DEPARTMENY OF BIOTECHNOLOGY

PARTICULARS

CBCS ENABLED SYLLABUS

For B.Sc.-M.Sc. Dual Degree Programme in Biotechnology

SYLLABUS FOR B.SC.-M.SC. DUAL DEGREE IN BIOTECHNOLOGY

Choice Based Credit System (CBCS)

Approval Date: 1st March, 2017

(22nd BoS Meeting)

DEPARTMENT OF BIOTECHNOLOGY

JAMIA HAMDARD

Deemed to be University

Accredited in 'A' Grade by NAAC

Declared to be designated as Institute of Eminence (IoE) by MHRD, GOI

New Delhi 110 062

www.jamiahamdard.edu

PROGRAMME NAME: B.Sc.-M.Sc. DUAL DEGREE
PROGRAMME CODE: 336
ACADEMIC SESSION OF INTRODUCTION OF THE PROGRAMME: (2021-2022)
SCHOOL NAME: SCLS
DEPARTMENT NAME: DEPARTMENT OF BIOTECHNOLOGY

APPROVAL DATE OF THE BOARD OF STUDIES (B.O.S) MEETING FOR THE PRESENT SYLLABUS

1st March 2017 (22nd BOARD OF STUDIES)

APPROVAL DATE AND NUMBER OF ACADEMIC COUNCIL OF MEETING FOR THE PRESENT SYLLABUS

2017

VISION:

The Department of Biotechnology at Jamia Hamdard, New Delhi was established in the year 1997 with a vision to be recognized as a Department of International repute with a strong interdisciplinary research and teaching base in Plant and Animal Biotechnology with active collaboration of industries and health-care institutions.

MISSION STATEMENTS:

MS1: To create opportunities for multi-disciplinary education, training and research in biotechnology.

MS2: To provide Biotechnology Educational Program with impetus to generate quality workforce.

MS3: To create awareness about potentials of Biotechnology with socio-ethical implications.

MS4: To instil spirit of innovation and creativity in young minds with sound research aptitude.

MS5: To nurture confident individuals who are effective contributors towards growth of the nation.

MS6: To establish industry academia partnership and partnership with health care institutions for health and industry-oriented research.

MS7: To provide in depth knowledge and practical exposure to students, so that they should qualify national exams and go for higher training in National/International laboratories.

QUALIFICATION DESCRIPTORS (QD's) B.Sc.-M.Sc. Dual Degree PROGRAMME IN BIOTECHNOLOGY

After completion of this academic program, the students will be able to:	
QD 1	Illustrate substantial skills to acquire knowledge and decipher experimental and theoretical aspects in specific fields of Biotechnology like Plant and Animal Biotechnology, Genetic engineering, Molecular Biology, Microbiology, Environmental Biotechnology and Immunology etc.
QD 2	Utilize knowledge and skills to recognize problems and challenges, collect relevant scientific data, analyse and evaluate data using methodologies appropriate to the subject(s), offer evidence-based solutions and effectively communicate that data to stakeholders.
QD 3	Apply subject knowledge and transferable skills in areas such as Molecular Biology, Transgenic technology, Plant and Animal Biotechnology, and Pharmaceutical Biotechnology to translational use in industry and field settings.
QD 4	Understand and execute effectively their societal roles as biotechnology professionals, employers and employees in various industries and academic institutes.
QD 5	Comprehend the Biotechnological developments and other scientific advancements and introspect their use in relation to human health and daily affairs.

Mapping of Course Qualification Descriptors (QDs) with Mission Statements (MS)

3, Substantial Correlation (75%-100); 2, Moderate Correlation (60-75%); 1, Low correlation (40-60%)

	MS 1	MS 2	MS 3	MS 4	MS 5	MS 6	MS 7
QD 1	3	3	2	3	2	2	3
QD 2	2	2	2	3	3	2	3
QD 3	3	2	2	2	2	3	3
QD 4	2	3	3	3	3	3	2
QD 5	1	1	3	3	3	3	1

PROGRAMME LEARNING OUTCOMES (PLO) of B.Sc.-M.Sc. Dual Degree PROGRAMME IN BIOTECHNOLOGY

At the end of the programme, students will be able to	
PLO 1	Propose logical and novel solutions to contemporary problems/issues supported by relevant facts and data.
PLO 2	Develop scientific outlook and the ability to question the existence and relevance of universally accepted scientific concepts in all aspects of life.
PLO 3	Identify, formulate and analyse complex scientific problems using principles of natural and applied sciences.
PLO 4	Comprehend concepts, frameworks and inventions through various learning methods and effectively communicate the same orally or in writing to the stakeholders.
PLO 5	Critically analyse the given scientific data, ascribe meaning to it and draw objective conclusions.
PLO 6	Demonstrate empathetic social concern, skills to effectively participate in civic affairs and democratic decision making.
PLO 7	Imbibe ethical, moral and social values to become cultured and civilised global citizens.
PLO 8	Apply concepts of sustainable development in daily life to carve out a socially relevant and environment friendly living.
PLO 9	Foster and develop attitude and aptitude for acquisition of multidimensional skills by way of promoting lifelong learning.

Mapping of Qualification Descriptors (QDs) with Program Learning Outcomes (PLOs)

3, Substantial Correlation (75%-100); 2, Moderate Correlation (60-75%); 1, Low correlation (40-60%)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**
QD 1	1	3	2	3	3	3	1	3	2
QD 2	2	3	3	3	3	2	1	1	2
QD 3	3	1	2	2	3	3	1	3	1
QD 4	1	2	1	2	3	3	3	2	1
QD 5	3	3	3	3	3	1	1	3	2

PROGRAM SPECIFIC OUTCOME (PSO) of B.Sc.-M.Sc. Dual Degree PROGRAMME IN BIOTECHNOLOGY

PSO1: To provide students with basic concepts of interdisciplinary biotechnology courses for better comprehension and bring their inclination towards research approaches for their career in the field of biotechnology.

PSO2: The practical courses will help to impart in-depth practical oriented knowledge along with hands on training to students in various thrust areas of biotechnology to meet the academia and industry demands of our country.

PSO3: The students will be taught about interdisciplinary biotechnology courses to impart an ability among students to apply various biotechnological skills (including, cell biology, immunology, molecular biology, micro biology, recombinant DNA technology, bioinformatics, genetic engineering, bioprocess and fermentation and food technology) and its applications in industries and human welfare.

PSO4: Students will be apprised with the complex problems of health and agricultural sector and encouraged to address through use of biotechnology.

PSO5: Students will also learn about IPR and entrepreneurship and will be encouraged for Start-Up's and research incubator set ups to support Atmanirbhar Bharat and Start-Up India schemes of Government.

DEPARTMENT OF BIOTECHNOLOGY
SCHEME AND COURSE STRUCTURE
B.Sc. – M.Sc. Dual Degree Program

Course Code	Name of the Paper	Paper Category	IA	SE	Total Marks	Course Credits
SEMESTER–I						
BBT-CC01 TH	Basics of Computer Science and Statistics	Core	25	75	100	4
BBT-CC01 TU	Basics of Computer Science and Statistics	Core	20	30	50	2
BBT-CC02 TH	Basics of Chemistry	Core	25	75	100	4
BBT-AEC01 TH	English Communication	AEC	13	37	50	2
BBT-AEC02 TH	Environmental Studies	AEC	13	37	50	2
BBT-GE01A TH BBT-GE01B TH	Basics of Physics and Biology OR Basics of Physics and Mathematics	GE	25	75	100	4
BBT-GE01A TU BBT-GE01B TU	Basics of Physics and Biology OR Basics of Physics and Mathematics	GE	20	30	50	2
		Total				**20**
For PCM stream students: BBT-GE01A **For PCB stream students: BBT-GE01B**						
SEMESTER–II						
BBT-CC03 TH	Biomolecules	Core	25	75	100	4
BBT-CC04 TH	Cell Biology	Core	25	75	100	4
BBT-CC05 TH	Immunology	Core	25	75	100	4
BBT-CC06 TH	Enzymes and Proteins	Core	25	75	100	4
BBT-GE02A TH BBT-GE02B TH	Bioethics and IPR OR Biotechnology and Human Welfare	GE	25	75	100	4
					Total	**20**
SEMESTER–III						
BBT-CC07 TH	Genetics	Core	25	75	100	4
BBT-CC08 TH	Microbiology	Core	25	75	100	4
BBT-CC09 TH	Molecular Biology	Core	25	75	100	4
BBT-CC10 TH	Plant Anatomy & Physiology	Core	25	75	100	4
BBT-CC11 TH	Bioprocess Technology	Core	25	75	100	4
BBT-SEC01 TH	Molecular Diagnostics	SEC	13	37	50	2
BBT-GE03 TH	Developmental Biology	GE	25	75	100	4
					Total	**26**
SEMESTER–IV						
BBT-CC02 P	Basics of Chemistry	Core	13	37	50	2
BBT-CC03 P	Biomolecules	Core	13	37	50	2
BBT-CC04 P	Cell Biology	Core	13	37	50	2
BBT-CC05 P	Immunology	Core	13	37	50	2
BBT-CC06 P	Enzymes and Proteins	Core	13	37	50	2
BBT-CC12 TH	Recombinant DNA Technology	Core	25	75	100	4
BBT-CC13 TH	Bio-Analytical Tools	Core	25	75	100	4
BBT-SEC02 TH	Basics of Forensic Science	SEC	13	37	50	2
BBT-GE04 TH	Introduction to Biological data analysis	GE	25	75	100	4
BBT-GE04 P	Introduction to Biological data analysis	GE	13	37	50	2
					Total	**26**

SEMESTER–V						
BBT-CC14 TH	Genomics and Proteomics	Core	25	75	100	4
BBT-CC14 P	Genomics and Proteomics	Core	13	37	50	2
BBT-DSE01 TH	Bioinformatics	DSE	25	75	100	4
BBT-DSE01 P	Bioinformatics	DSE	13	37	50	2
BBT-DSE02 TH	Animal Biotechnology	DSE	25	75	100	4
BBT-DSE02 P	Animal Biotechnology	DSE	13	37	50	2
BBT-DSE03 TH	Environmental Biotechnology	DSE	25	75	100	4
BBT-DSE03 P	Environmental Biotechnology	DSE	13	37	50	2
					Total	**24**
SEMESTER–VI						
BBT-CC07 P	Genetics	Core	13	37	50	2
BBT-CC08 P	Microbiology	Core	13	37	50	2
BBT-CC09 P	Molecular Biology	Core	13	37	50	2
BBT-CC10 P	Plant Anatomy & Physiology	Core	13	37	50	2
BBT-CC11 P	Bioprocess Technology	Core	13	37	50	2
BBT-CC12 P	Recombinant DNA Technology	Core	13	37	50	2
BBT-CC13 P	Bio-Analytical Tools	Core	13	37	50	2
BBT-GE02A P BBT-GE02B P	Bioethics and IPR OR Biotechnology and Human Welfare	GE	13	37	50	2
BBT-GE03 P	Developmental Biology	GE	13	37	50	2
BBT-DSE06 TH	Ecology and Environment Management	DSE	25	75	100	4
BBT-DSE06 P	Ecology and Environment Management	DSE	13	37	50	2
					Total	**24**

TH = Theory;
P = Practical;
TU = Tutorial
CC = Core Courses
AEC = Ability Enhancement Compulsory Courses
SEC = Skill Enhancement Courses
DSE = Discipline Specific Elective
GE = Generic Electives

Bye-laws for

B.Sc. (Honours) component of B.Sc.-M.Sc. Dual Degree Programme in Biotechnology
Programme Code: 336
Under

Choice Based Credit System
Effective from October 2021

Rules and Regulations of the Programme

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1. Programme of Study: B.Sc.-M.Sc. Dual Degree Programme

B.Sc.-M.Sc. Dual Degree Programme shall be offered in the following subjects

- Biochemistry
- Biotechnology
- Botany
- Chemistry
- Clinical Research
- Toxicology

The courses (papers) in the first two semesters will be the same across all the programmes of study in the school.

2. Programme Code: Each programme shall be denoted by three-digit code as follows

- Biochemistry
- Biotechnology 336
- Botany
- Chemistry
- Clinical Research
- Toxicology

3. Programme Abbreviation: Each course of the programme shall be given a course number which shall be preceded by a three-letter abbreviation identifying the discipline as follows

- Biochemistry
- Biotechnology BBT
- Botany
- Chemistry
- Clinical Research

- Toxicology

All these are regular full-time programmes.

4. Outline of CBCS Scheme

- **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
- **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures candidate's proficiency/skill is called an Elective Course.
- **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study and are referred to as Discipline Specific Elective.
- **Dissertation/Project**: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called Dissertation/Project.
- **Generic Elective (GE) Course**: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.
- **Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement Courses (AECs) are the courses based upon the content that lead to knowledge enhancement. They include Environmental Science and. English/MIL Communication which are mandatory for all disciplines.

The Core, Discipline Specific and Generic Elective Courses shall be abbreviated as follows:

Core Course	:	CC
Discipline Specific Elective	:	DSE
Generic Elective	:	GE
Ability Enhancement Courses	:	AEC
Skill Enhancement Courses	:	SEC

These abbreviations shall precede the course number of each course of the programme.
During an academic year, a candidate who is enrolled in the B.Sc.-M.Sc. Dual Degree Programme, shall not be allowed to enroll for any other full-time programme of study and shall not appear in any other examination of a full-time course of this or any other university.

5. Duration: Five years spread over 10 semesters

B.Sc.-M.Sc. Dual Degree Programme is a five-year full time academic program of study spread over 10 semesters. Every year, the new session commences in July. The session for the 10 semesters are as under.

Semester I	(1^{st} year)	August-December (Odd Semester)
Semester II	(1^{st} year)	January-May (Even Semester)
Semester III	(2^{nd} year)	August-December (Odd Semester)
Semester IV	(2^{nd} year)	January-May (Even Semester)
Semester V	(3^{rd} year)	August-December (Odd Semester)
Semester VI	(3^{rd} year)	January-May (Even Semester)
Semester VII	(4^{th} year)	August-December (Odd Semester)
Semester VIII	(4^{th} year)	January-May (Even Semester)

Semester IX	(5^{th} year)	August-December (Odd Semester)
Semester X	(5^{th} year)	January-May (Even Semester)

The number of working days in a semester shall not be less than 90 days.

The candidate will have the option to exit after 3 years with B.Sc. Hons degree in the chosen subject.

6. Medium of instruction and examination: English

7. Eligibility for admission

Eligibility: A candidate seeking admission to the BSc-MSc Dual Degree Programme must have passed Senior Secondary (12 / Intermediate) examination with Biology /Mathematics from CBSE or any other Board recognized by Jamia Hamdard (JH) as equivalent thereto, securing at least 50% marks or equivalent CGPA in aggregate.

Selection procedure: Selection will be based on merit of qualifying examination.

8. Course Structure

For B.Sc. Component

- The course, as approved by the Board of Studies of the respective Departments of the School and reviewed regularly, shall be divided into not less than 14 theory and practical core courses having 04 and 02 credits each. The course will have two ability enhancement courses of 2 credits each. The student will have to undertake two Skill enhancement elective courses of 02 credits each along with 04 discipline specific and 04 generic electives of 06 credits each in the first six semesters. Each discipline specific and generic elective will have 04 credits assigned to theory component and two credits to either tutorial or practical component.

- In Semester I and II there will be common courses in basic subjects like Physics, Mathematics, Statistics, Computer Science, Biology and Chemistry across all the programmes.

- A minimum of 02 credits and a maximum of 04 credits shall be assigned for each theory paper and 02 credits for each practical course. The lab work may also include a report or industrial visit.

- One theory credit will be counted as 1 hour of contact per week, and two practical credits will be counted as 4 hours of contact per week.

- There shall be no less than 20 credits and no more than 26 credits for each semester. This includes the lab work also.

- The contents of each theory course shall be divided into four units. All the units shall preferably have equal teaching hours

9. Attendance

- 100% attendance is desirable, but 75% attendance is mandatory in each paper for a student to enable him/her to appear in the Semester examination. In unforeseen contingencies, on the recommendation of the Dean of the School, 5% relaxation in attendance may be considered. This 5% shortage condoning may be on account of sickness, provided the medical certificate, duly certified by a Registered Medical Practitioner/Public Hospital had been submitted in the office of the Head of the Department at the time of re-joining the classes, immediately after the recovery from illness. The Head of Department shall forward such cases along with all related documents to the Dean. The relaxation should not be considered as the right of the student.

- In order to maintain the attendance record of a particular course, a roll call will be taken by the teacher in every scheduled lecture and practical class. For the purpose of attendance, each practical class will count as one attendance unit, irrespective of the number of contact hours. Attendance on account of participation in the prescribed and notified activities such as NCC, NSS, Inter-university sports, educational tours/field work, shall be granted provided the participation of the student is duly verified by the officer-in-charge and is sent to the Head of the Department within two weeks of the function/activity etc.

- The subject teacher shall consolidate the attendance record for lectures and practicals at the end of each month and submit to the Head of the Department. At the end of the semester, the teacher shall consolidate the attendance record for the whole semester and submit it to the Head of the Department. The statement of attendance of students shall be displayed by the Head of the Department on the Notice Board/University Website. A copy of the same shall be preserved as record. Attendance record displayed on the Notice Board/University Website shall deem to be a proper notification for the students and no individual notice shall be sent to any student.

- If a student is found to be continuously absent from the classes without any information for a period of 30 days, the concerned teacher shall report the matter to the Head of the Department who in turn will then report the matter to the Dean for appropriate action that may include striking off the name of such student(s) from the roll. Such a student may, however, apply for readmission within 7 days from the date of issue of the notice of striking off the name from the rolls. The request for re-admission may be considered by the Dean of the School. Such a student shall not be eligible for re-admission after the prescribed period of 7 days. The re-admission shall be affected only after the payment of prescribed re-admission fee.

- The cases of students with less than 70% attendance may be forwarded to the Vice-Chancellor through Dean for considering these cases to further condone the attendance shortage as a special case.

- A student detained on account of shortage of attendance in any semester shall be readmitted to the same class in the subsequent academic year on payment of prescribed fees applicable in that year to complete the attendance requirement of that course.

10. Internal assessment

- The performance of the student in each paper will be evaluated both continuously (Internal Assessment) and at the end of semester (Semester Examination). 25% marks for each theory paper will be allocated for internal assessment and 75% marks will be kept for semester end examination.

- For the evaluation of the lab work, laboratory notebook, practical test/viva voce shall be taken into account. The marks shall be awarded by the respective teacher conducting the practical course. For sessional tests, discontinuance of classes will not be permitted and the teacher may take the test in his/her scheduled class. Under the compelling circumstance such as sickness of the student or mourning in the family, the candidate may be given another chance. For sickness only, a credible medical certificate issued by a hospital shall be considered. In case of casualties, a letter from the parents would be required.

- Evaluation of tutorials will be done by conducting a written test or viva. Weightage shall also be given to the attendance in the tutorials.

11. Semester examination

- Semester examination shall be held at the end of each semester as per schedule given in the Academic Calendar of the School.

- Up to a maximum of seven days preparatory holidays may be given to the examinees before the start of the semester examinations.

- There shall be not less than two theory courses and one lab course in each semester, except the 4 Semester. The detailed contents of the courses of studies shall be prescribed by the respective Board of Studies and shall be reviewed regularly.

- Each theory paper having 04 credits shall be of 100 marks out of which 75% marks shall be for semester examination and 25% marks for internal assessment.

- Each practical paper having 02 credits shall be of 50 marks out of which 75% marks shall be for semester examination and 25% marks for internal assessment.

- The question paper for each theory paper shall have five questions. There shall be one question from each of the 4 units of the course and one question shall contain objective type/short answer questions covering all the units of the course. The candidate shall have to answer all the five questions. There shall, however, be internal choice within a unit. The choice shall be given by setting alternative questions from the same unit. The question paper should be such that it covers all the topics of that course.

- The duration of the semester examination of a theory course shall be three hours. Practical exams of a lab course shall be of at least four hours duration. The practical examination shall be conducted by an internal and external examiner.

- The question paper for semester examinations shall be set either by the external examiner or an internal examiner. The Board of Studies of the department shall draw a panel of names of examiners, both internal and external, for approval by the Vice Chancellor/Dean. If the external examiner is unable to send the question paper by the deadline set by the examination branch of the University, the dean after consultation with the examination branch shall get the paper set internally by a faculty. The papers set by the examiners can be moderated by a moderation committee. Teachers appointed on contractual basis with appointment of less than one academic session, and temporary as well as ad-hoc teachers may not ordinarily be appointed as examiners. All such teachers, however, will be expected to assist in the practical examination.

- The botanical tour/educational tour shall be organized in the vacations. The final year students shall participate as per the University rules and regulations.

12. Choice Based Credit System (CBCS)

Definitions of keywords

a) **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.
b) **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).
c) **Course:** Usually referred to as 'paper', course is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory.
d) Work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/term papers/assignments/ presentations/ self-study etc. or a combination of some of these.
e) **Credit Point:** It is the product of grade point and number of credits for a course.
f) **Credit:** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
g) **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
h) **Grade Point:** It is a numerical weight allotted to each letter grade on a 10-point scale.
i) **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.
j) **Programme:** An educational programme leading to award of a degree, diploma or certificate.
k) **Semester Grade Point Average (SGPA):** It is a measure of performance of work done in a semester. It is the ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.
l) **Semester:** Each semester will consist of 15-18 weeks of academic work equivalent to not less than 90 actual teaching days. The odd semester may be scheduled from July to December and even semester from January to May.
m) **Transcript or Grade Card or Certificate:** Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

13. Semester System and Choice Based Credit System

The semester system accelerates the teaching-learning process and enables vertical and horizontal mobility in learning. The credit-based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The choice-based credit system provides a 'Cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.

14. Types of Courses

The courses in a programme may be of three kinds according to CBCS: Core, Elective and Foundation

15. Classification of Result

a. Two methods - relative grading or absolute grading- have been in vogue for awarding grades in a course. The relative grading is based on the distribution (usually normal distribution) of marks obtained by all the students of the course and the grades are awarded based on a cut-off marks or percentile. Under the absolute grading, the marks are converted to grades based on predetermined class intervals. To implement the following grading system, the colleges and universities can use any one of the above methods.

b. Following grading system with a 10-point scale shall be followed to represent performance of students in the examination.

Letter Grade*	**Grade Point****
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above Average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (Absent)	0

***Letter Grade**: It is an index of the performance of students in a said course. Grades are denoted by letters viz, O, A+, A, B+, B, C, P and F

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

Converting the marks into letter grades

Letter Grade	**Grade Point**	**Range of Percentage of Marks**
O (Outstanding)	10	90 and above 100 (90 -100)
A+ (Excellent)	9	80 and above and less than 90 (80<90)
A (Very Good)	8	70 and above and less than 80 (70<80)
B+ (Good)	7	65 and above and less than 70 (65<70)
B (Above Average)	6	55 and above and less than 65 (55<65)
C (Average)	5	50 and above and less than 55 (50<55)
P (Pass)	4	40 and above and less than 50 (40<50)
F (Fail)	0	00 and above and less than 40 (00<40)
Ab (Absent)	0	--

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

Computation of SGPA and CGPA

As per UGC norms, the following procedure will be adopted to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all courses taken by a student and the number of credits of all the courses undergone by a student.
SGPA (Si) = ∑ (Ci x Gi) / ∑Ci where Ci is the number of credits of the ith course and Gi is the Grade point scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e. CGPA = ∑ (Ci x Si) / ∑Ci where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Formula for Conversion of CGPA into Marks percentage

The percentage equivalent to the CGPA shall be obtained by using the following formula:

Equivalent percentage of CGPA = CGPA x 10

14. Criteria for award of CGPA

The result of successful candidates who fulfill the criteria for the award of M. Sc. shall be categorized after the IV semester, on the basis of his/her CGPA.

Award of division/class shall be done on the basis of following criteria

Range of CGPA	**Division/Class**
CGPA of 7.50 and above and upto 10	1st Division with Distinction
CGPA of 6.00 and above and less than 7.50	I Division
CGPA of 5.00 and above and less than 6.0	II Division
CGPA of 4.00 and above and less than 5.00	III Division

19. Promotion

a) Promotion from I semester to consecutive semesters shall be automatic. However, pre-registration is compulsory to move to a new semester.

b) A student shall be promoted from II to III semester and from IV to V semester of the programme provided that student has passed 50% papers of I and II semester taken together or III and IV semesters taken together, including practical and tutorial papers.

c) Students who do not fulfil the promotion criteria as given above shall be declared failed in the part concerned. However, they shall have the option to retain the marks in the papers in which they have secured Pass marks.

d) A student who has to reappear in a paper prescribed for Semester I/III/V may do so only in the Semester examinations to be held in November/December and a student who has to

reappear in a paper prescribed for Semester II/IV/VI may do so only in the examinations to be held in April/May.

e) A candidate will be given a total number of 3 attempts, inclusive of the first attempt, to clear the papers in which he/she fails. The promotion to the next higher class will be considered subject to rules relating to passing the I and II /III and IV semester examinations within two academic years.

f) The award of degree shall be subject to successful completion of all the requirements of the programme of study within six years from admission.

g) A detained student is not allowed to reappear in sessional tests.

h) The minimum marks required to pass any paper in a semester shall be 40% in theory and in practical. The student must secure 40% in the End Semester Examination and 40% in the aggregate (End Semester Examination & Internal Assessment) of the paper for both theory and practical separately.

i) In case of VI semester, a student can appear in a supplementary examination in all backlog papers after declaration of their final semester results.

20. Classification of successful candidates

The result of successful candidates who fulfil the criteria for the award of B.Sc. Hons. after the VI semester shall be classified, on the basis of his/her CGPA of all the six semesters. The classification shall be done on the basis of following criteria:

a. He/she will be awarded "I Division" if his/her final CGPA is 6.75 or above.
b. He/she will be awarded "II Division" if his/her final CGPA is 6 or above but less than 6.75.
c. He/she will be awarded "Pass" if his/her final CGPA is 5 or above but less than 6.
d. He/she will be treated as "fail" if his/her final CGPA is less than 5.

21. Span period

(a) I and II Semester Exams: Within two years from the first admission to the programme

(b) All requirements of B.Sc. Hons. degree within a total period of **six years** from the date of their first admission.

23. Improvement

A candidate, with Grade C, D or E, who wishes to improve the previous performance will be allowed to do so after the declaration of the result of VI semester as per the following regulation:

- A student shall be allowed only once to reappear in the semester examination of up to six theory courses along with regular students of that semester to improve upon the previous performance. The examination fee which will be charged from such candidates shall be double the current examination fee.

- Such a student shall inform the Head of the Department in writing of his/her intention to improve performance, two months before the date of semester examination to be held.

- If the student improves the performance, he/she shall be required to submit the earlier mark-sheet/degree. A new mark-sheet and degree bearing the year in which the student improved the grade shall be issued.

- In case, the grade obtained in improvement is lower than the one obtained earlier, the higher grade shall prevail.

24. Conduct and discipline

- Disciplinary policies of Jamia Hamdard are put in place to promote civility on campus and to ensure a secure and academically enriching environment.

- Students are expected to show personal integrity, respect for university resources and respect for others' rights.

- Students are expected to adhere to the rules and regulations of the University. Any violation will be handled according to the rules set forth in the disciplinary policies of the university.

DETAILED SYLLABUS & LEARNING/ASSESSMENT PEDAGOGIES

SEMESTER I

Paper Code: BBT-CC01 TH/BBT-CC01 TU **Core Course**

BASICS OF COMPUTER SCIENCE AND STATISTICS
(THEORY/TUTORIAL)

(**CREDITS**: 4/2; **LECTURE**: 60/**TUTORIAL (hrs):** 30
MAXIMUM MARKS: **THEORY** 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)
TUTORIAL 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The course aims to provide basic knowledge of computers. Students will be introduced to hardware and software of computers. Students will also be introduced to commonly used software in research. Students will also learn basic concepts in information technology. In this course, students will be taught basic skills of statistics. This will allow them to develop analytical thinking and will also provide knowledge of statistical methods for critical evaluation of data.

Course Learning Outcomes

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

CLOCC01.1: This is a skill-based course that introduces the students to the basics of computer operations. **(Cognitive level: Understand)**
CLOCC01.2: The student is imparted with knowledge on both hardware and software. This course will provide a better understanding of the use of computers for various applications. **(Cognitive level: Apply)**
CLOCC01.3: The students will learn the importance of statistics in research and prepare them for a career in research. **(Cognitive level: Analyse and Evaluate)**
CLOCC01.4: Comprehend the application of statistical analysis. **(Cognitive level: Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	2	1	1	2	1	2	2	2	2	1	1
CLO2	2	1	1	2	2	1	2	1	2	1	2	2	1	1
CLO3	3	2	2	2	3	1	1	2	1	2	1	2	1	1
CLO4	1	1	2	1	2	1	1	2	2	2	1	1	1	1

Course Content

Unit-I: Elements of Computer Systems (15 hours)
Computer: Definition, Characteristics, Hardware & Software, Computer Organization. Operating Systems: Multi-tasking, Multi programming, Multiuser. Types of Operating System: MS-Windows, Unix/Linux, Mac OS. Database Models: Network, Hierarchical, Relational, Object Oriented. MS-Office: MS-Word, MS-Excel, MS-Power Point, MS-Access.

Unit-II: Information Technology (15 hours)
Elements of Computer Network. Network Topologies: Ring, Bus, Star, Mesh, Hybrid. Internet, Intranet, WWW, URL, Email, HTTP, HTML, Website, Portal, Web Browser, E-Commerce, IP Address. Issues and Threats of Cyber & Information Security: Virus, Worms, Trojan, Malware, Ransomware, Anti-Virus, Basics of Computer Troubleshooting.

UNIT-III: Statistics (15 hours)
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. Probability classical & axiomatic definition of probability, Theorems on total and compound probability, Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT-IV: Advanced Statistics (15 hours)
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) Correlation and Regression. Emphasis on examples from Biological Sciences.

Reference Books:

1. Rajaraman V., Adabala, Neeharika, "***Fundamentals of Computer***" 6th ed., PHI
2. Sinha & Sinha, "***Computer Fundamentals***", 6th ed., BPB Publications
3. Kahate A., "***Introduction to Database Management System***", Pearson's Education
4. Norton P, "***Introduction to Computers***", Mc Graw Hills
5. Online Tutorial, Jone L. & Curtis F., "***Microsoft Office 2016: Step by Step***", Microsoft Press
6. Le CT. ***Introductory Biostatistics***. 1st edition, John Wiley, USA
7. Glaser AN. ***High Yield ™ Biostatistics***. Lippincott Williams and Wilkins, USA
8. Edmondson A and Druce D. ***Advanced Biology Statistics***, Oxford University Press.
9. Danial W. ***Biostatistics***: ***A foundation for Analysis in Health Sciences***, John Wiley
10. M.V. Ismail. ***Biostatistics***, 1st Edition, Laxmi publication Pvt. Ltd.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two

sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Assessment methods for Tutorials: The internal tutorial sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC02 TH **Core Course**

BASICS OF CHEMISTRY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The course aims to provide basic knowledge of chemistry which is indispensable for an understanding of the several biomolecules and the way they interact to effect life processes in a plant. Thus, a sound understanding of basic principles of chemistry is required for appreciating biochemistry of plants.

Course Learning Outcomes

On completing this course, the students should be able to

CLOCC02.1: Understand the concept of chemical and ionic bonding. **(Cognitive level: Remember and Understand)**

CLOCC02.2: Understand the laws of thermodynamics. **(Cognitive level: Understand and Apply)**

CLOCC02.3: Comprehend the Basics of organic molecules, structure, bonding, reactivity and reaction mechanisms. **(Cognitive level: Understand, Analyze and Evaluate)**

CLOCC02.4: Understand how stereochemistry can be used to delineate a molecule's structure. **(Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	2	3	2	3	2	1	1	2	2	2	2	2	1	1
CLO2	2	3	3	2	2	1	1	1	1	2	1	2	1	1
CLO3	3	3	3	2	3	2	1	2	1	2	2	3	3	1
CLO4	2	3	3	3	2	1	1	1	1	3	2	2	2	1

Course Content

Unit-I: Chemical Bonding and Molecular Structure Ionic Bonding (15 hours)

Lattice energy and solvation energy. Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, Covalent Bonding: VB Approach, Lewis's theory, VSEPR theory to explain the shapes of molecules, salient features of the Valence bond (VB) theory and the concept of hybridization, MO Approach: limitations of the VB approach, salient features of the MO theory. Rules for the LCAO method, bonding and anti-bonding MOs and their characteristics for s-s-, s-p and p-p combinations of atomic orbitals, nonbonding combinations of orbitals MO treatment of homonuclear diatomic molecules of 1st period and heteronuclear diatomic molecules such as CO, HF.

Unit-II: Chemical Thermodynamics (15 hours)

Qualitative idea of thermodynamics. First Law of Thermodynamics: Calculation of work (w), heat (q), changes in internal energy (ΔE) and enthalpy (ΔH) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w,q, ΔE, and ΔH for processes involving changes in physical states. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature Kirchhoff's equation. Second law of thermodynamics, concept of entropy, Gibbs free energy and Helmoltz free energy. Calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions. Criteria of spontaneity, Gibbs Helmholtz equation. Maxwell's relations. Statements of Third Law of thermodynamics: calculation of absolute entropies of substances.

Unit-III: Fundamentals of Organic Chemistry (15 hours)

Hybridization in organic compounds, cleavage of covalent bond, homolysis and heterolysis, electronic effects: Electronic effects and their applications inductive, resonance and hyperconjugation effects. Structure and relative stability of reactive carbon species – carbocations, carbanions, free radicals and carbenes, Molecular Forces: types of intermolecular and intra-molecular forces and their characteristics: dipole-dipole, dipole induced dipole and dispersion (London) forces. Hydrogen bond (both intramolecular and intermolecular), Effect of inter/intramolecular forces on physical properties such as solubility, vapour pressure, melting and boiling points of different compounds, Aromaticity.

Unit-IV: Stereochemistry (15 hours)

Stereochemistry and its importance. Geometrical isomerism, cis-trans and E/Z nomenclature Optical isomerism – optical activity, plane polarized light, enantiomerism, chirality, specific molar rotation, Stereoisomerism with two chiral centres: Diastereomers, mesoisomers, Resolution of racemic modification. Projection diagrams of stereoisomers: Fischer, Newman and Sawhorse projections. Relative Configuration: D/L designation. Absolute Configuration: R/S designation of chiral centres, Conformational isomerism – ethane, butane and cyclohexane, diagrams and relative stability of conformers.

Reference Books:

1. J. D. Lee: ***A New Concise Inorganic Chemistry***, E.L.B.S.
2. P.W. Atkins: ***Physical Chemistry***, Oxford University Press
3. R.T. Morrison & R.N. Boyd: ***Organic Chemistry***, Prentice Hall
4. James E. Huheey *et al.*: ***Inorganic Chemistry: Principles of Structure and reactivity***
5. Mann, F.G. & Saunders, B.C. ***Practical Organic Chemistry***, Pearson Education
6. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. ***Practical Organic Chemistry***, *5th Ed.,* Pearson

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-AEC01 TH

Ability Enhancement Compulsory Courses

ENGLISH COMMUNICATION (THEORY)

(**CREDITS**:2; **LECTURE**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The course aims to train students to be more effective at communicating successfully in interviews, public speaking, letter writing, report writing, presentations, and inter-personal debates and conversations. The learner also imbibes the fundamentals of communication and the art of persuasive speaking and writing which depends crucially on clarity of thought and contextual understanding expressed through appropriate vocabulary.

Course Learning Outcomes

On completion of this course, the students will be able to understand:
CLOAEC01.1: This course is designed to develop the communication and vocabulary skills in the students. After studying this course, students will find difference in their personal and professional interactions. **(Cognitive level: Understand and Apply)**
CLOAEC01.2: Upon completion of the course, the students have sufficient knowledge for professional communication to excel in the chosen profession. **(Cognitive level: Apply)**
CLOAEC01.3: understand the importance of reading for life and develop an interest for reading (**Cognitive level: understand and create**); and
CLOAEC01.4: understand the importance of writing in academic life and career (**Cognitive level: understand**).

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	1	2	1	2	2	1	2	1	2	1	1	1	1	1
CLO2	1	1	2	2	1	1	2	1	1	1	1	1	1	1
CLO3	1	1	1	2	2	1	3	1	2	1	1	1	1	1
CLO4	1	1	1	2	1	2	3	1	2	1	1	1	1	2

Course Content

UNIT – 1 **(15 hours)**

Introduction: Theory of Communication, Types and modes of Communication

Language of Communication: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication

Speaking Skills: Monologue, Dialogue Group Discussion, Effective Communication/ Mis- Communication Interview, Public Speech

UNIT – 2 **(15 hours)**

Reading and Understanding: Close Reading, Comprehension, Summary Paraphrasing, Analysis and Interpretation, Translation (from Indian language to English and vice-versa) Literary/Knowledge Texts

Writing Skills: Documenting, Report Writing, Making notes, Letter writing

Reference Books:

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

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Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End semester examination: 37 Marks).

Paper Code: BBT-AEC02 TH

Ability Enhancement Compulsory Course

ENVIRONMENTAL STUDIES (THEORY)

(**CREDITS**: 2; **LECTURE**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The objective of this course is to provide basic concept of environment, ecology, natural resources, importance of biodiversity and need for its conservation along with various environmental issues and Government policies and movements.

Course Learning Outcomes

Upon completion of the course the students will understand:

CLOAEC02.1: Will develop their own insights into the functioning of several things or understanding human processes in their environment. **(Cognitive level: Remember and Understand)**

CLOAEC02.2: Appreciate concepts and methods from ecological and physical sciences and their application in environmental problem solving. **(Cognitive level: Apply and Create)**

COAEC02.3: Comprehend the concept and functioning of the ecosystem. **(Cognitive level: Understand)**

CLOAEC02.4: Understand the interactions of environmental components. **(Cognitive level: Remember and Understand)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	2	2	1	1	1	1	2	1	2	1	1	2	1
CLO2	2	2	2	1	2	1	2	3	1	2	1	1	2	1
CLO3	2	1	2	3	3	2	2	3	1	2	1	1	2	1
CLO4	1	2	1	1	2	1	1	2	1	2	1	1	1	1

Course Content

UNIT – 1: The multidisciplinary nature of environmental studies (3 hours)

Definition, scope and importance, Need for public awareness.

UNIT – 2: Natural resources: Renewable and non-renewable resources (9 hours)

a) Natural resources and associated problems
- Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests, and tribal people.
- Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems.
- Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
- Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers- pesticides problems, water logging, salinity, case studies.
- Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies
- Land Resources: Land as a resource, land degradation, man induced landslides, soil erosion, and desertification.

b) Role of individual in conservation of natural resources.
c) Equitable use of resources for sustainable life styles.

UNIT – 3: Ecosystems (9 hours)
- Concept of an eco-system
- Structure and function of an eco-system.
- Producers, consumers, decomposers.
- Energy flow in the eco systems.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the following eco systems:
- Forest ecosystem
- Grass land ecosystem
- Desert ecosystem.
- Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT – 4: Biodiversity and its conservation (9 hours)
- Introduction-Definition: genetics, species and ecosystem diversity.
- Biogeographically classification of India.
- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values
- Biodiversity at global, national and local level.
- India as a mega diversity nation.
- Hot-spots of biodiversity.
- Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts.
- Endangered and endemic spaces of India.
- Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

Reference Books:

1. ***Textbook of Environmental studies***, Erach Bharucha, UGC
2. ***Fundamental concepts in Environmental Studies***, D. D. Mishra, S Chand & Co Ltd

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Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 13 marks. End semester exam is of 37 marks.

Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End semester examination: 37 Marks).

Paper Code: BBT-GE01A TH/BBT-GE01A TU	**Generic Elective Course**

BASICS OF PHYSICS AND BIOLOGY

(THEORY/TUTORIAL)

(**CREDITS**: 4/2; **LECTURE**: 60/**TUTORIAL (hrs):** 30
MAXIMUM MARKS: **THEORY** 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)
TUTORIAL 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The aim of the course is to provide basic concepts in physics. The natural laws of physics have shaped the evolution of all bodies, both human and non-human. As a result of this, biologists need to understand physics in order to understand how the human body works. The course also provides basic concepts in biology. This portion will help students coming from diverse backgrounds.

Course Learning Outcomes

Upon completion of the course the students will understand:
CLOGE01A.1: Understand the basic knowledge of oscillations and electromagnetic waves. **(Cognitive level: Remember and Understand)**
CLOGE01A.2: Comprehend the application of LASERS. **(Cognitive level: Apply)**
CLOGE01A.3: Understand the basic knowledge of plant and animal kingdom and their basic unit of life. **(Cognitive level: Understand)**
CLOGE01A.4: Thorough knowledge of cell biology and life processes in plants. **(Cognitive level: Remember)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	1	2	2	1	2	1	1	1	1	2	1	2	1	1
CLO2	3	2	3	2	2	1	1	2	3	1	2	1	2	1
CLO3	1	3	3	1	2	1	1	2	2	2	2	3	2	1
CLO4	2	3	3	2	2	1	1	2	2	2	3	3	2	1

Course Content

SECTION A: BASICS OF PHYSICS (02 CREDITS)

UNIT – 1 **(15 hours)**

a) Oscillations: Periodic motion, time period, frequency, Simple Harmonic Motion (SHM) and its equations, phase, restoring force, Kinetic Energy and Potential Energy in SHM.

b) Electromagnetic waves: Electromagnetic Spectrum, Electromagnetic waves and their characteristics, Maxwell's Equations

UNIT – 2 **(15 hours)**

a) Interference due to division of amplitude and division of wave fronts, Young's double slit Experiment, Principle of Superposition, Theory of Biprism, Newtons' Rings.

b) LASER: Introduction, Temporal and Spatial Coherence, Principle of LASER, Stimulated and spontaneous emission. Einstein's Coefficients, He-Ne Laser, Ruby Laser, Applications of Lasers.

SECTION B: BASICS OF BIOLOGY (02 CREDITS)

UNIT – 3 **(15 hours)**

a) **Animal and Plant Kingdom**

Salient features and classification of plants into major groups - Algae, Bryophyta, Pteridophyta, Gymnospermae and Angiospermae. Salient features and classification of animals, non-chordates up to phyla level and chordates up to class.

b) **Cell-The Unit of Life**

Cell as the basic unit of life: Structure of prokaryotic and eukaryotic cells; Plant cell and animal cell; Cell envelope, cell membrane, cell wall; Cell organelles - structure and function. Elementary idea of cell cycle, mitosis, meiosis and their significance.

c) **Biomolecules**

Chemical constituents of living cells: biomolecules, structure and function of proteins, carbohydrates, lipids, nucleic acids.

UNIT – 4 **(15 hours)**

a) Human and Plant Physiology

Plant: basic concepts of transport, photosynthesis, respiration and reproduction in higher plants.

Human: Basic concepts of digestion and absorption; respiration, body fluids and circulation; excretion, nervous system, and reproduction.

b) **Basic Principles of Inheritance and Variation**

Mendelian Inheritance; Deviations from Mendelism-Incomplete dominance, Co-dominance, Multiple alleles and Inheritance of blood groups, Pleiotropy; Elementary idea of polygenic inheritance; Chromosome theory of inheritance; Chromosomes and genes.

Reference Books:

1. Ajoy Ghatak, ***Optics***, TMH
2. D. S. Mathur, ***Mechanics***
3. Griffith, ***Electrodynamics***
4. Brij Lal and Subramaniyam, ***Optics***
5. Nelson, D.L. & Cox, M.M. ***Lehninger: Principles of Biochemistry,***
6. Alberts, B., Johnson, A., Lewis, J. & Enlarge, M. (2008). ***Molecular Biology of the Cell,***
7. Gardner, B.J., Simmons, M.J., Snustad, D.P. (2006). ***Principles of Genetics.***

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Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Assessment methods for tutorials: The internal tutorial sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-GE01B TH/BBT-GE01B TU	**Generic Elective Course**

BASICS OF PHYSICS AND MATHEMATICS
(THEORY/TUTORIAL)

(**CREDITS**: 4/2; **LECTURE**: 60/**TUTORIAL (hrs):** 30
MAXIMUM MARKS: **THEORY** 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)
TUTORIAL 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The aim of the course is to provide basic concepts in physics. The natural laws of physics have shaped the evolution of all bodies, both human and non-human. As a result of this, biologists need to understand physics in order to understand how the human body works. The course also provides basic concepts in math. Mathematics plays a key role in many disciplines of science, primarily as a mathematical modelling tool. New innovations and developments in physics are by the influence of mathematics.

Course Learning Outcomes

On completion of this course, the student will be able to
COGE01B.1: Understand the basic knowledge of oscillations and electromagnetic waves. **(Cognitive Level: Remember and Understand)**
COGE01B.2: Comprehend the application of LASERS. **(Cognitive level: Apply)**
COGE01B.3: Understand the concept of Matrices and Determinants. **(Cognitive level: Remember and Understand)**
COGE01B.4: Comprehend the basic knowledge of calculus. **(Cognitive level: Understand, Evaluate and Analyse)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	1	2	2	1	2	1	1	1	1	2	1	2	1	1
CLO2	3	2	3	2	2	1	1	2	3	1	2	1	2	1
CLO3	3	2	2	1	1	1	1	1	1	2	1	1	1	1
CLO4	3	2	2	2	2	1	1	1	1	2	1	1	1	1

Course Content

SECTION A: BASICS OF PHYSICS (02 CREDITS)

UNIT – 1 **(15 hours)**

a) Oscillations: Periodic motion, time period, frequency, Simple Harmonic Motion (SHM) and its equations, phase, restoring force, Kinetic Energy and Potential Energy in SHM.
b) Electromagnetic waves: Electromagnetic Spectrum, Electromagnetic waves and their characteristics, Maxwell's Equations

UNIT – 2 **(15 hours)**

a) Interference due to division of amplitude and division of wave fronts, Young's double slit Experiment, Principle of Superposition, Theory of Biprism, Newtons' Rings.
b) LASER: Introduction, Temporal and Spatial Coherence, Principle of LASER, Stimulated and spontaneous emission. Einstein's Coefficients, He-Ne Laser, Ruby Laser, Applications of Lasers.

SECTION B: BASICS OF MATHEMATICS (02 CREDITS)

UNIT – 1: **Matrices and Determinants** **(15 hours)**

Matrices: Concept, notation, order, equality, types of matrices, zero and identity matrix, transpose of a matrix, symmetric and skew symmetric matrices. Operation on matrices: Addition and multiplication and multiplication with a scalar. Simple properties of addition, multiplication and scalar multiplication.
Determinants: Determinant of a square matrix (up to 3 x 3 matrices), properties of determinants, minors, co-factors and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix.

UNIT – 2: Calculus **(15 hours)**

Continuity and Differentiability: Continuity and Derivative, derivative of composite functions, chain rule, derivative of implicit functions. Concept of exponential and logarithmic functions.
Derivatives of logarithmic and exponential functions. Logarithmic differentiation, derivative of functions expressed in parametric forms. Second order derivatives.
Integrals: Integration as inverse process of differentiation. Integration of a variety of functions by substitution, by partial fractions and by parts, Evaluation of simple integrals of the following types and problems based on them. Definite integrals as a limit of a sum, Basic properties of definite integrals and evaluation of definite integrals.
Differential Equations: Definition, order and degree, general and particular solutions of a differential equation. Formation of differential equation whose general solution is given.

Reference Books:

1. Ajoy Ghatak, ***Optics***, TMH
2. D.S.Mathur, ***Mechanics***
3. Griffith, ***Electrodynamics***
4. Brij Lal and Subramaniyam, ***Optics***
5. George B. Thomas, ***Thomas' Calculus***
6. James Stewart, ***Calculus***
7. A. C. Aitken, ***Determinants and Matrices***

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Assessment methods for tutorials: The internal tutorial sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

SEMESTER II

Paper Code: BBT-CC03 TH	**Core Course**

BIOMOLECULES (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The course aims to provide students with an understanding of biomolecules, the basic building blocks of living organisms, focusing on their structural underpinnings, unique properties, biological roles, functions and interrelationships. The course will outline the importance of water as a biological solvent and vitamins as vital ingredients of life. Emphasis will be on the association between structure and function of various biomolecules at a chemical interface with a biological perspective as well as hands-on approach.

Course Learning Outcomes

On completing this course, students should be able to

CLOCC03.1: Through this course the students are exposed to importance of biological macromolecules. They acquire knowledge in the quantitative and qualitative estimation of biomolecules. **(Cognitive level: Understand and Apply)**

CLOCC03.2: At the end of the course, the students have a thorough understanding of the biologically derived sugar derivatives. They will learn structure and function of glycoproteins and proteoglycans. **(Cognitive level: Remember, Analyse and Evaluate**)

CLOCC03.3: Comprehend the function of lipids. **(Cognitive level: Understand)**

CLOCC03.4: Understand the concept of nucleic acids and their chemistry. **(Cognitive level: Remember and Understand)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	3	3	2	2	2	1	1	1	1	1	2	2	1	1
CLO2	2	3	3	2	3	1	1	1	1	2	2	3	2	2
CLO3	2	3	3	2	3	1	1	1	1	2	2	3	2	2
CLO4	3	3	3	2	3	1	1	1	1	3	2	3	3	2

Course Content

UNIT – 1: Introduction to Biomolecules (15 hours)

Introducing carbohydrates, proteins, fats. Biochemistry and its scope, physicochemical properties of water, weak interactions in aqueous systems, ionization of water, water as a reactant, buffers, fitness of the aqueous environment, structure and classification of amino acids, physical and chemical properties of amino acids.

UNIT – 2: Carbohydrates (15 hours)

Characteristic features of sugars. Monosaccharides-structure of aldoses, ketoses, conformation of sugars, anomers, epimers, enantiomers, conformation of sugars, mutarotation, structure of biologically important sugar derivatives, disaccharides: formation, structure, reducing, non-reducing disaccharides. Polysaccharides: classification and function. Structure and function of glycoproteins and proteoglycans. Carbohydrates as signals.

UNIT – 3: Lipids (15 hours)

Classification of fats, structure of fatty acids, triacylglycerol and waxes. Membrane lipids-glycerophospholipids, galactolipids, sphingolipids, sterols: types, structure and function of membrane lipids, gangliosides and lipopolysaccharides. Plant steroid, lipids as signals.

UNIT – 4: Nucleic acids and Vitamins (15 hours)

Nucleotides, nucleosides-structure, properties, Nucleic acids: Deoxyribonucleic acid and Ribonucleic acid, Watson and Crick model of DNA, structure and function of messenger RNA, ribosomal RNA, transfer RNA, nucleic acid chemistry: UV absorption, physicochemical properties of DNA, nucleotides: energy source, coenzyme components, second messengers. Vitamins: classification, active forms, deficiency disorders, symptoms, hypervitaminosis.

Reference Books:

1. Nelson, D.L. & Cox, M.M., ***Principles of Biochemistry, 5th Edn.,*** W.H. Freeman & Company.
2. Berg, M.J., Tymockzo, J.L. & Stryer, L. ***Biochemistry, 6th Edition***, W.H. Freeman & Company.
3. Wood. E.J. & Pickering, W.R. ***Introducing Biochemistry***. John Murray, London.
4. Nelson, D.L. & Cox, M.M. ***Lehninger: Principles of Biochemistry***, 6th Edn, W.H. Freeman and Company, New York.
5. Devlin, T.M. ***Textbook of Biochemistry with Clinical Correlations***, 7th Edn, John Wiley & Sons, New York.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-CC04 TH **Core Course**

CELL BIOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The objective of this paper is to offer insights into the basic structure and function of cell and organelles. The course also aims to impart understanding of cell cycle, cell death, cell renewal processes and various techniques in cell biology.

Course Learning Outcomes

After completing this course, the students will understand:

CLOCC04.1: This course introduces the students to the basics of cell and its components. This gives them a strong foundation on the basic unit of life. At the end of the course, the student has a strong foundation on the functions of the cell. **(Cognitive level: Remember and Understand)**

CLOCC04.2: Understand various tools of cell biology like microscopy and Flow cytometry. **(Cognitive level: Apply)**

CLOCC04.3: Understand the structure and function of cell wall and its role in cellular processes. **(Cognitive level: Remember)**

CLOCC04.4: Comprehend the cell cycle and its check points. Students will also have the knowledge of apoptosis and necrosis. **(Cognitive level: Remember, Analyze and Evaluate)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	2	3	1	3	3	1	2	1	3	3	3	2	2	2
CLO2	3	3	3	3	3	2	1	1	1	3	3	3	3	3
CLO3	2	3	2	2	3	1	1	2	3	3	3	3	1	1
CLO4	1	3	3	1	3	1	1	1	1	3	3	2	1	1

Course Content

UNIT – 1: Introduction to cell biology (15 hours)
Structure of different cell organelles, Prokaryotic (Achaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models, structure of nuclear envelope, nuclear pore complex, ER structure, Organization Golgi, Lysosome. Structure and function of mitochondria, chloroplast and peroxisomes, Zellweger syndrome.

UNIT – 2: Tools of cell biology (15 hours)
Light microscopy, phase contrast microscopy, fluorescent microscopy, confocal microscopy, electron microscopy, FACS, centrifugation for sub cellular fractionation.

UNIT – 3: Cell wall, extracellular matrix and cytoskeletal protein (15 hours)
Prokaryotic and eukaryotic cell wall, cell matrix protein, cell matrix interaction and cell to cell interaction, Adherence j unction, tight junctions, gap junction, desmosomes, hemidesmosomes, focal adhesion and plasmodesmata. Structure and organization of actin filaments, treadmilling and role of ATP in microfilament polymerization, organization of actin filament. Non muscle myosin, intermediate filament proteins, assembly and intracellular organization. Assembly, organization, and movement of cilia and flagella.

UNIT – 4: Cell cycle and cell death (15 hours)
Eukaryotic cell cycle, restriction point, checkpoints. Cell division, Apoptosis and necrosis-brief outline. Salient feature of transformed cell.

Reference Books:

1. Becker, W.M., Kleinsmith, L.J., Hardin, J., Bertoni, G. P. ***The World of the Cell, 7th edition***. San Francisco, Cambridge: Pearson Benjamin Cummings Publishing
2. Cooper, G.M., Hausman, R.E. ***The Cell: A Molecular Approach, 5th edition***. Washington, D.C.: ASM Press & Sunderland, Sinauer Associates, MA.
3. Karp, G. ***Cell Biology, 6th edition***. New Jersey, U.S.A.: John Wiley & Sons.
4. Majumdar, R., Sisodia, R. ***Laboratory Manual of Cell Biology, with reference to Plant Cells***. New Delhi, Delhi: Prestige Publication.
5. Reven, F.H., Evert, R.F., Eichhorn, S.E. ***Biology of Plants***. New York, NY: W. H. Freeman and Company.
6. Lodish, H., Berk, A. Zipursky, S.L., Matsudaira, P., Baltimore, D. & Darnell, J. ***Molecular Cell Biology***, 7th Edn., W.H. Freeman & Company, New York.
7. Alberts, B., Johnson, A., Lewis, J. & Enlarge, M. ***Molecular Biology of the Cell***, 5th Edn., Garland Science (Princeton).

Teaching – Learning Strategies in brief

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Paper Code: BBT-CC05 TH **Core Course**

IMMUNOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

This course describes the molecular and cellular basis of the development and function of the immune system. The course provides the basic framework in immunology that will cover the major topics including innate and adaptive immunity, antibodies and antigens, molecular events leading to the generation of antibody, humoral and cell-mediated adaptive immune response, hypersensitivity, self-tolerance, autoimmunity and vaccines.

Course Learning Outcomes

This course will enable the students to understand

CLOCC05.1: The student will learn about the immune system including organs, cells and receptors. Thorough knowledge of Innate immunity and cell types involved in innate immunity. **(Cognitive level: Remember and Understand)**

CLOCC05.2: Comprehend the antibody structure and function. **(Cognitive level: Understand and Analyse)**

CLOCC05.3: Understand the pathways of antigen processing and presentation. **(Cognitive level: Understand)**

CLOCC05.4: The students will have a thorough knowledge of molecular basis of antigen recognition, hypersensitivity reaction, antigen-antibody reactions. The course develops in the student an appreciation for principles of immunology and its applications in treating human diseases. **(Cognitive level: Understand, Evaluate and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	1	3	3	2	3	1	1	1	1	3	3	3	1	2
CLO2	2	3	3	3	3	1	1	1	1	3	3	3	1	2
CLO3	1	3	3	3	3	1	1	1	3	3	3	3	3	3
CLO4	3	3	3	3	3	1	1	1	3	3	3	3	3	3

Course Content

UNIT – 1 **(15 hours)**

Cells and organs of the immune system: Haematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT).

Innate immunity and leucocyte extravasation: Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response.

Immunogens and antigens: Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes.

UNIT – 2 **(15 hours)**

Antibody structure and function: Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, Effector functions of antibody, antigenic determinants on Ig and Ig super family.

Complement system: Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies.

Generation of receptor diversity: Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification.

UNIT – 3 **(15 hours)**

Biology of B lymphocyte

Antigen independent phase of B cell maturation and selection, humoral response T-dependent and T-independent response, anatomical distribution of B cell populations.

MHC complex and antigen presentation: General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, linkage disequilibrium, pathways of antigen processing and presentation.

UNIT – 4: **(15 hours)**

Biology of the T lymphocyte: Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation.

Cell mediated cytotoxic responses: General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC).

Tolerance, autoimmunity and hypersensitivity: Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, Gell and Coombs classification, lgE mediated (Type I) hypersensitivity.

Reference Books:

1. Kindt, T.L., Goldsby, R.A. & Osborne, B.A. ***Kuby Immunology***, 6th Edn., W.H. Freeman Company, New York.
2. Coico, R. & Sunshine, G. ***Immunology: A Short Course***, 6th Edn., Jonh Wiley & Sons, New Jersey.
3. Murphy, K., Mowat, A. & Weaver, C.T. ***Janeway's Immunobiology***, 8th Edn., Garland Science (London & New York.)

Teaching – Learning Strategies in brief

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Paper Code: BBT-CC06 TH **Core Course**

ENZYMES AND PROTEINS (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The objective of the course is to provide detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life. The course also aims to outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry. Further, it introduces "proteins" and stresses on their importance in modern biochemistry, highlighting their structural features and unique characteristics that help them participate in most of the physiological processes.

Course Learning Outcomes

Upon completion of this course the students will understand:
CLOCC06.1: Students will gain detailed knowledge of Protein isolation and analysis. **(Cognitive level: Understand and Apply)**
CLOCC06.2: Understand the structure, functions and the mechanism of action of enzymes. **(Cognitive level: Remember)**
CLOCC06.3: Learn kinetics of enzyme catalyzed reactions and enzyme inhibitions and regulatory process. **(Cognitive level: Apply)**
CLOCC06.4: Exposure of wide applications of enzymes and future potential. **(Cognitive level: Understand, Apply and Create)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

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CLO1	1	3	3	3	3	1	1	1	2	3	3	3	2	2
CLO2	2	3	3	3	3	2	1	1	1	3	3	3	3	3
CLO3	2	3	3	3	3	1	1	1	1	3	3	3	1	1
CLO4	2	3	3	3	3	1	1	1	1	3	3	3	2	2

Course Content

Unit – 1: Proteins: Introduction, isolation and analysis (15 hours)
Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function. Techniques to isolate and analyze proteins- salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, and IEF. Protein primary structure - sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides. Synthesis of peptides using Merrifield method.

UNIT – 2: Introduction to protein three-dtri1ensional structures (15 hours)
Secondary structure- helices and sheets, Ramachandran maps. Nature of non-covalent bonds and covalent bonds in protein folding. Tertiary and quaternary structures. Oxygen binding curves, cooperativity models for hemoglobin.

UNIT – 3: Introduction to enzyme catalysis and kinetics (15 hours)
Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature. Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation. Significance of Km and Vmax. Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

UNIT – 4: Mechanisms of enzyme action and regulation (15 hours)
Mechanism of action of chymotrypsin. Inhibitors of enzymes - antibiotics. Regulation of enzyme activity and its importance - aspartate transcarboxylase. Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry.

Reference Books:

1. Nelson, D.L. & Cox, M.M. ***Lehninger: Principles of Biochemistry***, 6th Edn, W.H. Freeman and Company, New York.
2. Price, N.C. & Stevens, L. ***Fundamentals of Enzymology***, 3rd Edn., Oxford University Press Inc, New York.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

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Paper Code: BBT-GE02A TH	**Generic Elective Course**

BIOETHICS AND IPR (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

Through this course, students will learn the significance and framework of intellectual property rights and understand the protocols of patenting. Students will also learn the importance of biosafety protocols and bioethics. This course helps to adhere to the ethical practices appropriate to the discipline and to adopt safe working practices relevant to the bioindustries and field of research.

Course Learning Outcomes

After completing this course, the students will understand:

CLOGE02A.1: Understand fundamentals of bioethics. **(Cognitive level: Understand)**
CLOGE02A.2: Comprehend the ethical use in medicine. **(Cognitive level: Remember and Apply)**
CLOGE02A.3: Understand regulatory guidelines and steps involved in protection of intellectual property rights Create awareness on the Biosafety, Bioethics and patenting of biotechnological processes and products. **(Cognitive level: Analyze, Evaluate and Apply)**
CLOGE02A.4: Analyze the basic principles and legal framework of intellectual property rights and its application to biotechnology. **(Cognitive level: Analyze and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	2	2	1	2	2	3	3	3	3	3	3	3	3	3
CLO2	3	1	1	2	2	3	3	3	3	3	3	2	2	3
CLO3	2	2	2	1	2	3	3	3	2	3	2	3	2	3
CLO4	2	2	1	1	2	2	1	2	2	3	3	3	3	3

Course Content

UNIT – 1: Fundamentals of bioethics (15 hours)

Definition, historic evolution, codes and guidelines, universal principles of bioethics. Codes, agreements, Declarations and Guidelines. Define the term "Bioethics" in relation to profession, society, and biomedicine, learn about gradation of moral and ethical norms and learn about prayers, oaths, agreements, declarations, guidelines and codes which have relevance to bioethics Clinical ethics. Describe the sanctity of human life and the need to preserve human life, explain about issues related to prenatal screening, clinical trials (Phase I/II/III/IV) studies. Informed consent, Ethics committees.

UNIT – 2: Bioethics in practice (15 hours)

Medical errors and Negligence Medical error and medical negligence difference, remedies against medical negligence, protection and compensation related to it. Care in infectious diseases, identify ethical issues in clinical practice of HIV, TB, leprosy and its prevention, research ethics related to infectious diseases Ethical use of animals in the laboratory

UNIT – 3: Introduction to intellectual property rights (15 hours)

Basics of Intellectual Property, History and Evolution of Intellectual Property, Treaty and Convention on IP, World Intellectual Property Organization and International Cooperation, Types of IPR, Economic importance of IPR

UNIT – 4: Intellectual property laws and its role in development (15 hours)

Patents, Trademarks, Copyright, Designs, Geographical Indications, Other related rights, Prosecution of IPR, Infringement and Enforcement of IPRs, Effect of Intellectual Property Protection in Development, Ideal industrial and institutional setup for Intellectual Property Outcomes, Role of Licensing and commercialization, IP Cells and Technology Transfer Offices, Future scope and career in Intellectual Property Field.

Reference Books:

1. **IPR, Biosafety and Bioethics** by Goel and Parashar
2. **Genetically Modified Crops and Agricultural Development** (Palgrave Studies in Agricultural Economics and Food Policy)" by Matin Qaim
3. **Biosafety and Bioethics** by Rajmohan Joshi
4. **Bioethics and Biosafety in Biotechnology** by V Sree Krishna
5. **"An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology"** by Padma Nambisan

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Paper Code: BBT-GE02B TH **Generic Elective Course**

BIOTECHNOLOGY AND HUMAN WELFARE (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The course aims to introduce applications of these techniques in production of recombinant therapeutic proteins and vaccines will also be outlined in this course. The course aims to provide an understanding of the applications of biochemistry in forensic sciences through analysis of evidences, which will help students develop analytical and problem-solving skills for real life situation. The course also introduces various environmental pollutants that affect human health.

Course Learning Outcomes

After completing this course, the students will understand:
CLOGE02B.1: The course imparts knowledge regarding benefits of biotechnology in forensic science and crime detection by employing various molecular biology techniques. **(Cognitive level: Remember and Apply)**
CLOGE02B.2: Understand Nitrogen fixation interaction between plants and microbes. The student will comprehend the qualitative improvement of livestock. **(Cognitive level: Understand)**
CLOGE02B.3: Comprehend the detailed knowledge of environment pollutants and development of biodegradable polymers such as PHB. **(Cognitive level: Analyze and Evaluate)**
CLOGE02B.4: Biotechnology for human welfare aims to provide introduction of various fields of biotechnology e.g., Agricultural, pharmaceutical and industrial biotechnology and their contribution for human welfare. **(Cognitive level: Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

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CLO1	1	2	2	1	2	2	2	2	3	2	3	3	2	2
CLO2	1	2	1	1	1	1	1	2	2	2	2	2	3	1
CLO3	3	2	2	2	2	2	3	3	3	2	2	1	3	2
CLO4	3	2	2	2	3	3	3	3	3	2	2	3	2	2

Course Content

UNIT – 1 **(15 hours)**

Protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation. 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.

UNIT – 2 **(15 hours)**

Nitrogen fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT – 3 **(15 hours)**

Environments: e.g., chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT – 4 **(15 hours)**

Health: e.g., development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in E. coli, human genome project.

Reference Books:

1. ***Biotechnology and Human Welfare for Competitive Examinations*** by Dr. Subroto Biswas
2. ***Biotechnology and Biopharmaceuticals***, Ho Rodney J. Y.
3. ***Biotechnology Operations: Principles and Practices,*** John M Centanni and Michael J Roy
4. ***Biotechnology***, Clark David P.

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Semester III

Paper Code: BBT-CC07 TH **Core Course**

GENETICS (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

This course aims to describe the fundamentals of genetics and inheritance. The course will enable the students to learn about mendelian experiments, gene interaction, model organism and genomic organization of prokaryotes and eukaryotes. It will provide a brief understanding about the underlying mechanism of sex determination, gene mutation and genetic disorders. Students will also be introduced to the concept of extra nuclear inheritance, genetic linkage and mapping, theory of evolution and Hardy-Weinberg equilibrium.

Course Learning Outcomes

After completion of this course, the student will understand:

CLOCC07.1: The paper will enable the students to understand the scope and significance of genetics by imbibing the principles of hereditary genetic transmission and interactions of gene with environment. **(Cognitive Level: Remember & Understand)**

CLOCC07.2: Comprehend the knowledge of chromosome and genomic organization along with mechanism of sex determination. **(Cognitive Level: Understand)**

CLOCC07.3: Students will learn the molecular aspects of genetic disorders and mutation. **(Cognitive Level: Analyze)**

CLOCC07.4: The concepts of gene and the relationship between genotype and phenotype. **(Cognitive Level: Evaluate and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	3	3	3	2	3	2	2	1	1	3	3	3	2	2
CLO2	2	3	3	2	3	2	2	1	1	3	3	3	3	1
CLO3	3	3	3	2	3	2	1	1	1	3	3	3	3	2
CLO4	3	3	3	3	3	2	1	1	1	3	3	3	2	1

Course Content

Unit I **(15 hours)**

Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance.

Mendelian Genetics: Mendel's experimental design, monohybrid, di-hybrid and tri-hybrid crosses. Law of segregation and principle of independent assortment. Significance of test and back crosses. Chromosomal theory of inheritance. Allelic interaction: dominance, excessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple alleles, pseudo-allele, essential and lethal genes, penetrance and expressivity.

Unit II **(15 hours)**

Non-allelic interactions: Complementary genes, supplementary genes, duplicate genes, inhibitory genes and epistasis (dominant and recessive).

Chromosome and genomic organization: Structure and characteristics of bacterial and eukaryotic chromosome, concept of euchromatin and heterochromatin, packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, special chromosomes (e.g., polytene and lamp brush chromosomes).

Eukaryotic nuclear genome nucleotide sequence composition- unique and repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences-VNTRs and dinucleotide repeats, repetitive transposed sequences-SINE and LINEs, middle repetitive multiple copy genes, non-coding DNA, genetic organisation of prokaryotic and viral genome.

Unit III **(15 hours)**

Variations in chromosome structure and number: deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings: aneuploidy and euploidy.

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, sex influenced dominance, sex limited gene expression, sex linked inheritance.

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.

Unit IV **(15 hours)**

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes, cytological basis of crossing over, molecular mechanism of crossing over, crossing over at four strand stage, multiple crossing over, 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

1. Gardner, B.J., Simmons, M.J., Snustad, D.P. (2006). **Principles of Genetics**. VIII Edition John Wiley and Sons.
2. Snustad, D.P., Simmons, M.J. (2009). **Principles of Genetics**. V 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. (2009). **Genetics- A Molecular Approach**. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. **Introduction to Genetic Analysis**, W. H. Freeman and Co.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-CC08 TH **Core Course**

MICROBIOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The goal of the course is to put insights on microbial world and its diversity. The course will cover some important and basic concepts including- microbial taxonomy, unique morphological as well as structural features of various microbes. Emphasis will be given to the bacterial culture, growth curve, modes of bacterial reproduction and biosynthetic pathways. It will let students to gain knowledge about different techniques employed for bacterial isolation and purification. This course will also discuss various factors affecting microbial growth, sewage management and role of microbes in food industry.

Course Learning Outcomes

After completing this course, the students will:

CLOCC08.1: study the importance of microorganisms and become familiar with the types of microorganisms in and around humans **(Cognitive Level: Remember)**

CLOCC08.2: Examine the growth requirements and maintenance of microorganisms for physiochemical characterization and other research studies. **(Cognitive Level: Apply)**

CLOCC08.3: analyse and review the metabolic and biosynthetic pathways to better comprehend utility of microbial life. **(Cognitive Level: Analyse)**

CLOCC08.4: Comprehend the knowledge of water and food microbiology to gauge the human dependence on microbial life **(Cognitive Level: Evaluate)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	3	3	2	2	2	1	1	1	2	2	3	2	1
CLO2	2	3	3	2	3	2	1	2	1	2	3	2	2	1
CLO3	2	3	3	2	2	1	1	1	1	2	2	2	1	1
CLO4	2	2	2	3	3	1	1	1	1	2	1	1	2	1

Course Content

Unit I **(15 hours)**

Fundamentals of Microbiology: Discovery of microbial world, controversy over spontaneous generation, history of microbiology.

Classification of microorganisms: Microbial taxonomy, criteria used, including molecular approaches, microbial phylogeny and current classification of bacteria.

Microbial Diversity: Distribution and characterisation of Prokaryotic and Eukaryotic cells.

Morphology and cell structure of microorganisms: Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

Unit II **(15 hours)**

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

Unit III **(15 hours)**

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Microbial metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways.

Bacterial Reproduction: Transformation, transduction and conjugation. Endospores and sporulation in bacteria.

Unit IV **(15 hours)**

Factors affecting growth of Microorganisms: Physical, chemical factors and chemotherapeutic agents.

Water Biology: 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 borne infections and intoxications, food preservation and fermented food products.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). **Introductory Mycology**. 4th 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. (2009). **Brock Biology of Microorganisms**. 12th 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. (2008). **Microbiology: An Introduction**. 9th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). **Prescott, Harley and Klein's Microbiology**. 7th edition. McGraw Hill Higher Education

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

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Paper Code: BBT-CC09 TH **Core Course**

MOLECULAR BIOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objective

This course aims a providing valuable insights about the structure and framework of nucleic acid and its types. It will help in understanding the molecular mechanism of replication, DNA damage and repair. This course will also cover the molecular aspects of transcription, translation and regulation of gene expression in both prokaryotes and eukaryotes respectively. This course will prepare the students to lay out the difference between prokaryotes and eukaryotes in terms of genetic organization and its machinery.

Course Learning Outcomes

Upon completion of this course the students will:

CLOCC09.1: Comprehend the molecular aspects of the Life. The concept of central dogma of molecular biology spanning from DNA Replication till Protein Synthesis and Reverse transcription will be elucidated. **(Cognitive Level: Remember & Understand)**

CLOCC09.2: Understand the molecular mechanism of DNA damage and explore the repair pathways. **(Cognitive Level: Understand and Analyse)**

CLOCC09.3: Be familiar with the process of transcription and processing of RNA. **(Cognitive Level: Understand)**

CLOCC09.4: Understand the basis of regulation of gene expression to devise better strategies of protein expression. **(Cognitive Level: Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	3	3	3	3	3	2	1	1	1	2	2	3	2	1
CLO2	2	3	3	3	3	2	1	1	1	2	2	3	3	1
CLO3	3	3	3	3	3	1	1	1	1	2	2	3	2	1
CLO4	3	3	3	3	3	1	1	1	1	2	2	3	2	1

Course Content

Unit I **(15 hours)**

DNA structure and replication- DNA as genetic material, structure of DNA, types of DNA, Replication of DNA in prokaryotes and eukaryotes. Semi-conservative nature of DNA replication, Bi-directional replication, DNA polymerase. The replication complex- pre-priming proteins, primosome, replisome, rolling circle replication, Unique aspects of eukaryotic replication, Fidelity of replication.

Unit II **(15 hours)**

DNA damage, repair and homologous recombination: DNA damage and repair-causes and types of DNA damage, Mechanism of DNA repair-photo reactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombination repair, non-homologous end joining. Homologous recombination-models and mechanism.

Unit III **(15 hours)**

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 **(15 hours)**

Translation & regulation of gene expression: Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthesis, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, post-translational modification of proteins, Regulation of gene expression in prokaryotes, Operon concept (inducible and repressible system).

SUGGESTED READING

1. Karp, G. (2010). **Cell and Molecular Biology: Concepts and Experiments.** VI Edition. John Wiley and 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., (2008) **Molecular Biology of the Gene** (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-CC10 TH **Core Course**

PLANT ANATOMY AND PHYSIOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The aim of this course is to conceptualize the anatomical features of the plant kingdom. This subject focuses on transportation processes taking place in plants, macro/micro nutrients, carbon cycle, and nitrogen fixation. The students will able to expand their knowledge regarding various plant hormones along with their physiological role and mode of action, seed germination, photoperiodism and vernalization.

Course Learning Outcomes

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

CLOCC10.1: to understand and appreciate the complexity of the anatomy of plant structures like root, shoot and leaves. **(Cognitive Level: Remember)**

CLOCC10.2: Comprehend the role of nutrients and understand the mechanism of their uptake. **(Cognitive Level: Understand)**

CLOCC10.3: Determine the mechanism of food transport with major focus on carbon and nitrogen metabolism in plants. **(Cognitive Level: Analyze)**

CLOCC10.4: Comprehend the role of growth hormones in plant development. **(Cognitive Level: Analyze and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
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CLO2	2	2	3	3	3	1	1	2	1	2	1	2	2	1
CLO3	2	3	3	3	3	1	1	2	1	2	1	2	2	1
CLO4	2	3	3	3	3	1	1	2	1	2	1	2	2	1

Course Content

Unit I **(15 hours)**

Anatomy: The root and shoot apical meristems and its histological organization, simple and complex permanent tissues, primary structure of root and shoot, secondary growth, growth rings, leaf anatomy (dorsi-ventral and isobilateral leaf).

Unit II **(15 hours)**

Plant water relations and mineral nutrients: Importance of water to plant life, diffusion, osmosis, plasmolysis, inhibition, guttation, transpiration, stomata and their mechanism of opening and closing. Micro and macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients.

Unit III **(15 hours)**

Carbon and nitrogen metabolism: Photosynthesis- photosynthetic pigments, concept of two photosystems, photophosphorylation, Calvin cycle, CAM plants, photorespiration, compensation point, mechanism of food transport. Nitrogen assimilation- inorganic and molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

Unit IV **(15 hours)**

Growth and development: Definitions, phases of growth, growth curve and growth hormones (auxins, gibberellins, cytokinin, abscisic acid, ethylene), physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization.

SUGGESTED READING

1. Dickinson, W.C. 2000. **Integrative Plant Anatomy**. Harcourt Academic Press, USA.
2. Esau, K. 1977. **Anatomy of Seed Plants**. Wiley Publishers.
3. Fahn, A. 1974. **Plant Anatomy**. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008. **Introduction to Plant Physiology**. John Wiley and Sons.
5. Mauseth, J.D. 1988. **Plant Anatomy**. The Benjammin/Cummings Publisher, USA. 6. Nelson, D.L., Cox, M.M. 2004. **Lehninger Principles of Biochemistry,** 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991. **Plant Physiology**, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006. **Plant Physiology**, 4 th edition, Sinauer Associates Inc .MA, USA

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Assessment methods and weightages in brief

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Paper Code: BBT-CC11 TH **Core Course**

BIOPROCESS TECHNOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The purpose of this course is to provide brief idea about principle of fermentation and components of fermenter. This course outlines different types of bioreactors and their application, role of oxygen in bioreactors, types of microbial culture and growth kinetics. The students will be well-versed with practical knowledge about the principles of upstream and downstream processing and its day-to-day applications.

Course Learning Outcomes

Upon completion of the course the student will understand:

CLOCC11.1: Aware of various methodologies of bio-process technology **(Cognitive level: Remember and Understand)**

CLOCC11.2: Comprehend product isolation using various analytical methods **(Cognitive level: Apply)**

CLOCC11.3: Understand the importance of oxygen in bioprocessing. **(Cognitive level: Understand)**

CLOCC11.4: Understand downstream processing to recover and purify the products. **(Cognitive level: Analyze, Evaluate and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

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CLO1	3	3	2	3	3	1	2	2	1	2	1	2	2	1
CLO2	1	2	2	2	2	1	1	1	1	2	2	2	2	1
CLO3	2	2	3	2	3	1	1	1	1	2	2	2	1	1
CLO4	2	3	3	2	3	1	1	1	1	2	2	2	2	1

Course Content

Unit I **(15 hours)**

Introduction to bioprocess technology: Range of bioprocess technology and its chronological development. Basic principle and components of fermentation technology.

Types of microbial culture and their growth kinetics: Batch, Fed batch and Continuous culture.

Unit II **(15 hours)**

Design of bioprocess vessels: Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes.

Principles of upstream processing: Media preparation, Inoculum development and sterilization.

Unit III **(15 hours)**

Introduction to oxygen requirement in bioprocess: mass transfer coefficient; factors affecting K_{La}.

Bioprocess measurement and control system with special reference to computer aided process control.

Unit IV **(15 hours)**

Introduction to downstream processing: Product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and single cell proteins.

SUGGESTED READING

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

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Paper Code: BBT-SEC01 TH | **Skill Enhancement Course**

MOLECULAR DIAGNOSTICS (THEORY)

(**CREDITS**: 2; **LECTURE**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This course aims at providing the experimental aspects and different techniques used in molecular biology, cell biology and immunology. This will help to learn about the application of various technique, enzyme and protein purification and its standardized methods. The students will also learn about the latest technology like electron microscopy, flow cytometry and different laboratory tests.

Course Learning Outcomes

Upon completion of this course the students will understand:

CLOSEC01.1: To comprehend the basics of immunoassays and its applications. **(Cognitive level: Understand and Apply)**

CLOSEC01.2: Students will be exposed to routine methods used for diagnosis. **(Cognitive Level: Analyze, Evaluate and Apply)**

CLOSEC01.3: To strengthen their fundamentals about the immune-diagnostics**.** **(Cognitive level: Remember and Understand)**

CLOSEC01.4: Students will gain knowledge about cell studies. **(Cognitive level: Apply and Create)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

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CLO1	3	2	3	3	3	2	1	1	1	2	3	2	2	1
CLO2	2	2	3	2	3	1	1	1	1	2	3	2	2	1
CLO3	2	3	2	2	2	1	1	1	1	2	2	2	2	1
CLO4	2	3	3	2	2	1	1	1	1	2	2	3	2	1

Course Content

Unit I **(7 hours)**

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

Unit II **(8 hours)**

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 test: Micro-dilution and macro-dilution broth procedures. Susceptibility tests: Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

Unit III **(8 hours)**

Automation in microbial diagnosis: Rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies, concepts and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immnuoflorescence. Radioimmunoassay.

Unit IV **(7 hours)**

Chromatography and cell studies: GLC, HPLC, Electron microscopy, flow cytometry and cell sorting. Transgenic animals.

SUGGESTED READING

1. **Practical Biochemistry, Principles and Techniques**, Keith Wilson and John Walker
2. **Bioinstrumentation**, Webster
3. **Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes**, J.F. Van impe, Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). **Textbook of Microbiology.** 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). **Jawetz, Melnick and Adelberg's Medical Microbiology**. 24th edition. McGraw Hill Publication.
6. Goering R, Dockrell II, Zuckerman M and Wakelin D. (2007). **Mims' Medical Microbiology**. 4th edition. Elsevier.

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Paper Code: BBT-GE03 TH

General Elective Course

DEVELOPMENTAL BIOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The course is designed to put foundation about different perspective of developmental biology- gametogenesis, spermatogenesis, fertilization and its types and classification of different types of eggs. In this course, concept of blastulation, morphogenesis and fate of early embryos. This course will also throw light on important topics related to cell commitment, determination, differentiation, organogenesis and will fill the student's knowledge gaps.

Course Learning Outcomes

Upon completion of this course, students will be able to

CLOGE03.1: Students will be able to gain a vast knowledge of gametogenesis and fertilization. **(Cognitive level: Remember and Understand)**

CLOGE03.2: To comprehend the concepts of embryonic development, morphogenesis and fate of early embryos. **(Cognitive level: Understand and Apply)**

CLOGE03.3: Student will able to describe about the differentiation and concept about embryonic induction. **(Cognitive level: Understand and Analyse)**

CLOGE03.4: Student will able to learn the basics of organogenesis. **(Cognitive level: Remember and Understand)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	3	3	2	1	2	1	1	1	2	2	3	2	1
CLO2	2	3	3	2	2	1	2	1	1	2	2	2	1	1
CLO3	2	3	3	2	3	2	1	1	1	2	2	2	2	1
CLO4	2	3	3	3	3	2	1	1	1	2	2	2	2	1

Course Content

Unit I Gametogenesis and Fertilization (15 hours)
Definition, scope and historical perspective of development biology. Gametogenesis- Spermatogenesis, Oogenesis. Fertilization- Definition, types of fertilization, different types of eggs on the basis of yolk.

Unit II Early embryonic development (15 hours)
Cleavage: Definition, types, patterns and mechanism. Gastrulation: Morphogenetic movements- epiboly, emboly, extension, invagination, convergence, de-lamination. Formation and differentiation of primary germ layers. Fate maps in early embryos.

Unit III Embryonic Differentiation (15 hours)
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-translational concept of embryonic induction: primary, secondary and tertiary embryonic induction. Neural induction and induction of vertebrate lens.

Unit IV Organogenesis (15 hours)
Neurulation, Notogenesis, development of vertebrate eye. Fate of different primary germ layers. Development of behaviour: constancy and plasticity, extra embryonic membranes, placenta in mammals.

SUGGESTED READING

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

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

SEMESTER IV

Paper Code: BBT-CC02 P **Core Course**

BASICS OF CHEMISTRY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The aim of the course is to provide students with the experimental aspects of chemistry. Students will get to learn about the calibration technique, purification methods. The practical of this course will also include: determination of melting and boiling points and study on impurities of compounds. Students will be able to strengthen their practical knowledge.

Course Learning Outcomes

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

CLOCC02P.1: Calibration of thermometer. **(Cognitive level: Remember and Apply)**

CLOCC02P.2: Purification organic compounds by crystallization. **(Cognitive level: Analyze and Evaluate)**

CLOCC02P.3: Studying the effect of impurities on the melting of two unknown organic compounds. **(Cognitive level: Understand and Apply)**

CLOCC02P.4: Determination of boiling point of liquid compounds. **(Cognitive level: Remember and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	1	1	2	2	1	2	1	1	2	2	1	1	1
CLO2	1	2	3	2	2	1	1	1	1	2	3	2	2	1
CLO3	2	2	3	3	2	1	1	1	1	2	2	2	1	1
CLO4	2	2	3	2	3	2	1	1	1	2	2	1	1	1

Course Content

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
    - Water
    - Alcohol
    - Alcohol-Water
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point melting point of two unknown organic compounds.
5. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method)

Suggested Reading

Mann, F.G. & Saunders, B.C. **Practical Organic Chemistry**, Pearson Education (2009)

Furniss, B.S.; Hannaford, A.J. Smith, P.W.G.; Tatchell, A.R. **Practical Organic Chemistry**, 5th Ed., Pearson (2012)

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC03 P **Core Course**

BIOMOLECULES (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This practical course focuses on giving clear understanding about the concepts of normality, molarity and molality. Students will be guided to prepare buffer, stock and working solutions. Some other experiments that will ensure in building strong practical foundation of the students includes- qualitative estimation of different biomolecules, determination of pKa, and chromatography techniques.

Course Learning Outcomes

After completion of this course the students will understand

CLOCC03.1: Through this course the students are exposed to importance of biological macromolecules. They acquire knowledge in the quantitative and qualitative estimation of biomolecules. **(Cognitive level: Understand and Apply)**

CLOCC03.2: At the end of the course, the students have a thorough understanding of the biologically derived sugar derivatives. They will learn structure and function of glycoproteins and proteoglycans. **(Cognitive level: Remember and Understand)**

CLOCC03.3: Comprehend the function of lipids. **(Cognitive level: Understand and Analyze)**

CLOCC03.4: Understand the concept of nucleic acids and their chemistry. **(Cognitive level: Analyze, Evaluate and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	2	3	2	2	1	1	1	1	2	3	2	2	1
CLO2	2	3	3	2	3	2	1	1	1	2	3	2	2	1
CLO3	2	2	3	3	2	1	1	1	1	2	2	2	2	1
CLO4	2	3	3	2	2	1	1	1	1	2	2	2	1	1

Course Content

1. Safety measures in laboratories.
2. Preparation of Normal and Molar solutions
3. Preparation of buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
6. Separation of amino acids/sugars/bases by thin layer chromatography.
7. Estimation of vitamin C.

Reference Books:

1. Berg, M.J., Tymockzo, J.L. & Stryer, L. ***Biochemistry, 6th Edition***, W.H. Freeman & Company.
2. Wood. E.J. & Pickering, W.R. ***Introducing Biochemistry***. John Murray, London.
3. Nelson, D.L. & Cox, M.M. ***Lehninger: Principles of Biochemistry***, 6th Edn, W.H. Freeman and Company, New York.
4. Devlin, T.M. ***Textbook of Biochemistry with Clinical Correlations***, 7th Edn, John Wiley & Sons, New York.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC04 P **Core Course**

CELL BIOLOGY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs):** 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This course will allow students to have a better understanding about the visualization techniques, different stains used for different types of biological cell and cellular compartments. Through these experiments, students will able to closely observe cell cycle in both plant and animal cell. It will further help students to enhance their lab experience.

Course Learning Outcomes

After completing this course, the students will understand:

CLOCC04P.1: Students will understand the visualization techniques for animal and plant cell. **(Cognitive level: Remember and Understand)**

CLOCC04P.2: Students will learn about the practical aspects of different stages of mitosis in plant cell and meiosis in animal cell. **(Cognitive level: Analyze and Evaluate)**

CLOCC04P.3: Students will be to grasp knowledge about micrographs. **(Cognitive level: Understand)**

CLOCC04P.4: Comprehend the application of different stains in visualizing various cellular components. **(Cognitive level: Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	2	3	2	3	1	1	1	1	2	3	2	2	1
CLO2	3	2	2	2	3	1	1	1	1	2	3	2	2	1
CLO3	1	1	2	2	2	1	1	1	1	2	2	1	1	1
CLO4	1	1	3	2	3	1	1	1	1	2	3	2	1	1

Course Content

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of amitosis in onion root tip.
3. Identification of different stages of meiosis in grasshopper testis.
4. Micrographs of different cell components (dry lab).
5. Sub-cellular fractionation.
6. Visualization of nuclear fraction by ace to carmine stain.
7. Staining and visualization of mitochondria by Janus green stain.

Reference Books:

1. Cooper, G.M. & Hausman, R.E. (2009). **The Cell: A Molecular Approach**, 5th Edn., ASM Press &* Sunderland (Washington DC), Sinauer Associates, M.A.
2. Lodish, H., Berk, A. Zipursky, S.L., Matsudaira, P., Baltimore, D. & Darnell, J. (2012). **Molecular Cell Biology**, 7th Edn., W.H. Freeman & Company, New York.
3. Alberts, B., Johnson, A., Lewis, J. & Enlarge, M. (2008). **Molecular Biology of the Cell**, 5th Edn., Garland Science (Princeton).

Teaching – Learning Strategies in brief
The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief
The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC05 P **Core Course**

IMMUNOLOGY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs):** 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The practical part of this course will make the students learn about the isolation of PBMCs from human sample (blood), purification of immunoglobulins and agglutination assays. Students will also be well-versed with the one of the most employed immunological assays in diagnostics-ELISA and its variants.

Course Learning Outcomes

This course will enable the students to understand

CLOCC05.1: The student will learn about the immune system including organs, cells and receptors. Thorough knowledge of Innate immunity and cell types involved in innate immunity. **(Cognitive level: Remember and Understand)**

CLOCC05.2: Comprehend the antibody structure and function. **(Cognitive Level: Understand and Analyse)**

CLOCC05.3: Understand the pathways of antigen processing and presentation. **(Cognitive level: Understand)**

CLOCC05.4: The students will have a thorough knowledge of molecular basis of antigen recognition, hypersensitivity reaction, antigen-antibody reactions. The course develops in the student an appreciation for principles of immunology and its applications in treating human diseases. **(Cognitive level: Analyse, Evaluate and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	3	3	3	3	2	2	1	1	2	1	2	2	1
CLO2	3	3	3	2	3	2	1	1	1	2	2	2	2	1
CLO3	2	2	3	2	3	2	1	1	1	2	2	3	2	1
CLO4	3	3	2	2	3	2	2	1	1	2	3	3	2	2

Course Content

1. Isolation of PBMCs from blood.
2. Purification of immunoglobulins.
3. Assays based on agglutination reactions-Blood typing (active) & passive agglutination.
4. Enzyme Linked Immune-sorbent Assay (ELISA).
5. DOT blot assay.
6. Immunoblot assay.

Reference Books:

1. Kindt, T.L., Goldsby, R.A. & Osborne, B.A. ***Kuby Immunology***, 6th Edn., W.H. Freeman Company, New York.
2. Coico, R. & Sunshine, G. ***Immunology: A Short Course***, 6th Edn., Jonh Wiley & Sons, New Jersey.
3. Murphy, K., Mowat, A. & Weaver, C.T. ***Janeway's Immunobiology***, 8th Edn., Garland Science (London & New York.)

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC06 P **Core Course**

ENZYMES AND PROTEINS (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs):** 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The practical approach aims to clarify the different assays for protein estimation. The practical study also includes ammonium sulphate fractionation from mung beans and its progress curve along with effect of pH. The practical performed in this course would lead students to gain a better understanding about the determination of Km, Vmax and inhibition activity of phosphatase.

Course Learning Outcomes

Upon completion of this course the students will understand:

CLOCC06.1P: Students will gain detailed knowledge of Protein isolation and analysis **(Cognitive level: Understand and Apply)**

CLOCC06.2P: Understand the structure, functions and the mechanism of action of enzymes. **(Cognitive level: Remember, Analyse and Evaluate)**

CLOCC06.3P: Learn kinetics of enzyme catalysed reactions and enzyme inhibitions and regulatory process. **(Cognitive level: Remember and Understand)**

CLOCC06.4P: Exposure of wide applications of enzymes and future potential. **(Cognitive level: Apply and Create)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	2	2	3	3	1	1	1	1	2	3	2	2	1
CLO2	2	2	3	3	3	1	1	1	1	2	2	3	2	1
CLO3	3	3	3	3	3	2	1	1	1	2	2	2	2	1
CLO4	2	2	2	2	3	1	1	2	1	2	2	2	1	1

Course Content

1. Protein estimation by UV absorbance and Biuret method.
2. Protein micro assay by Lowry/Bradford method.
3. Ammonium sulphate fractionation of crude homogenate from germinated mung bean.
4. Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions. (Progress curve and effect of pH).
5. Determination of Km and Vmax of enzyme enriched fraction.
6. Inhibition of acid phosphatase activity by inorganic phosphate.

Reference Books:

1. Nelson, D.L. & Cox, M.M. ***Lehninger: Principles of Biochemistry***, 6th Edn, W.H. Freeman and Company, New York.
2. Price, N.C. & Stevens, L. ***Fundamentals of Enzymology***, 3rd Edn., Oxford University Press Inc, New York.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC12 TH **Core Course**

RECOMBINANT DNA TECHNOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

This course will provide information about the different method and various enzymes used in molecular biology and cloning. The students will learn about plasmids and vectors, different methods of transformation, genetic engineering and its application in both plants and animals. Students will also learn about PCR, its variants and primer designing.

Course Learning Outcomes

After completing this course, the students will understand:
CLOCC12.1: Students will learn the isolation techniques of chromosomal DNA from plant cells and *E. Coli*. **(Cognitive level: Remember and Apply)**
CLOCC12.2: To learn about the qualitative and quantitative analysis of DNA using Spectrophotometer. **(Cognitive level: Analyze and Evaluate)**
CLOCC12.3: To comprehend the thorough knowledge of competent cells and its transformation. **(Cognitive level: Understand)**
CLOCC12.4: To grasp in-depth working principle of PCR techniques from the demonstration. **(Understand and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	2	2	2	2	2	2	1	1	1	2	2	2	2	1
CLO2	1	2	2	2	3	2	1	1	1	2	2	2	1	1
CLO3	1	1	2	1	2	1	1	1	1	2	2	2	1	1
CLO4	1	2	2	1	2	1	1	1	1	2	2	2	1	1

Course Content

UNIT I **(15 hours)**

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 **(15 hours)**

Genetic Engineering: 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 **(15 hours)**

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 **(15 hours)**

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

1. Brown TA. (2006). **Gene Cloning and DNA Analysis**. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). **Biotechnology-Applying the Genetic Revolution**. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). **Molecular Biotechnology- Principles and Applications of recombinant DNA**. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). **Principles of Gene Manipulation and Genomics**, 7th edition. Blackwell Publishing, Oxford, U.K.

Teaching – Learning Strategies in brief

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Assessment methods and weightages in brief

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Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-CC13 TH **Core Course**

BIO-ANALYTICAL TOOLS (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

This course focuses on providing information about the various techniques used in molecular biology, cell biology like microscopy, chromatography, electrophoresis, centrifugation and different instruments used for measuring absorbance. This course will allow the students to learn about the principles of instrumentation, their working and pros/cons of each technique. This will also cover CD, biosensors and nanotechnology-its fundamental concept and applications.

Course Learning Outcomes

After completing this course, the students will understand:

CLOCC13.1: Understand the detailed knowledge of microscopy. **(Cognitive level: Remember and Understand)**

CLOCC13.2: Understand the difference between UV visible and fluorescence spectroscopy and colorimetry. **(Cognitive level: Analyze and Evaluate)**

CLOCC13.3: To differentiate between paper, ion exchange and affinity chromatography, calculate Rf value from a chromatogram. **(Cognitive level: Evaluate)**

CLOCC13.4: Learn fundamental principles behind centrifugation and electrophoresis and apply them practically. **(Cognitive level: Analyze and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	2	1	2	2	1	1	1	2	2	2	1	1
CLO2	1	2	2	1	2	2	1	1	1	2	2	2	1	1
CLO3	1	1	2	1	2	1	1	1	1	2	2	2	1	1
CLO4	1	1	2	2	3	2	1	1	1	2	3	2	1	1

Course Content

UNIT I **(15 hours)**

Microscopy: Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM).

UNIT II **(15 hours)**

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

UNIT III **(15 hours)**

Types of Chromatography, its principle and applications: Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV **(15 hours)**

Electrophoresis: Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing. Biosensors: Introduction, types, principle and examples of Biosensors Nanotechnology: Fundamental concept, properties and types of nanomaterials. Application of nanotechnology in agriculture, medicine and industry.

SUGGESTED READING

1. Karp, G. 2010. **Cell and Molecular Biology: Concepts and Experiments**. 6th Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. **Cell and Molecular Biology**. 5th edition. Lippincott Wiliams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. **The Cell: A Molecular Approach**. 5th edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardín. J. and Bertoni, G. P. 2009 **The World of the Cell**. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.
Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-SEC02 TH | **Skill Enhancement Course**

BASICS OF FORENSIC SCIENCE (THEORY)

(**CREDITS**: 2; **LECTURE**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The course is structured to bring some important aspects of forensic science to the knowledge of students. This subject is intent to clear the basics of tools and techniques in forensic science, its role in criminal activities, categorization of injuries and their medico-legal outlooks. The course also provides a chance to study about fire alarms, explosives and interpretation of individual's handwriting. Through this course, the students will be able to comprehend themselves with the role of toxicology, role of forensic science in DNA Fingerprinting, DNA profiling and cyber security.

Course Learning Outcomes

Upon completion of this course:

CLOSEC2.1: Students will be able to gather knowledge about basics and principles of forensic sciences. **(Cognitive level: Remember and Understand)**

CLOSEC2.2: It will help students to have a thorough idea about explosives, chemical evidences, handwriting patterns and analysis of various ink samples. **(Cognitive level: Analyze, Evaluate and Apply)**

CLOSEC2.3: Students will be able to elaborate on some important topics-DNA fingerprinting and profiling. **(Cognitive level: Remember and Apply)**

CLOSEC2.4: Students will learn the preservation of evidence and cyber security. **(Cognitive level: Understand and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	2	1	2	2	1	1	1	2	1	2	1	1
CLO2	1	1	2	1	2	1	1	1	1	2	1	2	1	1
CLO3	2	1	1	1	2	2	1	1	1	2	1	2	2	1
CLO4	2	2	2	2	2	1	1	1	1	2	2	2	1	1

Course Content

Unit I- Introduction and principles of forensic science: (8 hours)
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 II- Fire arms, explosives and writing skills: (8 hours)
Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink various samples.

Unit III- Toxicologists, fingerprinting and Data analysis: (7 hours)
Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of fingerprint as science for personal identification.

Unit IV- Investigation tools and their applications: (7 hours)
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
1. Molecular Biotechnology-**Principles and Applications of recombinant DNA**. ASM Press, Washington.
2.B.B. Nanda and R.K. Tiwari, **Forensic Science in India: A Vision for the Twenty First Century**, Select Publishers, New Delhi (2001).
3. M.K. Bhasin and S. Nath, **Role of Forensic Science in the New Millennium**, University of Delhi, Delhi (2002).
4.S.H. James and J.J. Nordby, Forensic Science: **An Introduction to Scientific and Investigative Techniques**, 2nd Edition, CRC Press, Boca Raton (2005).
5.W.G. Eckert and R.K. Wright. **An 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 (2004).
7. W.J. Tilstone, M.L. Hastrup and C. Hald, **Fisher's Techniques of Crime Scene Investigation**, CRC Press, Boca Raton (2013).

Teaching – Learning Strategies in brief
Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief
There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 13 marks. End semester exam is of 37 marks.
Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End semester examination: 37 Marks).

Paper Code: BBT-GE04 TH

General Elective Course

INTRODUCTION TO BIOLOGICAL DATA ANALYSIS (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objective

The course features to impart knowledge regarding various platforms applied for data analysis. This subject entails introduction to Linux, essential commands, different operators and loop control structures. The students will get benefit by learning basic as this course incorporates coding, basic as well as advanced python and its applications in biology.

Course Learning Outcomes

After completion of this course, students will be able to

CLOGE4.1: To comprehend the basics of Linux and essential Linux commands. **(Cognitive level: Remember and Understand)**

CLOGE4.2: To know the basics of python and its implementation in biology. **(Cognitive level: Understand, Analyse and Apply)**

CLOGE4.3: The students will get a better understanding about advanced python and its functioning. (Cognitive Level: Analyse, Evaluate and Apply)

CLOGE4.4: Students will learn to do coding and build user interfaces. **(Cognitive level: Apply and Create)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	2	2	2	1	1	1	2	1	2	1	1
CLO2	1	1	1	2	2	1	1	1	1	2	1	1	1	1
CLO3	1	1	1	2	2	1	1	1	1	2	1	2	1	1
CLO4	1	1	1	2	2	2	1	1	1	2	2	2	1	1

Course Content

Unit-I: Introduction to Linux (15 hours)
Introduction to Unix shell organization, Introduction to command line and file system, essential Unix commands like cal, banner, touch, Hie, we, sort, cut, grep, dd, write, wall, introduction to piping, loops, regular expressions, decision commands including various forms of if commands, logical operators and loop control structures.

Unit-II: Basic Python for Biology (15 hours)
Introduction and Environment, Printing and Manipulating text, Reading and Writing files, Lists and Loops, Writing customized functions, Conditional Tests, Regular Expressions, Dictionaries, Files, Programs and user input.

Unit-III: Advanced Python for Biology (15 hours)
Introduction, Recursion and Trees, Complex data structures, Object Oriented Python, Functional Python, iterators, comprehensions and generators and exception handling

Unit-IV: Python Development for Biology (15 hours)
Introduction, Environments for developing in Python, Organizing and Sharing Code, Testing Code, Performance, Building user interfaces.

SUGGESTED READING

1. Daniel J. Barrett. **Linux Pocket Guide: Essential Commands**
2. William Shotts. **The Linux Command Line**
3. Jason Cannon. **Linux for Beginners: An Introduction to the Linux Operating System and Command Line**
4. Richard Petersen. **Linux: The Complete Reference**
5. Eric Matthews. **Python Crash Course**
6. Mark Lutz. **Learning Python, 5th Edition**
7. Paul Barry. **Head-First Python (2nd edition)**
8. Allen Downey, Jeff Elkner, and Chris Meyers. **Learning with Python: How to Think Like a Computer Scientist**

Teaching – Learning Strategies in brief
Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief
There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.
Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-GE04 P

General Elective Course

INTRODUCTION TO BIOLOGICAL DATA ANALYSIS (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

Via the dry lab approach, students will be nurtured with the practical applications of genome sequencing, data analysis, genome assembly and alignment.

Course Learning Outcomes

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

CLOGE4P.1: To comprehend the practical aspects of DNA sequence. **(Cognitive level: Remember, Apply and Create)**

CLOGE4P.2: To learn the usage of DNA strings and superstrings. **(Cognitive level: Apply)**

CLOGE4P.3: To assess the applications of FASTA, sequence alignment. **(Cognitive level: Understand and Evaluate)**

CLOGE4P.4: To get the knowledge of Boyar Moore basics and its implementation. **(Cognitive level: Understand, Analyse and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	2	2	2	2	3	1	1	1	1	3	2	2	1	1
CLO2	1	1	2	1	2	1	1	1	1	2	1	1	1	1
CLO3	2	2	2	1	2	1	1	1	1	2	1	1	1	1
CLO4	2	2	2	2	2	1	1	1	1	2	1	1	1	1

Course Content

Introduction DNA sequencing data analysis Manipulating DNA strings. Downloading and parsing genome Sequencing reads in FASTA format. Working and analysis sequencing reads. Introduction to alignment.

Boyar Moore basics and its use in DNA sequencing, indexing reads. Implementation and variations of k-mer indexing. Introduction to genome assembly, its laws and shortest common superstring.

SUGGESTED READING

1. Daniel J. Barrett. **Linux Pocket Guide: Essential Commands**
2. William Shotts. **The Linux Command Line**
3. Jason Cannon. **Linux for Beginners: An Introduction to the Linux Operating System and Command Line**
4. Richard Petersen. **Linux: The Complete Reference**
5. Eric Matthews. **Python Crash Course**
6. Mark Lutz. **Learning Python, 5th Edition**
7. Paul Barry. **Head-First Python (2nd edition)**
8. Allen Downey, Jeff Elkner, and Chris Meyers. **Learning with Python: How to Think Like a Computer Scientist**

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

SEMESTER V

Paper Code: BBT-CC14 TH **Core Course**

GENOMICS AND PROTEOMICS (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

This course will allow students to learn about the different DNA and protein sequencing methods. It will give a brief introduction about different software's employed in genome analysis. This course will cover protein biochemistry: protein structure, bonding pattern, stability of protein different environment and protein purification techniques. The students will also learn about mass spectrometry and proteome analysis.

Course Learning Outcomes

Upon completion of this course the student shall understand:

CLOCC14.1: This unit aims to provide the knowledge and practical skills of functional genomics and proteomics. **(Cognitive level: Understand and Apply**)

CLOCC14.2: Understand the use of software in managing genomic data. **(Cognitive level: Apply and Create)**

CLOCC14.3: Thorough knowledge of protein structure and their interactions. **(Cognitive level: Remember and Understand)**

CLOCC14.4: Comprehend the concept of proteomics and various methods of protein identification. **(Cognitive level: Analyze and Evaluate)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	2	3	3	3	3	1	1	1	1	3	3	2	1	1
CLO2	3	3	3	3	3	1	1	1	1	2	3	2	1	1
CLO3	1	2	3	2	2	1	1	1	1	3	2	2	2	1
CLO4	1	3	3	2	3	1	1	1	1	3	3	2	1	1

Course Content

UNIT I **(15 hours)**

Introduction to Genomics, DNA sequencing methods manual and automated: Maxam and Gilbert and Sangers method. Pyro sequencing, Genome Sequencing: Shotgun and Hierarchical (clone counting) methods, Computer tools for sequencing projects: Genome sequence assembly software. Introduction of NGQ.

UNIT II **(15 hours)**

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

UNIT III **(15 hours)**

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

UNIT IV **(15 hours)**

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

1. **Genes IX** by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. **Modern Biotechnology**, 2nd Edition, S.B. Primrose, Blackwell Publishing,1987.
3. **Molecular Biotechnology**: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
4. **Molecular Cloning: A Laboratory Manual** (3rd Edition) Sam brook and Russell Vol. I to II, 1989.
5. **Principles of Gene Manipulation,** 6th Edition, S.B. Primrose, R.M. Twyman and R.W. Old. Blackwell Science, 2001.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-CC14 P **Core Course**

GENOMICS AND PROTEOMICS (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The practical of this subject will help students to clear the fundamentals topics related to NCBI, SNP, OMIM and other databases as well. It will also adhere with the concept of ORF, protein databases, prediction and hydropathy plots.

Course Learning Outcomes

Upon completion of this course the student shall understand:

CLOCC14P.1: The students will be able to learn the various databases and data retrieval. **(Cognitive level: Understand and Apply**)

CLOCC14P.2: Understand the use of software in managing genomic data. **(Cognitive level: Apply and Create)**

CLOCC14P.3: Comprehend the concept of proteomics and various methods of protein identification. **(Cognitive level: Analyze and Evaluate)**

CLOCC14P.4: Deduction of hydropathy plots. **(Cognitive level: Evaluate and Apply and Create)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	2	2	3	2	2	1	1	1	1	2	2	2	2	1
CLO2	2	2	3	3	3	1	1	1	1	2	1	1	2	1
CLO3	2	2	2	2	2	1	1	1	1	2	2	2	1	1
CLO4	3	2	2	1	2	1	1	1	1	3	3	3	1	1

Course Content

PRACTICALS:

- Use of SNP databases at NCBI and other sites
- Use of OMIM database
- Detection of Open Reading Frames using ORF Finder
- Proteomics2D PAGE database
- Software's for Protein localization.
- Hydropathy plots

SUGGESTED READING

1. Snustad, D.P., Simmons, M.J. (2009). **Principles of Genetics**. V Edition. John Wiley and SonsInc.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). **Concepts of Genetics**. IX Edition. Benjamin Cummings. 8. Russell, P. J. (2009). **iGenetics-A Molecular Approach**. III Edition. Benjamin Cummings.
3. Pevsner, J. (2009). **Bioinformatics and Functional Genomics**. II Edition. John Wiley and Sc
4. Glick, B.R., Pasternak, J.J. (2003). **Molecular Biotechnology-Principles and Applications of recombinant DNA**. ASM Press, Washington

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-DSE01 TH

Discipline Specific Course

BIOINFORMATICS (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

This course directs students to learn about the different software used to increase the knowledge of biological system. Students will get to learn about the various online information source and websites to predict the structure and sequence of biomolecules. They will learn about data retraction and submission of protein and nucleic acid, sequence alignment, phylogenetic analysis and gene annotation.

Course Learning Outcomes

Upon completion of this course the student shall understand:

CLODSE01.1: This course introduces the students to concepts in bioinformatics. **(Cognitive level: Remember and Understand)**

CLODSE01.2: The student will be able to apply basic principles of biology, computer science and mathematics to address complex biological problems. **(Cognitive level: Evaluate and Apply)**

CLODSE01.3: Comprehend the sequence and Phylogeny analysis. Students will be able to perform phylogenetic analysis. **(Cognitive level: Analyze, Apply and Create)**

CLODSE01.4: Understand the concept of data base and gene identifying tools. **(Cognitive level: Understand)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	3	2	2	3	1	1	1	1	3	2	2	2	1
CLO2	2	3	3	2	3	1	1	1	1	3	3	3	3	1
CLO3	1	2	2	1	2	1	1	1	1	2	2	2	1	1
CLO4	3	3	2	1	2	1	1	1	1	2	2	2	2	1

Course Content

UNIT I **(15 hours)**

Introduction of Bioinformatics: History of Bioinformatics. The notion of Homology Sequence information Sources, EMBL, GEN BANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT II **(15 hours)**

Protein biology and computational biology: Protein Information Sources, PDB, SWISSPROT, LEMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction L Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT III **(15 hours)**

Sequencing and phylogenetics: Sequence and Phylogeny analysis, Detecting Open Reading frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT IV **(15 hours)**

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

SUGGESTED READING

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

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.
Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-DSE01 P | **Discipline Specific Course**

BIOINFORMATICS (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This practical would act as an introductory window for the students to world of bioinformatics and its tools: EMBL, PDB, PIR, Genbank, BLAST. Students will learn to interpret about data BLAST and data retrieval and multiple sequence alignment will also be covered as an important topic under this practical.

Course Learning Outcomes

Upon completion of this course the student shall understand:

CLODSE01P.1: To get introduced to the basic concepts of Bioinformatics and its significance in biological data analysis. **(Cognitive level: Remember and Understand)**

CLODSE01P.2: Implementation of bioinformatics tools in understanding protein structures. **(Cognitive level: Analyze and Apply)**

CLODSE01P.3: Understanding the classification of protein databases. **(Cognitive level: Understand)**

CLODSE01P.4: Learning about the sequence alignment. **(Cognitive level: Remember, Understand and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	2	2	1	2	1	1	1	1	3	2	2	2	1
CLO2	1	2	3	1	2	1	1	1	1	3	2	2	1	1
CLO3	1	1	2	1	2	1	1	1	1	3	2	2	1	1
CLO4	2	2	2	2	2	1	1	1	1	3	1	1	1	1

Course Content

PRACTICALS

- Sequence information resource
- Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
- Understanding and using: PDB, Swissprot, TREMBL
- Using various BLAST and interpretation of results.
- Retrieval of information from nucleotide databases
- Sequence alignment using BLAST.
- Multiple sequence alignment using Clustal W.

SUGGESTED READING

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

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-DSE02 TH | **Discipline Specific Course**

ANIMAL BIOTECHNOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The course is designed to discuss gene transfer methods in animals involving microinjection, virus-mediated gene transfer. The students will be introduced to the concept of transgenesis and role of biotechnology in animal diseases. The course will put light on the important notions of animal biotechnology- cloning, stem cell therapy and its application. Some interesting chapters revolving around gene therapy, molecular and genetic engineering and its ethical perspectives will pave a broader way for the students to have a clear understanding.

Course Learning Outcomes

Upon completion of this course the student shall understand:

CODSE02.1: Understand basics of gene transfer methods in animals. **(Cognitive level: Remember and Understand)**

CODSE02.2: Students will learn about transgenic animal, their application in pharmaceutical industry, cloning and its importance. **(Cognitive level: Analyze and Apply)**

CODSE02.3: Implementation of animal biotechnology in animal breeding and understanding the concept of stem cell technology. **(Cognitive level: Analyze and Evaluate)**

CODSE02.4: To understand the basics of gene therapy and its types, problems and ethics involved in human genetic engineering. **(Cognitive level: Understand and Evaluate)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	3	3	2	2	3	1	2	2	1	2	2	2	2	1
CLO2	2	2	2	3	2	1	1	1	1	3	3	2	2	2
CLO3	2	2	3	2	3	1	1	1	1	2	3	2	2	1
CLO4	2	3	2	2	3	2	3	2	2	3	3	2	2	2

Course Content

UNIT I **(15 hours)**

Gene transfer methods in Animals: Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer

UNIT II **(15 hours)**

Introduction to transgenesis: Transgenic Animals -Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology Foot-and mouth disease, Coccidios1s, Trypanosomiasis, Theileriosis.

UNIT III **(15 hours)**

Animal propagation: Artificial insemination, Animal Clones. Conservation Biology - Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

UNIT IV **(15 hours)**

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

SUGGESTED READING

- Brown, T.A. (1998). **Molecular biology Labfax II: Gene analysis**. II Edition. Academic Press, California, USA.
-Butler, M. (2004). **- Animal cell culture and technology: The basics.** II Edition. Bios scientific publishers.
- Glick, B.R. and Pasternak, J.J. (2009). **Molecular Biotechnology- Principles and applications of recombinant DNA**. IV Edition. ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). **An introduction to genetic analysis.** IX Edition. Freeman & Co., N. Y., USA.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). **Recombinant DNA- genes and genomes- A short course**. III Edition. Freeman and Co., N. Y., USA.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.
Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-DSE02 P | **Discipline Specific Course**

ANIMAL BIOTECHNOLOGY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs):** 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This practical course will act as a platform for the students to learn about the sterilization techniques and explore various interesting animal cell techniques. They will be encouraged to perform isolation of lymphocytes and DNA from animal culture. Further, the experiments will focus on quantification and gel electrophoresis, thereby enabling students in their progress.

Course Learning Outcomes

Upon completion of this course the student shall understand:

CODSE02P.1: Understand the practical aspects of sterilization. **(Cognitive level: Remember and Understand)**

CODSE02P.2: Students will be able to prepare various salt solutions as well as growth medium **(Cognitive level: Remember and Apply)**

CODSE02P.3: Students will able to perform isolation techniques for both lymphocytes and nucleic acids. **(Cognitive level: Analyze and Apply)**

CODSE02P.4: Students will also practically quantify the DNA and run the gel. **(Cognitive level: Understand and Evaluate)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	1	1	1	1	1	1	3	3	2	1	1
CLO2	1	1	1	1	1	1	1	1	1	3	3	2	1	1
CLO3	1	2	1	1	2	1	1	1	1	3	2	2	1	1
CLO4	1	1	1	1	1	1	1	1	1	3	3	3	1	1

Course Content

PRACTICALS

- Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
- Sources of contamination and decontamination measures.
- Preparation of Hanks Balanced salt solution.
- Preparation of Minimal Essential Growth medium.
- Isolation of lymphocytes for culturing.
- DNA isolation from animal tissue.
- Quantification of isolated DNA.
- Resolving DNA on Agarose Gel.

SUGGESTED READING

- Brown, T.A. (1998). **Molecular biology Labfax II: Gene analysis**. II Edition. Academic Press, California, USA.
-Butler, M. (2004). **- Animal cell culture and technology: The basics.** II Edition. Bios scientific publishers.
- Glick, B.R. and Pasternak, J.J. (2009). **Molecular Biotechnology- Principles and applications of recombinant DNA**. IV Edition. ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). **An introduction to genetic analysis.** IX Edition. Freeman & Co., N. Y., USA.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). **Recombinant DNA- genes and genomes- A short course**. III Edition. Freeman and Co., N. Y., USA.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-DSE03 TH

Discipline Specific Course

ENVIRONMENTAL BIOTECHNOLOGY (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

This particular course aims to elucidate the relation between biotechnology and environment. The subject matter is framed to discuss renewable ad non-renewable sources, bioremediation and role of micro-organism in degradation. The students will encompass about the topics including treatment of waste, biofertilizers, nitrogen fixation by bacteria and importance of genetically modified microbes.

Course Learning Outcomes

CODSE07.1: The course provides competence in exploring applications of biotechnology in monitoring and ameliorating environmental pollution. **(Cognitive level: Understand)**

CODSE07.2: It also provides technology for developing plants tolerant/resistant to biotic and abiotic stresses. **(Cognitive level: Understand and Analyze)**

CODSE07.3: To determine biochemical oxygen demand and chemical oxygen demand. **(Cognitive level: Analyze)**

CODSE07.4: To learn about the most probable number for the determination of bacterial colonies. **(Cognitive level: Evaluate and Apply)**

CODSE07.5: To perform the experiment for the determination of total dissolved solids. **(Cognitive level: Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	3	2	1	2	2	2	3	3	3	3	3	2	2	2
CLO2	3	2	2	1	1	1	1	1	1	2	2	2	2	1
CLO3	1	1	2	1	1	1	1	1	1	2	2	2	1	1
CLO4	1	1	2	1	1	1	1	1	1	2	2	2	1	1
CLO5	1	1	1	1	1	1	1	1	1	2	2	2	1	1

Course Content

UNIT I **(15 hours)**

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 **(15 hours)**

Bioremediation and Phytoremediation:

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto- remediation. Degradation of pesticides and other toxic chemicals by micro- organisms-degradation aromatic and chlorinates hydrocarbons and petroleum products.

UNIT III **(15 hours)**

Waste management and biofertilizers:

Treatment of municipal waste and Industrial effluents. Bio- fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil.
Algal and fungal biofertilizers (VAM).

UNIT IV **(15 hours)**

Applications of Environmental Biotechnology:

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

SUGGESTED READING

- **Environmental Science**, S.C. Santra
- **Environmental Biotechnology**, Pradipta Kumar Mohapatra
- **Environmental Biotechnology Concepts and Applications**, Hans-Joachim Jordening and Jesef Winter
- **Waste Water Engineering**, Metcalf and Eddy, Tata McGraw hill
- **Agricultural Biotechnology**, S.S. Purohit
- **Environmental Microbiology: Methods and Protocols**, Alicia L. Ragout De Spencer, John F.T. Spencer
- **Introduction to Environmental Biotechnology**, Milton Wainwright
- **Principles of Environmental Engineering**, Gilbert Masters

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.
Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-DSE03 P

Discipline Specific Course

ENVIRONMENTAL BIOTECHNOLOGY (PRACTICALS)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This course includes calculative practice: TDS, BOD and COD of water sample. The students will be demonstrated about the bacterial examination of water by MPN method.

Course Learning Outcomes

CODSE07P.1: To learn about calculative methods for BOD. **(Cognitive level: Understand and Apply)**

CODSE07P.2: To learn about calculative methods for COD. **(Cognitive level: Understand and Apply)**

CODSE07P.3: To grasp calculations for TDS of water sample as well. **(Cognitive level: Understand, Analyze and Apply)**

CODSE07P.4: They will able to deduce MPN method employed for bacterial examination of water. **(Cognitive level: Remember and Understand)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	2	2	1	1	2	1	1	1	1	2	2	2	1	1
CLO2	2	2	1	1	1	1	1	1	1	2	2	2	1	1
CLO3	2	2	2	1	2	1	1	1	1	3	2	1	1	1
CLO4	2	2	2	2	2	1	1	1	1	3	1	1	1	1

Course Content

PRACTICALS

- Calculation of Total Dissolved Solids (TDS) of water sample
- Calculation of BOD of water sample.
- Calculation of COD of water sample.
- Bacterial Examination of Water by MPN Method.

SUGGESTED READING

- Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
- Agricultural Biotechnology, S.S. Purohit
- Environmental Microbiology: Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
- Introduction to Environmental Biotechnology, Milton Wainwright
- Principles of Environmental Engineering, Gilbert Masters

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

SEMESTER VI

Paper Code: BBT-CC07 P **Core Course**

GENETICS (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The practical aspects of this course deals with the mounting techniques in relevance to mitosis and meiosis. The students will be given demonstration on Barr Body and karyotyping. Students will gain next level knowledge about pedigree charts and polyploidy in onion root tip.

Course Learning Outcomes

This practical course will enable students to

COCC07P.1: Comprehend the concept of karyotyping and pedigree. **(Cognitive level: Analyse and Evaluate)**

COCC07P.2: Students will get in-depth knowledge of mitosis and meiosis. They will be able to prepare mitotic and meiotic slides. **(Cognitive level: Understand and Apply)**

COCC07P.3: Via demonstrations and figures, students will know about barr-bodies, blood grouping, pedigree.

COCCO7P.4: Students will study about the polyploidy. **(Cognitive level: Analyze and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	2	2	2	2	1	1	1	1	3	2	2	1	1
CLO2	1	1	1	1	1	1	1	1	1	3	1	2	1	1
CLO3	1	2	1	1	1	1	1	1	1	3	2	1	1	1
CLO4	1	1	2	1	2	1	1	1	1	2	2	1	1	1

Course Content

1. Permanent and temporary mount of mitosis.
2. Permanent and temporary mount of meiosis.
3. Mendelian deviations in dihybrid crosses
4. Demonstration of -Barr Body
5. Karyotyping with the help of photographs
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of polyploidy in onion root tip by colchicine treatment.

SUGGESTED READING

1. Gardner, B.J., Simmons, M.J., Snustad, D.P. (2006). **Principles of Genetics**. VIII Edition John Wiley and Sons.
2. Snustad, D.P., Simmons, M.J. (2009). **Principles of Genetics**. V 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. (2009). **Genetics- A Molecular Approach**. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. **Introduction to Genetic Analysis**, W. H. Freeman and Co.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC08 P **Core Course**

MICROBIOLOGY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The practical of this subject will be aiming for the student to learn isolation of bacteria and their biochemical characterization, staining methods and the basics of media preparation. These practical will incorporate important topics based on microscopy and enumeration of micro-organism-total and viable count.

Course Learning Outcomes

This practical course will enable students to

COCC08P.1: This course will teach students various staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop. **(Cognitive level: Remember and Evaluate)**

COCC08P.2: Students shall learn the preparation of media and sterilization methods. **(Cognitive level: Understand and Apply)**

COCC08P.3: Methods of isolation of bacteria from different sources will be comprehended. **(Cognitive level: Apply)**

COCC08P.4: Implementation of microscopy. **(Cognitive level: Remember, Analyze and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CLO1	1	1	2	1	2	1	1	1	1	3	2	3	1	1
CLO2	1	1	1	1	1	1	1	1	1	3	3	3	1	1
CLO3	1	1	1	1	1	1	1	1	1	3	2	2	1	1
CLO4	1	2	2	2	2	1	1	1	1	3	3	3	1	1

Course Content

PRACTICALS

1. Isolation of bacteria and their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media and sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell by microscope.
5. Enumeration of microorganism-total and viable count.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). **Introductory Mycology**. 4th 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. (2009). **Brock Biology of Microorganisms**. 12th 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. (2008). **Microbiology: An Introduction**. 9th edition. Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). **Prescott, Harley and Klein's Microbiology**. 7th edition. McGraw Hill Higher Education

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC09 P **Core Course**

MOLECULAR BIOLOGY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The practical aspect of molecular biology techniques included in this subject put emphasis on reagent preparation, isolation of chromosomal and plasmid DNA. It will also involve technicalities dealt in gel electrophoresis and digestion of restriction enzymes.

Course Learning Outcomes

This practical course will enable students to

COCC09P.1: Students will learn preparation of reagents for Molecular Biology experiments. **(Cognitive level: Remember and Apply)**

COCC09P.2: Isolation of chromosomal DNA and Plasmid DNA from the bacterial cells. **(Cognitive level: Analyze and Apply)**

COCC09P.3: Practical aspects of gel electrophoresis. **(Cognitive level: Apply)**

COCC09P.4 Practical aspects of restriction enzyme digestion. **(Cognitive level: Understand and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	1	1	1	1	1	1	3	2	2	1	1
CLO2	1	1	1	1	2	1	1	1	1	3	2	3	1	1
CLO3	1	1	1	1	1	1	1	1	1	3	3	3	2	1
CLO4	1	1	1	1	1	1	1	1	1	3	2	2	1	1

Course Content

PRACTICALS

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA and plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples

SUGGESTED READING

1. Karp, G. (2010). **Cell and Molecular Biology: Concepts and Experiments.** VI Edition. John Wiley and 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., (2008) **Molecular Biology of the Gene** (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC10 P **Core Course**

PLANT ANATOMY AND PHYSIOLOGY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The practical aspects of this subject include preparation of stained mounts of various anatomical structures of plant. Students will be given demonstration of processes such as plasmolysis, opening & closing of stomata and aerobic respiration. It will also help students to clear their practical concepts regarding preparation of root nodules and chromatography techniques.

Course Learning Outcomes

After completing this practical course, the students shall be able to:

COCC10P.1: To prepare anatomical slides of different parts of the plant. **(Cognitive level: Remember and Apply)**

COCC10P.2: Demonstration of opening and closing of Stomata and preparation of root nodules from a leguminous plant. **(Cognitive level: Understand)**

COCC10P.3: Understand the concept of chromatography and perform separation of photosynthetic pigments by paper chromatography. **(Cognitive level: Apply)**

COCC10P.4: Students will get demonstrations for different processes such as plasmolysis, aerobic respiration. **(Cognitive level: Understand and Analyze)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	1	1	1	1	1	1	3	2	2	1	1
CLO2	1	1	1	1	1	1	1	1	1	2	1	1	1	1
CLO3	1	1	1	1	1	1	1	1	1	3	3	2	1	1
CLO4	1	1	1	1	1	1	1	1	1	3	3	1	1	1

Course Content

PRACTICALS

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem and leaf.
2. Demonstration of plasmolysis by Tradescantia leaf peel.
3. Demonstration of opening and closing of Stomata
4. Separation of photosynthetic pigments by paper chromatography.
5. Demonstration of aerobic respiration.
6. Preparation of root nodules from a leguminous plant.

SUGGESTED READING

1. Dickinson, W.C. 2000. **Integrative Plant Anatomy**. Harcourt Academic Press, USA.
2. Esau, K. 1977. **Anatomy of Seed Plants**. Wiley Publishers.
3. Fahn, A. 1974. **Plant Anatomy**. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008. **Introduction to Plant Physiology**. John Wiley and Sons.
5. Mauseth, J.D. 1988. **Plant Anatomy**. The Benjammin/Cummings Publisher, USA. 6. Nelson, D.L., Cox, M.M. 2004. **Lehninger Principles of Biochemistry,** 4th edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991. **Plant Physiology**, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006. **Plant Physiology**, 4 th edition, Sinauer Associates Inc .MA, USA

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC11 P **Core Course**

BIOPROCESS TECHNOLOGY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The course objective includes in practical based on bacterial growth curve, analysis of amylase and lactic acid. The students will also get a chance to isolate industrially important microbes which will help them to expand their knowledge boundaries.

Course Learning Outcomes

COCC11P.1: To understand the practical aspect of bacterial growth kinetics and calculation of thermal death point. **(Cognitive level: Remember and Understand)**
COCC11P.2: Understand about the isolation and purification of amylases and lactic acid. **(Cognitive level: Apply)**
COCC11P.3: To learn the isolation techniques for industrially important microbes from natural sources. **(Cognitive level: Analyze, Evaluate and Apply)**
COCC11P.4: To learn about the calculative knowledge about TDP **(Cognitive level: Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	2	2	1	2	1	1	1	1	3	3	3	1	1
CLO2	1	1	1	1	1	1	1	1	1	2	2	2	1	1
CLO3	1	1	1	1	1	1	1	1	1	3	3	3	1	1
CLO4	1	1	1	1	1	1	1	1	1	2	1	1	1	1

Course Content

PRACTICALS

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of amylase.
4. Production and analysis of lactic acid.
5. Isolation of industrially important microorganism from natural resource.

SUGGESTED READING

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

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC12 P **Core Course**

RECOMBINANT DNA TECHNOLOGY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This course deals with the practical learnings about isolation of DNA from both animal and plant cells. Students will be able gain practical knowledge of spectrophotometry in qualitative and quantitative analysis of nucleic acids, plasmid DNA isolation, usage of restriction enzymes and competent cells. The course will further adhere with the demonstration of one of the crucial experiments involved in diagnostics-PCR.

Course Learning Outcomes

After completing this practical course, the students shall be able to:

COCC12P.1: Students will learn the isolation techniques of chromosomal DNA from plant cells and *E. coli*. **(Cognitive level: Remember and Apply)**

COCC12P.2: To learn about the qualitative and quantitative analysis of DNA using Spectrophotometer. **(Cognitive level: Analyze and Evaluate)**

COCC12P.3: To comprehend the thorough knowledge of competent cells and its transformation. **(Cognitive level: Understand)**

COCC12P.4: To grasp in-depth working principle of PCR techniques from the demonstration. **(Understand and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	1	1	1	1	1	1	3	2	2	1	1
CLO2	1	1	1	1	1	1	1	1	1	3	3	3	1	1
CLO3	1	1	1	1	2	1	1	1	1	3	2	2	1	1
CLO4	1	2	2	2	2	1	1	1	1	3	3	3	2	2

Course Content

PRACTICALS

1. Isolation of chromosomal DNA from plant cells.
2. Isolation of chromosomal DNA from *E. coli*
3. Qualitative and quantitative analysis of DNA using Spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of Competent cells.
8. Demonstration of PCR

SUGGESTED READING

1. J.F. Sambrook and D.W. Russell, ed., **Molecular Cloning: A Laboratory Manual,** 3rd ed., Vols 1,2 and 3
2. Brown TA. (2006). **Gene Cloning and DNA Analysis**. 5th edition. Blackwell Publishing, Oxford, U.K.
3. Clark DP and Pazdernik NJ. (2009). **Biotechnology-Applying the Genetic Revolution**. Elsevier Academic Press, USA.
4. Glick, B.R., Pasternak, J.J. (2003). **Molecular Biotechnology- Principles and Applications of recombinant DNA**. ASM Press, Washington
5. Primrose SB and Twyman RM. (2006). **Principles of Gene Manipulation and Genomics**, 7th edition. Blackwell Publishing, Oxford, U.K.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-CC13 P **Core Course**

BIO ANALYTICAL TOOLS (PRACTICALS)

(**CREDITS**: 2; **Practical (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This course will allow the students to learn about protein separation in Native and Reducing condition, amino acid separation, preparation of sub-cellular fractions of rat liver cells, identification of lipids by TLC and determination of molar extinction co efficient of NADH. This course will also teach about the use of biosensor in estimation of blood glucose.

Course Learning Outcomes

This practical course enables students to:

COCC13P.1: Students will learn about the practical approach of Native and SDS gel electrophoresis. **(Cognitive level: Understand and Apply)**

COCC13P.2: To prepare sub-cellular fraction of rat liver cells. **(Cognitive level: Analyze and Evaluate)**

COCC13P.3: Students will able to separate amino acids by using paper chromatography. **(Cognitive level: Remember and Apply)**

COCC13P.4: To learn the hands-on approach of TLC and validation of Beer's Law. **(Cognitive level: Understand and Apply)**

COCC13P.5: To learn the applications of biosensors in day-to-day life. **(Cognitive level: Remember and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	1	1	1	1	1	1	2	2	2	1	1
CLO2	1	1	1	1	1	1	1	1	1	2	2	2	1	1
CLO3	1	1	2	1	2	1	1	1	1	3	3	2	1	1
CLO4	1	1	1	1	2	1	1	1	1	3	3	2	1	1
CLO5	2	2	2	2	2	1	1	2	1	3	3	3	2	2

Course Content

PRACTICALS

1. Native gel electrophoresis of proteins
2. SDS- polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub- cellular fractions of rat liver cells.
4. Separation of amino acids by paper chromatography.
5. To identify lipids in a given sample by TLC.
6. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.
7. Estimation of blood glucose level using biosensor.

SUGGESTED READING

1. Karp, G. 2010. **Cell and Molecular Biology: Concepts and Experiments**. 6th Edition. John Wiley and Sons. Inc.
2. HOFMANN A. **Wilson And Walkers Principles and Techniques of Biochemistry and Molecular Biology.** (2018) CAMBRIDGE UNIVERSITY PRESS
3. Cooper, G.M. and Hausman, R.E. 2009. **The Cell: A Molecular Approach**. 5th edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. **Cold Spring Harbor Protocols.** by Cold Spring Harbor Laboratory Press.
5. Khalid Z. Masoodi, Sameena Maqbool Lone and Rovidha Saba Rasool. **Advanced Methods in Molecular Biology and Biotechnology, A Practical Lab Manual.** Academic Press, 2021

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-GE02A P

General Elective Course

BIOETHICS AND IPR (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This course will allow students to know about the ethics of animal handling, biosafety regulation and risk assessment while carrying out experimentation. Students will also learn about the significance and framework of IPR along with patenting protocol.

Course Learning Outcomes

Upon completion of this practical course the students shall enable:

COGE02A.1: To create awareness on the Biosafety, Bioethics and patenting of biotechnological processes and products. **(Cognitive level: Understand and Remember)**

COGE02A.2: To understand legal, ethical and social impacts of biotechnology research. **(Cognitive level: Remember and Apply)**

COGE02A.3: Students will be well-versed with guidelines of bioethics committee-IRB and BAC. **(Cognitive level: Remember and Understand)**

COGE02A.4: Students will learn about the risk involved in experiment and will help them to plan accordingly. **(Cognitive level: Remember and Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
CLO2	1	1	1	1	1	2	2	2	2	2	2	2	2	2
CLO3	1	1	1	1	1	2	2	2	2	2	2	2	1	2
CLO4	1	1	1	2	1	1	1	1	1	3	3	2	1	1

Course Content

1. Ethical Consideration for Laboratory animals while handling and other procedures during research.
2. Bio safety regulation during biological research. 3.Significance of IPR/ criteria for India patient Act. 1970.
4. Concept of Bioethics (organization of economic Cooperation/Development cartagena Biosafety Protocol.
5. Guidelines of International review board (IRB) & Bioethics Advisory Committee (BAC)
6. Steps involved in Risk Assessment & Communication.

Reference Books:

1. **IPR, Biosafety and Bioethics** by Goel and Parashar
2. **Genetically Modified Crops and Agricultural Development** (Palgrave Studies in Agricultural Economics and Food Policy)" by Matin Qaim
3. **Biosafety and Bioethics** by Rajmohan Joshi
4. **Bioethics and Biosafety in Biotechnology** by V Sree Krishna
5. **"An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology"** by Padma Nambisan

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-GE02B P

General Elective Course

BIOTECHNOLOGY AND HUMAN WELFARE (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This course will focus on giving a hand on experience in isolation of DNA from biological sample, isolation of crude polyphenol oxidase from banana pulp, production of ethanol from baker's yeast and application of protein engineering to alter enzyme kinetics. This course will teach them to perform the quantitative estimation of residual chlorine in water samples, development of fingerprint by iodine crystals and also the demonstration of morphological and anatomical features of root nodule of a leguminous plant.

Course Learning Outcomes

After completing this course, the students shall understand:

COGE02B.1: Biotechnology for human welfare aims to provide introduction of various fields of biotechnology e.g., Agricultural, pharmaceutical and industrial biotechnology and their contribution for human welfare. **(Cognitive level: Remember, Understand and Apply)**

COGE02B.2: It aims at gaining an understanding of current experimentation in biotechnology and genetic engineering. **(Cognitive level: Understand and Remember)**

COGE02B.3: The course imparts knowledge regarding benefits of biotechnology in forensic science and crime detection by employing various molecular biology techniques. **(Cognitive level: Analyze and Apply)**

COGE02B.4: Students will learn about fingerprint techniques. **(Cognitive level: Apply)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	1	1	1	1	1	1	3	2	2	2	2
CLO2	1	1	2	1	1	1	1	1	1	3	3	3	1	1
CLO3	2	2	2	2	2	2	1	1	2	2	2	2	1	1
CLO4	1	1	1	1	1	1	1	1	2	3	2	2	1	1

Course Content

PRACTICAL

(Wherever wet lab experiments are not possible the Principles and Concept can be demonstrated through any other material or medium including videos/ vital labs etc.)

1. Principle and application of protein engineering to improve/ alter the enzyme kinetics of a given industrial enzyme.
2. Isolation of crude polyphenol oxidase from banana pulp.
3. Production of ethanol using Baker's yeast in a fermenter.
4. To describe the morphological and anatomical features of root nodule of a given leguminous plant.
5. To perform quantitative estimation of residual chlorine in water samples
6. Isolation and analysis of DNA from available biological sample.
7. Fingerprint development by iodine crystals.

Reference Books:

1. ***Biotechnology and Human Welfare for Competitive Examinations*** by Dr. Subroto Biswas
2. ***Biotechnology and Biopharmaceuticals***, Ho Rodney J. Y.
3. ***Biotechnology Operations: Principles and Practices,*** John M Centanni and Michael J Roy
4. ***Biotechnology***, Clark David P.

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-GE03 P

General Elective Course

DEVELOPMENTAL BIOLOGY (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

The practical aspects of this course deals with the identification of developmental stage of chick and frog embryo using permanent mounts, preparation of temporary stained mount of chick embryo, study of developmental stages of Drosophila from stock culture/photographs and study of different type of placenta.

Course Learning Outcomes

After performing the experiments, the students shall understand

COGE03.1: Understand the developmental stage of chick and frog embryo. **(Cognitive level: Remember and Understand)**

COGE03.2: Preparation of mounted slides for different embryos **(Cognitive level: Remember, Analyse and Apply)**

COGE03.2: Comprehend the developmental stages of Drosophila. **(Cognitive level: Analyse and Evaluate)**

COGE03.3: Understand different types of placentas. **(Cognitive level: Remember and Evaluate)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	1	1	1	1	1	1	1	1	1	2	2	1	1	1
CLO2	1	1	1	1	1	1	1	1	1	2	2	2	1	1
CLO3	1	1	2	1	1	1	1	1	1	2	2	1	1	1
CLO4	1	1	1	1	1	1	1	1	1	3	1	1	1	1

Course Content

PRACTICALS

1. Identification of developmental stage of chick and frog embryo using permanent mounts
2. Preparation of a temporary stained mount of chick embryo
3. Study of the developmental stages of Drosophila from stock culture/ Photographs.
4. Study of different types of placentas.

SUGGESTED READING

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

Teaching – Learning Strategies in brief

The teaching learning strategy followed is learning by doing.

Assessment methods and weightages in brief

The internal practical sessional exam is conducted for 13 marks. End semester exam is of 37 marks. Total Marks are 50 for the subject (Internal Assessment: 13 Marks and End Semester Examination: 37 Marks).

Paper Code: BBT-DSE06 TH

Discipline Specific Course

ECOLOGY AND ENVIRONMENT MANAGEMENT (THEORY)

(**CREDITS**: 4; **LECTURE**: 60; **MAXIMUM MARKS**: 100 (25 **INTERNAL ASSESSMENT** + 75 **SEMESTER EXAM**)

Course Objectives

The course offers detailed insight on structural and functional components of an ecosystem. The topics that are covered under this subject mainly focus on food chain, trophic levels, pyramids and bio-geochemical cycles. Students will able to have a better and clear understanding about their previous knowledge regarding pollution and its related health/environment hazards, role of biotechnology in protecting our environment.

Course Learning Outcomes

Upon the completion of the course, the students shall be able to:

CODSE06.1: The course provides competence in exploring various biotic and abiotic ecosystems. **(Cognitive level: Understand and Remember)**

CODSE06.2: The course provides basic theory and hands on expertise in the soil testing. **(Cognitive level: Analyze and Apply)**

CODSE06.3: It provides basic theory in the survivorship curves and theory & applications of global positioning system (GPS) in agrometeorology. **(Cognitive level: Understand and Evaluate)**

CODSE06.4: Understand and explore a few major about the various biotic and abiotic ecosystems. **(Cognitive level: Remember)**

Mapping of Course Learning Outcomes (CLOs) with Program Learning Outcomes (PLOs) and Program Specific Outcomes (PSOs)

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CLO1	2	1	3	2	1	2	2	2	1	2	1	1	2	1
CLO2	1	2	2	1	1	1	1	2	1	2	1	1	2	1
CLO3	2	2	2	1	3	2	1	1	1	2	1	1	2	1
CLO4	2	2	3	2	2	1	1	1	1	2	1	1	2	1

Course Content

Unit I **(15 hours)**

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere, Scope of Ecology. Development and Evolution of Ecosystem. Principles and concepts of Ecosystem. Structure of Ecosystem. Strata of an Ecosystem. Types of ecosystems including habitats. Cybernetics and Homeostasis. Biological control of chemical environment.

Unit II **(15 hours)**

Energy transfer in an Ecosystem: Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids. Ecological energetic, principles of pertaining to limiting factor, Bio-geochemical cycles (N, C, P cycles)

Unit III **(15 hours)**

Pollution and Environment: Environmental health related to soil, water, air, food, pesticides, radiations, metals, carcinogens, solvents, poisons, etc. Detection of environmental pollutant. Indicators in detection system. Biotransformation, plastic, aromatics, hazardous waste, environmental clean-up case studies.

Unit IV **(15 hours)**

Environmental Biotechnology: Biotechnology in protection and preservation of environment. Bioremediation, waste disposal.

SUGGESTED READING

1.Chapman, J.L., Reiss, M.J. 1999. **Ecology: Principles and applications** (2nd edition) Cambridge University Press.
2.Divan Rosen craz, **Environmental laws and policies in India**, Oxford Publication.
3.Ghosh, S.K. Singh, R. 2003. **Social forestry and forest management**. Global Vision Publishing House
4.Joseph, B., **Environmental studies**, Tata Mc Graw Hill.
5.Michael Allabay, **Basics of environmental science**, Routledge Press.
6.Miller, G.T. 2002. **Sustaining the earth, an integrated approach** (5th edition) Books/Cole, Thompson Learning, Inc.
7. Mohapatra, **Textbook of environmental biotechnology**. IK publication.
8. Rana SVS, **Environmental pollution-health and toxicology**, Narosa Publication
9. Sinha, S. 2010. **Handbook on Wildlife Law Enforcement in India**. TRAFFIC, India.
10. Thakur, S, **Environmental Biotechnology**, I K Publication.

Teaching – Learning Strategies in brief

Board (black and jam board) and chalk teaching, learning through discussion among the peer group, classroom interactions, quizzes, presentations, Q & A sessions and reflective learning are some of the teaching - learning strategies adopted by the department.

Assessment methods and weightages in brief

There are two components of assessment namely internal assessment and end semester examination. Internal assessment consists of assessment through administration of three sessional exams/tests. The average marks of best of two sessional exams/tests are computed for internal assessment. Sessional exam/test is conducted and computed for 25 marks. End semester exam is of 75 marks.
Total Marks are 100 for the subject (Internal Assessment: 25 Marks and End semester examination: 75 Marks).

Paper Code: BBT-DSE06 P

Discipline Specific Course

ECOLOGY AND ENVIRONMENT MANAGEMENT (PRACTICAL)

(**CREDITS**: 2; **PRACTICAL (hrs)**: 30; **MAXIMUM MARKS**: 50 (13 **INTERNAL ASSESSMENT** + 37 **SEMESTER EXAM**)

Course Objectives

This course deals with the practical aspects of study of biotic and abiotic components of any simple ecosystem- natural pond, terrestrial or human modified ecosystem; determination of population density by quadrate method and calculation of the Simpson's and Shannon-Weiner diversity index for the sample community; principle of GPS, study of life table and fecundity table and plotting of survivorship curves of the hypothetical data and study of different types of soil, their texture by sieve method and rapid tests for pH, chlorides, nitrates, carbonates and organic carbon. Students will also learn about any endangered and threatened Species-one from each class.

Course Learning Outcomes

After completion of this course, the students shall understand

CODSE06.1: Understand all the biotic and abiotic components of any simple ecosystem natural pond or terrestrial ecosystem or human modified ecosystem. **(Cognitive level: Remember and Understand)**

CODSE06.2: Understand life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data. **(Cognitive level: Analyse and Evaluate)**

CODSE06.3: Comprehend the concept of soil and its types, their texture by sieve method. **(Cognitive level: Analyse and Apply)**

CODSE06.4: Rapid tests for -pH, Chlorides, nitrates Carbonates and organic carbon. **(Cognitive level: Apply)**

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CLO3	2	2	2	2	3	2	1	1	1	2	1	1	2	1
CLO4	2	2	3	2	2	1	1	1	1	2	1	1	2	1

Course Content

PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem-natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quadrate Method and calculation of the Simpson's and Shannon- Weiner diversity index for the sample community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for -pH, Chlorides, nitrates Carbonates and organic carbon.
6. Study any five endangered threatened Species -one from each class.

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1.Chapman, J.L., Reiss, M.J. 1999. **Ecology: Principles and applications** (2nd edition) Cambridge University Press.
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Assessment methods and weightages in brief

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