Immunogenicity. Antigens - Types, properties, Haptens, Adjuvants, Toxoids, Immunoglobulins- structure, types and properties, Theories of antibody formation, Structural and genetic basis of antibody formation.	**10**
3	Antigen and antibody reactions, Immunodiagnostic methods - Agglutination, precipitations, complement fixation, Coomb's test, RIA, ELISA and its types, Immunofluorescence, Production of Monoclonal Antibodies and Hybridoma technique..	**10**
4	Cytokines & Chemokines - Classification, types and its functions, Complement system: - structure, properties, functions of complement components and its pathways	**10**
5	Immune disorders and tumors: Types of tumors, tumor antigens, immune response to tumors. Immunodeficiency and Auto immune diseases, MHC - Structure and function of class I and class II MHC molecules, Hypersensitivity reactions: Type I, II, III and IV Transplantation immunology - types and mechanisms involved.	**10**

SUGGESTED TEXTBOOKS & REFERENCES:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

REFERENCE BOOKS

1. Male. D and Roth. D, Immunology (8 edition), Reed Elsevier India Pvt Limited 2013.

2. Khan. F.H. The Elements of Immunology, Pearson Education India, 2009

COURSE OUTCOMES:

On completion of this course, the students will be able to:

1. To learn fundamental principles of modern immunology.
2. Understand and apply related immunological techniques in medical laboratory.
3. Learn the concepts of developing bacterial and viral vaccines and adjuvants.
4. Learn the various immnuno-diagnostic tests- RIA, ELISA.
5. Relate and apply medical laboratory science knowledge to immunological changes in healthy and disease contexts.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	1	2	2	-	-
CO2	3	2	1	-	2
CO3	3	3	3	2	2
CO4	3	-	-	-	-
CO5	-	3	2	3	2

BASIC IMMUNOLOGY LAB (BBT 473)

COURSE OBJECTIVES: The objective of this course is to provide an introduction to experimental design and basic techniques commonly used in immunology research laboratories.

Credits: 01 L-T-P:0-0-2

Module No.	Contents	Lab Hours
I	1. Differential leucocytes count 2. Total leucocytes count 3. Total RBC count 4. Haemagglutination assay 5. Haemagglutination inhibition assay 6. Separation of serum from blood 7. Double immunodiffusion test using specific antibody and antigen 8. ELISA.	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

COURSE OUTCOMES:

On completion of this course, the students will be able to:

1. Have the ability to specimen handling
2. Can perform various immunological tests which augment the capability to understand related theory.

(GENERIC ELECTIVE-2)

ROLE OF BIOTECHNOLOGY IN FORENSIC SCIENCE (BBT 414)

COURSE OBJECTIVES: The course in skill enhancement provides an insight into various aspects of forensic sciences to the students.

Credits: 4 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1.	Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science.	10
2.	Causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.	10
3.	Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink in various samples.	10
4.	Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification.	10
5.	Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, e-Discovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).

COURSE OUTCOMES:

On completion of this course, the students will be able to:

1. To understand the principles and the tools and techniques of forensic science.

2. Gain knowledge of the applications of DNA profiling in forensic medicine.
3. Know the various investigation tools used in forensic science.
4. Have knowledge about the causes of crime, crime investigation and the medico-legal aspects of injuries.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	-	2	2
CO2	1	2	1	3	3
CO3	3	2	3	2	3
CO4	-	2	1	3	1

(SKILL ENHANCEMENT COURSES-3)

BIO-SAFETY AND ETHICS IN BIOLOGICAL SCIENCES (BBT 415)

COURSE OBJECTIVES: To apprise the students of the various societal, governance and regulatory issues in biotechnology with special emphasis on ethics, safety and intellectual property rights. Through this course, the students develop a perspective on the importance of these aspects in the success of biotechnology products and services in the market.

Credits: 03 L-T-P: 3-0-0

Module No	Content	Teaching Hours
1	Bioethics: Ethical issues related to biotechnology, legal and socioeconomic impacts of biotechnology, health and safety issues, Ethical issues in Human Cloning and stem cell research.	10
2	Biosafety– Introduction to biosafety and health hazards concerning biotechnology.Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	10
3	Risk assessment in biotechnological research and their regulation, physical and biological contaminants, Biosafety guidelines in India, Biosafety levels for plant, animal and microbial research.	10
4	Regulatory framework in Biotechnology: Regulation of RDT research, Prevention Food Adulteration Act (1955), Food Safety and Standards Bill (2005).	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers.
3. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Knowledge on Indian Patent Law, intellectual property.
2. Knowledge on biosafety issues related to Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).
3. Knowledge on Bioethics i.e., National & International. Ethical issues

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	-
CO2	1	3	-	3	3
CO3	3	2	2	2	-

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(VALUE ADDITION COURSE-4)
INNOVATION AND ENTREPRENEURSHIP (VBT 411)

COURSE OBJECTIVES: This course focus on the basis of Skills of bio-entrepreneur and biotechnology entrepreneurship. It basically covers the patenting, licensing and partnership in biotechnology industry It also covers the scope and importance of product development in biotech industries. It also includes about the marketing of the desired pharmaceutical drug..

Credits: 2 L-T-P: 2-0-0

Module No	Content	Teaching Hours
1	Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Scope of Biotechnology Entrepreneurship.	10
2	Biotechnology Marketing: Biotechnology in capital market; Initial Public Offering (IPO) in the capital market; examples of success and failure of biotechnology companies and the possible reasons; factors that influence success of company; product selection; failure of the product ; product development ; R&D with expertise ; cost of product development.	10
3	Patenting, licensing and partnership in biotechnology industry: Patents on biological inventions, licensing revenue, selection of right partner; negotiations of the terms of the terms of deal.	10
4	Entrepreneurship Skills: Entrepreneurship Skills of bio-entrepreneur, bio entrepreneurial training; research experience, creativity, communication skills and other attributes; participation in conferences, training and educational courses; institutes offering entrepreneurship courses.	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Holt DH. Entrepreneurship: New Venture Creation.
2. Kaplan JM Patterns of Entrepreneurship.
3. Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.
4. Biotech Entrepreneur-to-Entrepreneur: http://www.bioe2e.org

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Have the ability to discern distinct entrepreneurial traits.
2. Know how about the loans and repayments for the start-up industries.

3. Understand the fundamentals of marketing research and importance of survey, physical distribution and raw materials.
4. Know the parameters to assess opportunities and constraints for new business ideas.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	1	3	-	3
CO2	-	-	-	-	-
CO3	-	-	-	-	-
CO4	-	-	-	1	-

Students exiting the programme after securing 80 credits will be awarded UG, Diploma in the relevant Discipline /Subject provided they secure additional 4 credit in, skill based vocational courses offered during first year or second year summer term.

(VOCATIONAL COURSE 3)
INDUSTRIAL ENZYME TECHNOLOGY (VBT 413)

OBJECTIVES: This course is designed to introduce students to enzyme production, characterization, and applications in various industries. Students will learn about enzyme kinetics, the use of bioreactors in enzyme production, and the practical steps involved in enzyme purification and industrial-scale applications.

Credits: 02 L-T-P: 2-0-0

Module No	Content	Teaching Hours
1	**Overview of Enzymes:** Classification, structure, and function of enzymes, Introduction to enzyme kinetics: Michaelis-Menten equation **Industrial Importance of Enzymes:** Applications of enzymes in food, pharmaceutical, textile, and detergent industries, Advantages of enzyme use over chemical processes	10
2	**Microbial Sources of Industrial Enzymes:** Isolation of microorganisms producing industrial enzymes (e.g., fungi, bacteria), Genetic modification for enhanced enzyme production **Fermentation Technology for Enzyme Production:** Solid-state and submerged fermentation, Use of bioreactors for large-scale enzyme production	10
3	**Methods of Enzyme Purification:** Precipitation methods: ammonium sulfate, organic solvents, Chromatographic techniques: ion exchange, affinity, gel filtration **Optimization of Purification Processes:** Assessing purity and activity during purification, Factors affecting enzyme stability during purification	10
4	**Kinetics of Enzyme Catalysis:** Determination of Vmax and Km using Lineweaver-Burk plot, Effect of pH, temperature, and substrate concentration on enzyme activity **Inhibition of Enzyme Activity:** Types of enzyme inhibitors: competitive, non-competitive, uncompetitive, Industrial relevance of enzyme inhibitors	10
5	**Enzyme Immobilization Techniques:** Methods of immobilization: adsorption, covalent bonding, entrapment, encapsulation, Advantages of immobilized enzymes in industry **Applications of Immobilized Enzymes in Industry:** Use of immobilized enzymes in bioreactors, Case studies: immobilized enzymes in the production of high-fructose corn syrup, biofuel production, etc.	10

SUGGESTED TEXT BOOKS:

1. "Enzymes: Biochemistry, Biotechnology, and Clinical Chemistry" by Trevor Palmer
2. "Industrial Enzymes: Structure, Function, and Applications" edited by Julio Polaina and Andrew P. MacCabe
3. "Enzyme Technology" by Martin F. Chaplin and Christopher Bucke
4. Online Resources: Articles, case studies, and databases related to industrial enzyme applications

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Have a solid understanding of the role of enzymes in various industries.
2. Gain practical experience in enzyme production, purification, and characterization.

3. Be able to assess enzyme activity and optimize conditions for industrial use.
4. Learn how to apply enzyme immobilization techniques for large-scale applications.
5. Be prepared for roles in enzyme technology-related industries such as food, pharmaceuticals, and biofuels.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	3	3	2	2
CO3	3	2	2	1	1
CO4	3	3	2	2	2

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(VOCATIONAL COURSE 4)
ALLPIED MICROBILOGY IN INDUSTRY (VBT 414)

OBJECTIVES: The objective of this course is to equip students with the knowledge of industrial microbiology and its applications. Students will gain practical experience in microbial processes used in industries such as fermentation, biofuel production, pharmaceutical manufacturing, and bioremediation.

Credits: 02 L-T-P: 2-0-0

Module No	Content	Teaching Hours
1	**Overview of Microbes in Industry:** Types of microorganisms used in industrial processes (bacteria, fungi, yeast), Historical development of industrial microbiology **Applications of Microbes in Industry:** Role of microbes in the production of enzymes, antibiotics, vitamins, and biofuels, Microbial roles in waste management and bioremediation	10
2	**Microbial Growth and Cultivation:** Growth phases: lag, log, stationary, and death phase, Types of culture: batch, fed-batch, and continuous culture **Microbial Metabolism in Industry:** Primary and secondary metabolites in industrial microbiology, Metabolic pathways for the production of alcohol, organic acids, and antibiotics	10
3	**Basics of Fermentation Processes :** Types of fermentation: aerobic and anaerobic , Industrial fermenters (bioreactors): design, components, and operation **Microbial Fermentation for Product Synthesis:** Fermentation of pharmaceuticals (e.g., penicillin production), Fermentation for food and beverages (e.g., yogurt, cheese, beer, and wine)	10
4	**Microbial Production of Pharmaceuticals:** Production of antibiotics (e.g., penicillin, streptomycin), vitamins, and amino acids, Use of genetically modified microorganisms in pharmaceutical production **Biofuel Production:** Role of microorganisms in the production of bioethanol, biogas, and biodiesel, Sustainable energy production using microbial fermentation	10
5	**Microbes in Food Industry:** Role of microbes in food preservation, probiotics, and food spoilage, Production of fermented foods (sauerkraut, soy sauce, vinegar) **Microbes in Agriculture:** Microbial biofertilizers and biopesticides, Plant growth-promoting rhizobacteria (PGPR) and nitrogen fixation	10

SUGGESTED TEXT BOOKS:

1. "Industrial Microbiology" by L.E. Casida
2. "Prescott & Dunn's Industrial Microbiology" by Gerald Reed
3. "Comprehensive Biotechnology" by Murray Moo-Young
4. Online Resources: Research articles, case studies, and industry reports on microbial processes

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Understand the role of microorganisms in industrial applications.
2. Gain practical experience in microbial fermentation, product synthesis, and bioremediation.
3. Learn about microbial contributions to food, agriculture, and environmental sustainability.
4. Acquire skills to pursue careers in industries related to food, pharmaceuticals, biofuels, and waste management.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	1	3	-
CO2	-	-	-	-	-
CO3	-	-	3	3	2
CO4	-	-	3	3	2
CO5	-	-	2	3	-

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SEMESTER-5

(CORE COURSE -11)

RECOMBINANT DNA TECHNOLOGY (BBT 511)

COURSE OBJECTIVES: This course would familiarize students with facile molecular techniques involved in isolation and manipulation of genetic material for achieving the desired goal. To train the students in various techniques involved in Genetic engineering.

Credits: 4 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	History and basic steps involved in genetic engineering, Enzymes involved in genetic engineering (Nucleases, Restriction enzymes and their types, DNA ligases and ligation, Kinases, Phosphatases, Reverse transcriptase, Deoxynucleotidyl transferases, DNA polymerase), Restriction mapping.	10
2	Basic design of cloning vectors - plasmid (pBR322 and pUC 18/19), cosmids, phage vectors (lambda and M13), phagemid, yeast vectors (YEp, YRp, YIp), shuttle vectors, BAC and YAC Expression of cloned genes - general features of an expression vector, expression of eukaryotic gene in prokaryotes - advantages and limitations.	10
3	Gene transfer techniques - physical (Electroporation, microinjection and biolistic transformation), chemical (CaCl2 mediated transformation and Lipofection), transduction. Selection of recombinants - blue and white screening and plus and minus screening.	10
4	Construction of genomic and cDNA library, PCR- steps involved, Guidelines for PCR, primer designing, variants of PCR (multiplex, nested, quantitative real time, RT- PCR), applications and limitations. Blotting - southern, northern and western blotting;	10
5	Manipulation of gene sequences by random mutations and site directed mutagenesis, Applications of Genetic engineering in industry, medicine and agriculture. Bioethics and Biosafety..	10

SUGGESTED TEXT BOOKS:

1. Primrose Sandy B. and Richard Twyman, Principles of Gene Manipulation and Genomics (7th Edition), Wiley-Blackwell 2006.
2. Brown T. A, Gene Cloning and DNA Analysis: An Introduction, (6th Edition) Wiley-Blackwell, 2010.
3. Winnacker L Ernst, From genes to clones -Introduction to gene technology (4th edition), Panima

Publishing Corporation, 2003.

4. Dubey R.C, Advanced Biotechnology (1st edition), Chand and Company, 2014.

REFERENCE BOOKS:

1. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
2. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
3. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

Online links for study & reference materials:

https://learn.genetics.utah.edu/

https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/

COURSE OUTCOMES:

On completion of this course, the students will be able to:

1. Apply landmark discoveries in developing a number of facile molecular techniques used in rDNA technology.
2. Learn how to select the suitable hosts for the individual vectors for different purposes.
3. Know the extraordinary power of restriction and other enzymes in molecular cloning and genetic manipulations.
4. Perform application of PCR in rDNA technology. healthy and disease contexts.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	-	2
CO2	1	2	2	3	2
CO3	3	-	2	-	-
CO4	3	-	-	-	2

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(CORE COURSE -12)

FERMENTATION TECHNOLOGY (BBT 512)

COURSE OBJECTIVES: The course in skill enhancement provides an insight into microbial technologies and fermentations to the students.

Credits: 4 L-T-P: 4-0-6

Module No	Content	Teaching Hours
1.	**Introduction to Fermentation technology:** History, Scope and Development of Fermentation technology; Isolation and screening of industrially important microorganisms – primary and secondary screening; Maintenance of Strains; Strain improvement: Mutant selection and Recombinant DNA technology.	
2	**Fermentation media and Fermenter design:** Natural and Synthetic media; Basic components of an media (Carbon sources; Nitrogen sources; Vitamins; Minerals; Anti-foaming agents); Role of buffers in media; Process of aeration, and agitation. Basic designs of Fermentor; Type of fermentors: Waldhof, Tower, Deepjet, Cyclone column, Packed tower and airlift fermenter.	
3.	**Types of fermentations:** batch, continuous and fed batch fermentations. Surface, solid state and submerged fermentation. Monitoring and control of agitation, aeration, pH, temperature and dissolved oxygen. Industrial sterilization of media and air.	10
4	**Down-stream processing and Product recovery:** Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.	10
5.	**Production of Microbial Products:** Production of alcohol- ethanol; Organic acid – Citric acid, Lactic acid; Antibiotic – Penicillin, Amino acid – Glutamic acid; Vitamin – B1; Single Cell Protein (SCP).	10

SUGGESTED TEXTBOOKS

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology

REGFERENCE BOOKS:

6. Peter F Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology. (2016) Butterworth-Heinemann Press. UK.
7. H. J. Peppler, D. Perlman. Microbial Technology: Fermentation Technology. (2014). Academic Press

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Design of various reactors used in Industries.
2. Criteria for selection of media for microbial growth and fermentative media
3. Methods for strain improvement and preservation of cultures.
4. Upstream as well as downstream processing involved in fermentation industries

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	-	1
CO2	3	-	-	-	-
CO3	3	-	2	-	1
CO4	2	2	2	-	1

FERMENTATION TECHNOLOGY LAB (BBT 572)

COURSE OBJECTIVES: To acquaint students with technical and biological aspect of microbial utilisation for production of metabolites..

Credits: 01 L-T-P:0-0-2

Module No.	Contents	Lab Hours
I	1. Isolation of antibiotic producing microorganisms from soil 2. Isolation of enzyme producing microorganisms from soil 3. Isolation of organic acid producing microorganisms from soil 4. Isolation of protease and amylase producers 5. Production of Alcohol 6. Production of Citric acid	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2n edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Learn the isolation of antibiotic producer microorganisms.
2. Perform enzyme assay of industrially important enzymes.

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(CORE COURSE -13)

BIOINFORMATICS (BBT513)

COURSE OBJECTIVES: Bioinformatics involves the analysis of biological information using computers and statistical techniques.

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	Introduction to Computational Biology and Bioinformatics; some of the biological problems that require computational methods for their solutions; Role of internet and www in bioinformatics. Biological Databases Acquisition –Primary and Secondary databases, Nucleotide sequence databases, Expressed sequence tags (ESTs).	10
2	Sequence Analysis – Methods of sequence alignment: Dot plots; Scoring matrices – identify matrix, genetic code matrices (GCM); Substitution matrices, Percentage accepted Mutation (PAM). Block Substitution Matrices (BLOSUM), dynamic programming algorithms; Needlman-Wunch and Smith Waterman; alignment scores and gap penalties; Database searching (BLAST and FASTA). Multiple Sequence alignment (MSA) – signifiance. Softwares : ClustalW and Meme.	10
3	Phylogenetics, cladistics and ontology; Phylogenetic representations – graphs, trees and cladograms Methods of phylogenetic analysis – similarity and distance tables, distance matrix method; Method of calculation of distance matrix (UPGMA, WPGMA); The Neighbor Joining Method; The Fitch/Margoliash method; Steps in constructing alignments and phylogenies; Phylogenetic softwares –PHYLIP	10
4	Structure prediction: protein- Methods for prediction of secondary and tertiary structures of proteins – knowledge-based structure prediction; fold recognition; ab initio, methods for structure prediction, Comparative protein modeling. Identification of motifs and domains, protein family database. RNA structure prediction.	10
5	Finding new drug targets to treat diseases – Pharmacophore identification - Structure based drug design.	

SUGGESTED TEXTBOOKS :

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II

Edition. Benjamin Cummings.

4. Rastogi, S.C, Mendiratta. N and Rastogi. R. Bioinformatics: Concepts, Skills and Applications, CBS Publishers, New Delhi, India. 2006 .

REFERENCE BOOKS:

5. Pevzner, P.A. Computational Molecular Biology; Prentice Hall of India Ltd, New Delhi. 2004
6. Sensen, C.W. Essentials of Genomics and Bioinformatics. Wiley-VCH Publishers, USA. 2002
7. Andrew R. Leach Molecular Modeling – Principles and Applications Second Edition, Prentice Hall, USA. 2001
8. Creighton, T.E. Proteins: structure and molecular properties Second edition, W.H. Freeman and Company, New York, USA. 1993

COURSE OUTCOMES:

On completion of this course, the students will be able to:

1. Gain knowledge on Computational Biology and Bioinformatics
2. Gain knowledge on structure prediction and drug designing using Bioinformatics tools.
3. Learning of database searching and sequence retrival
4. Gain the knowledge about multiple sequence analysis and phylogenetic analysis.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	-	-	-
CO2	2	-	-	-	1
CO3	3	2	-	-	-
CO4	3	2	-	-	-

BIOINFORMATICS LAB (BBT572)

COURSE OBJECTIVES: Bioinformatics involves the analysis of biological information using computers and statistical techniques.

Credits: 01 L-T-P: 0-0-2

Module No	Content	Teaching Hours
1	1. Sequence information resource 2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR) 3. Using various BLAST and interpretation of results. 4. Retrieval of information from nucleotide databases.	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Students can implement a suite of core bioinformatics services and describe their application.
2. Perform the reterive the Nucletide sequence and BLAST analyis.
3. Gain the Knowledge about phylogenetic analyis

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-3)

ANIMAL BIOTECHNOLOGY (BBT514)

COURSE OBJECTIVES: The course provides the basic knowledge and understanding of cell culture techniques. The students will learn the maintenance and various in vitro applications of cell and molecular techniques.

Credits: 04

Module No.	Content	Teaching Hours
1	Introduction, history, basic concepts of animal cell culture, primary cell culture and established cell lines, maintenance of cultures, requirements of animal cell culture, media - natural (clots, biological fluids and tissue extracts) and synthetic (serum containing media, serum free media, chemically defined media, protein free media).	10
2	Basic techniques of mammalian cell culture, disaggregation of animal tissues - mechanical, enzymatic and EDTA, evolution of cell line, monolayer culture, suspension culture, immobilized culture, organ culture - plasma clot, raft method, agar gel, grid method, embryo culture, maintenance of cell culture.	10
3	Artificial insemination, Super ovulation, In vitro fertilization and embryo transfer, applications and limitation, Transgenic animals (avian, rodent & ruminants), Transgenic methods, Embryonic Stem cell transfer, Targeted Gene Transfer, Detection of transgenic animals, Production of useful proteins in transgenic animals,	10
4	Role of Animal models in Experimentation. Molecular markers - RFLP, RAPD, VNTR, AFLP. Somatic and Reproductive cloning - Definition, history and types. Somatic cell nuclear transfer, story of dolly, Therapeutic cloning and its significance..	10
5	Animal diseases (cattle) -Mad cow, Anthrax, Foot and Mouth, Lumpy skin, Bluetongue; (Poultry)- Newcastle; Bird flu, Avian Influenza, Marek's disease – Vaccines; Bioethics and biosafety in animal handling.	8

SUGGESTED TEXT BOOKS

1. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th edition), ASM publisher (2009).
2. Michael wink, An Introduction to Molecular Biotechnology: Fundamentals, methods and applications, (2nd edition) , John Wiley and sons 2013.
3. Ganga. G & Slochanachetty, An Introduction to Sericulture, (2nd edition), Oxford and IBH publishers Pvt.Ltd.Delhi (2012).
4. Old R.W, Primrose S.B, Twyman R. M, Principles of Gene manipulation (6th edition), Blackwell

Sciences, (2001)

REFERENCE BOOKS:

1. Tom Strachan & Andrew P. Read, Human Molecular Genetics, 2nd edition. Garland Science, (2004).
2. Maule J.P, The Semen of Animals and Artificial Insemination, Commonwealth Agricultural Bureaux, 1962
3. John R.W. Masters, Animal Cell Culture, 3rd edition, OUP Oxford, (2000).

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Explain the fundamental scientific principles that underlie cell culture and acquire knowledge for isolation, maintenance and growth of cells.
2. The students will gain an insight into the concepts and techniques of genetically modified animals and its applications in various fields of science.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	1	1
CO2	1	3	3	2	1

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(ABILITY ENHANCEMENT COMPULSORY COURSE-04)

BIOSTATISTICS (BBT515)

COURSE OBJECTIVES: The discipline of biostatistics provides tools and techniques for collecting data and then summarizing, analyzing, and interpreting it.

Credits: 02 L-T-P: 2-0-0

Module No.	Contents	Teaching Hours
1	Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.	**10**
2	Probability classical & axiomatic definition of probability, Theorems on total and compound probability, Elementary ideas of Binomial, Poisson and Normal distributions.	**10**
3	Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, and chi-square test for goodness of fit.	**10**
4	Correlation and Regression. Emphasis on examples from Biological Sciences.	**10**

SUGGESTED TEXTBOOKS & REFERENCES:

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield™ Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

COURSE OUTCOME:

After completion of the course, student will be able to:

1. Develop and apply different of statistical methods.
2. Learn the graphical representation of data.
3. Enhance the applicability in data analysis.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	-	-	2
CO2	2	1	-	-	-
CO3	3	2	-	-	1

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(SKILL ENHANCEMENT COURSE-04)

INDUSTRIAL INTERNSHIP (BBT573)

COURSE OBJECTIVES: The objective of industrial training is to enhance the employability of students and prepare them for their future careers.

Credits: 03 L-T-P: 0-0-6

Industrial training offers the students with important practical knowledge and skills and encourage them in becoming a successful and best professional engineer. The main objectives of the industrial training is to provide the best and relevant theoretical knowledge to gain in a particular time period. Students complete their industrial training during minimum period of 4 weeks and pass the training assessment in order to graduate. It provides the liability for real life work and internships to choose the career options with different work environments and publicity to the latest technologies that are currently being used by an important and relevant industry, etc.

COURSE OUTCOME:

After completion of the course, student will be able to:

1. Participate in the projects in industries during his or her industrial training.
2. Describe use of advanced tools and techniques encountered during industrial training and visit
3. Interact with industrial personnel and follow engineering practices and discipline prescribed in industry.
4. Develop awareness about general workplace behavior and build interpersonal and team skills.
5. Prepare professional work reports and presentations.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	3	3	-	3
CO2	2	-	-	-	1
CO3	-	2	2	-	-
CO4	-	2	3	-	-
CO5	-	2	1	1	1

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SEMESTER-6

CORE COURSE-14

BIOPROCESS TECHNOLOGY (BBT611)

COURSE OBJECTIVES: This course is to provide basic concepts of bioprocess engineering to the students. They will learn engineering principles that can be applied to processes involving cell or enzyme catalysts with applications in the industry

Module No.	Content	Teaching Hours
1	Introduction to bioprocess technology. Range of bioprocess technology and its chronological development – Introduction and history of traditional and modern bioprocess technology, Outline of an integrated bioprocess and various unit operations. Industrially important microbes: Isolation, Screening & Preservation techniques – Slant culture, spore culture, overlaying culture with mineral oil, Lyophilization,	10
2	Basic principal components of fermentation technology. Sterilization (batch & continuous)-Air, Filter and Media sterilization, Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.	10
3	Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inoculam development.	10
4	Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.	10
5	Introduction to downstream processing, product recovery and purification. Effluent treatment.Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.	10

SUGGESTED TEXT BOOKS

1. Stanbury P.F., Whitaker. A & Hall. S. J. Principles of fermentation technology (2nd edition), Aditya Books Private ltd., 2000.
2. Crueger, W. and Crueger, A, Biotechnology: A Textbook of Industrial Microbiology. (2nd Ed.), Panima Publishing Corporation, New Delhi. 2000.
3. Waites M.J., Morgan N.L., Rockey J.S., Industrial Microbiology. 2nd edition, Blackwell Science, 2002.

REFERENCE BOOKS:

1. Demain L. & Davies E. Manual of Industrial Microbiology and Biotechnology (2nd edition), ASM Press, Washington, 2004.
2. Emt El Mansi, Bryce, CFA, Demain, AL (Eds). Fermentation Microbiology and Biotechnology (2nd Edition), CRC Press. 2006

COURSE OUTCOME:

After completion of the course, student will be able to:

1. At the end of this course, the students will learn the basics of bioprocess engineering.
2. Will also learn the principle, design, and operation control of various types of bioreactors
3. and their scale-up strategies.
4. Develop skills to understand Bioprrocess Engineering at Industrial level for its applications.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	1	1	-	-
CO2	3	1	1	-	1
CO3	3	1	1	-	1

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CORE COURSE-15

NANOTECHNOLOGY (BBT612)

COURSE OBJECTIVES: To understand the nature and properties of nanomaterials. To provide scientific understanding of application of nanomaterials and nanotechnology inagriculture, health and environmental conservation.

Credits: 04

Module No.	Content	Teaching Hours
1	Introduction to nanomaterials; Various types of nanomaterials, Three-dimensional, twodimensional, one-dimensional and zero-dimensional nanomaterials. Carbon nanotubes, Graphene, Carbon dots, metal nanoparticles, metal oxide-based nanomaterials, semiconductor nanomaterials, quantum dots, hybrid nanoparticles,	10
2	Structural properties, chemical properties, surface functionalization, physical properties. Characterization of nanomaterials by various analytical methods, optical characterization and spectroscopy such as FTIR, UV-Vis, DLS, Zetapotential, structural characterization by X-Ray Diffraction, XPS and advanced microscopy (TEM, SEM, AFM) etc	10
3	Nanobiotechnology in healthcare; Role of nanobiotechnology in the area of infectious & noninfectious diseases, Nanopharmaceutical, Diagnosis, sensors and biosensors, Delivery vehicles, biomedical applications of nanomaterials.	10
4	Nanobiotechnology for Agriculture: Nanotechnology based tools to enhance agricultural productivity, Nanobased Agri and Food Products, food preservation and Toxicity, Nanopesticides and Nanofertilizers, Nano-biostimulants and soil enhancers	10
5	Nanobiotechnology for Crop improvement, Precision Delivery Systems, Diagnostics and sensing, Nanotechnology for environment: contamination detection and remediation	10

SUGGESTED TEXT BOOKS

1. L. Rogach, Semiconductor nanocrystal quantum dots synthesis, assembly, spectroscopy and applications (Springer, Wien; London, 2008).
2. E. Gazit, Plenty of room for biology at the bottom: an introduction to bionanotechnology (Imperial College Press ; Distributed by World Scientific Pub. in the USA, London : Hackensack, NJ, 2007).

3. G. E. J. Poinern, A laboratory course in nanoscience and nanotechnology (CRC Press, Taylor & Francis Group, Boca Raton, 2015).
4. C.A. Mirkin, C. M. Niemeyer, Eds., More concepts and applications (Wiley-VCH, Weinheim, 2007), Nanobiotechnology.
5. P. N. Prasad. Nanophotonics (Wiley, New York, 2003).
6. A.K. Mishra, Ed., Application of nanotechnology in water research (Wiley, Scrivener Publishing, Hoboken, New Jersey, 2014).

COURSE OUTCOME:

After completion of the course, student will be able to:

1. Familiarity with working principles, tools and techniques in the field of nanomaterials.
2. Understanding of the strengths, limitations and potential uses of nanomaterials.
3. Gain the knowledge of Nanobiotechnology use in different sectors.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	1	1	-	-
CO2	3	1	1	-	1
CO3	3	1	1	-	1

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CORE COURSE-16

ENVIRONMENTAL BIOTECHNOLOGY (BBT613)

COURSE OBJECTIVES: The students will learn the application of processes for the protection and restoration of the quality of the environment.

Credits: 4 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	Introduction to environmental biotechnology, Non Renewable resources - coal, petroleum, and natural gas. Renewable resources - solar, wind, tidal, biomass, nuclear, geothermal and hydroelectric resources. Current status and environmental impact of renewable and non-renewable resources.	**10**
2	Methanogenic bacteria and biogas, microbial hydrogen production, conversion of sugars to alcohols, plant-based petroleum industry, cellulose as the source of energy, Environmental impact of modern fuels.	**10**
3	Principles of waste management, types, sources and effects of solid waste, Physical and biological treatment methods, Concept of composting and vermicomposting, Waste to energy conversion, Disposal of wastes.	**10**
4	Basics and types of bioremediation, Bioremediation of oil, heavy metals, pesticides contaminated soil and water, Phytoremediation and its types, Biochemical and genetic basis of biodegradation, Xenobiotic compounds and recalcitrance, Biodegradation of pesticides and petroleum products, Biotransformation of heavy metals, Biopolymers and Biodegradable plastics.	**10**
5	Biomonitoring - Bioassays, Biosensors, Biochips, Biological indicators and Biomarkers, Biorestoration of waste land, Bioleaching – microbes involved, Role of Biotechnology in pollution abatement.	**10**

SUGGESTED TEXT BOOKS:

1. Scragg A. H, Environmental Biotechnology, (2nd revised edition), Oxford University Press 2005
2. Jogdand S. N, Environmental Biotechnology (3rd edition), Himalaya publishing house pvt.ltd 2012.
3. Thakur. I. S, Environmental Biotechnology: Basic Concepts and Applications, (2nd revised edition), I K International Publishing House Pvt. Ltd, 2011.

REFERENCE BOOKS:

1. Varnam A. H - Environmental Microbiology (1st Edition), ASM Press 2001

2. Wang, L.K., Ivanov, V., Tay, J.H., Hung, Y.T, Environmental Biotechnology (Volume 10), Humana Press 2010

COURSE OUTCOME:

After completion of the course, student will be able to:

1. Comprehend environmental issues and role of biotechnology in the cleanup of contaminated environments
2. Comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals
3. Apply biotechnological processes in waste water and solid waste management.
4. Demonstrate innovative biotechnological interventions to combat environmental challenges.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	-	2
CO2	-	2	3	-	-
CO3	3	2	3	-	1
CO4	2	2	3	-	2

ENVIRONMENTAL BIOTECHNOLOGY LAB (BBT671)

COURSE OBJECTIVES: The course content aims to make the students understand how biotechnology can help in monitoring or removing the pollutants and management.

Module No	Content	Teaching Hours
1	1. Calculation of Total Dissolved Solids (TDS) of water sample. 2. Calculation of BOD of water sample. 3. Calculation of COD of water sample. 4.Estimation of salinity in water samples 5. Bacterial Examination of Water by MPN Method.	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill

COURSE OUTCOME:

After completion of the course, student will be able to:

1. Apply biotechnological processes in waste water and solid waste management.
2. demonstrate innovative biotechnological interventions to combat environmental challenges.
3. Gain the Knowledge about enviromental practical handling.

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-4)

PLANT BIOTECHNOLOGY (BBT 614)

COURSE OBJECTIVES: The main objective of the study program is to prepare motivated, able to think creatively plant biotechnology specialists familiar with plant biotechnological processes.

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	Introduction of plant biotechnology, types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micro-propagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micro-propagation.	10
2	In vitro haploid production Androgenic methods: Anther culture, Significance and use of haploids, chromosome doubling. Diploidization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.	10
3	Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development. Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation, applications basis and disadvantages.	10
4.	Molecular Marker, RAPD, RFLP, AFLP, SSR, ISSR, Application in plant science.	10
5	Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8 edition Principles of Genetics. Wiley India.

COURSE OUTCOME:

On the completion of course students will able to-

1. Students will gain foundational knowledge of different types of plant cultures, including seed, embryo, callus, organ, cell, and protoplast culture, and the principles of micro-propagation and its applications in biotechnology.
2. Students will comprehend androgenic and gynogenic methods for haploid production, explore

chromosome doubling and elimination techniques, and understand their significance in crop improvement, particularly in cereals. Know about the plant growth promoting bacteria and their role in yield of plants.

3. Students will learn about various molecular marker techniques, including RAPD, RFLP, AFLP, SSR, and ISSR, and apply these tools in plant genetics, breeding, and the identification of growth-promoting bacteria.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	-	3
CO2	3	2	3	-	2
CO1	2	-	-	-	-

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PLANT BIOTECHNOLOGY LAB (BBT 672)

COURSE OBJECTIVES: The course content aims to make the students understand how biotechnology can help crop improvement and devlop new variety.

Credits: 01

Module No	Content	Teaching Hours
1	1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid. 2. Preparation of complex nutrient medium (Murashige & Skoog's medium) 3. To selection, Prune, sterilize and prepare an explant for culture. 4. Significance of growth hormones in culture medium. 5. To demonstrate various steps of Micropropagation. 6. Isolation of total genomic DNA from leaves by CTAB method 7. Microbial population in rhizospheric soil of various crops.	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8 edition Principles of Genetics. Wiley India.

COURSE OUTCOME:

On the completion of course students will able to

1. By applying complex biotechnology means, a graduate is able to use bioprocesses and possibilities of to create and produce novel and useful products for humans.
2. Know the application of plant tissue culture in agro-industry.

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-5)

FOOD BIOTECHNOLOGY (BBT 615)

COURSE OBJECTIVES: Identify the conditions under which the important pathogens are commonly inactivated, killed or made harmless in foods.

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	Historical Background, Composition of Food, Growth of microorganisms in food: Intrinsic and extrinsic factors. Food Spoilage (microbial and non-microbial), Control mechanisms of food spoilage: Physical and Chemical. Food preservation and storage. Basic principles of the equipment involved in the commercially important food processing methods and unit operations	**10**
2	Common Food and water borne diseases: Gastroenteritis, Diarrhoea, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Food borne intoxications: Staphylococcal, Bacillus, Clostridium etc. Detection of food-borne pathogens.	**10**
3	Starter cultures, Production process of fermented foods: cheese, butter, yoghurt, alcoholic beverages (beer, wine, distilled beverages), Pickles, Soy products. Process of Brewing, malting, mashing, primary & secondary fermentation. Problems in food industry: catabolic repression, High gravity brewing, B-glucan problem, getting rid of diacetyl.	**10**
4	Value added products: High Fructose Corn Syrup, Invert Sugars, Edible fungus: Mushrooms. Concept of Prebiotics and Probiotics. Improvement of food resources through Biotechnology (e.g. Golden Rice, Flavor savor tomato), Traditional fermented foods (meat, fish, bread, sauerkraut, tea)	**10**

SUGGESTED TEXTBOOKS & REFERENCES:

1. Frazier, W.S. and Weshoff, D.C., 1988. Food Microbiology, 4th Edn., McGraw Hill Book Co., New York.
2. Jay, J.M., 1987. Modern Food Microbiology, CBS Publications, New Delhi.

COURSE OUTCOME:

On the completion of course students will able to

1. Contribution of microbes in food borne diseases.
2. Understand the microbial and non-microbial causes of food preservation.

3. Principles of the physical and chemical techniques of food preservation.
4. Production process of fermented foods in food industry.
5. Know about the production of value added food products.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	3	2	-	-
CO2	-	2	2	-	-
CO3	-	3	2	-	-
CO4	-	3	2	-	3
CO5	-	3	2	-	3

FOOD BIOTECHNOLOGY LAB (BBT673)

COURSE OBJECTIVES: To demonstrate the application of modern biotechnological tools and techniques for the manufacture and processing of food.

Credits: 01

Module No.	Contents	Lab Hours
1.	1. Estimation of Total Plate Count in any food sample. 2. Detection of Salmonella, E. coli in food material. 3. MBRT test of milk samples. 4. Sauerkraut production 5. Acetic acid/Vinegar Production and estimation of the product. 6. Toxin detection in the food materials. 7. Effect of internal factors on microbial growth in food i.e. pH, Temperature, Water Activity.	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Frazier, W.S. and Weshoff, D.C., 1988. Food Microbiology, 4th Edn., McGraw Hill Book Co., New York.
2. Mann & Trusswell , 2007. Essentials of human nutrition. 3rd edition. Oxford university press.
3. Jay, J.M., 1987. Modern Food Microbiology, CBS Publications, New Delhi.

COURSE OUTCOME:

On the completion of course students will able to

1. Practical aspects of the different biotechnological processes
2. Food transformation, as well as those usually used by the food industry with the objective of improve production.

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SEMESTER-7

CORE COURSE-17

STEM CELL ENGINEERING (BBT 711)

COURSE OBJECTIVES: The objective of this paper is to familiarize the students with stem cell technology and its applications for betterment of the society. The course is designed to give a broad view of mammalian stem cells, reviewing where they are found in the body, the different types and how they are cultured..

Credits: 4 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	Introduction to stem cells: Definition, properties, proliferation, culture of stem cells, medical applications of stem cells, ethical and legal issues in use of stem cells.	10
2	Types of stem cells: Stem Cell biology and therapy, types embryonic stem cell, Adult stem cell, Stem Cell Biology and Therapy, Embryonic Stem Cells, culture and the potential benefits of stem cell technology	10
3	Therapeutic applications of stem cells Gene Therapy: Introduction, History and evolution of Gene therapy, optimal disease targets, Failures and successes with gene therapy and future prospects, Genetic Perspectives for Gene Therapy, Gene Delivery methods: Viral vectors and Non-viral Vectors.	10
4	Ethical Issues associated with stem cell-based regenerative medicine field: Regulatory and Ethical Considerations of stem cell and Gene Therapy, Assessing Human Stem Cell Safety, Use of Genetically Modified Stem Cells in Experimental Gene Therapies.	10

SUGGESTED TEXT BOOKS

1. Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring HarbouLaboratory Press
2. Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press.
3. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer,

REFERENCE BOOKS

1. Stem Cell Biology and Gene Therapy. Quesenberry PJ, Stein GS, eds. (£65.00.) Wiley, 1998.,
2. Progress in gene therapy, Volume 2,Pioneering stem cell/gene therapy trials, Roger Bertolotti, Keiya Ozawa and H. Kirk Hammond, VSP international science publishers

3. Stem Cells Handbook: Stewart Sell, Humana Press; Totowa NJ, USA; Oct. 2003,
4. Human Embryonic Stem Cells: The Practical Handbook by Stephen Sullivan and Chad A Cowan.

COURSE OUTCOMES:

On the completion of course students will be able to

1. Learn about the Basics of stem cell and related ethical issues.
2. Understand the concepts of stem cell based therapy and types of stem cells.
3. Know the therapeutic application of stem cell
4. Understand the ethical issues associated with stem cell-based regenerative medicine field.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	1
CO2	2	3	3	-	-
CO3	-	2	1	1	-
CO4	3	3	3	3	1

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CORE COURSE-18

MEDICAL MICROBIOLOGY (BBT 712)

COURSE OBJECTIVES: This course will introduce basic principles and conceptual basis for understanding pathogenic microorganisms.

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. leprae.*	10
2	Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E. coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae, Rickettsiaceae, Chlamydiae.*	10
3	Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.	10
4	Fungal and Protozoan infections. Dermatophytoses (*Trichophyton, Microsporun and Epidermophyton*) Subcutaneous infection (*Sporothrix, Cryptococcus*), systemic infection (*Histoplasma, Coccidoides),* opportunistic fungal infections (*Candidiasis, Aspergillosis*), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria).	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

COURSE OUTCOMES:

On the completion of course students will be able to

1. Know about the normal microflora of human body, pathogenicity and virulence factors of disease causing microorganisms.
2. Detailed knowledge of diseases caused by different types of bacteria and viruses.
3. Undesrtand the mechanism of fungal and protozoan infections.
4. Develop diagnostic skills in microbiology, including the practical application and interpretation of laboratory tests for the diagnosis of infectious diseases.
5. Learn about the preventive measures and prophylactic measures to control microbial infections.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	3	2	-	-
CO2	2	2	2	-	-
CO3	2	2	2	-	-
CO4	1	2	2	1	3
CO5	-	3	1	-	-

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-6)

GENOMICS AND PROTEOMICS (BBT 713)

COURSE OBJECTIVES: Students will acquire extensive and in-depth knowledge about the structure and function of the genome at all basic levels of living systems.

Credits: 04

Module No.	Content	Teaching Hours
1	Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods.	10
2	Computer tools for sequencing projects: Genome sequence assembly software. Managing and Distributing Genome Data: Web based servers and software's for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.	10
3	Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, vander waal interactions, hydrogen bonds, Hydrophobic ineractions. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures–Edman degradation.	10
4	Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry-based methods for protein identification. *De novo* sequencing using mass spectrometric data.	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Terence A. Brown, Genomes 2, (2nd edition) – Garland Science publishing, 2002.
2. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
3. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.

COURSE OUTCOMES:

On the completion of course students will be able to

1. Explain the properties of genetic materials and storage and processing of genetic information.

2. Analyze genomic data.
3. Explain biological phenomena based on comparative genomics
4. Design transcriptomics and proteomics experiments for studying differential gene expression and related analysis

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	-	-	-
CO2	2	2	-	-	1
CO3	3	2	-	-	-
CO4	3	2	2	-	-

GENOMICS AND PROTEOMICS LAB (BBT 772)

COURSE OBJECTIVES: To demonstrate the application of modern biotechnological tools and techniques for the manufacture and processing of food.

Credits: 01

Module No.	Contents	Lab Hours
1.	1. Use of SNP databases at NCBI and other sites 2. Use of OMIM database 3. Detection of Open Reading Frames using ORF Finder 4. Proteomics 2D PAGE database 5. Softwares for Protein localization. 6. Hydropathy plots 7. Native PAGE 8. SDS PAGE	20

SUGGESTED TEXTBOOKS & REFERENCES:

1. Terence A. Brown, Genomes 2, (2nd edition) – Garland Science publishing, 2002.
2. Old R.W & Primrose S. B, Principles of gene manipulation – An introduction to genetic Engineering, Black well publishers, (5th Edition), 2000.
3. Helen Kreuzer and Adrianne Massey, Recombinant DNA and Biotechnology (2nd edition), ASM Press, 2001

COURSE OUTCOME:

On the completion of course students will be able to

1. Explain biological phenomena based on comparative genomics
2. Design transcriptomics and proteomics experiments for studying differential gene expression and related analysis

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-7)

RESEARCH METHODOLOGY (BBT 714)

COURSE OBJECTIVES: The course will give the consept of research design, sampling and data analysis.

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	**Foundations of Research:** Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process, Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance	**10**
2	**Research Design:** Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.	**10**
3	**Qualitative and Quantitative Research**: Qualitative research – Quantitative research Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio.	**10**
4	**Sampling:** Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.	**10**
5	**Data Preparation & Analysis:** Interpretation of Data and Paper Writing Layout of a Research Paper, Journals in Life Science, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Self-Plagiarism.	**10**

SUGGESTED TEXT BOOKS :

1. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
2. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
3. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

REFERENCE BOOKS:

4. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
5. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

COURSE OUTCOME:

On the completion of course students will be able to

1. Understand the basic concept of research and development.
2. Discuss the qualitative and quantitative research methods.
3. Describe the basic procedure of sampling.
4. Explain the data analysis procedure and interpretation of the data.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	-	-
CO2	3	2	2	-	-
CO3	2	2	-	-	-
CO4	3	-	-	-	-

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(DISSERTATIONS-1)

Major Project -1 (BBT 771)

COURSE OBJECTIVES: Develop an ability to understand the basic requirement to conduct a research project. Student also develop skill of writing and presentation on the assigned research topics in the field of biotechnology

Credits: 06 L-T-P: 0-0-12

COURSE CONTENTS:

Every student will be required to undertake a research project based on any of the areas of biotechnology. The research project should have applied significance. The project report will be submitted in the form of dissertation duly certified by the supervisor of the Department of Biotechnology or at national institutes and Universities in India, by seeking the placement. The project will be presented for evaluation at the end of semester by external examinar.

COURSE OUTCOMES:

On the completion of course students will be able to

1. Understand about the Research in Biotechnology
2. Develop presentation skill during the conduction of research, discussion and presentation.
3. Student will develop analysis of results, drafting and writing skill.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	2	3
CO3	3	3	3	-	-

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(SKILL ENHANCEMENT COURSE-5)

APPLICATION OF BIOSENSOR IN BIOTECHNOLOGY (BBT 715)

COURSE OBJECTIVES: To learn the Fundamentals of biosensors. To acquaint the student with design and construction of biosensors. To expose the students to recent advances in application of biosensors in health, environment, agriculture and food industry.

Credits: 02 L-T-P: 2-0-1

Module No.	Content	Teaching Hours
1	**Introduction to biosensor:** General configuration of biosensor, Generations of biosensors, Basic principle and instrumentation of different biosensors, electrochemical, optical, acoustic, piezoelectric, and calorimetric biosensors.	**10**
2	**Biological recognition systems:** Biomolecules in biosensors such as enzyme, antibody, nucleic acid, cell, and tissue	**10**
3	**Properties of ideal materials for biosensors;** Classes of materials for biosensors: polymers, material containing metal complex, sol-gel materials, nanomaterials, composite materials, metal oxides, photonic crystals, and zeolite materials	**10**
4	**Applications of biosensors in health and environment:** Biosensors and diabetes management, Microfabricated biosensors and point-of-care diagnostics systems, Noninvasive biosensors in clinical analysis; Surface plasmon resonance and evanescent wave biosensors, Biosensor in cancer and HIV early diagnosis..	**10**
5	**Applications of biosensors in food and agriculture industry:** Detection of product content, allergic components, pathogens, pesticide residues. Monitoring of raw material Conversions. Detection of crop diseases, pathogens in plants, detection of soil nutrients, pesticide and its residual Detection.	**10**

SUGGESTED TEXT BOOKS :

1. Jeong-Yeol Yoon,Introduction to Biosensors, Springer-Verlag New York Ed. 2016
2. Mohammed Zourob,Recognition Receptors in Biosens; Publisher: Springer-Verlag New York Ed. 2010

SUGGESTED REFERENCE BOOKS:

1. Zvi Liron,Novel Approaches in Biosensors and Rapid Diagnostic Assays; Publisher: Springer US Ed..2001
2. Pierre R. C, and Loïc J.B,Biosensor Principles and Applications, , CRC Press, 2019

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=kQ6CY1qpGjY

https://nptel.ac.in/courses/102101054

https://onlinecourses.nptel.ac.in/noc20_ph13/preview

https://onlinecourses.nptel.ac.in/noc22_ph01/preview

COURSE OUTCOME:

On the completion of course students will be able to

1. Classify types of biosensors based on principle
2. Able to differentiate different types of transducers based on theirphysicochemical characteristics
3. Apply bio sensing techniques in health, environment, agriculture and food industry.
4. Use biomaterial and nanomaterials in biosensors for signal amplification, Detection and Transducer Fabrication

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	-	-	2
CO2	2	2	-	-	2
CO3	3	2	-	-	2
CO4	3	2	-	-	2

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-11)

EVOLUTIONARY BIOLOGY (BBT716)

COURSE OBJECTIVES: The course will give an outline on basic Concepts of Evolution and descriptive background about Origin of Life.

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	Introduction to evolutionary Biology, Classification, Phylogeny & the tree of life. Patterns of evolution. Evolution of genes and genomics. Evolution and development. Macroevolution. Evolution & society. Human evolution.	10
2	Evolution & fossil record. History of life on earth. Geography of evolution. Evolution of biodiversity. Genetic variation.	10
3	Phenotypic variation. Genetic drift. Natural selection and adaptation. Genetic theory of natural selection. Evolution of phenotypic traits.	10
4	Conflict and cooperation. Species and speciation. Reproductive success. Co-evolution- interactions amongst species.	10

SUGGESTED TEXTBOOKS & REFERENCES:

1. Evolutionary Biology, 2nd Edition, 1979; Douglas J. Futuyma.
2. Evolutionary Biology, 3rd Edition, Douglas J. Futuyma. (ISBN: 9780878931897).

COURSE OUTCOME:

On the completion of course students will be able to

1. Learn most of the essential aspects of Evolutionary Biology in detail which will help them in acquiring better understanding regarding the subject.
2. Understanding about Phenotypic variation during evalution.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	3	2	3
CO2	1	1	1	-	1

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SEMESTER-8

(CORE COURSE-19)

ADVANCE CELL BIOLOGY (BBT 811)

COURSE OBJECTIVES: The aim of the course is to provide students with in depth knowledge of cell as a functional unit of life. The intra and intercellular interactions among the various cellular organelles, their structure and function communication that facilitates optimal function and development of any organism.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	**Membrane structure and function:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.	**10**
2	**Structural organization and function of intracellular organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.	**10**
3	**Organization of genes and chromosomes.** unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons. Cell division and cell cycle Regulation and control of cell cycle.	**10**
4	**Cell Signaling:** Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.	**10**
5	**Cell communication:** Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.	**10**

Text Books:

1. GM Cooper, Cell: A Molecular approach, 8th edition, Oxford University Press, 9781605358635, 1605358630, 2018
2. deRobertis and deRobertis, Cell and Molecular Biology, 8th edition, Lea & Febiger, 9780812110128

Reference Books:

1. Gerald Karp, Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc, 9780470483374, 0470483377 (2010)
2. G.M. Cooper, and R.E. Hausman. The Cell: A Molecular Approach. 5th Edition. ASM Press 780878931064, 0878931066 (2009)
3. B Alberts et al Molecular Biology of the Cell. 6th edition, Garland Science, Taylor and Francis group, 9781317563754, 1317563751

Online links for study and reference materials:

www.khanacademy.org

https://www.ncbi.nlm.nih.gov/pmc

COURSE OUTCOME:

On the completion of course students will be able to

1. Will have understanding of Cell membrane as a dynamic entity with numerous functions that facilitates normal cellular function as well as cellular transport.
2. Will have a clear understanding of the structural organization and function of all intracellular organelles.
3. Insight on regulation of cell cycle and organization gene and chromosomes.
4. How pathogens interact with their host in higher eukaryotes. Deciphering disease mechanisms.
5. Basic concept of all the pathways and mechanisms involved in cell signalling and communication

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	3	-	-	-
CO2	-	3	-	-	-
CO3	1	3	-	-	-
CO4	2	2	-	-	1
CO5	2	-	-	-	-

ADVANCE CELL BIOLOGY LAB (BBT 872)

COURSE OBJECTIVE: The course aims at providing students with the methodological concepts and tools needed to acquire top-level skills in the field of cell and molecular biology.

Credits: 01

Module No.	Content	Lab Hours
1.	1. Chromosome preparation: Mitosis-Onion root tip/human lymphocytes 2. Chromosome preparation: Meiosis- Rat/mouse testis/Grasshopper testis/ anthers. 3. Study of polyploidy in onion root tip by colchicine treatment followed by acetocarmine stain 4. Identification and study of properties of different types of cancerous cells through light and electron micrographs	20

SUGGESTED BOOKs

1. A Cell Biology Manual by J. Francis. Kendall/Hunt Publishing Co, USA. 2022.
2. Practical Laboratory Manual- Cell Biology by A. Gupta, B.K. Sati. Lambert Academic Publishing, USA. 2019.
3. Cell Biology Practical Manual by R. Gupta, S. Makhija and R. Toteja. Prestige Publishers, India. 2018.
4. Laboratory Manual of Cell Biology by R. Majumdar, R. Sisodia. Prestige Publishers,
5. India. 2018.
6. Essential Cell Biology Vol 1: Cell Structure- A Practical Approach by J. Davey and M.Lord. Oxford University Press, UK. 2003.
7. Essential Cell Biology Vol 2: Cell Function- A Practical Approach by J. Davey and M. Lord. Oxford University Press, UK. 2003

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Gain hands-on training for operating microscope for cell analysis
2. Use relevant tools and techniques for the analysis of chromosomes, and cell size determination using micrometry.
3. Utilize their knowledge for the research work during their higher studies.

(DISCIPLINE SPECIFIC ELECTIVE COURSE-08)

FUNDAMENTAL OF BIOMEDICAL SCIENCES (BBT 812)

COURSE OBJECTIVES: t is intended to impart basic knowledge in the area of Medical Biotechnology & Molecular Medicine. This course will introduce the students with basic concept of biotechnology, medical genetics and Medical oncology and therapeutics..

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1	**Medical Biotechnology & Molecular Technology:** Introduction to Biotechnology, Different classes of Biotechnology and its application: Medical Biotechnology, DNA Mapping, DNA Marker, Cloning of DNA, DNA Sequencing, Recombinant DNA technology, Mutation & Polymorphism.	10
2	**Medical Genetics:** Introduction of Medical Genetics and Genetic Diseases. Thalassaemia – Model for Molecular Genetics, Chromosomal Disorders, Heterogeneity, Genetic counseling, Stem cell and its application.	10
3	**Medical Oncology:** Introduction of medical oncology, Tumour and Cytogenetic Markers, Gene regulation in cancer: Oncongenes and Tumour Suppressor genes, Genetic Models and Cancer, Diagnostic Application & Therapeutics.	10
4	**Therapeutics:** rDNA derived Drugs, Gene Therapy, Hybridoma Technology, Monitoring & Response to Therapy Immunotherapy.	10
5	**Bioethical issues and Forensic Medicine:** Introduction to Bioethics & Biosafety in Research, Human Genome Project, Introduction to Forensic Medicine, Tissue identification and DNA profiling.	10

Text Books:

1. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology, Wiley, ed. 2, 2011
2. Campbell, M.A and Heyer L.J., Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, CSHL Press, Pearson/Benzamin Cummings San Francisco, USA, 2007.
3. Andrew Read and Dian Donnai, New Clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK, 2007.

Reference Books:

1. New Clinical Genetics, Scion Publishing Ltd, Oxford shire, UK, 2007
2. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, CSHL Press,

3. Pearson/Benzamin Cummings San Francisco, USA, 2007
4. Strachan T and Read A P, Human molecular genetics, 3rd Edition Wiley Bios, 2006.

Online links for study and reference materials:

http://www.onlinebiologynotes.com

http://www.ornl.gov/TechResources/Human_Genome/home.html

https://www.biotecharticles.com

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Basic concept of Medical Biotechnology and its scope.
2. Develop an understanding of medical genetics and chromosomal disorder. Insight on regulation of cell cycle and organization gene and chromosomes.
3. Understand basic concept of Molecular Oncology, and Gene regulation in cancer development.
4. Explain the basic concept of gene therapy and its application
5. Discuss the basic introduction to Bioethics & Biosafety in Research and concept of forensic medicine.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	3	2	-	1
CO2	3	3	2	-	-
CO3	3	3	3	-	1
CO4	3	3	3	2	1
CO5	2	2	2	3	1

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-09)

SCIENTIFIC WRITING SKILL (BBT 813)

COURSE OBJECTIVES: This course will uderstand the formulate a research problem and translate it into an empirical step-by-step approach for working with data. To practice statistical techniques required in research for presentation and analysis of research data.

Credits: 04 L-T-P: 4-0-0

Module No.	Content	Teaching Hours
1	**Curriculum Vitae:** Basic introduction and importance of Curriculum Vitae and Resume. Difference between CV and Resume. How to introduce yourself in corporate and academic meetings. Academic writing and its importance.	**10**
2	**Cover Letter:** Prepare a Cover letter, Application for Job in Academic and industrial purpose. Scope of Biotechnology, Microbiology, Biochemistry, Agriculture and Forensic Science.	**10**
3	**Research article:** Basic background of Structural, non-structural and graphical abstracts, Introduction, materials, methodology, results, discussion and Conclusion.	**10**
4	**Review article:** Basic background of narrative review and systemic review, Introduction, materials, methodology, results, discussion and Conclusion.	**10**
5	**Research Report:** Research report writing, Steps in drafting, Use of Indexing, Content drafting, Research ethics, Plagiarism, and types of Plagiarism..	**10**

SUGGESTED TEXT BOOKS :

1. Kothari, C.R., Research Methodology (Methods and Techniques). New Age Publisher
2. Broota, K. D., Experimental designs in psychological research, Wiley eastern, New York, 1992.
3. Guilford, Statistics in Psychology and Education, McGraw Hill, New York, 1986.

COURSE OUTCOME:

After successful accomplishment of the course, the students will be able to:

1. Understand the basic structure of CV and Resume.
2. Develop skill to write cover letter for academic and industrial interviews.
3. Understand some basic concepts of research article and basic structure including abstracts, Introduction, materials, methodology, results, discussion and Conclusion.
4. Understand some basics of review articles and their types in details.

5. Understanding of concepts of Research report drafting, Research ethics, Plagiarism, and other related issues

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	-	-	-	-
CO2	-	-	-	-	-
CO3	3	-	-	-	-
CO4	3	-	-	-	-
CO5	3	-	-	-	-

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-10)

INTELLECTUAL PROPERTY RIGHTS (BBT 814)

COURSE OBJECTIVES: The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work.

Credits: 04 L-T-P: 4-0-0

Module No	Content	Teaching Hours
1.	Concept of IPR: Introduction to Intellectual Property Rights, Kinds of Intellectual Property Rights, Need for Private Rights versus Public Interests, Advantages and Disadvantages of IPR .	10
2.	International scenario of IPR Relating to IPR, International Regime, TRIPS and other Treaties (WIPO , WTO , GATTS), Economic analysis of Intellectual Property Rights	10
3.	Copyright Act , 1957: Overview of Copyright Act , 1957, Terms of Copyright conditions for grant of copyright , the extent of rights exception to copyright protection , fair use provision , assignment and licensing, Copyright in Literary , Dramatic and Musical , Works , Sound Recording ,Cinematograph Films, Copyright in Computer Programme , Author Special Rights , Rights of Broadcasting and performers	10
4.	Overview of Patent Act 1970, Main objectives of the Patent Act, Registration of Patent, Duration of Patent	10
5.	Emerging Issues and Challenges: Traditional knowledge and IPR, Bio – piracy, Domain Name Disputes and Cyber – squatting, IPR and Climate change, Patents and Biotechnology	10

SUGGESTED TEXT BOOKS:

1. Intellectual Property Rights and the Law, Gogia Law Agency, by Dr. G.B. Reddy
2. Law relating to Intellectual Property, Universal Law Publishing Co, by Dr. B.L.Wadehra
3. IPR by P. Narayanan
4. Law of Intellectual Property, Asian Law House, Dr.S.R. Myneni.

REFERENCES :

Bare Act :

1. Trademarks Act , 1999 cts of sale and the rights we stjes of buyer and seller

2. Patents Act , 1970 Instruments and their legist impact .
3. Copyright Act , 1957
4. Designs Act , 2000

COURSE OUTCOME:

On completion of this course, the students will be able to:

1. Competent after study of this law on how to file a property dispute case .
2. Understand to seek and get remedies for violating intellectual property rights .
3. Learn the procedure for obtaining Patents , Copyrights , Trademarks & Industrial Design .

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	1	-	-	-
CO2	-	3	-	-	-
CO3	1	2	-	-	-

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(DISCIPLINE SPECIFIC ELECTIVE COURSE-11)

DRUG DESIGN (BBT 815)

COURSE OBJECTIVES: Drug Design course aims to provide students with an understanding of the process of drug discovery and development.

Credits: 04

Module No.	Content	Teaching Hours
1	**Structural Analysis of Biomolecules:** Introduction to the primary, secondary, and tertiary structure of proteins, Distinct forms of DNA structure, 2D and 3D forms of ligand molecules. The binding cavity of biomolecules.	**10**
2	**Three-dimensional structural analysis of protein:** Protein fold and protein folding, protein topology, monomer, homo-dimer, homo-trimer, homo-tetramer, hetero-dimer, hetero trimer, and hetero-tetramer.	**10**
3	**Structural Databases of Biomolecules and drug-like compounds:** Introduction to Protein Data Bank, PDBSum database. Ligand and drug-like compounds databases: Drug Bank, Zinc database, Pubchem, and Natural compounds databases..	**10**
4	**Introduction to molecular interactions in Biomolecules:** Covalent and Non-covalent bonding, Attractive or repulsive forces between molecules. Hydrogen bonding, Van-der wall forcers, non-bonding electrostatic interrelations, pi-pi interactions, cation-anion interactions, and other weak interactions.	**10**
5	**Various types of Molecular docking:** Introduction to Molecular docking, types of docking, types of protein-ligands docking (Rigid docking, flexible docking, manual docking), protein-protein docking, protein-peptide docking, and protein-DNA docking. Docked complex analysis, and molecular docking leading to virtual screening and identification of lead hit molecule.	**10**

SUGGESTED REFERENCE BOOKS :

1. Molecular Docking for Computer-Aided Drug Design: Fundamentals, Techniques, Resources and Applications by Mohane S. Coumar (Editor).
2. Docking Screens for Drug Discovery: Editors: Walter Filgueira de Azevedo Jr.
3. Stephen Misener, Stephen A. Krawetz . Bioinformatics Methods and Protocols, Humana Press, 1999, ISBN 978-0- 89603-732-8

COURSE OUTCOMES:

After successful accomplishment of the course, the students will be able to:

1. Understanding the importance of drug design and different techniques of drug design
2. Knowledge about chemistry of drugs with respect to their biological activity and its application
3. Knowledge about metabolism, adverse effects and therapeutic value of drugs and its use
4. Understanding the importance of structural activity relationship of different class of drugs
5. Ability to carry out synthesis and assay of specific medicinal compounds

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	-	2	2	-	-
CO2	2	3	1	-	-
CO3	1	3	1	-	-
CO4	2	3	1	-	-
CO5	-	-	-	-	

DRUG DESIGN LAB (BST 873)

COURSE OBJECTIVES: The practical syllabus for drug design aims to provide undergraduate students with hands-on experience in computational methods and laboratory techniques used in modern drug discovery and development. The course will cover various aspects of drug design, including molecular modeling, structure-based drug design, and quantitative structure-activity relationship (QSAR) analysis.

Credits: 01

Module No.	Contents	Lab Hours
1.	1. Introduction to Drug Design, Overview of drug discovery process 2. Basic concepts in drug design 3. Introduction to molecular modeling software (e.g., AutoDock, PyMOL) Building and visualizing small molecules and macromolecules 4. Introduction to SBDD concepts, Docking studies: Preparing protein and ligand structures 5. Performing docking simulations and analyzing results 6. Introduction to Ligand-Based Drug Design concepts, Pharmacophore modeling Virtual screening of compound libraries	20

COURSE OUTCOME:

After successful accomplishment of the course, the students will be able to:

1. Understand the principles and techniques of drug design.
2. Gain proficiency in computational tools for molecular modeling and drug discovery.
3. Develop skills in designing and optimizing drug candidates.
4. Apply QSAR and other computational techniques to predict drug activity

SUGGESTED TEXTBOOKS & REFERENCES:

1. Drug Design: Structure- and Ligand-Based Approaches" by Kenneth M. Merz, Dagmar Ringe, and Charles H. Reynolds
2. Computational Drug Design: A Guide for Computational and Medicinal Chemists" by David C. Young
3. Molecular Modelling: Principles and Applications" by Andrew R. Leach

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(DISSERTATIONS-2)

Major Project -2 (BBT 871)

COURSE OBJECTIVES: Develop an ability to understand the basic requirement to conduct a research project. Student also develop skill of writing and presentation on the assigned research topics in the field of biotechnology

L-T-P: 0-0-6

Credits: 06

COURSE CONTENTS:

Every student will be required to undertake a research project based on any of the areas of biotechnology. The research project should have applied significance. The project report will be submitted in the form of dissertation duly certified by the supervisor of the Department of Biotechnology or at national institutes and Universities in India, by seeking the placement. The project will be presented for evaluation at the end of semester by external experiments.

COURSE LEARNING OUTCOMES (CLOS):

After completion of the course, students will be able to:

1. Understand about the Research in Biotechnology
2. Develop presentation skill during the conduction of research, discussion and presentation.
3. Student will develop analysis of results, drafting and writing skill.

MAPPING BETWEEN COURSE OUTCOMES AND PROGRAM OUTCOMES

CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	2	3
CO3	3	3	3	-	-