SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

Common Minimum Syllabus for B.Sc. Biotechnology/ B.Sc. Biotechnology (Honors)/ B.Sc. Biotechnology (Honors with Research

National Education Policy-2020

Subject: Biotechnology

SYLLABUS OF UG BIOTECHNOLOGY (Common Minimum Syllabus for B.Sc. Biotechnology/ B.Sc. Biotechnology (Honors)/ B.Sc. Biotechnology (Honors with Research)

Effective from Academic Session 2025-2026 Onward

VISION AND MISSION- DEPARTMENT OF BIOTECHNOLOGY

Vision

1. To be producing technical manpower through excellence in research and development, teaching, learning and training, with concern for worldwide environment and human society.
2. To provide well and quality education in the field of Life Sciences and Applied Sciences with proper training and practical expertise responsive to the needs of present and future century so that students excel and enhance in their professional life.

Mission

1. Providing friendly learning ambience to develop competence in diversified areas to create excellence in industrial, educational, research and technical areas.
2. Provide an efficient educational environment where students and research scholars can realize their full potential in their chosen disciplinary subjects and attain quality education to face the challenges of the future.
3. Establish networks collaborations and linkages with industries and academic institutes to produce ethically and morally strong workforce contributing to the development of knowledge economy.
4. Harness the skills of the students and assist them to excel in their professional life by providing life long leaning skills, sound theoretical knowledge, practical experience and all-round development with the help of well qualified and experienced faculty. Inculcate moral and ethical values for character building.

C U R R I C U L U M

B. Sc. Biotechnology Graduate/ B. Sc. Biotechnology (Honors)/ B. Sc. Biotechnology (Honors with Research) Degree Programme (2024-2025 Onwards)

1. Nomenclature:

There will be full time Biotechnology Degree Programme named as B. Sc. Biotechnology (three full academic years), B.Sc. Biotechnology (Honors) (four full academic years) and B.Sc. Biotechnology (Honors with Research) (four full academic years). The duration of this programme shall be of three years/four years (three/four full academic years) which shall be divided into six semesters/eight semesters. Each semester will be of six. months. Actual teaching in each semester is required minimum of 90 days. The examination for the first, third, fifth and seventh semester will normally be held in the month of December and for the second, fourth, sixth and eight semester in the month of May or as convenient to the University.

2. The Medium of Instruction:

The medium of Instruction will be English.

3. The Medium of Examination:

The medium of examination will be English.

4. Intake: The intake to B. Sc. Biotechnology (Honors/Research) course is 40 students. It may increase or decrease as per provisions of the University.

5. Eligibility to apply for Admission:

No candidate shall be eligible for admission to three years/four years Full Time B. Sc. Biotechnology (three full academic years), B.Sc. Biotechnology (Honors) (four full academic years) and B.Sc. Biotechnology (Honors with Research) (four full academic years) unless he/she has successfully completed higher secondary or Intermediate (with any biological/mathematical/science subject/Biotechnology/Intermediate with Biology/Math) with prescribed number of credits or percentage through the examinations conducted by a National/State Board. Such qualifications as recognized by the University. Any candidate who has passed the plus two of the higher secondary board of Examinations in any state recognized as equivalent to the plus two of the Higher Secondary Board in with not less than 45 % marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given relaxation as per University rules.

Duration of the Programme : 3/4 Year

6. Selection Procedure for Admission: A candidate willing to seek admission to B. Sc. Biotechnology (three full academic years), B.Sc. Biotechnology (Honors) (four full academic years) and B.Sc. Biotechnology (Honors with Research) (four full academic years) will have to appear in written entrance Test conducted by the University or on behalf of the University and followed by the counseling as per University norms. The selection for admission will be made on merit basis or as per University norms.

7. Semesters:

(a) An academic year shall consist of two semesters :

Odd Semester (I, III, V and VII Semester) : generally July to November/December

Even Semester (II, IV, VI and VIII Semester): generally January to May/ June

The academic calendar for each semester shall be notified well before the commencement of the semester by the Dean, School of Basic and Applied Sciences.

(b) A semester shall normally extend over a period of 15 weeks. Each week shall have 30 hours of instruction including lab/ field work as applicable.

8. Credits:

(a) Credit defines the quantum of contents/ syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus credits shall be assigned on the basis of the number of lectures/ tutorials / laboratory work/ project work and other forms of learning required to complete the course contents in a 15 week schedule.

(b) 1 Credit = 1 hour of lecture for theory and 1 Credit = 2 hour of laboratory for practical.

(c) Motivate students with industrial visit, educational trip, seminar/conference during semester.

9. Roll Numbers and Enrollment Numbers:

The University shall allot a Roll Number to the students after payment realization, thorough scrutiny/ verification of the required documents for the course. After the completion of the admission procedure the enrolment number for the students shall be allotted by the University at the entry point which shall remain same for the entire period of study in the University.

10. The Credit Based Course Structure: B. Sc. Biotechnology (three full academic years), B.Sc. Biotechnology (Honors) (four full academic years) and B.Sc. Biotechnology (Honors with Research) (four full academic years)- Choice Based Credit System (CBCS)

B. Sc. Biotechnology (three full academic years), B.Sc. Biotechnology (Honors) (four full academic years) and B.Sc. Biotechnology (Honors with Research) (four full academic years) program shall be based on the choice based credit system in which credit defines the quantum of content/ syllabus prescribed for a course system and determines the number of hours of instruction per week.

Total Credits:

A. 64 (DSC/MC)+ 16 (DSE/ME)+ 16 (GE/OE)+ 08 (VAC)+ 12 (SEC)+ 08 (AEC)+ 08 (Minor Project/Educational of Tour) =132 (For three years B. Sc. Biotechnology)

B. 132 (For three years B. Sc. Biotechnology)+ 16 (DSC/MC)+ 8 (DSE/ME)+ 08 (OE)+ 12 (Project)= 176 (For four years B. Sc. (Hons.) Biotechnology)

C. 132 (For three years B. Sc. Biotechnology)+ 12 (DSC/MC)+ 19 (Research Project)+ 13 (Dissertation)=176 (For four years B. Sc. (Hons.) Biotechnology with Research)

D. Where,

a. DSC/MC=Discipline Specific Core/ Major Core
b. DSE/ME= Discipline Specific Elective/Major Elective
c. GE/OE= Generic Elective/Open Elective
d. VAC/VC= Value Addition Course
e. SEC/DC= Skill Enhancement Course
f. AEC= Ability Enhancement Course

E. Undergraduate degree programes of either 3 or 4-year duration, with multiple entry and exit points and reentry options within this period, with appropriate certifications such as:

1. **a certificate after completing 1 year (2 semesters) of study in the chosen fields of study,**
2. **a diploma after 2 years (4 semesters) of study,**
3. **a bachelor's degree after a 3-year (6 semesters) programme of study,**
4. **a bachelor's degree with honours after a 4-year (eight semesters) programe of study or a bachelor's degree with research after a 4-year (eight semesters) programe of study if the student completes a rigorous research project in their major area(s) of study.**

F. **Remote/blended learning modes:** Options will be available for students to earn credit by completing quality-assured remote learning modes, including online programmes offered on the Study Webs of Active Learning for Young Aspiring Minds (SWAYAM: www.swayam.gov.in) or other online educational platform approved by the competent body from time to time. Students may opt to earn credits from such courses up to 40 per cent of the total credits required for the award of a certificate/Diploma/Degree.

G. ***If students want to quit the course after first year or second year it will be compulsory to obtain one month 4 Credit exit course.**

H. **Students can opt Generic/ Open Elective either from other Department or Host Depaartment.**

11. Student Advisor:

Every student shall have a teacher of the Department as his/her student advisor. All teachers of the department shall function as student advisors and will have more or less equal number of students with them. The student advisor will advise the students in choosing elective courses and offer all possible student support services.

12. Attendance:

a. The teacher handling a course shall be responsible for maintaining a record of attendance of students who have registered for the course.

b. All teachers shall intimate the Head of the Department at least seven calendar days before the last instruction day in the semester, the particulars of all students who have less than 75% attendance in one or more courses.

c. A candidate who has less than 75% attendance shall not be permitted to sit for the end-semester examination in the course in which the shortfall exists. However, it shall be open to the Dean/ HOD to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons on payment of prescribed fee and such exemptions shall not under any circumstances be granted for attendance below 65%.

d. A candidate who fails to put in least 75% attendance in I semester shall not be allowed to pursue the studies in next semester. Such candidates may apply to the Dean/HOD for re-registration in the II semester in the next academic session.

Note : Rest of the provisions will be as framed by the University.

13. Fee and Resource Generation

As per decision of the University.

14. Examination and Evaluation

(a) Evaluation will be done on a continuous basis. Three times during each semester. For the purpose of uniformity, there will be a uniform procedure of examination to be adopted by all teachers. There will be two sessional tests (Three if any student are unable to attend any sessional test) and one end-semester examination.

(b) Sessional tests (of one to two hours duration) may employ one or more assessment tools such as objective tests, assignments, paper presentation, laboratory work, etc suitable to the course. This requires an element of openness. The students are to be informed in advance about the nature of assessment. It will be obligatory for the Students to attend the both Sessional tests, failing which they will not be allowed to appear in the concerned semester examination. The sessional test as part of the continuous internal assessment shall be conducted and evaluated by the teacher offering the course. A Student cannot repeat sessional tests (without permission from HOD). However, if for any compulsive reason the student could not attend the test, the prerogative of arranging a special test lies with the teacher with the approval of the Head of the Department. In case of students who could not attend any of the sessional tests due to medical reason or under extraordinary circumstances, a separate test shall be conducted before the concerned semester examinations by the concerned faculty member after the approval of the Head of the Department and the Dean concerned.

(c) The sessional tests will carry 30% of total marks for the course. The marks of the two Sessional Tests shall be taken into account for the computation of Grades.

(d) There shall be a written end semester examination which shall be of 2/3 hours duration carrying 70% of total marks assigned for the course, covering the entire syllabus prescribed for the course.

(e) The end semester practical examinations (field tour report, project report and training report) shall normally be held before the theory examination/or as per convenience by the Department . The internal faculty shall associate themselves with the examination process.

OUTCOME BASED EDUCATION

Programme outcomes (POs)

Students will be able to

PO 1	Knowledge of Biotechnology and Applied sciences: Students have the basic knowledge of Biotechnology, Biochemistry (Biomolecules), Microbiology, Plant Biotechnology, environmental science, chemistry, Common biology (Botany and Zoology) and understand its applicability or correlate these applied science to nature.
PO2	Problem analysis: Identify, express, analyze the problems related to Applied (Biotechnology), basic and natural sciences.
PO3	Design/development of solutions: Students will be able to design or generate solutions of common problems of Applied Sciences (Biotechnology) and its output is to improve public and environmental health.
PO4	Modern tool usage: Generate, select, and apply appropriate modern techniques and resources for understanding the concept of Biotechnology.
PO5	Environment and sustainability: Understand the impact of the Applied science and Biotechnology to improve the environmental health and aware about the knowledge and need of sustainable development.
PO6	Project management, lab culture and Communication : Acquired the skills in handling scientific instruments, planning and performing in laboratory experiments. Communicate effectively on complex Biotechnological activities with the other science community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.
PO7	Future prospective, Individual and Team Work: After the completion of this course students have the option to go for higher studies i.e. M. Sc. and then do some research for the welfare of mankind or prepare for other competitive examination**.** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings followed with the knowledge of Biotechnology.
PO8	Life-long and interdisciplinary approach of learning: Realized how developments in any Biotechnological subject helps in the development of other science subjects and vice-versa and how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments. Recognize the need for and have the preparation and ability to Engage in independent and life- long learning in the broadest context of Biotechnological Change.
PO9	Effective Writing: Got Skill for Write up in scientific literature and other social media platform related to life science.
PO10	Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
PO11	Social Interaction and Ethics: Elicit views of others, mediate disagreements and help reach conclusions in group. Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them settings conclusions in group settings.
PO12	Interdisciplinary approach and Practical learning: Analyse the relationships among animals, plants, microbes and Industry. Perform procedures as per laboratory standards in the areas of Biochemistry, Bioinformatics, Genomics, industrial biotechnology and fermentation technology.

Program Specific Outcomes (PSOs)

PSO 1	The students will understand the basic metabolic and molecular processes required for normal cellular functions.
PSO2	The students will learn about different tools and techniques required for genetic manipulation, microbial culture and biochemical analysis.
PSO3	The students will be able to execute basic experiments related to biochemistry, microbiology, cell biology, recombinant DNA technology, etc.
PSO4	The students will be able to pursue higher studies in diverse areas of biological sciences or take up jobs in various biotechnology sectors.

NEP- 2020-Choice Based Credit System/
B.Sc. Biotechnology/ B.Sc. Biotechnology (Honors)/ B.Sc. Biotechnology (Honors with Research
Certificate Course in Biotechnology

First Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Discipline Specific Core (DSC-1) /Major Core- 1	BBTDC 101	Basic Biochemistry	3	0	0	3	30	70	100
2	Discipline Specific Core (DSC-2) /Major Core- 2	BBTDC 103	Elementary Cell Biology	3	0	0	3	30	70	100
3	Discipline Specific Core (DSC-3) /Major Core- 3	BBTDC 105	General Microbiology	3	0	0	3	30	70	100
4	Generic Elective (GE)/Open/minor Elective/ Multidisciplinar	BBTGE 107	Introductory Bioinformatics	4	0	0	4	30	70	100
5	Value Addition Course (VAC)	BBTVC 108	Concept of food technology	2	0	0	2	30	70	100
6	Skill Enhance Course (SEC)	BBTSC 109	Basics of fermentation technology	2			2	30	70	100
7	Ability Enhance Course (AEC)	AEC-1	Environmental Science	2	0	0	2	30	70	100
8	Remedial Course (For PCM)	BBTRB 110	Remedial Biology	2	0	0	0	50	-	50
Practical										
1	Major Core-1	BBTDC 102	Lab course based on course BBTDC 101	0	0	1	1	30	70	100
2	Major Core-2	BBTDC 104	Lab course based on course BBTDC 103	0	0	1	1	30	70	100
3	Major Core-3	BBTDC106	Lab course based on course BBTDC 105	0	0	1	1	30	70	100
Total				20	-	3	22	350	700	1050

L – Lecture, T – Tutorial, P – Practical, C – Credit

Second Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Discipline Specific Core (DSC-1) /Major Core- 1	BBTDC 201	Human Physiology	3	0	0	3	30	70	100
2	Discipline Specific Core (DSC-2) /Major Core- 2	BBTDC 203	Plant Physiology	3	0	0	3	30	70	100
3	Discipline Specific Core (DSC-3) /Major Core- 3	BBTDC 205	Basic Molecular Biology	3	0	0	3	30	70	100
4	Generic Elective (GE)/Open/minor Elective/ Multidisciplinary	MICGE 204	Vermitechnology	4	0	0	4	30	70	100
5	Value Addition Course (VAC)	BBTVC 208	General Biotechnology	2	0	0	2	30	70	100
6	Skill Enhance Course (SEC)	BBTSC 209	Elementary Forensic Science	2	0	0	2	30	70	100
7	Ability Enhance Course (AEC)	AEC- 2	English Communication	2	0	0	2	30	70	100
Practical										
1	Major Core-1	BBTDC 202	Lab course based on course BBTDC 201	0	0	1	1	30	70	100
2	Major Core-2	BBTDC 204	Lab course based on course BBTDC 203	0	0	1	1	30	70	100
3	Major Core-3	BBTDC 206	Lab course based on course BBTDC 205	0	0	1	1	30	70	100
Total				19	-	3	22	300	700	1000

L – Lecture, T – Tutorial, P – Practical, C – Credit

Diploma Course in Biotechnology

Third Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Discipline Specific Core (DSC-1) /Major Core- 1	BBTDC 301	Basic concept of Genetics	3	0	0	3	30	70	100
2	Discipline Specific Core (DSC-2) /Major Core- 2	BBTDC 303	Developmental Biology	3	0	0	3	30	70	100
3	Discipline Specific Core (DSC-3) /Major Core- 3	BBTDC 305	Chemistry-I	3	0	0	3	30	70	100
4	Generic Elective (GE)/Open Elective/ Multidisciplinary or MOOC/ SWAYAM	BBTGE 307	Bioethics and Biosafety	4	0	0	4	30	70	100
5	Value Addition Course (VAC)	BBTVC 308	Indian Knowledge System	2	0	0	2	30	70	100
6	Skill Enhance Course (SEC)	BBTSC 309/Code from University Pool (SGRRU)	Green Chemistry/Disaster Management (University Pool)	2	0	0	2	30	70	100
7	Ability Enhance Course (AEC)	AEC- 3	Molecular Diagnostics	2	0	0	2	30	70	100
Practical										
1	Major Core-1	BBTDC 302	Lab course based on course BBTDC 301	0	0	1	1	30	70	100
2	Major Core-2	BBTDC 304	Lab course based on course BBTDC 303	0	0	1	1	30	70	100
3	Major Core-3	BBTDC 306	Lab course based on course BBTDC 305	0	0	1	1	30	70	100
Total				19	-	3	22	300	700	1000

L – Lecture, T – Tutorial, P – Practical, C – Credit

Fourth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Discipline Specific Core (DSC-1) /Major Core- 1	BBTDC 401	Biostatistics	3	0	0	3	30	70	100
2	Discipline Specific Core (DSC-2) /Major Core- 2	BBTDC 403	Basic Immunology	3	0	0	3	30	70	100
3	Discipline Specific Core (DSC-3) /Major Core- 3	BBTDC 405	Chemistry II	3	0	0	3	30	70	100
4	Generic Elective (GE)/Open Elective/ Multidisciplinary or MOOC/ SWAYAM	BBTGE 407	Biotechnology and Human Welfare	4	0	0	4	30	70	100
5	Value Addition Course (VAC)	BBTVC 408	Analytical techniques	2	0	0	2	30	70	100
6	Skill Enhance Course (SEC)	BBTSC 409	Enzymology and Applications	2	0	0	2	30	70	100
7	Ability Enhance Course (AEC)	AEC- 4	Basics of Drug Designing	2	0	0	2	30	70	100
Practical										
1	Major Core-1	BBTDC 402	Lab course based on course BBTDC 401	0	0	1	1	30	70	100
2	Major Core-2	BBTDC 404	Lab course based on course BBTDC 402	0	0	1	1	30	70	100
3	Major Core-3	BBTDC 406	Lab course based on course BBTDC 405	0	0	1	1	30	70	100
Total				19	-	3	22	300	700	1000

L – Lecture, T – Tutorial, P – Practical, C – Credit

*QUIT OR EXIT COURSE

Course code	**: BBTEX 210/410**
Course Name	**: Internship/ Training**
Semester	**: (After II and IV Semester)**

Duration 2 Month **(60Hours)**

L	T	P	C
4	0	0	4

1. Good Laboratory Practices & Biochemical calculations.
2. DNA isolation from Bacteria.
3. Quantitative estimation of isolated DNA.
4. Agarose gel electrophoresis.
5. Determination of melting temperature (Tm).
6. Ascending paper chromatography for amino acids.
7. Thin Layer Chromatography (TLC) for lipids.
8. Determination of absorption spectrum of a dye.

***If students want to quit the course after first year or second year it will be compulsory to obtain one month 4 Credit exit course.**

Degree Course in Biotechnology
B.Sc. Biotechnology

Fifth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Discipline Specific Core (DSC-1) /Major Core-1	BBTDC 501	Bioprocess technology	3	0	0	3	30	70	100
2	Discipline Specific Core (DSC-2) /Major Core-2	BBTDC 503	Recombinant DNA Technology	3	0	0	3	30	70	100
3	Discipline Specific Elective- 1 (DSE- 1)/ Major Elective-1 (Any one)	BBTDE 505a/505b	Animal Diversity-I/ Plant Diversity I	3	0	0	3	30	70	100
4	Discipline Specific Elective- 2 (DSE- 2)/ Major Elective-2 (Any one)	BBTDE 507a/507b	Microbial Physiology/ Pharmaceutical Biotechnology	3	0	0	3	30	70	100
5	Skill Enhance Course (SEC)	BBTSC 509	Intellectual Property Rights	2	0	0	2	30	70	100
6	Project 1	BBTPR 510	Project Report I	0	0	0	4	100	-	100
Practical										
1	Major Core- 1	BBTDC 502	Lab course based on course BBTDC 501	0	0	1	1	30	70	100
2	Major Core- 2	BBTDC 504	Lab course based on course BBTDC 503	0	0	1	1	30	70	100
3	Major Elective - 1 (Any one)	BBTDE 506a/506b	Lab course based on course BBTDE 505a/505b	0	0	1	1	30	70	100
4	Major Elective- 1 (Any one)	BBTDE 508a/508b/508c	Lab course based on course BBTDE 507a/507b/507c	0	0	1	1	30	70	100
Total				15	-	4	22	370	630	1000

L – Lecture, T – Tutorial, P – Practical, C – Credit

Sixth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Discipline Specific Core (DSC-1) /Major Core- 1	BBTDC 601	Bio Analytical Tools	3	0	0	3	30	70	100
2	Discipline Specific Core (DSC-2) /Major Core- 2	BBTDC 603	Genomics & Proteomics	3	0	0	3	30	70	100
3	Discipline Specific Elective-1 (DSE-1)/ Major Elective-1 (Any one)	BBTDE 605a/605b/605c	Animal Diversity-II/ Plant Diversity II/Environment Biotechnology	3	0	0	3	30	70	100
4	Discipline Specific Elective-2 (DSE-2)/ Major Elective-2 (Any one)	BBTDE 607a/607b/607c	Animal Biotechnology/ Plant Biotechnology	3	0	0	3	30	70	100
5	Skill Enhance Course (SEC)	BBTSC 609	Medical Microbiology	2	0	0	2	30	70	100
6	Project 2	BBTPR 610	Project Report II	0	0	0	4	100	-	100
Practical										
1	Major Core- 1	BBTDC 602	Lab course based on course BBTDC 601	0	0	1	1	30	70	100
2	Major Core- 2	BBTDC 604	Lab course based on course BBTDC 603	0	0	1	1	30	70	100
3	Major Elective-1 (Any one)	BBTDE 606a/606b/606c	Lab course based on course BBTDE 605a/605b/605c	0	0	1	1	30	70	100
4	Major Elective-2 (Any one)	BBTDE 608a/608b	Lab course based on course BBTDE 607a/607b	0	0	1	1	30	70	100
Total				15	-	4	22	370	630	1000

L – Lecture, T – Tutorial, P – Practical, C – Credit

Degree Course in Honors Biotechnology
B.Sc. Biotechnology (Honors)

Seventh Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Discipline Specific Core (DSC-1) /Major Core- 1	BBTDC 701	Molecular Cell Biology	3	0	0	3	30	70	100
2	Discipline Specific Core (DSC-2) /Major Core- 2	BBTDC 703	Clinical Immunology	3	0	0	3	30	70	100
3	Discipline Specific Elective (DSE-1) /Major Elective-1	BBTDE 705a/705b	Immunotechnology/ Virology	3	0	0	3	30	70	100
4	Generic Elective (GE)/Open Elective/ Multidisciplinary	BBTGE 707	Biomolecule & Metabolism	4	0	0	4	30	70	100
5	Project 3	BBTPR 708	Project Report III	0	0	0	6	100	-	100
Practical										
1	Major Core-1	BBTDC 702	Lab Course based on course BBTDC 701	0	0	1	1	30	70	100
2	Major Core-2	BBTDC 704	Lab Course based on course BBTDC 703	0	0	1	1	30	70	100
3	Major Elective-1	BBTDE 706a/706b	Lab Course based on course BBTDE 705a/705b	0	0	1	1	30	70	100
Total				13	0	3	22	310	490	800

L – Lecture, T – Tutorial, P – Practical, C – Credit

Eight Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Discipline Specific Core (DSC-1) /Major Core- 1	BBTDC 801	Molecular Biology and Applications	3	0	0	3	30	70	100
2	Discipline Specific Core (DSC-2) /Major Core- 2	BBTDC 803	Nanobiotechnology	3	0	0	3	30	70	100
3	Discipline Specific Elective (DSE-1) /Major Elective-1	BBTDE 805a/805b	Molecular Endocrinology & Enzymology/ Biomaths, Biostats, Computers Programming & Applications	3	0	0	3	30	70	100
4	Generic Elective (GE)/Open Elective/ Multidisciplinary	BBTGE 807	Epigenetics and Cancer Biology	4	0	0	4	30	70	100
5	Project 4	BBTPR 808	Project/Educational Tour Report IV	0	0	0	6	30	70	100
Practical										
1	Major Core-1	BBTDC 802	Lab Course based on course BBTDC 801	0	0	1	1	30	70	100
2	Major Core-2	BBTDC 804	Lab Course based on course BBTDC 803	0	0	1	1	30	70	100
3	Major Elective-1	BBTDE 806a/806b	Lab Course based on course BBTDE 805a/805b	0	0	1	1	30	70	100
Total				13	0	3	22	310	490	800

L – Lecture, T – Tutorial, P – Practical, C – Credit

Degree Course in (Hons.) Biotechnology with Research

B.Sc. Biotechnology (Honors with Research)

Seventh Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
	Discipline Specific Core (DSC-1) /Major	BBTDC 701	Research Methodology	4	0	0	4	30	70	100
	Discipline Specific Core (DSC-2) /Major	BBTDC 702	Research Publications and Ethics	4	0	0	4	30	70	100
Research										
	Research 1	BBTRM 703	Review of literature/ Minor Project	0	0	0	9	60	140	200
	Research 2	BBTRS 704	Research Seminar Presentation-I	0	0	0	5	50	50	100
Total				8	0	0	22	170	330	500

L – Lecture, T – Tutorial, P – Practical, C – Credit

Eight Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
	Discipline Specific Core (DSC-1) /Major Core- 1	BBTDC 801	Research –IPR	4	0	0	4	30	70	100
Research										
	Dissertation	BBTDI 802	Major Project/ Internship	0	0	0	13	60	240	300
	Research 3	BBTRS 803	Research Seminar Presentation-II	0	0	0	5	50	50	100
Total				4	0	0	22	140	360	500

L – Lecture, T – Tutorial, P – Practical, C – Credit

Certificate Course in Biotechnology

B. Sc. Biotechnology

Course code	**: BBTDC 101**
Course Name	**: Basic Biochemistry**
Semester	**: I**

L	T	P	C
3	0	0	3

Course objective: This course is aimed to introduce the knowledge of biomolecules and their role in metabolic pathways. Also, it deals with the structure and function of enzymes.

UNIT I: Introduction to Biochemistry

A historical prospective. Amino acids & Proteins**:** Structure & Function. Structure and properties of Amino acids.

UNIT II

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA.

UNIT III

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites.

UNIT IV

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

SUGGESTED READING AND TEXT BOOKS

1. Buchanan, B., Gruissem, W. and Jones, R. (2015) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
2. Nelson, D.L., Cox, M.M. (2021) Lehninger Principles of Biochemistry, 8th Edition, WH Freeman and Company, New York, USA.
3. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology, 4th Edition , John Wiley and Sons.
4. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.
5. Berg, JM, Tymoczko, JL and Stryer, L(2023). Biochemistry. 10th ed. WH Freeman and Co.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the knowledge about the define the terms and basic concepts of Biochemistry and Metabolism and their different roles in biological systems, Nucleic Acid Metabolism	1 Remember
CO2	**Catch on** the principle, mechanism of basic and advanced Biochemistry and Metabolism, Nucleic Acid Metabolism.	1,2 Remember, Understand
CO3	**Demonstrating** detailed process of structure and function of biomolecules and enzymes, Nucleic Acid Metabolism.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the coordinated regulation of carbohydrate, Protein and lipid metabolic pathway, nucleic acid metabolism.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of Biochemical enzymes and molecules, nucleic acid metabolism.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the Biomolecules and Enzymes, nucleic acid metabolism.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	1	1	1	1	3	1	1	1	3	2	1	1
CO2	3	3	1	1	1	1	1	1	3	1	1	1	3	2	1	1
CO3	2	3	3	3	3	3	2	2	3	2	2	2	3	2	2	1
CO4	3	2	3	3	3	3	1	1	3	1	0	1	3	3	2	1
CO5	3	2	3	1	1	1	2	2	3	3	2	1	3	2	1	1
CO6	1	1	1	1	1	1	1	1	2	2	2	1	3	2	2	1

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 102**
Course Name	**: Lab Course Based on BBTDC 101**
Semester	**: I**

L	T	P	C
0	0	1	1

Practicals

1. Preparation of solutions: percentage solution, Molar solution, Nornal solution. Preparation ofbuffers.
2. Qualitative tests for Carbohydrates like Molisch's test, Anthrone test, Iodine test, Seliwanoff'stest, and Fehling's test.
3. Principles of Colorimetry: Verification of Beer-Lambert Law; Study relation between absorbanceand % transmission.
4. Estimation of blood glucose by glucose oxidase method.
5. Preparation of buffers.
6. Sugar estimation by Anthrone method.
7. Protein estimation by Bradford method.
8. Nucleic acid estimation by Diphenylamine reagent.
9. Study activity of any enzyme under optimum conditions.
10. Study the effect of pH, temperature on the activity of salivary amylase enzyme.
11. Separation of Amino acids by paper chromatography.
12. JMol via Spoken Tutorial: Visualization of geometrical structure of simple molecules likecarbohydrates, fatty acids, amino acids and proteins.

B. Sc. Biotechnology

Course code	**: BBMDC 103**
Course Name	**: Elementary Cell Biology**
Semester	**: I**

L	T	P	C
3	0	0	3

Course Objective: Cell is the structural and functional unit of life. It is often referred to as the building block of life as well. The course on cell biology aims to impart knowledge of cell structure and functions of diverse cellular organelles.

UNIT-I

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II

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 including role in protein secretion.

UNIT III

Lysosomes: Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.

UNIT IV

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, characteristics and molecular basis of cancer.

SUGGESTED READING AND TEXT BOOKS

1. Karp, G. 2020. Cell and Molecular Biology: Concepts and Experiments. 9th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 1987. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2022. The Cell: A Molecular Approach. 9th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2015. The World of the Cell. 9th edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the knowledge about the define the terms and basic concepts of cell biology and their different roles in biological systems	1 Remember
CO2	**Perceive** the principle, mechanism of cellular reaction like cell membrane functions, membrane vacuolar system, intracellular campartmentization and extracellular complexes.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes of structure and function of Cell membrane, cytoplasmic organelles and different components of cells.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed processes of structure and function of Membrane carbohydrates, lipids and proteins, cytoplasmic organelles and different components of cells.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties, functions and isolation of Biochemical cell's components and organelles.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the cell biology and cancer biology. Create awareness to different cellular functions.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	1	2	2	2	2	3	1	1	1	3	2	1	2
CO2	3	2	2	2	2	2	1	1	3	1	1	1	3	2	1	2
CO3	3	2	3	3	3	3	2	2	3	2	2	2	3	2	2	2
CO4	2	2	3	3	3	3	1	1	3	1	0	1	3	3	2	2
CO5	2	2	3	1	1	1	2	2	3	3	2	1	3	2	2	2
CO6	2	2	1	1	1	1	1	1	3	2	2	1	3	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 104**
Course Name	**: Lab Course Based on BBTDC 103**
Semester	**: I**

L	T	P	C
0	0	1	1

Practicals

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Study the working and functioning of microscope.
3. Demonstration of dialysis.
4. Study of plasmolysis and de-plasmolysis.
5. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
6. Study of structure of any Prokaryotic and Eukaryotic cell.
7. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
8. Cell division in onion root tip/ insect gonads.
9. Preparation of permanent slides of transverse sections (TS) of stem, root and leaf.
10. Demonstrate the structure of biomolecule using Cell Designer via Spoken Tutorial.
11. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

B. Sc. Biotechnology

Course code	**: BBTDC 105**
Course Name	**: General Microbiology**
Semester	**: I**

L	T	P	C
3	0	0	3

Course objectives: This course is designed to be an introduction to microbiology that will familiarize students with the diversity within the microbial world, biology of bacteria, their metabolism and genetics, and their control. The specific objectives are:

1. To illustrate the criteria used for classification of microorganisms
2. To explain the structure of a prokaryotic cell
3. To give an overview of growth, nutrition and metabolism in bacteria
4. To illustrate the concepts of bacterial recombination

UNIT I

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. 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.

UNIT II

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

UNIT III

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 pathwaysBacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents. 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.

SUGGESTED READING AND TEXT BOOKS

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2021). Brock Biology of Microorganisms. 16th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2018). Microbiology: An Introduction. 13 th edition. Pearson
8. **Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's** Microbiology. 7th edition. McGraw Hill Higher Education.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the knowledge about the different concept of fundamentals, History and Evolution of Microbiology, microbial diversity, Cultivation and Maintenance of microorganisms, Microbial growth, Microbial Metabolism, Bacterial Reproduction, Control of Microorganisms, water microbiology	1 Remember
CO2	**Perceive/Catch on** the concept of fundamentals, History and Evolution of Microbiology, microbial diversity, Microbial growth, Microbial Metabolism, Bacterial Reproduction, Control of Microorganisms, water microbiology, food microbiology and Cultivation and Maintenance of microorganisms.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of microbiology, genetic recombination in microbiology, diversity and metabolism of microbiology along with Control of pathogenic microorganisms, water microbiology and food microbiology.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to different concept of microbiology, genetic recombination in microbiology, diversity and metabolism of microbiology along with Control of pathogenic microorganisms, water microbiology and food microbiology.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of essential techniques and features of microbiology, genetic recombination in microbiology, diversity and metabolism of microbiology along with Control of pathogenic microorganisms, water microbiology and food microbiology.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the Take part in essential techniques and features of microbiology, genetic recombination in microbiology, diversity and metabolism of microbiology along with Control of pathogenic microorganisms, water microbiology and food microbiology.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	3	3	2	3	2	2	2	3	2	1	2
CO2	3	2	2	3	3	2	1	3	3	3	3	3	3	2	1	2
CO3	3	3	2	2	3	3	2	2	3	2	2	2	2	2	2	2
CO4	3	3	3	3	2	3	2	2	3	1	1	1	2	3	2	2
CO5	3	2	3	2	2	2	2	2	3	3	2	3	2	2	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 106**
Course Name	**: Lab Course Based on BBTDC 105**
Semester	**: I**

L	T	P	C
0	0	1	1

Practicals

1. Preparation and sterilization of media for bacterial culture.
2. Isolation of bacteria from the soil.
3. Preparation of pure culture of bacteria.
4. Streaking of bacterial culture.
5. Gram staining of bacteria.
6. Determination of bacterial cell size by micrometry.
7. Enumeration of microorganisms.
8. Preparation of bacterial growth curve.
9. Antimicrobial sensitivity test.
10. Demonstration of flagella staining.

B. Sc. Biotechnology

Course code	**: BBTGE 107**
Course Name	**: Introductory Bioinformatics**
Semester	**: I**

L	T	P	C
4	0	0	4

Course objectives: The aim of the course is to introduce students to the basic tenets of bioinformatics. The course provides a strong foundation for developing skills in using biological sequence databases, and tools for biological sequence analysis. The specific objectives of the course are as follows:

1. To teach students about biological sequence data storage.
2. To make students understand about various bioinformatics tools used for DNA, RNA and proteinsequence analysis.
3. To impart knowledge about biological sequence alignment.
4. To teach the fundamental principles of molecular phylogeny.

UNIT I

History of Bioinformatics. The notion of Homology. Sequence Information Sources.

UNIT II

EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT III

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web.

UNIT IV

Introduction of Data Generating Techniques and
Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1 Remember
CO2	**Perceive/Catch on** the specific and basic concepts of Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2
CO3	3	3	3	3	3	3	3	2	2	2	3	3	3	3	3	3
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	3	3	2	2	3	3	3	2	2	2	2	2	2	2
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTVC 108**
Course Name	**: Concept of Food Technology**
Semester /Year	**: I**

L	T	P	C
2	0	0	2

Course Objectives: The objectives of this course are

1. To provide scientific knowledge related to various techniques associated with Food and Beverages Biotechnology.
2. To impart laboratory skills for handling analytical tools in Food and Beverages industry and research institution.
3. To give the scientific knowledge regarding safety regulations for handling of instruments in the laboratory and industry.
4. To demonstrate the operating procedures associated with upstream and downstream process related to Food and Beverages.

Couse Contents [Credit = 2]

Unit I

Food and Microorganism: Microorganism in food & beverage industry, contamination of food. General principles underlying spoilage and chemical changes. Food hygiene: Food sanitation, Bacteriology of water and food products, food manufacturing practice. Hazard Analysis Critical Points. Processing Industry and Microbial criteria of food. Principles of food preservation: Preservation by high temperature, low temperatures, Drying, Food additives and Radiation. Contamination and spoilage of different kinds of food & beverages: Cereals & cereal products, sugar and sugar products, vegetables and fruits, meat, fish, poultry & eggs, sea food, milk & milk products, canned foods, Alcohol & alcoholic beverages fruit juices & soft drinks etc.

Unit II

Biotechnology of food and feed; cultures & fermentation, Beverage production: Alcohol & alcoholic beverages, fruit furies, soft drinks, feed production, SCP, fats, amino acid, food additives. Food, Beverages & Disease : Food borne illness due to bacterial food poisoning, infection and intoxication. Food-borne disease outbreaks, Disease-investigation, Materials & Equipments, laboratory testing, field analysis, interpretation of data and preventive measures.

Suggested Reading and Text Books

1. Food Sciences and Food biotechnology- G.F.G. Lopez, G. Canaas, E.V.Nathan 1st edition (2003)
2. Genetically Modified Foods- M.Ruse, D. Castle (Eds.) 1st ed (2002)
3. Biotechnology of Food Crops in Developing Countries- T.Hohn and K.M. Leisinger (Eds.) (1st ed) 1999
4. Biotechnology and Food Process Engineering- H.G. Schwartzberg, M.A. Rao (Eds.) (1st ed)(1990)
5. Food Biotechnology- (Eds.) R.Angold, G.A.Beech, J.Taggart 1st ed (1989)
6. Food Biotechnology—Microorganisms- (Ed.) Y.H. Hui et al 1st ed (1996)
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Development of scientific and analytical knowledge regarding various tools and techniques in the field of Food and Beverages Biotechnology. Food, Beverages & Disease : Food borne illness due to bacterial food poisoning, infection and intoxication, Food and Microorganism Contamination and spoilage of different kinds of food & beverages and Food hygiene.	1 Remember
CO2	**Perceive/Catch on** the specific and basic concepts of basic principle components of tools and techniques in the field of Food and Beverages Biotechnology. Food, Beverages & Disease : Food borne illness due to bacterial food poisoning, infection and intoxication, Food and Microorganism Contamination and spoilage of different kinds of food & beverages and Food hygiene and their utilization to solve the society and industry-related problems.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of apply modern techniques in spoilage and contamination for solving various scientific problems in food industry and food and beverages related research institution.decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge regarding safety regulations for handling of hazardous microbes, chemicals and food hygiene in the laboratory decision making Knowledge of the biological systems information and the explanation of the key concepts. Demonstrate the biotechnological principles and working food and feed.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of the scientific knowledge regarding safety regulations for handling of hazardous microbes, chemicals and food hygiene in the laboratory decision making Knowledge of the biological systems information and the explanation of the key concepts of Food and Beverages Biotechnology. Demonstrate an understanding of transgenic technology and applications in health, agriculture and environment, alongwith associated social and environmental issues.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in the scientific knowledge regarding safety regulations for handling of hazardous microbes, chemicals and food hygiene in the laboratory decision making Knowledge of the biological systems information and the explanation of the key concepts of Food and Beverages Biotechnology. Acquire domain-specific knowledge and develop globally-relevant skills for academic and professional enhancement.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	3	2	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	3	3	3	2	3	2	2	3	3	3	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	3	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	3	3	2	2	2	3	3

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTSC 109**
Course Name	**: Basic Fermentation Technology**
Semester	**: III**

L	T	P	C
2	0	0	2

Course objectives: The specific objectives of the course are as follows:

1. To familiarize students with the production of industrial chemicals.
2. To impart knowledge about metabolic engineering of secondary metabolism.
3. To teach students about the enzyme and cell immobilization techniques relevant to industrialprocessing.
4. To make students understand the different methods of experimental model for design offermentation systems.
5. To teach about the enzyme kinetics used in fermentation technology.

UNIT I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT II

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.

SUGGESTED READING AND TEXT BOOKS

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2017). Biotechnology: A textbook of Industrial Microbiology. 3rd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to production of industrial chemicals, biochemicals and chemotherapeutic products, Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics.	1 Remember
CO2	**Perceive** the specific and basic concepts of industrial chemicals, biochemicals and chemotherapeutic products, Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of industrial chemicals, biochemicals and chemotherapeutic products, Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of industrial chemicals, biochemicals and chemotherapeutic products, Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of industrial chemicals, biochemicals and chemotherapeutic products, Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the Take part in essential techniques and features of industrial chemicals, biochemicals and chemotherapeutic products, Microbial products of pharmacological interest, Enzyme and cell immobilization techniques in industrial processing, purification of products and enzymes, enzyme kinetics.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	3	3	3	2	3	2	2	2	3	2	1	2
CO2	3	3	2	2	2	2	3	3	2	3	3	3	2	2	1	2
CO3	3	3	2	2	3	3	2	2	3	2	3	3	2	2	3	2
CO4	3	2	2	3	2	3	2	2	3	1	3	3	3	3	3	3
CO5	3	3	3	3	3	2	2	2	3	3	2	3	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: AEC- 1**
Course Name	**: Environmental Science**
Semester	**: I**

L	T	P	C
2	0	0	2

Course Objective: The basic objective of the environmental studies is to enable the students for interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including ecosystem, geosystems, biology, chemistry and global process. They will acquire an attitude of concern for the environment and will be able to critically evaluate the science and policy ramifications of diverse portfolios on air and water quality, natural resources etc.

Unit 1: Introduction to Environmental Sciences and Ecosystems

Multidisciplinary nature of Environmental Sciences; Scope and importance; Concept of sustainability and sustainable development.What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession.

Unit 2: Renewable and Non-renewable Resources/ Biodiversity and Conservation

Land resources and land use change; Land degradation, soil erosion and desertification.

Deforestation, Water. Energy resources: Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies. Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation.

Unit 3: Environmental Pollution/ Human Communities and the Environment

Environmental pollution. Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Disaster management: floods, earthquake, cyclones and landslides. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmentalconservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles inDelhi).

SUGGESTED READING AND TEXT BOOKS

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner 2nd ED
2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R). (2006)
3. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 1st Ed
4. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB).
5. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumbai, 1st Ed
6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the define the terms and basic concepts of environmental biology and their different roles to inflence biological systems.	1 Remember
CO2	**Perceive** the principle, mechanism of air pollution, water pollution and methods to control.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes of environmental biology and their different roles to inflence biological systems.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed processes of structure and function of environmental biology and their different roles to inflence biological systems. Biodiversity, ecosystem and Global Environmental Problems.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of environmental biology and their different roles to inflence biological systems. Biodiversity, ecosystem and Global Environmental Problems.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the environmental biology and their different roles to inflence biological systems. Biodiversity, ecosystem and Global Environmental Problems.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	2	2	2	2	3	1	1	1	3	2	1	2
CO2	2	2	2	2	2	2	1	1	3	1	1	1	3	2	1	2
CO3	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	3	3	3	3	1	1	3	1	1	1	2	3	2	2
CO5	2	2	3	1	1	1	2	2	3	3	2	1	2	2	2	2
CO6	2	2	1	1	1	1	1	1	3	2	2	1	3	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTRB 110**
Course Name	**: Remedial Biology**
Semester	**: I**

L	T	P	C
2	0	0	0

Objectives of the Course:

1. To appraise the structure and function of cell and its division.
2. To acknowledge the different micro-organisms and their characteristics.
3. To inculcate the concept of genetics and heredity.
4. To understand the basics of Plant Biotechnology and characteristics of characteristics of archegoniate, Bryophytes, Pteridophytes and Gymnosperms.
5. To interpret the immunological response and basic knowledge of immunity.

UNIT I

CELL: Introduction To cell, types of cell (Eukaryotes, Prokaryotes) their general characteristics with examples. Ultra microscopic structures of animal & plant cell. Cell organelles, their structure and functions. Types of cell division. Mitosis and Meiosis (brief introduction)

UNIT II

Micro-organism :-Introduction to Micro-organism, General Characteristics, Examples of each group for the following micro-organisms

1. Bacteria 2. Algae 3. Fungi 4. Virus

UNIT- III

Genetics and Heredity:-Mendel's laws- Monohybrid and Dihybrid cross, Structure of DNA and types of RNA, mutation. The flow of genetic information from DNA to RNA to protein.

UNIT-IV

Introduction to Plant and Biotechnology-Plant Diversity, brief study of Algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms. Brief about root, stem, leaf, flower and seed.

Introduction to Biotechnology-Plant biotech, food biotech, animal biotech, environmental biotech and Genetic Engineering. Gene Cloning-Introduction and methodology in brief. Applications of Genetic Engineering in plants- Insects and virus resistant plants

UNIT-IV

Immunity-Introduction to Immune system and types of immunity. Brief about antigen and antibody: Structure and functions.

SUGGESTED READING AND TEXT BOOKS

1. Text books of NCERT for Biology

Course Outcomes (COs)

CO 1. Understand the basic structure and function of cells.

CO 2. Appraise about different types of microorganisms, their shape, size, structure, reproduction and importance

CO 3. Understand different modes of sexual reproduction in microorganisms.

CO 4. Interpret generation of immune response in human body

CO 5. Identify characteristics of archegoniate, Bryophytes, Pteridophytes and Gymnosperms.

CO6. Constructing (Creating), Evaluating, Analyzing, demonstrating, remembering, and understanding the developmental biology.

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	2	2	2	2	1	1	1	1	3	2	1	2
CO2	2	2	2	2	2	2	1	1	1	1	1	1	3	2	1	2
CO3	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	3	3	3	3	1	1	1	1	1	1	2	3	2	2
CO5	2	2	3	1	1	1	2	2	1	3	2	1	2	2	2	2
CO6	2	2	1	1	1	1	1	1	1	2	2	1	3	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 201**
Course Name	**: Human Physiology**
Semester	**: II**

L	T	P	C
3	0	0	3

Course objective: The objectives of the course are as follows:

1. To examine basic concepts of mammalian physiology
2. To understand mechanisms of digestion, respiration, circulation and endocrine function
3. To explore the physico-chemical basis and operation of each organ system.

UNIT I: Digestion and Respiration

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.

UNIT II: Circulation

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.

UNIT III: Muscle physiology and osmoregulation

Structure of cardiac, smooth & skeletal muscle, threshold stimulus.

Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

UNIT IV: Nervous and endocrine coordination

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction. Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

SUGGESTED READING AND TEXT BOOKS

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XV Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XV Edition. John wiley & sons,Inc.
3. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the define the terms and basic concepts of mammalian physiology and their different roles to inflence biological body systems.	1 Remember
CO2	**Perceive** the principle, mechanism of cellular reaction like digestion and respiration, muscular system, nervous, endocrine and osmoregulation.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes of digestion and respiration, muscular system, nervous, endocrine and osmoregulation.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed structure and function of digestion and respiration, muscular system, nervous, endocrine and osmoregulation.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of mammalian physiology.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the mammalian physiology and the awareness and appreciation for mammals/animals in environment, and their diverse physiological functions.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	2	2	2	2	3	1	1	1	3	2	1	2
CO2	2	2	2	2	2	2	1	1	3	1	1	1	3	2	1	2
CO3	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	3	3	3	3	1	1	3	1	1	1	2	3	2	2
CO5	2	2	3	1	1	1	2	2	3	3	2	1	2	2	2	2
CO6	2	2	1	1	1	1	1	1	3	2	2	1	3	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 202**
Course Name	**: Lab Course Based on BBTDC 201**
Semester	**: II**

L	T	P	C
0	0	1	1

Practicals

1. Determination of Haemoglobin
2. Preparation of temporary slide of a mammalian tissue sample
3. Estimation of bleeding time and clotting time of the human being
4. Identification of blood cells by differential staining
5. Perform differential leukocyte count (DLC) in the blood sample
6. Counting of mammalian RBCs
7. Estimation of blood glucose level by glucometer
8. Identification of blood group in humans
9. Demonstration of action of an enzyme (catalase enzyme)
10. Separation of plasma and serum from the whole blood
11. Study pulmonary function test via online video tutorial

B. Sc. Biotechnology

Course code	**: BBTDC 203**
Course Name	**: Plant Physiology**
Semester	**: II**

L	T	P	C
3	0	0	3

Course Objective: The objectives of the course are as follows:

1. To provide detailed information about the basic principles of plant function
2. To teach the plant-water relationships
3. To teach principles of plant cell physiology and plant growth and development
4. To teach carbon and nitrogen metabolism
5. To provide information about plant secondary metabolites and their role in plant stressphysiology

UNIT I: Basics of Plant Physiology

General History and Basics of Plant water relations, Photosynthesis, transpiration, Nitrogen metabolism, Growth and development, photoperiodism and vernalization.

UNIT II: Plant water relations and micro & macro nutrients

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

UNIT III: Carbon and nitrogen metabolism

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point Nitrogen metabolism-inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

UNIT IV: Growth and development

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene) Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization

SUGGESTED READING AND TEXT BOOK

1. Dickinson, W.C. 2000 Integrative Plant Anatomy. Harcourt Academic Press, USA 1st Ed.
2. Esau, K. Anatomy of Seed Plants. Wiley Publishers(1993) 2nd Ed.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK 1st Ed.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons 4th Ed.
5. Mauseth, J.D. 2018 Plant Anatomy. The Benjammin/Cummings Publisher, USA 1st Ed.
6. Nelson, D.L., Cox, M.M. 2021 Lehninger Principles of Biochemistry, 8th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology 5th Ed, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2023 Plant Physiology, 5th edition, Sinauer Associates Inc .MA, USA
9. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** and define the terms and basic concepts of plant physiology and their different roles to influence biological plant body systems.	1 Remember
CO2	**Perceive/Catch on** the principle, mechanism of Anatomy, Plant water relations and micro & macro nutrients, Carbon and nitrogen metabolism and Growth and development.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes of Anatomy, Plant water relations and micro & macro nutrients, Carbon and nitrogen metabolism and Growth and development.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to Anatomy, Plant water relations and micro & macro nutrients, Carbon and nitrogen metabolism and Growth and development.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess, Examine, Demonstrating, Perceive** and **Reminisce** the principle, methods, properties and functions of plant physiology.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the plant physiology and the awareness and appreciation for plants in environment, and their diverse physiological functions.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	2	3	3	3	2	3	1	1	1	3	2	1	2
CO2	3	2	2	2	2	2	1	1	3	3	3	3	3	2	1	2
CO3	3	3	3	3	3	3	2	2	3	2	2	2	2	2	2	2
CO4	2	2	3	3	3	3	1	1	3	1	1	1	2	3	2	2
CO5	2	2	3	1	1	1	2	2	3	3	2	1	2	2	2	2
CO6	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 204**
Course Name	**: Lab Course Based on BBTDC 203**
Semester	**: II**

L	T	P	C
0	0	1	1

Practicals

1. Demonstration of plasmolysis in *Tradescantia* leaves.
2. Determination of water potential of plant tissue.
3. Study stomatal distribution on leaf surfaces and calculation of stomatal index.
4. Study of ascent of sap in plants.
5. Study aerobic respiration in germinating seeds.
6. Separation of photosynthetic pigments by paper chromatography.
7. Chlorophyll and carotenoid quantification via spectrophotometric analysis.
8. Demonstration of photosynthesis in aquatic plant.
9. Determine the presence of starch and sucrose in plants.
10. Determination of transpiration from foliar surface.

B. Sc. Biotechnology

Course code	**: BBTDC 205**
Course Name	**: Basic Molecular Biology**
Semester	**: II**

L	T	P	C
3	0	0	3

Course objectives: Molecular biology has witnessed a paradigm shift after the discovery of double helical structure of DNA. This course on molecular biology aims to teach the fundamental role of DNA molecule as a blueprint of life. The specific objectives of the course are as follows:

1. To familiarize students with the structure and function of biological system at the molecularlevel.
2. To impart knowledge about the key components participating in the replication of geneticmaterial.
3. To teach the processes and pathways which replicate, transcribe and translate DNA.
4. To make students understand the different methods of DNA damage, repair and recombination.
5. To teach the fundamental principles of gene expression regulation.

UNIT I: DNA structure and replication

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication.

UNIT II: DNA damage, repair and homologous recombination

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, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III: Transcription and RNA processing

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV: Regulation of gene expression and translation

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides.

SUGGESTED READING AND TEXT BOOKS

1. Karp, G. (2020). Cell and Molecular Biology: Concepts and Experiments. IX 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.
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., (2017) Molecular Biology of the Gene (VII Edition.). Cold Spring Harbour Lab. Press, Pearson Pub

5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1 Remember
CO2	**Perceive** the specific and basic concepts of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	2	2	3	3	2	3	3	2	2	2	2	2
CO3	3	3	2	3	3	3	2	2	3	2	2	2	3	2	2	2
CO4	3	2	2	3	2	3	2	2	3	1	3	2	2	2	2	3
CO5	3	2	2	2	2	2	2	2	3	2	2	3	2	2	2	2
CO6	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 206**
Course Name	**: Lab Course Based on BBTDC 205**
Semester	**: II**

L	T	P	C
0	0	1	1

Practicals

1. Preparation of solutions for Molecular Biology experiments.
2. Genomic DNA isolation from animal tissue.
3. Genomic DNA isolation from bacterial cells.
4. Isolation of DNA From coconut endosperm.
5. Characterization of DNA by spectrophotometric analysis.
6. Purification of DNA.
7. Melting point determination of DNA.
8. Isolation of Plasmid DNA by alkaline lysis method
9. Agarose gel electrophoresis of genomic DNA & plasmid DNA
10. Preparation of restriction enzyme digests of DNA samples
11. Demonstration of AMES test or reverse mutation for carcinogenicity

B. Sc. Biotechnology

Course code	**: BBTGE 207**
Course Name	**: Computational Biology**
Semester	**: II**

L	T	P	C
4	0	0	4

Course objectives: The aim of the course is to introduce students to the basic tenets of bioinformatics. The course provides a strong foundation for developing skills in using biological sequence databases, and tools for biological sequence analysis. The specific objectives of the course are as follows:

1. To teach students about biological sequence data storage.
2. To make students understand about various bioinformatics tools used for DNA, RNA and protein sequence analysis.
3. To impart knowledge about biological sequence alignment.
4. To teach the fundamental principles of molecular phylogeny.

UNIT I

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices.

UNIT II

Pairwise Alignments, Introduction to BLAST, using it on the web,
Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT III

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1 Remember
CO2	**Perceive** the specific and basic concepts of Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Bioinformatics, history of Bioinformatics, Sequence Information Sources, Protein Information Sources, techniques for data identifications, Sequence and Phylogeny analysis, Searching Databases and genome annotation.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2
CO3	3	3	3	3	3	3	3	2	2	2	3	3	3	3	3	3
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	3	3	2	2	3	3	3	2	2	2	2	2	2	2
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTVC 208**
Course Name	**: General Biotechnology**
Semester /Year	**: II**

L	T	P	C
2	0	0	2

Course objective: The students will be able to execute basic experiments related to biochemistry, microbiology, cell biology, recombinant DNA technology, etc.

UNIT I

Biotechnological innovations in the area of medical, agriculture, industrial and forensic sciences. Definition and scopes; Fundamentals of Genetic engineering (Isolation of DNA, Cutting of DNA and Sorting out of DNA pieces, PCR and Cloning). Instrumentation used in Biotechnology: Autoclave, Laminar air flow, Centrifuge, Water baths, Ovens, PCR

UNIT II

Laboratory requirements for animal cell culture, media preparation, Serum and serum free media, culture vessels. Primary culture and Cell lines Adhesion, proliferation and differentiation of cultures cells. Geneal idea of the production of transgenic animals. Production of transgenic plants: marker genes and various gene transfer methods. Applications of transgenic animals and plants

SUGGESTED READING AND TEXT BOOKS

1. Brown TA. (2020). Gene Cloning and DNA Analysis. 8th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution 1st Ed. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA 6thEd. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2012). Molecular Cloning-A Laboratory Manual. 4th edition. Cold Spring Harbor Laboratory Press.
6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the principle of genetic engineering and recombinant DNA technology and their different roles in Biotechnology.	1, 2 Remembering,
CO2	**Perceive** the detailed process of functioning of laboratory requirements for animal cell culture.	1, 2 Remembering, Understanding
CO3	**Demonstrating the** general idea for the production of transgenic plants and animals.	1, 2,4 Remembering, Understanding, Analyzing
CO4	**Examine** the role of Biotechnological innovations in the area of medical, agriculture, industrial and forensic sciences.	1, 2,4 Remembering, Understanding, Analyzing, Applying
CO5	**Assess** the principle, methods, properties and functions of General Biotechnology.	1,2,3,4,5 Remembering, Understanding, Analyzing, Applying Evaluating
CO6	**Constructing** the General Biotechnology.	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Applying Evaluating, Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	2	2	2	2	3	1	1	1	3	2	1	2
CO2	2	2	2	2	2	2	1	1	3	1	1	1	3	2	1	2
CO3	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	3	3	3	3	1	1	3	1	1	1	2	3	2	2
CO5	2	2	3	1	1	1	2	2	3	3	2	1	2	2	2	2
CO6	2	2	1	1	1	1	1	1	3	2	2	1	3	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTSC 209**
Course Name	**: Elementary Forensic Science**
Semester	**: II**

L	T	P	C
2	0	0	2

Course objectives: This is an introductory course on forensic sciences withthe following objectives:

1. To familiarize students with the fundamentalprinciples of forensic sciences.
2. To impart knowledge about the injuries and deaths and how they are assessed.
3. To make students understand the process of documentation of crime scenes.
4. To impart the knowledge about the importance of cyber security in forensic sciences.

Unit I

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, 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.

Unit III

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

SUGGESTED READING AND TEXT BOOKS

1. Molecular Biotechnology- Principles and Applications of recombinant DNA (2022) 6th Ed. ASM Press, Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century 4th Edition, Select Publishers, New Delhi (2014). _
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002). 2nd Edition
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 4th Ed, CRC Press, Boca Raton (2003).
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2021).
7. **W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene** Investigation, CRC Press, Boca Raton (2013) 1st Ed.
8. Latest Research Publications

COURSE OUTCOME(CO): Upon successful completion of this course the student will:

1. Apply the Laboratory skills to participate in the career needs of Forensic community.
2. Become trained in the laboratory skills of different division of Forensic Science.
3. Be able to work with different R&D organizations.
4. Learn about the knowledge about the importance of cyber security in forensic sciences.

COURSE OUTCOMES (CO): On completion of this course, the students will be able to:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** about the different facets of forensics.	1 Remember
CO2	**Perceive the** methods to identify important evidences present at crime	1,2 Remember, Understand
CO3	**Demonstrating** the importance and involvement of cyber security in forensic sciences	1,2,3 Remember, Understand, Apply
CO4	**Examine** the importance of forensic science in solving criminal cases.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the importance of forensic science in solving criminal cases.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the importance of forensic science in solving criminal cases.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)									Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8		PSO1	PSO2	PSO3	PSO4
CO1	3	3								3	3	1	2
CO2	3	3	2	2	3		3			3	3	1	2
CO3	3	3	2	2	2					3	2	2	1
CO4	3	3	2	2	3	2				3	3	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: AEC- 2**
Course Name	**: English Communication**
Semester	**: II**

L	T	P	C
2	0	0	2

Course Objectives:

1. To define and explain various techniques of word formation; and develop skills of sensiblewriting and vocabulary building.
2. To illustrate and elaborate fundamental techniques and features of writing skills.
3. To demonstrate and discuss various types of common errors committed by users of English and solve exercises to develop their understanding in use of grammatically correct sentences.
4. To organize language lab activities and workshops to develop oral communication skills

Unit I: Theory of Communication, Types and Modes of Communication:
Introduction, Definitions and Function of Communication, Needs for Effective Communication,
Listening and Speaking Skills:
Types of Listening, Developing Effective Listening Skills, Academic Listening (Lectures), Listening to Talks and Presentation, Monologue, Dialogue, Group Discussion, Miscommunication, Interview, Public Speech, Pronunciation, Accent and Intonation and Rhythm.
Unit II: Reading Skills:
Skimming, Scanning, Summary, Paraphrasing, Comprehension.
Introductory English Grammar:
Parts of Speech, Tenses, Punctuation, Common Errors in English.
Writing Skills; Social and Official Correspondence:
Enquiries, Complaints and Replies, Letters to the Editor, Social Appeals in the Form of Letter/ Pamphlets, Standard Business Letter, Email Drafting and Etiquettes, Preparing Agenda and Writing Minutes for Meetings.
Career Skills:
Job Application, Cover Letter, Bio-data, CV and Resume and Effective Profiling,
Mock Interviews, Group Discussions.

SUGGESTED READINGS AND TEXT BOOKS

1. Fluency in English- Part II, Oxford University Press, 2006 1st Edition.
2. Business English, Pearson, 2008 1st Edition.
3. Language, Literature and Creativity, Orient Blackswan, 2013 1st Edition.
4. Language through Literature (Forthcoming) ed. Dr. Gauri Mishra, Dr. RanjhanaKaul, Dr.
5. Brati Biswas.
6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different techniques of word formation; and demonstrate knowledge of synonyms, antonyms and skills of sensible writing.	1 Remember
CO2	**Perceive** the principle, mechanism of Communication skills, essential techniques and features of effective writing and **make use of** them in written communication.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes of essential techniques and features of effective writingand make use of them in written communication. Knowledge of synonyms, antonyms and skills of sensible writing.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related common errors in English and solve exercises based on them; apply acquired knowledge and skills of oral and written communication in personal and professional life.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess,** the principle, methods, properties and functions of plant physiology.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the **Take part in** individual and group communication activities; and **determine** and **invent** new forms and methods of communication to as per the situation.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	3	3	2	3	1	1	1	3	2	1	2
CO2	3	2	2	2	2	2	1	1	3	3	3	3	3	2	1	2
CO3	3	2	3	3	3	3	2	2	3	2	2	2	2	2	2	2
CO4	2	2	3	3	2	3	1	1	3	1	1	1	2	3	2	2
CO5	2	2	3	1	1	1	2	2	3	3	2	1	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 301**
Course Name	**: Basic Concept of Genetics**
Semester	**: III**

L	T	P	C
3	0	0	3

Course objectives: The objectives of the course are as follows:

1. To make the student understand the Mendelian and non-Mendelian genetics of inheritance.
2. To make the student understand the allele and gene interactions.
3. To make the student learn the fundamentals of chromosome and gene organization.
4. To impart the knowledge about sex determination among humans and animals.
5. To teach the concepts of extra-chromosomal inheritance

UNIT I

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. Mendelian genetics : **Mendel's experimental design, monohybrid, di**-hybrid and tri hybrid crosses, Law of segregation. Principle of independent assortment.

UNIT II

Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT III

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure. Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT IV

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.

SUGGESTED READING AND TEXT BOOKS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2016). Principles of Genetics. VII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2018). Principles of Genetics. 12th Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2013). Genetics- A Molecular Approach. 11th Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. 11th Edition(2015). Introduction to Genetic Analysis, W. H. Freeman & Co.

6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different concept of genetics, Mendelian and non-Mendelian genetics of inheritance, Chromosome and genomic organization, Chromosome and gene mutations and Genetic linkage, crossing over and chromosome mapping.	1 Remember
CO2	**Perceive** the different concept of genetics, Mendelian and non-Mendelian genetics of inheritance, Chromosome and genomic organization, Chromosome and gene mutations and Genetic linkage, crossing over and chromosome mapping.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of effective concept of genetics, Mendelian and non-Mendelian genetics of inheritance, Chromosome and genomic organization, Chromosome and gene mutations and Genetic linkage, crossing over and chromosome mapping.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to different concept of genetics, Mendelian and non-Mendelian genetics of inheritance, Chromosome and genomic organization, Chromosome and gene mutations and Genetic linkage, crossing over and chromosome mapping.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions genetics, Mendelian and non-Mendelian genetics of inheritance, Chromosome and genomic organization, Chromosome and gene mutations and Genetic linkage, crossing over and chromosome mapping.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the **Take part in** individual and group to different concept of genetics, Mendelian and non-Mendelian genetics of inheritance, Chromosome and genomic organization, Chromosome and gene mutations and Genetic linkage, crossing over and chromosome mapping.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	3	3	2	3	1	1	1	3	2	1	2
CO2	3	2	2	2	2	2	1	1	3	3	3	3	3	2	1	2
CO3	2	2	2	2	3	3	2	2	3	2	2	2	2	2	2	2
CO4	2	2	3	3	2	3	2	2	3	1	1	1	2	3	2	2
CO5	2	2	3	2	2	2	2	2	3	3	2	1	2	2	2	2
CO6	2	2	3	3	2	2	2	2	3	3	2	2	2	3	3	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 302**
Course Name	**: Lab Course Based on BBTDC 301**
Semester	**: III**

L	T	P	C
0	0	1	1

Practicals

1. Safety guidelines of genetics laboratory and good laboratory practices.
2. Bacterial conjugation for genetic recombination.
3. Isolation of *E. coli* mutants by UV irradiation.
4. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
5. Simulation of genetic drift in an isolated population.
6. Karyotyping with the help of photographs
7. Polyploidy in onion root tip cells by colchicine treatment.
8. Preparation of the pedigree chart of blood group.
9. Permanent and temporary mount of mitosis.
10. Permanent and temporary mount of meiosis.
11. Mendelian deviations in dihybrid crosses
12. Demonstration of - Barr Body -*Rhoeo* translocation.
13. Study of polyploidy in onion root tip by colchicine treatment.

B. Sc. Biotechnology

Course code	**: BBTDC 303**
Course Name	**: Developmental Biology**
Semester	**: III**

L	T	P	C
3	0	0	3

Course objectives: The course aims to teach the principles and molecular biology of eukaryotic development, from zygote to embryo development and differentiation. The specific objectives of the course are:

1. To understand the history and basic concepts of embryology
2. To become familiar with the process of fertilization, spermatogenesis and oogenesis
3. To understand the process of organogenesis.
4. To understand the molecular basis of development.

UNIT I: Gametogenesis and Fertilization

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.

UNIT II: 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.

UNIT III: Embryonic Differentiation

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 Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT IV: Organogenesis

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals**.**

SUGGESTED READING AND TEXT BOOKS

1. Gilbert, S. F. (2023). Developmental Biology, 13th Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.

2. Balinsky, B.I. (2012) 5thEd. An introduction to Embryology, International Thomson Computer Press.

3. Kalthoff, (2000). Analysis of Biological Development, II Edition, McGraw-Hill Professional.

4. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the define the terms and basic concepts of Developmental biology and their different roles in biological systems	1 Remember
CO2	**Perceive** the principle, mechanism of cellular reaction like Gametogenesis and Fertilization, Early embryonic development, Embryonic Differentiation and organogenesis.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes of Gametogenesis and Fertilization, Early embryonic development, Embryonic Differentiation and organogenesis.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed processes of structure and function of Gametogenesis and Fertilization, Early embryonic development, Embryonic Differentiation and organogenesis.	1,2,3,4 Remember, Understand, Apply,
CO5	**Assess** the principle, methods, properties and functions of developmental biology.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the developmental biology.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	2	2	2	2	3	1	1	1	3	2	1	2
CO2	2	2	2	2	2	2	1	1	3	1	1	1	3	2	1	2
CO3	2	2	3	3	3	3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	3	3	3	3	1	1	3	1	1	1	2	3	2	2
CO5	2	2	3	1	1	1	2	2	3	3	2	1	2	2	2	2
CO6	2	2	1	1	1	1	1	1	3	2	2	1	3	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 304**
Course Name	**: Lab Course Based on BBTDC 303**
Semester	**: I**

L	T	P	C
0	0	1	1

Practicals

1. Study of different types of eggs.
2. Development of fate maps in the early embryos.
3. Observation of frog embryos, different developmental stages and life cycle of frog.
4. Identification of developmental stages of chick embryo using permanent mounts.
5. Preparation of a temporary stained mount of chick embryo.
6. Study developmental stages of Anopheles.
7. Demonstration of developmental stages of Drosophila.
8. Study of different types of placenta.
9. Examine the sections of mammalian skin, salivary glands, cartilage and bones.
10. Stages of flower development in plants.

B. Sc. Biotechnology

Course code	**: BBTDC 305**
Course Name	**: Chemistry- I**
Semester	**: III**

L	T	P	C
3	0	0	3

Course objectives: The course aims to teach the principles of chemistry. The specific objectives of the course are:

1. To teach students the basic concepts of chemistry.
2. To make students understand the importance of chemistry in sustainable development.
3. To teach students the fundamental principles of biocatalysis, photochemistry and electrochemistry.
4. To teach students about chemistry in daily practice

UNIT I

Stereochemistry: Writing of Fischer projection, Newmann and Sawhorse projection and Wedge formulae. Interconversion of one type of structural representation into another type. Conformation: Restricted rotation about single bonds, Various conformations of ethane, butane and cyclohexane. Relative stability of different conformations in terms of energy difference is to be discussed for all these compounds. Geometrical Isomerism: Requirements for a molecule to show geometrical isomerism.

UNIT II

Alkenes and Alkynes: Hydrogenation, addition of halogens, Hydrohalogenation (Markovnikov's and anti-Markovnikov's addition), hydration, hydroxylation (cis and trans), oxymercurationdemercuration, hydroboration-oxidation, ozonolysis. Reactivity of alkenes vs alkynes.

UNIT III

Free radical substitution reactions: Halogenation of alkanes, allylic compounds and alkylbenzenes.
Nucleophilic substitution reactions: Alkyl, allyl and benzyl halides – substitution of halogen by some common nucleophiles. Mechanism of SN1 and SN2 reactions (stereochemistry, nature of substrate, nucleophile and leaving group).

UNIT IV

Elimination Reactions: Alkyl halides (dehydrohalogenation, Saytzeff's rule), vicinal dihalides (dehalogenation), alcohols (dehydration), Quaternary ammonium salts (Hofmann's elimination).
Mechanism of E1 and E2 reactions (nature of substrate and base), elimination vs substitution. Oxidation Aromatic side chain: Oxidation with potassium permanganate, potassium dichromate Introduction and reactions of Alcohols, Aldehydes, Ketones and Nitro compounds

SUGGESTED READING AND TEXT BOOKS

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical OrganicChemistry, 5th Ed., Pearson (1996).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Longman, London & New York .
3. Ahluwalia, V.K.; Dhingra, S. & Gulati, A. College Practical Chemistry, Universities Press.
4. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S 5thEd.(1980).
5. R. T. Morrison & R. N. Boyd: Organic Chemistry, Pearson Education.
6. Arun Bahl and B. S. Bahl : Advanced Organic Chemistry, S. Chand
7. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
8. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
10. **T. W. Graham Solomon's Organic Chemistry, John Wiley and Sons 13th Edition(2024).**
11. P.S. Kalsi, Stereochemistry, Conformation and Mechanism, John Wiley and Sons.1994
    D. Nasipuri, Stereochemistry of Organic Compounds, New Age International Publishers.
12. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Remember** the different basic concepts of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.	1 Remember
CO2	**Understand** the **specific** concepts of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of concepts of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the Take part in essential techniques and features of chemistry: stereochemistry, alkenes and alkynes, Aldehydes and ketones, Free radical substitution reactions, Nucleophilic substitution reactions, Electrophilic Substitution Reactions, Elimination Reactions and the different functional groups.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	3	3	2	3	2	2	2	3	2	1	2
CO2	2	2	2	3	3	2	1	3	2	2	2	2	2	2	1	2
CO3	2	3	2	2	3	3	2	2	3	2	2	2	2	2	2	2
CO4	3	2	2	3	2	3	2	2	3	1	1	1	2	3	2	2
CO5	3	2	3	2	2	2	2	2	3	3	2	3	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 306**
Course Name	**: Lab Course Based on BBTDC 305**
Semester	**: III**

L	T	P	C
0	0	1	1

Practicals

1. Purification of organic compounds by crystallization using the following solvents: (a) Water (b) Alcohol

2. Determination of the melting points of organic compounds (by Kjeldahl method and electrically heated melting point apparatus).

3. Determination of optical- 1g of starting compound. Recrystallize the product and determine the melting point of activity by using polarimeter Organic preparations: Carry out the following preparations using 0.5 the recrystallized sample.

4. To prepare acetanilide by the acetylation of aniline.

5. To prepare p-bromoacetanilide.

6. Benzolyation of aniline or β-naphthol by Schotten-Baumann reaction

7. Hydrolysis of benzamide or ethyl bezoate.

8. Semicarbazone derivative of one the following compounds: acetone, ethyl methylketone, diethylketone, cyclohexanone, benzaldehyde.

9. Nitration of nitrobenzene.

10. Oxidation of benzaldehyde by using alkaline potassium permanganate.

B. Sc. Biotechnology

Course code	**: BBTGE 307**
Course Name	**: Bioethics and Biosafety**
Semester	**: III**

L	T	P	C
4	0	0	4

Course Objectives: The objectives of the course are as follows:

1. To understand importance of bioethics and biosafety.
2. To understand legal social and economic impacts of biotechnology.
3. To understand regulatory guidelines and their importance.
4. To understand importance of patent.
5. To understand procedure to apply for patent.
6. To understand procedure of assessment of biosafety for biotech foods.
7. To understand ethical implications of biotechnology.

UNIT-I

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development.

UNIT II

Patenting in Biotechnology, economic, ethical and depository considerations. Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc.

UNIT III

The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT IV

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies. 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).

SUGGESTED READING AND TEXT BOOKS

1. Entrepreneurship: New Venture Creation : David H. Holt 1st Edition 2016.
2. Patterns of Entrepreneurship : Jack M. Kaplan **6th edition 2020**
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons. 8th Edition 2022
4. Sateesh MK (2013) 1st ed Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) 1st ed Bioethics and Biosafety in Biotechnology, New age international publishers.
6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Indian Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety.	1 Remember
CO2	**Perceive** the specific and basic concepts of Indian Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the Take part in essential techniques and features of Patent Law, IPR Entrepreneurship, the basic regulations of excise, Bioethics and Biosafety, Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	3	3	2	3	2	2	2	3	2	1	2
CO2	2	3	2	2	2	2	1	3	2	3	3	3	2	2	1	2
CO3	2	3	2	2	3	3	2	2	3	2	3	3	2	2	3	2
CO4	3	2	2	3	2	3	2	2	3	1	1	1	2	3	2	2
CO5	3	2	2	2	2	2	2	2	3	3	2	3	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTVC 308**
Course Name	**: Indian Knowledge System**
Semester /Year	**: III**

L	T	P	C
2	0	0	2

Course Objectives: The objectives of this course are

1.To understand various types of cancer, tumor invasion, markers in cancer research and diagnosis
2.To acquire knowledge related to genetic disease, gene diagnosis, gene tracking & other diagnostic application of biomedical technology.
3.To understand the concept and types of mutations in Molecular biology.
4.To acquire knowledge related to cellular and molecular mechanisms in biomedical technology.

Unit 1

Introduction to Indian Knowledge System (IKS), Definition, Concept and Scope of IKS: Definition, Concept and Scope of IKS, IKS based approaches on Knowledge Paradigms, IKS in ancient India and in modern India. **IKS and Indian Scholars, Indian Literature:** Philosophy and Literature (Maharishi Vyas, Manu, Kanad, Pingala, Parasar, Banabhatta, Nagarjuna and Panini), Mathematics and Astronomy (Aryabhatta, Mahaviracharya, Bodhayan, Bhashkaracharya, Varahamihira and Brahmgupta), Medicine and Yoga (Charak, Susruta, Maharishi Patanjali and Dhanwantri), Sahitya (Vedas, Upvedas, Upavedas (Ayurveda, Dhanurveda, Gandharvaveda) Puran and Upnishad) and shad darshan (Vedanta, Nyaya.Vaisheshik, Sankhya, Mimamsa, Yoga, Adhyatma and Meditation), Shastra (Nyaya, vyakarana, Krishi, Shilp, Vastu, Natya and Sangeet)

Unit 2

Indian Traditional/tribal/ethnic communities, their livelihood and local wisdom: Geophysical aspects, Resources and Vulnerability, Resource availability, utilization pattern and limitations, Socio-Cultural linkages with Traditional Knowledge System, Tangible and intangible cultural heritage. **Unique Traditional Practices and Applied Traditional Knowledge:** Myths, Rituals, Spirituals, Taboos and Belief System, Folk Stories, Songs, Proverbs, Dance, Play, Acts and Traditional Narratives; Agriculture, animal husbandry, Forest, Sacred Groves, Water Mills, Sacred Water Bodies, Land, water and Soil Conservation and management Practices; Indigenous Bio-resource Conservation, Utilization Practices and Food Preservation Methods, Handicrafts, Wood Processingand Carving,-Fiber Extraction and Costumes; Vaidya (traditional health care system),Tantra-Mantra, Amchi Medicine System; Knowledge of dyeing, chemistry of dyes, pigments and chemicals

Unit 3

Protection, preservation, conservation and Management of Indian Knowledge System: Documentation and Preservation of IKS; Approaches for conservation and Management of nature and bio-resources; Approaches and strategies to protection and conservation of IKS.

Suggested Reading and Text Books

1. Introduction to Indian Knowledge System: Concepts and Applications**:** B. Mahadevan, Vinayak Rajat Bhat, R.N. Nagendra Pavana. 1st Edition (published 2022)
2. Rediscovering Indian Knowledge System**:** Satish Kulkarni (Editor), Pranay Abhang, Pramod Moghe, Prashant Holay (Research and Compilation). 1st Edition 2016.
3. Indian Knowledge Systems **(Vol. 1 & 2):** Kapil Kapoor.
4. Ancient Indian Knowledge System : Archaeological Perspective**:** Dr. Vasant Shinde.
5. An Introduction to Indian Philosophy**:** Satishchandra Chatterjee.
6. Ancient Indian Knowledge: Implications To Education System**:** Boski Singh.
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** Introduction to Indian Knowledge System (IKS), Definition, Concept and Scope of IKS, IKS and Indian Scholars, Indian Literature, Indian Traditional/tribal/ethnic communities, their livelihood and local wisdom, Unique Traditional Practices and Applied Traditional Knowledge, Protection, preservation, conservation and Management of Indian Knowledge System	1 Remember
CO2	**Perceive** the introduction to Indian Knowledge System (IKS), Definition, Concept and Scope of IKS, IKS and Indian Scholars, Indian Literature, Indian Traditional/tribal/ethnic communities, their livelihood and local wisdom, Unique Traditional Practices and Applied Traditional Knowledge, Protection, preservation, conservation and Management of Indian Knowledge System	1,2 Remember, Understand
CO3	**Demonstrating** the introduction to Indian Knowledge System (IKS), Definition, Concept and Scope of IKS, IKS and Indian Scholars, Indian Literature, Indian Traditional/tribal/ethnic communities, their livelihood and local wisdom, Unique Traditional Practices and Applied Traditional Knowledge, Protection, preservation, conservation and Management of Indian Knowledge System	1,2,3 Remember, Understand, Apply
CO4	**Examine** the introduction to Indian Knowledge System (IKS), Definition, Concept and Scope of IKS, IKS and Indian Scholars, Indian Literature, Indian Traditional/tribal/ethnic communities, their livelihood and local wisdom, Unique Traditional Practices and Applied Traditional Knowledge, Protection, preservation, conservation and Management of Indian Knowledge System	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the introduction to Indian Knowledge System (IKS), Definition, Concept and Scope of IKS, IKS and Indian Scholars, Indian Literature, Indian Traditional/tribal/ethnic communities, their livelihood and local wisdom, Unique Traditional Practices and Applied Traditional Knowledge, Protection, preservation, conservation and Management of Indian Knowledge System	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the introduction to Indian Knowledge System (IKS), Definition, Concept and Scope of IKS, IKS and Indian Scholars, Indian Literature, Indian Traditional/tribal/ethnic communities, their livelihood and local wisdom, Unique Traditional Practices and Applied Traditional Knowledge, Protection, preservation, conservation and Management of Indian Knowledge System	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	3	2	2	2	3	2	3	2
CO2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	1	1	1	1	2	2	1	3	2	2	2	1	3

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTSC 309**
Course Name	**: Green Chemistry**
Semester	**: III**

L	T	P	C
2	0	0	2

Course objectives: The course aims to teach the principles of green chemistry. The specificobjectives of the course are:

5. To teach students the basic concepts of green chemistry.
6. To make students understand the importance of green chemistry in sustainable development.
7. To teach students the fundamental principles of biocatalysis, photochemistry andelectrochemistry.
8. To teach students about green chemistry in daily practice

UNIT I: Introduction and principles

Introduction to green chemistry and its guiding principles; green chemistry and industry; wasteminimization and atom economy; reduction of material use, reduction of energy requirement; energy efficiency improvements; alternative energy sources; alternative solvents.

UNIT II: Green chemistry and sustainable development

The concept of sustainability; green chemistry and sustainability's parameters; sustainable use of chemical feedstock; sustainable use of water; sustainable use of energy. Biocatalysis, Impact of green process technology on the chemical industry.

SUGGESTED READIND AND TEXT BOOKS

1. Clark, J and Macquarrie, D 2002. Handbook of Green Chemistry and Technology, 1st ed.Blackwell Science Ltd.
2. Lancaster, M 2010. Green Chemistry: An Introductory Text, 1st ed. Royal Society of Chemistry.
3. Sharma, SK and Mudhoo, A 2010. Green Chemistry for Environmental Sustainability, 1st ed.CRC Press, Boca Raton.
4. Torok, B and Dransfield, T 2017. Green Chemistry: An Inclusive Approach, 1st ed. Elsevier.
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction and principles of green chemistry, sustainable development, Biocatalysis, Photochemistry, electrochemistry and fuel cells.	1 Remember
CO2	**Perceive** the specific and basic concepts of green chemistry, sustainable development, Biocatalysis, Photochemistry, electrochemistry and fuel cells.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of green chemistry, sustainable development, Biocatalysis, Photochemistry, electrochemistry and fuel cells.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of green chemistry, sustainable development, Biocatalysis, Photochemistry, electrochemistry and fuel cells.	1,2,3,4 Remember, Understand, Apply,
CO5	**Assess** the principle, methods, properties and functions green chemistry, sustainable development, Biocatalysis, Photochemistry, electrochemistry and fuel cells.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in green chemistry, sustainable development, Biocatalysis, Photochemistry, electrochemistry and fuel cells.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	2	2	2	2	3	2	2	2	3	2	3	2
CO2	2	2	2	2	2	2	3	3	2	3	3	2	2	2	2	2
CO3	2	3	2	2	2	2	2	2	3	2	2	2	3	2	2	2
CO4	2	2	2	3	2	3	2	2	3	1	3	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	3	2	2	3	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: AEC- 3**
Course Name	**: Molecular Diagnostics**
Semester	**: III**

L	T	P	C
2	0	0	2

Course objectives: The course is designed to give an overview and applications of differentmolecular biology techniques used in disease diagnosis. The specific objectives of the course are:

1. To teach students different molecular techniques used for disease diagnosis.
2. To make students understand the utilization of these techniques in disease diagnosis.
3. To teach the use of different enzyme immunoassay based diagnostic methods.
4. To impart the knowledge about the molecular diagnostic of different human diseases.

UNIT I

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology.

UNIT II

Molecular methods in clinical microbiology: Applications of PCR, RFLP, 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. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

SUGGESTED READING AND TEXT BOOKS

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker 5th Edition (1996)
2. Bioinstrumentation, Webster 1st Ed (2003)
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic 1St Ed(2013)
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. **Brooks GF, Carroll KC, Butel JS and Morse SA. (2025). Jawetz, Melnick and Adelberg's** Medical 28th edition
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2024). M**ims' Medical Microbiology.** 7th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 20th edition. Appleton-Centuary-Crofts publication.
8. **Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's** Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert 2003 1st ED.
8. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Enzyme Immunoassays, Molecular methods in clinical microbiology, Susceptibility tests, standardization of antigen and specific antibodies, GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.	1 Remember
CO2	**Perceive** the specific and basic concepts of Enzyme Immunoassays, Molecular methods in clinical microbiology, Susceptibility tests, standardization of antigen and specific antibodies, GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of Enzyme Immunoassays, Molecular methods in clinical microbiology, Susceptibility tests, standardization of antigen and specific antibodies, GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of immunological methods, Enzyme Immunoassays, Molecular methods in clinical microbiology, Susceptibility tests, standardization of antigen and specific antibodies, GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of immunological methods, Enzyme Immunoassays, Molecular methods in clinical microbiology, Susceptibility tests, standardization of antigen and specific antibodies, GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in immunological methods, Enzyme Immunoassays, Molecular methods in clinical microbiology, Susceptibility tests, standardization of antigen and specific antibodies, GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	3	3	3	3	2	3	2	2	2	3	2	1	2
CO2	2	3	2	2	2	2	3	3	2	3	3	3	2	2	1	2
CO3	2	3	2	2	2	2	2	2	3	2	2	2	2	2	3	2
CO4	3	2	2	3	2	3	2	2	3	1	3	3	2	2	3	3
CO5	3	2	2	2	2	2	2	2	3	3	2	3	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 401**
Course Name	**: Biostatistics**
Semester	**: IV**

L	T	P	C
3	0	0	3

Course objectives: This is an introductory course on statistics. The specific objectives of the courseare as follows:

1. To teach students the basic principles of statistics, data types and collection of data.
2. To make students understand the various methods of data presentation and measures of centraltendency.
3. To make students understand the basic concepts of probability and Probability distribution
4. Understand the testing of the hypothesis and learn its applications.

UNIT I

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.

UNIT II

Probability classical & axiomatic definition of probability, Theorems on total and compound Probability), Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT III

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, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV

Correlation and Regression. Emphasis on examples from Biological Sciences.

SUGGESTED READING

1. Le CT (2003) Introductory biostatistics. 2nd edition, John Wiley, USA
2. Glaser AN (2013) High YieldTM Biostatistics. Lippincott Williams and Wilkins, USA 4th Edition
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press. 1st Edition.
4. Danial W Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons In (11th Edition, 2018)
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character and concepts of biostatistics, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1 Remember
CO2	**Perceive** the specific and basic concepts of measurement of biostatistics, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to measurement of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the measurement of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	2	2	2	2	2	2	3	2	3	3	3	3
CO3	2	3	2	2	3	3	3	2	3	2	2	2	2	2	2	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 402**
Course Name	**: Lab Course Based on BBTDC 401**
Semester	**: IV**

L	T	P	C
0	0	1	1

Practicals

1. Based on graphical Representation.
2. Based on measures of Central Tendency & Dispersion.
3. Based on Distributions Binomial Poisson Normal.
4. Based on t, f, z and Chi-square.

B. Sc. Biotechnology

Course code	**: BBTDC 403**
Course Name	**: Basic Immunology**
Semester	**: IV**

L	T	P	C
3	0	0	3

Course objectives: The specific objectives of the course are as follows:

1. To familiarize students with the structure and function of the immune system.
2. To impart knowledge about the key components participating in fighting the disease.
3. To make students understand immunodiagnostic methods like RIA and ELISA.
4. To teach students about vaccines and modes of vaccination.

UNIT I

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, Tlymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT II

Regulation of immunoglobulin gene expression – Clonal selection theory, allotypes & idiotypes,
allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody
diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT III

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing
Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of
recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial
vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

SUGGESTED READING AND TEXT BOOKS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 11th edition Saunders Publication, Philadelphia.

2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 13th edition Wiley-

3. Goldsby **RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 8th edition W.H.** Freeman and

4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 10th edition Garland Science Publishers, New York.

5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA.	1 Remember
CO2	**Perceive** the specific and basic concepts of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	2	2	2	2	2	2	2	2	3	2	3	2
CO2	2	2	3	3	3	2	3	3	2	3	3	2	2	2	2	2
CO3	2	3	2	3	3	3	2	2	2	2	3	3	3	2	2	2
CO4	3	2	2	3	2	3	2	2	2	1	3	2	2	2	2	3
CO5	3	2	2	2	2	3	3	3	3	2	2	3	2	2	2	2
CO6	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 404**
Course Name	**: Lab Course Based on BBTDC 403**
Semester	**: IV**

L	T	P	C
0	0	1	1

Practicals

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.

B. Sc. Biotechnology

Course code	**: BBTDC 405**
Course Name	**: Chemistry- II**
Semester	**: IV**

L	T	P	C
3	0	0	3

Course objective: This course is aimed to introduce the knowledge of biomolecules and their role in metabolic pathways. Also, it deals with the structure and function of enzymes.

UNIT I

Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose.

UNIT II

Amino Acids, Peptides and Proteins: Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins.

UNIT III

Enzymes and correlation with drug action: Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and noncompetitive inhibition including allosteric inhibition).

UNIT IV

Components of Nucleic acids: Adenine, guanine, thymine and cytosine (structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

SUGGESTED READING

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 7th Edition 2010
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 6th Edition 2002.
3. Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson
4. **Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 8th Ed., W. H.** Freeman. 2021
5. Berg, J. M., Tymoczko, J. L. & Stryer, L. Biochemistry 10th Ed., W. H. Freeman. 2023
6. **Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. Vogel's** Textbook of Practical Organic Chemistry, ELBS. 5th Edition 1990
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Enzyme inhibitors and their importance.	1 Remember
CO2	**Perceive** the specific and basic concepts of Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation. Enzyme inhibitors and their importance.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation. Enzyme inhibitors and their importance.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Carbohydrates, amino acids, peptides, proteins, Enzymes and correlation with drug action and Components of nucleic acids. Biological roles of DNA and RNA: Replication, Transcription and Translation. Enzyme inhibitors and their importance.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	2	2	2	2	2	2	2	3	2	3	2
CO2	2	2	3	3	3	2	3	3	2	3	3	2	2	2	2	2
CO3	3	2	2	3	2	3	2	2	2	2	3	3	3	2	2	2
CO4	3	2	2	3	2	3	2	2	2	1	3	2	2	2	2	3
CO5	3	2	2	2	2	3	3	3	3	2	2	3	2	2	2	2
CO6	2	2	1	1	2	2	2	2	2	1	1	2	2	2	1	1

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 406**
Course Name	**: Lab Course Based on BBTDC 405**
Semester	**: IV**

L	T	P	C
0	0	1	1

Practicals

1. Separation of amino acids by paper chromatography
2. To determine the concentration of glycine solution by formylation method.
3. Study of titration curve of glycine
4. Action of salivary amylase on starch
5. Effect of temperature on the action of salivary amylase on starch.
6. To determine the saponification value of an oil/fat.
7. To determine the iodine value of an oil/fat
8. Differentiate between a reducing/nonreducing sugar.
9. Extraction of DNA from onion/ cauliflower
10. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.

B. Sc. Biotechnology

Course code	**: BBTGE 407**
Course Name	**: Biotechnology and Human Welfare**
Semester	**: IV**

L	T	P	C
4	0	0	4

Course Objective: The course introduces students to the fundamentals of biotechnology, current trends and careers in biotechnology, regulatory, and ethical aspects of biotechnology. The knowledge and skills gained in this course will provide students with a broad understanding of biotechnology andits impact on society.

UNIT I

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, Alcohol and antibiotic formation. Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT II

Chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes,

UNIT III

Stress management, development of biodegradable polymers such as PHB. Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in *E.coli*, human genome project.

UNIT IV Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

SUGGESTED READING AND TEXT BOOKS

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd. 1st Edition
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers 1st Edition.
3. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Industry, protein engineering, enzyme and polysaccharide synthesis, Agriculture, N2 fixation, Environments, Forensic science and health.	1 Remember
CO2	**Perceive** the specific and basic concepts of Industry, protein engineering, enzyme and polysaccharide synthesis, Agriculture, N2 fixation, Environments, Forensic science and health.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of Industry, protein engineering, enzyme and polysaccharide synthesis, Agriculture, N2 fixation, Environments, Forensic science and health.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of Industry, protein engineering, enzyme and polysaccharide synthesis, Agriculture, N2 fixation, Environments, Forensic science and health.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of Industry, protein engineering, enzyme and polysaccharide synthesis, Agriculture, N2 fixation, Environments, Forensic science and health.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Industry, protein engineering, enzyme and polysaccharide synthesis, Agriculture, N2 fixation, Environments, Forensic science and health.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	2	2	2	2	2	2	2	3	2	3	2
CO2	2	2	3	2	2	2	2	3	2	3	3	2	2	2	2	2
CO3	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	1	1	2	2	2	2	2	1	1	2	2	2	1	1

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTVC 408**
Course Name	**: Analytical Techniques**
Semester	**: IV**

L	T	P	C
2	0	0	2

UNIT I

Principle of simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy.

UNIT II

Principle of fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared),

centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC. Introduction to electrophoresis

SUGGESTED READING AND TEXT BOOKS

1. Karp, G. 2013. Cell and Molecular Biology: Concepts and Experiments. 7th Edition. John Wiley& Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2014. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 8th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2017 The World of the Cell.9th edition. Pearson Benjamin Cummings Publishing, San Francisco.

5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of bio-analytical, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques and Biosensors and Nanotechnology and their applications**.**	1 Remember
CO2	**Perceive** the specific and basic concepts of Biosensors and Nanotechnology and their applications**,** bio-analytical, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques and cell fractionation techniques.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of bio-analytical, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques, Biosensors and Nanotechnology and their applications and cell fractionation techniques.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to bio-analytical tools, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques, Biosensors and Nanotechnology and their applications and cell fractionation techniques.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the bio-analytical tools, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques, Biosensors and Nanotechnology and their applications and cell fractionation techniques.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in bio-analytical tools, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques, Biosensors and Nanotechnology and their applications and cell fractionation techniques.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	2	2
CO2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	3	3	2	2	3	3	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTSC 409**
Course Name	**: Enzymology and Applications**
Semester	**: IV**

L	T	P	C
2	0	0	2

Course objectives: The course aims to impart the knowledge about fundamental principles of enzyme reactions, and applications of enzyme engineering. The specific objectives of the course are:

1. To make students understand the mechanism of enzyme action.
2. To teach students Michaelis-Menten equation for enzyme kinetics.
3. To teach students the regulation of enzyme kinetics
4. To impart knowledge about enzyme engineering and its applications.

UNIT - I

History and Classification of Enzyme. Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation.

UNIT – II

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis, Allosteric enzymes, Enzyme technology..

SUGGESTED READING AND TEXT BOOKS

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,McGrawHill, 2009.
1. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley andSons,1995.
2. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning,2005.
3. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 3rd Edition 1999
4. Fundamentals of Enzyme Kinetics Athel Cornish-Bowden Portland Press 2004. 3rd Edition
5. Practical Enzymology Hans Bisswanger Wiley–VCH 2004 2nd Edition
6. The Organic Chemistry of Enzyme-catalyzed Reactions Richard B. Silverman Academic Press 2002 1st Edition
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	1 Remember
CO2	**Perceive** the specific and basic concepts of isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in isolation, crystallization, purification classification and kinetics of enzymes, Two substrate reactions, Allosteric enzymes and Enzyme technology.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	2	2	2	2	2	2	2	3	2	3	2
CO2	3	2	3	3	3	3	2	2	2	3	3	2	3	3	3	2
CO3	3	2	2	2	2	3	2	3	3	3	2	2	3	3	3	2
CO4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	1	1	2	2	2	2	2	1	1	2	2	2	1	1

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: AEC- 4**
Course Name	**: Basics of Drug Designing**
Semester	**: IV**

L	T	P	C
2	0	0	2

Course objectives: The course is designed to give an overview of the process of drug design anddevelopment.The specific objectives of the course are as follows:

1. To teach the criteria used for drug development as a process involving target selection and leaddiscovery.
2. To impart the knowledge about computer aided drug design.
3. To give students an overview of drug delivery system, pre clinical and clinical testing.

UNIT I

Delivery considerations of biotechnological products: Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification (protein engineering), Toxicology profile characterization. Drug targeting and drug delivery systems, Introduction to drug design cycle, Introduction to molecular modeling.

UNIT II

Vaccines: Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotype vaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems.

Suggested Reading and Text Books

1. Hill, RG and Rang, HP 2012. Drug Discovery and Development: Technology in Transition. 3ed. Churchill Livingstone.
2. Kenakin, TP 2012. Pharmacology in Drug Discovery, 1st ed. Elsevier.
3. Gad, SC 2005. Drug Discovery Handbook, 1st ed. Wiley-Interscience.
4. Stromgaard, K,Krogsgaard-Larsen, P and Madsen, U 2016. Textbook of Drug Design andDiscovery, 5th ed. CRC press.
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Remember** the different basic concepts of introduction to delivery considerations of biotechnological products, Drug targeting and drug delivery systems, vaccines, drug design cycle and molecular modeling.	1 Remember
CO2	**Perceive** the specific and basic concepts of delivery considerations of biotechnological products, Drug targeting and drug delivery systems, vaccines, drug design cycle and molecular modeling, Docking and modeling substrate and s/w tools for CADD.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of delivery considerations of biotechnological products, Drug targeting and drug delivery systems, vaccines, drug design cycle and molecular modeling, Docking and modeling substrate and s/w tools for CADD.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of delivery considerations of biotechnological products, Drug targeting and drug delivery systems, vaccines, drug design cycle and molecular modeling, Docking and modeling substrate and s/w tools for CADD.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of delivery considerations of biotechnological products, Drug targeting and drug delivery systems, vaccines, drug design cycle and molecular modeling, Docking and modeling substrate and CADD.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part delivery considerations of biotechnological products, Drug targeting and drug delivery systems, vaccines, drug design cycle and molecular modeling, Docking and modeling substrate and CADD.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	2	2	2	3	2	2	2	3	2	3	2
CO2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	1	1	2	2	2	2	2	1	1	2	2	2	1	1

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 501**
Course Name	**: Bioprocess Technology**
Semester	**: V**

L	T	P	C
3	0	0	3

Course objectives: The specific objectives of the course are as follows:

1. To impart the knowledge of cultivation and growth kinetics of microorganisms.
2. To make students understand the basic concept of sterilization and different parts of a bioreactor.
3. To teach the application of bioprocess technology in industries.
4. To make students understand about thermal death kinetics of microorganisms.

UNIT I

Introduction to bioprocess technology.

Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II

Airlift; Cyclone Column; Packed Tower and their application in production processes.

Principles of upstream processing – Media preparation, Inoculation development and sterilization.

UNIT III

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.

UNIT IV

Introduction to downstream processing, product recovery and purification. Effluent treatment.

Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

SUGGESTED READING AND TEXT BOOKS

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. 3rd edition, Elsevier Science Ltd.

5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Introduction to bioprocess technology, Basic principle components of fermentation technology, Principles of upstream processing, oxygen requirement in bioprocess, Bioprocess measurement and Microbial production.	1 Remember
CO2	**Perceive** the specific and basic concepts of bioprocess technology, Basic principle components of fermentation technology, Principles of upstream processing, oxygen requirement in bioprocess, Bioprocess measurement and Microbial production.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of bioprocess technology, Basic principle components of fermentation technology, Principles of upstream processing, oxygen requirement in bioprocess, Bioprocess measurement and Microbial production.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of bioprocess technology, Basic principle components of fermentation technology, Principles of upstream processing, oxygen requirement in bioprocess, Bioprocess measurement and Microbial production.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of bioprocess technology, Basic principle components of fermentation technology, Principles of upstream processing, oxygen requirement in bioprocess, Bioprocess measurement and Microbial production.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part bioprocess technology, Basic principle components of fermentation technology, Principles of upstream processing, oxygen requirement in bioprocess, Bioprocess measurement and Microbial production.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	3	3	3	3	2	2	2	3	2	3	2
CO2	3	3	3	2	3	3	3	2	3	2	2	3	3	3	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	3	3	3	3	2	2
CO6	2	2	3	3	2	2	2	2	2	3	3	2	2	2	3	3

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 502**
Course Name	**: Lab Course Based on BBTDC 501**
Semester	**: V**

L	T	P	C
0	0	1	1

Practicals

1. Bacterial growth curve.
2. Estimation of Biomass Production.
3. Determination of the specific growth rate and generation time of a bacterium during submergedfermentation.
4. Estimation of the effect of temperature and pH on the growth of microbes.
5. Estimation of the effect of substrate concentration on the growth of *E.coli.*
6. Estimation of Monod Parameters for microbial growth kinetics.
7. Calculation of thermal death point (TDP) of a microbial sample.
8. Isolation of industrially important microorganisms from natural resource.
9. Screening of microbes for the production of enzymes.
10. Optimization of production and analysis of ethanol.
11. Biological treatment of wastewater originating from an industrial source.

B. Sc. Biotechnology

Course code	**: BBTDC 503**
Course Name	**: Recombinant DNA Technology**
Semester	**: V**

L	T	P	C
3	0	0	3

Course objectives: The specific objectives of the course are as follows:

1. To impart knowledge about different components such as vectors, restriction enzymes, ligases, polymerases, alkaline phosphatases used for making recombinant DNA molecule.
2. To make students understand the different techniques such as PCR, transformation, site-directedmutagenesis, etc.
3. To teach the basics of gene transfer technique in plants.
4. To understand Agrobacterium Ti plasmid biology been utilized for making genetically-modifiedplants.

UNIT

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

UNIT II

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

UNIT III

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

UNIT IV

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

SUGGESTED READING AND TEXT BOOKS

1 Brown TA. (2020). Gene Cloning and DNA Analysis. 8th edition. Blackwell Publishing, Oxford, U.K.

2 Clark DP and Pazdernik NJ. (2016). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA 3rd Edition.

3 Glick, B.R., Pasternak, J.J. . Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington 5th Edition (2017)

4 Primrose SB and Twyman RM. . Principles of Gene Manipulation and Genomics, . Blackwell Publishing, Oxford, U.K 8th Edition (2013).

5 Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Introduction to molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants.	1 Remember
CO2	**Perceive** the specific and basic concepts of basic principle components of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques and features of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to concepts of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in molecular tools used in RDT and applications, Restriction and modification system, hybridization techniques, Genetic engineering in animals, Random and site-directed mutagenesis and Genetic engineering in plants	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	2	2	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	3	3	3	2	3	2	2	3	3	3	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	3	3	2	2	2	3	3

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 504**
Course Name	**: Lab Course Based on BBTDC 503**
Semester	**: V**

L	T	P	C
0	0	1	1

Practicals

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Plasmid DNA isolation and electrophoresis of DNA from *E. coli*.
4. Restriction digestion of plasmid DNA.
5. Restriction mapping of DNA.
6. Ligation of DNA molecules.
7. Preparation of competent cells.
8. Transformation of competent cells.
9. Designing of primers for polymerase chain reaction (PCR).
10. Perform PCR to amplify a DNA fragment.
11. Isolation of recombinant protein from bacterial cells.

B. Sc. Biotechnology

Course code	**: BBTDE 505a**
Course Name	**: Animal Diversity- I**
Semester	**: V**

L	T	P	C
3	0	0	3

Course objectives: This course presents an overview of invertebrates, ranging from protozoa tohemichordata. The specific objectives of the course are as follows:

1. To make the student understand the classification invertebrates of animal kingdom.
2. To make the student understand the characteristics of invertebrates.
3. To make the student learn the diversity of protozoa to hemichordata.
4. To impart the knowledge about parasitic adaptation of roundworms.

UNIT I

a) Outline of classification of Non- Chordates upto subclasses. Coelomata, Acoelomata,Symmetries, Deutrostomes, Protostomes.

b) Protozoa: Locomotion, Reproduction, evolution of Sex, General features of *Paramoecium* and *Plasmodium*. Pathogenic protozoans

c) Porifera: General characters, outline of Classification; skeleton, Canal System

UNIT II

a) Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation.

b) Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations.

c) Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT III

a) Annelida: - General features, Outline of classification, Coelom: Metameric segmentation,General features of Earthworm, Vermicomposting.

b) Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT IV

a) Mollusca : general features, Outline of classification, Shell Diversity; Torsion ingastropoda.
b) Echinodermata: General features, Outline of Classification Larval forms
c) Hemichordata: Phylogeny: Affinities of *Balanoglossus*

SUGGESTED READING AND TEXT BOOKS

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) TheInvertebrates: A New Synthesis. III Edition. Blackwell Science.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones 3rd ed. University of Chicago Press.
5. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-HillCompanies.

6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Outline of classification of Non- Chordates upto subclasses, Protozoa, Porifera to Arthopoda, Mollusca, Echinodermata and Hemichordata. Apiculture, sericulture.	1 Remember
CO2	**Perceive** the specific and basic concepts of Non- Chordates upto subclasses, Protozoa, Porifera to Arthopoda, Mollusca, Echinodermata and Hemichordata. Apiculture, sericulture.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques for identificatin and features of Non- Chordates upto subclasses, Protozoa, Porifera to Arthopoda, Mollusca, Echinodermata and Hemichordata. Apiculture, sericulture.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to Non- Chordates upto subclasses, Protozoa, Porifera to Arthopoda, Mollusca, Echinodermata and Hemichordata. Apiculture, sericulture.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the Non- Chordates upto subclasses, Protozoa, Porifera to Arthopoda, Mollusca, Echinodermata and Hemichordata. Apiculture, sericulture.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Non- Chordates upto subclasses, Protozoa, Porifera to Arthopoda, Mollusca, Echinodermata and Hemichordata. Apiculture, sericulture.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDE 506a**
Course Name	**: Lab Course Based on BBTDE 505a**
Semester	**: V**

L	T	P	C
0	0	1	1

Practicals

1. Study of protozoa using permanent slides.
2. Identification and classification of porifera: *Euspongia*, *Scypha*.
3. Study of hydra by permanent slides.
4. Identification and classification of platyhelminthes: *Taenia, Fasciola*.
5. Ecological Note – On any of the specimens in Exercise No 1 Models of dissection of Earthworm, Cockroach Earthworm: Digestive, Nervous System, Cockroach: Digestive Reproductive, Nervous System.
6. Study digestive system of earthworm using models.
7. Dissection of salivary glands of cockroach.
8. Glycerin preparation of hastate plate.
9. Permanent preparation of gill lamella.
10. Dissection of *Pila*.

B. Sc. Biotechnology

Course code	**: BBTDE 505b**
Course Name	**: Plant Diversity-I**
Semester	**: V**

L	T	P	C
3	0	0	3

Course objectives: This course presents an overview of lower plants, ranging from algae to pteridophytes. The specific objectives of the course are as follows:

1. To make students understand the organization of plant kingdom.
2. To teach the characteristics of lower plant genera.
3. To make students learn the economic importance of lower plants.
4. To impart the knowledge about diseases caused by plant pathogens.

UNIT I

Algae:

General character, classification and economic importance. Life histories of algae belonging to various classes:

Chlorophyceae – *Volvox, Oedogonium*

Xantho phyceae –*Vaucheria*

Phaeophyceae – *Ectocarpus*

Rhodophyceae-*Polysiphonia*

UNIT II

Fungi:

General characters, classification & economic importance. Life histories of Fungi:

Mastigomycontina- *Phytophthora*

Zygomycotina-*Mucor*

Ascomycotina- *Saccharomyces*

Basidomycotina-*Agaricus*

Deutromycotina-*Colletotrichum*

UNIT III

Lichens :

Classification, general structure, reproduction and economic importance. Plant diseases:

4 of 36 Casual organism, symptoms and control of following plant diseases.

Rust & Smut of Wheat.

White rust of Crucifers.

Late blight of Potato.

Red rot of Sugarcane.

Citrus Canker.

UNIT IV

Bryophytes:

General characters, classification & economic impotence. Life histories of following:

Marchantia.

Funaria.

SUGGESTED READING AND TEXT BOOKS

1. Agrios, G.N. 2005, Plant Pathology 5 th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4 Th edition, John Wiley and Sons (Asia) Singapore.
3. Bold, H.C. & Wayne, M.J. 1985 (2 nd Ed.) Introduction to Algae.
4. Kumar, H.D. 1999.1st Ed. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
5. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
6. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
7. Shaw, A.J. and Goffinet, B. 2009 2nd Ed. Bryophyte Biology. Cambridge University Press.
8. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
9. Vander-Poorteri 2009 Introduction to Bryophytes. COP 1st Ed..
10. Webster, J. and Weber, R. 2007 Introduction to Fungi. 3 Rd edition, Cambridge University Press, Cambridge.

11. Wickens, G.E. 2004 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands 1st Ed.
12. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character, classification and economic importance of plants, fungi, plant diseases and general characters, classification & economic impotence. Life histories of *Marchantia* and *Funaria.*	1 Remember
CO2	**Perceive** the specific and basic concepts of plants, fungi, plant diseases and general characters, classification & economic impotence. Life histories of *Marchantia* and *Funaria.*	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of plants, fungi, plant diseases and general characters, classification & economic impotence. Life histories of *Marchantia* and *Funaria.*	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to plants, fungi, plant diseases and general characters, classification & economic impotence. Life histories of *Marchantia* and *Funaria.*	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the plants, fungi, plant diseases and general characters, classification & economic impotence. Life histories of *Marchantia* and *Funaria.*	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part plants, fungi, plant diseases and general characters, classification & economic impotence. Life histories of *Marchantia* and *Funaria.*	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDE 506b**
Course Name	**: Lab Course Based on BBTDE 505b**
Semester	**: V**

L	T	P	C
0	0	1	1

Practicals

1. Collection of algae, fungi, bryophytes and pteridophytes from nearby localities and the campus.
2. Slide preparation of *Volvox* and *Oedogonium* to study their vegetative and reproductivestructures.
3. Preparation of temporary mounts of fungi to study hyphae.
4. Prepare sections of the gills of *Agaricus*.
5. Preparation of temporary mount of *Saccharomyces cerevisiae* (Baker's yeast).
6. Section cutting and lectophenol mount of plant disease materials.
7. Section cutting of lichen to study the anatomy.
8. Study of growth forms of lichens (crustose, foliose and fruticose).
9. Comparative study of thalli of various bryophytes.
10. Section cutting of pteridophyte to study their anatomy and vascular system.

B. Sc. Biotechnology

Course code	**: BBTDE 507a**
Course Name	**: Microbial Physiology**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course objectives: The specific objectives of the course are as follows:

1. To make students understand the classification of microbes.
2. To teach students about the transport of metabolites in microbes.
3. To teach students about the effects of the environmental factors on microbial growth andmetabolism.
4. To impart knowledge about nitrogen fixation by microbes.

UNIT I

Nutritional classification of microorganisms based on carbon, energy and electron sources, Metabolite Transport, Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

UNIT II

Microbial Growth. Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve. Measurement of microbial growth. Measurement of cell numbers, cell mass and metabolic activity

UNIT III

Effect of the environment on microbial growth

Temperature- temperature ranges for microbial growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure. Chemolithotrophic metabolism,

Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing

bacteria and methanogens.

UNIT IV

Phototrophic metabolism. Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbon dioxide fixation, Calvin cycle and reductive TCA cycle.

SUGGESTED READING AND TEXT BOOKS

1. Gottschalk G. (1986).. 2nd edition. Springer Verlag. Bacterial Metabolism
2. Madigan MT, Martinko JM and Parker J. (2021). Brock Biology of Microorganisms.16th edition. Pearson/ Benjamin Cummings.
3. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
4. Reddy SR and Reddy SM. (2022). Microbial Physiology 2nd edition. Scientific Publishers India.
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of microbial physiology, Nutritional classification of microorganisms, metabolism transport through membrane, Microbial Growth and effect of environmental factors of microbial growth and microbial physiology.	1 Remember
CO2	**Perceive** the specific and basic concepts of measurement of cell numbers, cell mass and metabolic activity, Nutritional classification of microorganisms, metabolism transport through membrane, Microbial Growth and effect of environmental factors of microbial growth and microbial physiology.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of measurement of cell numbers, cell mass and metabolic activity, Nutritional classification of microorganisms, metabolism transport through membrane, Microbial Growth and effect of environmental factors of microbial growth and microbial physiology.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to measurement of cell numbers, cell mass and metabolic activity, Nutritional classification of microorganisms, metabolism transport through membrane, Microbial Growth and effect of environmental factors of microbial growth and microbial physiology.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the measurement of cell numbers, cell mass and metabolic activity, Nutritional classification of microorganisms, metabolism transport through membrane, Microbial Growth and effect of environmental factors of microbial growth and microbial physiology.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in measurement of cell numbers, cell mass and metabolic activity, Nutritional classification of microorganisms, metabolism transport through membrane, Microbial Growth and effect of environmental factors of microbial growth and microbial physiology.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1				
CO1	3	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	3	3	3	3	3	2	3	2	3	3	3	3
CO3	2	3	2	2	3	3	3	2	3	2	3	3	3	3	3	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
CO5	3	3	3	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDE 508a**
Course Name	**: Lab Course Based on BBTDE 507a**
Semester	**: V**

L	T	P	C
0	0	1	1

1. Introduction to microbiological laboratory safety rules and laboratory instructions.
2. Calculation of specific growth rate and generation time in bacteria.
3. Determination of the effect of pH on bacterial growth.
4. Determination of the effect of temperature on the growth of *Aspergillus niger* by dry weightmethod.
5. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
6. Demonstration of lactic acid fermentation.
7. Demonstration of the thermal death time and decimal reduction time of *E. coli.*
8. Effect of inhibitors on growth of bacteria.
9. Effect of carbon source on microbes growth.
10. Biofilm analysis.

Course code	**: BBTDE 507B**			
Course Name	**: Pharmaceutical Biotechnology**			
Semester /Year	**: V**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To understand the Concept, Need and Importance of Biotechnology in Pharmaceutical Biotechnology & Drug Designing.
2. To demonstrate the scientific method and the use of problem-solving within the field of Pharmaceutical Biotechnology & Drug Designing.
3. To develop scientific knowledge regarding vaccines and role of biotechnology in development of pharmaceutical drugs.
4. To demonstrate the scientific method and the use of Drug targeting and drug delivery systems.

Couse Contents [Credit = 3]

Unit 1

Delivery considerations of biotechnological products: Introduction, Stability profile, Barriers to proteins and peptide delivery, Delivery of protein & peptide drugs, Lymphatic transportation of proteins, Site specific protein modification(protein engineering), Toxicology profile characterization.

Unit 2

Drug targeting and drug delivery systems: Introduction, Historical perspectives, Drug targeting, Cellular levels events in targeting. Ligands as means of targeting, Blood cell receptors for endogenous compounds, Carrier system for targeting, Vesicular systems for ligand mediated drug targeting, Specialized liposomes for cellular drug targeting.

Unit 3

Vaccines: Introduction, Multivalent subunit vaccines, Purified macromolecules, Synthetic peptide vaccines, Immuno-adhesions, Recombinant antigen vaccines, Vector vaccines, Anti-idiotype vaccines, Targeted immune stimulants, Miscellaneous approaches, New generation vaccines, Novel vaccine delivery systems.

Unit 4

Introduction to drug design cycle: Structure Activity Relationship (SAR), Rational Drug Design, Pharmacophoric patterns, Quantitative Structure-Activity Relationship. (Q SAR) & Hans equation.

Unit 5

Introduction to molecular modeling: Quantum mechanical and molecular orbital methods, Introduction to semiempirical, molecular mechanics and ab initio techniques. Potential energy surface, Docking and modeling substrate – receptor interactions. Introduction to s/w tools for CADD.

Suggested Reading and Text Books

1. Leon Lachman. Theory and Practice of Industrial Pharmacy, 4th Edition, Lea and Febiger, 2020 .
2. Remington's Pharmaceutical Science, Mark Publishing and Co. 23rd Edition 2020
3. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling.	1 Remembering
CO2	**Perceive** the specific and basic concepts of basic principle components of tools and techniques in the field of Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling and their utilization to solve the society and industry-related problems.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of apply modern techniques in Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling.related research institution.decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge of Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling. Knowledge of the pharmaceutical sciences and drug designing in biological systems information and the explanation of the key concepts.	1,2,3,4 Remembering, Understanding, Appying, Analyzing
CO5	**Assess** the principle, methods, properties and functions of Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling. Knowledge of the pharmaceutical sciences and drug designing in biological systems information and the explanation of the key concepts and applications in health, agriculture and environment, alongwith associated social and environmental issues.	1,2,3,4,5 Remembering, Understanding, Applying, Analyzing, Evaluating
CO6	**Constructing** the take part in the scientific knowledge regarding Pharmaceutical Biotechnology & Drug Designing: Delivery considerations of biotechnological products, Drug targeting and drug delivery systems, Vaccines, drug design cycle and molecular modeling. Knowledge Acquire domain-specific knowledge and develop globally-relevant skills for academic and professional enhancement.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	3	2	2	2	3	2	3	2
CO2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	1	1	1	1	2	2	1	3	2	2	2	1	3

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDE 508b**
Course Name	**: Lab Course Based on BBTDE 507b**
Semester	**: V**

L	T	P	C
0	0	1	1

1. Introduction to laboratory safety rules and laboratory instructions.
2. Formulation and process of Vaccine Development.
3. Demomstration of Delivery of protein & peptide drugs.
4. CADD.
5. Demonstration of career mediated drug targetiong.
6. SAR
7. QSAR

B. Sc. Biotechnology

Course code	**: BBTSC 509**
Course Name	**: Intellectual Property Rights**
Semester	**: V**

L	T	P	C
2	0	0	2

Course objectives: The course aims to explain students about intellectual property rights and patents.The specific objectives of the course are as follows:

1. To make students aware of types of IPRs and their utility.
2. To make students understand the procedure of filing a patent.
3. To teach students about the bioethical and biosafety practices related to biotechnology.
4. To familiarize students with copyright, trademarks, designs and information technology act.

UNIT I: Introduction to IPR

Basic understanding of intellectual property rights; utility of IPRs; different types of IPRs; introduction to Indian patent law; world trade organization and its related intellectual property provisions world organizations: WIPO and TRIPS agreement, international treaties and conventions on intellectual property.

Unit II: Property and Protection of IPRs

Intellectual/industrial property and its legal protection in research, design and development. Forms of protection of IPRs: Introduction to copyrights and its applicability; fundamental concepts and importance of trademarks and trade secrets; geographical indications; design layout design of integrated circuits. Patents

SUGGESTED READINGS AND TEXT BOOKS

1. Pandey, N and Dharni, K 2014. Intellectual Property Rights, 1st ed. PHI Learning Pvt. Ltd.
2. Tomkowicz, R 2011. Intellectual Property Overlaps: Theory, Strategies and Solutions, 1st ed.Routledge.
3. Bouchoux, DE 2015. Intellectual property: The Law of Trademarks, Copyrights, Patents andTrade Secrets, 4th ed. Cenage Learning.
4. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks.	1 Remembering
CO2	**Perceive** the specific and basic concepts of IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes and features of IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	1,2,3,4 Remembering, Understanding, Analyzing
CO5	**Assess** the IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	1, 2,3,4,5 Remembering, Understanding, Analyzing, Evaluating
CO6	**Constructing** the take part in IPR, Protection of IPRs, Patents, Copyright, assignment and licence of copyright, trademarks and rights of holder and assignment and licensing of marks. patenting in biotechnology, economic, ethical and depository considerations.	1,2,3,4,5,6 Remembering, Understanding, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTPR 510**
Course Name	**: Project Report I**
Semester	**: V**

L	T	P	C
0	0	0	4

Course Objectives: The objectives of this course are

1. To make the students industry, university and research institute deployable.
2. To provide an opportunity to students to gain practical knowledge.
3. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/ under the guidance of faculty member/supervisor from industry/research organizations & submit by the guidance of internal supervisor. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings: NA

Course Outcome:

CO1.	Remembering and demonstrate analytical, practical training and understand the scope and importance of Biotechnology through exposure.
CO2.	**Understand t**he specific and basic concepts interpretation and organization of data.
CO3.	**Applying** the detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO4.	**Analyzing** the detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO5.	**Evaluating** the detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO6.	**Constructing** the take part in detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	3
CO4	2	3	2	3	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 601**
Course Name	**: Bio-Analytical Tools**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course objectives: The broad objective of the course is to make students aware about the importance and significance of the diverse tools and techniques used to study and understand the biologicalworld. The specific objectives of the course are as follows:

1. To introduce the basic principle, types and application of microscopy.
2. To study concepts applications and types of centrifugation.
3. To acquaint students with chromatography and spectroscopy techniques.
4. To makes students understand the techniques of electrophoresis and blotting.

UNIT I

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy.

UNIT II

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications**.**

SUGGESTED READING AND TEXT BOOKS

1. Karp, G. 2020. Cell and Molecular Biology: Concepts and Experiments. 9th Edition. John Wiley& Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2022. The Cell: A Molecular Approach. 9th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2015 The World of the Cell.9th edition. Pearson Benjamin Cummings Publishing, San Francisco.

5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of bio-analytical, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques and Biosensors and Nanotechnology and their applications**.**	1 Remember
CO2	**Perceive** the specific and basic concepts of Biosensors and Nanotechnology and their applications**,** bio-analytical, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques and cell fractionation techniques.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of bio-analytical, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques, Biosensors and Nanotechnology and their applications and cell fractionation techniques.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to bio-analytical tools, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques, Biosensors and Nanotechnology and their applications and cell fractionation techniques.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the bio-analytical tools, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques, Biosensors and Nanotechnology and their applications and cell fractionation techniques.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in bio-analytical tools, Simple microscopy, Principle and law of techniques, Introduction to the principle of chromatography, electrophoresis, blotting techniques, Biosensors and Nanotechnology and their applications and cell fractionation techniques.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	2	2
CO2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	3	3	2	2	3	3	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 602**
Course Name	**: Lab Course Based on BBTDC 601**
Semester	**: VI**

L	T	P	C
0	0	1	1

1. Centrifugation principle and separation of precipitate by centrifugation.
2. Native gel electrophoresis of proteins.
3. Separation of protein sample by SDS-polyacrylamide gel electrophoresis.
4. Separation of amino acids by paper chromatography.
5. Verification of Beer's law and determine the molar extinction coefficient of NADH.
6. Brightfield microscopy of the onion membrane cells.
7. Identification of lipids in a given sample by TLC.
8. Study of DNA blotting.
9. Demonstration of preparation of the sub-cellular fractions of rat liver cells.
10. Study the applications of spectroscopy.

B. Sc. Biotechnology

Course code	**: BBTDC 603**
Course Name	**: Genomics & Proteomics**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course objectives: The broad objective of the course is to make students aware about the importance of the modern methods of genome and proteome analysis and the significance of these on the changing paradigm in genetics, medicine and agriculture. The specific objectives of the course are as follows:

1. To introduce the basic concepts of genomics and next generation sequencing.
2. To acquaint students with various genome databases and their applications.
3. To make students aware about the applications of genomics in various industries.
4. To makes students understand the techniques of proteome analysis diverse applications andbenefits of genome and proteome analysis.

UNIT I

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation.

UNIT IV

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.

SUGGESTED READING AND TEXT BOOKS

1. Genes X by Benjamin Lewin, Johns and Bartlett Publisher, 12th Edition 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 6th Edition(2022), B.R.
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. VII Edition. John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2019). Concepts of Genetics. XII Edition. Benjamin Cummings.
8. Russell, P. J. (2009). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
10. Glick, B.R., Pasternak, J.J. (2022). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
9. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons
11. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1 Remember
CO2	**Perceive** the specific and basic concepts of genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of Mass spectrometry based methods for protein identification, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in genomics and proteonomics, Computer tools for sequencing projects, Managing and Distributing Genome Data, protein structure, interactions, Determination of sizes (Sedimentation analysis), Analysis of proteomes and genome and protein sequencing.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	2	2	2	2	2	3	3	3	3	2	3	3	3	3
CO3	2	3	2	2	3	3	3	2	2	2	3	3	3	3	3	3
CO4	2	3	2	3	2	2	3	3	3	1	3	2	2	2	2	2
CO5	2	3	3	3	2	2	3	3	3	2	2	3	3	3	3	2

CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDC 604**
Course Name	**: Lab Course Based on BBTDC 603**
Semester	**: VI**

L	T	P	C
0	0	1	1

1. Identification of unknown sequence by BLAST and its functional annotation.
2. SNP analysis using SNP database of NCBI.
3. Comparison of genomes of two organisms using SynMap of CoGe.
4. Demonstration of microarray applications and analysis of microarray data.
5. Computation of pI and molecular weight of a protein using ExPASy ProtParam tool.
6. Demonstration of 2D PAGE and data analysis.
7. Generation of protein interaction networks using STRING software.
8. Subcellular protein localization study using CELLO tool.
9. Protein motif identification using MEME software.
10. Conserved domain analysis using NCBI batch-CD research.

B. Sc. Biotechnology

Course code	**: BBTDE 605a**
Course Name	**: Animal Diversity-II**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course objectives: The objectives of the course are as follows:

1. To make the student understand the classification and characteristics of Proto-chordates and theOrigin of Chordates
2. To make the student understand the characteristics and classifications of Pisces and Ambhibia
3. To make the student learn the diversity of different classes of Reptilia and Aves and Mammalia
4. To impart the knowledge about the Comparative anatomy of vertebrates.

UNIT I: Proto-chordates, Pisces and Ambhibia

Proto-chordates: Outline of classification, General features and important characters of *Herdmania, Branchiostoma.* Origin of Chordates. Pisces: Migration in Pisces, Outline of classification.

Amphibia: Classification, Origin, Parental care, Paedogenesis

UNIT II: Reptilia, Aves and Mammalia

Reptelia: Classification, Origin

Aves: Classification, Origin, flight- adaptations, migration.

Mammalia: Classification, Origin, dentition

UNIT III: Comparative anatomy of vertebrates I

Comparative anatomy of various systems of vertebrates: Integumentary, digestive, respiratory systems.

UNIT IV: Comparative anatomy of vertebrates II

Comparative Anatomy of vertebrates – Heart, Aortic arches, Kidney & urinogenital system, Brain, Eye, Ear. Autonomic Nervous system in Mammals.

SUGGESTED READING AND TEXT BOOKS

1. **Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. V Edition. Jones and**
2. Bartlett Publishers Inc.
3. Kardong, K.V. (2019) Vertebrates Comparative Anatomy, Function and evolution. 8th Edition. McGraw-Hill Higher Education.
4. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
5. Weichert, C.K. (1970). Anatomy of Chordate. McGraw Hill.
6. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.

5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of Proto-chordates, Pisces and Ambhibia, Reptilia, Aves and Mammalia, Comparative anatomy of vertebrates, Comparative anatomy of vertebrates.	1 Remember
CO2	**Perceive** the specific and basic concepts of Proto-chordates, Pisces and Ambhibia, Reptilia, Aves and Mammalia, Comparative anatomy of vertebrates, Comparative anatomy of vertebrates, Autonomic Nervous system in Mammals and Outline of classification.	1,2 Remember, Understand
CO3	**Demonstrating, Perceive** and **Reminisce** the detailed processes and features of Proto-chordates, Pisces and Ambhibia, Reptilia, Aves and Mammalia, Comparative anatomy of vertebrates, Comparative anatomy of vertebrates, Autonomic Nervous system in Mammals and Outline of classification.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to Proto-chordates, Pisces and Ambhibia, Reptilia, Aves and Mammalia, Comparative anatomy of vertebrates, Comparative anatomy of vertebrates, Autonomic Nervous system in Mammals and Outline of classification.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the Proto-chordates, Pisces and Ambhibia, Reptilia, Aves and Mammalia, Comparative anatomy of vertebrates, Comparative anatomy of vertebrates, Autonomic Nervous system in Mammals and Outline of classification.	1,2,3,4 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Proto-chordates, Pisces and Ambhibia, Reptilia, Aves and Mammalia, Comparative anatomy of vertebrates, Comparative anatomy of vertebrates, Autonomic Nervous system in Mammals and Outline of classification.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	2	2	2	2	2	2	3	2	3	2	3	3	3	3
CO3	3	3	2	2	3	3	3	2	3	2	3	3	3	3	3	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDE 606a**
Course Name	**: Lab Course Based on BBTDE 605a**
Semester	**: VI**

L	T	P	C
0	0	1	1

Practicals

1. Identification and classification upto order of the Proto-chordata: Salpa, Doliolum,
2. Herdmania, Branchiostoma.
3. Classification and identification upto order of the Cyclostomata: Myxine, Petromyzon.
4. Virtual dissection of frog (Rana tigrina).
5. Identification and classification upto order of the Reptiles: Hemidactylus, Calotes and Draco.
6. Classification upto order of the Aves: Columba, Alcedo and Passer.
7. Identification and classification upto order of the Mammalia: Ornithorhynchu and Macropus.
8. Slides of mammalian histology of liver, lung, intestine, kidney, ovary and testes.
9. Preparation of slides of spicules of Herdmania and tadpole of Frog.
10. Preparation of mount of tadpole larva of frog.
11. Identification of endoskeletons of frog and rabbit.

B. Sc. Biotechnology

Course code	**: BBTDE 605b**
Course Name	**: Plant Diversity-II**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course objectives: The objectives of the course are as follows:

1. To make students understand the general features and classification of pteridophytes.
2. To impart knowledge about the features of gymnosperms and process of fossil formation.
3. To make students learn about general characters of angiosperms.
4. To remember the origin, evolution of flowering plants and their economic importance.

UNIT I:

Pteridophytes

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia.*

UNIT II:

Pteridophytes: Type studies

Life histories of *Selaginella*- (Heterospory and seed habit), *Equisetum, Pteris, Lycopodium.*

UNIT III:

Gymnosperms

General characters, classification, geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms- *Williamsonia* & *Glossopteris*, telome and stele concept. Life histories of *Cycas & Pinus*, economic importance of gymnosperms.

UNIT IV:

Angiosperms: Type studies

Life histories of flowering plants, economic importance of Angiosperms.

SUGGESTED READING AND TEXT BOOKS

1. Bhatnager, S.P. and Moitra, A. 1996 Gymnosperms. New Age International (P) Ltd. Publishers,New Delhi. 1st Edition
2. Parihar, N.S. 1983.. Central Book Depot, Allahabad. The Biology and Morphology of Pteridophytes 1st Edition
3. Sambamurty 2005 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers. 1st Edition
4. Wickens, G.E. 2001 Economic Botany: Principles and Practices, Springer. Kuwer Publishers, Dordrecht, The Netherlands 1st Edition
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to general character of Pteridophytes, types of Pteridophytes, Gymnosperms, types of Gymnosperms, economic importance of gymnosperms and pteridophytes.	1 Remember
CO2	**Perceive** the specific and basic concepts of Pteridophytes, types of Pteridophytes, Gymnosperms, types of Gymnosperms, economic importance of gymnosperms and pteridophytes.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of Pteridophytes, types of Pteridophytes, Gymnosperms, types of Gymnosperms, economic importance of gymnosperms and pteridophytes.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to Pteridophytes, types of Pteridophytes, Gymnosperms, types of Gymnosperms, economic importance of gymnosperms and pteridophytes.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the Pteridophytes, types of Pteridophytes, Gymnosperms, types of Gymnosperms, economic importance of gymnosperms and pteridophytes.	1,2,3,4 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Pteridophytes, types of Pteridophytes, Gymnosperms, types of Gymnosperms, economic importance of gymnosperms and pteridophytes.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2
CO3	2	3	2	2	2	2	2	2	3	2	2	2	2	2	2	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDE 606b**
Course Name	**: Lab Course Based on BBTDE 605b**
Semester	**: VI**

L	T	P	C
0	0	1	1

1. Collection of plants pteridophytes, gymnosperms and angiosperms.
2. Sectioning to study anatomy of vegetative and reproductive parts of *Selaginella.*
3. Sectioning to study anatomy of vegetative and reproductive parts of *Equisetum.*
4. Study anatomy of vegetative and reproductive parts of *Pteris.*
5. Examination of morphology and anatomy of vegetative and reproductive parts of *Cycas.*
6. Section cutting of *Pinus* needle.
7. Examination of morphology and anatomy of vegetative and reproductive parts of *Ephedra.*
8. Study morphology and anatomy of vegetative and reproductive parts of angiospermic flower.
9. Permanent slide of LS and TS of monocot root.
10. Permanent slide of LS and TS of dicot root.

B. Sc. Biotechnology

Course code	**: BBTDE 605c**
Course Name	**: Environmental Biotechnology**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course objectives: The course is aimed to introduce basics of environmental biotechnology and focuses on the utilization of different biotechnological methods to protect environment. The course is designed to meet the following specific objectives:

1. To impart the basic knowledge about environmental biotechnology.
2. To make students understand the concepts and applications of biofuels and bioremediation.
3. To make the student understand the process of formation of biofertilizers and leran its applications.
4. To give students an overview of various applications of biotechnology in pollution control and biotransformation of pollutants.

UNIT I

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas.

Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen

Production, Conversion of sugar to alcohol Gasohol

UNIT II

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents.

Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms. Treatment of municipal waste and Industrial effluents.

UNIT III

Bio-fertilizers. Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers VAM)

UNIT IV

Bioleaching. Environmental significance of genetically modified microbes, plants and animals

SUGGESTED READING

1. Environmental Science, S.C. Santra 6th Edition 2011
2. Environmental Biotechnology, Pradipta Kumar Mohapatra1st Ed., 2007

3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter 1st Edition 2005

4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill 5th Edition 2015
5. Agricultural Biotechnology, S.S. Purohit 3rd Edition 2010

6. Environmental Microbiology: Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer 2004
7. Introduction to Environmental Biotechnology, Milton Wainwright 1999
8. Principles of Environmental Engineering, Gilbert Masters 3rd Edition 2015
9. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of general character of environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching. Environmental significance of genetically modified	1 Remember
CO2	**Perceive** the specific and basic concepts and applications environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of Environmental significance of genetically modified microbes, plants and animals, environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching, Environmental significance of genetically modified microbes, plants and animals	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching, Environmental significance of genetically modified microbes, plants and animals.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in environmental biotechnology, conventionala and modern fuels and their environmental impact, bioremediation, phytoremediation, biodegradation, Bio-fertilizers and Bioleaching, Environmental significance of genetically modified microbes, plants and animals	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	3
CO4	2	3	2	3	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDE 606c**
Course Name	**: Lab Course Based on BBTDE 607a**
Semester	**: VI**

L	T	P	C
0	0	1	1

Practicals

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of Total Suspended Solids (TSS) and Total Dissolved Solids (TDS) of water sample.
3. Calculation of Total Solids (TS) of water sample.
4. Calculation of BOD of water sample.
5. Calculation of COD of water sample.
6. Bacterial Examination of Water by MPN Method.

B. Sc. Biotechnology

Course code	**: BBTDE 607a**
Course Name	**: Animal Biotechnology**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course objectives: The course aims to make students gain knowledge in the current trends and techniques in animal biotechnology. The specific objectives of the course are as follows:

1. To develop an understanding about animal cell culture and gene delivery methods in animals.
2. To provide an overview of in-vitro fertilization, embryo transfer methods and other relatedtechniques.
3. To gain knowledge about the stem cells and their various applications
4. To learn about the production of transgenic animal and gene therapy and their applications.

UNIT I

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer,

Retrovirus & Gene transfer.

UNIT II

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect.

Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis,

Trypanosomiasis, Theileriosis.

UNIT III

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo

transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

SUGGESTED READING AND TEXT BOOKS

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.

2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.

3. Glick, B.R. and Pasternak, J.J. (2022). Molecular biotechnology- Principles and applications of recombinant DNA. VI Edition. ASM press, Washington, USA.

4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2015). An introduction to genetic analysis. XI Edition. Freeman & Co., N.Y., USA.

5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.	1 Remember
CO2	**Perceive** the specific and basic concepts of animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine..	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes, essential techniques for identificatin and features of animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in animal biotechnology, gene transfer methods in animals, transgenesis, animal diseases need help of biotechnology, animal propagation and genetic modification in medicine.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2
CO2	2	2	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO3	3	3	3	2	2	2	2	3	2	2	2	2	2	2	2	2
CO4	2	3	3	3	3	3	3	3	3	1	3	2	3	3	3	3
CO5	3	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDE 608a**
Course Name	**: Lab Course Based on BBTDE 505b**
Semester	**: VI**

L	T	P	C
0	0	1	1

Practicals

1. Sources of contamination and decontamination measures.
2. Preparation of Hanks Balanced salt solution.
3. Preparation of Minimal Essential Growth medium.
4. Isolation of lymphocytes for culturing.
5. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization.
6. Preparation of animal cell culture media.
7. Inoculation of cells in animal cell culture media.
8. Trypsinizing and subculturing cells from a monolayer.
9. Perform animal cell counting.
10. Determine the percentage of viable cells by trypan blue exclusion test.
11. MTT cell proliferation assay.
12. Establishment of primary cell culture.
13. Giemsa staining of animal cells.
14. DPPH (2,2 Diphenyl-1-Picryl Hydrazyl) radical scavenging assay.
15. Preservation of animal cells.
15. DNA isolation from animal tissue.
16. Quantification of isolated DNA.
17. Resolving DNA on Agarose Gel.

B. Sc. Biotechnology

Course code	**: BBTDE 607b**
Course Name	**: Plant Biotechnology**
Semester	**: VI**

L	T	P	C
3	0	0	3

Course objectives: This course presents an overview of the techniques and underlying theory of plant tissue culture, and plant genetic engineering, and their applications. The specific objectives of the course are as follows:

1. To enable students acquire knowledge of the fundamental principles of plant tissue culture.
2. To learn about different kinds of plant culture techniques.
3. To make students understand the principles of *Agrobacterium tumefaciens* biology and Ti-plasmid.
4. To impart knowledge about the diverse applications of plant biotechnology and genetically- modified crops.

UNIT I

Introduction, Cryo and organogenic differentiation, Types of culture: Seed , Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT- II

In vitro haploid production: Androgenic methods: Anther culture, Microspore culture andogenesis

Sgnificance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic

haploids, factors effecting gynogenesis, chromosome elimination

techniques for production of haploids in cereals.

UNIT – III

Protoplast Isolation and fusion: Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclautre, methods, applications basis and disadvantages.

UNIT – IV

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

SUGGESTED READING AND TEXT BOOKS

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice. 1996

2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication. 8th Edition 2020

3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2015 7th edition Principles of Genetics. Wiley India.

4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.

5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.

6. Russell, P.J. 2014 Genetics – A Molecular Approach. 3rd edition. Benjamin Co.

7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)

8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press 2nd Edition.

9. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character of plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria.	1 Remember
CO2	**Perceive** the specific and basic concepts of plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Somaclonal variation nomenclautre, methods, applications basis and disadvantages.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Somaclonal variation nomenclautre, methods, applications basis and disadvantages.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Somaclonal variation nomenclautre, methods, applications basis and disadvantages.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Somaclonal variation nomenclautre, methods, applications basis and disadvantages.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in plant biotechnology, cryo and organogenic differentiation, types of culture, In vitro haploid production, protoplast Isolation and fusion and Plant Growth Promoting bacteria. Somaclonal variation nomenclautre, methods, applications basis and disadvantages.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	3	2	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTDE 608b**
Course Name	**: Lab Course Based on BBTDE 607c**
Semester	**: VI**

L	T	P	C
0	0	1	1

Practicals

1. Sterilization of glassware, plastic ware, and preparation of stock solutions.
2. Preparation of Murashige and Skoog (MS) medium.
3. Sterilization and inoculation of the explant on MS medium.
4. Induction of callus from the explant.
5. Isolation of DNA from plant tissue by CTAB method.
6. Isolation of RNA from plant tissue.
7. Isolation of protein from plant tissue.
8. Isolation of protoplasts by mechanical method.
9. Perform seed viability test by tetrazolium chloride test.
10. Isolation of plant embryos and their *in vitro* culture.

B. Sc. Biotechnology

Course code	**: BBTSC 609**
Course Name	**: Medical Microbiology**
Semester	**: VI**

L	T	P	C
2	0	0	2

Course objectives: The objective of this course is:

1. To introduce basic principles and application relevance of microbiological diseases
2. To gain the knowledge about the bacterial agents responsible for infectious diseases.
3. To understand the pathology of the viruses and fungal diseases.
4. To gain the knowledge about laboratory diagnosis

UNIT I

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. Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy

caused by gram negative bacteria.

UNIT II

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses,

Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis

viruses. Fungal and Protozoan infections. Dermatophytoses, Subcutaneous infection, systemic infection and opportunistic fungal infections. Gastrointestinal infections and Blood-borne infections

SUGGESTED READINGS

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2025). Ja**wetz, Melnick and Adelberg's** Medical Microbiology. 29th edition. McGraw Hill Publication.

2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2024). Mims' Medical Microbiology.

3. 7th edition. Elsevier.

4. Willey JM, Sherwood LM, and Woolverton CJ. **(2008). Prescott, Harley and Klein's** Microbiology. 7th edition. McGraw Hill Higher Education.

5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of general character of medical microbiology, Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels, Morphology, pathogeneis, symptoms, laboratory diagnosis, Diseases caused by viruses, Fungal and Protozoan infections.	1 Remember
CO2	**Perceive** the specific and basic concepts of Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels, Morphology, pathogeneis, symptoms, laboratory diagnosis, Diseases caused by viruses, Fungal and Protozoan infections.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels, Morphology, pathogeneis, symptoms, laboratory diagnosis, Diseases caused by viruses, Fungal and Protozoan infections.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels, Morphology, pathogeneis, symptoms, laboratory diagnosis, Diseases caused by viruses, Fungal and Protozoan infections.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels, Morphology, pathogeneis, symptoms, laboratory diagnosis, Diseases caused by viruses, Fungal and Protozoan infections.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels, Morphology, pathogeneis, symptoms, laboratory diagnosis, Diseases caused by viruses, Fungal and Protozoan infections.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2
CO3	2	3	3	3	3	3	2	2	3	2	3	3	3	3	2	3
CO4	2	3	2	3	3	3	3	3	3	1	3	2	2	2	2	2
CO5	3	3	3	3	2	2	3	3	3	3	3	3	3	2	2	2
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTPR 610**
Course Name	**: Project Report II**
Semester	**: VI**

L	T	P	C
0	0	0	4

Course Objectives: The objectives of this course are

4. To make the students industry, university and research institute deployable.
5. To provide an opportunity to students to gain practical knowledge.
6. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/ under the guidance of faculty member/supervisor from industry/research organizations or submit an educational tour report by the guidance of internal supervisor. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings: NA

Course Outcome:

CO1.	Remembering and demonstrate analytical, practical training and understand the scope and importance of Biotechnology through exposure.
CO2.	**Understand** the specific and basic concepts interpretation and organization of data.
CO3.	**Applying** the detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO4.	**Analyzing** the detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO5.	**Evaluating** the detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO6.	**Constructing** the take part in detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	3
CO4	2	3	2	3	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Degree Course in Honours Biotechnology [B.Sc. (Hons.) Biotechnology]

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDC 701**
Course Name	**: Molecular Cell Biology**
Semester	**: VII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To study and provide profound knowledge about the cell ultrastructure, physiological and molecular pathways within cell.
2. To study the cell organelles, basic components of prokaryotic and eukaryotic cells. cellular motility and transportation mechanism
3. To study the cell-signaling pathways for cellular division or cell cycle and molecular level pathways in a living organisms.
4. To study about the cancer, types, molecular basis of cancer, mutation, genes for cancer and cell death and mode of action.

Unit I

Plasma membrane: Structure, organisation, lipid bilayer, proteins & glycoconjugates, liposomes. Function- Ionic transport, types of transport (symport, antiport, active & passive), channel proteins. Structure, organization and functions of Nucleus, Mitochondria, lysosome, Golgi body, Chloroplast, Peroxisome, Endoplasmic reticulum (Rough and smooth). Structure and functions, Microfilament, Microtubules and Intermediate filament.

Unit II

Vesicular traffic in the secretory and endocytic pathway: transport from endoplasmic reticulum through the Golgi network to lysosome, endocytosis, exocytosis, Molecular mechanisms of vesicular transport and the maintenance of compartments diversity. Cell signaling: General principles (Types of signaling). Cell surface receptor mediated signaling (ion channel, G protein and enzyme linked).

Unit III

Cell cycle, Molecular events and regulation. Cell division: General strategy and regulation, Molecular mechanism of mitosis and meiosis. Cancer- Biology: Types of cancer, onset of cancer, Proto-oncogenes and tumor suppresser genes, Oncogenic mutations affecting cell proliferation, cell cycle and genome stability.Programmed cell death, Apoptosis.

Unit IV

Developmental Biology: Gametogenesis: Spermatogenesis and Oogenesis including structure, differentiation and longevity of gametes. Chemical and metabolic events during gamete formation. Types of eggs. Fertilization: Significance of fertilization, approximation of gametes, Capacitation, Acrosome reaction, formation of fertilization membrane, egg activation, Blockage to polyspermy, Parthenogenesis.

Unit V

Cleavage: Patterns, control of cleavage patterns, chemical changes during cleavage.

Physical phenomena and processes in the living organisms. Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.

Suggested Reading and Text Books

1. Lodish et al.: Molecular Cell Biology (9^{th} ed.) 2021
2. Alberts et al.: Molecular Biology of the cell (7^{TH} ed.) 2022
3. Scott F. Gilbert: Developmental Biology (13^{th} ed.) 2023
4. Zubay, Parson & Vance: Principles of Biochemistry 1995
5. De Robertes & Robertis: Cell & Molecular Biology, 2006, Lee & Fabiger Philadelplna 8th Edition 2006
6. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of general character of Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology.	1 Remember
CO2	**Perceive** the specific and basic concepts and applications of Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Cell Biology, Developmental Biology, Biophysics**:** Plasma membrane, intracellular compartments, cell movements, Vesicular trafficking and signal transduction, Cell cycle, Molecular events and regulation, cancer, Developmental Biology and physical processes in biology including Principle of measurement. Applications of ultrasound in medical diagnostics. X-rays, their properties.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	3	3	2	3	2	2	2	2	2	3	2	2
CO2	3	2	2	3	3	3	3	2	3	2	3	2	2	2	2	2
CO3	3	2	2	2	2	2	2	2	3	2	3	3	3	2	2	3
CO4	3	3	2	3	3	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	3	3	3	3	2	3	2	2	3	3	3	3	3
CO6	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDC 702**
Course Name	**: Lab Course based on BBTDC 701**
Semester	**: VII**

L	T	P	C
0	0	1	1

1. To study the cell organelles, basic components of prokaryotic and eukaryotic cells. cellular motility and transportation mechanism
2. To study and provide profound knowledge about the cell ultrastructure, physiological and molecular pathways within cell.
3. To study about the cancer, types, molecular basis of cancer, mutation, genes for cancer and cell death and mode of action.
4. To study the cell-signaling pathways for cellular division or cell cycle and molecular level pathways in a living organisms.
5. Mitosis and meiosis stages identification through squash staining methods.
6. Preparation of Permanent slides.
7. Study developmental processes and morphogenetic movements.
8. Effect of temperature on plant membranes.
9. Learn the operation of centrifuge through cell fractionation by isolation of Chloroplast, chlorophyll content and identification of pigments through thin layer chromatography.

Course code	**: BBTDC 703**			
Course Name	**: Clinical Immunology**			
Semester /Year	**: VII**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

5.To understand various types of cancer, tumor invasion, markers in cancer research and diagnosis
6.To acquire knowledge related to genetic disease, gene diagnosis, gene tracking & other diagnostic application of biomedical technology.
7.To understand the concept and types of mutations in Molecular biology.
8.To acquire knowledge related to cellular and molecular mechanisms in biomedical technology.

Couse Contents [Credit = 3]

Unit 1
Molecular diagnosis (genetic disease, gene diagnosis, gene tracking & other diagnostic application of RDT) Molecular diagnostic- direct gene diagnosis, Linkage analysis. Nucleic acid sequences as diagnostic tools, SNPs, VNTRs, Non-invasive methodology. MRI, CT-SCAN. Reproductive Health Technologies – ICSI, IVE.

Unit 2
Mutations and genetic disorders. Single gene disorders, Receptor proteins (hypercholesterolemia). Cytogenic disorders (Trisomy, Klienfelters). Mutation in mitochondrial genes (LHDN), Fragile X Syndrome.

Unit 3
Types and grading of cancer. Introduction to molecular diagnosis of cancer. (Southern & Northern blot analysis, PCR based diagnosis). Gene therapy, Immunotherapy and chemotherapy of cancer cells.

Unit 4
Chemical mutagens. Carcinogenic agents and their cellular interactions. Radiation as health hazard. (Types, measurements, effects & protective measures) Introduction to DNA damage and repair mechanism.

Unit 5
Cellular Pathology: causes of cell injury, necrosis, biochemical mechanism, Ischemic and hypoxic injury. Apoptosis (Biochemical features, mechanisms) Immunological basis of diseases: Hypersensitivity (I – IV) Autoimmune diseases, Preparation of polyclonal antisera: characterization of antisera, Immunodiagnostic – RIA, ELISA.

Suggested Reading and Text Books

1. Biomedical Technology and Devices Handbook, James E Moore, George Zouridakis, CRC Press 2nd Edition (2013).

2. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology.	1 Remembering
CO2	**Perceive** the specific and basic concepts of Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of apply modern techniques in Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems and decision making for higher studies, employment and advanced research in industrial and academic scale.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge of Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems. Knowledge of the Biomedical technology in biological systems information and the explanation of the key concepts.	1,2,3,4,5 Remembering, Understanding,Applying, Analyzing
CO5	**Assess** the principle, methods, properties and functions of Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems	1, 2,3,4,5 Remembering, Understanding, Applying, Analyzing, Evaluating
CO6	**Constructing** the take part in the scientific knowledge regarding Biomedical technology: Molecular diagnosis, RDT, Reproductive Health Technologies, Mutations and genetic disorders, Types and grading of cancer, molecular diagnosis of cancer, Chemical mutagens and cellular pathology and their utilization to solve the society and industry-related problems.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	3	2	2	2	3	2	3	2
CO2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	1	1	1	1	2	2	1	3	2	2	2	1	3

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDC 704**
Course Name	**: Lab Course based on BBTMC 703**
Semester	**: VII**

L	T	P	C
0	0	1	1

1. To study the basic concepts of molecular diagnostics tools
2. To demonstrate PCR based diagnosis of cancer.
3. To study about the cancer, types, molecular basis of cancer, mutation, genes for cancer and cell death and mode of action.
4. Immunological experiments.

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDE 705a**
Course Name	**: Immuno-technology**
Semester	**: VII**

L	T	P	C
3	0	0	3

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To instill detailed study of the molecular and cellular components that comprises the immune system including their function and interaction to provide a lifelong learning & disciplinary knowledge to implement the concepts.
2. To appraise study of the different analytical techniques for the disease diagnosis, assist advancement and career options in the field of molecular diagnostics and applicate as well emerge with the solutions concerned with health and environment.
3. To broaden the area of understanding the structure, function, components of immune system for better advancement & comprehend the need of tools & techniques with broadening the area in distinguished fields.
4. To comprehend the essential elements of immune system clearing up the facts of theoretical and technical aspects and help in employing the scientific knowledge for development of medical interventions.

Couse Contents [Credit = 3]

Unit 1

Overview of the Immune System. Cells and Organs of the Immune System. Antigens. Haptens & Epitopes.

Unit 2

Immunoglobulins: Structure and Function. Major Histocompatibility Complex. Antigen processing and presentation. Structure and functions of BCR & TCR.

Unit 3

Cytokines. Complement System. Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis. Ab-dependent cell mediated cytotoxicity (ADCC).

Unit 4

Overview of Hypersensititivity and Introduction to Transplantation. Vaccines: Active and Passive Immunization.

Unit 5

Introduction to Monoclonal Antibodies and polyclonal Antibodies. Antigen-Antibody Interactions RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence.

Suggested Reading and Text Books

1. Kuby : Immunology 2013 (7^{th} ed.)
2. Roitt, Male & Brostof : Immunology 2006 (7^{rd} ed).
3. Elgert & Elgert : Immunology
4. Wilson & Walker: Practical Biochemistry 1990(5^{th} ed.)
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA.	1 Remembering
CO2	**Perceive** the specific and basic concepts of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to concepts of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms.	1,2,3,4 Remembering, Understanding, Appying, Analyzing
CO5	**Assess** the principle, methods, properties and functions of Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms.	1,2,3,4,5 Remembering, Understanding, Applying, Analyzing, Evaluating
CO6	**Constructing** the take part in Immunology, Immune Response, Immuno-globulins or Antibodies, Regulation of immunoglobulin gene expression, Major Histocompatibility complexes, Immunity to infection, Vaccines & Vaccination and immunodiagnostics – RIA, ELISA. Immunity to different organisms.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	2	2	2	2	2	2	2	2	3	2	3	2
CO2	2	2	3	3	3	2	3	3	2	3	3	2	2	2	2	2
CO3	2	3	2	3	3	3	2	2	2	2	3	3	3	2	2	2
CO4	3	2	2	3	2	3	2	2	2	1	3	2	2	2	2	3
CO5	3	2	2	2	2	3	3	3	3	2	2	3	2	2	2	2
CO6	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDE 706a**
Course Name	**: Lab Course based on BBTDE 705a**
Semester	**: VII**

L	T	P	C
0	0	1	1

1. To teach students about the diagnostic significance, Principles of ELISA, RIA, Immunodiffusions etc in clinical approaches and their limitations.
2. To introduce students to the challenges involved in diagnostics & health.
3. To adhere skills regarding the use of all laboratory devices related to immunological tests and kits.

Course code	**: BBTDE 705b**
Course Name	**: Virology**
Semester	**: VII**

L	T	P	C
0	0	1	1

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To instill detailed study of the molecular and cellular components that comprises the immune system including their function and interaction to provide a lifelong learning &disciplinary knowledge to implement the concepts.
2. To appraise study of the different analytical techniques for the disease diagnosis, assist advancement and career options in the field of molecular diagnostics and applicate as well emerge with the solutions concerned with health and environment.
3. To broaden the area of understanding the structure, function, components of immune system for better advancement & comprehend the need of tools & techniques with broadening the area in distinguished fields.
4. To comprehend the essential elements of immune system clearing up the facts of theoretical and technical aspects and help in employing the scientific knowledge for development of medical interventions.

Unit 1

History of Virology and Biosafety: History and principles of virology, virus taxonomy. Structures of animal and plant viruses and their morphology. Principles of biosafety, containment facilities, maintenance and handling of laboratory animals, and requirements of virology laboratory.

Unit 2

Virus Replication: Structure and replication strategies of bacteriophages - T7, λ, ΦX174, and plant viruses - ss RNA virus (TMV) and ds DNA virus (CaMV). Structure and replication strategies of animal viruses - Influenza virus, Adeno virus and Retro virus.

Unit 3

Interferon and Antiviral Agents: Viral Interference and Interferons. Nature and source of interferons, Classification of interferons. Induction of interferon. Antiviral agents (chemical and biological) and their mode of actions.

Unit 4

Cultivation of Viruses and Viral Vaccines : Cultivation of viruses in embryonated egg, tissue culture and laboratory animals. Conventional vaccines - Killed and attenuated. Modern vaccines - Recombinant proteins, subunits, DNA vaccines, peptides, immunomodulators (cytokines). Vaccine delivery and adjuvants, large-scale manufacturing.

Unit 5

Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Quantitative diagnostic methods - Haemagglutination, complement fixation, neutralization, Western blot, flowcytometry. Nucleic acid based diagnosis - PCR, microarray and nucleotide sequencing. Application of Microscopic techniques - Fluorescence, confocal and electron microscopic techniques.

Suggested Reading and Text Books

1. General Virology - Luria and Darnel Virology and Immunology – Jokli 3rd Edition (1978)
2. Text book of Virology - Rhodes and Van Royen 5th Edition (1968)
3. Plant Virology - Smith
4. Genetics of bacteria and their viruses - W. Hayes
5. Molecular Biology of the gene - Watson, Roberts, Staitz and Weiner 6th ed, 2008.
6. A laboratgory guide in virology - Charles H. Lunningham
7. Basic lab procedures in diagnostic virology - Marty Cristensen
8. Review of medical microbiology - Jawitz et al 29th Edition (2025)
9. Medical laboratory Manual for tropical countries Vol I & II by Monica Cheesbrough(2010–2012)
1. Text Book of Microbiology - Ananthanarayanan and Jayaram Paniker Viral and Ricketsial

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts and introduction to Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods.	1 Remembering
CO2	**Perceive** the specific concepts of Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Exhibit competent scientific writing (with critical analysis) and enhance presentation skills.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features of Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution/ conclusion to complex problem of virology and infections.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to demonstrate the scientific knowledge of Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods.	1,2,3,4 Remembering, Understanding,Applying, Analyzing
CO5	**Assess** the principle, methods, properties and functions of Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods. Exhibit competent scientific writing (with critical analysis) and enhance presentation skills.	1, 2,3,4,5 Remembering, Understanding, Applying, Analyzing, Evaluating
CO6	**Constructing** the Molecular virology and infections: History of Virology and Biosafety, Virus Replication, Interferon and Antiviral Agents, Cultivation of Viruses and Viral Vaccines, Virological Methods: Methods for purification of viruses with special emphasis on ultracentrifugation methods.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	3	2	2	3	2	2	2	3	2	3	2
CO2	3	2	3	2	2	2	3	2	3	2	2	2	2	2	2	2
CO3	3	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	3	2	3	2	2	2	2	3	2	2	2	2	2	2	2
CO6	2	2	2	2	1	3	1	2	2	1	3	2	2	2	2	3

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDE 706b**
Course Name	**: Lab Course based on BBTDE 705b**
Semester	**: VII**

L	T	P	C
0	0	1	1

1. Detection methods of Viruses.
2. Cultivation methods of Viruses
3. Purification methods of Viruses

B. Sc. (Hons.) Biotechnology

Course code	**: BBTGE 707**
Course Name	**: Bio-molecules and Metabolism**
Semester	**: VII**

L	T	P	C
4	0	0	4

Unit I

Enzymes: Classification, overview and specific example Zymogens and their activation (protease and Prothrombin) Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity.

Unit II

Lock and Key Hypothesis, Induced –Fit Hypothesis, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax . Enzyme inhibition: types of inhibition, suicide Inhibitor. Carbohydrate – Classification, structure and functions.

Unit III

Protein – Classification, structure and functions. Urea cycle and its regulation. Conversion of nitrogen to ammonia by microorganisms, overview of amino-acid biosynthesis. N_2 fixation.

Unit IV

Fatty Acids - Classification and structure, Fatty Acid Metabolism. Nucleic Acid - structure and functions. Nucleic Acid Metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis and its regulation.

Suggested Reading and Text Books

1. Lehninger: Principles of Biochemistry,8th ed., Nelson & Cox, WH Freeman and Company, 2021
2. Voet & Voet: Biochemistry, 4TH ed., Wiley & Sons 2010 .
3. Berg, Tymoczko, Stryer: Biochemistry, 10th ed., WH Freeman and Company, 2023.
4. Garett & Grisham: Biochemistry, 7th ed., Brooks/Cole Cengage learning, 2016.
5. Murray, Granner, Rodwell: Harper's Illustrated Biochemistry, 31th ed. McGraw Hill, 2018.
6. Conn & Stumpf: Outlines of Biochemistry, 5th ed., Willey India, 1987.
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the define the terms and basic concepts of Biochemistry Enzyme metabolism, Mechanism and their different roles in biological systems, carbohydrates, proteins, fatty acids and nucleic acids.	1 Remember
CO2	**Perceive** the principle, mechanism of basic and advanced Biochemistry.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed process of structure and function of biomolecules and enzymes.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the coordinated regulation of carbohydrate bisynthesis, Protein bisynthesis and lipid bisynthesis, nucleic acid bisynthesis and enzyme metabolic pathway.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of enzymes and molecules.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the Biomolecules and Enzymes.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	1	1	1	1	3	1	1	1	3	2	1	1
CO2	3	3	1	1	1	1	1	1	3	1	1	1	3	2	1	1
CO3	2	3	3	3	3	3	2	2	3	2	2	2	3	2	2	1
CO4	3	2	3	3	3	3	1	1	3	1	0	1	3	3	2	1
CO5	3	2	3	1	1	1	2	2	3	3	2	1	3	2	1	1
CO6	1	1	1	1	1	1	1	1	2	2	2	1	3	2	2	1

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTPR 708**
Course Name	**: Project Report III**
Semester	**: VII**

L	T	P	C
0	0	0	6

Course Objectives: The objectives of this course are

1. To make the students industry, university and research institute deployable.
2. To provide an opportunity to students to gain practical knowledge.
4. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/ under the guidance of faculty member/supervisor from industry/research organizations or submit an educational tour report by the guidance of internal supervisor. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings: NA

Course Outcome:

CO1.	**Reminisce** and demonstrate analytical, practical training and understand the scope and importance of Biotechnology through exposure.
CO2.	**Perceive** the specific and basic concepts interpretation and organization of data.
CO3.	**Demonstrating** the detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO4.	**Examine** the detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO5.	**Assess** the detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO6.	**Constructing** the take part in detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	3
CO4	2	3	2	3	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDC 801**
Course Name	**: Molecular Biology and Applications**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To provide fundamental aspects of molecular biology with detailed basics of cellular organization and biochemical molecules present in the cell.
2. To understand the basic knowledge molecular events like replication, transcription and translation that is important for cell.
3. To provide basic knowledge and understanding of principle and mechanism of inheritance.
4. To provide students basic knowledge of gene expression ant its regulation in prokaryotes and eukaryotes.

Couse Contents [Credit = 3]

Unit 1

Chemical and physical properties of nucleic acids, Structure and types of RNA and DNA, The Watson-Crick model. DNA as genetic material. Different forms of DNA. Topological properties of DNA. DNA renaturation kinetics.

Unit 2

Mechanism of DNA replication in prokaryotes and eukaryotes. Mechanism of transcription in prokaryotes and eukaryotes. Reverse transcription. Post transcriptional processing of RNA: (capping, polyadenylation, splicing, RNA editing). Mechanism of translation in prokaryotes and eukaryotes.

Unit 3

Concept of genetic code, Gene expression and regulation in prokaryotes (Lac operon and tryptophan operon). Gene expression and regulation in eukaryotes. Introduction to various types of DNA damage and repair. Retrovirus and cancer.

Unit 4

Mendelism: The basic principles and applications of inheritance, exceptions to mendelian law. The chromosomal basis of Mendelism (chromosomal theory of heredity). The molecular structure of chromosome in eukaryotes: structure of chromatin and Higher order packaging in chromosome. Centromere and telomere Giant chromosome : polytene and lampbrush chromosome. Linkage, Recombination and chromosome mapping in eukaryotes. Cytoplasmic inheritance.

Unit 5

Chromosomal Aberrations: Change in Number and Structure. Allelic variation and Gene function. Sex chromosome and sex determination. Dosage compensation of X-linked gene. Sex linked gene in human. Pedigree analysis in man.

Suggested Reading and Text Books

1. Lewin: Genes, Vol. XII Oxford, 2017, Inded.
2. Straehan & Read: Human Molecular Genetics 5th Edition (2018) , John Wiley & Sons Pte. Ltd.
3. Snustad et al: Principles of Genetics 7th Edition (2011) , John Wiley & Sons.
4. De Robertes & Robertis: Cell & Molecular Biology, 8th Edition (2001), Lee & Fabiger Philadelplna.
5. Strickberger: Genetics ,3rd Ed, 1996, Prentice Hall.
6. Friefelder: Molecular Biology (2^{nd} ed.), 1996 Narosa Publ. House.
7. Alberts et al: Molecular biology of the cell (7^{th} ed.) 2022, Garland Publ. New York.
8. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to molecular biology and genetics: DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation, concept of genetic code, Mendelism's and cocept of chromosomal aberrations.	1 Remembering
CO2	**Perceive** the specific and basic concepts of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation. concept of genetic code, Mendelism's and cocept of chromosomal aberrations.	1,2 Remembering, Understanding
CO3	**Demonstrating** the detailed processes, essential techniques and features DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation, concept of genetic code, Mendelism's and cocept of chromosomal aberrations.	1,2,3 Remembering, Understanding, Demonstrating
CO4	**Examine** the detailed study related to concepts of genetic code, Mendelism's and cocept of chromosomal aberrations, DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1,2,3,4 Remembering, Understanding, Appying, Analyzing
CO5	**Assess** the principle, methods, properties and functions of DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation, concept of genetic code, Mendelism's and cocept of chromosomal aberrations.	1,2,3,4,5 Remembering, Understanding, Applying, Analyzing, Evaluating
CO6	**Constructing** the take part in concept of genetic code, Mendelism's and cocept of chromosomal aberrations, DNA structure and replication, define the terms and basic concepts of Molecular Biology, DNA damage, repair and homologous recombination, Transcription and RNA processing, Regulation of gene expression and translation.	1,2,3,4,5,6 Remembering, Understanding, Applying, Analyzing, Evaluating Creating

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	2	2	3	2	2	2	3	2	3	2
CO2	3	2	2	2	2	2	3	3	2	3	3	2	2	2	2	2
CO3	3	3	2	3	3	3	2	2	3	2	2	2	3	2	2	2
CO4	3	2	2	3	2	3	2	2	3	1	3	2	2	2	2	3
CO5	3	2	2	2	2	2	2	2	3	2	2	3	2	2	2	2
CO6	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDC 802**
Course Name	**: Lab Course based on BBTDC 801**
Semester	**: VIII**

L	T	P	C
0	0	1	1

1. To provide students basic knowledge of DNA isolation from various tissues using molecular biology techniques.
2. To understand, learn and apply the principle, tools and techniques of molecular biology, which prepares students for further study and /or higher education and employment.
3. To provide basic knowledge of Mendelian inheritance, concept and principle of pedigree analysis.
4. To provide basic learning of different genetic crosses to enhance the analytical skills in the students.
5. To elucidate metabolism of living system well enough for the prediction and control the various changes that occur in cells with the help of theoretical and practical concepts.

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDC 803**
Course Name	**: Nano-biotechnology**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To provide knowledge about the microbial world, classification and study about the branch of bacteriology, virology, and their distinguishing features associated with them such as morphological, chemical, structural and metabolic characteristics.
2. To learn and study about the laboratory guidelines, sterilization methods, aseptic conditions for microbial culture, genetics, microbial nutrients, culture medium, their type and metabolic pathways.
3. To study about the extra-chromosomal genome or plasmids, their types, properties and bacteriophages genetics and understand the techniques used to study the genetic recombination in bacteria and their role in genetic mapping.
4. To study about the different techniques used to elucidate physiological processes of microbes their growth process and their mode of action, principles, tools and techniques for the screening of microbes and to know their beneficial and harmful effects.

Unit I

Terminology and Techniques in Nanobiotechnology. Definitions, Scopes and applications of Biotechnology, Nanobiotechnology, Biomolecular Nanotechnology, Biomedical Nanotechnology, Green Nanotechnology. Fundamentals and introduction to techniques such as mechanical extraction, physical methods of homogenization, centrifugation, dialysis, electrophoresis and chromatography techniques for purification of biomolecules and microsopy.

Unit II

Definitions, Relationship and Differences. Nano and Nature: Nanoscopic Colours (Butterfly Wings), Bioluminescence (Fireflies), Tribiology (Geckos sticky feet, lotus leaf effect). Introduction to hydrophilic and hydrophobic materials. Nanotechnology timeline, Pre-18thCentury, 19th Century, 20th Century and 21st Century. Future perspectives of nanoscience and nanotechnology.

Unit III

Introduction to Self-assembled Biological Nanomaterials in Nature. Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus).

Unit IV

Biological synthesis of Nanoparticles, Concept of reducing and capping agents, introduction to biomolecules as reducing and capping agents, Bacteria, fungi and plants as sources of reducing and capping agents and for biogenic synthesis of nanomaterials. Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, DNA based Nano structures, Protein based Nano structures.

Suggested Reading and Text Books

1. Tortora, Funke, Case: Microbiology, (14th ed.) Pearson Education, Inc, 2023.
2. Prescott, Harley & Kliens: Microbiology (7th ed.) McGraw-Hill International Edition, 2008.
3. Michael J. Pelczar, E.C.S. Chan, Noel R. Krieg: Microbiology (6th ed.) Tata McGrall-Hill, 2024.
4. Alcamo's Jeffrey C. Pommerville: Fundamental of Microbiology (12th ed.) Jones & Bartlet Publ.2021.
5. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different concept of Terminology and Techniques in Nanobiotechnology, Definitions, Relationship and Differences. Nano and Nature, Introduction to Self-assembled Biological Nanomaterials in Nature. Fundamentals of nanoscale self-assembly process, Biological synthesis of Nanoparticles.	1 Remember
CO2	**Perceive** the concept of Terminology and Techniques in Nanobiotechnology, Definitions, Relationship and Differences. Nano and Nature, Introduction to Self-assembled Biological Nanomaterials in Nature. Fundamentals of nanoscale self-assembly process, Biological synthesis of Nanoparticles.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and concept of Terminology and Techniques in Nanobiotechnology, Definitions, Relationship and Differences. Nano and Nature, Introduction to Self-assembled Biological Nanomaterials in Nature. Fundamentals of nanoscale self-assembly process, Biological synthesis of Nanoparticles.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to different concept of Terminology and Techniques in Nanobiotechnology, Definitions, Relationship and Differences. Nano and Nature, Introduction to Self-assembled Biological Nanomaterials in Nature. Fundamentals of nanoscale self-assembly process, Biological synthesis of Nanoparticles.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the principle, methods, properties and functions of essential techniques and concept of Terminology and Techniques in Nanobiotechnology, Definitions, Relationship and Differences. Nano and Nature, Introduction to Self-assembled Biological Nanomaterials in Nature. Fundamentals of nanoscale self-assembly process, Biological synthesis of Nanoparticles.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the Take part in essential techniques and concept of Terminology and Techniques in Nanobiotechnology, Definitions, Relationship and Differences. Nano and Nature, Introduction to Self-assembled Biological Nanomaterials in Nature. Fundamentals of nanoscale self-assembly process, Biological synthesis of Nanoparticles.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	2	3	3	2	3	2	2	2	3	2	1	2
CO2	3	2	2	3	3	2	1	3	3	3	3	3	3	2	1	2
CO3	3	3	2	2	3	3	2	2	3	2	2	2	2	2	2	2
CO4	3	3	3	3	2	3	2	2	3	1	1	1	2	3	2	2
CO5	3	2	3	2	2	2	2	2	3	3	2	3	2	2	2	2
CO6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDC 804**
Course Name	**: Lab Course based on BBTDC 803**
Semester	**: VIII**

L	T	P	C
0	0	1	1

1. Biology for Engineers.
2. Elements of Nanoscience and Nanotechnology.
3. Statistical Mechanics and Thermodynamics.
4. Fundamentals of Solid State Technology.
5. Properties of Nanomaterials.
6. Quantum Mechanics.
7. Production of Nanomaterials.

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDE 805a**
Course Name	**: Molecular Endocrinology & Enzymology**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To provide the basic knowledge of endocrinology and their molecular aspects.
2. To provide the basic knowledge of endocrine glands, functions and their molecular aspects.
3. To provide the basic knowledge about enzymatic reactions and factors effecting it.
4. To instill the concept and fundamentals about the classification of enzymes.
5. To provide exposure to students about mechanism of enzyme actions and industrial use of enzyme.

Unit I

Mechanism of hormone action: Signal discrimination, signal transduction and signal amplification. Receptors: identification and physico-chemical properties. Hormone-receptor interaction, binding to cellular receptors. Pineal hormone.Pineal as a photo-transducer. Biosynthesis, secretion and physiological actions of protein hormones.

Unit II

Biosynthesis, control of secretion & physiological actions of amino acid derived hormones (Thyroid).Environmental Iodine deficiency disorders and thyroid.Pancreatic hormones. Hormonal regulation of carbohydrate, lipid, protein and nucleic acid metabolism.

Biosynthesis of steroid hormones: Steroidogenesis, cellular sites of synthesis. Physiological actions of estrogen, progesterone. Hormonal control of Estrus/ Menstrual cycle. Brief introduction to female & male infertility (causes and diagnosis).

Unit III

Biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions. Stress & Adrenal. Phytohormones: Introduction to plant growth regulators. Auxins, Gibberlins, Cytokinins. Ethylene: A volatile hormone, Triacontanol, Brassins, Polyamines and Absicisic acid, its role and function. Environment & Hormonal control of flowering in plants.

Unit IV

Historical perspectives of enzyme. Isolation, crystallization and purification of enzymes, Methods of enzyme analysis. Enzyme technology: Methods for large scale production of enzymes. Immobilized and soluble enzymes and their application. Artificial enzyme. Enzyme electrodes, Enzyme reactors. Two substrate reactions: Random ordered and ping pong mechanism.

Unit V

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: nucleophillic and covalent. Mechanism of reactions catalyzed by enzymes. Specific examples: chymotrypsin, lysozyme, ribonuclease and carboxypeptidase. Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Concerted and sequential models. Isozymes special reference to lactate dehydrogenase. Ribozymes.

Suggested Reading and Text Books

1. Endocrinology, Mac E. Hadley: Prentice-Hall International Sixth ed. 2009.
2. Basic and Clinical Endocrinology, F.S. Greenspan & P.H. Forsham: Maruzen Asian 3rd Ed. Lange Medical Publ. USA, Singapore
3. Williams Textbook of Endocrinology, Wilson Foster(2024), 15th Ed..Saunders Inter. ed. London.
4. Essential Endocrinology John F. Laycock Peter H. Wise: 3rd Edition 1996
5. Lodish et al. Molecular Cell Biology 9th Edition (2021)
6. Ross & Stanbury: Plant Physiology 4th Edition (1992)
7. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of general character of endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1 Remember
CO2	**Perceive** the specific and basic concepts and applications of endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2,3,4 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in endocrine and enzymology, mechanism of hormone action: Signal discrimination, signal transduction, biosynthesis, control of secretion & physiological actions of amino acid derived hormones, biosynthesis and control of secretion of adreno corticoids & catecholamines & their physiological actions, Historical perspectives of enzyme, enzyme technology and mechanism of enzyme action.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	3	3	3	3	2	3	2	3	2	2	2	2	2
CO3	3	2	2	2	2	3	3	3	3	2	3	3	3	2	2	3
CO4	3	3	2	3	3	2	2	2	3	1	3	2	3	3	3	3
CO5	2	3	3	3	3	3	3	2	3	2	2	3	3	3	3	3
CO6	1	2	2	2	1	1	1	1	3	2	2	1	1	1	1	1

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDE 806a**
Course Name	**: Lab Course based on BBTDE 805a**
Semester	**: VIII**

L	T	P	C
0	0	1	1

1. To provide the basic knowledge of endocrinology and their molecular aspects.
2. To provide the basic knowledge of endocrine glands, functions and their molecular aspects.
3. To provide the basic knowledge circulation of hormones.
4. To instill the concept and fundamentals hormonal regulations.
5. To instill the concept and fundamentals hormonal disorders.
6. To provide exposure to students about mechanism of action of hormones.
7. To provide the basic knowledge about enzymatic reactions and factors effecting it.

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDE 805b**
Course Name	**: Biomaths, Biostats, Computer Programming & Application**
Semester	**: VIII**

L	T	P	C
3	0	0	3

Course Objectives: The objectives of this course are

1. To learn to define and find the solution of arithmetic mean, median and mode, Quartiles, deciles and percentiles.
2. To demonstrate knowledge of chi square test, t-test, distributions, correlation and regression.
3. To develop the concepts of moments, skewness and kurtosis and determining whether the given distribution is normal or not.
4. To understand and illustrate the theory and applications of the probability.
5. To demonstrate computer programming and components of a computer system.

Unit I

Relation of Life Science with mathematics, Linear function concept, 0.5 coordinate system, trigonometry relations, differentiation & integration concept, logarithms, complex numbers, Plotting of graphs, matrices.

Unit II

Importance of statistics in biomedical research. Mean, Mode, median, range, mean deviation, standard deviation, standard error, skewness & kurtosis. Correlation & Regression. Probability: Theorems, Addition rules, multiplication rules, probability applications, probability distributions- Binomial, Poisson & Normal Distributions.

Unit III

Chi square test-characteristics of Chi square test, validity of Chi square test, applications of Chi square test. Test for significance- comparison of means of two samples, comparison of means of three or more samples (f-test, t-test).

Unit IV

Need for computer language, reading C Programs, Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units). Data storage device, Memory concepts. Software and types of software. Applications of common packages, Microsoft Office: Microsoft word, Microsoft excel, Microsoft Power Point.

Suggested Reading and Text Books

1. Rajaraman V: Computer Programming in "C". PHI 2nd Edition (2010).
2. Yashwant Kanetker: Let us "C" BPB 19th Edition (2023).
3. Peter Norton's: Introduction to Computer.
4. Hoel, P.G: Elementary Statistics John Wiley & Sons, Inc. New York.
5. Mahajan: Methods in Biostatistics (10^{th} ed.) Jaypee Bros. 2024.
6. Sokal & Rohlf: Introduction to Biostatistics, Freeman, Toppan, 1993.
7. D. Rajaraman & V. Rajaraman: Computer primer (2^{nd} ed.) Prentice Hall of India, New Delhi.
8.Roger Hunt & John Shelley: Computer and Commonsense Prentice Hall of India, New Delhi.
9.Norton, Peter: Introduction to Computers (2^{nd} ed.), TMH Publishing Company Ltd., New Delhi.
10. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the different basic concepts of introduction to general character and concepts of biostatistics, Biomaths and computer applications: Relation of Life Science with mathematics, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences. Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units).	1 Remember
CO2	**Perceive** the specific and basic concepts of measurement of biostatistics, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences. Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units).	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of biostatical analysis, Types of Data, Measures biostatical analysis, Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units), Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to measurement of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the measurement of biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences.	1,2,3,4,5 Remember, Understand, Apply, Analyze,
CO6	**Constructing** the take part in biostatical analysis, Types of Data, Measures biostatical analysis, Probability classical & axiomatic definition of probability, distributions, sampling, analysis of variance, Correlation and Regression. Emphasis on examples from Biological Sciences. Introduction to Computers: Mini, micro, mainframe and super computers. Components of a computer system (CPU, I/O units).	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	2	2	2	2	2	2	3	2	3	3	3	3
CO3	2	3	2	2	3	3	3	2	3	2	2	2	2	2	2	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

B. Sc. (Hons.) Biotechnology

Course code	**: BBTDE 806b**
Course Name	**: Lab Course based on BBTDE 805b**
Semester	**: VIII**

L	T	P	C
0	0	1	1

1. To instill the concept and fundamentals about the classification of enzymes.
2. To provide exposure to students about mechanism of enzyme actions and industrial use of enzyme.
3. To learn to define and find the solution of arithmetic mean, median and mode, Quartiles, deciles and percentiles.
4. To demonstrate knowledge of chi square test, t-test, distributions, correlation and regression.
5. To develop the concepts of moments, skewness and kurtosis and determining whether the given distribution is normal or not.
6. To understand and illustrate the theory and applications of the probability.
7. To demonstrate computer programming and components of a computer system.

B. Sc. (Hons.) Biotechnology

Course code	**: BBTGE 807**
Course Name	**: Epigenetics and Cancer Biology**
Semester	**: VIII**

L	T	P	C
4	0	0	4

Course Objectives: The objectives of this course are

1. To provide the basic knowledge of cancer biology and their molecular aspects.
2. To provide the basic knowledge of morphological and ultrastructural properties of cancerous cells.
3. To provide the basic knowledge about cancer biology, cancer biochemistry mode of infection of cancerous cells, possible treatments and preventions.
4. To instill the concept and fundamentals about the classification of carcinogenesis and therapies of cancer.

Unit I

Introduction, growth characteristics of cancers cells; Morphological and ultrastructural properties of cancer cells. Types of growth: hyperplasia, dysplasia, anaplasia and neoplasia. Nomenclature of neoplasms.

Unit II

Differences between benign and malignant tumors. Epidemiology of cancer. Cancer biology and biochemistry.

Unit III

Carcinogenesis- radiation and chemical carcinogenesis- stages in chemical carcinogenesis- Initiation, promotion and progression. Free radicals, antioxidants in cancer; Viral carcinogenesis -DNA and RNA Viruses. Hormone mediated carcinogenesis in humans.

Unit IV

Cell Cycle Regulation-Tumor suppressor genes p53, p21, Rb, BRACA1 and BRACA2. Apoptosis in cancer-Cell death by apoptosis, role of caspases; Death signaling pathways-mitochondrial and death receptor pathways. Detection of Cancers, Different forms of therapy.

Suggested Reading and Text Books

1. The Biological Basis of Cancer: R. G. McKinnell, et al 2nd Ed, Cambridge University Press, 2006.
2. The Biology of Cancer: R. A. Weinberg.2nd Ed Garland Science. 2013.
3. The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication 2nd Ed 2013
4. Virology a practical approach, Maly B.W.J. IRL Press, Oxford, 1987.
5. Introduction to modern Virology, Dunmock N.J and Primrose.S.B., Blackwel Scientific Publications. Oxford, 1988.
6. An Introduction to Cellular & Molecular Biology of Cancer, Oxford Medical publications, 1991.
7. Gene expression systems. Joseph M. Fernandez & James P. Hoeffler. Academic Press, 1999.
8. Cancer Biology IV Ed Volume2 Raymond W Ruddon M.D. 4th Edition (2007).
9. Cancer Biology (3rd_Edition) Roger J.B. et al (2006).
10. Latest Research Publications

Course Outcomes (COs): On completion of this course, the students will be:

CO	Description	Bloom's Taxonomy Level
CO1	**Reminisce** the basic concepts of Epigenetics and cancer Biology: Introduction, growth characteristics of cancers cells, cancer biology and biochemistry, carcinogenesis- radiation and chemical carcinogenesis, cell cycle regulation-tumor suppressor genes, apoptosis in cancer, detection of cancers, therapy, and immuno therapy and identification of targets for drug development.	1 Remember
CO2	**Perceive** the specific and basic concepts and applications of Remember the basic concepts of Epigenetics and cancer Biology: Introduction, growth characteristics of cancers cells, cancer biology and biochemistry, carcinogenesis- radiation and chemical carcinogenesis, cell cycle regulation-tumor suppressor genes, apoptosis in cancer, detection of cancers, therapy, and immuno therapy and identification of targets for drug development.	1,2 Remember, Understand
CO3	**Demonstrating** the detailed processes and features of Epigenetics and cancer Biology: Introduction, growth characteristics of cancers cells, cancer biology and biochemistry, carcinogenesis- radiation and chemical carcinogenesis, cell cycle regulation-tumor suppressor genes, apoptosis in cancer, detection of cancers, therapy, and immuno therapy and identification of targets for drug development.	1,2,3 Remember, Understand, Apply
CO4	**Examine** the detailed study related to Epigenetics and cancer Biology: Introduction, growth characteristics of cancers cells, cancer biology and biochemistry, carcinogenesis- radiation and chemical carcinogenesis, cell cycle regulation-tumor suppressor genes, apoptosis in cancer, detection of cancers, therapy, and immuno therapy and identification of targets for drug development.	1,2,3,4 Remember, Understand, Apply, Analyze
CO5	**Assess** the Epigenetics and cancer Biology: Introduction, carcinogenesis- radiation and chemical carcinogenesis, cell cycle regulation-tumor suppressor genes, apoptosis in cancer, detection of cancers, therapy, and immuno therapy and identification of targets for drug development, growth characteristics of cancers cells, cancer biology and biochemistry.	1,2,3,4,5 Remember, Understand, Apply, Analyze, Evaluate
CO6	**Constructing** the take part in Epigenetics and cancer Biology: Introduction, growth characteristics of cancers cells, cancer biology and biochemistry, carcinogenesis- radiation and chemical carcinogenesis, cell cycle regulation-tumor suppressor genes, apoptosis in cancer, detection of cancers, therapy, and immuno therapy and identification of targets for drug development. Hormone mediated carcinogenesis in humans.	1,2,3,4,5,6 Remember, Understand, Apply, Analyze, Evaluate, Create

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	3	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	3	3	3	3	2	3	2	3	2	2	2	2	2
CO3	3	2	2	2	2	3	3	3	3	2	3	3	3	2	2	3
CO4	3	3	2	3	3	2	2	2	3	1	3	2	3	3	3	3
CO5	2	3	3	3	3	3	3	2	3	2	2	3	3	3	3	3
CO6	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

B. Sc. Biotechnology

Course code	**: BBTPR 808**
Course Name	**: Project Report IV**
Semester	**: VIII**

L	T	P	C
0	0	0	6

Course Objectives: The objectives of this course are

1. To make the students industry, university and research institute deployable.
2. To provide an opportunity to students to gain practical knowledge.
5. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/ under the guidance of faculty member/supervisor from industry/research organizations or submit an educational tour report by the guidance of internal supervisor. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings: NA

Course Outcome:

CO1.	Remembering and demonstrate analytical, practical training and understand the scope and importance of Biotechnology through exposure.
CO2.	**Understand** the specific and basic concepts interpretation and organization of data.
CO3.	**Applying** the detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO4.	**Analyzing** the detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO5.	**Evaluating** the detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.
CO6.	**Constructing** the take part in detailed study related to detailed processes and features of develop thesis writing skills and Project/Educational Tour Report.

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	2	2	2	3	2	2	2	2	2	3	2	2
CO2	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	3	2	3	2	2	2	2	3
CO4	2	3	2	3	3	2	2	2	2	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	2
CO6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

3: High, 2: Medium, 1: Low

Degree Course in Honors Biotechnology with Research

Course code	**: BBTDC 701**
Course Name	**: Research Methodology**
Semester	**: VII**

L	T	P	C
4	0	0	4

Course Objectives: The objectives of this course are

1. To introduce with meaning, functions of research and research process.
2. To highlights the various postulates of research problems, research Design, interpretation and report writing.
3. To expose the student to concepts of measure of central tendency and variation and their application to analyze the statistical data.
4. To acquire the knowledge of correlation, regression, data analysis and hypothesis testing using suitable test of statistical significance.

UNIT-I: Meaning &Functions of Research

Meaning of Research, Characteristics of Research, Steps involved in Research, Research in Pure and Applied Sciences, Inter Disciplinary Research, Trans disciplinary research, Significance of Research, Research and scientific methods, Research Process, Criteria of good Research, Problems encountered by Researchers, Literature review.

UNIT –II: Research Problem and Research Design

Selecting the Research problem, Necessity of defining the problem, Goals and Criteria for identifying problems for research, Perception of Research problem, Formulation of Research design, Need for Research design, Features of good design, Basic principles of experimental designs, Computer and internet in designs.

UNIT- III: Interpretation and Report Writing

Meaning and Technique of interpretation, Precautions in interpretation, Significance of report writing, Different steps in writing a report, Layout of a Research report, Types of report, Mechanics of writing a research report, Precautions for writing a research report

UNIT-IV: Statistical Techniques and Tools -I

Introduction of statistics, frequency distribution, Graphical representation of data, Measures of central tendency, Mean, Median, Mode, Standard deviation, Co-efficient of variation, Probability & distribution.

Statistical Techniques and Tools –II: Correlation, coefficient of correlation, Scatter diagram, Regression, Sampling distribution, Standard error, Hypothesis testing, Level of significance, Degree of freedom, Chi Square, T-test, Analysis of variance (ANOVA)

Suggested readings:

1. KothariC.R., Research Methodology Methods & Techniques 5th Edition2023,New Age international Publishers.
2. GuptaG. and GuptaM., Research Methodology 2011, PHI Learning Private Ltd.
3. GuptaS.C. and Kapoor V.K., Fundamentals of Mathematical statistics, 12th Edition 2020 , Sultan Chand & Sons, New Delhi.
4. Latest Research Publications

Course Outcome

CO1.	Developed understanding on various kind of research, objectives of doing research, researchprocess and research design.
CO2.	Demonstrate the ability to choose methods appropriate to research aims and objectives.
CO3.	Obtain skills to analyze data and draw reasonable interpretations as well as communicate research findings in a clear and well-organized way.
CO4.	**Analyzing** the detailed and complete study related to of Statistical tools and techniques to carry out data analysis and hypothesis testing using suitable test of statistical significance.
CO5.	**Evaluating** the properties of mechanism of research methodology
CO6.	**Constructing** the research methodology

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	3	3	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	3	3	2	2	2	2	2	2	3	2	3	3	3	3
CO3	2	3	2	2	3	3	3	2	3	2	2	2	2	2	2	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

Course code	**: BBTDC 702**
Course Name	**: Research Publication and Ethics**
Semester	**: VII**

L	T	P	C
4	0	0	4

Course Objectives: The objectives of this course are

Its objectives to provide knowledge about quality and ethics publication with concept of plagiarism.

UNIT-I: Meaning &Functions of Research

Philosophy: Definition, introduction of concept, branches of Philosophy, Introduction of Metaphysics, Epistemology, Ethics/ Moral, Political and Aesthetics Philosophy

Moral philosophy, nature of moral judgments and reactions.

UNIT –II: Research Problem and Research Design

Ethics: Definition with respect to science and research, Intellectual honesty and research integrity

Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data

UNIT- III: Interpretation and Report Writing

Publication ethics: Definition, introduction and importance, Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: Definition, concept, Introduction about authorship and contributorship, Violation of Publication Ethics, Identification of publication, complaints and appeals

UNIT-IV: Statistical Techniques and Tools -I

Introduction about Journals & Publishers, Predatory publishers and journals, Quality of Journals & Publication, Introduction about Scopus/SCI, eSCI/Web of Science Indexing (Scopus.com) etc., Software tool to identify predatory publications developed by SPPU Plagiarism tools , Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal Suggester, etc.

Suggested readings:

1. Dutta, Sumanta, Research and Publication Ethics 3rd Edition 2021, Bharti Publications.
2. Yadav S.K., Research and Publication Ethics 2023, Anne Publications.
3. Latest Research Publications

Course Outcome

CO1.	**Reminisce** the basics of philosophy of science with research ethics.
CO2.	**Perceive** Familiarize with important issues in research ethics, integrity & scientific misconduct.
CO3.	**Demonstrating** the best practices for publications, publication ethics and identify the
CO4.	**Examine** the detailed and complete study related to the use plagiarism software tools, citation tabases and research metrics.
CO5.	**Assess** the properties of mechanism of Research Publication and Ethics.
CO6.	**Constructing** the Research Publication and Ethics.

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1	2	1	3	3	2	2	3	1	1	1	1	3	2	2
CO2	1	1	1	3	2	2	2	2	2	2	2	2	3	3	3	3
CO3	2	2	2	2	1	3	1	2	3	2	2	2	2	2	2	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3: High, 2: Medium, 1: Low

Course code	**: BBTRM 703**
Course Name	**: Review of literature/ Minor Project**
Semester	**: VII**

L	T	P	C
0	0	0	9

Course Objectives: The objectives of this course are

1. The intention of this course is to expose the student to new dimensions of research & development.
2. The course enhances different aspects of scientific reading and writing.
3. The course also ensures the student to learn practical based scientific skills.

In the beginning of 4th year (7th semester), students are required to undertake review of literature as a part of their minor project. Its progress will be assessed at the end of 7th semester. Title of the project work may be extended in the 8th semester as a major project. At the end of the 8th semester the dissertation is to be submitted in the department. If a student opts to carry out his/her project (major/minor) from industry or research organization/Institute then he/she may be allowed for the same but the dissertation copy is to be submitted in the department and the internal supervisor will be required from the university

Suggested readings:

1. Dutta, Sumanta, Research and Publication Ethics 3rd Edition 2022, Bharti Publications.
2. Yadav S.K., Research and Publication Ethics 2023, Anne Publications
3. Latest Research Publications

Course Outcome.

CO1.	**Reminisce** the Enhance his/her presentation skills in a creative manner
CO2.	**Perceive** the Enhancing thinking skills and create innovative new products
CO3.	**Demonstrating** the Develop qualities like perseverance, curiosity and self-confidence
CO4.	**Examine** the detailed and complete study related to grade up their problem-solving ability
CO5.	**Assess** the properties of mechanism of Review of literature/ Minor Project.
CO6.	**Constructing** the Review of literature/ Minor Project.

Mapping of COs with POs & PSOs

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	1	3	3	2	2	3	1	1	1	1	3	2	2
CO2	1	1	1	3	2	2	2	2	2	2	2	2	3	3	3	3
CO3	2	2	2	2	1	3	1	2	3	2	2	2	2	2	2	3
CO4	2	3	2	3	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	1	1	1	1	1	1	1	1	1	1	3	3	1	1	1	1

3: High, 2: Medium, 1: Low

Course code	**: BBTRS 704**
Course Name	**: Research Seminar Presentation-I**
Semester	**: VII**

L	T	P	C
0	0	0	5

Course Objectives: The objectives of this course are

1. To demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities.
2. To exhibit good communication and presentation skills.
3. To acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc.

Each student has to participate in any one of the following mentioned academic activity. A power point presentation will be presented by each student pertaining to the activity in which the student has participated. A hard copy of the presentation will be submitted in the department. Evaluation will be done based upon the presentation and report submitted.

Activities:

(i) Participation in seminar / conference / workshop

Poster presentation/ oral presentation in any other academic event (beside seminar / conference) organized by departmental clubs / College / University / research institute.

Suggested Readings: NA

Course Outcome.

CO1.	**Reminisce the** Demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities
CO2.	**Perceive** the Exhibit good communication and presentation skills
CO3.	**Demonstrating** the Acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc
CO4.	**Examine** the detailed and complete study related to Research Seminar Presentation.
CO5.	**Assess** the properties of mechanism of Research Seminar Presentation.
CO6.	**Constructing** the Research Seminar Presentation.

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	1	1	1	3	3	2	2	3	1	1	1	1	3	2	2
CO2	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1
CO3	2	2	2	2	1	1	1	2	3	2	2	2	2	2	2	3
CO4	2	1	2	1	1	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	1	1	1	1	1	1	1	1	1	1	3	3	1	1	1	1

3: High, 2: Medium, 1: Low

Course code	**: BBTDC 801**
Course Name	**: Research-IPR**
Semester	**: VIII**

L	T	P	C
4	0	0	4

Course Objectives: The objectives of this course are

1. To explain about Intellectual Property and Copyrights
2. To explain about software patents and their importance.
3. To gain knowledge about trade marks
4. To layout design of integrated circuits and Industrial Designs
5. To Illustrate layout design and Different International Agreements

UNIT-I:

Introduction to Intellectual Property: Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights: Introduction, how to obtain, Differences from Patents.

UNIT –II:

Trade Marks: Introduction, how to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

UNIT- III:

Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.

Industrial Designs: Definition, how to obtain, features, international design registration.

Layout design of integrated circuits: Circuit Boards, Integrated Chips, Importance for electronic industry.

UNIT-IV:

Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. Word Trade Organization (WTO): (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade related Services (GATS), (iii) Madrid Protocol (iv) Berne Convention, (v) Budapest Treaty (b) Paris Convention WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity IP Infringement issue and enforcement-Role of Judiciary, Role of law enforcement Agencies-Police, Customs etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.

Suggested Readings:

1. Acharya, N.K.: Textbook on intellectual property rights, Asia Law House.
2. Guru, M,&Rao, M.B., Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications.
3. Ganguli, P., Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
4. Miller,A, R,Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers.
5. Watal, J., Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford
6. Latest Research Publications

Course Outcome:

CO1.	Acquire knowledge about Intellectual property rights, copyrights, trademarks and patents.

CO2.	Appraise about geographical indications, industrial designs, trade secrets and different international agreements including Paris convention, Budapest treaty etc
CO3.	Analyse layout designs of integrated circuits, risks involved in trade secret protection, international design registration, rules for registration of geographical indications etc.
CO4.	**Examine** the detailed and complete study related to Research-IPR. Assess introduction and historical perspectives of trade secrets, working of WTO, Madrid protocol, different type of IPs, trademarks, copyrights etc.
CO5.	**Assess** the properties of mechanism of Research-IPR.
CO6.	**Constructing** the Research-IPR.

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	3	3	2	2	3	1	1	1	1	3	2	2
CO2	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1
CO3	2	2	2	2	1	1	1	2	3	2	2	2	2	2	2	3
CO4	2	2	2	2	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	1	1	2	2	2	2	2	2	1	1	3	3	1	1	1	1

3: High, 2: Medium, 1: Low

Course code	**: BBTDI 802**
Course Name	**: Major Project/ Internship**
Semester	**: VIII**

L	T	P	C
0	0	0	13

Course Objectives: The objectives of this course are

6. To make the students industry deployable.
7. To provide an opportunity to students to gain practical knowledge.
8. To provide an opportunity to pursue higher education in reputed organization across the globe.

Every student must enroll for project/dissertation under the guidance of faculty member/supervisor from industry/research organizations. Students will have to submit project work and will be evaluated at the end of the semester followed by presentation and viva. The thesis will be evaluated internally by a panel of examiner.

Suggested Readings: NA

Course Outcome:

CO1.	Demonstrate analytical and practical training.
CO2.	Interpretation and organization of data
CO3.	Develop thesis writing skills.
CO4.	**Examine** the detailed and complete study related to Major Project/ Internship.
CO5.	**Assess** the properties of mechanism of Major Project/ Internship.
CO6.	**Constructing** the Major Project/ Internship.

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	3	3	2	2	3	1	1	1	1	3	2	2
CO2	1	1	1	1	2	2	2	2	2	2	2	2	1	1	1	1
CO3	2	2	2	2	1	1	1	2	3	2	2	2	2	2	2	3
CO4	2	2	2	2	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	1	1	2	2	2	2	2	2	1	1	3	3	1	1	1	1

3: High, 2: Medium, 1: Low

Course code	**: BBTRS 803**
Course Name	**: Research Seminar Presentation-II**
Semester	**: VIII**

L	T	P	C
0	0	0	5

Course Objectives: The objectives of this course are:

1. To demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities.
2. To exhibit good communication and presentation skills.
3. To acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc.

Each student has to participate in any one of the following mentioned academic activity. A power point presentation will be presented by each student pertaining to the activity in which the student has participated. A hard copy of the presentation will be submitted in the department. Evaluation will be done based upon the presentation and report submitted.

Activities:

(i) Participation in seminar / conference / workshop

(ii) Poster presentation/ oral presentation in any other academic event (beside seminar / conference) organized by departmental clubs / College / University / research institute.

OR

If student opts internship, it is compulsory to complete 4 weeks internship between 7^{th} and 8^{th} semester in any industry/ research institute/ various agencies/ other organizations and to submit internship report in department will be evaluate in department through presentation and internship report.

Suggested Readings: NA

Course Outcome:

CO1.	Demonstrate technical skills for effective preparation of presentations, write-ups through participant in academic and extracurricular activities.
CO2.	Exhibit good communication and presentation skills.
CO3.	Acquire critical thinking ability to analyze and interpret observations, recent scientific developments, etc.
CO4.	**Examine** the detailed and complete study related to Major Project/ Research Seminar Presentation.
CO5.	**Assess** the properties of mechanism of Major Project/ Major Project/ Research Seminar Presentation.
CO6.	**Constructing** the Major Project/ Major Project/ Research Seminar Presentation.

Mapping of COs with POs & PSOs

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	3	3	2	2	3	1	1	1	1	3	2	2
CO2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1
CO3	2	2	2	2	1	1	1	2	3	2	2	2	2	2	2	3
CO4	2	2	2	2	2	2	2	2	3	1	3	2	2	2	2	2
CO5	2	2	2	2	2	2	3	3	3	2	2	3	3	3	3	2
CO6	1	1	2	2	2	2	2	2	1	1	3	3	2	2	2	2

3: High, 2: Medium, 1: Low

Agenda No. 11. List of Examiner for Theory/Practical/Dissertation/Viva voce examinations:

Resolutions:

S. No.	Name of Examiner	Affiliating Institute/University
1.	Professor Dhruv Kumar	Professor & Cluster Head, Allied Health Sciences , School of Health Sciences & Technology (SoHST), UPES, Dehradun, Uttrakhand
2.	Professor Gulshan Kumar Dinghra	Department of Botany, Shri Dev Suman University, Rishikesh, Uttrakhand
3.	Professor Pravindra Kumar	Department of Biosciences and Bioengineering, Indian Institute of Technology, Roorkee- 247667, Uttarakhand
4.	Professor V. K. Bajaj	Department of Biotechnology, Jammu University, J&K
5.	Professor Rahul Kumar	Department of Plant Breeding and Genetics, Meerut University, Meerut -250004, Uttar Pradesh
6.	Professor Gaurav Sharma	Department of Biotechnology, Suresh Gyan Vihar University, Jaipur-333031, Rajasthan
7.	Dr. Sujeet Kumar	Department of Biotechnology, Amity University, Lucknow-226010, Uttar Pradesh
8.	Dr. Mamta Arya	Department of Biotechnology, Hemvati Nandan Bahuguna University, Garhwal-246174, Uttarakhand
9.	Dr. Kumud Bala	Department of Medical Biotechnology, Amity University, Noida-201303, Uttar Pradesh
10.	Dr. Pooja Saklani	Department of Biotechnology, Hemvati Nandan Bahuguna University, Garhwal-246174, Uttarakhand
11.	Dr. Poonam Choudhary	Department of Biosciences and Bioengineering, Indian Institute of Technology, Roorkee- 247667, Uttarakhand
12.	Professor Harsh Vardhan Pant	Department of Chemistry, Shri Guru Ram Rai (PG) College, Dehradun- 248001, Uttarakhand
13.	ProfessorDeepshikhaPandeKatare	Department of Medical Biotechnology, Amity University, Noida-201303, Uttar Pradesh
14.	Dr. Indra Rautela	Department of Biotechnology, Uttaranchal University, Dehradun-248007, Uttarakhand
15.	Dr. Nidhi Belwal	Department of Microbiology, Sardar BhagwanSsingh University, Dehradun-248161, Uttarakhand
16.	Professor Anuja Pandey	School of Pharmaceutical Sciences, Himgiri, Zee University, Dehradun-248011, Uttarakhand
17.	Dr. Pankaj Kumar Assistant Professor	Department of Microbiology, Hemvati Nandan Bahuguna University, Garhwal-246174, Uttarakhand
18.	Dr. Neha Kapoor	Department of Biotechnology, Suresh Gyan Vihar University, Jaipur-333031, Rajasthan

*No of Examiner may be increase or decrease as per University Norms