Rayat Shikshan Sanstha's

SADGURU GADAGE MAHARAJ COLLEGE, KARAD.

(An Autonomous)

Accredited By NAAC with 'A^{+} (3.63 CGPA)' Grade
ISO- 9001-2015 Certified
Affiliated to Shivaji University, Kolhapur

Bachelor of Science (B. Sc.)

DEPARTMENT OF BIOTECHNOLOGY (ENTIRE)

Under the Faculty of Science and Technology
Choice Based Credit System (CBCS)

Regulations in accordance with **National Education Policy**
to be implemented from Academic Year 2023-2024

Syllabus For
B. Sc. Part – II (Biotechnology-Entire)
SEMESTER III & IV
(Syllabus to be implemented from June 2023)

Rayat Shikshan Sanstha's

SADGURU GADAGE MAHARAJ COLLEGE, KARAD.

(An Autonomous College)

Regulations and Guidelines

Choice Based Credit System (CBCS)

Syllabus for Bachelor of Science Part- II (Biotechnology- Entire)

- Guidelines shall be as per B.Sc. Regular Program.
- Rules and Regulations shall be as per B.Sc. Regular Programexcept CBCS R. B. Sc. 3 Structure of Program and List of Courses.

1. Title: B.Sc. II Biotechnology (Entire)

2. Year of Implementation: 2023-2024

3. Duration: One Year

4. Pattern: Semester wise CBCS

5. Medium of Instruction: English

6. Structure of Course:

a. Semester III:

Theory: 06 Papers

b. Semester IV:

Theory: 06 Papers

c. Practical's (Semester III & IV): 03 Papers

7. Examination Pattern:

- Internal Evaluation for Theory Paper – Each theory paper having **10 Marks**

  i) Home Assignments /Unit test/ Project Work/Viva / Online /Offline Test

- There shall be 6 theory papers each having **40 Marks**
- Practical Examination will be Conducted Annually – **100 Marks** for per subject.

8. Preamble :

This syllabus is so designed to give a sound basis to the undergraduate students of B.Sc. Biotechnology (Entire).

It is known that Biotechnology is no doubt a youngest branch oflife science but it is a very important interdisciplinary subject, where in subjects of Plant science, Animal science, Microbiology, Physics, Chemistry and other sciences are blended in such a way that the students are prepared with basic knowledge of Molecular biology, Biochemistry, Biophysics, Genetic engineering, Bioinformatics, Environmental sciences, Plant and Animal cell culture etc. and their technological applications.

Such students having multidisciplinary knowledge are in tremendous demand in industries, education and fundamental research, as trainee workforce. The career opportunities of these students arevery wide in different sectors dealing with life sciences.

9. GENERAL OBJECTIVES OF THE PROGRAM

- To introduce the concepts in various allied subjects.
- To enrich students' knowledge in basic and applied aspects of lifesciences.
- To help the students to build interdisciplinary approach in teaching/learning & in research.
- To inculcate the sense of scientific responsibilities and socialawareness.
- To help students build-up a progressive and successful career inacademia and industry.
- To make the students knowledgeable with respect to the subject andits practicable applicability.
- To promote understanding of basic and advanced concepts in Biotechnology.
- To expose the students to various emerging areas of Biotechnology.
- To prepare students for further studies, helping in their bright careerin the subject.
- To expose the students to different processes used in industries andin research field.
- To prepare the students to accept the challenges in life sciences.
- To develop skills required in various industries, research labs and inthe field of human health.

10. PROGRAM SPECIFIC OUTCOMES:

- The present course curriculum will generate skilled human resource required in academia and Industry.
- The student will be able to achieve basic and advance knowledge based proficiency in applied subjects of life sciences.
- It will create and develop students with interdisciplinary mind set for learning science.
- Student will improve problem solving aptitude using scientific methods in biotechnology and allied subjects.
- Student will adopt scientific approach for implications of biotechnology in society, environment and education.
- It will demonstrate knowledge and learn various biological processes at cellular and molecular level and get expertise in the different techniques used in the fields of Biotechnology.
- Student will learn to design and perform experiments in the labs to demonstrate the concepts, principles and theories learnt in theclassroom.

10. **Structure of Program and List of Courses are as follows:**

Choice Based Credited System with Multiple Entry and Multiple Exit to be implemented from Academic Year: 2022-2023

❖ **Second Year Bachelor of Science (Level-6) Programme Structure (NEP-2020 Pattern)**

Structure of B. Sc. II Programme Semester- III & IV

Rayat Shikshan Sanstha's

SADGURU GADAGE MAHARAJ COLLEGE, KARAD.

COURSE STRUCTURE UNDER AN AUTONOMY

B. Sc. BIOTECHNOLOGY (ENTIRE)

B. Sc. II SEMESTER– III (Duration – 6 Months)

Sr. No.	COURSE CODE	TEACHING SCHEME: THEORY Credits	THEORY No. of lectures	THEORY Hours	COURSE CODE	TEACHING SCHEME: PRACTICAL Credits	PRACTICAL No. of lectures	PRACTICAL Hours	EXAMINATION SCHEME: THEORY Hours	THEORY Theory	THEORY Internal	THEORY Total Marks (Min.)	THEORY Total Marks	PRACTICAL
1	BBTT22-301	2	3	2.4	BBTP22-407	4	6.4	8	2	40	10	16+4=20	50	Practical Examination is Annual
2	BBTT22-302	2	3	2.4					2	40	10	16+4=20	50	
3	BBTT22-303	2	3	2.4	BBTP22-408	4	6.4	8	2	40	10	16+4=20	50	
4	BBTT22-304	2	3	2.4					2	40	10	16+4=20	50	
5	BBTT22-305	2	3	2.4	BBTP22-409	4	6.4	8	2	40	10	16+4=20	50	
6	BBTT22-306	2	3	2.4					2	40	10	16+4=20	50	
7	AECC-C	---	3	2.4					---	---	---	---	---	
8	SEC-III	2	3	2.4					2	40	10	16+4=20	50	
Total of SEM I		14	24	19.2		12	19.2	24	14	280 + 70 = 350				

TOTAL NO OF CREDITS FOR SEMESTER – I : 26

B. Sc. II SEMESTER– IV (Duration – 6 Months)

Sr. No.	COURSE CODE	TEACHING SCHEME: THEORY Credits	THEORY No. of lectures	THEORY Hours	COURSE CODE	TEACHING SCHEME: PRACTICAL Credits	PRACTICAL No. of lectures	PRACTICAL Hours	EXAMINATION SCHEME: THEORY Hours	THEORY Theory	THEORY Internal	THEORY Total Marks (Min.)	THEORY Total Marks	PRACTICAL	PRACTICAL Max Marks	PRACTICAL Min Marks
1	BBTT22-401	2	3	2.4	BBTP22-407	4	6.4	8	2	40	10	16+4=20	50	As per BOS Guid-lines	100	40
2	BBTT22-402	2	3	2.4					2	40	10	16+4=20	50			
3	BBTT22-403	2	3	2.4	BBTP22-408	4	6.4	8	2	40	10	16+4=20	50		100	40
4	BBTT22-404	2	3	2.4					2	40	10	16+4=20	50			
5	BBTT22-405	2	3	2.4	BBTP22-409	4	6.4	8	2	40	10	16+4=20	50		100	40
6	BBTT22-406	2	3	2.4					2	40	10	16+4=20	50			
7	AECC-D	4	3	2.4					2	60	40	24+16=40	100			
8	SEC-IV	2	3	2.4					2	40	10	16+4=20	50			
Total of SEM II		18	24	19.2		12	19.2	24	16	340 + 110 = 450					300	
Grand Total		32	48	38.4		24	38.4	32	--	800+300=1100						

TOTAL NO OF CREDITS FOR SEMESTER - IV: 30

TOTAL NO. OF CREDITS FOR SEMESTER - III + IV: (26+30)=56

- Student contact hours per week : 36.8Hours (Min.)
- Theory lectures and practical : 48 Minutes Each
- Total Marks for B.Sc.-II (Including EVS) : **1100**
- Total Credits for B.Sc.-II (Semester III & IV) : **56**

• **BBTT – Bachelor of Biotechnology (Entire) Theory:** for Semester- III (BBTT22-301 to BBTT22-306) and for Semester- IV (BBTT22-401 to BBTT22-406)
• **AECC**- Theory: for Ability Enhancement Compulsory Course (AECC-C and AECC-D)- Environmental Studies – **EVS** (Theory – 60 & Project – 40 Marks)
• **BBTP – Bachelor of Biotechnology (Entire) Practical:** for (BBTP22-407 to BBTP22-409)
• Practical Examination will be conducted annually for100 Marks per course (subject).
• There shall be separate passing for theory and practical courses also for Environmental Studies.
• The examination of each BBTT22 course will be of 50 marks. Minimum 20 marks (40%) out of 50 are required for passing. Separate passing for SEE and CCE (Theory and Internal examination having separate passing).
● Students can exit after Level 5 with Certificate Course in Science (with the completion of courses equal to minimum of 52 credits).
●Students can exit after Level 6 with Diploma in Science (with the completion of courses equal to minimum of 104 credits).
●Students can exit after Level 7 with Bachelor of Science (with the completion of courses equal to minimum of 140 credits).
●SEC: Skill Based Courses (4 credits). Students have to select one for each semester from the pool of courses available at their respective colleges.

Note for SEC courses:

- SEC courses are of Self Study mode. The study material of all above courses will be made available on College website.
- The examination of each of the course will be of 50 marks having 25 MCQ questions. Minimum 20 marks (40%) out of 50 are required for passing.
- The duration of examination shall be conducted at the college level.
- The list of candidates along with marks is to be submitted to the College.
- The degree will be awarded only after successful completion of these courses.

Bachelor of Science (B.Sc.)
Under the Faculty of Science and Technology Choice Based Credit System (CBCS)
Regulations in accordance with National Education Policy to be implemented from Academic Year 2023-2024

1. Implementation of Revised guidelines and rules:

The revised guidelines and rules shall be implemented gradually as mentioned below:

Level	Programme	Course	From Academic Year
Undergraduate Programme:			
Level 5	Undergraduate Certificate(One year or two semesters)	B.Sc. Part-I	2022-23
Level 6	Undergraduate Diploma(Two years or four semesters)	B.Sc. Part-II	2023-24
Level 7	Bachelor's Degree(Three years or six semesters)	B.Sc. Part-III	2024-25
Level 8	Bachelor's Degree with Honours /Research (Four years or eight Semesters)	B.Sc. Part-IV	2025-26

(If the candidate wants to exit after a certain level, the Awards after completing specific level will be: Under graduate Certificate in Science, Undergraduate Diploma in Science, B.Sc. And B.Sc. (Hon./Research)forLevel-5,Level- 6,Level-7 andLevel-8 respectively. Other provisions for multiple entry and exit as per the Institute's rules and regulations are applicable).

2. Eligibility Criteria: As per Ordinance – B.Sc.I

3. Pattern of B.Sc. Programme: Combination of internal assessment and semester-end examination for B.Sc. will be 40:10 pattern shall be applicable for each theory paper in each semester wherein 40 marks shall be for Institutional (An Autonomous College- Affiliated Shivaji University, Kolhapur) Semester end examination and 10 marks for internal assessment except Environmental Studies. Only for Environmental Studies in Semester IV, 70 marks shall be for University examination for theory paper and 30 marks for project work.

4. Weightage: There shall be Three Year B.Sc. Programme with 160 Credits. The candidate wish to exit with three years Degree Programme Bachelor of Science (B.Sc.) (with the completion of courses equal to minimum of 160 credits).or The candidate wish to continue studies for Four Year B.Sc. (Hon./Research) may opt for 4th year which will have 26 credits for Sem. VII and 26 credits for Sem. VIII, total 52 credits for 4th year, out of them (4+2=6*4=24) credits for Discipline Specific Elective Courses (DSE) and 02 credits for SBC-7 of Sem.VII .

Programme will require 160 credits. (Please refer the university regulations and structure of the programme for details).

Model Programme Structure for Bachelor of Science (160Credits)

SEM	Discipline Specific Core Courses (DSC)(L+P)(Credits)	Discipline Specific Elective Courses (DSE)(L+P)(Credits)	Ability Enhancement Compulsory Courses (AECC)(L+P)(Credits)	Skill Enhancement Courses(SEC/VBC)		Total Credits
				Vocational Courses(L+P) (Credits) (Non CGPA)	Value Based Courses (P) (Credits) (Non-CGPA)	
I	**Biotechnology** **(2x8=16)** 2 Credit for each Theory subject **(2x4=8)** 2 Credit for each Practical subject **Total Credits= 24**	**Non-CGPA-I (Nil)**	**AECC-A (4)** English for communication-I	**SEC-1(2)** Multidisciplinary (Democracy, Elections and Good Governance)	**VBC(Nil)** NCC / NSS /Sports /Cultural, **etc.**	**30**
II	**Biotechnology** **(2x8=16)** 2 Credit for each Theory subject **(2x4=8)** 2 Credit for each Practical subject **Total Credits= 24**	**Non-CGPA-II (Nil)**	**AECC-B (4)** English for communication-II	**SEC-2 (2)** Multidisciplinary (Constitution of India and Local Self Government)	**VBC(Nil)** NCC / NSS /Sports /Cultural, **etc.**	**30**
Total						**60**
Level 5: Exit with Certificate Course in Science (with the completion of courses equal to minimum of 60 credits)						
III	**Biotechnology** **(2x6=12)** 2 Credit for each Theory subject **(3x4=12)** 2 Credit for each Practical subject **Total Credits= 24**	--	--	**SEC-3(2)** Multidisciplinary (Clinical Haematology)	**VBC(Nil)** NCC / NSS /Sports /Cultural, **etc.**	**26**
IV	**Biotechnology** **(2x6=12)** 2 Credit for each Theory subject **(3x4=12)** 2 Credit for each Practical subject **Total Credits= 24**	--	**AECC-D (4)** Environmental science	**SEC-4 (2)** Multidisciplinary (Bio fertilizers – Production and Applications)	**VBC(Nil)** NCC / NSS /Sports /Cultural, **etc.**	**30**
Total						**56**
Level6:Exit with Diploma in Science (with the completion of courses equal to minimum of 116 credits)						

V	**Biotechnology** **(2x3=6)** 2 Credit for each Theory subject **(4x1.5=6)** 2 Credit for each Practical subject **Total Credits= 12**	**Biotechnology** **(2x1=2)** 2 Credit for each Theory subject **(4x0.5=2)** 2 Credit for each Practical subject **Total Credits= 4**	**AECC-E (4)** English communication III	**SEC-5(2)** Multidisciplinary (Bioinformatics-I)	**VBC(Nil)** NCC / NSS /Sports /Cultural, **etc.**	**22**
VI	**Biotechnology** **(2x3=6)** 2 Credit for each Theory subject **(4x1.5=6)** 2 Credit for each Practical subject **Total Credits= 12**	**Biotechnology** **(2x1=2)** 2 Credit for each Theory subject **(4x0.5=2)** 2 Credit for each Practical subject **Total Credits= 4**	**AECC-F (4)** English communication IV	**SEC-6 (2)** Multidisciplinary (Bioinformatics-II)	**VBC(Nil)** NCC / NSS /Sports /Cultural, **etc.**	**22**
Total						**44**
	120	**08**	**20**	**12 (Non CGPA)**	**00 (Non CGPA)**	**160**
Level 7 : Exit with three years Bachelor of Science B.Sc. (with the completion of courses equal to minimum of 160 credits) or continue studies for Bachelor of Science B.Sc. with (Honours/Research) four year Degree Programme (with the completion of courses equal to minimum of 212 credits)						
VII	**Biotechnology** **(2x4=8)** 2 Credit for each Theory subject **(4x4=16)** 4 Credit for each Practical subject **Total Credits= 24**	--		**SBC-7(2)** Multidisciplinary (From Pool of Courses)	--	**26**
VIII	**Biotechnology** **(2x4=8)** 2 Credit for each Theory subject **(4x4=16)** 2 Credit for each Practical subject **Total Credits= 24**	--		**SBC-8 (2)** Multidisciplinary (From Pool of Courses)	---	**26**
Total						**52**
	176	**00**	**20**	**16 (Non CGPA)**	**00 (Non CGPA)**	**212**
Level 8 : Exit with four years Bachelor of Science B.Sc. with (Honours/Research) (with the completion of courses equal to minimum of 212 credits).						

Biotechnology (Entire) Total Credits points:

Levels	Sem.	DSC	DSE/OEC/GEC/IDS	AECC Languages And Env. Sci.	SEC (Multidisciplinary)	Total Credits
Level-5	I	T=(2x8=16) P=(2x4=8) Total=24	-	1X4=4 (ENG)	SEC-I (2) VBC-I (Nil)	30
	II	T=(2x8=16) P=(2x4=8) Total=24	-	1X4=4 (ENG)	SEC-II (2)	30
Level-6	III	T=(2x6=12) P=(3x4=12) Total=24	-	-	SEC-III (2)	26
	IV	T=(2x6=12) P=(3x4=12) Total=24	-	1X4=4 (EVS)	SEC-IV (2)	30
Level-7	V	T=(2x3=6) P=(4x1.5=6) Total=12	T=(2x1=2) P=(4x0.5=2) Total=4	1X4=4 (ENG)	SEC-V (2)	22
	VI	T=(2x3=6) P=(4x1.5=6) Total=12	T=(2x1=2) P=(4x0.5=2) Total=4	1X4=4 (ENG)	SEC-VI (2)	22
						160
Level-8	VII	-	4X(4+2)=24 (DSE)	-	SEC-VII (2)	26
	VIII	-	4X(4+2)=24 (DSE)	-	SEC-VIII (2)	26
	Total Credits					212

11. Gradation Chart:

Marks Obtained	Numerical Grade (Grade Point)		CGPA	Letter Grade
Absent	0 (zero)		--	--
0 – 39	0 (zero)		0.0 – 4.99	F (Fail)
40 – 49	5		5.00 – 5.49	C
50 – 59	6		5.50 – 6.49	B
60 – 69	7		6.50 – 7.49	B+
70 – 79	8		7.50 – 8.49	A
80 – 89	9		8.50 – 9.49	A+
90 – 100	10		9.50 – 10.0	O (Outstanding)

Note:
1. Marks obtained > = 0.5 shall be rounded off to next higher digit.
2. The SGPA & CGPA shall be rounded off to 2 decimal points.

Calculation of SGPA & CGPA

1. Semester Grade Point Average (SGPA)

$$\textbf{SGPA} = \frac{\Sigma\ (\text{Course credits} \times \text{Grade points obtained}) \text{ of a semester}}{\Sigma\ (\text{Course credits}) \text{ of respective semester}}$$

2. Cumulative Grade Point Average (CGPA)

$$\textbf{CGPA} = \frac{\Sigma\ (\text{Total credits of a semester} \times \text{SGPA of respective semesters}}{\Sigma\ (\text{Total course credits}) \text{ of all semesters}}$$

OTHER FEATURES:

(A) LIBRARY:
Reference and Text Books, Journals and Periodicals, Reference Books for advanced studies are available in this college. – (List is attached with respective paper section)

(B) SPECIFIC EQUIPMENTS: Necessary to run the Course.
Computer, L.C.D., Projector

(C) LABORATORY SAFETY EQUIPMENTS:
1) Fire extinguisher
2) First aid kit
3) Fumigation chamber
4) Stabilized power supply
5) Insulated wiring for electric supply.
6) Good valves & regulators for gas supply.
7) Operational manuals for instruments.
8) Emergency exits**.**

Laboratory Equipment's:

Sr. No.	Name of Instrument
1	Autoclave Vertical
2	Bacteriological Incubator
3	BOD Incubator
4	BOD incubator
5	Centrifuge
6	COD refluxing unit
7	Colorimeter
8	Compound Microscope
9	Conductivity Meter
10	Cooling Centrifuge
11	Cyclomixer
12	Deep freezer
13	Dissecting microscope
14	Double distillation assembly
15	Flame Photometer
16	Gel doc
17	Hemocytometer
18	Homogenizer
19	Horizontal Electrophoresis unit
20	Horizontal Laminar Airflow
21	Hot Plate
22	Lux Meter
23	Micro centrifuge
24	Microscope camera device
25	Microwave Oven
26	Mini Centrifuge
27	Mixer

28	pH Meter
29	Refractometer
30	Refrigerator
31	Rotary Shaker
32	Shaking incubator
33	Shaking incubator
34	Spectrophotometer UV-Vis
35	Stabilizer
36	Thermo Cycler
37	UV trans-illuminator
38	Vacuum pump
39	Variable type power pack
40	Vertical Electrophoresis Unit
41	Visible Spectrophotometer
42	Water bath
43	Weighing balance

Rayat Shikshan Sanstha's
SADGURU GADAGE MAHARAJ COLLEGE, KARAD.
Estd.: 1954
(An Autonomous College - Affiliated to Shivaji University, Kolhapur)
Accrediated A^+ with CGPA 3.63 by NAAC; RUSA Beneficiary and NAAC Designated Mentor College
Website: www.sgm.edu.in

SGM/SCIENCE/BOS/Biotech. **Date:**

To,
The Principal,
Sadguru Gadage Maharaj College, Karad
An Autonomous College- Affiliated to Shivaji University, Kolhapur

Subject: Regarding syllabi of B.Sc. and M.Sc. (NEP-2020) a degree program under the faculty of Science and Technology as per National Education Policy, 2020.

Respected Sir,

With reference to the subject mentioned above, I am directed to inform you that the Academic Council of Sadguru Gadage Maharaj College, Karad have accepted and granted approval to the **Syllabi and Nature of question paper of B.Sc. (NEP-2020) System** under the faculty of Science and Technology as per National Education Policy, 2020.

Sr. No.	Faculty of Science and Technology	Programme/ Course
1.	**Biotechnology (Entire)**	**B.Sc.- II Biotechnology**

This Syllabi and Nature of question paper of B.Sc. II shall be implemented from the Academic Year 2023-2024 onwards. A soft copy containing the syllabi is attached herewith and it is also available on college website **www. sgm.edu.in.**

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking You,

Yours Faithfully,

Chairman,
BOS in Biotechnology
(Entire)

Programme Outcome (POs)

The B.Sc. Program of Biotechnology (Entire) at Sadguru Gadage Maharaj College, Karad, started in 2007,

1.	**Basic concepts in Biotechnology:**
	Aims to train students in Biotechnology where engineering and technology principles could be used to probe biological questions or to develop technologies, devices and systems that require substantive expertise in Biology, Agriculture, Pharmaceutical, Industrial, as well as Clinical Research components.
2.	**Thinking skill:**
	The students in this program acquire knowledge, critical thinking skills and experience in conducting cutting edge research. This program develops human capital for advanced scientific research and entrepreneurship.
3.	**Problem solving skills:**
	Problem solving skills and relevant biological technologies which provides a strategic roadmap for India's emergence as a global biotechnology innovation and manufacturing hub, which also highlighted importance of human resource development and need for nurturing tailor-made human capital for advanced strategic research and entrepreneurship
4.	**Laboratory skills:**
	Laboratory skills and exposure to a variety of important experiments at appropriate levels that illustrate phenomena discussed in the lecture classes. Instrumentation and experimental techniques; methods for quantitative analysis of data and measurement uncertainty.
5.	**General skills:**
	General knowledge of the development of biotechnology and the nature of scientific inquiry, particularly the progression from classical biotechnology to the modern biotechnology, ideas of genetic engineering, molecular biology, plant and animal biotechnology, bioinformatics, biochemistry and relativity.
6.	**Contemporary areas of biotechnology:**
	Contemporary areas of biotechnology inquiry as introduced in upper-level biotechnology and interdisciplinary elective courses, as well as in faculty-mentored undergraduate research available to all majors who seek this experience.
7.	**Communication skills:**
	Written and oral communication skills for dissemination of scientific results in report, article, or oral presentation formats, standard citation methods, ethics in science and scholarship and its importance to scientific inquiry and professionalism.
(*key-topic areas as given in the Mission Statements of the Biotechnology (Entire) undergraduate program are: i) Biochemistry, ii) Genetic Engineering, iii) Molecular Biology, iv) Microbiology, v)Plant and Animal Biotechnology, vi)Industrial biotechnology, vii) Experimental methods.)	

Programme Specific Outcomes (PSOs)

Programme Specific Outcomes (PSOs):

PSO1:	Undergraduate students will be able to demonstrate and apply their knowledge of cell biology, biochemistry,microbiology, bioinformatics and molecular biology to solve the problems related to the field of biotechnology.
PSO2:	Undergraduate students will be able to demonstrate and apply the principles of bioprocess engineering in the design,analysis, optimization and simulation of bioprocess operations.
PSO3:	Students will be able to gain fundamental knowledge in animal and plant biotechnology and their applications.
PSO4:	Students will be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?
PSO5:	Student will be able to (a) Describe fundamental molecular principles of genetics; (b) Understand relationship between phenotype and genotype in human genetic traits; (c) Describe the basics of genetic mapping; (d) Understand how gene expression is regulated.
PSO6:	Students will be able to (a) elaborate concepts of biochemistry with easy to run experiments; (b) familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.
PSO7:	Students will be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.
PSO8:	Students will able to applied bioinformatics knowledge in drug designing, genetic engineering and phylogenetic analysis.
PSO9:	Students will be able to gain hands on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

Course Outcomes (COs)

Sr. No.	Name of the course	Course Outcome
1	**Cell Biology**	Sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules,the understanding of various biological processes becomes deeper and inclusive.
2	**Biochemistry**	Students should be able to: ● Gain fundamental knowledge in biochemistry; ● knowledge of biochemical principles with specific emphasis on different metabolic pathways and regulators ● Understand the molecular basis of various pathological conditions from the perspective ofbiochemical reactions.
3	**Microbiology and Genetics**	To introduce field of microbiology with special emphasison microbial diversity, morphology, physiology and nutrition; methods for control of microbes and host- microbe interactions. Students should be able to ● Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity; ● Identify and demonstrate structural, physiological,genetic similarities and differences of major categories of microorganisms; ● Identify and demonstrate how to control microbialgrowth; ● Demonstrate and evaluate interactions betweenmicrobes, hosts and environment.
4	**Immunology**	To learn about structural features of components of immune system as well as their function, development of immune system and mechanisms bywhich our body elicits immune response. It will help Students to predict about nature of immune response that develops against bacterial, viral or parasiticinfection, and prove it by designing new experiments.
5	**Molecular Biology**	Students should be able to understand basics of genetics and classical genetics covering prokaryotic/phage genetics to yeast and higher eukaryoticdomains. On successful completion of this course, student will beable to: • Describe fundamental molecular principles of genetics; • Understand relationship between phenotype and genotype in human genetic traits; • Describe the basics of genetic mapping; • Understand how gene expression is regulated.

6	**Industrial Biotechnology**	Students should be able to: ● Appreciate relevance of microorganisms from industrial context; ● Carry out stoichiometric calculations and specifymodels of their growth; ● Give an account of design and operations of various bioreactors and downstream processes; ● Calculate yield and production rates in a biological production process, and also interpret data; ● Critically analyze any bioprocess from market pointof view; ● Give an account of important microbial/enzymatic industrial processes
7	**Plant Biotechnology**	The objectives of this course are to introduce students to the principles, practices and applications of plant biotechnology, plant tissue culture, plant genomics, genetic transformation and molecular breeding of plants.
8	**Animal Tissue Culture**	To introduce students to the principles, practices andapplication of animal biotechnology in Tissue Engineering, Vaccines and biopharmaceuticals.
9	**Genetic Engineering**	The objectives of this course are to teach students with various approaches to conducting genetic engineering andtheir applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on fundamental understanding of the principles of molecular biology and this is reflected in the contents of this course.
10	**Biostatistics and Bioinformatics**	The objectives of this course are to provide theory and practical experience of the use of common computationaltools and databases which facilitate investigation of molecular biology and evolution-related concepts. Student should be able to : • Develop an understanding of basic theory of these computational tools; • Gain working knowledge of these computational toolsand methods; • Appreciate their relevance for investigating specific contemporary biological questions; • Critically analyse and interpret resultsof their study.
11	**Environmental Biotechnology**	This course aims to introduce fundamentals of Environmental Biotechnology. The course will introducemajor groups of micro-organisms tools in biotechnology and their most important environmental applications. On completion of course, students will be able to understand the use of basic microbiological, molecularand analytical methods, which are extensively used in environmental biotechnology.

12	**Industrial Biotechnology**	The objectives of this course are to introduce students to developments/ advances made in field of microbial technology for use in human welfare and solving problems of the society. On completion of this course, students would develop deeper understanding of the industrial Biotechnology andits applications.
13	**Plant Physiology**	This course will give a broad overview of research and development carried out in phytosecondary metabolitesand their applications.
14	**Research Methodology**	This course will give a broad overview of research and development carried out in industrial setup towards drug discovery. On completion of this course, students should be able to understand basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields ofpharmaceutical industry.
15	**Molecular Marker**	The objectives of this course are to sensitize students about recent advances in molecular biology and variousfacets of molecular medicine which has potential to profoundly alter many aspects of modern medicine. Students should be able to understand various facets of molecular procedures and basics of genomics, proteomicsand metabolomics that could be employed in early diagnosis and prognosis of human diseases.
16	**Projects**	The purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research andexplain its importance to their fellow classmates and teachers. Students should be able to demonstratethe following abilities: • Formulate a scientific question; • Present scientific approach to solve the problem; • Interpret, discuss and communicate scientific results inwritten form; • Gain experience in writing a scientific proposal; Learn how to present and explain their research findingsto the audience effectively.

B. Sc. Part II (Semester III and IV)

Course code	Name of Course	Course code	Name of course
Semester III		**Semester IV**	
BBTT22-301	Genetics	**BBTT22-401**	Immunology
BBTT22-302	Fundamentals of Biophysics	**BBTT22-402**	Advances in Cell Biology
BBTT22-303	Metabolic Pathways	**BBTT22-403**	Plant Biochemistry
BBTT22-304	Ecology	**BBTT22-404**	Environmental Biotechnology
BBTT22-305	Molecular Biology-I	**BBTT22-405**	Molecular Biology-II
BBTT22-306	Plant Tissue Culture	**BBTT22-406**	Animal Tissue Culture
AECC-C	Environmental Studies (Theory)	**AECC-D**	Environmental Studies (Project)
SEC-III	Clinical Haematology	**SEC-IV**	Bio fertilizers – Production and Applications

AECC – C and D:- Ability Enhancement Compulsory Course : Environmental Studies

BBTT22-407	Techniques in Genetics, Immunology and Cell Biology	**BBTT22-409**	Techniques in Plant Tissue Culture and Environmental Biotechnology
BBTT22-408	Techniques in Molecular Biology and Metabolic Pathways		

Note: - Practical Examination will be Conducted Annually

BBTT22-301- Genetics

Learning Objectives-

- To understand principle of Mendelian genetics.
- To make students aware of Gene interaction and Gene expression.
- To Study the basic concepts of Cytogenetics.
- To study the basic concepts of microbial genetics.

Topic No.		Lectures 30
	Credit I	
1	**Mendel's law of Inheritance** – Mendel's Experiment, Dominance and recessiveness, Principle of segregation, independent assortment, back and test cross. Incomplete dominance, co-dominance, multiple allele. Modifiers, suppressors, pleiotropic gene. Interaction of gene- Epistasis, complimentary gene, duplicate gene. **Linkage** Definition, coupling and repulsion hypothesis, linkage groups. Crossing over-Mechanism and theory. Structural and numerical changes in chromosomes. Maternal effect- Concept and example. Extra chromosomal or cytoplasmic or organellar inheritance-mitochondrial and plastid.	**15**
	Credit II	
2	**Transposable elements**-IS elements, transposons and retroelements. Transposons in prokaryotes and eukaryotes, mechanism of transposition, uses of transposons. **Plasmid**- Types, Structure, properties and applications. **Genetic recombination in bacteria-** Definition, fate of exogenote in recipient cell, transformation, conjugation, transduction. **Mechanism of recombination**-The Holliday model, Messelson and Radding model, Double strand break repair model, Fox model for non reciprocal recombination.	**15**

Learning Outcomes-

- The basic knowledge of Inheritance Biology.
- The concepts of Gene interaction and Gene expression.
- The structural and numerical changes in chromosomes.
- The mechanisms of bacterial genetics such as: -transformation, Conjugation, transduction and recombination.

References:

1. Strickberger "Genetics"
2. Freifelder "Genetics"
5. Stanier "General Microbiology"
6. P. K. Gupta "Genetics"
7. C. Sarin "Genetics"
8. Larry Snyder Wendy Champness "Molecular Genetics of Bacteria"

BBTT22-302 Fundamentals of Biophysics

Learning Objectives

- To study the cell and cellular organelles.
- To study in detail structure of nucleus and its characteristics.
- To introduce chromosome structure, organization and general features.
- To study Cytoskeletal system and membrane transport system of cell.

Topic No.		Lectures 30
	Credit- I	
1.	**IR spectroscopy** – Introduction, vibration spectra (without proof), possible modes of vibrations of atoms in polyatomic molecules, Instrumentation, Applications. **Atomic Absorption Spectroscopy:** Introduction, Principle, Instrumentation, Applications. **Flame Photometry:** Introduction, Principle, Instrumentation, Applications.	**15**
	Credit-II	
2.	**Electrophoresis:** Introduction, Principle, theory and applications of native and SDS PAGE, pulse field electrophoresis, capillary electrophoresis, immunoelectrophoresis. **Chromatography:** Introduction, Theory, Principle and applications of column chromatography, size exclusion chromatography, Ion exchange chromatography, Affinity chromatography, HPLC, GLC. **Tracer technique:** Introduction, α, β, γ radiations, measurement (scintillation counting, Geiger-Muller counting), radioactive isotopes, half life of isotopes, autoradiography.	**15**

Learning Outcomes:

- Knowledge of cell and cellular theories.
- Knowledge about nucleus, features of chromosome
- Study of Cytoskeletal assembly and filaments.
- Study membrane transport system.

References:

1. Instrumental Methods of Chemical Analysis – Gurudeep R. Chatwal, Sham K.Anand (Himalaya Publishing House).
2. Handbook on Analytical Instruments –R. S. Khandpur. (Mc. Graw Hill).
3. Biophysical Chemistry - Upadhyay, Nath, Upadhyay (Himalaya Publishing House).
4. Introduction to Molecular Spectroscopy – C.N.Banwell.
5. Biophysics ,Mohan P. Arora, Himalaya Publishing House,Delhi
6. Practical Biochemistry- Wilson and Walker

BBTT22-303 Metabolic Pathways

Learning Objectives:

- To make students aware of metabolism.
- To study different types of metabolism and its study.
- To understand the concepts of metabolism of Biomolecules.
- To study the Metabolic Pathways with its Energetics.

Topic No.		Lectures 30
	Credit- I	
1.	**Metabolism:-** Introduction to metabolism, anabolism & catabolism, catabolism & its three stages, types of metabolic reactions, Methods employed to study metabolism (by cell free extract, using auxotrophic mutants, radioisotopes), High energy compounds enlist some examples 5 to 6. **Carbohydrates Metabolism:-**Reactions and energetics of Glycolysis, Gluconeogenesis, TCA cycle, Glyoxylate cycle, HMP and its significance.	**15**
2.	**Credit-II** **Lipid Metabolism:** Biosynthesis of fatty acid with respect to Palmitic acid & degradation of fatty acid (β-oxidation) with respect to Palmitic acid. **Respiration:-** Aerobic:-Flow of electrons in ETC, Redox potential components of ETC, Mechanism of ATP generation- Chemiosmotic hypothesis, ATP synthase complex. Anaerobic Respiration:- Alcoholic and Lactic acid fermentation**.**	**15**

Learning outcomes:

- Principle & types of metabolism.
- Parameters used to study metabolism
- Biosynthesis of lipid, carbohydrates and hormones.
- Metabolic pathways with regulation.

References:-

1) Biochemistry- Lubert Stryer
2) Biochemistry- Nelson and Cox
3) Practical Biochemistry- Wilson and Walker
4) Fundamentals of Biochemistry – J. L. Jain
5) Principals of Biochemistry- Voet and Voet
6) Fundamentals of Plant Physiology- V. K. Jain

BBTT22-304 Ecology

Course Objectives:

- To make the student aware of basic concepts of Ecology
- To make the student aware of Population Ecology and Evolution .

Topic No.		Lectures 30
	Credit- I	
1.	**Ecosystem-** Concept, structure, function. **Productivity-** Kinds of productivity. **Food chain-** types of food chain, food web, concept of tropic level, **Ecological pyramids-** concepts and types. **Energy flow in ecosystem** –concept of energy, unit of energy, ecological energetics, laws governing energy transformation, ecological efficiency, Lindeman's atrophic dynamic concept. **Biogeochemical cycle** Carbon cycle, Nitrogen cycle, Sulphur cycle, Phosphorus cycle **Biodiversity** Types of biodiversity, causes of loss of biodiversity, conservation ofbiodiversity, importance of biodiversity, Hot Spots.	**15**
	Credit-II	
2.	**Population Ecology-** Introduction, population characteristics, Natality, Mortality, survivor ship curves, age structure, age pyramid. **Population growth-** Exponential and logistic, r and k strategists. **Evolution :-** Theories of evolution-Lamarckism, Darwinism, Modern synthetic theory &mutational theory. Evidences of evolution and Adaptive radiation.Concept of species and speciation. Hardy-Weinberg law.	**15**

Learning Outcomes:

- Understand fundamentals of Ecology.
- Learn biogeochemical cycles.
- Understand the Population Ecology.
- Learn Evolution.

References:

1. Fundamentals of ecology ; E.P Odum.
2. Concept of ecology ; Dash.
3. Enviornmental Biology,Verma & Agarwal
4. Enviornmental Science., Saigo, Canninhham
5. General ecology., H.D.Kumar

BBTT22-305 Molecular Biology- I

Learning Objective:

- To familiarize the students with basic concept in molecular biology.
- To understanding the DNA structure & Replication.
- To understanding the DNA alterations by Mutation & Repair.
- Understand DNA damage.

Topic No.		Lectures 30
	Credit I	
1.	**Experimental Evidences for DNA as a genetic material:-** Griffith's Exp., Avery, Macleod, McCarty Exp., Blender Exp., RNA As agenetic material Gierer and Schram expt. **Properties and Function of DNA:-** Tm, Cot Curve, Purity of DNA, Acid- Base Nature, Buoyant Density Concept of Gene, Unit of Gene (Cistron, Recon, Muton), Fine Structure of gene, One gene One Polypeptide Hypothesis, interrupted gene. **Nucleic Acid biosynthesis:-** De novo synthesis of Purine and Pyrimidine ring, Salvage Pathway, Synthesis of Deoxyribonucleotide, Feedback inhibition. **Organization of genome:-**Viral (Lambda,T4), Bacteria (*E.coli*), Eukaryote, Typical Structure of chromosome (Euchromatin & Heterochromatin), Packaging of DNA (Nuclesome, Solenoid Model).	**15**
	Credit II	
2.	**DNA Replication-** Semi conservative model of replication (M.S Expt.). Direction of replication (Uni & Bidirectional). Prokaryotic and eukaryotic replication- Enzymes involved in replication, initiation, elongation and termination. Rolling circle model and telomere replication. **Mutation** Introduction, Types –Spontaneous, Induced. Mutagenesis – Base analogues, Nitrous acid, hydroxyl amine, alkylating agent, Acridine dyes, U. V. light. **DNA Repair** DNA repair- Direct repair, Excision repair (Nucleotide and Base), Mismatch repair, SOS repair, Recombination repair, Repair of double strand DNA break.	**15**

Learning Outcome:

- Experiment behind the Genetic material.
- Understanding the DNA structure & Replication.
- DNA alterations by Mutation & Repair.
- Functions of DNA.

References:

1) Molecular biology by Watson
2) Genetics by Strickberger
3) Molecular Biology by Glickpastornack
4) Molecular biolage Geralad Carph
5) Gene By Levin
6) Genome by T.A. Brown

BBTT22-306 Plant Tissue Culture

Learning Objectives:

- To make students aware of fundamentals of Plant Tissue culture
- Study of laboratory organization for plant tissue culture.
- Study of callus, organ, anther and pollen culture Technique.
- Study of suspension, protoplast culture and micropropagation Technique.
- To study use and application of Plant Tissue culture

Topic No.		Lectures 30
	Credit- I	
1.	**Introduction to plant tissue culture-** Definition, History ,Cellular totipotency, techniques in plant tissue culture. **Infrastructure & Organization Of Plant Tissue Culture Laboratory-General and aseptic laboratory-** different work areas, equipments and instruments required and other requirements. **Aseptic Techniques-** Washing and preparation of glassware's, packing and sterilization, media sterilization, surface sterilization, aseptic workstationand precautions to maintain aseptic conditions. **Culture Medium-** Composition of basal M.S. medium and preparation of media. **Callus Culture Techniques-** Introduction, principle, protocol, morphology and internal structure, genetic variations and applications. **Somatic Embryogenesis-** Introduction, principle, protocol, factors affecting, applications and limitations. **Organogenesis-** Introduction, principle, protocol, applications. **Ovary and ovule Culture Technique-** Introduction, principle, protocol, and applications.	**15**
	Credit-II	
2.	**Anther & Pollen Culture Technique-** Introduction, principle, protocol, factors affecting and applications. **Micropropagation-** Introduction, stages of Micropropagation, factors affecting, advantages and applications. **Different Pathways of Micropropagation**- Axillary bud proliferation, somatic embryogenesis, organogenesis and meristem culture. **Somaclonal Variation-** Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism, assessment, applications and limitations. **Suspension Culture Technique**- Introduction, principle, protocol, types, growth measurement, synchronization and applications. **Plant Protoplast Culture:-** History, Principle, protocol for isolation-Mechanical and Enzymatic, protoplast culture and importance.	**15**

Learning Outcomes :

- Knowledge about laboratory organization for plant tissue culture.
- Know technique of preparation of plant tissue culture media.
- Knowledge about various techniques for plant tissue culture.
- Job oriented skill developments of students to start or work in commercial plant tissue culture laboratory.

References:-

1] Introduction to plant tissue culture- M.K. Razdan
2] Plant tissue culture-Theory & practice-S.S.Bhojwani & M.K. Razdan3] Plant tissue culture-Kalyankumar Dey
4] Biotechnology- B.D. Singh
5] A text book of Biotechnology- R.C. Dubey6] Plant tissue culture-U.Kumar
7] Plant cell, tissue & organ culture-Gam Borg & Phillips8] Fundamentals of Biotechnology- S.S. Purohit
9] Biotechnology- H.S. Chawla
10] Crop Improvement In biotechnology- H.S.Chawla

Skill Enhancement Course (SEC-III)
Clinical Haematology

Credits-02

Learning Objective:

- To understand the staining and counting technique for identification of different type of blood cells.
- To understand collection methods of blood sample.
- To understand separation techniques of blood sample components.
- To understand diagnosis of different blood related diseases.

Sr. No.	Redesigned Modules	Lectures 30
1.	**Unit-I** **1.The components of blood** • Plasma • Red blood cells • White blood cells • Platelets **2.Collection of Blood** • Criteria for sample collection • Collection of capillary blood (Peripheral Blood) blood by skin punctures • Collection of venous blood by Venipuncture, • Collection of arterial blood **3. Practical:** • Collection Blood by Skin puncture and Venipuncture. • Separation of Blood components Plasma, Serum and Corpuscles	**08**
2.	**Unit-II Haemoglobin** • Structure and function of Haemoglobin • Anemia Causes, Effect and Control • Types of anemia • Causes and Symptoms of anemia • Control measure of anemia • Diagnosis of anemia **Practical** • Estimation of Haemoglobin	**07**
3.	**UNIT – III.** • Haemopoiesis, erythropoiesis and leucopoiesis **Practical:** • Complete Blood Count (CBC) • RBC Counting • WBC Counting • Platelet count and Hamatocrit	**07**
4.	**UNIT – IV** • Blood Clotting, • Mechanism of Clotting • Extrinsic and Intrinsic Mechanism • Blood choesterols and Urea and Creatine	

	Practical: • Clotting and bleeding time of blood. • Study of Blood Smear for differential WBC Count - Preparation and Staining of smears, • Counting Methods, Morphology of White cells, Types of White Cells, Abnormalities in • Morphology of blood cells and related diseases.	**08**

Learning Outcomes:

- After completion of this course students should be able to:
- Perform staining and counting technique for identification of different type of blood cells.
- Collect blood sample by different methods.
- Separate different components of blood
- Estimate Hb from blood samples
- Diagnose various blood diseases like anaemia

SEMESTER-IV

Subject Code	Title of Paper
BBTT22-401	Immunology
BBTT22-402	Advances in Cell Biology
BBTT22-403	Plant Biochemistry
BBTT22-404	Environmental Biotechnology
BBTT22-405	Molecular Biology-II
BBTT22-406	Animal Tissue Culture
AECC-D	Environmental Studies (Project)
SEC-IV	Bio fertilizers – Production and Applications
BBTT22-407	Techniques in Genetics, Immunology and Cell Biology
BBTT22-408	Techniques in Molecular Biology and Metabolic Pathways
BBTT22-409	Techniques in Plant Tissue Culture and Environmental Biotechnology

Note: - Practical Examination will be Conducted Annually

BBTT22-401 Immunology

Learning Objectives–

- To study the overview of vertebrates Immune System.
- To study the Types and mechanism of Defence.
- To study the Cells and Organs of immune system.
- Students should aware of Antigen and antibody reactions.
- Students should aware of immune response and parasitic immunology.

Topic No.		Lectures 30
	Credit- I	
1.	**Introduction-** **Types of immunity**-i)Innate (specific and non-specific) ii) Acquired (Active and Passive), **Types of Defense-** a) first line of defense (barriers at the portal of entry, physical and chemical barriers) b) second line of defense (Phagocytosis– oxygen dependent and independent) c) third line of defense-specific defense mechanism. **Complement-** classical and alternative pathways **Introduction to cells and organs of immune system-** Organs of immune system-primary and secondary lymphoid organs-structure and their role. Cells of immune system-a)broad categories of leucocytes, their role and properties b) B-lymphocytes c) T-cells-subsets d) other cells (APC, Null, NK)	**15**
	Credit-II	
2.	**Antigen and Antibody** **Antigen-** definition , nature, types of antigen, factors affecting antigenicity.**Antibody-** definition, nature, basic structure of immunoglobulin molecule, major human immunoglobulin classes, properties and functions. **Immune response**-primary and secondary immune response, theories of antibody production. **Antigen Antibody reactions**-Principle and applications of a) agglutination b) precipitation c) complement fixation d) ELISA. **Hypersensitivity-** Concept and types with example.	**15**

Learning Outcomes -

- The basic knowledge of vertebrates Immune System.
- The knowledge about Types and mechanism of defence.
- The knowledge of Cells and Organs of immune system.
- The concept of Antigen and antibody reaction.

References:

1. Riott "Essential Immunology"
2. Kuby "Immunology"
3. Ashim Chakravar "Immunology and Serology"
4. Tizzard "Immunology-An Introduction"-4th Edition
5. S. K. Gupta "Essentials of Immunology"
6. M. P. Arora "Immunology"

BBTT22-402 Advances in Cell Biology

Learning Objectives:

- To study secretary pathways and trafficking.
- To study cell signaling and Cell surface receptor proteins.
- To gain knowledge of cell cycle, molecular events in cell cycle.
- To gain knowledge of programmed cell death.
- To study cancer cells, causes of cancer and tumour suppressor genes.

Topic No.		Lectures 30
	Credit I	
1.	**Secretary pathway and protein trafficking** Secretary pathway-ER associated ribosomal translation, co-translational vectoral transport of nascent polypeptide chain to ER lumen. Transport to Golgi apparatus, secretary granules. Transport of proteins to- mitochondria, chloroplast, peroxisomes, nucleus. **Cell signaling** Introduction, general principles of cell signaling. Types of cell signaling-contact dependent signaling, autocrine, paracrine, synaptic, endocrine, gap junctions, combinatorial signaling. Cell surface receptor proteins- Ion channel linked receptors, G-protein linkedreceptors and enzyme linked receptors. Signaling through G-protein coupled receptors.	**15**
	Credit II	
2.	**Cell division cycle** Introduction, definition, phases of cell cycle. Regulation of cell cycle- CDK and cyclins (G-CDK, S-CDK, M-CDK andAPC). Cell cycle checkpoint-Start checkpoint, G2/M checkpoint, Metaphase to anaphase transition Programmed cell death. Cancer - types, characteristics of cancer cells, causes of cancer, tumor suppressor genes, p53 and Rb. **Cell division** Introduction and types of cell division-amitosis, mitosis and meiosis. Mitosis- history, phases in mitosis, significance. Meiosis -history, phases in meiosis, significance. Role of spindle fibers in chromosome separation. Condensation of chromosome. Synaptonemal complex.	**15**

Learning Outcomes:-

- Transport systems through membrane.
- Cell cycle, cell division and cellular events.
- Cell signaling and cell surface receptor proteins.
- Cancer cells, tumour suppressor genes.

References:-

1) Molecular biology of cell-Albert
2) Molecular biology & cell biology – Loddish et al
3) Cell biology –De Robertis
4) Cell biology-Genetics, molecular biology-P.S. Warma & Agarwal
5) Genes- Lewin
6) Cell biology –Geral karp
7) Practical biochemistry – Keith Wilson and Walker

BBTT22-403 Plant Biochemistry

Learning Objectives:

- To make students aware of physiology of plants.
- To study and use of biochemistry in growth and development of plant.
- To study biosynthesis and role of plant hormones in plant.
- To study concept of Photosynthesis and oxidative photophosphorylation.

Topic No.		Lectures 30
	Credit- I	
1.	**Plant Water Relation:-** Introduction, Absorption of water- Mechanism, Theories (Active and Passive), Translocation of water- Mechanism, Theories (Root pressure, Capillary), Transpiration. **Photosynthesis:-**Ultra structure of chloroplast, Photosynthetic pigments, red drop and Emerson's enhancement effect, mechanism of photosynthesis, light reaction, dark reaction, C-3 pathway, C-4 pathway, CAM, photorespiration.	**15**
	Credit-II	
2.	**Nitrogen Metabolism: -** Role of nitrogen in plants, source of nitrogen, nitrogen fixation- symbiotic & Non-symbiotic, Mechanism of Nitrogen fixation, nif gene- concept and significance, transamination. **Introduction to Plant Hormones** Biosynthesis of plant hormones- Auxin, Cytokinin, Gibberellin. **Growth:-** Definition, phases of growth curve, Photoperiodism, Vernalisation.	**15**

Learning outcomes:

- Mechanism of plant growth and development.
- The basic knowledge about photosynthesis, respiration and biosynthesis.
- Synthesis and applications of secondary metabolites
- The basic concept of plant -water relation and related theories.

References:-

1) Biochemistry- Lubert Stryer
2) Biochemistry- Nelson and Cox
3) Practical Biochemistry- Wilson and Walker
4) Fundamentals of Biochemistry – J. L. Jain
5) Principals of Biochemistry- Voet and Voet
6) Fundamentals of Plant Physiology- V. K.Jain

BBTT22-404 Environmental Biotechnology

Learning Objectives:

- To make students aware of Environmental Biotechnology
- Study of Environmental Impact Assessment.
- Study of Environmental Survey for different approaches.
- Study of environmental toxicology their magnification, effects.
- To study different remediation techniques for environmental pollution

Topic No.		Lectures 30
	Credit I	
1.	**Water Pollution** -Definition, Sources and Types-Physical, Chemical and Biological, Hardness [Mechanism, Determination, Types],Water softening methods [Clark's method, Use of cation and anion exchange resins], COD and BOD [Concept, Determination], Eutrophication (Concept, Types and Control), Purification of water (Physical Methods-UV Treatment, Distillation, Chemical Methods- Chlorination, Ozonization) **Air Pollution** -Definition, Sources, London and LA Smogs (Mechanisms of Formation), Greenhouse Effect (Concept, Reasons, Role of dipole moment of gaseous molecules), Ozone Depletion (Role of CFCs, Control), Instrumental analysis methods of SO2, NOx. **Soil Pollution** -Definition, Sources, Role of pesticide in soil pollution, control Measures. **Environmental Toxicology** Definition, classification and concept, Pesticide Toxicity – Classification (Organic and Inorganic), Mode of action of toxicants (Metals, organophosphates, carbamates and mutagens), Bioconcentration, Bioaccumulation, Biomagnification, Potentiation and Synergism, Control of Toxic effects- Biotransformation and excretion.	**15**
	Credit II	
2.	**Environmental quality Assessment and Monitoring** Definition, Quality of environment for life on earth and man. Deterioration of environment quality, short term studies, rapid assessment, continuous-short and long term monitoring, Basic Concept of Environment Impact Assessment. **Bioremediation Techniques** -Definition, Principle, *Insitu and Exsitu* Bioremediation, Bioremediation of waste waters (MSW, BSW and ISW), Activated Sludge Process, Lagoons, Oxidation ponds, Trickling filter. Solid Waste Treatment [Plastics and Aromatics], Slurry Phase Treatment, Agricultural Bioremediation- Microbial Composting, Biogas, Land, Farming and paste Control, Bioremediation of Industrial wastes, Xenobiotics, Bioaugmentation and Biofiltration.	**15**

Learning Outcomes

- Knowledge about recycling, and remediation methods of different pollutants.
- Know the technique of remediation method for pollution.
- Knowledge about various techniques for Environmental Impact Assessment.
- Knowledge about effluent treatment system.

References:-

1. Applied and enviornmental Microbiology; Amann, R.I Stromely,J.Stahl.
2. Enviornmental Biotechnology. , Chattergy.
3. Enviornmental Biology,Verma Agerwal
4. Enviornmental pollution, Peavy and Rowe.
5. Enviornmental problems and solution., Asthana and Asthana.
6. Enviornmental Science., Saigo, Canninhham

BBTT22-405 Molecular Biology-II

Learning Objective:

- To familiarize the students with advanced research area.
- To Understanding the basic concept in molecular biology.
- To understanding about central dogma of life.
- To Knowledge about gene expression and regulation.

Topi cNo.		Lectures 30
	Credit I	
1.	**Transcription in prokaryote and Eukaryote** Mechanism of transcription-Enzyme involved, initiation, elongation and termination. Inhibitors of transcription, Post transcriptional modification, Transcriptional control by hormones. **Genetic Code** Properties of genetic code. Assignment of codons with Unknown sequences a) Polyuridylic b) Acid Copolymers method. Assignment of codons with known sequences a) Binding technique b) Repetitive seq. technique. Wobble Hypothesis, Variation in genetic code.	**15**
2.	**Translation in prokaryote and Eukaryote** Structure and role of ribosome in translation, Amino acid t-RNA complex formation, Initiation, Elongation, termination of translation Inhibitors of translation. Post- translation modifications (Protein folding, Removal of Leadersequences, Phosphorylation, glycosylation, acetylation). **Regulation of gene expression in prokaryote and eukaryote.** Regulation of gene expression in prokaryote a) Lac operon b) Tryptophan operon c) Arabinose operon. Regulation of gene expression in eukaryote a) Promoter b) Enhancers c) Activators d) Repressor e) Co-Repressors. Regulation of geneexpression at transcriptional and translation level.	**15**

Learning Outcome

- At the end of the course, the students will have sufficient scientific understanding of DNA Transcription, Translation and Gene Expression.
- Discuss the mechanisms associated with Gene Expression at the level of Transcription and Translation.
- Discuss the mechanisms associated with Regulation of Gene Expression in Prokaryotes and Eukaryotes

References:

1) Molecular biology by Watson
2) Genetics by Strickberger
3) Molecular Biology by Glickpastornack
4) Molecular biolage Geralad Carph
5) Gene by Levin
6) Genome by T.A. Brown

BBTT22-406 Animal Tissue Culture

Learning Objectives:

- The organization of animal tissue culture laboratory
- Basic concepts in animal tissue culture with understanding of different physicochemical requirements, variations in techniques.
- To understanding different types of cell cultures.
- Applications of animal tissue culture.

Topic No.		Lectures 30
	Credit I	
1.	**History and Introduction of Animal Cell culture**- History of animal cell culture **Requirements of Animal cell culture-** Characteristics of animal cell in culture, substrate for cell growth, Equipment's required for animal cell culture (Laminar air flow, CO_2 incubator, Centrifuge, Inverted microscope) **Culture media-** Natural media, synthetic media (serum containing media, serum free media, balanced salt solution, media constituent, complete culture media, physicochemical properties of media). **Laboratory design and layout-**Construction and services, layout of aspetic room (sterile handling area, laminar air flow, service bench), incubation (incubators, hot room), preparation area (media preparation, washing area, storage). **Cultured cells- Biology and Characterization-** Characteristics of cultured cells, cell adhesion, cell proliferation, cell differentiation, metabolism of cultured cells, Initiation of cell culture, Evolution and development of cell lines. **Characterization of cultured cells-** Morphology of cells, species of origin of cells, Identification of tissue of origin, transformed cells, Identification of specific cell lines. **Measurement of growth parameters of cultured cells-** Growth cycle of cultured cells, plating efficiency of cultured cells **Cell synchronization-** Cell separation by physical means, cell separation by chemical blockade **Senescence and apoptosis-** Cellular senescence, Measurement of senescence, Apoptosis, Measurement of apoptosis.	**15**
	Credit II	
2.	**Basic technique of mammalian cell culture-** Isolation of tissue, disaggregation of tissue, measurement of viability, primary cell culture, Cell lines, Maintainance of cell culture, Subculture, Stem cell cultures **Scale up of Animal cell culture-**Scale up in suspension-stirrer culture, continuous flow culture, Airlift fermenter culture, Scale up in monolayer- Roller bottle culture, multisurface culture, multiarray disks and tubes, Microcarrier culture, Perfused monolayer culture. **Contamination-** Concept and Sources of contamination, types of microbial contamination, eradication of contamination. **Applications of cell culture-**In transplantation, and tissue engineering, monoclonal antibodies, culture based vaccine, valuable recombinant product, cloning, ethics and morality. **Stem Cell technology:** General introduction and applications.	**15**

Learning Outcomes:

- The basic knowledge of animal tissue culture.
- Knowledge about laboratory organization and safety.
- Known techniques of preparation of ATC media.
- To understand the ethics of animal tissue culture techniques.

References:-

1] Animal tissue culture- Paul
2] Culture of animal cell 3rd edition-R Ian
Freshney3] Animal cell culture- R.W.Masters
4] Animal biotechnology-M.M.Ranga
5] Animal biotechnology-R.Sasidhara

Skill Enhancement Course (SEC-IV)
Bio fertilizers – Production and Applications

Learning Objectives:

- To exploit the microbial diversity in various agro-ecologies for biofertilizer application in diversified system.
- To study the impact of soil management practices on microbial functions and soil health.
- To improve biofertilizer technology to ensure high quality and improved delivery.
- To diversify biofertilizer research and application in dry lands, degraded soils and tribal areas.

Sr. No.	Redesigned modules	Lectures 30
1.	**Unit- I** **Introduction**: General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis	05
2.	**Unit-II** Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication	10
3.	**Unit-III** Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.	10
4.	**Unit-IV** Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.	05

Practical's:

Sr. No.	Title	Practical's
1	Isolation of Azotobacter from soil	01
2	Isolation of PSB from soil	01
3	Isolation of Rhizobium from root nodules	01
4	Production of Biofertilizer- Azotobacter, PSB,	02
5	Production of Biofertilizer- Rhizobium	01
6	Isolation of Acetobacter, Azospirullum	01
7	Production of Biofertilizer- Acetobacter, Azospirullum	02
8	Study the mass production of Azolla	01
9	Study the mass production of Nostoc	01
10	Field visit	--

Learning Outcomes:

- Understand the role of microorganism in improving the fertility of soil and also in control the pest and other pathogens.
- Will know the techniques involved in mass production, quality control and application of Bioinoculants in organic farming.
- Students will have an opportunity to work in research laboratory, biofertilizer industry and can also be an bio-entrepreneurs.

BBTP22-407 Techniques in Genetics, Immunology and Cell Biology

Techniques in Genetics, Immunology	
Sr. No.	**Name of the Practical**
Major Experiments	
1	Isolation of Lac negative mutants of *E. coli* by visual detection method.
2	Isolation of Streptomycin resistant mutants by gradient plate technique.
3	Isolation of vitamin B_{12} requiring mutants by replica plate technique.
4	Transformation in *E. coli*.
5	Conjugation in *E. coli.*
6	U.V survival curve.
7	ELISA-dot ELISA.
Minor Experiments	
1	Radial immunodiffusion Assay.
2	Immunoelectrophoresis- (Qualitative).
3	Double Immunodiffusion Technique (Qualitative).
4	Widal test – Qualitative and Quantitative.
5	RPR card test.
6	Problems based on Mendelian Inheritance, linkage and crossing over.
7	Study of meiotic abnormality in *Rhoeo.*
8	Study of karyotype by using photograph.
Techniques in Cell Biology	
Sr. No.	**Name of the Practical**
Major Experiments	
1	Isolation of chloroplast.
2	Isolation of nucleus.
3	Isolation of mitochondria.
4	Study of Meiosis.
5	Isolation of giant chromosomes using Drosophila / Chironomous larvae.
Minor Experiments	
1	Study of separation of chromosome by paradichlorobenzene (PDB).
2	Study of methodology of cell lyses.
3	Use of dialysis to separate smaller molecules than larger molecules.
4	Effect of temperature and organic solvent on membrane permeability of cells
5	Study of Mitosis.
6	Measurement of size of pollens/cell organelle/spores by micrometry.
7	Study of plasmolysis.

BBTT22-408 Techniques in Molecular Biology and Metabolic Pathways

Techniques in Molecular Biology	
Sr. No.	**Name of the Practical**
Major Experiments	
1	Eukaryotic DNA Isolation from - Plant Material and Animal Material.
2	DNA isolation from fungi.
3	Purification of DNA by silica membrane.
4	Plasmid isolation from *E. coli.*
5	Determination of Tm of DNA.
6	Isolation of RNA.
7	SDS-PAGE for separation of protein using CCB and Silver staining.
Minor Experiments	
1	Genomic DNA isolation from bacteria.
2	Agarose gel electrophoresis to separate DNA.
3	Agarose gel electrophoresis to separate RNA.
4	Restriction digestion of DNA.
Techniques in Metabolic Pathways	
Sr. No.	**Name of the Practical**
Major Experiments	
1	Estimation of fructose by Resorcinol method.
2	Estimation of DNA by Diphenylamine method.
3	Estimation of RNA by Orcinol Method.
4	Isolation of Amylase from germinating seed and determination of its activity.
5	Paper electrophoresis of Amino Acids.
6	Purification of proteins /enzymes by Ion exchange chromatography using DEAE Cellulose.
Minor Experiments	
1	Separation of Amino acids by TLC.
2	Separation of Biomolecules by Gel Filtration Chromatography.
3	Study of lipase activity.
4	Study of nitrate reductase activity.
5	Estimation of Indole-3 Acetic Acid by (Salkowaski reagent) Colorimetric method.

BBTT22-409 Techniques in Plant Tissue Culture and Environmental Biotechnology

Techniques in Plant Tissue Culture	
Sr. No.	**Name of the Practical**
1	Laboratory Organizations & general techniques.
Major Experiments	
1	Preparation of M.S. stock solutions & medium .
2	Micropropagation stage I-Initiation of micropropagation of shoot tip.
3	Micropropagation stage I-Initiation of micropropagation of axillary bud.
4	Callus culture technique- Initiation of culture and study of callus morphology.
Minor Experiments	
1	Suspension culture technique-Initiation of culture.
2	Aseptic *in vitro* seed germination.
3	Embryo culture technique.
4	Anther Culture technique.
5	Micropropagation stage II- multiplication of culture.
6	Micropropagation stage III-Rooting- *in vitro* .
7	Micropropagation stage IV-Acclimatization & hardening.
	Visit to commercial Plant Tissue Culture Laboratory
Techniques in Environmental Biotechnology	
Sr. No.	**Name of the Practical**
Major Experiments	
1	Estimation of COD of water sample.
2	Estimation of BOD of water sample.
3	IMVIC Test
4	Determination of phenol coefficient of phenol derivative.
5	Study of effect of pesticide on *Azotobater* population by viable count method.
6	Isolation of phages of *E. coli* from sewage.
Minor Experiments	
1	Determination of TDS of water sample.
2	Routine bacteriological analysis of water Presumptive, Confirmatory, Completed, MPN.
3	Determination of total and permanent hardness of water sample.
4	Isolation of microorganism from air by solid impaction technique.
5	Study of effect of heavy metal on growth of organisms.
	Visit to ETP plant

Nature of Question Paper:

- **Theory-**

	Nature of Question Paper	
Q. No.1	**Multiple choice based objective type (four options for each question be given)**	**08 Marks**
Q. No. 2	**Attempt any two of the following (out of three)**	**16Marks**
Q. No. 3	**Attempt any four of the following (out of six)**	**16 Marks**
Total		**40 Marks**
	Internal Examination (CCE)-Unit Test	**10 Marks**
Grand Total	**Grand Total Marks**	**50 Marks**

- **Practical-**

Annual Practical examination

A) Every candidate must produce a certificate from the Head of the Department in his college, stating that he has completed in a satisfactory manner a practical course on the lines laid down from time to time by the Academic Council on the recommendations of the Board of Studies and that the laboratory Journal has been properly maintained. Every candidate must have recorded his/her observations in the Laboratory journal and written a report on each exercise performed. Every journal is to be signed periodically by a member of the teaching staff and certified by the Head of the Department at the end of the year. Candidates are to produce their journals at the practical examination and such journals will be taken into account by the examiners in assigning marks.

B) The practical examination will be conducted on two (2) consecutive days for each practicalnot less than 5 hours on each day of the practical exanimation.

BBTP22-407 (Techniques in Genetics, Immunology and Cell Biology) and
BBTP22-408 (Techniques in Molecular Biology and Metabolic Pathways)

Q.1 Major Experiment- 20 Marks
Q.2 Minor Experiment- 10 Marks
Q.3 Major Experiment- 20 Marks
Q.4 Minor Experiment- 10 Marks
Q.5 Spotting- 10 Marks (5 spots- each carry two marks)
Q.6 Journal- 10 Marks
Q.7 Case study- 10 Marks
Q.8 Viva-voce- 10 Marks

BBTP22-409 Techniques in Plant Tissue Culture and Environmental Biotechnology

Q.1 Major Experiment- 20 Marks
Q.2 Minor Experiment- 10 Marks
Q.3 Spotting 10 Marks- (5 spots- each carry two marks)
Based on Plant tissue culture
Q.4 Major Experiment- 20 Marks
Q.5 Minor Experiment- 10 Marks
Q.6 Spotting 10 Marks- (5 spots- each carry two marks)
Based on Environmental Biotechnology
Q.7 Tour Report- 10 Marks
Q.8 Journal- 10 Mark