M.Sc. BIOTECHNOLOGY

LOCF SYLLABUS – 2021

SCHOOLS OF EXCELLENCE

WITH CHOICE BASED CREDIT SYSTEM (CBCS)

DEPARTMENT OF BIOTECHNOLOGY
SCHOOL OF BIOLOGICAL SCIENCES
ST.JOSEPH'S COLLEGE (AUTONOMOUS)
Special Heritage Status Awarded by UGC
Accredited at A^{++} Grade (IV Cycle) by NAAC
College with Potential for Excellence by UGC
DBT-STAR & DST-FIST Sponsored College
Tiruchirappalli - 620 002, Tamil Nadu, India

SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS)
POSTGRADUATE COURSES

St. Joseph's College (Autonomous), a pioneer in higher education in India, strives to maintain and uphold the academic excellence. In this regard, it has initiated the implementation of five "Schools of Excellence" from the academic year 2014 – 15, to meet and excel the challenges of the 21st century.

Each School integrates related disciplines under one roof. The school system enhances the optimal utilization of both human and infrastructural resources. It also enhances academic mobility and enriches employability. The School system preserves the identity, autonomy and uniqueness of every department and reinforces Student centric curriculum designing and skill imparting. These five schools adhere to achieve and accomplish the following objectives.

Optimal utilization of resources both human and material for the academic flexibility leading to excellence.

Students experience or enjoy their choice of courses and credits for their horizontal mobility.

The existing curricular structure as specified by TANSCHE and other higher educational institutions facilitate the Credit-Transfer Across the Disciplines (CTAD) - a uniqueness of the choice based credit system.

Human excellence in specialized areas

Thrust in internship and / or projects as a lead towards research and

The multi-discipline nature of the School System caters to the needs of stake-holders, especially the employers.

Credit system:

Weightage to a course is given in relation to the hours assigned for the course. Generally one hour per week has one credit. For viability and conformity to the guidelines credits are awarded irrespective of the teaching hours. The credits and hours of each course of a programme is given in the table of Programme Pattern. However, there could be some flexibility because of practical, field visits, tutorials and nature of project work.

For PG courses, a student must earn a minimum of 110 credits as mentioned in the programme pattern table. The total number of minimum courses offered by the Department is given in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)
LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

OBE is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience, each student should have achieved the goal. There is no single specified style of teaching or assessment in OBE; instead, classes, opportunities and assessments should all help the students achieve the specific outcomes

Outcome Based Education, as the name suggests depends on Outcomes and not Inputs. The outcomes in OBE are expected to be measurable. In fact each Educational Institute can state its own outcomes. The ultimate goal is to ensure that there is a correlation between education and employability

Outcome –Based Education (OBE): is a student-centric teaching and learning methodology in which the course delivery, assessment are planned to achieve, stated objectives and outcomes. It focuses on measuring student performance i.e. outcomes at different levels.

Some important aspects of the Outcome Based Education

Course: is defined as a theory, practical or theory cum practical subject studied in a semester.

Course Outcomes (COs): are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Generally three or more course outcomes may be specified for each course based on its weightage.

Programme: is defined as the specialization or discipline of a Degree.

Programme Outcomes (POs): Programme outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be aligned closely with Graduate Attributes.

Programme Specific Outcomes (PSOs):

PSOs are what the students should be able to do at the time of graduation with reference to a specific discipline.

Programme Educational Objectives (PEOs): The PEOs of a programme are the statements that describe the expected achievement of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after Graduation.

Some important terminologies repeatedly used in LOCF.

Core Courses (CC)

A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course. These are the courses which provide basic understanding of their main discipline. In order to maintain a requisite standard certain core courses must be included in an academic program. This helps in providing a universal recognition to the said academic program.

Discipline Specific Elective Courses (DSE)

Elective course may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective (DSE). These courses offer the flexibility of selection of options from a pool of courses. These are considered specialized or advanced to that particular programme and provide extensive exposure in the area chosen; these are also more applied in nature.

DSE: Four courses are offered, one course in each semester.

Note: To offer **one DSE**, a minimum of two courses of equal importance / weightage is a must.

One DSE Course in semester two is offered as interdisciplinary/common course among the departments in a School (Common Core Course) at the PG level.

Generic Elective Courses

An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

Generic Elective courses are designed for the students of **other disciplines**. Thus, as per the CBCS policy, the students pursuing particular disciplines would have to opt Generic Elective courses offered by other disciplines, as per the basket of courses offered by the college. The scope of the Generic Elective (GE) Courses is positively related to the diversity of disciplines in which programmes are being offered by the college.

Two GE Courses are offered, one each in semesters II and III. The GE course offered in semester II is within the school level and the GE in semester III is Between Schools level

The Ability Enhancement Courses (AEC)

One Main discipline related Ability Enhancement Course for 3 credits is offered for a PG programme by the Department.

Skill Enhancement Courses (SECs)

These courses focus on developing skills or proficiencies in the student, and aim at providing hands-on training. Skill enhancement courses can be opted by the students of any other discipline, but are highly suitable for students pursuing their academic programme.

One SEC is offered in semester II as a compulsory course on Soft Skills, offered by the Department of Human Excellence, common to all the students of PG programme.

Self–paced Learning: It is a course for two credits. It is offered to promote the habit of independent/self learning of Students. Since it is a two credit course, syllabus is framed to complete within 45 hours. It is not taught in the regular working hours.

Comprehensive Examinations: A detailed syllabus consisting of five units to be chosen from the courses offered over the five semesters which are of immense importance and those portions which could not be accommodated in the regular syllabus.

Extra Credit Courses: In order to facilitate the students, gaining knowledge/skills by attending online courses MOOC, credits are awarded as extra credits, the extra credit are at three semesters after verifying the course completion certificates. According to the guidelines of UGC, the students are encouraged to avail this option of enriching their knowledge by enrolling themselves in the Massive Open Online Courses (MOOC) provided by various portals such as SWAYAM, NPTEL and etc.

Course Coding:

The following code system (10 alphanumeric characters) is adopted for Post Graduate courses:

21	PXX	N	XX	NN/NNX
Year of Revision	PG Department Code	Semester number.	Part Category	running number/with choice

N:- Numerals X :- Alphabet

Part Category

CC - Core Theory

CP- Core Practical

IS- Internship

SP- Self Paced Learning

CE- Comprehensive Examination

PW- Project Work & viva-voce

Electives Courses

ES – Department Specific Electives

EG- Generic Electives

EC - Additional core Courses for Extra Credits (If any)*

Ability Enhancement Courses

AE – Ability Enhancement Course

SE – Skill Enhancement Course – Soft skills

CW - SHEPHERD & Gender Studies (Outreach)

CIA AND SEMESTER EXAMINATION

Continuous Internal Assessment (CIA):

Distribution of CIA Marks	
Passing Minimum: 50 Marks	
Library Referencing	5
3 Components	35
Mid-Semester Test	30
End-Semester Test	30
CIA	100

MID-SEM & END-SEM TEST

Centralised – Conducted by the office of COE

1. Mid-Sem Test & End-Sem Test: (2 Hours each); will have Objective and Descriptive elements; with the existing question pattern PART-A; PART-B; PART-C and PART D.
2. One of the CIA Component II/III for UG & PG will be of 15 marks and compulsorily a online objective multiple choice question type.
3. The online CIA Component must be conducted by the Department / faculty concerned at a suitable computer centre.
4. The one marks of PART-A of Mid-Sem and End-Sem Tests will comprise only: OBJECTIVE MULTIPLE CHOICE QUESTIONS.
5. The number of hours for the 5 marks allotted for Library Referencing/ work would be 30 hours per semester. The marks scored out of 5 will be given to all the courses (Courses) of the Semester.

Duration of Examination must be rational; proportional to teaching hours 90 minute-examination / 50 Marks for courses of 2/3 hours/week (all Part IV UG Courses) 3-hours examination for courses of 4-6 hours/week.

Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

S. No.	Level	Parameter	Description
1	K1	Knowledge/Remembering	It is the ability to remember the previously learned
2	K2	Comprehension/Understanding	The learner explains ideas or concepts
3	K3	Application/Applying	The learner uses information in a new way
4	K4	Analysis/Analysing	The learner distinguishes among different parts
5	K5	Evaluation/Evaluating	The learner justifies a stand or decision
6	K6	Synthesis /Creating	The learner creates a new product or point of view

WEIGHTAGE of K – LEVELS IN QUESTION PAPER

(Cognitive Level)	Lower Order Thinking			Higher Order Thinking			Total
K- LEVELS	K1	K2	K3	K4	K5	K6	%
SEMESTER EXAMINATIONS	15	20	35	30			**100**
MID / END Semester TESTS	12	20	35	33			**100**

QUESTION PATTERN FOR SEMESTER EXAMINATION	
SECTION	**MARKS**
SECTION–A (No choice ,One Mark) **THREE** questions from each unit **(**15x1 =15)	**15**
SECTION-B (No choice ,2-Marks) **TWO** questions from each unit (10x2 =20)	**20**
SECTION-C (Either/or type) (7- Marks) **ONE** question from each unit (5x7 =35)	**35**
SECTION-D (3 out of 5) (10 Marks) **ONE** question from each unit (3x10 =30)	**30**
Total	**100**

BLUE PRINT OF QUESTION PAPER FOR SEMESTER EXAMINATION							
DURATION: 3. 00 Hours.							**Max Mark : 100**
K- LEVELS / **SECTIONS**	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**Total Marks**
SECTION–A (One Mark, No choice) (15x1 =15)	15						**15**
SECTION-B (2-Marks, No choice) (10x2=20)		10					**20**
SECTION-C (7- Marks) (Either/or type) (5x7=35)			5				**35**
SECTION-D (10 Marks) (3 out of 5) (3x10=30) Courses having only **K4** levels				3			**30**
Courses having **K4** and **K5** levels **One K5 level question is compulsory**				2	1		
(Courses having **all the 6** cognitive levels **One K5 and K6 level questions can be compulsory**				1	1	1	
Total	**15**	**20**	**35**	**30**			**100**

QUESTION PATTERN FOR MID/END TEST		
SECTION		**MARKS**
SECTION–A (No choice, One Mark)	(7x1 =7)	**7**
SECTION-B (No choice , 2-Marks)	(6x2 =12)	**12**
SECTION-C (Either/or type) (7- Marks)	(3x7 =21)	**21**
SECTION-D (2 out of 3) (10 Marks)	(2x10=20)	**20**
	Total	**60**

BLUE PRINT OF QUESTION PAPER FOR MID/END TEST							
DURATION: 2. 00 Hours.							**Max Mark: 60.**
K- LEVELS / **SECTIONS**	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**Total Marks**
SECTION –A (One Mark, No choice) (7 x 1 = 7)	7						**07**
SECTION-B (2-Marks, No choice) (6 x 2 = 12)		6					**12**
SECTION-C (Either/or type) (7-Marks) (3 x 7 =21)			3				**21**
SECTION-D (2 out of 3) (10 Marks) (2x10=20) Courses having only **K4** levels				2			**20**
Courses having **K4** and **K5** levels **One K5 level question is compulsory**				1	1		
Courses having **all the 6** cognitive levels **One K6 level question is compulsory**					1	1	
Total Marks	**07**	**12**	**21**	**20**			**60**
Weightage for 100 %	**12**	**20**	**35**	**33**			**100**

Assessment pattern for two credit courses.

S. No.	Course Title	CIA	Semester Examination	Total Marks
1	Self Paced Learning Course	25 + 25 = 50	50 Marks MCQ (COE)	100
2	Comprehensive Examinations	25 +25 = 50	50 Marks (MCQ) (COE)	100
3	Internship	100	--	100
4	Field Visit	100	--	100
5	Ability Enhancement Course (AEC) for PG (3 credits)	50 (Three Components)	50 (COE) Specific Question Pattern	100
Assessment Pattern for Courses in Part - IV				
6	Value Education Courses and Environmental Studies	50	50 Marks (For 2.00 hours) (COE)	100
7	Skill Enhancement Courses(SECs)	50 marks (by Course in-charge) 50 Marks (by an External member from the Department)		100
8	SEC: SOFT SKILLS (For UG and PG)	100	(Fully Internal)	100

EVALUATION

GRADING SYSTEM

Once the marks of the CIA and the end-semester examination for each of the courses are available, they will be added and converted as final mark. The marks thus obtained will then be graded as per the scheme provided in Table-1.

From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by semester Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA) respectively. These two are calculated by the following formulae:

$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$	$WAM\,(Weighted\,Average\,Marks) = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$
Where, C_i is the Credit earned for the Course i G_i is the Grade Point obtained by the student for the Course i M_i is the marks obtained for the course i and n is the number of Courses **Passed** in that semester.	

CGPA: Average GPA of all the Courses starting from the first semester to the current semester.

CLASSIFICATION OF FINAL RESULTS:

i) The classification of final results shall be based on the CGPA, as indicated in Table-2.

ii) For the purpose of Classification of Final Results, the candidates who earn the CGPA 9.00 and above shall be declared to have qualified for the Degree as 'Outstanding'. Similarly the candidates who earn the CGPA between 8.00 and 8.99, 7.00 and 7.99, 6.00 and 6.99 and 5.00 and 5.99 shall be declared to have qualified for their Degree in the respective programmes as 'Excellent', 'Very Good', 'Good', and 'Above Average' respectively.

iii) A Pass in SHEPHERD will continue to be mandatory although the marks will not count for the calculation of the CGPA.

iv) Absence from an examination shall not be taken an attempt.

Table-1: Grading of the Courses

Marks Range	Grade Point	Corresponding Grade
90 and above	**10**	**O**
80 and above and below 90	**9**	A+
70 and above and below 80	**8**	**A**
60 and above and below 70	**7**	**B+**
50 and above and below 60	**6**	**B**
Below 50	**0**	**RA**

Table-2: Final Result

CGPA	Corresponding Grade	Classification of Final Result
9.00 and above	**O**	**Outstanding**
8.00 to 8.99	A+	Excellent
7.00 to 7.99	**A**	**Very Good**
6.00 to 6.99	**B+**	**Good**
5.0 0 to 5.99	**B**	**Above Average**
Below 5.00	**RA**	**Re-appearance**

Credit based weighted Mark System is adopted for the individual semesters and cumulative semesters in the column 'Marks secured' (for 100)

Declaration of Result

Mr./ MS. _____ has successfully completed the Post Graduate in _____ programme. The candidate's Cumulative Grade Point Average (CGPA) is _____ and the class secured is _____ by completing the minimum of 110 credits.

The candidate has also acquired _____ (if any) extra by attending MOOC courses.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

The Programme Outcomes(POs)/Programme Specific Outcomes(PSOs) are the qualities that must be imbibed in the graduates by the time of completion of their programme. At the end of each programme the PO/PSO assessment in done from the CO attainment of all curriculum components. The POs/PSOs are framed based on the guidelines of LOCF. There are five POs UG programme and five POs for PG programme framed by the college. PSOs are framed by the departments and they are five in numbers.

For each Course, there are five Course Outcomes to be achieved at the end of the course. These Course outcomes are framed to achieve the POs/PSOs. All course outcomes shall have linkage to POs/PSOs in such a way that the strongest relation has the weight 3 and the weakest is 1. This relation is defined by using the following table.

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

Mean Scores of COs = $\frac{\text{Sum of values}}{\text{Total No.of POs \& PSOs}}$		**Mean Overall Score =** $\frac{\text{Sum of Mean Scores}}{\text{Total No.of COs}}$	
Result	**Mean Overall Score**	**< 1.2**	**# Low**
		≥ 1.2 and < 2.2	**# Medium**
		≥ 2.2	**# High**

If the mean overall score is low then the course in charge has to redesign the particular course content so as to achieve high level mean overall score.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

The Programme Outcomes (POs)/Programme Specific Outcomes(PSOs) are the qualities that must be imbibed in the graduates by the time of completion of their programme. At the end of each programme the PO/PSO assessment in done from the CO attainment of all curriculum components. The POs/PSOs are framed based on the guidelines of LOCF. There are five POs UG programme and five POs for PG programme framed by the college. PSOs are framed by the departments and they are five in numbers.

For each Course, there are five Course Outcomes to be achieved at the end of the course. These Course outcomes are framed to achieve the POs/PSOs. All course outcomes shall have linkage to POs/PSOs in such a way that the strongest relation has the weight 3 and the weakest is 1. This relation is defined by using the following table.

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		≥ 1.2 and < 2.2	**# Medium**
		≥ 2.2	**# High**

If the mean overall score is low then the course in charge has to redesign the particular course content so as to achieve high level mean overall score.

Vision

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

Mission

- Fostering learning environment to students of diverse background, developing their inherent skills and competencies through reflection, creation of knowledge and service.
- Nurturing comprehensive learning and best practices through innovative and value-driven pedagogy.
- Contributing significantly to Higher Education through Teaching, Learning, Research and Extension.

Programme Educational Objectives (PEOs)

- Graduates will be able to accomplish professional standards in the global environment.
- Graduates will be able to uphold integrity and human values.
- Graduates will be able to appreciate and promote pluralism and multiculturalism in working environment.

Programme Outcomes (POs)

1. Graduates will be able to apply assimilated knowledge to evolve tangible solution to emerging problems.
2. Graduates will be able to analyze and interpret data to create and design new knowledge.
3. Graduates will be able to engage in innovative and socially relevant research and effectively communicate the findings.
4. Graduates will become ethically committed professional and entrepreneurs upholding human values.
5. Graduates imbibed with ethical values and social concern will be able to understand and appreciate cultural diversity, social harmony and ensure sustainable environment.

Programme Specific Objectives (PSOs)

1. Post graduates will acquire knowledge in the domain of Biotechnology with respect to emerging concepts and techniques.
2. Post Graduates will be able to identify, understand, design, perform experiments and apply the acquired skills in solving complex biotechnology problems using modern tools and techniques.
3. Post graduates will be able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.
4. Post graduates will be fostered for R & D activities, entrepreneurship, and effectively communicate the novel findings to the scientific community.
5. Post graduates will apply bioethical principles and related norms towards next-generation product / technique development.

M.Sc. BIOTECHNOLOGY					
PROGRAMME STRUCTURE					
Sem.	**Specification**	**No. of Courses**	**No. of Hours**	**Credits**	**Total Credits**
I-IV	Core Courses : Theory	**11**	**49**	**46**	**46**
I-IV	Core Courses : Practicals	7	29	**23**	23
II	Self-paced learning	1	-	**2**	2
IV	Comprehensive Examination	1	-	**2**	2
IV	Project work & Viva Voce	1	6	**5**	5
I- IV	Discipline Specific Elective	4	20	**16**	16
I	Ability Enhancement Course	1	4	**3**	3
II	Skill Enhancement Course (Soft Skills)	1	4	**3**	3
II	Generic Elective IDC (WS)	1	4	**3**	3
III	Generic Elective IDC (BS)	1	4	**3**	3
II - IV	Online courses (MOOC)	3	-	**(2)**	(6)
I-IV	**Outreach Programme**	**-**	**-**	**-**	4
	Total		**120**		**110(6)**

M.Sc. BIOTECHNOLOGY							
PROGRAMME PATTERN							
Course Details					**Scheme of Exams**		
Sem	**Code**	**Course Title**	**Hrs**	**Cr**	**CIA**	**SE**	**Final**
I	21PBT1CC01	Molecular Biology	5	4	100	100	100
	21PBT1CC02	Biochemistry	4	4	100	100	100
	21PBT1CC03	Microbiology	4	4	100	100	100
	21PBT1CP01	Practical – I: Molecular Biology and Microbiology	4	3	100	100	100
	21PBT1CP02	Practical – II : Biochemistry	4	3	100	100	100
	21PBT1ES01A	**DSE-1:** Developmental Biology	5	4	100	100	100
	21PBT1ES01B	**DSE-1:** Stem Cell Technology					
	21PBT1AE01	**AEC:** Entrepreneurship skills for Biotechnology	4	3	50	50	50
		Total	**30**	**25**			
II	21PBT2CC04	Recombinant DNA Technology	4	4	100	100	100
	21PBT2CC05	Synthetic Biology	4	4	100	100	100
	21PBT2CC06	Genomics and Proteomics	4	3	100	100	100
	21PBT2CP03	Practical – III :Recombinant DNA Technology, Genomics and Immunology	5	4	100	100	100
	21PBT2SP01	**Self-Paced Learning:** Fundamental of Genetics	-	2	50	50	50
	21SBS2ES02B	**DSE -2:** Immunotechnology	5	4	100	100	100
	21PBT2ES02	**DSE -2:** Cell Signaling					
	21PSS2SE01	**SEC:** Soft skills	4	3	100	-	100
	21PBT2EG01	**GE-1(WS):** Medical Biotechnology	4	3	100	100	100
		Extra Credit courses (MOOC)-1	-	(2)			
		Total	**30**	**27 (2)**			
III	21PBT3CC07	Bioinstrumentation and Research Methodology	5	4	100	100	100
	21PBT3CC08	Industrial Biotechnology	4	4	100	100	100
	21PBT3CC09	Intellectual Property Rights (IPR) and Bioethics	4	4	100	100	100
	21PBT3CP04	Practical – IV: Bioinformatics and Biostatistics	4	3	100	100	100
	21PBT3CP05	Practical – V : Industrial Biotechnology	4	3	100	100	100
	21PBT3ES03A	**DSE -3 :** Bioinformatics	5	4	100	100	100
	21PBT3ES03B	**DSE -3 :** Drug Discovery and Development					
	21PBT3EG02	**GE-2 (BS) :** Food Technology	4	3	100	100	100
		Extra Credit courses (MOOC)-2		(2)			
		Total	**30**	**25 (2)**			
IV	21PBT4CC10	Bio nanotechnology	6	6	100	100	100
	21PBT4CC11	Plant and Animal Biotechnology	5	5	100	100	100
	21PBT4CP06	Practical – VI: Bionanotechnology	4	3	100	100	100
	21PBT4CP07	Practical – VII: Plant and Animal Biotechnology	4	4	100	100	100
	21PBT4ES04A	**DSE -4 :** Environmental Biotechnology	5	4	100	100	100
	21PBT4ES04B	**DSE -4 :** Food Biotechnology					
	21PBT4PW01	Project work & Viva Voce	6	5	100	100	100
	21PBT4CEO1	Comprehensive Examination	-	2	50	50	50
		Extra Credit courses (MOOC)-3		(2)			
		Total	**30**	**29 (2)**			
I-IV	21PCW4OR01	Outreach programme (SHEPHERD)		**4**			
		Total (Four Semesters)	**120**	**110(6)**			

*The courses with a scheme of Exam 50 in CIA and SE will be converted to 100 for grading.

GENERIC ELECTIVE -1: 2nd Semester Within school (WS)- Offered to students belong to other Departments in the School							
Course Details					Scheme of Exams		
School	**Course Code**	**Course Title**	**Hrs**	**Cr**	**CIA**	**SE**	**Final**
SBS	21PBI2EG01	Herbal Technology	4	3	100	100	100
	21PBT2EG01	Medical Biotechnology	4	3	100	100	100
	21PBO2EG01	Medicinal Botany	4	3	100	100	100
SCS	21PCA2EG01	Applied Statistics using R	4	3	100	100	100
	21PMA2EG01	Mathematical Foundation	4	3	100	100	100
	21PCS2EG01	Mobile Adhoc Networks (MANET)	4	3	100	100	100
SLAC	21PEN2EG01A	Indian Literature in Translation	4	3	100	100	100
	21PEN2EG01B	English Literature For Competitive Examinations					
SMS	21PCO2EG01	Supply Chain Management	4	3	100	100	100
	21PEC2EG01	Labour Economics	4	3	100	100	100
	21PHR2EG01	Organizational Behaviour	4	3	100	100	100
	21PCC2EG01	Stress Management	4	3	100	100	100
SPS	21PCH2EG01	Industrial Products	4	3	100	100	100
	21PPH2EG01A	Solar Energy and Utilization	4	3	100	100	100
	21PPH2EG01B	Renewable Energy Resources	4	3	100	100	100

GENERIC ELECTIVE -2: 3rd Semester Between schools (BS)- Offered to students in the Departments belong to other Schools (Except the school offering the course)							
Course Details					Scheme of Exams		
School	**Course Code**	**Course Title**	**Hrs**	**Cr**	**CIA**	**SE**	**Final**
SBS	21PBI3EG02	First Aid Management	4	3	100	100	100
	21PBT3EG02	Food Technology	4	3	100	100	100
	21PBO3EG02	Horticulture and Landscaping	4	3	100	100	100
SCS	21PCA3EG02	Web Design	4	3	100	100	100
	21PMA3EG02	Operations Research	4	3	100	100	100
	21PCS3EG02	Advances in Computer Science	4	3	100	100	100
	21PDS3EG02	Deep Learning	4	3	100	100	100
SLAC	21PEN3EG02	English for Effective Communication	4	3	100	100	100
SMS	21PCO3EG02	Basics of Taxation	4	3	100	100	100
	21PEC3EG02	Managerial Economics	4	3	100	100	100
	21PHR3EG02	Counselling and Guidance	4	3	100	100	100
	21PCC3EG02	Dynamics of Human Behaviour in Business	4	3	100	100	100
SPS	21PCH3EG02	Health Science	4	3	100	100	100
	21PPH3EG02A	Physics for Competitive Exam	4	3	100	100	100
	21PPH3EG02B	Nano Science	4	3	100	100	100

Semester	Course Code	Title of the Course	Hours	Credits
I	21PBT1CC01	CORE-1: MOLECULAR BIOLOGY	5	4

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	describe the basic structure and functioning of the genetic elements.	K1
CO-2	explain the molecular mechanisms of bacterial & eukaryotic transcription, and translation respectively.	K2
CO-3	examine the causative factors of genetic related disorder.	K3
CO-4	compare and contrast the mechanisms of bacterial and eukaryotic DNA replication and DNA repair.	K4
CO-5	create appropriate DNA profiling tools and inspect the efficacy of particular techniques in their research projects.	K5 & K6

Unit – I **(15-Hours)**

Experiments to prove DNA and RNA as the genetic materials, Viral genome – types. Types and basic structure of Chromosomes. Chromosomal Proteins – Histones and Protamines – Nucleosomes – levels in the organization of Metaphase Chromosome, Special types of Chromosome: Polytene and Lamp brush chromosomes.

Unit – II **(15 Hours)**

Transposons: Discovery and Classification, Transposons in Bacteria (*Tn* elements), Maize (*Ac/Ds* and *Sp/Dsp* elements), Drosophila (*P* elements) and Yeast (*Ty* elements). Extra chromosomal DNA: Natural and artificial plasmids. Plasmid curing, plasmid transfer and their applications. Maternal Inheritance, Structure, gene contents and functions of Chloroplast and Mitochondrial DNA - Interaction between cpDNA and nDNA.

Unit – III **(15 Hours)**

DNA replication: Models – Meselson & Stahl Experiments, Molecular mechanism of the replication of linear and circular (Rolling circle Model) DNA. DNA polymerases – structure and function. Recombination: Homologous and non-homologous recombination- Site specific recombination. Transformation, Conjugation, F+, *Hfr*, Transduction generalized and specialized.

Unit – IV **(15 Hours)**

Transcription: RNA types and their processing and modifications. Transcription factors and machinery including RNA polymerases, formation of initiation complex, elongation and termination of transcription. Regulation of transcription: activators (enhancers) and repressors, Locus control regions. Translation of genetic information and its control. Post translational modifications, chaperones and protein targeting.

Unit – V **(15 Hours)**

Changes and consequences: Changes in the chromosome number: Euploidy and aneuploidy and related genetic disorders. Changes in the chromosome structure: addition, deletion, inversion and translocation and related genetic disorders. Mutation: Types (Induced, reversed, suppressor and spontaneous mutations) Mutagens: Physical and chemical. DNA repair mechanism: Thymine dimer, Light activation, Excision, Recombinational and SOS.

Books for Study

1) Watson J. D., *et al*., 2006. Molecular Biology of the gene (Ed. 5) Pearson Education Inc. London. (Unit 1 and Unit 2)
2) Jeoffrey M. Cooper and Rober E. Hausman. 2000. The Cell: A Molecular Approach (Ed:4) ASM Press, Washington D.C. (Unit 3 and Unit 4)
3) Stickberger MW *et al*., Genetics, 2008, (Ed. 3), Macmillan and Company. (Unit 5)

References

1) David Freifelder. 2008. Molecular Biology. (Ed: 2). Narosa Publications. NewDelhi.
2) Bruce Alberts *et al*., 2015. Molecular Biology of Cell (Ed: 6). Garland Science, Taylor and Francis Group
3) Gerald Karp. 2008. Cell and Molecular Biology. (Ed: 5). John Wiley and Sons, New York.
4) Ajoy Paul. 2011. Textbook of Cell and Molecular Biology. Books and Allied Ltd.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
I	**21PBT1CC01**			**MOLECULAR BIOLOGY**						**5**	**4**
Course Outcomes (CO. No.)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean score of COs.**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	1	1	3	3	2	2	2	2
CO2	2	2	2	2	1	3	3	2	2	3	2.2
CO3	2	2	2	2	1	3	2	2	2	3	2.1
CO4	2	2	2	2	1	3	3	3	2	2	2.2
CO5	3	3	3	2	2	2	3	2	2	3	2.5
									Mean overall score		**2.2**
										Result	**High**

Semester	Course Code	Title of the Course	Hours	Credits
I	**21PBT1CC02**	**CORE-2: BIOCHEMISTRY**	**4**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	name the enzymes and outline their catalysis reactions as well as enzyme kinetics	**K1 & K2**
CO-2	outline the structure of fundamental monosaccharides and polysaccharides.	**K2**
CO-3	classify amino acids structures, chemical properties and their organization into polypeptides.	**K3 & K4**
CO-4	assess the synthesis of biomolecules and their role in metabolic pathways along with their regulation.	**K5**
CO-5	design appropriate protein structure protocol.	**K6**

Unit – I **(12-hours)**

Physical properties of water and their role in biology. Concepts of pH, ionic strength and buffers. Basic Thermodynamics: Laws of thermodynamics. Concepts of ΔG, ΔH and ΔS. Enzymology: Introduction to enzymes. Types of enzymatic reaction mechanisms, Michaelis-Menten kinetics. Competitive, Non-competitive and Un-competitive inhibition. Bi-substrate reaction kinetics. Allostery. Chemical kinetics: Concepts of order and molecularity of a chemical reaction. Derivation of first and second order rate equation, measurement of rate constants. Concept of activation energy.

Unit – II **(12-hours)**

Carbohydrates – Classification, Structure and Isomerism. Monosaccharides, Oligosaccharides, Polysaccharides– Structure and Properties. Metabolism of Carbohydrates-Glycolysis, Citric acid cycle, HMP shunt, Glucuronic acid pathway, Gluconeogenesis, Glycogenesis, Glycogenolysis, Glyoxylate cycle. Metabolism of Amino sugars, Sialic acids, Mucopolysaccharides and Glycoproteins. Metabolic disorders associated with carbohydrate metabolism.

Unit – III **(12-hours)**

Aminoacids- structures, classification, properties. Biosynthesis of Aspartate, Pyruvate and Aromatic aminoacids families. Amphibolic activity of amino acids. Protein Structure: Structural characteristics of α-helix, β-sheet and β-turn. Ramachandran plot. Protein domains and domain architecture. Solid state synthesis of peptides, Sequence determination. Degradation of Proteins and Aminoacids, Urea cycle and its significance. Metabolic disorders associated with aminoacid metabolism.

Unit – IV **(12-hours)**

Nucleic acids- bases, nucleosides & nucleotides, Structure of RNAs and DNA, Forces stabilizing nucleic acid structures. Fractionation, sequencing and chemical synthesis of oligonucleotides. Denaturation and Hybridization. Synthesis of Purines and Pyrimidines, salvage pathways. Biosynthesis of nucleotide coenzymes, nucleotide degradation.

Unit – V **(12-hours)**

Lipids – classification, sources and biological functions. Biosynthesis of fatty acids and its regulation, Hydroxy fatty acids, Acylglycerols. Membrane lipids- Phospholipids, Sphingolipids & Eicosanoids. Cholesterol biosynthesis and its regulation. Transport and storage of cholesterol. Fatty acid degradation. Lipoproteins types and its functions. Methods of inter organ transport of fatty acids. Formation of ketone bodies. Metabolic disorders associated with lipid metabolism.

Books for study

1. Nelson *et al*., 2013.Lehinger Principles of Biochemistry (6th Edition), Macmillan Learning. (Unit 1, Unit II and Unit III)
2. Stryer, I., 2015. Biochemistry (7thEdition), W.H. Freeman & Co., New York. (Unit 4 and Unit 5)
3. Murray, R.K., Granner, B.K., Mayes. P.A., Rodwell, V.W., 2012. Harper's Biochemistry Prentice Hall International (29th Edition).

Books for References

1. Dean *et al*., 2016. Biochemistry: Concepts and Connections. (Global Ed.) Pearson Education.
2. Robert K. Murray *et al*., 2000. Harper's Biochemistry (25th Edition), Appleton and Lange Stainford Publishers, Connecticut.
3. Voet *et al*., (2016) Fundamentals of Biochemistry: Life at the Molecular Level (5th Ed). Wiley.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code			Title of the Course				Hours		Credits
I	21PBT1CC02			BIOCHEMISTRY				4		4
Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	1	3	3	2	2	2	2.1
CO2	2	2	2	2	2	3	2	2	2	3	2.2
CO3	3	2	2	2	1	3	3	2	2	3	2.3
CO4	3	3	3	2	2	3	3	2	2	2	2.5
CO5	2	2	2	2	2	3	3	3	2	2	2.3
	Mean overall score										2.28
Result											High

Semester	Course Code	Title of the Course	Hours	Credits
I	21PBT1CC03	CORE-3: MICROBIOLOGY	4	4

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	apply knowledge in microbial organisms and their relevance of infectious diseases.	K1
CO-2	understand the basic microbial structure and similarities and differences among various groups of microorganisms such as bacteria/archaea/cyanobacteria/fungi/protozoans.	K2
CO-3	apply bioprocess techniques for the production of organic acids, alcohols, wine and vinegar with the help of different microbes.	K3
CO-4	categorize microorganisms in varied fields of agricultural like bio fertilizers and biocontrol.	K4
CO-5	inspect and design the bioprospecting of microbes for the production of vaccines, antibiotics and foods.	K5 & K6

Unit - I **(12-Hours)**

General Microbiology Introduction and scope of microbiology. Brief study of structure and organization of major groups of microorganisms - Archaebacteria, Cyanobacteria, Eubacteria, Fungi, Algae, Protozoa and Viruses. Microbial Taxonomy: Diversity and distribution of microbes. Control of microorganisms – physical, chemical and chemotherapeutic agents. Preservation of microorganisms. GLP for handling highly infectious disease samples and documentation. Personal safety and laboratory safety.

Unit - II **(12-Hours)**

Agricultural Microbiology Bio-fertilizers and Biopesticides in agriculture: Principles of crop inoculation with microbial agents, microbial inoculants and production, carriers for inoculants: types and characteristics, strain selection of bacteria, cyanobacteria and microalgae for bio fertilizer production, phosphate solubilising microorganisms, AM fungi, Plant Growth Promoting Rhizobacteria (PGPR), biocontrol agents. Bacterial and mycopesticides.

Unit - III **(12-Hours)**

Industrial Microbiology Microbial growth: Kinetics of growth. Effect of temperature, pH, osmotic pressure and radiation on microbial growth. Selection of industrially useful microbes. Fermenters and fermentation technology. Industrial production of alcohol, vinegar, lactic acid, antibiotics, enzymes and amino acids. Microbiology of food – sources of contamination – food spoilage – food preservation methods.

Unit IV **(12-Hours)**

Clinical Microbiology Epidemic, endemic, pandemic and sporadic diseases. Pathogenicity, virulence and infection. Epidemiology of infectious diseases. Bacterial diseases of human (Typhoid, Cholera, Syphilis, Fungal diseases of human (superficial, cutaneous, subcutaneous

and systemic mycoseses). Viral diseases of human (SARS, MERS, COVID – 19, AIDS, Hepatitis and Polio). Mycoplasmal, Chlamydial, Rickettsial and protozoan diseases of human. Mycotoxins.

Unit – V **(12-Hours)**

Applied Microbiology Role of microbes in the manufacture of antibiotics and vaccines. Microbes as foods - SCP production. Role of microbes in bio-gas production, petroleum industry, mining, microbial fuel cells, biodegradation and bioremediation. Microbial degradation of lignin, cellulose and pesticides. Microbial immobilization. Microbes in biological warfare.

Books for study

1. Pelczar *et al*., (2001): Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi. (Unit I and Unit IV)
2. Prescott *et al*., (2016): Microbiology, 10th Edition, McGraw-Hill Education, New Delhi. (Unit III)
3. Tortora GJ, Funke BR, Case CL. Microbiology: An introduction 11th Edition. San Francisco: Pearson Publishers, 2013. (Unit V).

Books for References

1. Murray *et al*.,(2015): Medical microbiology. Elsevier.
2. Baltz et al. (2010): Manual of Industrial Microbiology and Biotechnology. 3rdEdition, ASM Press, USA. (Unit II).
3. Alcamo IE., Fundamentals of Microbiology, 6th Edition, Benjamin Cummings Publishing Company, Inc., 2001.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code			Title of the Course				Hours		Credits
I	21PBT1CC03			MICROBIOLOGY				4		4
Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	3	3	2	2	2.4
CO2	2	2	3	2	2	2	3	2	2	2	2.4
CO3	3	3	3	2	2	2	3	2	1	3	2.4
CO4	3	3	2	2	1	2	3	3	3	2	2.4
CO5	3	3	3	2	1	3	2	2	2	2	2.3
	Mean overall score										2.38
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
I	**21PBT1CP01**	**Laboratory Course – I MOLECULAR BIOLOGY AND MICROBIOLOGY**	**4**	**3**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	recall the basic principles of molecular biology techniques.	**K1**
CO-2	examine the various microbial preservation techniques for the long time storage.	**K2**
CO-3	apply and separate the proteins by its molecular weight.	**K3**
CO-4	investigate cell morphology by staining techniques.	**K4**
CO-5	evaluate the concentration of DNA/RNA and design a protocol for the isolation of plasmid DNA, genomic DNA and RNA respectively.	**K5 & K6**

Molecular Biology

1. Calculations in Molecular biology – (a) Calculating DNA in mM and conversion to picomoles (b) Oligonucleotide Quantitation (c) Calculating Molecular weight of a vector (d) Calculations in Oligonucleotide synthesis. (e) Calculating Tm and concentration of primers.
2. Isolation of extracellular DNA from biofilm matrix.
3. Induced mutation by: (a) Chemical mutagen. (b) Ultraviolet light.
4. Spectroscopic analysis of DNA/RNA and calculate dsDNA, ssDNA and RNA concentration.
5. Determination of size of Nucleic acids in Agarose gel electrophoresis.
6. SDS-PAGE and Native PAGE
7. Western blotting

Microbiology

1. Sterilization techniques – physical, chemical, filtration and irradiation techniques.
2. Preparation of basal media – Solid, Liquid: Serial dilution, plating with microbial strain;
3. Isolation of single colonies.
4. Study of a compound microscope.
5. Staining methods – simple, differential, acid – fast & negative.
6. Sub-culturing of a strain using a synthetic liquid media.
7. Study of bacterial growth of *E.coli* by a Spectrophotometer.
8. Preservation Techniques and maintenance.
9. Assay of an antibiotic by zone-inhibition method using antibiotic impregnated discs.
10. Estimation of antimicrobial activity using standard guidelines (NCCLS/ CLSA)
11. Study of biochemical identification of microorganisms.
12. Bacterial biofilm formation by microtitre plate assay.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
I	21PBT1CP01	Laboratory Course – I MOLECULAR BIOLOGY AND MICROBIOLOGY	4	3

Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	1	2	2	2	3	3	2	2	2	2.2
CO2	3	3	3	3	2	3	3	3	2	3	2.8
CO3	3	3	3	3	2	3	3	3	2	3	2.8
CO4	2	3	2	2	1	2	2	2	2	1	1.9
CO5	3	3	2	2	1	3	2	2	2	1	2.1
	Mean overall score										2.36
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
I	**21PBT1CP02**	**Laboratory Course-II BIOCHEMISTRY**	**4**	**3**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	recall and list the basic biochemical laboratory techniques.	**K1**
CO-2	explain the basic operating procedure in handling different chromatographic techniques.	**K2**
CO-3	apply *Rf* value of a chromatogram to identify the separated biomolecule.	**K3**
CO-4	analyze and evaluate the concentration of protein.	**K4 & K5**
CO-5	design a protocol to inspect various aspects of enzymology.	**K6**

Biochemistry

1. Preparation of Standard solutions (Molar & Normal) and various buffers.
2. Preparation of Titration curve & determination of pKa values for amino acids
3. Estimation of Amino acids by Ninhydrin.
4. Estimation of reducing sugars (DNS method)
5. Estimation of lipids
6. Estimation of Proteins by Bradford method.
7. Estimation of Vitamin C (Titration)
8. Chromatography: Column Chromatography - Separation of Photosynthetic Pigments and recording their absorption spectra in the visible range.
9. Separation of amino acids / sugars by Ascending Paper Chromatography.
10. Separation of lipids/ sugars/amino acids by Thin Layer Chromatography.
11. Enzyme Kinetics
    - Phosphatase assay (chicken liver)
    - Assay of enzyme activity,
    - Effect of pH,
    - Temperature,
    - Enzyme concentration
    - Substrate concentration.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
I	21PBT1CP02	Laboratory Course-II BIOCHEMISTRY	4	3

Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	3	3	3	2	2.5
CO2	3	3	3	2	2	3	3	2	2	3	2.6
CO3	3	3	2	3	2	3	3	3	2	3	2.7
CO4	3	3	2	2	1	2	2	2	2	1	2
CO5	3	3	2	2	1	3	2	2	2	1	2.1
	Mean overall score										2.38
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
I	21PBT1ES01A	DSE-1: DEVELOPMENTAL BIOLOGY	5	4

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	recall the concepts in developmental biology morphogenesis and organogenesis.	K1
CO-2	outline the concepts of cellular competence, induction, specification, commitment and differentiation in embryonic development.	K2
CO-3	classify the genetic disorders in human development.	K3
CO-4	analyze developmental biology related to cell fate specification and patterning.	K4
CO-5	assess the early development process of humans.	K5

Unit – I **(15-Hours)**

Basic concepts of development: Morphogenesis and organogenesis in animals (Human). Embryonic fields, potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting.

Unit – II **(15-Hours)**

Fertilization, development and sex determination in humans: Gametogenesis - Sperm & Egg formation; ultrastructure of sperm and ovum, egg types, egg membrane. Fertilization, cleavage, Morula, Implantation, blastulation, gastrulation, formation of germ layers, axis formation -anterior and posterior. Sex determination - chromosomes and environment.

Unit – III **(15-Hours)**

Organogenesis - I: Organogenesis: Central nervous system and the epidermis - Formation of neural tube, Differentiation of the neural tube, tissue architecture of the central nervous system, origin of cutaneous structures. Neural crest cells and axonal specificity - Specification, Trunk Neural Crest, Pattern generation in the nervous system.

Organogenesis - II: Plant meristem organization and differentiation - Organization of shoot apical meristem (SAM); Organization of root apical meristem (RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixes.

Unit – IV **(15-Hours)**

Organogenesis - III: Paraxial and intermediate mesoderm - Somites formation, Osteogenesis, Urogenital system. Lateral plate mesoderm and endoderm - Heart formation, digestive tube and its derivatives.

Unit – V **(15-Hours)**

Implications of developmental biology: Medical implications of developmental biology - genetic disorders in human development, environmental assaults on human development, Future therapies and Developmental biology, Environmental regulation of animal development - Environment as a part of normal development, Polyphenisms and plasticity, Learning system.

Books for Study

1. Gilbert S.F. 2010. Developmental Biology, (Ed: 9) Sinauer Associates Inc. Pub., Sunderland,
Massachusetts. (Unit I, II, III, IV and V)

Books for References

1. Alberts B *et al*., 2002. Molecular Biology of the Cell, (Ed: 3). Garland Science, New York.
2. Lodish, H *et al*., 2000. Molecular Cell Biology. (Ed: 4). W.H. Freeman, New York.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	**Course Code**			**Title of the Course**				**Hours**		**Credits**
I	**21PBT1ES01A**			**DSE-1: DEVELOPMENTAL BIOLOGY**				**5**		**4**
Course Outcomes (CO. No.)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	1	1	1	3	2	2	2	2	1.8
CO2	3	3	3	2	2	2	3	2	2	3	2.5
CO3	2	2	2	2	2	3	3	3	2	2	2.3
CO4	2	2	2	2	1	3	3	2	2	3	2.2
CO5	2	2	2	2	2	3	2	2	2	3	2.2
									Mean overall score		**2.2**
									Result		**High**

Semester	Course Code	Title of the Course	Hours	Credits
I	21PBT1ES01B	DSE-1: STEM CELL TECHNOLOGY	5	4

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	describe the basic concepts of stem cell.	K1
CO-2	discuss the ethical and political issues related to stem cell research.	K2
CO-3	examine clinical problems for which stem cells can provide novel regenerative therapies.	K3
CO-4	compare and contrast the concepts of pluripotency and self-renewal.	K4
CO-5	justify the current ethical guidelines in India.	K5

Unit – I **(15-Hours)**

Basic concepts of Stem cells – definition, History; unique properties – proliferation and differentiation; Potency definitions: totipotent, pluripotent, multipotent and unipotent. Stem-cell plasticity, Regulators of pluripotency. The isolation, expansion, genetic manipulation, genomic reprogramming, and cloning of stem cells. Stem Cells and imprinted genes.

Unit – II **(15-Hours)**

Differentiation & Types of Stem cells: Isolation, culture, identification and assays. Types: unlimited and limited; Embryonic and adult stem cells – bone marrow, cord blood, neural, endothelial, hematopoietic, corneal, epithelial, pancreatic, hepatic, glandular, cardiac and gastrointestinal, leukaemia and cancer stem cells. Correlation between stem cells and cancer stem cells. Clinical applications of stem cells. Stem cell cryopreservation.

Unit – III **(15-Hours)**

Stem cells and cloning; Identification of stem cell using specific markers. Isolation of stem cells- Fluorescence based cell sorting. Induced Pluripotent stem cells (iPS), germ line stem cells; Recruiting Donors and Banking Hes Cells; IPRs and Hes Cells. Fate mapping of stem cells in experimental systems.

Unit – IV **(15-Hours)**

Stem cell based therapies: Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopaedic applications, eye diseases, stem cell in aging and gene therapy.

Unit – V **(15-Hours)**

Controversies and Guidelines for Hes cell research – Scientific background of Hes research; societal implications: women, low-income, Different religious views, Current Ethical Guidelines in India, Ethical views of other countries and how this affects advancement of science Policy. Current Regulation of Human Embryonic Stem Cell Research. Future of SC research.

Books for Study

1. Hossein Baharvand. 2009. Trends in stem cell biology and Technology. Humana Press, New York. (**Unit III**)
2. The Natl Academies, USA 2007 Understanding Stem Cells **(Unit - II**)
3. Robert Paul Lanza. 2006. Essentials of Stem Cell biology. Elsevier Academic Press. (**Unit I**).
4. C.S. Potten. Stem Cells. Academic Press. 2008.

Books for References

1. Verma IM and Gage FH. 2002. (Ed) Regenerative Medicine, Natl, Acad. Sci. & Engg, USA
2. Yanhong Shi, Dennis O. Clegg. Stem Cell Research and Therapeutics. Springer edition. 2010
3. The Natl Academies, USA 2002 Stem Cells and the Future of Regenerative Medicine (**Unit–IV & V**)
4. Julie Audet, Willian L. Standford. 2009. Stem Cells in Regenerative Medicine. Methods and protocols (Springer edition).
5. Robert Lanza, Irina Klimanskaya. 2009. Essential Stem Cell Methods (Elsevier-First edition).

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	**Course Code**			**Title of the Course**				**Hours**		**Credits**
I	**21PBT1ES01B**			**DSE-1: STEM CELL TECHNOLOGY**				**5**		**4**
Course Outcomes (CO. No.)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	1	1	3	3	2	2	2	2
CO2	2	2	2	2	2	3	3	3	2	2	2.3
CO3	3	3	3	2	2	2	3	2	2	3	2.5
CO4	2	2	2	2	1	3	2	2	2	3	2.1
CO5	2	2	2	2	1	3	3	2	2	3	2.2
									Mean overall score		**2.22**
									Result		**High**

Semester	Course Code	Title of the Course	Hours	Credits
I	21PBT1AE01	AEC: ENTREPRENEURSHIP SKILLS FOR BIOTECHNOLOGY	4	3

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	describe freshwater aquaculture and farm management.	K1
CO-2	explain concepts of horticulture science to select, manage, and improve plants and their products.	K2
CO-3	use entrepreneurship skills, including an increased capability to start a biotech business.	K3
CO-4	form and participate in an entrepreneurial group, developing understanding of a variety of entrepreneurial strategies.	K4 & K5
CO-5	design an integrated farm management of nursery, rearing and stocking ponds of cultivable fishes.	K6

Unit - I: Entrepreneurship (12-Hours)

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship. Establishing an enterprise: Financing the enterprise, Marketing management, Entrepreneurship and international business. Types of bio-industries: bio-services, bio-industrial, agri-bio and biopharma; business incubators.

Unit - II: Horticulture (12-Hours)

Fundamentals of horticulture, Introduction to soil science, Growth development of horticulture crops, Plant propagation, Ornamental horticulture, Medicinal and aromatic plants, Commercial floriculture, Processing of horticulture crops, Fundamentals of entomology, Horticulture business management, Entrepreneurship development.

Unit – III: Aquaculture (12-Hours)

An Introduction to Genera; Biology and Physiology of Cultivable species, Ornamental Fish-culture, Freshwater Aquaculture, Farm Engineering and Aquaculture techniques, Farm management and Water qualities studies, Microbial Infections, Disease Diagnosis and Control measures, Postharvest Technology, Fish Nutrition and Feed Management.

Unit - IV: Mushroom Cultivation (12-Hours)

Morphology, Classification, edibility and poisonous properties. Breeding and genetic improvement of mushroom strains. Culturing condition for tropical and temperate countries. Isolation, spawn production, growth media, and harvesting of mushrooms. Biological importance: Medicinal and Nutritional value of mushrooms. Disease management and Post Harvesting Technology.

Unit - V: Apiculture (12-Hours)

Introduction and Importance of apiculture. Different species of honey bees. Morphology, anatomy, colony organization and life cycle. Beekeeping equipment. Social behaviour. Queen rearing. Collection and preservation of bee pasture. Seasonal management. Familiarization

with bee enemies and diseases and their control. Handling of bee colonies and manipulation for honey production.

Books for Study

1. G.K. Vashney (2019). Fundamentals of Entrepreneurship. Sahitya Bhawan Publications, India. **(Unit I)**
2. Tavis Lynch (2018). Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home.Quarry Books; 3rd edition **(Unit IV)**
3. Chris Bird (2014). The Fundamentals of Horticulture. Royal Horticulture Society. (**Unit II**)
4. Robert R Stickney (2016). Aquaculture: An Introductory Text. CABI. (**Unit III**)
5. Dr. A. G. Jaiswal (2019). Practical hand book of Apiculture. Lulu Publications. (**Unit V**)

Books for References

1. Atuar Rahman (2017). Apiculture in India. Directorate of Knowledge Management in Agriculture.
2. R K Patnaik (2008). Sericulture Manual. Biotech Books.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
I	21PBT1AE01	AEC: ENTREPRENEURSHIP SKILLS FOR BIOTECHNOLOGY	4	3

Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	3	2	2	3	3	3	2	2	2.5
CO2	2	3	3	2	2	2	3	3	2	2	2.4
CO3	2	2	3	2	2	2	2	3	3	2	2.3
CO4	3	2	3	3	2	2	3	3	2	2	2.5
CO5	2	3	3	2	2	2	3	3	2	2	2.4
	Mean overall score										2.42
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
II	**21PBT2CC04**	**CORE-4: RECOMBINANT DNA TECHNOLOGY**	**4**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	describe underlying principles of genetic engineering that forms the basis of rDNA technology.	**K1**
CO-2	understand the methodologies, the applications and related issues of rDNA technology.	**K2**
CO-3	apply research methodologies for genetic engineering techniques.	**K3**
CO-4	categorize and evaluate the specificity of vectors for cloning genes and their expressions.	**K4 & K5**
CO-5	compose the applications in medical, microbial, environmental, agricultural, and forensic sciences.	**K6**

Unit - I **(12-Hours)**

Introduction to Recombinant DNA technology - Enzymes in Molecular Biology - Restriction endonuclease, Ligases, Reverse transcriptase, Nucleases, Polymerase, Alkaline phosphatase, Terminal transferase, T4 polynucleotide kinase; Linkers, Adaptors, Homopolymers. Chromatin immune precipitation, DNA - protein interactions, electro-mobility shift assay and methyl interference assay.

Unit - II **(12-Hours)**

Expression Cassette & Viral vectors: Promoters (Constitutive, Inducible, Tissue specific), Terminators, Reporters, Markers (Antibiotic resistant, Herbicide resistant, Antimetabolite); Vectors in gene cloning – Plasmids (pBR322, pUC), Bacteriophages (Phage λ, M13), CO. No.mids, Phagemids, Yeast plasmid vector, Viral vectors (Adenovirus, Adeno associated virus, Baculo virus, Herpes virus, Retrovirus, Cauliflower mosaic virus, Tobacco mosaic virus, Potato virus X), Transposons (Ac-Ds, P) Artificial chromosome (BAC, YAC, HAC), Shuttle vector, Expression vector.

Unit - III **(12-Hours)**

Gene transfer Methods – Transformation – Physical methods (Electroporation, Microinjection, Particle bombardment, Magnet assisted transfection and Liposome mediated transfer); Chemical methods (PEG mediated, DEAE Dextran mediated and $CaPO_4$ mediated gene transfer); Biological methods (*Agrobacterium*, Bactofection and Viral transduction mediated gene transfer). Expression systems – Prokaryotes (Bacteria) and Eukaryotes (Yeast, Mammalian and Insect cell lines).

Unit –IV **(12-Hours)**

Screening & Selection methods – Insertional inactivation, Blue-White selection, Colony– *In situ* hybridization, *In vitro* selection, *In vitro* translation, Radioactive antibody test, Immunological techniques, DNA labelling, dot blot hybridization. DNA bar coding, marker

assisted selection and QTL mapping. Trait related markers and Marker Assisted Selection (MAS), screening and validation, gene introgression and pyramiding.

Unit - V **(12-Hours)**

Molecular Techniques – RFLP, RAPD, AFLP, DNA Finger printing, DNA Foot printing, Microarray (DNA & Non-DNA). Libraries - Genomic library; C-DNA library & its types; BAC library; YAC library; Methyl filtration libraries; COT fractionation based libraries. CRISPR, Transcription activator-like effector nucleases (TALEN) and Zinc-finger nucleases (*ZFNs*). Bioethics & Biosafety in genetic engineering; IPR & Patenting. Applications of genetic engineering in medicine, agriculture, veterinary and industry.

Books for Study

1. Glick R., J. J. Pasternak and C.L. Pattern. 2009. Molecular Biotechnology: Principles and applications of Recombinant DNA (Ed:4). ASM Press, Washington. (Unit III)
2. Sandy B. Primrose and Richard Twyman. 2006. Principles of gene manipulation and genomics (Ed:7). Blackwell scientific publications, London. (Unit I, Unit II and Unit IV)
3. Alberts, B., Johnson, A., Lewis, J., M., Roberts, K., and P. Walter. Molecular Biology of the Cell, (Ed: 5). Garland & Co. 2007.

Books for References

1. Brown T. A. 2020. Gene cloning and DNA analysis – An introduction. (Ed. 8) Wiley – Blackwell publications Co. Ltd, England.
2. Ernst L Winnacker. 2002. From genes to clones - Introduction to gene technology. VCR Pub., Weinheim. (Unit V)
3. Lodish H *et al*., Molecular Cell Biology, Sixth edition, W.H Freeman & Co. 2007.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	**Course Code**	**Title of the Course**	**Hours**	**Credits**
II	**21PBT2CC04**	**CORE-4: RECOMBINANT DNA TECHNOLOGY**	**4**	**4**

Course Outcomes (CO. No.)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	2	3	3	2	2	1	2.3
CO2	3	3	3	2	1	3	3	3	2	1	2.4
CO3	3	3	3	2	2	2	3	2	2	2	2.4
CO4	2	3	3	3	3	2	2	2	3	1	2.4
CO5	3	3	2	2	1	2	3	3	1	2	2.3
									Mean overall score		**2.36**
										Result	**High**

Semester	Course Code	Title of the Course	Hours	Credits
II	**21PBT2CC05**	**CORE-5: SYNTHETIC BIOLOGY**	**4**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	describe synthetic biology modules and genetic circuits	**K1**
CO-2	explain the methodologies for Biobricks, gene assembly and gene design.	**K2**
CO-3	apply research ideology in gene editing techniques.	**K3**
CO-4	compare and contrast of biological cell and synthetic cell.	**K4**
CO-5	construct and evaluate the minimal genome approaches.	**K5 & K6**

UNIT I **(12-Hours)**

Fundamentals of Synthetic Biology, Introduction to engineering and design, designing and constructing of biological modules, biological systems, and biological machines. Synthetic biology toolkit. Genetic circuits, oscillators and logic gates, synchronized oscillators.

UNIT II **(12-Hours)**

DNA synthesis: BioBricks, gene assembly, gene design – synthetic genomes, new genetic polymers, XNA and CST for selection, orthogonality, refactoring translation, DNA based bio-circuits

UNIT III **(12-Hours)**

Elements of synthetic biology: Gene shuffling for large scale pathway assembly and engineering; Choices for microbial hosts for industrial applications– bacteria, yeast, insect. Gene Editing Technologies- CRISPR and Zinc Finger Nuclease (ZFN) methods.

UNIT IV **(12-Hours)**

Synthetic cell: The notion of the minimal cell, minimal RNA, minimal genome. Approaches to the minimal cell: Complex biochemical reactions in vesicles, Protein expression in vesicles. Novel chassis and hosts. Craig Venter synthetic cell.

UNIT V **(12-Hours)**

Commercial Applications – Biosensors, Designed nucleic acid and proteins, Biomedicine, Biomaterials, Biofuels and Bioremediation; Global events & competitions- iGEM, synbiobeta. Synbiosafe: Biosafety and biocontainment. Ethical aspects of synthetic biology. Patenting, Responsible Innovation and the Ethical, Legal and Social aspects of Synthetic Biology.

Books for Study

1. Kuldell *et al*., 2015. Biobuilder – Synthetic biology in lab. Octal Publishing. (Unit I and II).
2. Baldwin *et al*., 2016. Synthetic biology – A Primer. Imperial college press. (Unit III).
3. Pier Luigi Luisi, 2006. The Emergence of Life - from chemical origins to synthetic biology.
4. Cambridge University Press, New York. (Unit IV and V).

Books for References

1. Eric Davidson, (2006). The Regulatory Genome: Gene regulatory networks in development and evolution, Academic Press.
2. Covert, M.W. (2014). Fundamentals of Systems Biology: from Synthetic Circuits to Whole Cell Models. CRC Press
3. Konopka, A. K. (2006). Systems Biology: Principles, Methods, and Concepts. CRC Press.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
II	21PBT2CC05	CORE-5: SYNTHETIC BIOLOGY	4	4

Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	1	2	3	2	2	3	2.1
CO2	2	2	2	2	2	2	2	2	3	3	2.2
CO3	3	1	2	2	2	3	3	2	2	3	2.3
CO4	3	3	3	2	2	3	3	2	2	2	2.5
CO5	2	3	2	2	2	3	3	2	2	2	2.3
	Mean overall score										2.28
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
II	21PBT2CC06	CORE-6: GENOMICS AND PROTEOMICS	4	3

CO. No.	CO- Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	classify the complexity of genome/ proteome structural and functional organization.	K1
CO-2	discuss the concepts and techniques applied in genomics, transcriptomics and proteomics.	K2
CO-3	apply structural and functional genomics approaches on newly sequenced genome for functional characterization of genes.	K3
CO-4	design the experiments using various techniques of genome sequencing as well as organization of biological data.	K4
CO-5	formulate and assess experimental problems in omics fields.	K5 & K6

Unit - I **(12-Hours)**

Concept of genome organization and minimal cell genome. Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *In situ* hybridization. Chromosome walking and characterization of chromosomes, gene function - forward and reverse genetics, gene ethics.

Unit - II **(12-Hours)**

Comparative genomics: Bacteria, Organelles and Eukaryotes. Sequencing strategies and automation: (Sanger's method), advanced methods (Automated DNA sequencing and Pyrosequencing), Human Genome Project. Introduction to the CoGe system for Comparative Genomics.

Unit - III **(12-Hours)**

Functional genomics: Genetic interaction mapping, Transcriptome profiling: (Microarray, ChIP, SAGE), RNAi - Studying gene function through protein-protein interaction (Phage display and yeast two hybrid), Loss of function techniques (mutagenesis and RNAi). Functional annotation of genes. Metagenomics: Prospecting for novel genes from metagenomes and their biotechnological applications.

Unit –IV **(12-Hours)**

Proteomics - Protein sequencing, Protein expression analysis by 2-DE, 2DMALDI-TOF MS, LC-MS/MS, Quantitative proteomics. Tandem Mass spectrometry, Peptide mass fingerprinting. Mining the proteome, Protein expression profiling, Protein tags; protein arrays and antibody arrays.

Unit - V **(12-Hours)**

Metabolomics: Introduction to metabolomics: Metabolome, Metabolomics, Metabolite profiling, Metabolome fingerprinting, Role of Biomarker in metabolomics, Metabolome projects of plant and human, Future prospective of metabolomics.

Books for study

1. Daniel L. Hartl and Elizabeth W. Jones. 2009. Genetics (Ed: 7) Jones and Barlett Publishers Inc, Subury. (Unit I)
2. Watson J.D. *et al*., 2006 Molecular Biology of the Gene (Ed.5), Pearson Education INC. London.

References

1. John Lindon Jeremy Nicholson Elaine Holmes. 2006**.** The Handbook of Metabonomics and Metabolomics (Ed: 1), Elsevier Science. (Unit V)
2. Brown T.A. 2007. Genomes 3. Garland Science Publishing. (Unit II and Unit III)
3. Cullis C.A. 2004. Plant Genomics and Proteomics. John Wiley & Sons, Inc., Hoboken, New Jersey. (Unit III and Unit IV)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
II	21PBT2CC06	CORE-6: GENOMICS AND PROTEOMICS	4	3

Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	2	1	3	3	3	1	1	2.1
CO2	3	3	2	1	2	3	3	3	2	2	2.3
CO3	3	3	3	1	1	3	3	3	3	1	2.4
CO4	3	3	3	1	1	2	2	2	3	3	2.3
CO5	3	3	3	2	2	3	3	2	1	3	2.5
	Mean overall score										2.32
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
II	**21PBT2CP03**	**Practical – III: RECOMBINANT DNA TECHNOLOGY, GENOMICS AND IMMUNOLOGY**	**5**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	know-how on versatile techniques in recombinant DNA technology.	**K1**
CO-2	explain the role on antigen antibody interactions in various immune-techniques.	**K2**
CO-3	perform the various types of Immunological techniques.	**K3**
CO-4	examine and formulate the experiment for gene identification and prediction.	**K4 & K5**
CO-5	design and conduct experiments involving genetic manipulation.	**K6**

Recombinant DNA Technology

1. Agarose gel electrophoresis
2. Isolation of genomic and plasmid DNA from bacteria
3. Isolation of total RNA from plant tissue
4. Isolation of genomic DNA from Plant tissue
5. Restriction digestion
6. Ligation of DNA
7. Transformation of bacteria by Calcium chloride method
8. Blue-White screening method
9. GFP cloning
10. Gel elution of DNA
11. DNA fingerprinting
12. Bacterial gene expression

Genomics

1. Gene prediction using Genscan.
2. Primer designing
3. Gene finding
4. Online Mendelian Inheritance in Man (OMIM)
5. KEGG (Kyoto Encyclopedia of Genes and Genomes)

Immunology

1. Collection of body fluids and blood.
2. Separation of serum and plasma.
3. Precipitation - Agar Gel Diffusion, Counter current Immuno-electrophoresis, Single Radial Immunodiffusion, Rocket electrophoresis.
4. Agglutination - blood grouping, latex agglutination, heme-agglutination, WIDAL, VDRL.
5. Labelled assays - ELISA, Radio Immuno-Assay and Immunoblot.
6. Total count, Differential count (RBC & WBC).
7. Blood typing.
8. Isolation of DNA from leukocytes.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
II	21PBT2CP03	Practical III: RECOMBINANT DNA TECHNOLOGY, GENOMICS AND IMMUNOLOGY	5	4

Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	1	2	3	2	2	2	1	2.0
CO2	2	3	2	2	1	2	3	3	2	1	2.1
CO3	2	3	2	3	2	3	3	2	3	1	2.4
CO4	2	2	2	2	2	2	3	3	2	2	2.4
CO5	3	3	3	3	3	2	3	2	2	2	2.6
	Mean overall score										2.30
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
II	**21PBT2SP01**	**Self-paced Learning: FUNDAMENTALS OF GENETICS**	**--**	**2**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	critical thinking about how traits are inherited and to use this understanding in analyses.	**K1**
CO-2	outline the basics of cytogenetics, extra-chromosomal inheritance, linkage and cytoplasmic inheritance	**K2**
CO-3	classify the genetic basis of heredity, Mendelian and non-Mendelian modes of inheritance.	**K3**
CO-4	explain the concepts of gene & allele frequencies, analyze and apply the Hardy-Weinberg equilibrium for population genetics.	**K4**
CO-5	evaluate conclusions that are based on genetic data.	**K5**

Unit - I: History of Genetics - Mendelism – basic principles. Extensions of Mendelism, penetrance and expressivity of genes. Non - Mendelian inheritance – cytoplasmic inheritance.

Unit - II: Linkage and genetic mapping Linkage and Crossing over - Stern's hypothesis, Creighton and McClintock's experiments, single cross over, multiple cross over, two-point cross, three-point cross, map distances, gene order, interference and co-efficient of coincidence. Haploid mapping (*Neurospora*).

Unit - III: Inheritance of traits in humans; pedigree analysis, determination of human genetic diseases by pedigree analysis, genetic mapping in human pedigrees. Molecular cytogenetics, molecular genetics-DNA markers – VNTR, STR and microsatellite. Quantitative genetics – Polygenic inheritance, QTL, effect of environmental factors and artificial selection on polygenic inheritance.

Unit - IV: Population genetics Gene pool, allele and genotype frequency. Hardy Weinberg law and its applications, estimation of Allele and Genotype frequency of dominant genes, co-dominant genes, sex-linked genes and multiple alleles. Interaction of genes: incomplete dominance, co-dominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; Pleotrophy, genome imprinting, inheritance and lethal genes. Environment and gene expression: penetrance and expressivity; temperature, light, phenocopies,

Unit - V: Genetic equilibrium, genetic polymorphism. Factors that alter allelic frequencies; Mutation Genetic drift - Bottle neck effect and Founder effect, migration, selection, non-random mating, inbreeding coefficient.

Books for Study

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII ed. Principles of Genetics. Wiley India. (Unit I, Unit II and Unit III)
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and
3. Sons Inc.
4. 3. Hartl. D.L. A primer of population genetics. 3rd edition, Sinauer Associates Inc. Sunderland, 2000. (Unit IV and Unit V).

Books for References

1. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
2. Russell, P. J. (2009). Genetics 3. A Molecular Approach. III Edition. Benjam in Cummings.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology – 3: Principles and Applications of Recombinant DNA. ASM Press, Washington. (Unit III)
4. Human genetics, A. Gardner, R.T. Howell and T. Davies, Published by Vinod Vasishtha for Viva Books private limited, 2008.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	**Course Code**	**Title of the Course**	**Hours**	**Credits**
II	**21PBT2SP01**	**Self-paced Learning: FUNDAMENTALS OF GENETICS**	**--**	**2**

Course Outcomes (CO. No.)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	2	2	3	2	3	2	2	2.3
CO2	3	3	2	2	1	2	3	2	2	2	2.2
CO3	3	2	2	3	2	2	3	3	1	1	2.2
CO4	3	3	3	1	2	2	3	3	2	2	2.4
CO5	2	3	2	2	2	2	3	2	2	2	2.4
									Mean overall score		**2.30**
										Result	**High**

Semester	Course Code	Title of the Course	Hours	Credits
II	**21SBS2ES02B**	**DSE- 2: IMMUNOTECHNOLOGY**	**5**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	apply knowledge in various cellular functions, inculcate a knowledge related to the functioning of the different molecules and moieties.	**K1**
CO-2	understand the function of the major components of the immune system in health and disease.	**K2**
CO-3	apply the principles of cellular ontogeny and the gene rearrangement to understand the novel and complex immune system.	**K3**
CO-4	identify and categorize the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases	**K4**
CO-5	inspect and create immunological techniques for better understanding of immune disorders.	**K5 & K6**

Unit - I **(15-Hours)**

Basics of immunology Terminology - antigen, immunogen, hapten, antigenecity, immunogenicity, immunoglobulin, antibody, epitope, paratope, super antigen, allergen, tolerogen etc. Organs of immune system, tissues of immune system, cells of immune system & mediators of immune system. Active, passive and combined immunity. Vaccines - Live, killed, attenuated, plasma derived sub-unit, recombinant DNA, protein based, plant based, peptides, anti-idotypic and conjugate vaccines – production & applications. Role and properties of adjuvants & ISCOMS.

Unit - II **(15-Hours)**

Immunoglobulin Theories of antibody formation. Structure and Functions domains, classes, Organization and expression of Immunoglobulin Light and Heavy chain genes. B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation. Antibody genes and antibody engineering-chimeric and hybrid monoclonal antibodies, catalytic antibodies and generation of immunoglobulin gene libraries.

Unit - III **(15-Hours)**

Major Histocompatibility Complex (MHC) General organization and inheritance of MHC; MHC Haplotypes. The structure of MHC Class -I and Class-II molecules; organization of MHC class I and class II genes, peptide binding of MHC molecules. Complement system alternate and classical pathways. HLA typing. Transplantation - Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy. Cell Mediated Immunity, Humoral immunity, Antigen Presenting Cell.

Unit - IV **(15-Hours)**

Antigen-antibody interactions Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, Immunofluorescence, Flow cytometry and Immuno electron Microscopy; Biosensor assays for assessing ligand - receptor interaction, CMI techniques – Lympho-proliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis.

Unit - V **(15-Hours)**

Clinical Immunology Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity - Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD^{4+} T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Tumor immunology - Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy; Immunodeficiency - Primary immune deficiencies, Acquired or secondary immune deficiencies.

Books for study

1. Kuby R.A. Goldsby *et al*., 2002. Osborne Immunology (Ed: 6) Freeman & Co., New York. (Unit I, Unit II and Unit III)
2. Delves *et al*., 2016. Roitt's Essential Immunology (Ed: 13). Blackwell Scientific Publisher, England. (Unit IV and Unit V).
3. Tizard, Ian R. Immunology and introduction, 2010. (Ed: 4), Saunders college publishing, New Delhi.
4. Coico R, Sunshine G. 2009. Immunology: A short course, (Ed: 6), Wiley-Blackwell publishers, Canada

References

1. Donald M. Weir and John Steward. 1993. Immunology (Ed: 7). ELBS, London.
2. Murphy *et al*., 2008. Janeway's Immunology: the immune system in health and disease. (Ed: 7), Garland Science Publisher, New York.
3. Hudson, L. and Hay, F.C. Practical Immunology. Blackwell publishers 1989.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
II	21SBS2ES02B	DSE- 2: IMMUNOTECHNOLOGY	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	2	3	2	2	2.3
CO2	2	3	2	1	1	3	3	3	2	2	2.2
CO3	3	2	2	2	2	3	3	2	2	2	2.3
CO4	3	3	3	2	2	3	3	2	1	2	2.4
CO5	3	3	3	3	2	3	3	3	3	1	2.7
									Mean overall score		2.38
									Result		High

Semester	Course Code	Title of the Course	Hours	Credits
II	**21PBT2ES02**	**DSE- 2: CELL SIGNALING**	**5**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	write about signal transduction pathway in bacteria and plants system.	**K1**
CO-2	exhibit the knowledge in the regulation of target cell responsiveness.	**K2**
CO-3	classify the intracellular signaling cascades and their impact on cellular activities .	**K3**
CO-4	analyze the cytoskeleton rearrangements, motility and changes in gene expression.	**K4**
CO-5	organize and evaluate the basic knowledge in the components of the main signaling pathways and their functional properties.	**K5 & K6**

Unit – I **(15-Hours)**

Extra Cellular Matrix (ECM) and Cell Surface: Molecules in the ECM in plant and animals. Transport across cell membrane, Ficks Law. Types of transport - simple, passive, facilitated. Active transport, primary and secondary active transport system. Ionophores, gated channels (Voltage and Ligand). Cell communication and type of signaling molecules. Types of receptors and their structure. GPCR, inhibitory and stimulatory and type of down-stream effectors and signal termination. Monomeric G-proteins their role. Drugs targeting signaling molecules.

Unit – II **(15-Hours)**

Cell signaling: Various types cell signaling (Autocrine, paracrine, juxtacrine and endocrine). Cell signaling molecules: Hormones and growth factors, neurotransmitters, peptide hormones, steroid hormones, eicosanoids, vitamins and gases. Cell signaling cascades: Role of MAPK pathway in signaling. Cell signaling in neurons - long term potentiation, long term depression. Cell signaling in immune system. Cross talk between signaling pathways. JAK-STAT pathway, NF-kappa B signaling.

Unit – III **(15-Hours)**

Concept of transducers, effectors, GTP binding proteins - Gi, Gs, Gp, Gq, ras; adenylate cyclase, guanylate cyclase, phosphodiesterases, Protein kinase (PK) A, C and G, Calmodulin dependent PK, tyrosine kinase, stress activated PK, ribosomal S6 kinase; angiogenesis, PKs associated with cell survival and death processes.

Unit – IV **(15-Hours)**

Signal Transduction and Cancer: Discovery of oncogenes, proto-oncogenes. Modes of action of oncogenes – G proteins – Ras. Growth factors – Erb, Sis. Transcription factors – Fos, Jun, AP1, V-erbA. Discovery of tumor suppressor genes. RB and retinoblastoma, APC and colon cancer. Modes of action of TS genes – p110, p16, p21, Phosphatase and tensin homolog (pTEN). p53 and cancer risk. Selected examples – c-Myc and leukemia. BRCA and breast cancer.

Unit – V **(15-Hours)**

Signal Transduction in Bacteria and Plants: Introduction of signaling components in bacteria, Chemotaxis, Protein kinases in bacteria, His-kinases: structure and role, Plant signaling system an over view, Stress signaling in plants (biotic), Stress signaling in plants (abiotic). Plant hormones and their mechanism of action. Signaling in yeast: STAT pathway in yeast

Books for Study

1. Michel Friedman and Brett Friedman. 2004. Cell communication: Understanding how information is stored and used in cells. Ingram International Inc.
2. John T Hancock. 2005. Cell signaling. Oxford University press.

Books for References

1. Geoffery M Cooper and Robert E Hausman. 2009. The Cell and Molecular Approach. (Ed: 5). ASM Press and Sinauer Associates Inc.
2. Gomperts, Basten D, Ijbrand M Kramer and Peter ER Tatham. 2009. Signal transduction. (Ed:2). Academic Press.
3. Ernst JM Helmreich. 2001. The Biochemistry of cell signaling. Oxford Universiy Press.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	**Course Code**			**Title of the Course**				**Hours**		**Credits**
II	**21PBT2ES02**			**CELL SIGNALING**				**5**		**4**
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	2	3	2	2	2	2	2.3
CO2	3	2	2	2	2	3	3	3	2	1	2.3
CO3	3	3	2	2	2	2	3	2	2	2	2.3
CO4	2	3	3	2	2	3	3	2	2	2	2.4
CO5	3	3	3	2	2	2	3	2	3	2	2.5
									Mean overall score		**2.36**
										Result	**High**

Semester	Course Code	Title of the Course	Hours	Credits
II	21PSS2SE01	SEC: SOFT SKILLS	4	3

Programme Specific outcomes (PSOs)
After the successful completion of the course, students will learn:

- the dynamics of effective and professional communication skills and put them into daily use
- to write a Professional resume using creative methods of online platforms
- the dynamics of interview skills and GD preparations and presentations in public platforms and present the best of themselves as job seekers
- to understand, analyze and express their personality styles and personal effectiveness in various environments
- to learn and update themselves with the required knowledge in Numerical ability and Test of Reasoning for competitive examinations

Course outcomes (CO. NO.)
Upon completion of this course, students will:

- be exposed and trained in various nuances of Soft Skills in a Professional manner responding to the requirements of national and international market
- be able to synthesize the knowledge and practical skills learnt to be personal effective in any managerial positions
- be equipped to construct plans and strategies to work for better human society
- be able to illustrate the problems at work and home and design solutions and maintain a balance of work and home
- be able to connect on a continuum and maintain growth and sustainability and creativity in employment that increases in productivity, profit for individuals and the society.

Module 1: Effective Communication & Professional communication

Effective communication: Definition of communication, Process of Communication, Barriers of Communication, Non-verbal Communication. JOHARI Window as a tool of effective communication.

Professional Communication: The Art of Listening, The passage, Kinesthetic, Production of Speech, Speech writing , Organization of Speech, Modes of delivery, Conversation Techniques, Good manners and Etiquettes, Different kinds of Etiquettes, Politeness markers.

Module II. Resume Writing & Interview Skills

Resume Writing: Meaning and Purpose. Resume Formats. Types of s Resume. Functional and Mixed Resume**,** Steps in preparation of Resume, Model resumes for an IT professional Chronological, Types of interviews, Creative resumes using online platforms

Interview Skills: Common interview questions, Dos and Don'ts for an interview, Attitude, Emotions, Measurement, Body Language, Facial expressions, Different types of interviews, Telephonic interviews, Behavioral interviews and Mock interviews (Centralized).

Module III: Group Discussion & Team Building

Group Discussion: Group Discussion Basics, GD as the first criterion for selecting software testers, Essentials of GD, Factors that matter in GD, GD parameters for evaluation, Points for GD Topics, GD Topics for Practice, Tips for GD participation. Video shooting of GD presentation & Evaluation (Centralized)

Team Building: Characteristics of a team, Guidelines for effective team membership, Pedagogy of team building, Team building skills. Team Vs Group – synergy, Types of synergy, Synergy relates to leadership ,Stages of Team Formation, Broken Square-Exercise, Leadership, Leadership styles, Conflict styles, Conflict management strategies & Exercises

Module IV: Personal Effectiveness

Personal Effectiveness: Self Discovery: Personality, Characteristics of personality, kinds of self, Personality inventory table, measuring personality, intelligence and Exercises

Self Esteem: Types -High & Low self-esteem, Ways of proving self-esteem, Hypersensitive to criticism, activities. Goal setting: Goal setting process, Decision making process & Exercises.

Stress Management: Identifying stress, Symptoms of stress, Responding to Stress, Sources of stress, Coping with stress and Managing stress.

Module V: Numerical Ability

Average, Percentage, Profit and Loss**,** Problems of ages, Simple Interest, Compound Interest, , Area, Volume and Surface Area, Illustration, Time and Work, Pipes and Cisterns, Time and Distance**,** Problems on Trains**,** Illustrations, Boats and Streams, Calendars and Clocks.

Module VI: Test of Reasoning

Verbal Reasoning: Number series, letter series, coding and decoding, logical sequence of words, Assertion and Reasoning, Data Sufficiency, Analogy, Kinds of relationships.

Non-Verbal Reasoning: Completion of Series**,** Classification, analogical, Pattern comparison, Deduction of figures out of series, Mirror Reflection Pattern, Hidden figures, Rotation pattern, Pattern completion and comparison, Sense of direction, Blood relations.

Text cum Exercise book

Melchias G, Balaiah John, John Love Joy (Eds), 2018. Winners in the Making: A primer on soft skills. SJC, Trichy.

References

* Aggarwal, R.S. *Quantitative Aptitude, S. Chand & Sons*
* Aggarwal, R.S. (2010). *A Modern Approach to Verbal and Non Verbal Reasoning*. S. Chand & Co, Revised Edition.
* Covey, Stephen. (2004). *7 Habits of Highly effective people*, Free Press.

* Egan, Gerard. (1994). *The Skilled Helper* (5th Ed). Pacific Grove, Brooks/Cole.
* Khera ,Shiv (2003). *You Can Win.* Macmillan Books , Revised Edition.

Other Text Books

* Murphy, Raymond. (1998). *Essential English Grammar*. 2nd ed., Cambridge University Press.

* Prasad, L. M. (*2000). Organizational Behaviour, S.Chand & Sons.*

* Sankaran, K., & Kumar, M. *Group Discussion and Public Speaking* . M.I. Pub, Agra, 5th ed., Adams Media.

* Schuller, Robert. (2010) . *Positive Attitudes*. Jaico Books.

* Trishna's (2006). *How to do well in GDs & Interviews*, Trishna Knowledge Systems.

** Yate, Martin. (2005). H*iring the Best: A Manager's Guide to Effective Interviewing and Recruiting**

Semester	Course Code	Title of the Course	Hours	Credits
II	21PBT2EG01	GE - 1 (WS): MEDICAL BIOTECHNOLOGY	4	3

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	recall the knowledge in the fast emerging medical biotechnology, cancer biology and the innovative processes that ensures the success of such endeavors.	K1
CO-2	understand how the various drivers of medical biotechnology interact with one another and shape the business & finance of this industry and impact the growth of medical biotechnology companies.	K2
CO-3	apply the knowledge to develop the creative thinking and explore the ideas of new vision of medical biotechnology and cancer biology.	K3
CO-4	analyze the basics of medical genetics and their underlying mechanisms, one can be aware of the ways to avoid them and also know the implications of the drugs and their effects.	K4 & K5
CO-5	plan the appropriate diagnostic method for the detection of cancer.	K6

UNIT I **(12-Hours)**

Introduction to Medical biotechnology- Scope for Medical biotechnology, History of Medical Biotechnology, Molecular interactions: Protein-drug, protein-protein, protein-DNA, enzymes diagnostics, nucleic acid based diagnostics, PCR based diagnostics.

UNIT II **(12-Hours)**

Clinical Research in Drug Discovery, New Drug Application and Approval - Pharmaceutical Industry - Global and Indian Perspective - Clinical Trial market. Selection of drugs - Threats behind self-medication - Monitoring the prescribed drug advised, Clinical data management, Ethical issue in clinical studies.

UNIT III **(12-Hours)**

Pharmaceutical product manufacturing and their control: Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes. Special requirement for bulk drug manufacture. Control: Therapeutic categories such as vitamins, laxatives, analgesics, non-steroidal contraceptives, Antibiotics, biologicals, hormones. **Herbal-Drug and Herb-Food Interactions:** General introduction to interaction and classification. Study of following drugs and their possible side effects & interactions: Gingko biloba, Ginseng, Garlic & Pepper.

UNIT IV **(12-Hours)**

Fundamentals of cancer biology, Regulation of Cell cycle, Mutations that cause changes in signal molecules, tumor suppressor genes, Modulation of cell cycle in cancer, Different forms of cancers, Diet and cancer. Carcinogenesis and types.

UNIT V **(12-Hours)**

Oncogenes and treatment for cancer Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth factor and Growth factor receptors that are Oncogenes. Different forms of therapy, Chemotherapy, Radiation Therapy, Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection.

Books for study

1. Lodish *et al*., 2007. Molecular cell Biology: (Ed: 6), W.H Freeman Publishers. (**Unit I**)
2. R. G. McKinnell, R. E. Parchment, A. O. Perantoni, G. Barry Pierce, I. Damjanov. 2006. The Biological Basis of Cancer: (Ed: 4), Cambridge University Press, 2006. (**Unit IV**)
3. R. A. Weinberg. 2013. The Biology of Cancer (Ed: 2),W. W. Norton & Company. (**Unit V**)
4. Watson J.D. *et al*., 2007. Molecular Biology of the Gene (Ed.6), Pearson Education Inc., London.

Books for References

1. Stephen Hulley (2011), Outlines & Highlights for Designing Clinical Research: An Epidemiologic Approach, Academic Internet Publishers. (**Unit II**)
2. Dan Wood, Daron Smith (2012), Research in Clinical Practice, Springer Publications.
3. Robert J. Levine (2010), Ethics and Regulation of Clinical Research: Second Edition, Yale University Press. (**Unit II**)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	**Course Code**			**Title of the Course**				**Hours**		**Credits**
II	**21PBT2EG01**			**GE - 1 (WS): MEDICAL BIOTECHNOLOGY**				**4**		**3**
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	3	2	1	3	3	2	2	2	2.3
CO2	3	2	3	3	2	2	3	1	3	2	2.4
CO3	3	3	3	2	2	3	3	1	2	2	2.4
CO4	2	3	3	2	1	3	3	2	3	2	2.4
CO5	3	2	3	2	3	2	3	3	3	1	2.5
	Mean overall score										**2.4**
	Result										**High**

Semester	Course Code	Title of the Course	Hours	Credits
III	**21PBT3CC07**	**CORE-7: BIOINSTRUMENTATION AND RESEARCH METHODOLOGY**	**5**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	enumerate and classify the scientific knowledge on operation and application of instruments in day-to-day scientific experiments and research.	**K1**
CO-2	explain the concept of research & learn the art of paper writing, publication and ethics in research.	**K2**
CO-3	apply the instrumentation and technical skills to collect, analyze and interpret biological problems with appropriate solutions.	**K3**
CO-4	identify self-learning methods and organizational skills to enhance problem-solving abilities in societal context.	**K4**
CO-5	evaluate and create the novel tools for the accomplishment of specific biological tasks.	**K5 & K6**

Unit – I **(15-Hours)**

Microscopy - Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning and Transmission Electron Microscopy, Scanning Tunnel Microscopy, Atomic Force Microscopy, Confocal Microscopy, Cytophotometry. **Electrochemistry** – principles, electrochemical cells and reaction – pH and buffers. Measurement of pH – electrodes. Titration curves. Nephelometry, Turbidometry and Reflectance Photometry.

Unit – II **(15-Hours)**

Centrifugation – Principles, Preparative and Analytical Centrifuges, Sedimentation analysis, RCF, Density Gradient Centrifugation and Ultracentrifugation. **Electrophoresis -** Principles, electrophoretic mobility, DGGE, TGGE. Isoelectric focusing, 2D PAGE, capillary electrophoresis. **Chromatography -** Theory and Applications - Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC, GLC, HPLC, HPTLC and FPLC.

Unit – III **(15-Hours)**

Spectroscopy – Properties of EMR, Absorption & Emission Spectrum, types of sources. AAS & flame photometer, UV/VIS spectroscopy, Laser, IR, ESR, NMR, MS, spectrofluorimetry, CD and Raman spectroscopy and X-ray diffraction. **Radioisotopes** - Nature of Radioactivity and Half-life, Detection and measurement of radioactivity: Geiger Muller Counter - Scintillation counter.

Unit – IV **(15-Hours)**

Biostatistics – Basics and uses of Central value measures (Mean, Median, Mode), Measures of Dispersion (Standard Deviation and coefficient of variation) in data analysis and presentation. Basic theoretical knowledge of Correlation and Probability - Sample Testing:

Large samples (Z), small sample test: t, Chi-square, ANOVA - one way & two way. **Experimental Design-** Principles: Randomization, Replication, Local control, Size and shape of the plot. CRD and RBD.

Unit – V **(15-Hours)**

Research Methodology - Selection of research problems – hypothesis – definition and characteristics. Bibliography - Journals, e-journals, books, biological abstracts. Experimental approaches – biological, physical and chemical methods. Research outcome - Preparation of index cards, Review writing, Thesis writing, Article writing – structure of article (title, introduction, methods, specimens and techniques of statistics, results, discussion, acknowledgements, references, abstracts), Journal Selection. **Research Ethics** – Introduction and Principles.

Books for study

1. Braun, R.D. 2016. 2nd edition. Introduction to Instrumental Analysis, McGraw Hill. (Unit I, Unit II)
2. Donald Voet and Judith G. Voet. 2010. Biochemistry. 4th Edition. Wiley Press.

Books for References

1. Berry, A.K. 2015. A Textbook of Biochemistry (Biological Chemistry). Emkay Publications.
2. Gurumani. N. 2006. Research methodology for biological sciences, MJP publications. (Unit V)
3. Cantor and Schimmel. 2004. Biophysical chemistry: Part I, Part II and Part III, W.H. Freeman and Co., New York.(Unit III)
4. Wayne W. Daniel and Chad L. Cross. 2014. Biostatistics: Basic Concepts and Methodology for the Health Sciences, (Ed: 10), Wiley Press. (Unit IV)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3CC07	CORE-7: BIOINSTRUMENTATION AND RESEARCH METHODOLOGY	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	1	2	3	2	2	2	2	2
CO2	3	3	2	1	2	3	3	3	2	3	2.5
CO3	2	3	3	2	2	2	3	3	2	3	2.5
CO4	2	3	3	2	2	2	3	3	3	2	2.5
CO5	2	1	3	3	3	2	3	1	3	3	2.4
	Mean overall score										2.38
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
III	**21PBT3CC08**	**CORE-8: INDUSTRIAL BIOTECHNOLOGY**	**4**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	acquire knowledge on the basic principles of fermentation and technologies used in the development of fermented food products.	**K1**
CO-2	examine and classify the microbial growth kinetics, different types of fermentation, selection of microorganisms for industrial application and production of different fermented food products.	**K2**
CO-3	analyze the importance of ethics in fermentation technology in the selective production of commercial products.	**K4**
CO-4	evaluate the outcomes of fermentation methods when employing specific group of microorganisms in correlation with the substrate.	**K5**
CO-5	assess new ideas in the utilization of alternative microorganisms for the improvement in product yield and design a protocol for the operation of basic bioprocess operation.	**K5 & K6**

Unit – I **(12-Hours)**

Introduction to fermentation technology: Interaction between chemical engineering, Microbiology and Biochemistry. History of fermentation. Introduction to fermentation processes, Media formulation and optimization. Basic concepts- batch, Continuous and fed batch culture, selection methods for industrially important microorganisms. Strain improvement, preservation, and properties of industrial strains. Immobilization: different matrices, whole cell and enzyme immobilization.

Unit – II **(12-Hours)**

Fermentor – Design & Types: Gaden's Fermentation classification, Design and operation of Fermenters, Basic concepts for selection of a bioreactor, Impellers, baffles and sparger, sterilization. Types of reactor- submerged reactor – mechanically stirred draught- tube reactor- continuous flow stir type reactor – airlift reactor- jet loop reactor, surface reactor, packed bed reactor, Fluidized bed reactor.

Unit – III **(12-Hours)**

Bioprocess control and monitoring variables – O_2 requirement and uptake, Foam and antifoams, their effect on oxygen transfer, factors affecting KLa. Flow measurement and control, control system – manual and automatic. Application and the role of computers in bioprocess. Fermentation economics. Biosensors: construction and application.

Unit – IV **(12-Hours)**

Down-stream processing: Introduction, recovery of microbial cells, precipitation, filtration-theory of filtration, batch and continuous filters. Centrifugation. Cell disruption - physical

and chemical methods. Extraction liquid-liquid extraction and aqueous-two phase extraction. Chromatography, membrane processes, drying and crystallization.

Unit – V **(12-Hours)**

Production strategies for industrial products: (Lactic acid and Ethanol), therapeutics (Insulin and Interferon), antibiotics (Cephalosporin), Microbial enzymes (Chitinase, Glucose Oxidase, Lipase), Exopolysaccharides (Pullulan). Use of immobilized cells / enzymes to produce protease, Use of fungi in industry including food industry: fuel cells, Use of fungi in agriculture and environmental applications: Biofertilizers, Bioremediation and Biological control. Animal cell culture technology to produce recombinant vaccines.

Books for study

1. Stanbury P.F. *et al*., 1999. Principles of Fermentation Technology, Butterworth-Heinemann, UK. (Unit I, Unit II, Unit III and Unit IV)
2. El-Mansi E.M.T *et al*., 2007. Fermentation Microbiology & Biotechnology. CRC / Taylor & Francis. (Unit V)

Books for References

1. Bailey J and D.F. Ollis. 2017. Biochemical Engineering Fundamentals (Ed: 2) Indian Edition: McGraw-Hill, NY
2. Cinar A *et al*., 2003. Batch Fermentation - Modeling, Monitoring and Control. Marcel Dekker. USA.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	**Course Code**	**Title of the Course**	**Hours**	**Credits**
III	**21PBT3CC08**	**CORE-8: INDUSTRIAL BIOTECHNOLOGY**	**4**	**4**

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	3	2	2	2	2	2.1
CO2	3	3	3	2	3	2	3	2	3	2	2.6
CO3	3	3	2	2	2	2	3	3	2	3	2.5
CO4	3	3	2	2	3	2	3	3	2	2	2.5
CO5	3	2	2	2	3	2	3	3	3	2	2.5
									Mean overall score		**2.44**
										Result	**High**

Semester	Course Code	Title of the Course	Hours	Credits
III	**21PBT3CC09**	**CORE-9: INTELLECTUAL PROPERTY RIGHTS (IPR) AND BIOETHICS**	**4**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	understand the basic concepts of ethics and safety that are essential for different disciplines of science and procedures involved and protection of intellectual property and related rights.	**K1**
CO-2	interpret the importance of protection of new knowledge & innovations and its role in Business.	**K2**
CO-3	implement various aspects of biosafety and carry out risk assessment of products in biological research.	**K3**
CO-4	execute the technology, knowledge and business management aspects of intellectual property in biological research.	**K4**
CO-5	critique the ethical concerns associated with modern biotechnology processes and plan accordingly.	**K5 & K6**

Unit - I **(12-Hours)**

Introduction to intellectual property rights: Concepts of IPR; Types of IP: patents; Trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications; IP as a factor in R&D and of relevance to biotechnology; Implications of intellectual property rights on the commercialization of biotechnology products.

Unit – II **(12-Hours)**

Patenting: Basics of Patents; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing (Patent application - forms and guidelines including those of National Biodiversity Authority (NBA) and other regulatory bodies, fee structure, time frames; Filing of a patent application; precautions before patenting - disclosure/non-disclosure, concept of "prior art", patent databases including patent search, analysis and report formation).

Unit – III **(12-Hours)**

Biosafety: Laboratory safety - Chemical, electrical and fire hazards; handling and manipulating human or animal cells and tissues, toxic, corrosive or mutagenic solvents and reagents; mouth pipetting, and inhalation exposures to infectious aerosols, Safe handling of syringe needles or other contaminated sharps, spills and splashes onto skin and mucous membranes. Health aspects; toxicology, allergenicity, antibiotic resistance. Regulations and recommendations for biosafety, ascending levels of containment; Safety equipment and facility safeguards for corresponding level of risk associated with handling a particular agent.

Unit - IV **(12-Hours)**

Bioethics and GMOs: Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-radio isotopic procedure; Benefits of transgenics to human health, society and the environment.

Unit - V **(12-Hours)**

Bioethics in Biomedical Research: Nature, Concept and Relevance of Bioethics, Legal, Social, Moral and Economic Impacts of the Products and Techniques in Biotechnology, Ethical issues in Healthcare. **Biopiracy and Bioethics**: Application of IPR regime to Biological Resources and Biopiracy, Access to Biological Resources, Benefit Sharing and Informed Consent, Independent Ethics Committee, Constitution of institutional ethics committee, Conflicts of Interest.

Books for study

1. V. Shree Krishna, (2007). Bioethics and Biosafety in Biotechnology, New Age International Pvt. Ltd. Publishers. (Unit III, Unit IV and Unit V)
2. Deepa Goel, Shomini Parashar, (2013). IPR, Biosafety and Bioethics, Pearson. (Unit II)
3. R. Ian Freshney, 2016. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Ed, John Wiley & Blackwell.
4. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007. (Unit I)

Books for References

1. Biosafety in Microbiological and Biomedical Laboratories, (2020) 6th Ed. (https://www.cdc.gov/labs/pdf/SF__19_308133-A_BMBL6_00-BOOK-WEB-final-3.pdf)
2. Kankanala C., (2007), Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd.,

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3CC09	CORE-9: INTELLECTUAL PROPERTY RIGHTS (IPR) AND BIOETHICS	4	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	3	2	2	2	2.3
CO2	3	3	3	3	3	1	2	3	2	2	2.5
CO3	2	3	3	1	1	3	3	3	2	2	2.3
CO4	1	1	3	3	2	3	1	2	1	1	1.8
CO5	3	2	3	3	3	1	1	2	3	3	2.4
									Mean overall score		**2.26**
									Result		**High**

Semester	Course Code	Title of the Course	Hours	Credits
III	**21PBT3CP04**	**Practical-IV: BIOINFORMATICS AND BIOSTATISTICS**	**4**	**3**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	acquire knowledge on tools and servers used in bioinformatics.	**K1**
CO-2	discuss and evaluate the ethical concerns regarding the use of bioinformatics.	**K2**
CO-3	apply the knowledge and skills in the accomplishment of biological tasks such as DNA analysis using graph algorithms, clustering, trees and statistical analysis of biological data.	**K3**
CO-4	analyze and execute the latest software and tools in bioinformatics and biostatistics to solve biological problems.	**K4**
CO-5	construct skills to handle biological sequence database and tools for structural data analysis.	**K5 & K6**

Bioinformatics & Biostatistics

1. Data Collection on discrete and continuous variables.
2. Data classification: Discrete frequency distribution, Continuous frequency distribution and Cumulative frequency distribution.
3. Statistical Illustrations – Manual and Computer aided using Microsoft Excel.
4. Measure of central values: Minimum, Maximum, Mean, Median and Mode.
5. Measure of Dispersion: Standard Deviation and coefficient of variation.
6. Introduction to R programming and its importance in biostatistics.
7. Biological databases-file formats.
8. Data retrieval using ENTREZ.
9. Sequence analysis: Pairwise alignment (BLAST).
10. Sequence analysis: Multiple alignment (Clustal W).
11. Motif and domain analysis.
12. Phylogenetic analysis.
13. Molecular visualization using Rasmol.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3CP04	Practical – IV: BIOINFORMATICS AND BIOSTATISTICS	4	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	3	2	2	3	2	2.2
CO2	2	3	2	3	3	2	3	2	2	2	2.4
CO3	3	3	2	2	2	2	3	2	3	2	2.4
CO4	3	3	3	2	2	2	3	2	3	2	2.5
CO5	3	2	2	2	2	2	3	2	2	3	2.3
	Mean overall score										**2.36**
	Result										**High**

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3CP05	Practical-V: INDUSTRIAL BIOTECHNOLOGY	4	3

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	relate the principle of management and controls on the microbial processes in industrial settings.	K1
CO-2	develop the skills of large scale production of secondary metabolites.	K2
CO-3	examine and apply the principles of physiological understanding in improvement of industrial processes.	K3 & K4
CO-4	evaluate the application of different types of Bioreactors including immobilization reactor system and its kinetics.	K5
CO-5	design and optimize the parameter conditions for the bioreactors and downstream processing.	K6

Industrial Biotechnology

1. Bioassay and Chemical estimation of penicillin.
2. Preparation of bioinoculants and cell count determination on time scale.
3. Preparation of enzyme immobilized columns for biotransformation –e.g. yeast cells immobilized in calcium alginate beads.
4. Microbial Production of amino acids.
5. Screening and isolation of Antibiotic producing organisms from soil.
6. Isolation and screening of Enzyme producing microorganisms from soil.
7. Alcohol fermentation by Yeast.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3CP05	Practical – V: INDUSTRIAL BIOTECHNOLOGY	4	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	3	2	2	3	2	2.2
CO2	2	3	2	3	3	2	3	2	2	2	2.4
CO3	3	3	2	2	2	2	3	2	3	2	2.4
CO4	3	3	3	2	2	2	3	2	3	2	2.5
CO5	3	2	2	2	2	2	3	2	2	3	2.3
	Mean overall score										2.36
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
III	**21PBT3ES03A**	**DSE-3: BIOINFORMATICS**	**5**	**4**

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	acquire knowledge of competence in use of bio-informatical methods central to conduction of molecular biological research projects.	**K1**
CO-2	illustrate the exploration of proteins and solve biological problems including analysis of sequences, database searches, sequence comparison, protein structural analysis and phylogenetics.	**K2**
CO-3	predict the sequence variation in mutation and differential expression of genes.	**K3**
CO-4	explain the understanding of bioinformatics tools in annotation of genome and assess the ethical concerns regarding the use of bioinformatics software's and tools.	**K4 & K5**
CO-5	construct novel pipeline to sequence & structural analysis.	**K6**

Unit - I **(15-Hours)**

History of Bioinformatics; Role of Bioinformatics in biological sciences; Scope of Bioinformatics; Types of biological databases; Data mining and its techniques; Data warehousing. Application of Bioinformatics- gene prediction in prokaryotes, eukaryotes; other applications in the areas of health, food and medicine.

Unit - II **(15-Hours)**

Nucleic acid databases – Genbank, NCBI, EMBL, DDBJ; Primary protein databases – PIR, SWISSPROT, TrEMBL; Secondary protein databases – PROSITE, PROFILES, PRINTS, Pfam; Structural classification databases – SCOP, CATH; Literature databases – PubMed, Medline; Bibliographic databases – OMIM, PubMed.

Unit - III **(15-Hours)**

Sequence Annotation – Principles and tools; Sequence retrieval system – Entrez, SRS; Sequence submission tool – BANKIT, SEQUIN, WEBIN, SAKURA. Molecular phylogeny – Concepts of tree – rooted and unrooted trees; Clustering and Phenetic method, Cladistic method, Molecular Clocks; Steps in constructing phylogenetic analysis; Softwares used for phylogeny construction, Bootstrapping strategies. Molecular viewers - Rasmol, Chime and Spdb viewer.

Unit - IV **(15-Hours)**

Sequence alignment – concepts in alignment, Local & Global; Pairwise & Multiple; Tools for sequence alignment – BLAST, FASTA, ClustalW; Substitution matrices; Scoring matrices – PAM & BLOSUM; Dot plot; EST Clustering and analyses, Codon bias detection.

Unit - V **(15-Hours)**

Genomics & Proteomics: Concepts in Genomics and Proteomics, Genome annotation, Homology modelling. Applications of Metabolomics & Transcriptomics; Concept of system biology.

Books for study

1. Arthur M Lesk. 2009. Introduction to Bioinformatics(Ed:3). Oxford university press, New York.
2. Attwood, T.K. and Parrysmith, D.J. 2001. Introduction to Bioinformatics. Pearson Education (Singapore) Pvt. Ltd., New Delhi. (Unit I, Unit II)

Books for References

1. Andreas D. Baxevanis and B. F. Francis Ouellette. 2005. Bioinformatics - A Practical guide to the analysis of Genes and Proteins (Ed:3). John Wiley & Sons, Inc., Publications, US. (Unit III and Unit IV).
2. David W Mount. 2004. Bioinformatics: sequence and Genome analysis(Ed:2). Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York. (Unit V).
3. Rastogi, S.C., Menderatta, M. and Rastogi, P. 2004. Bioinformatics - concepts, skills and applications. CBS Publishers & Distributors, New Delhi.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3ES03A	DSE-3: BIOINFORMATICS	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	3	2	2	3	2	2	1	2	2.2
CO2	3	3	2	2	3	3	2	2	2	2	2.4
CO3	2	3	1	2	2	2	3	2	3	3	2.4
CO4	2	3	2	3	3	2	3	3	2	1	2.4
CO5	2	2	2	3	3	2	2	2	3	3	2.4
									Mean overall score		2.4
										Result	High

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3ES03B	DSE-3: DRUG DISCOVERY AND DEVELOPMENT	5	4

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	retrieve the major aspects of the drug discovery process, starting with target selection, to compound screening to designing lead candidates.	K1
CO-2	discuss and restate the ethical concerns in drug development right from synthesis of drug till the clinical trial of the developed drug.	K2
CO-3	implement various drug discovery tools and methods that are used for the identification and design of new drug molecule.	K3
CO-4	investigate drugs in detail, their absorption and distribution throughout the body.	K4
CO-5	inspect the integrate information from the scientific literature.	K5

Unit – I **(15-Hours)**

Drugs – definition, source and nature, types of classification and nomenclature, dose response curve and LD50. Role of drugs, Drug – protein interactions, routes of drug administration.

Unit – II **(15-Hours)**

Drug targets – Therapeutic categories such as vitamins, laxatives, analgesics, Antibiotics, hormones. Enzymes, receptors, carrier proteins. Forces in drug – receptor interaction, Receptor theories.

Unit – III **(15-Hours)**

Drug absorption and metabolism. Pharmacokinetic oriented drug design – Drug solubility and drug stability. Biological testing and bioassays – testing drugs *in vitro* and *in vivo*. Drug discovery. Lead compounds – natural sources and synthetic sources.

Unit – IV **(15-Hours)**

Development of Drug and Pharmaceutical Industry: Therapeutic agents, their use and economics; Regulatory aspects. Radio activity pharmacokinetic action of drugs in human bodies.

Unit – V **(15-Hours)**

Drug development. Target – oriented drug design, computer aided drug design, Quantitative structure, activity relationship – binding interaction, Functional groups and Pharmacophore. High throughput screening and Molecular docking. Docking softwares – AutoDock, Hex and PatchDock. Drug validation softwares – PreADMET server.

Books for study

1. Barar F S K (2004), Essentials of Pharmacotherapeutics, S Chand & Co. Ltd., New Delhi. (Unit I, Unit II and Unit IV).
2. G. Patrick (2013),An Introduction to Medicinal Chemistry, (Ed: 5), Oxford Press.

References

1. Kristian Stromgaard, Povl Krogsgaard-Larsen and Ulf Madsen.2016.Textbook of Drug Design and Discovery, CRC Press. (Unit III)
2. Rebecca Wade and Outi Salo-Ahen. 2019. Molecular Modeling in Drug Design. MDPI Press. (Unit V)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3ES03B	DSE-3: DRUG DISCOVERY AND DEVELOPMENT	5	4

Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	2	1	3	3	3	2	2	2.3
CO2	3	1	2	2	2	2	3	2	1	2	2.0
CO3	3	2	3	2	3	2	2	3	2	1	2.3
CO4	2	3	3	3	2	2	1	2	2	2	2.2
CO5	2	2	2	3	3	1	1	2	3	3	2.2
										Mean overall score	**2.2**
										Result	**High**

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3EG02	GE-2 (BS): FOOD TECHNOLOGY	4	3

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	acquire understanding on the chemical nature and association of microbes with food.	K1
CO-2	explain the principles and different methods used in food processing and preservation.	K2
CO-3	classify different methodologies and approaches involved in the production of different food products.	K3
CO-4	evaluate and identify a food science issue or problem.	K4, K5
CO-5	critical thinking and problem-solving skills to address current challenges in the food industry.	K5

Unit – I **(12-Hours)**

Food Nutrition

Food groups classification; Composition and nutritive value of cereals, millets and pulses; milk and animal products (meat, poultry and fish products). Constituent of food – contribution to texture, flavour and organoleptic properties of food;

Unit – II **(12-Hours)**

Food Microbiology

Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food additives – intentional and non-intentional and their functions. Food borne diseases – infections and intoxications, Food spoilage – causes.

Unit – III **(12-Hours)**

Food processing

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations – mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

Unit – IV **(12-Hours)**

Food preservation

Use of high temperatures – sterilization, pasteurization, blanching, canning – concept, procedure & application; Low temperature storage – Factors affecting quality of frozen foods; irradiation preservation of foods.

Unit – V **(12-Hours)**

Manufacture of food products

Bread and baked goods, dairy products – milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; confectionery, beverages.

Books for study

1. P.J.Fellows.2009. Food processing technology. Principles and practice. (Ed: 3). Woodhead Publishing Series in Food Science, Technology and Nutrition.
2. Sivasankar B. 2002. Food processing and preservation, Prentice Hall, New Delhi. (Unit III and Unit IV)

Books for References

1. James G.Brennan. 2006. Food processing handbook, 2nd Edition. Wiley Publishers.
2. Desrosier, N.W. 2006.The Technology of Food Preservation, CBS Publishers and Distributors, New Delhi.
3. Janet D.Ward. 2013. Principles of Food Science. 4th Edition. Goodheart-Willcox.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
III	21PBT3EG02	GE-2 (BS): FOOD TECHNOLOGY	4	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	1	3	3	2	2	3	3	2	2	2.2
CO2	2	3	2	2	2	2	3	3	2	2	2.3
CO3	2	2	3	2	2	2	2	2	2	2	2.1
CO4	2	2	2	3	2	2	2	2	3	3	2.4
CO5	2	3	3	2	2	2	2	2	3	3	2.4
	Mean overall score										2.28
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PBT4CC10	CORE-10: BIONANOTECHNOLOGY	6	6

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	gain knowledge on synthesis, applications and environmental impact of different types of nanoparticles.	K1
CO-2	apply their acquired knowledge of nature and properties of nanoparticles in the areas of diagnostics, agriculture and therapeutics for the empowerment of mankind.	K2
CO-3	classify the chemical and physical properties of each nanoparticles.	K3
CO-4	evaluate and restate the societal & ethical implications in the advancement of nanotechnology.	K4 & K5
CO-5	create ideas on the construction of novel nanoparticles with functional side chains and surface functionalization to accomplish a particular task.	K6

Unit – I **(18-Hours)**

Introduction to Nanotechnology and Bionanotechnology

Introduction to nanotechnology – concept of nanotechnology – advances. Nanochemistry – Classification of nanomaterials – Nanostructures and dynamics of biocompatible materials – fullerenes –nanoparticles – nanotubes – colloidal gold – quantum dots – nanostructures. Nanophysics – quantum dot – quantum wire – quantum point contact – nanocrystals.

Unit – II **(18-Hours)**

Nanoparticles in diagnostics: Biosensors – Gold nanoparticles - Synthesis – surface plasmon resonance (SPR) – Mie theory – Graphene-based (GR) – coupling GR and AuNPs. Carbon Nanotube-based biosensor (CNT) – single-walled and multi-walled CNTs. ZnO nanostructures as biosensors – fluorescence – photoluminescence – SPR – SERS – Quenching – conjugation and surface functionalization. Biomedical imaging – Fluorescence, MRI, CT, US, PET and SPECT.

Unit – III **(18-Hours)**

Nanoparticles in Agriculture: Nanotechnology in pesticides and fertilizers – control of plant pests – nanoinsecticidal – antimicrobial activity – nanofungicides – antiviral. Nanotechnology in food industry – Food process – food packaging and labeling – Nanomaterials for soil remediation – Fate of nanomaterials in soil – in plants. Recycling of Agricultural Waste.

Unit – IV **(18-Hours)**

Therapeutic applications of Nanoparticles: Natural and synthetic polymer nanoparticles – poly (lactic-co-glycolic acid) (PLGA), chitosan - Liposomes and solid lipid nanoparticles (SLNP) – Dendrimers – Hydrogel – Nanohydrogel — Drug laden nanocarriers – Factors influencing the biodistribution of drug-laden nanocarriers. Targeted drug delivery – Passive targeting – Active targeting – Different administration routes of nanocarriers – Transdermal,

Blood-brain barrier, Oral route administration, inhalation route and intravenous delivery. Nanotoxicity.

Unit – V **(18-Hours)**

Theragnostics / Theranostic applications of nanoparticles: Definition – multi-functional nanoparticles – lipid-polymer hybrid nanoparticles – mesoporous silica nanoparticles – Nanoinformatics – DNA origami – Protein-based nanoparticles. Nanorobots and Nanomachines in biological applications.

Books for study

1. Christof M. Niemeyer and Chad A. Mirkin. 2004. Nanobiotechnology: Concepts, Applications and Perspectives. 1st edition. Wiley-VCH. (Unit I)
2. Stergios Logothetidis. 2012. Nanomedicine and Nanobiotechnology. 12th edition. Springer. (Unit II)

References

1. Patrick Boisseau and Marcel Lahmani. 2009. Nanoscience: Nanobiotechnology and Nanobiology. Springer. (Unit IV and Unit V).
2. Khalid Rehman Hakeem and Tanveer Bilal Pirzadah. 2020. Nanobiotechnology in Agriculture. An Approach towards Sustainability. 1st edition. Springer. (Unit III)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PBT4CC10	CORE-10: BIONANOTECHNOLOGY	6	6

Course Outcomes (CO. No.)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	2	3	2	3	2	2	2.3
CO2	3	2	3	2	2	2	3	2	2	2	2.3
CO3	2	3	2	1	1	2	3	2	2	2	2
CO4	2	3	2	3	3	1	3	3	3	3	2.6
CO5	2	2	3	2	2	2	3	3	3	2	2.4
	Mean overall score										**2.32**
	Result										**High**

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PBT4CC11	CORE-11: PLANT AND ANIMAL BIOTECHNOLOGY	5	5

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	describe the basic idea on plant and animal culture techniques.	K1
CO-2	outline the mechanism of genetic engineering technology in the production of transgenic plants.	K2
CO-3	experiment with the various plant tissue culture media for the plant regeneration.	K3
CO-4	compare and interrogate with new ideas in techniques in plant and animal biotechnology & interpret them to solve complex problems.	K4
CO-5	inspect and plan for the production of artificial seeds and hardening of plants.	K5 & K6

Unit – I **(15-Hours)**

Establishment of plant tissue culture: culture media (types of media), explants and its preparation, Types of culture (callus, suspension, Meristem, Embryo, Protoplast and Root cultures), Regeneration of plants (Organogenesis and Somatic embryogenesis), Haploid plant production (androgenesis and gynogenesis). Isolation and fusion of Protoplast, Artificial seeds, Hardening of plants, Cryopreservation and Germplasm storage. Applications of plant tissue culture in Agriculture and Forestry.

Unit – II **(15-Hours)**

Introduction of genetic engineering of plants - Vector (Viral vectors, *Ti* & *Ri* plasmids) and Gene transfer methods (Electroporation, Particle bombardment, Microinjection). Chloroplast transformation. Transgenic plants - Biotic stress resistance (Pest, Viral, Bacterial & Fungal), Abiotic stress tolerance (Herbicide, Salt, Drought), Crop improvement (*Flavr Savr* tomato, Golden rice, Amino acid enrichment, preventing discolouration, Improving flower pigmentation, Male sterility).

Unit – III **(15-Hours)**

Transgenic plant as bioreactors – Plantibodies, Therapeutic proteins and Edible vaccines. Introduction to animal tissue culture - culture media. Primary cell culture. Development and maintenance of cell lines. Infinite and finite cell lines, Suspension culture, Embryo culture, Organ and Histotypic cultures.

Unit – IV **(15-Hours)**

Planning and layout of cell culture laboratories, Equipment used, Media preparation, Sources of contamination. Cell synchronization. Cryobiology. Applications of animal cell culture. Gene therapy - method, gene delivery systems and applications. Production and applications of monoclonal antibodies.

Unit – V **(15-Hours)**

Methods of animal cloning (Somatic nuclear transfer, Chromatin transfer, Embryo splitting) and its pros & cons. Methods of production of transgenic animals (Transfection, Retroviral vector, Microinjection, Embryonic stem cells, YAC, Gene targeting) and its applications (Human disease models, Gene knockout mice, Transgenic cattle, sheep, fish, chickens). Transgenic animals as bioreactors - Therapeutic proteins, Vaccines, Recombinant Insulin.

Books for study

1. Adrian Slater *et al*., 2008. Plant Biotechnology - The genetic manipulation of plants. Edition 2, Oxford University press, USA. (Unit II and Unit III)
2. Ashish Verma and Anchal Singh. 2013. Animal Biotechnology: Models in discovery and translation, Edition 1, Academic Press.
3. Freshney. R.I. 2010. Culture of Animal cells: Manual of Basic technique and specialized applications, 6th edition. John Wiley Publications. (Unit IV)

Books for References

1. Malik Zainul Abdin, Usha Kiran, M. Kamaluddin and Athar Ali. 2017. Plant Biotechnology: Principles and Applications. Springer Singapore

2. John M. Davis. 2011. Animal Cell Culture: Essential Methods. Wiley & Sons Ltd. (Unit V).

3. Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi. (Unit I)

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	**Course Code**	**Title of the Course**	**Hours**	**Credits**
IV	**21PBT4CC11**	**CORE-11: PLANT AND ANIMAL BIOTECHNOLOGY**	**5**	**5**

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	1	1	3	2	2	2	3	2.2
CO2	2	3	3	1	1	2	3	3	2	2	2.2
CO3	2	3	3	2	2	2	3	3	1	2	2.3
CO4	3	1	1	3	3	3	2	2	3	3	2.2
CO5	1	2	3	3	3	1	2	2	3	3	2.3
	Mean overall score										2.24
	Result										**High**

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PBT4CP06	Practical – VI: BIONANOTECHNOLOGY	4	3

CO No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	understand the microbiology of food, food-borne diseases and food spoilage	K1
CO-2	demonstrate knowledge of the regulatory frameworks and ethical principles relevant to food science and biotechnology.	K2
CO-3	apply the technical, scientific communication and interpretive skills.	K3
CO-4	analyze problems in food biotechnology, by selecting and applying practical techniques with technical competence in laboratory experiments.	K4
CO-5	evaluate and design the applications of various concepts & techniques of food biotechnology to facilitate biotechnological advancement and innovations.	K5 & K6

Experiments

1. Synthesis of Gold and Silver nanoparticles using traditional Chemical reduction method.
2. Synthesis of Gold and Silver nanoparticles using medicinal plant extract.
3. Characterization of gold and silver nanoparticles using UV-visible spectrophotometer.
4. Silanization of glass slides using APTES method.
5. Surface functionalization of 96-well microtiter plates using silanization technique.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PBT4CP06	Practical – VI: BIONANOTECHNOLOGY	4	3

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	1	1	1	3	3	2	1	1	1.8
CO2	3	2	3	3	3	2	2	3	3	3	2.7
CO3	3	2	3	3	3	1	2	2	2	1	2.2
CO4	2	2	3	2	2	2	3	3	3	3	2.5
CO5	3	2	3	1	1	1	2	3	2	2	2.0
	Mean overall score										2.24
	Result										High

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PBT4CP07	Practical – VII: PLANT AND ANIMAL BIOTECHNOLOGY	4	4

CO No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	understand the complex processes that occur in the plants and animals.	K1
CO-2	explain the basics of physiological and molecular processes that occur in plants & animals.	K2
CO-3	perform bioassay to analyze the cell cytotoxicity.	K3
CO-4	understand the processes involved in the planning, conduct and execution of plant & animal biotechnology experiments.	K4 & K5
CO-5	develop skills in the animal cell culture techniques.	K6

Plant Biotechnology

1. Organizing Plant Tissue Culture Laboratory
2. Preparation of Tissue Culture Media
3. Callus Induction
4. Shoot tip culture
5. Embryo/Endosperm Culture
6. Somatic Embryogenesis

Animal Biotechnology

1. Preparation of culture media and sterilization
2. Fibroblast culture.
3. Study of effect of anti-cancer agent in cell culture.
4. MTT Assay
5. Live cell counting
6. Leukocyte culture
7. Culturing of spleen cells
8. Fusion of cells by PEG
9. Isolation of DNA from animal tissues.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code:	Title of the Course	Hours	Credits
IV	21PBT4CP07	Practical – VII: PLANT AND ANIMAL BIOTECHNOLOGY	4	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	1	1	2	3	3	2	1	1	2.0
CO2	2	3	3	1	1	1	3	2	1	1	1.8
CO3	3	3	3	2	2	3	3	3	1	1	2.4
CO4	3	2	3	3	3	3	3	1	3	3	2.7
CO5	3	3	3	2	1	3	3	2	1	1	2.3
	Mean overall score										2.24
	Result										HIGH

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PBT4ES04A	DSE 4: ENVIRONMENTAL BIOTECHNOLOGY	5	4

CO No.	CO-Statements	COGNITIVE LEVEL (K-LEVEL)
On completion of this course, the students will be able to		
CO-1	understand the principles of environmental microbiology and the knowledge to ensure a sustainable environment.	K1
CO-2	examine the ecological status and illustrate the importance of conservation for maintaining a balanced ecosystem.	K2
CO-3	classify the treatment technologies to clean up contaminated environments and to carry out research strictly following ethics.	K3
CO-4	categorize and assess the new technologies with innovative ideas for effective biodegradation of organic pollutants, taking microbial and physical/chemical environments into consideration.	K4 & K5
CO-5	design plans for effective phytoremediation of decontaminated soil and water, wetlands as treatment processes and preserve the biological diversity and maintain social harmony.	K6

Unit –I **(15-Hours)**

Environmental pollution: Classification of pollutants, Air pollution and their properties, Gaseous pollutants, water pollutants and their properties. Noise pollution, soil pollution, thermal pollution, marine pollution, solid water pollution. Bioremediation and Phytoremediation: Biofeasibility, applications of bioremediation and bioreduction.

Unit –II **(15-Hours)**

Bioadsorption and bioleaching of heavy metals: cadmium, lead, mercury, metal binding targets and organisms, bioadsorption, metal microbial interaction, biomethylation of elements (methylation of mercury and arsenic), commercial biosorbants, bioleaching, metal precipitation, advantages and disadvantages of bioleaching.

Unit –III **(15-Hours)**

Waste water treatment: biological treatment system (oxidative ponds, aerobic and anaerobic ponds, facultative ponds, aerated ponds), biological waste treatment, activated sludge treatment, microbial pollution in activated sludge, percolating filters, waste water treatment by biofilms. Treatment scheme for dairy, distillery, tannery, sugar, fertilizers, refinery, chemical and antibiotic wastes.

Unit –IV **(15-Hours)**

Solid waste pollution and its management: Current practice of solid waste management, Treatment process for solid waste, Thermal conversion. Pyrolysis. Composting systems, vermicomposting, sewage treatment.

Unit –V **(15-Hours)**

Xenobiotics in environment: Biodegradation of hydrocarbons, substituted hydrocarbons, surfactant, pesticides, lignin, tannin, synthetic dyes, biotransformation: oxidation reactions: cytochrome P450 monooxygenase system, Alcohol and aldehyde dehydrogenases, peroxidases. Reduction reactions: cytochrome P450 and flavin dependent reactions. Hydrolysis reactions: carboxyl esterases. Conjugation reactions: Glutathione S transferase.

Books for study

1. Hans-Joachim Jordening and Josef Winter. 2004, Environmental Biotechnology: Concepts and Applications, Wiley-VCH Verlag GmbH & Co, USA. (Unit III and V)
2. Rittmann, B.E. and McCarty, P.L.2018, Environmental Biotechnology: Principles and applications, McGraw-Hill. (Unit I and Unit II)

Books for References

1. Peavy, H.S., Rowe, D.R., and Tchobanoglous, G. 1985, Environmental Engineering, McGraw-Hill International. (Unit IV)
2. Grady, Jr., C.P.L. and Lim, H.C. 1980, Biological waste water treatment: Theory and Applications, Marcel Dekker, Inc.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code:	Title of the Course	Hours	Credits
IV	21PBT4ES04A	DSE 4: ENVIRONMENTAL BIOTECHNOLOGY	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	1	1	3	3	3	1	3	2.3
CO2	2	2	3	2	3	2	1	1	2	3	2.1
CO3	3	3	3	3	3	2	3	3	3	2	2.8
CO4	3	2	3	1	1	1	1	3	2	3	2.0
CO5	3	3	2	3	2	3	3	3	2	3	2.7
	Mean overall score										2.38
	Result										HIGH

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PBT4ES04B	DSE- 4: FOOD BIOTECHNOLOGY	5	4

CO. No.	CO-Statements	Cognitive Level (K-Level)
On completion of this course, the students will be able to		
CO-1	understand the positive role of microorganisms and enzymes.	K1
CO-2	explain the chemistry and nutritional value of food.	K2
CO-3	apply the knowledge in food production, processing, and preservation	K3
CO-4	analyze the microbiology of food borne diseases and make use of the knowledge in protecting the human community.	K4
CO-5	plan and assess the strategies of food biotechnological industries and come out with new research findings with social concern.	K5 & K6

Unit – I **(15-Hours)**

Introduction to Food Biotechnology and Food Chemistry Biotechnology in relation to the food industry, classes of food, Characteristics of food - Nutritional value and sensory characteristics, Food chemistry – Carbohydrates, amino acids, proteins, lipids, vitamins, micro-elements. Herbal based foods, Nutraceuticals, probiotics, antioxidants, organic acids, single cell proteins.

Unit – II **(15-Hours)**

Spoilage of foods Mechanisms and types of spoilage, Intrinsic and extrinsic factors affecting spoilage: water activity, pH, temperature, redox potential etc., major spoilage micro-organisms and their growth conditions. Spoilage of vegetables, fruits, meat, poultry, beverage and other food products.

Unit – III **(15-Hours)**

Food microbiology and Food borne diseases Bacteria, yeasts and moulds – sources, types and some important species involved in food processing and preservation; fermented foods and food chemicals, single cell protein. Classification – food infections – bacterial and other types; food poisoning and intoxication – bacterial and non-bacterial.

Unit – IV **(15-Hours)**

Introduction to Food Processing Preliminary food processing methods – need and types, Raw material preparation: Cleaning, sorting, grading, peeling etc. Principles and methods of food preservation – Low temperature techniques: Refrigeration, Freezing and freeze drying, High temperature techniques: Blanching, HTST pasteurization, canning, UHT treatment, dehydration, drying, extrusion cooking, Irradiation techniques: UV light, microwave processing, gamma rays, cooking, use of additives, modified atmosphere packaging and storage.

Unit - V **(15-Hours)**

Enzymes used in food industry Microbial production of enzymes (proteases, amylases, invertases, pectinase, and xylanase), immobilization, applications, Microbial production of

organic acids, and production of novel sweeteners. Fermentation biotechnology of Indian traditional Foods.

Books for study

1. Shetty, K., Paliyath, G., Pometto, A. and Levin, R. E., (2005), 2nd edition. Food Biotechnology, CRC Press. (Unit V)
2. Fellows PJ (2005), Food Processing Technology: Principle and Practice. 2nd Ed. CRC Press., New York. (Unit IV).
3. Perry Johnson Green (2018), Introduction to Food Biotechnology, CRC Press, India. (Unit I and Unit II)

Books for References

1. Bibek Ray and Arun Bhunia. 2013. Fundamental Food Microbiology. (Ed: 5), CRC Press (Unit III).
2. Kalidas Shetty (2006), Food Biotechnology, Taylor & Francis Group, LLC. (Unit III and Unit V).
3. Belitz, W. Grosch, P. Schieberle, (2009), Food Chemistry, Springer-Verlag Berlin Heidelberg, 4th Edition. (Unit I)
4. Suzanne Nielsen (2009), Food Analysis, Purdue University West Lafayette, IN, USA (Unit I).

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
IV	21PBT4ES04B	DSE- 4: FOOD BIOTECHNOLOGY	5	4

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	1	1	3	3	2	2	1	2.1
CO2	1	2	2	2	2	3	2	2	2	1	1.9
CO3	3	3	3	3	3	2	3	3	3	2	2.8
CO4	1	2	3	3	3	1	2	3	3	3	2.4
CO5	3	2	3	3	3	3	2	1	3	3	2.6
	Mean overall score										2.36
	Result										High