



**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE**

**FACULTY OF SCIENCE  
B.Sc - Biotechnology  
New Syllabus**



BHARATI VIDYAPEETH (DEEMED TO BE  
UNIVERSITY)

RAJIV GANDHI INSTITUTE OF IT AND  
BIOTECHNOLOGY



REVISED SYLLABUS FOR

BACHELOR OF SCIENCE IN BIOTECHNOLOGY

UNDER

FACULTY OF SCIENCE

**SYLLABUS OF SEM I & SEM II UNDER**

**CHOICE BASED CREDIT SYSTEM**

**To be effective from Academic Year**

**2021-22**

Bharati Vidyapeeth Deemed To Be University is a multidisciplinary, multicampus university having 32 Institutions imparting quality education in various disciplines. All programmes of the University are approved by UGC and respective statutory councils. BVDU has been re accredited for the third time with 'A+' grade by NAAC in 2017. UGC has accorded 12B Status [UGC ACT1956] to the university. Ministry of Human Resource and Development, Government of India has awarded "A" category to the University in 2012 based on parameters including innovative programs, research and infrastructure facilities. The University is a member of Association of Indian Universities [AIU] which has ranked BVDU among top 10 universities of India for International students' enrollment. BVDU is also a member of International Association of Universities.

Rajiv Gandhi Institute of IT and Biotechnology is a constituent unit of BVDU established in 2003. The Institute is approved by UGC to conduct graduate and post graduate courses in Biotechnology. The Institute has excellent infrastructure, state-of-the-art laboratories and competent faculty facilitating appropriate learning environment. The Institute offers one undergraduate and four postgraduate programmes in Biotechnology.

The Bachelor of Science (B.Sc.) in Biotechnology is a full time graduate programme offered by Bharati Vidyapeeth Deemed to be University (BVDU) in its constituent unit Rajiv Gandhi Institute of IT and Biotechnology. The course was initiated in the year 2003 to facilitate empowerment of students and face challenges in biotechnology sector. The course has received very encouraging response from all its stakeholders. On its implementation for 17 years, the curriculum is being revised for the fourth time to embrace newer emerging disciplines and value added courses. The Revised B.Sc. Biotechnology is a full time 158 credits Programme to be implemented in Rajiv Gandhi Institute of IT and Biotechnology from the academic year 2021-22. The feedback of students, alumni, faculty, employers and parents has a substantial contribution in designing of this curriculum.

### **OBJECTIVES**

1. To impart deep knowledge of the discipline
2. Develop necessary skills to enhance employment opportunities
3. Introduce emerging areas of biotechnology sector
4. Build interdisciplinary approach
5. Foster global competence among students
6. Inculcate social and moral values and sense of scientific responsibilities in students

### **ELIGIBILITY FOR ADMISSION TO THE COURSE**

Candidates satisfying the following conditions are eligible to apply for admission to B.Sc. Biotechnology program.

- i. The candidate should have passed Higher Secondary School Certificate (10+2) or its equivalent examination with at least 45% (40% for SC/ST) marks in aggregate in the subjects Physics, Chemistry, Biology / Mathematics.
- ii. Subject to the above conditions, the final admission is based solely on the merit at the all India entrance test (BBT) conducted by Bharati Vidyapeeth Deemed University.

### **DURATION OF THE COURSE**

The duration of the course is three years (six semesters) and the medium of instruction and examination is English.

1. The entire course is of approximately 150 credits and will be executed in 6 semesters.
2. One credit for theory course is equivalent to 15 lectures/tutorials while one credit for practical course is equivalent to 25-35 hrs. of lab /field work / or demonstration.
3. The curriculum comprises of Core (C), Generic Elective (GE), Ability Enhancement Compulsory Courses(AECC), Value Added Courses (VAC) and Skill Enhancement Course (SEC).
4. In the Semester I and II of this revised syllabus- BSc Biotechnology 2021 programme, each semester consists of, 3 core Theory subjects (18 credits), 3 Core practical (18 credits), 2 AECC for 4 credits, two GE courses for 4 Credits, and 2 SEC for 4 credits. Choice is given for GE Courses. In all, semester I & II is of 24 credits each.
5. The Core Courses are aimed at imparting fundamental knowledge in various allied disciplines of biotechnology. The Generic Elective Courses are from unrelated discipline/subject with an aim to give exposure to students about the related subject, useful in his/her life. The Ability Enhancement Compulsory Courses are for knowledge enhancement/ Competencies/skills in relevant subjects; and the Skill Enhancement Courses are designed to develop relevant soft skills of students to compete in the global market.

## **RULES FOR EXAMINATION**

### **A: Nature of Examination:**

1. Each course (except those under Continuous Assessment) will have 40% marks for internal assessment and 60% marks for semester-end examination.
2. The assessment for 2 and 3 Credits courses will be as given in following table

**Table 1: Evaluation pattern for two & three Credit Courses**

<b>Course Credits</b>	<b>Marks for UE (60% Weightage)</b>	<b>Marks for IE (40% weightage)</b>	<b>Total Marks for evaluation</b>
<b>2</b>	<b>30</b>	<b>20</b>	<b>50</b>
<b>3</b>	<b>60</b>	<b>40</b>	<b>100</b>

3. The duration of **60 Marks UE theory paper will be 2.00 Hrs and for 30 Marks 1.00 Hrs.** respectively.
4. The Internal Assessments (IA) will be conducted by the Institute and the University Examination (UE) conducted by the university at the end-of-term.. The UE will be based on the entire syllabus.
5. The performances at UE and IA will be combined to obtain the Grade Point Average (GPA) for the course.

## STANDARD OF PASSING

**A: Grading System:** A **10-point absolute grading system** will be adapted for grading in each head of passing. The system will have seven grade points, the highest being 10. The grading system shall be as shown in Table-2 below. The performance indicators O, A+, A, B+, B, C, and D shall respectively mean Outstanding, Excellent, Very Good, Good, Average, Satisfactory, and Poor.

**Table-2: The grading system under CBCS**

<b>Range of Marks (out of 100)</b>	<b>Grade Point</b>	<b>Grade</b>
<b><math>80 \leq \text{Marks} \leq 100</math></b>	10	O
<b><math>70 \leq \text{Marks} \leq 80</math></b>	9	A+
<b><math>60 \leq \text{Marks} \leq 70</math></b>	8	A
<b><math>55 \leq \text{Marks} \leq 60</math></b>	7	B+
<b><math>50 \leq \text{Marks} \leq 55</math></b>	6	B
<b><math>40 \leq \text{Marks} \leq 50</math></b>	5	C
<b><math>\text{Marks} &lt; 40</math></b>	0	D

1. The grade point average (GPA) for a course shall be calculated by first finding the total marks **out of 100 for the course. The corresponding GP (as per the table-2) shall be the GPA for the course.**

### **B: Standards of Passing and ATKT rules:**

1. For all Core Courses, both UE and IE constitute separate heads-of-passing (HoP). In order to pass in such courses and to 'earn' the assigned credits

(a) the learner must obtain a minimum grade point of 5.0 (40% marks) at UE and also a minimum grade point of 5.0 (40% marks) at IA;

**OR**

(b) If he/she fails in IA, then also the learner passes in the course, **provided that a minimum of 25% is obtained in IA and GPA for the course is at least 6.0 (50%marks ) in aggregate.**

The GPA for a course will be calculated only if the learner passes in that course.

1. A student who fails at UE in a course has to reappear only at UE as a backlog candidate and clear the Head of Passing (HoP). Similarly, a student who fails in a course at IA has to reappear only at IA as a

backlog candidate and clear the HoP. **A student who passes in aggregate in a course need not reappear even if he failed at IA if he/she obtains 25% at IA.**

2. A student of Semester I and II will be admitted to Semester III and IV even if he/she gets backlog in any of the course. He/ She can reappear in the next semester examination as a backlog candidate. The student will however not be admitted to Semester V unless he/ she clears all heads in Semester I & II. In case the candidate gets backlog in Sem III & IV, then he will be admitted to Semester V and may improve the grade by reappearing in the next semester examination as a backlog candidate.

### C: AWARD OF HONOURS:

1. A student who has completed the minimum credits specified for the programme shall be declared to have passed in the programme. The final result will be in terms of letter grade and CGPA only and is based on the CGPA of all courses studied and passed. The criteria for the award of honours are given in Table 3.

**Table 3: Criteria for the award of honors at the end of the programme**

<b>Range of CGPA</b>	<b>Final Grade</b>	<b>Performance Descriptor</b>	<b>Equivalent Range of Marks (%)</b>
$9.50 \leq CGPA \leq 10.00$	O	Outstanding	$80 \leq Marks \leq 100$
$9.00 \leq CGPA \leq 9.49$	A+	Excellent	$70 \leq Marks \leq 80$
$8.00 \leq CGPA \leq 8.99$	A	Very Good	$60 \leq Marks \leq 70$
$7.00 \leq CGPA \leq 7.99$	B+	Good	$55 \leq Marks \leq 60$
$6.00 \leq CGPA \leq 6.99$	B	Average	$50 \leq Marks \leq 55$
$5.00 \leq CGPA \leq 5.99$	C	Satisfactory	$40 \leq Marks \leq 50$
CGPA Below 5.00	F	Fail	Marks below 40

## THE FORMAT OF THE TRANSCRIPTS

The transcripts may be acquired by the students indicating his/her performance in every semester examination. The transcript shall show the performance indicators given in the following table, in addition to any other information.

Course Number	Course Description	Number of Credits	University Examination		IA/CA		Grade Point Average (GPA)	Result
			Grade	Grade Point	Grade	Grade Point		
Total Cumulative Credits Completed		SGPA	CGPA	Equivalent Marks (%)	<b>Note: GPA is calculated by adding the UE marks out of 60 and IA marks out of 40. The total marks out of 100 are converted to Grade Point, which will be GPA</b>			

## PATTERN FOR ASSESSMENT

### A: Pattern of Evaluation for Internal Assessment of Theory Courses:

The weightage for Internal Assessment is 40 %. Students for IA of every theory course will be assessed for total of 40 marks for 3 credit course and for 20 marks for 2 credit course which will be cumulative marks obtained in two separate assessments specified below.

1. Two internal written examinations of 20 marks each for 3 credit course and 10 marks each for 2 credit course. A total of the two tests will be considered.
2. An optional assignment/ oral/ open book examination may be undertaken if desired.

### B. Pattern of Evaluation for Internal Assessment of Practical Courses:



The Internal Assessment for every practical course will be of 20 Marks for 2 credits and 40 marks for 4 credits practical courses. The students for IA will be assessed on the basis of;

1. Performance for every practical: 10 Marks/20 Marks for 2/3 Credits practical courses respectively.  
(Marks to be distributed depending on total number of practicals)
2. Assignment/ Oral examination/Tour Report: 10/20 Marks for 2/4 Credits courses

### **C: Pattern of question paper at University Examination**

University Examination for 3 credit and 2 credit theory course will be of 60 marks and 30 marks respectively.

**For 3 credit course**, the question paper will comprise of 6 questions, All questions will be compulsory and each question will carry 10 marks. The pattern of question paper will be as given on next page.

### **Pattern of question paper for 3 Credit Course of university theory examination of B.Sc. Biotechnology 2021 CBCS Course (Total Marks:60, Tme:3.00 Hrs.)**

#### **Instructions to Paper Setter:**

- I. Question paper of each course will comprise of total 6 questions,
- II. Section I will have 3 questions and Section II 3 questions.
- III. All questions will be compulsory. Each question will carry an internal option of one extra sub-question.
- IV. Q. no 1 and 4 will be objective, comprising of 6 questions of 2 mark each. They will be based on entire portion of Section I & Section II respectively. Students will have to attempt any 5 out of these.
- V. Questions 2 & 3 of **Section I** and 5 & 6 of **Section II** will be descriptive and contain 3 sub-questions of 5 marks each out of which students will attempt any two.
- VI. Q 2 and 3 will be based solely on Unit I and II whereas Q 5 and 6 will be based on Unit III and IV of the syllabus respectively.
- VII. Students will attempt answers to Section I and Section II in same answer book

<b>SECTION I</b>			
<b>Q. 1</b>		Attempt <b>Any Five</b> of the following (Based on Unit I &II) (Define/Give Example/ Short answer)	(10)
	<b>a</b>		
	<b>b</b>		
	<b>c</b>		
	<b>d</b>		

	e		
	f		
<b>Q. 2</b>		Attempt <b>Any Two</b> of the following (Based on Unit I)  (Answer the following/ Explain giving suitable diagram/ Any question of 5 marks weightage)	(10)
	a		
	b		
	c		
<b>Q. 3</b>		Write short notes on <b>Any Two</b> of the following (Based on Unit II)  (Differentiate between/Give reasons/Write true or false giving reasons)	(10)
	a		
	b		
	c		
		<b>SECTION II</b>	
<b>Q. 4</b>		Attempt <b>Any Five</b> of the following (Based on Unit III & IV)  (Define/Give Example/ Short answer)	(10)
	a		
	b		
	c		
	D		
	e		
	f		
<b>Q. 5</b>		Attempt <b>Any Two</b> of the following (Based on Unit III)  (Answer the following/ Explain giving suitable diagram/ Any question of 5 marks weightage)	(10)
	a		
	b		

	<b>c</b>		
<b>Q. 6</b>		Write short notes on <b>Any Two</b> of the following (Based on Unit IV)  (Application based; Can be single question with 2-3 subquestions. In case of single question, an option of complete 10 mark question to be given)	(10)
	<b>a</b>		
	<b>b</b>		
	<b>c</b>		

### Question Paper Pattern for 2 Credits Theory Course at University Examination

**For 2 credit course**, the question paper will comprise of 4 questions, 2 questions each in section I and section II. Q1 of section I and Q3 of section II will be of 5 marks each while Q2 and Q4 will be of 10 marks each. All questions will be compulsory. The pattern of question paper will be as given on next page.

**Pattern of question paper for 2 credit course of university theory examination of B.Sc. Biotechnology 2021 CBCS Course**  
(Total Marks:30, Tme:1.50 Hrs.)

#### **Instructions to Paper Setter:**

- VIII. Question paper of each course will comprise of total 4 questions,
- IX. Section I will have 2 questions and Section II 2 questions.
- X. All questions will be compulsory. Each question will carry an internal option of one extra sub-question.
- XI. Questions 1 of section I and 3 of section II will be objective and contain 6 questions of 1 mark each out of which students will attempt any 5. They will be based on entire portion of Section I and section II respectively.
- XII. Questions 2 of **Section I** and 4 of **Section II** will be descriptive and contain 3 sub-questions of 5 marks each out of which students will attempt any two.
- XIII. Q 2 and 4 will be based solely on Unit I and II of the syllabus respectively..
- XIV. Students will attempt answers to Section I and Section II in same answer books

		<b>SECTION I</b>	
<b>Q. 1</b>		Attempt <b>Any Five</b> of the following (Based on Unit I)  (Define/Give Example/ Short answer)	(05)
	<b>a</b>		
	<b>b</b>		

	<b>c</b>		
	<b>d</b>		
	<b>e</b>		
	<b>f</b>		
<b>Q. 2</b>		Attempt <b>Any Two</b> of the following (Answer the following/ Write short notes on/ Give reasons, Based on Unit I portion)	(10)
	<b>a</b>		
	<b>b</b>		
	<b>c</b>		
		<b>SECTION II</b>	
<b>Q. 3</b>		Attempt <b>Any Five</b> of the following (Based on Unit II portion) (Define/Give Example/ Short answer)	(05)
	<b>a</b>		
	<b>b</b>		
	<b>c</b>		
	<b>d</b>		
	<b>e</b>		
	<b>f</b>		
<b>Q. 4</b>		Attempt <b>Any Two</b> of the following (Answer the following/ Write short notes on/ Give reasons, Based on Unit II portion)	(10)
	<b>a</b>		
	<b>b</b>		
	<b>c</b>		

**D: Pattern for question paper of University Practical Examination of B.Sc. Biotechnology 2021 CBCS Course**

**(Total Marks:30/60 for 2/4 credit courses, Time: 3 .00/6.00 Hrs.)**

**Q. Major Practical (10/20)**

Q. 2	Spotting/Minor Experiment	(10/20)
Q. 3	Viva	(05/10)
Q. 4	Journal	(05/10)

## **BSc Biotechnology- Syllabus Revision- Comparison between 2015 and 2021 course and Highlights of the 2021 revision**

- The course was initiated in the year 2003 to facilitate empowerment of students and face challenges in biotechnology sector. The course has received very encouraging response from all its stakeholders.
- This is the fourth revision, in which along with the Core Courses, Value Added Courses (VA), Ability Enhancement Courses (AEC), Skill Enhancement Course (SEC) and Generic Elective Courses (GE) are included. The feedback of students, alumni, faculty, employers, subject experts from other universities and parents has a substantial contribution in designing of this curriculum.
- This Revised B.Sc. Biotechnology syllabus is of approximately 158 credits, spread over 6 semesters. The Course structure, examination rules and detail syllabus of Semesters I & II are being presented for approval, to be implemented in Rajiv Gandhi Institute of IT and Biotechnology from the academic year 2021-22.
- The tentative course structure for semesters III, IV, V & VI is also attached. It will be presented in the proposed BoS-Biotechnology meeting, in December 2021 for discussion and approval.

### **Comparison between the 2015 and 2021 syllabus (only for semesters 1 & 2):**

1. Total number of credits in semesters 1 & 2 is now 24 (earlier it was 28). The 4 credits reduced from each semester will be adjusted in semesters III, IV, V & VI suitably, wherever needed.
2. **Mathematics for Biologists-I and Mathematics for Biologists-II is new introduction in Semesters I & II respectively. These are AECC, worth 2+2 credits and are under Continuous Assessment.**
3. New courses under Generic Elective, worth 2+2 credits : (**Nutrition & Diet** OR Basic Programing for Biologists in Sem-I); and (Water Resource Conservation OR Biotechnology and Human Welfare in Semester-II) have been introduced.
4. Two Courses, one each in Semester I & II, under SEC ; English and communication skill and Understanding Finances and its Management are added.
5. The core courses which were present in the 2015 syllabus are retained in the new syllabus, with 25% revision in the contents of the courses that include topics of current relevance.

	<b>2015 Syllabus Semester-I</b>	<b>Credits</b>	<b>2021 Syllabus Semester-I</b>		<b>Remarks</b>
1	Animal Science	3	Animal Science	<b>3</b>	These are core courses. Their contents are modified (25%) to include current relevant topics
2	Plant Science	3	Plant Science	3	
3	Foundations of Chemistry & Biochemistry	3	Fundamentals in Chemistry & Biochemistry	3	
4	<b>Basics of Computer</b>	3			This subject and its corresponding practical (mentioned at Sr. No 8) is now included under Generic Elective subject for 2 credits at Sr. No 9
5	Animal Science Lab	3	Animal Science Lab	3	These are Core Practical Courses.
6	Plant Science Lab	3	Plant Science Lab	3	
7	Foundations of Chemistry & Biochemistry Lab	3	Fundamentals in Chemistry & Biochemistry Lab	3	
8	<b>Computer Fundamentals &amp; C-Programming Lab</b>	<b>3</b>	<b>Mathematics for Biologists-I</b>	2	<b>This is a new course introduced under AECC</b>
9	Elective- Basic Programming for Bioinformatics OR <b>English</b>	<b>2</b>	<b>Generic Elective (GE): Nutrition &amp; Diet OR Basic Programing for Biologists</b>	<b>2</b>	Same remark as mentioned above at Sr. No 4
10	Elective Open: Yoga & Meditation OR General course offered in other constituent units of BVDU	2	<b>English</b> and Communication Skills	2	This is under SEC- English language is clubbed with communication skills
	Total Credits	28	Total Credits	24	

	<b>2015 Syllabus SEMESTER-II</b>		<b>2021 Syllabus SEMESTER-II</b>		<b>Remarks</b>
1	Introduction to Microbiology	3	Microbiology I	3	These are core courses. Their contents are modified (25%) to include current relevant topics
2	Biochemistry I	3	Biochemistry I	3	
3	Cell Biology	3	Cell Biology	3	
4	<b>Genetics</b>	<b>3</b>	<b>-----</b>		<b>Shifted to Semester IV</b>
5	Introduction to Practical Microbiology	3	Microbiology- I Lab	3	These are core courses. Their contents are modified (25%) to include current relevant topics
6	Biochemistry I Lab	3	Biochemistry- I Lab	3	
7	Cell Biology Lab	3	Cell Biology Lab	3	
8	<b>Genetics Lab</b>	3	<b>-----</b>		<b>Shifted to Semester IV</b>
9	Elective-Ecology OR Gardening & Landscaping	2	<b>Mathematics for Biologists-II</b>	2	This is a new course introduced under AECC
10	Elective- Human Values OR General course offered in other constituent units of BVDU	2	<b>Generic Elective Course: Water Resource Conservation OR Biotechnology and Human Welfare</b>	2	These new courses introduced under Generic Elective
11	----		<b>Understanding Finance &amp; Its Management</b>	2	These new courses introduced under SEC
	Total Credits	28	Total Credits	24	



## B.Sc. Biotechnology Syllabus Under Choice Based Credit System

### Course Structure

SEMESTER I					
Course Description	Course no	Title	Credits	IA	Univ. Exam
Core T	BBT21-101	Animal Science	3	40	60
Core T	BBT21-102	Plant Science	3	40	60
Core T	BBT21-103	Fundamentals in Chemistry & Biochemistry	3	40	60
Core P	BBT21-104	Animal Science Lab	3	40	60
Core P	BBT21-105	Plant Science Lab	3	40	60
Core P	BBT21-106	Fundamentals in Chemistry & Biochemistry Lab	3	40	60
AECC-1	BBT21-107	Mathematics for Biologists-I	2	Continuous Assessment	
GE-1	BBT21-108	Basic Programing for Biologists	2	Continuous Assessment	
	BBT21-108	Health & Nutrition		Continuous Assessment	
SEC-1	BBT21-109	English and Communication Skills	2	Continuous Assessment	
Total Credit			24		

T (Theory), P (Practical), AECC (Ability Enhancement Compulsory Course), GE (Generic Elective), SEC (Skill Enhancement Course)

SEMESTER II					
Course Description	Course no	Title	Credits	IA	Univ. Exam
Core T	BBT21-201	Microbiology I	3	40	60
Core T	BBT21-202	Biochemistry I	3	40	60
Core T	BBT21-203	Cell Biology	3	40	60
Core T	BBT21-204	Microbiology I Lab	3	40	60
Core P	BBT21-205	Biochemistry I Lab	3	40	60
Core P	BBT21-206	Cell Biology Lab	3	40	60
AECC-2	BBT21-207	Mathematics for Biologists-II	2	Continuous Assessment	
GE -2	BBT21-208	Water Resource Conservation	2	Continuous Assessment	
	BBT21-208	Biotechnology and Human Welfare		Continuous Assessment	
SEC-2	BBT21-209	Understanding Finance & Its Management	2	Continuous Assessment	
Total Credits			24		

T (Theory), P (Practical), AECC (Ability Enhancement Compulsory Course), GE (Generic Elective), SEC (Skill Enhancement Course)

**SEMESTER III**

<b>Course Description</b>	<b>Course no</b>	<b>Title</b>	<b>Credits</b>	<b>IA</b>	<b>Univ. Exam</b>
<b>Core Course Theory</b>	BBT21-301	Microbiology II	3	40	60
<b>Core Course Theory</b>	BBT21-302	Biochemistry II	3	40	60
<b>Core Course Theory</b>	BBT21-303	Molecular Biology I	3	40	60
<b>Core Course Theory</b>	BBT21-304	Immunology	3	40	60
<b>Core Course Practical</b>	BBT21-305	Microbiology II Lab	3	40	60
<b>Core Course Practical</b>	BBT21-306	Biochemistry II Lab	3	40	60
<b>Core Course Practical</b>	BBT21-307	Molecular Biology and Immunology Lab	3	40	60
<b>Generic Course (Elective)</b>	BBT21-308	Physics for Biologists- I Course offered by SWAYAM-NPTEL	2		Continuous Assessment
<b>Skill Enhancement Courses (Elective)</b>	BBT21-309	Intellectual Property Rights Yoga and Sports	2		Continuous Assessment
<b>Value Added Course III</b>	BBT21-310	Enzymes and its industrial Applications	2		Continuous Assessment
<b>Total Credits</b>			<b>27</b>		

\*Students also need to appear for Compulsory Course “Environmental Studies” as prescribed by UGC.

### SEMESTER IV

Course Description	Course no	Title	Credits	IA	Univ. Exam
Core Course Theory	BBT21-401	Environmental Biotechnology	3	40	60
Core Course Theory	BBT21-402	Genetics	3	40	60
Core Course Theory	BBT21-403	Developmental Biology	3	40	60
Core Course Theory	BBT21-404	Analytical Techniques	3	40	60
Core Course Theory	BBT21-405	Molecular Biology II	3	40	60
Core Course Practical	BBT21-406	Environmental Biotechnology Lab	3	40	60
Core Course Practical	BBT21-407	Genetics and Developmental Biology Lab	3	40	60
Core Course Practical	BBT21-408	Analytical Techniques Lab	3	40	60
Generic Course (Elective)	BBT21-409	Physics for Biologist II Course offered by SWAYAM-NPTEL	2		Continuous Assessment
Skill Enhancement Courses	BBT21-410	Communication Skills and Personality Development	1		Continuous Assessment
<b>Total Credits</b>			<b>27</b>		

\*Students also need to appear for Compulsory Course “Environmental Studies” as prescribed by UGC.

<b>SEMESTER V</b>					
<b>Course Description</b>	<b>Course no</b>	<b>Title</b>	<b>Credits</b>	<b>IA</b>	<b>Univ. Exam</b>
<b>Core Course Theory</b>	BBT21-501	Biostatistics	3	40	60
<b>Core Course Theory</b>	BBT21-502	Bioinformatics	3	40	60
<b>Core Course Theory</b>	BBT21-503	Recombinant DNA Technology	3	40	60
<b>Core Course Theory</b>	BBT21-504	Applied Microbiology	3	40	60
<b>Core Course Practical</b>	BBT21-505	Bioinformatics Lab	3	40	60
<b>Core Course Practical</b>	BBT21-506	Recombinant DNA Technology Lab	3	40	60
<b>Core Course Practical</b>	BBT21-507	Applied Microbiology Lab	3	40	60
<b>Elective Sem V-I</b>	BBT21-508	Vocational Course (select one)	2	<b>Continuous Assessment</b>	
<b>Elective Sem V-II</b>	BBT21-509	Value Added Course (select one)	2	<b>Continuous Assessment</b>	
	<b>Total Credits</b>		<b>25</b>		

<b>Vocational Courses</b>	<b>Value Added Courses</b>
1) Biodiversity 2) Python	1) Organic Farming 2) Nano biotechnology

**SEMESTER VI**

<b>Course Description</b>	<b>Course no</b>	<b>Title</b>	<b>Credits</b>	<b>IA</b>	<b>Univ. Exam</b>
<b>Core Course Theory</b>	BBT21-601	Clinical Biochemistry	3	40	60
<b>Core Course Theory</b>	BBT21-602	Fermentation Technology	3	40	60
<b>Core Course Theory</b>	BBT21-603	Plant Tissue culture and Applications	3	40	60
<b>Core Course Theory</b>	BBT21-604	Animal Tissue culture and Applications	3	40	60
<b>Core Course Practical</b>	BBT21-605	Clinical Biochemistry Lab	3	40	60
<b>Core Course Practical</b>	BBT21-606	Fermentation Technology Lab	3	40	60
<b>Core Course Practical</b>	BBT21-607	Plant Tissue Culture Techniques Lab	3	40	60
<b>Core Course Practical</b>	BBT21-608	Animal Tissue Culture Techniques Lab	3	40	60
<b>Elective Sem VI-I</b>	BBT21-609	Project based learning course (Select any one)	2	<b>Continuous Assessment</b>	
	<b>Total Credits</b>		<b>26</b>		
<p><b>Project based learning courses</b></p> <ol style="list-style-type: none"> <li>1) Innovative ideas</li> <li>2) Scientific writing skill</li> <li>3) Group project</li> </ol>					

**B.Sc. Biotechnology: Sem-I; (2021)**

**Subject: BBT21-101 Animal Science**

**Core - Theory; 3 Credits**

**45 L**

Sr. No.	Topic	
<b>UNIT-I</b>		
1	<b>Introduction</b> to Kingdom Animalia, Principles and outline of classification of non chordates and chordates with representative examples.	03
2	<b>Type study: Non chordate: Earthworm (<i>Pheretima posthuma</i>)</b> Systematic position, habitat and habits, external morphology, digestive system, vascular system, excretory system, reproductive system, cocoon formation, nervous system.	06
3	<b>Type study: Chordates: Rat</b> Systematic position, habitat and habits, external morphology, sexual dimorphism, Digestive system, Respiratory system	03
<b>UNIT-II</b>		
4	<b>Rat: Circulatory system, (Heart, Arterial, Venous and Portal system),</b> Blood pigments: Role in oxygen transport, Transport of CO <sub>2</sub> Nervous system (brain and its functions), reproductive system, excretory system (structure of kidney and uriniferous tubules).	07
5	<b>Endocrinology and Physiology</b> Important endocrine glands and hormones of mammals, an overview; structure of pituitary gland , Chemical communication: Various types of communication systems with an emphasis on endocrine hormones and their action	04
<b>UNIT-III</b>		
6	<b>Parasitology:</b> Animal associations, Study of parasites with reference to <i>Entamoeba histolytica</i> , <i>Plasmodium vivax</i> , <i>Taenia solium</i> , <i>Ascaris lumbricoides</i> : systematic position, habitat and habits, morphology, life cycle, pathogenicity, mode of infection, pathogenicity and control measures.	08
7	The Importance of animals in the science of toxicology (Basic Overview of Preclinical Toxicology Animal Models)	03

## UNIT-IV

- |           |  |           |
|-----------|--|-----------|
| <b>8</b>  | <b>Apiculture</b>  | <b>03</b> |
|           | Types of honey bees, Wild species of honey bees: <i>Apis dorsata</i> , <i>Apis florea</i> ; domesticated species of honeybees: <i>Apisindica</i> , <i>Apis mellifera</i> , bee pollination and food plants, bee products (Pollen, glue, honey wax, venom, royal jelly) and their application                                     |           |
| <b>9</b>  | <b>Sericulture</b>   | <b>02</b> |
|           | Types of silkworms: Mulberry, Eri, Tasar, Muga; mulberry plant cultivation, rearing house, silkworm rearing, economic importance of wild and new silk moth.  |           |
| <b>10</b> | <b>Vermiculture</b>  | <b>03</b> |
|           | Types of earthworms in vermin composting; ( <i>Eudriius eugeniae</i> , <i>Eisenia foetida</i> , <i>Perionyx excavates</i> ); soil processing worms; ( <i>Heretimaposthuma</i> , <i>Pheretima elongate</i> ); economic and ecological importance of vermicomposting for garden, agriculture and industry. Vermiwash applications. |           |
| <b>11</b> | <b>Aquaculture</b>   | <b>03</b> |
|           | Fish as nutritive human food, Fish products: fish oil, fish glue, fish leather, fish manure, aqua culture industry and economic value of fishes.   |           |

## References

- 01 Modern Text Book of Zoology: Invertebrates. R.L.Kotpal. Publisher, Rastogi Publications,
- 02 12th Edition (2019)
- 03 Modern Text Book of Zoology: Vertebrates., R.L.Kotpal. Publisher, Rastogi Publications, (2012)
- 04 Economic Zoology, Shukla & Upadhyaya, 4th Edition., Rastogi Publications, 2009.
- 05 Textbook Of Human Parasitology Protozoology And Helminthology (2020) Edition by SOOD R , CBS Publishers and Distributors



**B.Sc. Biotechnology: Sem-I; (2021)**

**Subject: BBT21-102 Plant Science**

**Core - Theory; 3 Credits**

**Total Lectures 45**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	<b>Plant Kingdom</b> Characteristics and classification; binomial nomenclature; diversity in habit and habitat; life span; mode of nutrition.	<b>03</b>
<b>2</b>	<b>Algae, Fungi and Lichen</b> Characteristics, classification, Biological significance and Economic importance with examples; Life cycle and uses of Spirogyra, Aspergillus and Lichen.	<b>05</b>
<b>3</b>	<b>Bryophytes and Pteridophytes</b> Characteristics, classification , Biological significance and their economic importance with examples; Alternation of generations, life cycle of Riccia, Selaginella	<b>04</b>
<b>UNIT-II</b>		
<b>4</b>	<b>Gymnosperms and Angiosperms</b> General characteristics, classification with examples, Gymnosperms - life cycle of Pinus Angiosperms - differences between monocots and dicots, causes of phenomenal success of angiosperms and economic importance	<b>05</b>
<b>5</b>	<b>Plant Morphology</b> General organization of plant body; Morphological and biological functions of plant parts and their biotechnological significance.	<b>06</b>
<b>UNIT-III</b>		
<b>6</b>	<b>Inflorescences and Flowers</b> Inflorescences - major types with examples and significance. Flowers - floral parts and their functions; economic importance and their Applications in Biotechnology	<b>04</b>

<b>7</b>	<b>Fruits</b>	<b>03</b>
	Formation of fruit ; major types with examples; preservation of fruits and commercial applications	
<b>8</b>	<b>Embryology in Plant</b>	<b>04</b>
	Reproductive organs; fertilization; endosperm; embryogenesis in angiosperm; polyembryony; apomixes	
	Seed Structure and types; seed preservation and germination methods; Types of seed dormancy and methods to overcome seed dormancy.	

#### **UNIT-IV**

<b>9</b>	<b>Anatomy: Plant cells and tissue system</b>	<b>03</b>
	Types, structures and functions of plant tissues; Significance of anatomy in Ecological interpretation, pharmacognosy and wood identification.	
<b>10</b>	<b>Plant physiology</b>	<b>05</b>
	Water potential; Transpiration; guttation; photosynthesis and respiration ;Mineral nutrition and deficiency, overview of nitrogen fixation, phloem transport, Phototropism and Vernalisation, stress physiology (heat, water, salinity and metal), phytohormones and their role in fruit, seed and plant development.	
<b>11</b>	<b>Plant diseases</b>	<b>03</b>
	Signs and symptoms; fungal, viral and bacterial diseases; blight, rust, smut, powdery and downy mildew, Fusarium wilt; their post-harvest losses	

#### **References**

- 01** College Botany, Vol. I-II Gangulee, H.C., Das, K.S and Dutta, C.,New Central Book Agency (P) Ltd., Kolkota (2011).
- 02** Botany, An Introduction to Plant Biology ,Sixth Edition, James D. Mauseth (2016)
- 03** Plant Pathology,Fifth Edition,George Agrios (2005)
- 04** Plant Physiology and Development Sixth Edition, Book by Eduardo zeiger and Lin Coln Taiz (2018)

**B.Sc. Biotechnology: Sem-I; (2021)**

**Subject: BBT21-103 Fundamentals in Chemistry & Biochemistry**

**Core - Theory; 3 Credits**

**Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	<b>Introduction to Biotechnology:</b> Definition, branches of biotechnology, advantages and disadvantages, ethical considerations	02
2	Scope and contributions of biochemistry to human welfare; The cell as a unit of life and basic unit of biochemistry	02
3	Structure of atom-Models & theories, Periodic table, Concept of bonding; valence of carbon; hybridizations of carbon; hybridizations of nitrogen & oxygen; molecular orbital theories, polar & non polar molecules.	03
4	Water as a universal solvent -shape of H <sub>2</sub> O molecule, properties of water (B.P., M.P., solubility, polarity, adhesion-cohesion), diffusion, osmosis, osmotic pressure, surface tension, weak interactions, hydrogen bonding	04
<b>UNIT-II</b>		
5	<b>Carbohydrates</b> Occurrence/sources; Classification-on basis of carbon no & functional grs.; Structure with molecular formulae; Stereochemistry (structural and conformational isomers); isomers with one and more chiral centres, properties of stereoisomers; cyclization of sugars; conformations of cyclic forms (chair & boat forms).	04
6	Monosaccharides, oligosaccharides and polysaccharides 6 C sugars- glucose, fructose, mannose, galactose, 5 C sugars- ribose, deoxyribose, sialic acids, aminosugars, sugar acids (their biological role/ occurrence) Reducing-non-reducing properties; Structure and functions of important di-saccharides (sucrose, lactose, maltose, cellobiose) and polysaccharides (homo and heteropolymers, storage and structural polymers - starch, glycogen, cellulose, chitin, peptidoglycan)	04
7	Significance of carbohydrates in microbial, plant and animal system Introduction to conjugate sugars (Glycoproteins and glycolipids and their importance) ABO blood groups, heparin, lectins, carbohydrate vaccines	04

**UNIT-III**

- 8 Lipids: occurrence and fatty acids 05  
 Occurrence/sources: plant derived oils, ghee  
 Structure of fatty acids, triglycerides; Classification viz., simple and compound, structural and storage with examples; unsaturated-saturated, Oils (refined/unrefined significance); fats, waxes, rancidity
- 9 **Classification:** based on functions 04  
 Types of structural lipids, functions in a living system,  
 Cholesterol: Structure, function and significance  
 Role in vitamins, cofactors, for signalling, pigments
- 10 **Liposomes :** Types, liposomes in drug delivery, soaps, biosurfactants 02

#### UNIT-IV

- 11 Concept of buffers, how to prepare normal/molar solutions (examples), standard buffers, Henderson-Hasselbatch equation , Titration curve & pK values, Buffers & Stability of their pH , numerical problems. 03  
 Measuring pH with pH-meter: Working, Calibration, maintenance of electrodes, effect of molarity on pH maintenance
- 12 **Spectroscopy - colorimetry** 04  
 Absorption Spectroscopy: Electromagnetic spectrum, properties of electromagnetic radiations, concept and types of spectroscopy, absorption spectrum, energy characteristics of spectrum, Beer-Lambert law, concept of  $\lambda_{max}$ , chromophoric shifts, Spectrophotometer-design, working and Application.
- 13 **Chromatography :** Adsorption, Partition, Partition Basic principles of Adsorption & Partition Chromatography, Principle Experimental set-up, Methodology & Applications of all types of Adsorption & Partition Chromatography methods-chromatography using paper, thin layer. 04

#### References

- 01 Principles of Biochemistry by Lehninger, A., Nelson, D. L. and Cox, M.M. W.H. Freeman and Co., New York, USA (2008).
- 02 Biochemistry, Berg, J.M., Tymoczko, J. L. and Stryer, L. W.H. Freemanand Co., New York, USA (2003).
- 03 Biochemistry, Satyanarayan, U. Books and Allied (P) Ltd., Kolkata, India(2008)

**B.Sc. Biotechnology: Sem-I; (2021)**

**Subject: BBT21-104 Animal science Lab**

**Core - Practical; 3 Credits**

**Total Practical 20**

Sr. No.	Topic	P
1	<b>Animal Classification</b> Study of general and distinguishing characteristics; classification of chordates and non-chordates up to class level with examples	06
2	Demonstration of earthworm for visceral organs and various systems	02
3	Study of slides of Paramecium and Hydra.	02
4	<b>Study of parasites</b> Morphology, mode of infection, pathogenicity and control measures: <i>Entamoeba histolytica, Plasmodium vivax, Taenia solium, Ascaris lumbricoides.</i>	02
5	Study of honey bee and bee products (honey, wax, bee venom and royal jelly.)	01
6	Main fresh water cultivable fishes and their economic importance	01
7	Identification human blood groups	01
8	<b>Histology</b> Observation of permanent slides of important mammalian organs	02
9	<b>Excursion Tour</b> Visit to sericulture industry/ Apiculture center/Aquaculture industry/ Sea shore/Vermiculture Center.	03

**References**

- 01 Modern textbook of Invertebrate Zoology, 12th Edn, Kotpal R. L., Rastogi Publication, Meerut.2019
- 02 Modern textbook of Vertebrate Zoology, 5th Edn. Kotpal R L., Rastogi Publication, Meerut. (2019)
- 03 A manual of practical zoology, B.Sc. Biotechnology, sem -1; SK Gaikwad; BVDU, RGIT BT.
- 04 Invertebrates (Protozoa To Echinodermata), 2nd Edn, Verma, A., Narosa publishing house, New Delhi.(2009)

**05** Parasitology. Chernin, Jack. Published by Taylor & Francis, New York (2001). ISBN 10: 0748408177 ISBN 13: 9780748408177

**B.Sc. Biotechnology: Sem-I; (2021)**

**Subject: BBT21-105 Plant science Lab**

**Core - Practical; 3 Credits**

**Total Practical 20**

<b>Sr. No.</b>	<b>Topic</b>	<b>P</b>
1	Study of modes of nutrition in plants	01
2	Study of algae and life history of a typical alga	02
3	Study of fungi and Lichens; life history of a typical fungus	02
4	Study of Bryophyta and life history of a typical Bryophyte	01
5	Study of Pteridophyta and life history of a typical Pteridophyte	02
6	Study of Gymnosperms and life history of a typical gymnosperm	02
7	Study of general organization of plant body	02
8	Study of inflorescence and morphology of a typical flower	02
9	Study of types of fruits and structure of seeds	02
10	Anatomy of dicot and monocot.	02
11	Determination of Water potential	01
12	Visit to forest	01
	To study plant diversity	

**References**

- 01 College Botany, Vol. I-II, Gangulee, H. C., Das, K. S. and Dutta, C., New Central Book Agency (P) Ltd., Kolkota (2011).
- 02 Botany for Degree Students Part-I-III: Algae, Fungi and Bryophyta Vashishta, B. R., Sinha, A. K. and Singh, V.P., S Chand & Co. Ltd., New Delhi (2002).
- 03 Botany, An Introduction to Plant Biology ,Sixth Edition, James D. Mauseth (2016)
- 04 Botany, An Introduction to Plant Biology ,Sixth Edition, James D. Mauseth (2016)
- 05 A Text book of Practical Botany-2, Bendre, A. M. and Ashok Kumar, Rastogi Publication, Meerut (2006).

## B.Sc. Biotechnology: Sem-I; (2021)

Subject: BBT21-106 Foundations of Chemistry & Biochemistry Lab

Core - Practical; 3 Credits

Total Practical 20

Sr. No.	Topic	P
1	Significance of good laboratory practices (GLP) Safe handling of equipments/ Instruments. Introduction to volume and weight measurements, Personal safety, accuracy and reliability.	02
2	Safety in the use of acids, alkalies and organic solvents. Distillation of water, Preparation of de-mineralized water, Preparation of washing solution/ disinfectant	02
3	Preparation of buffers-acetate buffer & Preparation of biochemical reagents (Benedict's reagent) Preparation of Molar, Normal and Percent solutions	02
4	<b>Isolation of commercially important biomolecules</b> Isolation of starch from corn (separation on the basis of density) Extraction of triglycerides from oilseeds (separation on the basis of differential solubility)	02
5	Color reactions (qualitative determination) for identification Sugars and starch	02
6	To determine $\lambda$ max and extinction coefficient of coloured compounds using spectrophotometer & validation of Beer-Lambert Law (Varying concentrations of $KMnO_4$ ).	02
7	Determination of glucose by DNSA method.	02
8	Thin layer chromatography (TLC) Separation of plant pigments	02
9	Preparation of soap	02
10	Acid value or saponification value. Determination with reference to fatty acids.	02

### References

- 01 Laboratory Manual in Biochemistry, Jayraman J., New Age International (P) Ltd., New Delhi (2007).
- 02 Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J., Cambridge University Press, New York (2005).
- 03 An Introduction to Practical Biochemistry, Plummer, D.T., Tata-McGraw-Hill Publishing Co., New Delhi (2005).



**B.Sc. Biotechnology: Sem-I; (2021)**

**Subject: BBT21-107 Mathematics for Biologist I**

**AECC-1- Theory; 2 Credits**

**Total Lectures 30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	<b>Classical Algebra</b> Complex Number including D'Moivre's Theorem, Logarithm (only algebra, without Series expansion)	<b>05</b>
<b>2</b>	<b>Binomial Theorem</b> (without infinite series).	<b>05</b>
<b>3</b>	Determinant, Matrix, Rank of Matrices by Diagonalization method.	<b>05</b>
<b>UNIT-II</b>		
<b>4</b>	<b>Calculus - I</b> [For functions of single variable] Limit, Continuity, Differentiation (including differentiability), Successive Differentiation, Expansion of Functions - Rolle's theorem, Mean Value theorem,	<b>05</b>
<b>5</b>	<b>Integration</b> - Definite and Indefinite (ordinary, method of substitution, special trigonometric function, partial fraction) Application of integration to, Differential equations -homogeneous and Linear ODE's and its simple applications to biological problems.	<b>06</b>
<b>6</b>	<b>Calculus - II</b> [For functions of two variables] Partial Differentiation including Euler's theorem and it's application.	<b>04</b>
<b>References</b>		
<b>01</b>	Calculus Made Easy - Being a Very-Simplest Introduction to Those Beautiful Methods of Reckoning Which Are Generally Called by the TERRIFYING NAMES of the Differential Calculus and the Integral Calculus, By Silvanus Thompson, Second Edition, 2018, Publisher: Macmillan	
<b>02</b>	Calculus (Differentiation & Integration), Lesson/Practice Workbook for Self-Study and Test Preparation, By Aejeong Kang · 2014, ISBN:9780989368995, 0989368998, Publisher: MathRadar	
<b>03</b>	Numerical Methods by Balaguruswamy, 2008, TMH publishing	

**B.Sc. Biotechnology: Sem-I; (2021)**

**Subject: BBT21-108 Basics of Computer programming for Biologists**

**GE I - Practical; 2 Credits**

**Total Practical 20**

<b>Sr. No.</b>	<b>Topic</b>	<b>p</b>
<b>1</b>	<b>Introduction and First Program:</b> Why Programming Types of Programming Introduction to C C programming features Benefits of C Some Facts about C Understanding First C Program	<b>05</b>
<b>2</b>	<b>Laboratory assignments based on the following topics in 'C' programming:</b> Data types, operators and expressions, Hierarchy of operators Control statements including decision (if, if-else), loops (while, do-while, • for), branching statements (switch, break, continue) Functions, Arrays (1D, 2D- all matrix operations including inverse of a matrix), Strings	<b>15</b>

**References**

- 01** C Programming Language, A Step by Step Beginner's Guide to Learn C Programming in 7 Days, By Darrel L. Graham · 2017, ISBN:9781548548384, 1548548383, Publisher: CreateSpace Independent Publishing Platform
- 02** Let Us C Solutions - 17th Edition: Yashavant Kanetkar · 2020, BPB publication

**B.Sc. Biotechnology: Sem-I; (2021)**

**Subject: BBT21-108 Nutrition and Diet**

**GE- I - Theory; 2 Credits**

**Total Lectures 30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	<b>Introduction</b>	<b>01</b>
<b>2</b>	<b>Nutrition and its physiological role</b> Definition for nutrition, nutrients, body weight body composition, measurement of energy expenditure - calorimeter, BMR, SDA and RQ. Physico chemical properties and physiological actions of dietary fibre, protein energy malnutrition	<b>05</b>
<b>3</b>	<b>Food, Nutrition, Health And Hygiene - Interrelationships</b>	<b>03</b>
<b>4</b>	<b>Common Health Problems (age group 18-25 years)</b>	<b>01</b>
<b>5</b>	<b>Nutritional Biochemistry</b> Macronutrients Micronutrients Significance of water in metabolism	<b>05</b>
<b>UNIT-II</b>		
<b>6</b>	<b>Balanced diet</b>	<b>02</b>
<b>7</b>	<b>Conserving and enhancing nutritive value of food</b>	<b>03</b>
<b>8</b>	<b>Food selection and meal planning for health and fitness</b>	<b>03</b>
<b>9</b>	<b>Healthy Lifestyle: Eating behaviour, Physical Activity, Sleep and Stress Management</b>	<b>03</b>
<b>10</b>	<b>Nutraceuticals and Functional Foods</b>	<b>04</b>
<b>References</b>		
<b>01</b>	<b>Nutraceuticals and Functional Foods1. Wildman, R. E. (2016). Handbook of Nutraceuticals and Functional Foods. CRC Press</b>	
<b>02</b>	<b>Vattem, D.A. and Maitin V.(2016). Functional Foods, Nutraceuticals and Natural Products, Concepts and Applications. DEStech Publications, Inc</b>	
<b>03</b>	<b>Gupta, R. C. (2016). Nutraceuticals: Efficacy, Safety and Toxicity. Academic Press.</b>	

- 04 Cultivating Your Microbiome: Ayurvedic and Chinese Practices for a Healthy Gut and a Clear Mind by Bridgette Shea L.Ac. MAcOM, 2020
- 05 Anxiety-Free with Food: Natural, Science-Backed Strategies to Relieve Stress and Support Your Mental Health by Liana Werner-Gray, 2020

**B.Sc. Biotechnology: Sem-I; (2021)**

**Subject: BBT21-109 English and Communication Skills**

**SEC-I - Theory; 2 Credits**

**Total Lectures 30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
1	Listening, Speaking, Essential Grammar, Undergraduate writing, Writing PG Assignments	03
2	Comparing and contrasting: similarities and differences, Reporting and narrating. Expressing purpose, means and method, Expressing degrees of certainty, Expressing reasons and explanations / cause and effect, Describing developments and changes, Describing a sequence of events / time relations, Writing instructions	03
3	Answering exam questions: Understanding the question, Planning the answer, The exam answer, Evaluating the answer	02
4	Research and using the library: Finding relevant information, Using catalogues, Using books and periodicals, Using bibliographies and indexes, Using sources, Making notes, Paraphrasing and writing up notes, Summarising, Quoting directly, Referring to sources, Writing a references list.	03
5	Writing essays: Organisation: presentation and layout, Spelling and punctuation, Including graphs, charts and tables, Writing paragraphs, Writing introductions and conclusions, Academic writing style, Revising the essay - proofreading	05
<b>UNIT-II</b>		
6	Listening, empathic reaction, how to question, stealing the show, opening door question	02
7	Communication skills at work place/ place of study, vicious circle of attack and defense	02
8	Work with audience - ice-breaking, get them in the mood, work with emotions, visualization tools, nonstandard situations	02
9	Improvisation presentations and unprepared presentations	03
10	Analysing Strengths & weaknesses, Body Language & Preparation of Self Introduction	02
11	Etiquettes of writing e-mails, letters and effective communication of issues, CV writing	03

## References

- 01 Essential English Grammar by Raymond Murphy, Cambridge Publication (Available in paper back)
- 02 Practical English Usage by Michael Swan, Oxford University Press.
- 03 Practical English Grammar by Thomson, A J & Martinet, A V. Oxford University Press. 1986. Paperback. Intermediate. ISBN 0194313425

**B.Sc. Biotechnology: Sem-II; (2021)**

**Subject: BBT21-201 Microbiology I**

**Core - Theory; 3 Credits**

**Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	<b>History of Microbiology</b> Germ Theory of Disease, Scope and relevance	01
2	<b>Introduction to Microscopy</b> Principle, instrumentation and applications of bright field microscopy (Preparation and staining of preparation) Dark field, Phase contrast, Confocal, Fluorescence and Electron microscope	11
<b>UNIT-II</b>		
3	<b>General properties and structure of prokaryotes</b> Bacterial cell structure and function; cell wall, cell membrane, endospore, capsule, flagella, fimbriae & pili, nucleoid, ribosomes, plasmids, cell inclusions (Carbon Storage polymers, Polyphosphate, Sulfur and Carbonate, Magnetic inclusions), chemotaxis	06
4	<b>Microbial nutrition</b> Nutritional types of microorganisms, growth factors, macro and microelements, media ingredients, Different types of culture media: complex, defined, selective, differential media, pure culture techniques	05
<b>UNIT-III</b>		
5	<b>Microbial growth</b> Reproduction in microorganisms, Effect of environmental factors on growth (Temperature, pH, Oxygen, Salt) Growth curve, introduction to kinetics of growth, generation time, Chemostat and turbidostat, Measurement of Growth (Microscopic count, TVC and Spectrophotometry)	06
6	<b>Control of microorganisms:</b> Physical agents - Heat, Radiations, Filtration, Ultrasonication Chemical agents and their mode of action- Aldehydes, halogens, quaternary ammonium compounds, phenolic compounds, ethylene oxide, heavy metals, alcohol, soaps and detergents Sterility checking- chemical and biological indicators.	05
<b>UNIT-IV</b>		
8	<b>Bacterial genetics</b> Genetic exchanges in bacteria-Conjugation, Transformation, Transduction, Holliday model of Recombination	06
9	<b>Bacterial viruses</b> General characteristics, classification, nomenclature, morphology and structure, life cycle (lytic & lysogenic) of $\lambda$ phage, Phage therapy	05
<b>References</b>		

- 01 Prescott's Microbiology, *11th Edition* (2020), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, ChrisWoolverton, McGrawHil Science Engineering, USA
- 02 Brock Biology of Microorganisms, Madigan, M. T., Martinko, J. M. and Parker, J. B., 5th Global Edition (2018) Prentice-Hall Publ., New York.
- 03 Microbiology: An Introduction, 12<sup>th</sup> Edn. Tortora, G. J., Funke, B. R. and Case, C. L., Pearson Education Inc., New Jersey (2016).



**B.Sc. Biotechnology: Sem-II; (2021)**

**Subject: BBT21-202 Biochemistry I**

**Core - Theory; 3 Credits**

**Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	<b>Amino acids, peptides and proteins</b> Occurrence/sources, Naturally occurring amino acids; structures; abbreviated names; stereoisomerism; amphoteric nature of amino acids; modified amino acids and their role in nature; Classification of amino acids (on basis of functional groups, essential/non-essential); Chemical reactivity due to functional group (amide, acid, amine);	05
2	peptides & proteins (peptide bond, bond properties, N-Terminal, C-Terminal); importance of sequence of amino acids for structure and function of protein (eg. Sickle cell anaemia)	02
3	<b>Protein structure</b> Primary, secondary ( $\alpha$ helix and $\beta$ conformation), tertiary and quaternary structure. Forces stabilizing molecular structure (covalent bond, ionic bond, hydrogen bond, salt linkage, van der Waal's forces) a brief over view of Ramchandran plot	04
<b>UNIT-II</b>		
4	<b>Classification of Proteins according to function</b> Structural proteins, transport proteins, chromoproteins, phosphoproteins, glycoproteins and their structures and significance in microbial, plant and animal systems	03
5	<b>Introduction to enzymes as biocatalysts</b>	02
6	<b>AMP and cAMP, ADP &amp; ATP, NAD &amp; NADP, FMN &amp; FAD- structure, function and biological role.</b>	02
7	<b>Vitamins</b> Occurrence/sources; rich sources of different vitamins; Classification and general structural features, Role as coenzymes; Functions & Deficiency symptoms	03
8	<b>Minerals</b>	03

Role of Na, K, Mg, Fe, Zn, Co, Cu, P and I in physiology; General electronic configurations and their shapes/preferred geometries and its significance in metalloenzymes

#### UNIT-III

- 9 **Analytical tools for separation of biomolecules** 04  
Separation techniques: Filtration (gross, mini, micro and ultra-filtration), dialysis
- 10 **Column Chromatography:** - gel, affinity, ion exchange, applications; proteins and enzymes. 04
- 11 **Electrophoresis:** Principle of separation, factors affecting separation, types-paper, PAGE, 2D- gel electrophoresis. 03

#### UNIT-IV

- 12 **Kjeldahl method of nitrogen estimation** Soil /fertilizer/ water/ plant analysis 04
- 13 **Flame photometry:** Estimation of Na and K, principle and procedure, accuracy 04
- 14 **Estimation of important minerals:** Calcium and Iron from industrial effluents (gravimetry); modern methods of estimation. 02
- 15 **Estimation of inorganic phosphate:** Analysis of soil for phosphate fertilizer (colorimetry) 02

#### References

- 01 Principles of Biochemistry by Lehninger, A., Nelson, D. L. and Cox, M.M. W.H. Freeman and Co., New York, USA (2017).
- 02 Biochemistry, Satyanarayan, U. Books and Allied (P) Ltd., Kolkata, India(2020).
- 04 Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2018).

**B.Sc. Biotechnology: Sem-II; (2021)**

**Subject: BBT21-203 Cell Biology**

**Core - Theory; 3 Credits**

**Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	Introduction to Cell Evolution of cell from molecules to first cell, from prokaryotes to eukaryotes and from single to multicellular organisms. Cell size, shapes, morphology and cell theory, General structure of prokaryotic and eukaryotic cell (plant and animal).	03
2	Organelles of eukaryotic cells Nucleus, Mitochondria, Endoplasmic Reticulum, Golgi apparatus, Lysosomes, Chloroplast and Plant Cell Wall; Structure and function of different organelles, comparison between prokaryotic and eukaryotic cell structure. Types of cells (Neuron, RBC) and their functions.	06
3	Cytoskeleton: Actin filaments, Intermediate filaments, Microtubules, their structure, organization and functions and role in cellular activities.	03
<b>UNIT-II</b>		
4	Membrane Structure: Components of membrane, Structure (Fluid Mosaic Model), properties and functions of membrane. Function of lungs as membranous bags.	03
5	Transport across the membrane: Passive diffusion, facilitated diffusion, Active transport. Structure, function and significance of Na <sup>+</sup> / K <sup>+</sup> ATPase and Ca <sup>+</sup> ATPase;	05
6	Ion channels - leak channels, gated channels, voltage gated and ligand gated channels. Endocytosis and exocytosis , receptor mediated endocytosis.	03
<b>UNIT-III</b>		
7	Cell-cell interaction: Tight junctions, gap junctions, desmosomes & hemidesmosomes, plasmodesmata and extracellular matrix. Significance in neural transmission.	03
8	Cell cycle and cell division: Cell cycle: Check points and steps and regulation. Cell division - mechanism of cell division, Mitosis and meiosis, significance and comparison between two nuclear divisions.	08
<b>UNIT-IV</b>		
9	Cell signaling: Types of cell signaling Signal molecules, receptors and mechanism of signal transduction.	07
10	Cell death: Mechanism of apoptosis, its failure leading to cancer development, necrosis. Comparison between apoptosis and necrosis.	04

**References**

- 01 Molecular Cell Biology. 7th Edition, (2012) Lodish H., Berk A, Kaiser C., KReiger M., Bretscher A., Ploegh H., Angelika Amon A., Matthew P. Scott M.P., W.H. Freeman and Co., USA
- 02 The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA
- 03 Cell Biology, 6th edition, (2010) Gerald Karp. John Wiley & Sons., USA
- 04 Biochemistry, Berg, J. M., Tymoczko, J. L. and Stryer, L. W. H. Freeman & Co., New York (2003).
- 05 The Cell: A Molecular Approach, 6th edition (2013), Geoffrey M. Cooper, Robert E. Hausman, Sinauer Associates, Inc. USA

**B.Sc. Biotechnology: Sem-II; (2021)**

**Subject: BBT21-204 Microbiology I Lab**

**Core- Practical; 3 Credits**

**Total Practical 20**

<b>Sr. No.</b>	<b>Topic</b>	<b>P</b>
1	Safety precautions in microbiology laboratory	01
2	Introduction to laboratory instruments used in microbiology	02
3	Sterilization techniques, Fumigation	02
4	Introduction to microscopy :Demonstration of compound microscope	01
5	Preparation of media and its application: Complex, selective and differential media, Decontamination of culture media	02
6	Pure culture techniques Pour plate, streak plate, spread plate, observation of cultural characters	03
7	Staining techniques: Monochrome staining, Gram staining, Negative staining	03
8	Staining of cell organelles: Staining of capsule, spore, cell wall and metachromatic granule	02
9	Observation of bacterial motility- hanging drop, swarming growth methods	02
10	To study the growth curve of bacteria	02

**References**

- 01 Microbiology: A Laboratory Manual, (2014), 10<sup>th</sup> Edn. Cappuccino, J.G. and Sherman, N., Pearson Education Pvt. Ltd., Singapore.
- 02 Experiments in Microbiology, Plant Pathology and Biotechnology, (2017), 5<sup>th</sup> Edn., Aneja, K. R., New Age International Publishers, New Delhi

**B.Sc. Biotechnology: Sem-II; (2021)**

**Subject: BBT21-205 Biochemistry I Lab**

**Core - Practical; 3 Credits**

**Total Practical 20**

<b>Sr. No.</b>	<b>Topic</b>	<b>P</b>
1	Isolation of casein from milk (separation on the basis of isoelectric pH)	01
2	To determine $\lambda$ max and extinction coefficient of bio-molecules Tyrosine, purine and pyrimidine using spectrophotometer. Identification of purines from $\lambda$ max	02
3	Color reactions for identification. Amino acids and proteins	02
4	Estimation of proteins. Determination of albumin concentration by Biuret method	01
5	Paper chromatography/TLC for the separation of amino acids	02
6	Determination of pKa values of solutions.	03
7	Titration curve of acidic, basic and neutral amino acids	03
8	Quantitative estimation of ascorbic acid	02
9	Separation of dyes on the basis of ion exchange chromatography	02
10	Adsorption chromatography Separation of leaf pigments	02

**References**

- 01 Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2018).
- 02 Laboratory Manual in Biochemistry, Jayraman, J., New Age International (P) Ltd. New Delhi (2011).

**B.Sc. Biotechnology: Sem-II; (2021)**

**Subject: BBT21-206 Cell Biology Lab**

**Core - Practical; 3 Credits**

**Total Practical 20**

<b>Sr. No.</b>	<b>Topic</b>	<b>P</b>
1	Study of compound and dissecting microscope	02
2	Overview of plant and animal cell structure	02
3	Study of sub cellular organelles	02
4	Observation of human cheek epithelial cells	01
5	Staining of mitochondria in human cheek epithelial cells with Janus green B	02
6	Study of mitosis (onion root tip) - preparation of slides and identification of different stages of mitosis.	02
7	Study of blood cell types	01
8	Determination of total erythrocytes (RBCs) from given blood sample	02
9	Determination of total leucocytes (WBCs) from give.n blood sample	02
10	Effect of organic solvents on cell membrane permeability of a cell	01

**References**

- 01 Cell Biology : Practical Manual by Dr. Renu Gupta, Dr. Seema Makhija, et al. 2018
- 02 Dacie and Lewis Practical Haematology Paperback, by Barbara J. Bain, Imelda Bates ,Mitchell Lewis. Churchill Livingstone; Tenth Eds 2006
- 03 Cooper G.M., Hausman R. E. The cell: A molecular approach. 5th edition. ASM Press and Cinauer Associates Inc. 2009

**B.Sc. Biotechnology: Sem-II; (2021)**

**Subject: BBT21-207 Mathematics for Biologists-II**

**AECC-2- Theory; 2 Credits**

**Total Lectures 30**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	<b>Algebra :</b> Linear Algebra: - Rank of Matrix by Diagonalization method, Eigen value & eigen vector	03
2	<b>Vector Algebra:</b> - Vector addition, Vector multiplication (dot & cross product), Their geometrical meanings, Simple properties (without proof) with simple examples, Vector triple product with simple examples. vector space	03
3	<b>Abstract Algebra:</b> - Relation-definition, example, binary relation, construction of function from relation. Mapping, Composite mapping, with simple examples.	02
4	<b>Geometry:</b> 3D Straight Line, linear transportation, arithmetic and geometric progression, method of mathematical induction, locus, circle, mathematical logic	04
5	<b>Probability:</b> Space and Events, Axioms of Probability, Conditional Probability, Independent Events, Bayes' Theory	03
<b>UNIT-II</b>		
3	<b>Differentiation:</b> Existence of differentiation, Expansion of function - Rolle's Theorem (Statement only), Langrange's mean value theorem (with proof), Cauchy's mean value theorem (Statement only), Verification of each by simple examples.	04
4	<b>Integration-</b> Improper integration, Beta & Gamma function-statement and only examples. Fourier series- Definition and simple problems assuming convergence condition, D statement of Dirichlet's condition. (12 Periods)	04
5	<b>Deferential equation</b> - Linear ODE of second Order. (8 Periods)	04
6	<b>Applications To Mathematical Biology:</b> Enzyme kinetics, Immunology, Population genetics, Tumor modeling, Applications of ordinary & partial differential equations to Biology.	03
<b>References</b>		
01	The Math Book, By Janet Dangerfield, Heather Davis, John Farndon, Jonny Griffiths, Tom Jackson, Patel, Sue Pope · 2019, Publisher:DK Publishing, ISBN:9781465494207, 1465494200	
02	Calculus Made Easy - Being a Very-Simplest Introduction to Those Beautiful Methods of Reckoning Which Are Generally Called by the TERRIFYING NAMES of the Differential Calculus and the Integral Calculus, By Silvanus Thompson, Second Edition, 2018, Publisher: Macmillan	
03	Calculus (Differentiation & Integration), Lesson/Practice Workbook for Self-Study and Test Preparation, By Aejeong Kang · 2014, ISBN:9780989368995, 0989368998, Publisher: MathRadar	



**B.Sc. Biotechnology: Sem-II; (2021)**

**Subject: BBT21-208 Water Resource Conservation**

**GE -2 ; 2 Credits**

**Total Lectures 30**

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<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
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**UNIT-I**

- |          |   |           |
|----------|---|-----------|
| <b>1</b> | Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, Water ecology. Available water Resources & Their Present Utilization Overview of Water Resources Policy, Climate Change and Water Resources | <b>05</b> |
| <b>2</b> | Hydrology - Hydrologic cycle, definition, processes, and components of hydrologic cycle, precipitation, origin, process, forms and clouds and their formation, Global water scenario, water budget in India, irrigation development Application of RS and GIS in Water Resources      | <b>05</b> |
| <b>3</b> | Conservation problems - History of soil erosion and land degradation in India and abroad, soil erosion and availability, erosion types and its effects on natural resources   | <b>05</b> |

**UNIT-II**

- |          |  |           |
|----------|--|-----------|
| <b>4</b> | Watershed Management Applications for management: Soil and water conservation measures, erosion control, water resource conservation and management, flood management and control, landslide control and mitigation measures, coastal zone management, watershed management ,Rainwater harvesting, Freshwater Management (Lakes and Rivers), Groundwater Management, Wetlands Protection | <b>05</b> |
| <b>5</b> | Need for sustainable water management  | <b>03</b> |
| <b>6</b> | The Role of Local Governments in Water Resources Management  | <b>03</b> |
| <b>7</b> | Water resources conservation in India  | <b>04</b> |

**References**

- |           |   |
|-----------|---|
| <b>01</b> | Water Resources Conservation and Management, Chatterjee, S. N., Atlantic Publishers 2008      |
| <b>02</b> | Murthy, V.V.N. and M.K. Jha. 2009. Land and Water Management, 5th edition. Kalyani Publishers |
| <b>03</b> | Water Resources Shimon C Anisfeld, Island Press 2011  |
| <b>04</b> | Sustainable Water Resources Management XI S Mambretti, Polytechnic of Milan, WIT press, 2021  |
| <b>05</b> | Water Conservation and Management Prof.Kamaruzzaman Yunus, Z ibeline International.2021       |

## B.Sc. Biotechnology: Sem-II; (2021)

### Subject: BBT21-208 Biotechnology and Human Welfare

GE -2 ; 2 Credits

Total Lectures 30

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Sr. No.	Topic	L
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#### UNIT-I

- |   |  |    |
|---|--|----|
| 1 | <b>Biotechnology in medicines:</b> Development of several innovative techniques for diagnosing, treating and preventing diseases, in providing effective treatments and prevention measures for different diseases by its inventions of novel drugs and recombinant vaccines.  | 08 |
| 2 | <b>Biotechnology In Agriculture</b> - The application of biotechnology in agriculture field helps in improving food quality, quantity, and processing. Bio-fertilizers and Bio-pesticides are eco-friendly sources for agriculture, which contains the living microorganisms that help in promoting growth by increasing the supply or availability of primary nutrients. Farmers choose biotech crops to increase the yield and in lower production costs | 07 |

#### UNIT-II

- |   |  |    |
|---|--|----|
| 3 | <b>Biotechnology in Flora and Fauna:</b> Micropropagation system, a new method of plant breeding for producing many new plant species and of new varieties with highly desirable characteristics, productions of genetically engineered plants with improved quality of crops, increased nutritional qualities of food crops, improved taste, texture or appearance of food, reduced dependence on fertilizers, pesticides and other agrochemicals and lot more. Animal husbandry: several transgenic animals were produced to transfer the growth hormones, improve the efficiency of egg, meat and milk production | 06 |
| 4 | <b>Biotechnology in Environment:</b> Control of environmental pollution through biodegradation of potential pollutants, recycling of wastes and other waste treatment technologies, bioremediation, biomonitoring, biotreatment and biodegradation of all the solid, liquid and gaseous wastes   | 04 |
| 5 | <b>Biotechnology in Forensic science :</b> Solving violent crimes; solving claims of paternity and theft etc. using various methods of DNA finger printing   | 05 |

#### References

- 01 Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
- 02 Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers
- 03 Human Molecular Genetics -Tom Strachen and A P Read, Bios Scxientific Publishers
- 04 Human Genetics Molecular Evolution, Mc Conkey

- 05 Recombinant DNA Technology, AEH Emery
- 06 Principles and Practice of Medical Genetics, I, II, III Volumes by AEH Edts. Emery
- 07 Medical Biotechnology-Pratibha Nallari, V.Venugopal Rao-Oxford Press
- 08 Plant Cell, Tissue and Organ Culture Applied and Fundamental Aspects by Y.P.S. Bajaj and A. Reinhard
- 09 Plant Tissue Culture : Theory and Practice By S.S. Bhojwani and A. Razdan
- 10 Frontiers of Plant Tissue Culture By Trevor A. Thorpe
- 11 Plant Tissue Culture By Akio Fujiwara
- 12 Plant Tissue Culture and its Biotechnological Applications By W. Barz, E. Reinhard, M.H. Zenk
- 13 Biotechnology-U.Satyanarayana
- 14 Biotechnology in the sustainable environment, Plenumpress, NY
- 15 Biodegradation and bioremediation Academic press By:San Diego

**B.Sc. Biotechnology: Sem-II; (2021)**

**Subject: BBT21-209 Understanding Finance & Its Management**

**SEC-2 ; 2 Credits**

**Total Lectures 30**

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<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
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**UNIT-I**

	<b>Basics of Finance and Banking</b>	<b>16</b>
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- |          |   |  |
|----------|---|--|
| <b>1</b> | Introduction to Finance                     |  |
| <b>2</b> | Sources of Finance                          |  |
| <b>3</b> | Introduction to Banking                     |  |
| <b>4</b> | New trends in Banking                       |  |
| <b>5</b> | Introduction to Insurance                   |  |
| <b>6</b> | Benefits of Insurance                       |  |
| <b>7</b> | Types of Insurance and Insurance Calculator |  |

**UNIT-II**

	<b>Investment and Tax Management</b>	<b>14</b>
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- |           |                                |  |
|-----------|--------------------------------|--|
| <b>8</b>  | Meaning and Need of Investment |  |
| <b>9</b>  | Modes of Investment            |  |
| <b>10</b> | Risk Management                |  |
| <b>11</b> | Introduction to Taxation       |  |
| <b>12</b> | Tax Management                 |  |

**References**

- |           |   |
|-----------|---|
| <b>01</b> | The Financial System and the Economy Principles of Money and Banking, Prentice Hall India Learning Private Limited; 5th edition by Burton and Maureen, 2019 |
| <b>02</b> | Finance for Non Finance Revised and Updated Edition, Vishal Thakkar, 2019   |

**B.Sc. Biotechnology: Sem-III; (2021 Course)**

**Subject: BBT21-301 Microbiology II**

**Core – Theory; 3 Credits**

**Total Lectures 45**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
1	<b>Microbial Diversity-</b> Archea : Halophiles, Methanogens, Thermophiles Actinomycetes-Key Genera and economic importance, Rickettsia, Mycoplasma, Chlamydia	08
2	<b>Microbial Taxonomy-</b> Taxonomic ranks, techniques for determining microbial taxonomy and Phylogeny, Classical and molecular characteristics, Concept of phylogenetic tree	04
<b>UNIT-II</b>		
3	<b>Microbial Metabolism-</b> Energetics, Enzymes and redox reactions, Fermentation and Respiration, Biosynthesis	06
4	<b>Microbial Ecology:</b> Methods of microbial ecology, Culture dependent analysis- Enrichment and Isolation Culture independent analysis-Microscopic Methods and Genetic Analysis	05
<b>UNIT-III</b>		
5	<b>Microbial Pathogenicity-</b> Microbial flora of healthy human host, Oral cavity, Skin, GI tract, Mucosal tissue	04
6	<b>Pathogenesis-</b> Pathogenicity and Virulence, Adherence, Virulence factors, Exotoxins and Endotoxins	05
7	<b>Host factors in infection and diseases-</b> Innate resistance to infection, Risk factors	03
<b>UNIT-IV</b>		
8	<b>Antimicrobial chemotherapy:</b> Antibiotics and their mode of action, inhibition of cell wall synthesis, damage of cytoplasmic membrane, inhibition of nucleic acid & protein synthesis, inhibition of specific enzyme system, microbial assay.	05
9	<b>Overview of Animal viruses:</b> Reproduction of vertebrate viruses (Eg Influenza Virus) Methods of virus cultivation Subviral Agents: Virioids and Prions	06
<b>References</b>		
01	Presscott's Microbiology, 11th Edition (2020), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHill Science Engineering, USA	
02	Brock Biology of Microorganisms, 13th edition (2017) Madigan, M. T., Martinko, J. M. and Parker, J. B., Prentice-Hall Publ., New York.	
03	Microbiology: An Introduction, 4th Edition (2019) Tortora, G. J., Funke, B. R. and Case, C. L., Pearson Education Inc.,	

**B.Sc. Biotechnology: Sem-III; (2021 Course)**

**Subject: BBT21-302 Biochemistry II**

**Core – Theory; 3 Credits**

**Total Lectures 45**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
	<b>UNIT-I</b>	
<b>1</b>	<b>Bioenergetics and Catalysis</b> Thermodynamics: Recap second law of thermodynamics, entropy, spontaneous change, free energy, enthalpy, reactions at equilibrium, interpretation of equilibrium constants, acid and bases, solubility equilibria, biological activity, Bioenergetics: Anabolism and catabolism. Energy transformations obey laws of thermodynamics, oxidation and reduction, redox potential, high energy bonds / compounds.	<b>05</b>
<b>2</b>	<b>Enzymes:</b> Introduction, classification and nomenclature, specificity of enzymes, mechanism of enzyme actions (Induced fit theory etc), factors affecting enzyme activity; enzyme kinetics-Michaelis–Menten rate equation; regulatory enzymes; enzyme inhibition- allosteric, feedback, competitive and non-competitive inhibition (double reciprocal plots).	<b>06</b>
	<b>UNIT-II</b>	
<b>3</b>	<b>Carbohydrate metabolism:</b> Catabolism of carbohydrates: Carbohydrates from diet, its digestion, concept of cellular respiration; Glycolytic pathway, entry of pyruvate in citric acid cycle: site, enzymes, regulation, energetics, Glycogenolysis: site, enzymes, regulation, energetics TCA: pathway, site, enzymes, regulation, energetic, amphibolic nature of citric acid cycle. <b>Anabolism of carbohydrates:</b> Gluconeogenesis (C6): site, enzymes, regulation, energetics, Glycogenesis (C6 polymer): site, enzymes, regulation, energetics	<b>07</b>
<b>4</b>	<b>Electron transfer chain:</b> Enzymes, pathway and oxidative phosphorylation in mitochondria, energetic, regulation Overview of entry of other sugars , Alternate pathways: Pentose phosphate pathway	<b>04</b>
	<b>UNIT-III</b>	
<b>5</b>	<b>Lipid metabolism</b> Digestion, transport, absorption Fatty acid oxidation: Beta Oxidation of saturated fatty acids; Oxidation of unsaturated fatty acids; $\omega$ oxidation, Ketone bodies: Ketogenesis, utilization, overproduction and regulation	<b>06</b>
<b>6</b>	<b>Lipoproteins:</b> VLDL, LDL and HDL; Fatty liver <b>Lipotropic factors:</b> Important factors, action and deficiency <b>Obesity:</b> Nutritional basis; Genetics, obesity and leptin <b>Alcohol metabolism:</b> Biochemical changes; Chronic alcoholism	<b>06</b>

#### UNIT-IV

- 7     **Protein Metabolism**     08  
Amino acids: Metabolic fates; Molecules derived from amino acids; Digestion of proteins to peptides and amino acids, essential amino acids, transamination of amino acids and deamination.  
Nitrogen metabolism: Overview of nitrogen metabolism; Nitrogen excretion and urea cycle
- 8     Integration of carbohydrate, protein and lipid metabolism in human body     03

#### References

- 01    Principles of Biochemistry, Lehninger, A., Nelson, D.L and Cox, M. M., W.H. Freeman and Co., New York, USA (2008).
- 02    Biochemistry, Berg, J.M., Tymoczko, J. L. and Stryer, L. W.H. Freeman and Co., New York, USA (2003).
- 03    Biochemistry, Satyanarayan, U., Books and Allied (P) Ltd., Kolkata, India (2008).

**B.Sc. Biotechnology: Sem-III; (2021 Course)**

**Subject: BBT21-303 Molecular Biology I**

**Core – Theory; 3 Credits**

**Total Lectures 45**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
1	<b>Molecules of life;</b> Key experiments of DNA as carrier of genetic information, Structure of nucleotides (Purines Pyrimidines Nucleosides and nucleotides) Structure of DNA double helix, Base equivalence in DNA, Types of DNA, Tautomeric Structure.	06
2	<b>DNA topology</b> (Concept of Linking numbers, twist and writhe of DNA, Properties of DNA (Acid Base properties, Viscosity, Sedimentation, Denaturation of DNA, T <sub>m</sub> value Hyperchromic effect), Quantification of Nucleic acid Structure of t- RNA, m-RNA and r-RNA and their functions, Concept of Central Dogma	05
<b>UNIT-II</b>		
3	<b>Genetic Code:</b> Codons, ORF, Start and Stop codons, Codon-Anticodon Recognition, Modified Bases affect Anticodon-Codon Pairing, Wobble hypothesis	06
4	<b>Mutation</b> Mutation: Types of mutations, Point Mutation, Silent, Missense, Nonsense, Physical and chemical mutagenic agents, Effect of mutations on DNA, measuring mutation rate, somatic & germline mutations.	05
<b>UNIT-III</b>		
5	<b>Concept of gene and genome:</b> Features of genome Variation in Genome size, C value and C-Value paradox, Types of genomic sequences, Clusters and Repeats, Genome Sequences and Gene Numbers, Human Genes, Interrupted Gene (Introns and Exons)	03
6	<b>Prokaryotic genome,</b> Compaction of Bacterial Chromosomes, DNA Supercoiling, Role of gyrase, topoisomerase	04
7	<b>Eukaryotic Chromosomes,</b> Chromatin, Heterochromatin and Euchromatin, Gene distribution in Eukaryotes, High level organization of Chromosomes, Structure of Centromere and telomere	04
<b>UNIT-IV</b>		
8	<b>DNA replication</b> DNA polymerases: types, structure and catalytic role, priming reactions, semi-conservative replication of DNA, synthesis of leading, lagging strands, okazaki fragments, termination of replication	08
9	<b>DNA Repair</b> Damage to DNA, repair mechanisms (excision in prokaryotes and eukaryotes, mismatch, recombination, error prone), SOS response	04
<b>References</b>		
01	Lewin's GENES XI. Krebs J.E., Kilpatrick S.T., Goldstein E. S., (2013) International Student Ed. Jones and Bartlett Publ. MA, USA, 01776	
02	Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Losick R., (2013) Molecular Biology of the Gene 7 <sup>th</sup> Ed. Benjamin Cummings Publ. USA	
03	Cooper G.M., Hausman R. E., (2013) The Cell: A molecular approach, Sixth Ed. Sinauer Associates, Inc., ASM Press., Washington DC.	
04	Robert Brooker, (2018) Genetics: Analysis and Principles, 6 <sup>th</sup> Edition	



**B.Sc. Biotechnology: Sem-III; (2021 Course)****Subject: BBT21-304 Immunology****Core – Theory; 3 Credits****Total Lectures 45**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
1	<b>Introduction to basic immunology</b>	02
2	<b>Types of immune response:</b> Innate immunity; adaptive immunity; humoral and cell mediated immune response	04
3	<b>Cells of adaptive immune system:</b> Lymphocytes and antigen presenting cells, antigen processing and presentation	03
4	<b>Organs of the immune system:</b> Bone marrow, thymus, lymph nodes and spleen, MALT (Peyer's patches)	03
<b>UNIT-II</b>		
5	<b>Antigens and antibodies:</b> Antigens, nature and types; antibodies, molecular structure, classes and subclasses, monoclonal antibodies, applications of monoclonal antibodies and primary and secondary immune responses	05
6	<b>Cytokines:</b> Properties, attributes and characteristics and cytokine network	01
7	<b>Major Histocompatibility complex:</b> Class I, class II MHC molecules; Diversity of MHC molecules; role in thymic selection of T cells and in antigen presentation	03
8	<b>Complement system;</b> Classical pathway, alternative pathway, biological consequences of complement activation	02
<b>UNIT-III</b>		
9	<b>B cell differentiation:</b> B cell maturation, activation and differentiation	02
10	<b>T cell differentiation:</b> T cell receptor, TCR-CD3 complex, CD8, CD4 receptors, T cell maturation, activation and differentiation.	02
11	Immune response to infectious diseases: Influenza, tuberculosis, Malaria	03
12	<b>Immunological diseases:</b> Hypersensitivity; autoimmunity	04
<b>UNIT-IV</b>		
13	<b>Immuno – chemical techniques:</b> Characteristics of Antigen – antibody reactions, precipitation; agglutination; passive agglutination, complement fixation test, ELISA; RIA; Western blotting; immune fluorescence	06
14	Vaccines: Characteristics of ideal vaccine, types of vaccines with clinical examples, vaccination schedule in India	05
<b>References</b>		
01	Jenni Punt , Sharon Stranford , Patricia Jones, Judy Owen Kuby Immunology 8th edition, 2018	
02	Kenneth M. Murphy and Casey Weaver Janeway's Immunobiology 9th Edition, 2016	
03	Louise Hawley MD, Benjamin Clarke Ph.D, Richard Ziegler BRS Microbiology and Immunology, 6th edition, 2013	

**B.Sc. Biotechnology: Sem-III; (2021)**  
**Subject: BBT21-305 Microbiology II Lab**

**Core – Practical; 3 Credits**

**Total Practical 20**

Sr. No.	Topic	P
1	Antibiotic susceptibility by disc diffusion assay	02
2	Cell/ spore counting/ Micrometry	02
3	Biochemical Characterization of Bacteria	02
	a. Sugar fermentation Test	01
	b. Catalase, Oxidase and Urease Tests	02
	c. IMViC test	02
	d. Hydrogen Sulfide Test and Nitrate Reduction Test	02
4	Isolation of fungi and yeast from natural environment	02
5	Lactophenol Cotton blue staining of yeast and Fungi	02
6	Casein and Starch Hydrolysis by organism	02
7	Maintenance and revival of cultures through traditional and modern methods	01

**References**

- 01 Source Book for Experiments for the Teaching of Microbiology, (1982) Primrose, S. B. and Wardlow, A. C. Academic Press, London
- 02 Microbiology: A Laboratory Manual, (2004), 6th Edn. Cappuccino, J.G. and Sherman, N., Pearson Education Pvt. Ltd., Singapore.
- 03 Experiments in Microbiology, Plant Pathology and Biotechnology, (2007), 4<sup>th</sup> Edn., Aneja, K. R., New Age International Publishers, New Delhi

**B.Sc. Biotechnology: Sem-III; (2021)**  
**Subject: BBT21-306 Biochemistry II Lab**

**Core – Practical; 3 Credits**

**Total Practical 20**

Sr. No.	Topic	P
1	Detection of industrially significant enzymes: $\alpha$ - Amylase, protease, Lipase, invertase, phosphatase, cellulase.	04
2	Study of a metabolic pathway: the GPO–PAP triacylglycerol test	02
3	Laboratory Experiments on the Actions of Digestive Enzymes	03
4	Protein assay by biuret and folin lowry method	02
5	Estimation of $\alpha$ - amylase enzyme activity	02
6	Study of parameters affecting enzyme activity	07
	a. Effect of temperature (optimum temp).	
	b. Effect of pH (optimum pH).	
	c. Effect of incubation period.	
	d. Effect of substrate concentration ( $K_m$ & $V_{max}$ ).	
	e. Effect of enzyme concentration.	
	f. Effect of activators and inhibitors.	

**References**

- 01 An Introduction to Practical Biochemistry, Plummer, D.T., Tata-McGraw-Hill Publishing Co., NewDelhi (2005).
- 02 Laboratory Manual in Biochemistry, Jayraman J., New Age International (P) Ltd., New Delhi (2007)

**B.Sc. Biotechnology: Sem-III; (2021)**  
**Subject: BBT21-307 Molecular Biology and Immunology**

**Core – Practical; 3 Credits**

**Total Practical**

**20**

<b>Sr. No.</b>	<b>Topic</b>	<b>P</b>
1	Introduction to important equipments used for molecular biology laboratory; clean handling practice; precision and reliability in liquid and weight measurements	01
2	Preparation of buffers and stock solutions; learning of safety measures for hazardous chemicals	02
3	Isolation of genomic DNA from bacterial cells	03
4	Isolation of DNA from plant cells/cell lines	03
5	Extraction of RNA from bacteria/yeast/cell lines	02
6	Quantification of DNA and RNA and determination of purity by UV spectrophotometer	01
7	Analysis of DNA and RNA preparations by agarose gel electrophoresis	02
8	Widal test, VDRL test	02
9	Dot ELISA	02
10	Ouchterlony double diffusion	02

**References**

- 01 Green M.R., Sambrook J., Molecular cloning: A laboratory manual (Fourth Ed.): Three volume set. Cold Spring Harbor Laboratory Press. New York. 2012
- 02 Pal J.K., Ghaskadbi S.S., Fundamentals of Molecular Biology. Oxford University Press Incorporated 2009.
- 03 Wilson K. and Walker J. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, New York. 2005
- 04 Gangal S, Sontakke S, Textbook of basic and clinical immunology. University Press 2013 5. Golddy A, Thomas JK, Barbara AO and Kuby J, Immunology

**B.Sc. Biotechnology: Sem-III; (2021)**  
**Subject: BBT21-308 Physics for Biologists- I**

**GE -3 ; 2 Credits**

**Total Lectures 30**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	<b>Fluid Statics:</b> Fluids: Definition, Pressure and Density. The variation of pressure in a fluid at rest. Pascal's Principle. Archimedes' Principle Measurement of pressure. Various units of pressure and their inter-conversion.	07
2	<b>Fluid Dynamics (Viscosity):</b> Streamline and turbulent flow (definition and explanation). Equation of continuity. Flow of liquids through capillaries. Poiseuille's equation: Derivations and physical significance. Reynolds number: Physical significance. Concept of pressure energy. Bernoulli's theorem and its applications- Venturi meter and Pitot's tube. Viscosity estimation by Oswald's viscometer. Relevance to life sciences.	08
<b>UNIT-II</b>		
4	<b>Elasticity:</b> Stress and strain in solids, Hook's law, Stress-strain curves, Limit of elasticity. Relevance of elasticity to life sciences	04
5	<b>Surface tension:</b> Surface tension and surface energy: Definition, concept and derivation. Capillary action. Angle of contact. Wettability. Temperature dependence of surface tension. Relevance to life sciences and applications.	05
6	<b>Optics:</b> Properties of light: Reflection, refraction, dispersion, diffraction, Interference and Polarization. Concept of polarization. Lasers: Stimulated emissions, applications	06
<b>References</b>		
01	Biophysics, an introduction. 1st edition. (2002) Cotteril R. John Willey and Sons Ltd., USA	
02	Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer Academic Publisher, USA.	
03	Textbook of optics and atomic physics – P.P. Khandelwal (Himlaya Publishing House.)	
04	Instrumentation measurements and analysis – 2nd edition (2003). Nakra and Choudhari, Tata Mc Graw Hill, India.	
05	Nuclear Physics: An Introduction. 2nd edition (2011). S. B. Patel. Anshan Publication, India	

**B.Sc. Biotechnology: Sem-III; (2021)****Subject: BBT21-309 Intellectual Property Rights****SEC-3 ; 2 Credits****Total Lectures 30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	Introduction – Invention and Creativity – Intellectual Property (IP) – Importance Protection of IPR – Basic types of property (i). Movable Property - Immovable Property and - Intellectual Property.	<b>03</b>
<b>2</b>	Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs	<b>03</b>
<b>3</b>	International framework for the protection of IP; IP as a factor in R&D; Introduction to History of GATT, WTO, WIPO and TRIPS.	<b>03</b>
<b>4</b>	Patent databases; Searching International Databases; Country-wise patent searches	<b>03</b>
<b>5</b>	Case Studies on – Patents (Basmati rice, turmeric, Neem, etc.) Protection against unfair competition.	<b>03</b>
<b>UNIT-II</b>		
<b>6</b>	Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications;	<b>03</b>
<b>7</b>	PCT and convention patent applications; International patenting-requirement, procedures and costs;	<b>03</b>
<b>8</b>	financial assistance for patenting-introduction to existing schemes;	<b>03</b>
<b>9</b>	Role of a Country Patent Office ,Patent office in India, Role of patent Attorney .	<b>03</b>
<b>10</b>	Patent infringement- meaning, scope, litigation, case studies and examples	<b>03</b>
<b>References</b>		
<b>01</b>	Intellectual property rights in agricultural biotechnology By Frederic H. Erbisch, Karim M. Maredia, Biotechnology in Agriculture Series No 28	
<b>02</b>	The role of intellectual property rights in biotechnology innovation By David Castle, Edward Elgar Publishing	
<b>03</b>	<a href="http://www.wipo.int/portal/index.html.en">http://www.wipo.int/portal/index.html.en</a>	
<b>04</b>	<a href="http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html">http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html</a>	
<b>05</b>	<a href="http://www.patentoffice.nic.in">www.patentoffice.nic.in</a> <a href="http://www.iplawindia.org">www.iplawindia.org</a>	

**B.Sc. Biotechnology: Sem-III; (2021)**  
**Subject: BBT21-309 Yoga and Sports**

**Value Added Course III; 2 Credits** **Total Lectures**

**30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	Meaning and definition of Physical Education, Sports and Yoga.	<b>05</b>
<b>2</b>	Aim, Objectives and Importance of Physical Education, Sports and Yoga.	<b>05</b>
<b>3</b>	Food and Nutrition	<b>05</b>
<b>UNIT-II</b>		
<b>4</b>	Importance of Fitness and Yoga. Fundamentals and Principles of Yoga.	<b>06</b>
<b>5</b>	Components of Fitness and Fitness equipments.	<b>04</b>
<b>6</b>	Yoga Practices Asanas, Pranayam, Meditation and Mudras	<b>05</b>
<b>References</b>		
<b>01</b>	Amit Arjun Budhe, (2015) Career aspects and Management in Physical Education, Sports Publication, New Delhi	
<b>02</b>	Gharote, M. L. & Ganguly, H. (1988). Teaching methods for yogic practices. Lonawala: Kaivalyadhama.	

**B.Sc. Biotechnology: Sem-III; (2021)****Subject: BBT21-310 Enzyme and its industrial Applications****SEC-3 ; 2 Credits****Total Lectures 30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	<b>Principles of enzyme applications</b> : Value addition, stabilization, taste improvement, product improvement and development of special applications.	<b>05</b>
<b>2</b>	<b>Product development</b> : Meat tenderization, haze-proofing of beer, softening of chhole, rajma, idli	<b>04</b>
<b>3</b>	<b>Secondary metabolites for applications</b> : Lactates, gluconates in agriculture, sorbitol in cosmetics, hexitol in tobacco/shoe industry, bio-surfactants for petroleum recovery.	<b>06</b>
<b>UNIT-II</b>		
<b>4</b>	<b>Commercial applications of enzymes for product improvement</b> : Fish processing, de-hairing, silver recovery, bakery products and dairy products.	<b>05</b>
<b>5</b>	<b>Enzymes for resource preservation</b> : Bamboo/bagasse preservation Application of Enzymes in Environmental Monitoring, Application of Enzymes in Bioremediation of Solid Wastes	<b>03</b>
<b>6</b>	<b>Enzymes used in food industries</b> : Juice extraction from fruits/vegetables, Enzymes used in food and feed processing	<b>02</b>
<b>7</b>	<b>Immobilized enzymes for product improvement</b> : High fructose corn syrup, invert sugar, synthetic penicillin, urea recovery.	<b>02</b>
<b>8</b>	<b>Mixed enzyme applications</b> : Digestive aids, laundry detergents, hotel pipeline de-clogging and biogas yield improvement.	<b>03</b>
<b>References</b>		
<b>01</b>	Industrial Enzymology, 2nd Edn., Godfrey, T. and Reichelt, J.R., McMillan Publ. Co., London (1997)	
<b>02</b>	Principles of Fermentation Technology, Stanbury, P. F., Whitaker, A. and Hall, S. J. Butterworth-Heinemann, Burlington, MA, USA (2005).	



**B.Sc. Biotechnology: Sem-IV; (2021 Course)**  
**Subject: BBT21-401: Environmental Biotechnology**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	<b>Environmental Components:</b> Constituents of environment, biotic and abiotic factors.	02
2	<b>Ecosystems:</b> Aquatic, forest, marine life, mountain life and underground life.	02
3	<b>Atmosphere:</b> composition and structure. Green house effect, ozone depletion and problems of climate change, related international conventions	03
4	<b>Characteristics of hydrosphere,</b> water resources, hydrological cycle	02
5	<b>Composition of lithosphere/soil;</b> Biogeochemical cycles, their Implications on living systems	02
6	<b>Characteristics of the biosphere.</b>	01
<b>UNIT-II</b>		
7	<b>Natural resources and environment</b> Types of resources, current status and conservation. Sustainable development	04
8	<b>Concept of biodiversity</b> and its conservation, present status and types of biodiversity; extinct and endangered species; red data book, steps to preserve biodiversity; concept of in-situ and ex-situ conservation of species; concept of gene and germplasm banks in conservation of endangered species.	04
9	<b>History of Environmental Biotechnology:</b> Role of Environmental Biotechnology in Environment protection, Microbial interactions in the environment	03
<b>UNIT-III</b>		
10	<b>Environmental Toxicology :</b> Concept, Toxic chemicals in the environment and biochemical aspects of As Cd, Pb, Hg, CO, O <sub>3</sub> , PAN, pesticides and carcinogens in air.	03
11	<b>Environmental pollution &amp; Control</b> Introduction: Definition and sources of pollution; Different types of pollution	02
12	<b>Air pollutants,</b> monitoring techniques, pollution control devices, effects on human health, plants & atmosphere, acid rain, and aerobiology	02
13	<b>Water pollution,</b> effects on human health, monitoring techniques (BOD, COD, TVC), eutrophication, waste water treatment, ground water and marine pollution	02
14	<b>Soil erosion and remedial measures</b> to recover alkaline, acidic and saline soils, bio-pesticides	02
<b>UNIT-IV</b>		
15	<b>Solid waste and management:</b> Types of wastes (municipal, agricultural, industrial and mining), Hazardous wastes (electronic, nuclear and biomedical); Waste reduction for energy management - biomass, biogas, composting.	05
16	<b>Bioremediation,</b> biodegradation, biosorption	02
17	<b>Noise pollution: Sources,</b> measurement, effects on human health and control.	
18	<b>Radiation hazards:</b> Introduction, atomic radiation, effects of radiation, radioactive waste, radiation protection	03
19	<b>Sustainable sources of energy</b>	01

### References

- 01 Waste water Engineering: Treatment, Disposal and Reuse. Metcalf and Eddy Revised by G. Tchobanoglous, Franklin L. Burton & H. David Stensel Tata Mcgraw Hill Publishing Company Limited, New Delhi (2003).
- 02 De, A K (2008) Environmental Chemistry, New Age International (P) Ltd., New Delhi.
- 03 Rittmann, BE and McCarty, P L (2001) Environmental Biotechnology: Principles and Applications, International Edition, Mcgraw-Hill, New York.
- 04 Mohan Primplani (2005) Waste Water Treatment, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi

**B.Sc. Biotechnology: Sem-IV; (2021 Course)**  
**Subject: BBT21-402: Genetics**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
<b>1</b>	<b>Heredity</b> <b>Mendelian inheritance</b> Segregation, independent assortment, test cross, dominant and recessive traits, multiple alleles, patterns of inheritance; Autosomal, X-linked, Y Linked Prenatal and parental diagnosis; pedigree analysis and norms of genetic Counseling	05
<b>2</b>	<b>Non-Mendelian inheritance</b> Epistasis; Maternal effect, Cytoplasmic inheritance (mitochondrial and chloroplast) Horizontal gene transfer and its significance (Plasmid, Viral infections and Transposones) Epigenetics effect	06
<b>UNIT-II</b>		
<b>3</b>	<b>Chromosome mapping.</b> Linkage and recombination, gene mapping in diploids, tetrad analysis, other methods of gene mapping (RFLP)	05
<b>4</b>	<b>Applied genetics</b> Model study organisms - <i>E. coli</i> , <i>S. cereviceae</i> , <i>Arabidopsis</i> , <i>C. elegans</i> , <i>Drosophila</i> , <i>Hydra</i> , and mice. And more	06
<b>UNIT-III</b>		
<b>5</b>	<b>Sex determination</b> Chromosomal pattern of sex determination, sex determination in human, environment-dependent sex determination, Sex linked inheritance	06
<b>6</b>	<b>Changes in genetic material</b> Variation: continuous and discontinuous; Chromosomal aberrations: Numerical and Structural	05
<b>UNIT-IV</b>		
<b>7</b>	<b>Population genetics</b> The Hardy-Weinberg Law; Genetic equilibrium; changes in allelic frequencies: Mutation, Migration, Genetic Drift, Natural Selection; Co-evolution; Co-operation; Speciation; Molecular evolution	06
<b>8</b>	<b>Evolutionary genetics</b> Theories of evolution: Pre-Darwenian theories, Darwin's theory of evolution and Modern evolutionary theory. Evolution of Homosapiens	06
<b>References</b>		
<b>01</b>	Practical Genetic Counseling, 6th Edn., Harper, P. S. Butterworth- Heinemann, Oxford (2004).	
<b>02</b>	An Introduction to Genetic Analysis, Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C. and Gilbert, W. M., W. H. Freeman and Co., New York (2005).	

- 03** Principles of Genetics 8th Edn. Gardner, E. J., Snustad, D. P. and Simmons, M. J., John Wiley & Sons (Asia) Pvt. Ltd, New Delhi (2006).
- 04** Genetics, A Molecular Approach, Russell, P. J., 2nd Edn., Pearson Education Inc., San Fransisco (2006).

**B.Sc. Biotechnology: Sem-IV; (2021 Course)**  
**Subject: BBT21-403 Developmental Biology**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	Embryology: History & Concepts; Phases of embryonic development	03
2	Cell cycle in reference to mitosis and meiosis	04
3	Gametogenesis (Spermatogenesis, Oogenesis)	05
<b>UNIT-II</b>		
4	Fertilization: Different events in fertilization, Fertilization in Human , Significance of Fertilization.	05
5	Types of eggs	02
	Cleavage: Types and patterns	04
	Blastula: Types and Process in reference to amphioxus, amphibians, birds and mammals	
<b>UNIT-III</b>		
6	Gastrulation in frog and chick, formation of three germinal layers	04
7	Structure and functions of uterus, Ovarian and Menstrual cycle, Human embryonic development, Implantation, Extra embryonic membrane in human and chick	05
8	Structure and functions of placenta	02
<b>UNIT-IV</b>		
9	Concepts of cell differentiation, dedifferentiation, redifferentiation and transdifferentiation.	02
10	Concept of Stem cells, Progenitor cells, cell lineages	03
11	Cloning in mammals, transgenic technology in plants and animals	03
12	Ageing and apoptosis, abnormal development and teratogenesis in animals	03
<b>References</b>		
01	Verma P S & Agarwal V K; Chordate Embryology Developmental Biology, (2011); S. Chand and company, New Delhi 110055.	
02	Principles of Development, 4th edition (2010), Wilbert L and Tickle C, Publisher: Oxford University Press, USA.	
03	Sastry K V, Shukla Vinita, Developmental Biology, 2 <sup>nd</sup> edition (2017), Rastogi publication, Merrut 250002	
04	Sharma HP (2009) – Plant embryology: Classical and experimental (alpha sci)	

**B.Sc. Biotechnology: Sem-IV; (2021 Course)**  
**Subject: BBT21-404 Analytical Techniques**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	<b>Introduction, Significance of Analytical techniques in Biotechnology, Filtration techniques:</b> Filtration types, Gross filtration, steri-pad filtration, membrane filtration, milli-filtration, micro-filtration, ultra-filtration, reverse osmosis, dialysis, their applications in industry. Merits and limitations	04
2	<b>Centrifugation</b> -Basics of centrifugation, centrifugal force, sedimentation coefficient, Components of centrifuge: Rotors and their types (differential and preparatory) density gradient centrifugation. Isopycnic centrifugation. <b>Types of centrifuges:</b> Table top, high speed, microfuge, refrigerated, ultra., Basket centrifuges, applications in biotech industries.	05
3	<b>Lyophilization</b> : Principle and practice, applications in R&D (cells and proteins) and nutraceuticals	02
<b>UNIT-II</b>		
4	<b>Protein Purification by chromatographic Techniques:</b> Molecular exclusion (gel filtration) chromatography, Ion Exchange and Affinity chromatography	03
5	<b>Methods of determination of protein concentration:</b> Ultraviolet absorption, Lowry (Folin–Ciocalteu) method, Bradford method.	03
6	<b>Protein Separation techniques:</b> Polyacrylamide gel electrophoresis (SDS-PAGE), Native Gel Electrophoresis, 2D Electrophoresis	05
<b>UNIT-III</b>		
7	<b>Mass spectrometric techniques:</b> Ionization, mass analyzer and detectors	03
8	<b>Spectrophotometry:</b> Properties of electromagnetic radiation, Light spectroscopy: Ultraviolet and visible light spectroscopy, Fluorescence spectroscopy. Infrared and Raman spectroscopy, Atomic spectroscopy	06
9	<b>X-ray diffraction</b> – Principle, method, application for determining 3D structure of proteins - over view of Ramchandran plot.	03
<b>UNIT-IV</b>		
10	<b>HPLC and GC:</b> Concept, principle, procedure (analytical and preparatory), separation on the basis of detectors, accuracy, applications in research and quality control	04
11	<b>Introduction to NMR;</b> principle, <sup>1</sup> H and <sup>13</sup> C NMR, applications in determining structures of biomolecules, <b>MRI:</b> Magnetic resonance imaging (MRI)	04
12	<b>Radioisotope techniques:</b> Definition of isotopes and radioisotopes, measurement (counters), half-life, useful isotopes for applications in health and research.	03
<b>References</b>		
01	Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2005).	
02	Laboratory Manual in Biochemistry, Jayaraman, J., New Age International (P) Ltd., New Delhi (2007).	
03	Biochemistry laboratory: modern theory and techniques. Rodney Boyer. — 2nd ed.	

**B.Sc. Biotechnology: Sem-IV; (2021 Course)**  
**Subject: BBT21-405 Molecular Biology II**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
<b>1</b>	<b>Prokaryotic transcription</b> Overview; RNA polymerase structure and role; typical bacterial promoter and its interaction with sigma factor, initiation, elongation and termination of transcription	06
<b>2</b>	<b>Eukaryotic transcription</b> Eukaryotic RNA polymerases, structure and types; initiation of rRNA, tRNA and mRNA synthesis; promoter elements; role of TBP; transcription factors and enhancers; post transcriptional modification of RNA	05
<b>UNIT-II</b>		
<b>3</b>	<b>Translation</b> Structure and role of ribosomes; initiation, peptide bond formation, translocation, elongation and termination of protein synthesis in prokaryotes and eukaryotes, post translational modification of proteins	08
<b>4</b>	<b>RNA Splicing and Processing:</b> Pre-mRNA Splicing, Spliceosomes	03
<b>UNIT-III</b>		
<b>5</b>	<b>Regulation of gene expression</b> gene regulation in prokaryotes - Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation); Operon concept – lac, trp, Ara operons.	08
<b>6</b>	Regulatory RNA: Riboswitch, MicroRNAs	03
<b>UNIT-IV</b>		
<b>7</b>	<b>Techniques in Molecular Biology</b> Agarose gel electrophoresis PFGE, Southern & Northern blotting, PCR amplification, types of PCR (RT PCR, LA PCR, Nested PCR, Multiplex PCR, Real Time Q PCR, DNA Sequencing Sanger's method, Automated DNA sequencing, pyrosequencing, DNA Microarray.	12
<b>References</b>		
<b>01</b>	Lewin's GENES XI. Krebs J.E., Kilpatrick S.T., Goldstein E. S., (2013) International Student Ed. Jones and Bartlett Publ. MA, USA, 01776	
<b>02</b>	Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Losick R., (2013) Molecular Biology of the Gene 7 <sup>th</sup> Ed. Benjamin Cummings Publ. USA	
<b>03</b>	Cooper G.M., Hausman R. E., (2013) The Cell: A molecular approach, Sixth Ed. Sinauer Associates, Inc., ASM Press., Washington DC.	
<b>04</b>	Robert Brooker, (2018) Genetics: Analysis and Principles, 6 <sup>th</sup> Edition	

**B.Sc. Biotechnology: Sem-IV; (2021)**  
**Subject: BBT21-406 Environmental Biotechnology Lab**  
**Core – Practical; 3 Credits** **Total Practical**  
**20**

Sr. No.	Topic	P
1	Preparation of vermin-compost pit	01
2	Study of production of biogas from municipal sewage & food waste	02
3	Experiments based on Spectrometer and Flame Photometer Na/K	02
4	Determination of Dissolved Oxygen (DO) in given water sample	01
5	Determination of Biochemical Oxygen Demand (B.O.D) in given water sample	02
6	Determination of Chemical Oxygen Demand (C.O.D) in given waste water sample	01
7	Determination of equivalent noise level (Leq) of the surrounding air	01
8	Enumeration of coilform in water by Most Probable Number (MPN) test	02
9	Determination of organic Calcium and Magnesium from given sample	01
10	Determination of Phosphate	01
11	Determination of oxides of nitrogen(NO x) from ambient air	01
12	Determination of SO x from ambient air by high volume sampler	01
13	Determination of RSPM Conc. Using repairable dust sampler	01
14	Estimation of biomass from Planktonic organisms	02
15	Visit to waste water treatment plant(Industrial visit)	01

**References**

- 01 Waste water Engineering: Treatment, Disposal and Reuse. Metcalf and Eddy Revised by G. Tchobanoglous, Franklin L. Burton & H. David Stensel Tata Mcgraw Hill Publishing Company Limited, New Delhi (2003).
- 02 Sharma, B K (2006) Environmental Chemistry, Krishna Prakashan Media (P) Ltd., Delhi.
- 03 Mohan Pramlani (2005) WasteWater Treatment, Oxford and IBH Publishing Co.Pvt.Ltd. New Delhi
- 04 Environmental Microbiology(Second Edition)*Edited by: Ian L. Pepper, Charles P. Gerba, Terry Gentry and Raina M. Maier*  
ISBN: 978-0-12-370519-8



**B.Sc. Biotechnology: Sem-IV; (2021)**  
**Subject: BBT21-407 Genetics & Developmental Biology Lab**  
**Core – Practical; 3 Credits** **Total Practical**  
**20**

Sr. No.	Topic	p
1	Study of different types of eggs( Hen, Frog, Fish, Amphioxus, Insect)Study of sperm smear	01
2	Study of cleavages in frog	01
3	Types of blastulae and gastrulae (Insect, Amphioxus and Frog)	01
4	Study of frog development, observation of frog embryos, Tadpole and different development stages	01
5	Study of permanent histological slides of chick embryo (18h, 24 h, 48h,72 h, 96hrs)	02
6	Study of temporary preparation of whole mount of chick embryo	01
7	Chick limb bud staining with neutral red for morphogenetic cell death (D)	01
8	Filter paper ring method for in vitro culturing of chick Embryo.(D)	01
9	Regeneration of Hydra/Planaria.	01
10	Bacterial conjugation	03
11	Effect of mutagenic agents on seeds	01
12	Isolation and Cultivation of <i>C elegance</i>	02
13	Study of <i>Drosophila</i> life cycle	04

**References**

- 01 Development Biology, 9th edition, (2010), Gilbert S.F.(Sinauer Associates,(USA)
- 02 Principles of Development, 4th edition (2010), Wilbert L and Tickle C, Publisher: Oxford University Press, USA.
- 03 Drosophila, Methods and Protocols (2008) Edited by Christian Dahmann Max Planck Institute ofMolecular Cell Biology and Genetics, Dresden, Germany
- 04 S. Harisha. *Biotechnology Procedures and Experiments Handbook* (2007) Infinity Science Press.
- 05 Antoine Barrière and Marie-Anne Félix, Institut Jacques Monod Isolation of *C. elegans*and related Nematodes CNRS - Universities of Paris, 75251 Paris cedex 05, France

**B.Sc. Biotechnology: Sem-IV; (2021)**  
**Subject: BBT21-408 Analytical Techniques Lab**  
**Core – Practical; 3 Credits** **Total Practical 20**

Sr. No.	Topic	P
1	To Determine absorbance curve for 4 samples that are bromophenol blue, methyl red, NAD and $\alpha$ -ketoglutarate	02
2	Demonstration of Beer lambert's law by plotting standards for dye i.e., bromophenol blue and methyl red of a absorbance curve of a molecule at different conditions	02
3	To determine acidity and alkalinity of given sample	02
4	Separation of proteins by polyacrylamide gel electrophoresis (PAGE)	02
5	Sterilization of vitamins by membrane filtration	01
6	Separation of the biomolecules by using dialysis technique	02
7	Extraction of protein from liver sample	02
8	Isolation and partial purification of an enzyme from a given source	01
	a. Ion exchange Chromatography	01
	b. Affinity gel Chromatography	01
	c. Size exclusion Chromatography	01
9	Immobilization of the enzyme and determination of its activity	02
10	Demonstration of HPLC	01

**References**

- 01** An Introduction to Practical Biochemistry by Prof. David Plummer. third Edition
- 02** Laboratory Manual in Biochemistry, Jayraman, J., New Age International (P) Ltd. New Delhi (2007).

**B.Sc. Biotechnology: Sem-IV; (2021)**

**Subject: BBT21-409 Physics for  
Biologists-II**

**GE -4 ; 2 Credits**

**Total Lectures 30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	<b>Charge and Matter:</b> Electromagnetism – preview, Electric charge. Conductor, Semiconductor and Insulator. Coulomb’s law.	<b>05</b>
<b>2</b>	<b>Magnetism:</b> The magnetic field. The definition of B. Poles and dipoles. Gauss’ law of magnetism. Magnetism of earth. Paramagnetism. Diamagnetism. Ferromagnetism. Nuclear magnetism. Biomagnetism with minimum 3 examples.	<b>05</b>
<b>3</b>	<b>Waves and Sound:</b> Properties of Sound, Reflection and Refraction, Interference, Diffraction Clinical Uses of Sound: Ultrasonic Waves Ultrasonic Imaging, Ultrasonic Flow Meter, Echocardiography, Therapeutic Use of Ultrasound	<b>05</b>
<b>UNIT-II</b>		
<b>4</b>	<b>Heat and Kinetic Theory:</b> Kinetic Theory of Matter Unit of Heat : Specific Heat, Latent Heat, Transfer of Heat : Conduction, Convection, Radiation and Diffusion, Transport of Molecules by Diffusion, Diffusion through Membranes	<b>05</b>
<b>5</b>	<b>Thermodynamics:</b> First Law of Thermodynamics, Second Law of Thermodynamics, Difference between Heat and Other Forms of Energy, Thermodynamics of living system	<b>05</b>
<b>6</b>	<b>Atomic Physics</b> The Atom, Spectroscopy, Quantum Mechanics, X-rays, Lasers <b>Nuclear Physics: The Nucleus, Magnetic Resonance Imaging, Radiation Therapy</b>	<b>05</b>
<b>References</b>		
<b>01</b>	Physics in Biology and Medicine, Paul Davidovits (2019) Fifth Edition Academic Press	
<b>02</b>	Biophysics, an introduction. 1st edition. (2002) Cotteril R. John Willey and Sons Ltd., USA	
<b>03</b>	Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer Academic Publisher, USA	

**B.Sc. Biotechnology: Sem-IV; (2021)**  
**Subject: BBT21-410 Communication Skills and personality**  
**Development Value Added Course IV Theory; 2 Credits      15 L**

Sr. No.	Topic	L
<b>UNIT-I</b>		
<b>1</b>	Types of Communication: Verbal and Nonverbal	01
<b>2</b>	Verbal communication –argumentation, usable and unsuitable phrases Nonverbal communication	02
<b>3</b>	Conflict situation solving, attack from the audience – communication skills as a work experience	01
<b>4</b>	Preparation of presentation , reports –principles and presentation technique	02
<b>5</b>	Basics of Personality, Theories of Personality Development	02
<b>UNIT-II</b>		
<b>6</b>	Analysing Strengths & weaknesses, Body Language & Preparation of Self	02
<b>7</b>	Improvisation and unprepared presentations	01
<b>8</b>	Paradigm of human cooperation	01
<b>9</b>	Defense against manipulation, how to say NO, stress management	01
<b>10</b>	Image and etiquette	01
<b>11</b>	Preparing for interviews	01
<b>References</b>		
<b>01</b>	Prashant Sharma, Soft Skills 3rd Edition: Personality Development for Life Success (2021)	
<b>02</b>	Barun Mitra, Personality Development and Soft Skills (2016)	

**Subject: BBT21-501: Biostatistics**

**Core – Theory; 3 Credits**

**Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
<b>1</b>	<b>Basic concepts:</b>	<b>03</b>
	a. Definitions – population and parameter, sample and statistic, variable	
	b. Types of variables – scales of measurement	
	c. Data – types and classification	
<b>2</b>	<b>Presentation of data –</b>	<b>04</b>
	a. Tabulation – types and frequency distribution arrays	
	b. Diagrammatic – Line diagram and graphs, Bar diagram, Histogram, Frequency Polygon, Ogives, Pie chart	
<b>3</b>	<b>Description of Sample</b>	<b>04</b>
	a. Measures of Central Tendency – Mean (types), Median, Mode	
	b. Measures of Dispersion – Range, Quartile, Decile, Mean Deviation, Standard Deviation, Covariance, Coefficient of Variation	
<b>UNIT-II</b>		
<b>4</b>	<b>Set Theory</b>	<b>04</b>
	a. Definition and basic concepts, types of sets – finite, infinite, empty, singleton, equal, equivalent, power, universal, subset	
	b. Symbols, notations and formulae	
	c. Basic operations	
	d. Venn diagram	
<b>5</b>	<b>Probability</b>	<b>04</b>
	a. Basic concepts and scale	
	b. Events – definition and types	
	c. Axioms of probability and types – apriori, aposteriori	
	d. Permutation and combinations	
	e. Bayes' theorem for conditional probability	
<b>6</b>	<b>Theoretical distributions</b>	<b>03</b>
	a. Binomial, Poisson, Normal distributions and their importance	
	b. Skewness and Kurtosis in Normal distribution	
<b>UNIT-III</b>		
<b>7</b>	<b>Estimation and Hypothesis testing</b>	<b>04</b>
	a. Point and interval estimation – 95% and 99% confidence intervals	
	b. Hypothesis testing – basic concepts, Null and Alternate hypotheses, general procedure, one-tailed and two-tailed tests, Type I and Type II errors	
<b>8</b>	<b>Some common and important hypothesis tests</b>	<b>04</b>
	a. Student's <i>t</i> -test, Chi-squared ( $\chi^2$ ) test	
<b>Inferential Statistics – II and Computer Software packages</b>		
<b>9</b>	<b>ANOVA – F-test</b>	<b>03</b>
<b>UNIT-IV</b>		
<b>10</b>	<b>Correlation and Regression Analysis</b>	<b>03</b>

<b>11</b>	Spreadsheet as a statistical tool:	<b>06</b>
	a. Basic functions – Count, Counta, Countblank, Countifs	
	b. Intermediate functions – Average, Median, Mode, Stdev.P, Quartile, Correl	
	c. Advanced functions – Chisq.Test, Confidence.Norm, Confidence.T, F.Test, Frequency, Kurt, Pearson, Rsq, Skew, T.Test, Trend, Var.P, Z.Test	

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<b>12</b>	SPSS, PSPP and SAS – overview of features and applications	<b>03</b>
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#### **References**

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<b>01</b>	An Introduction to Biostatistics (2nd edition), by N. Gurumani, MJP Publishers Chennai
<b>02</b>	Biostatistics: A Foundation for Analysis in the Health Sciences (7th edition), by Wayne Daniel, John Wiley and Sons.

**Subject: BBT21-502: Bioinformatics****Core – Theory; 3 Credits****Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	<b>Introduction to Bioinformatics:</b> Introduction to Bioinformatics: Definition, History, Goal, Scope, Applications, Limitations	02
2	<b>Introduction to Biological Databases:</b> Nature of biological data, Introduction to database and types, Biological Data types, Biological Databases Pitfalls	02
3	<b>Primary Resource Institutes:</b> NCBI/EMBL/DDBJ	02
4	<b>Database search engines:</b> Entrez (GQuery), SRS	02
5	<b>Bibliographic databases:</b> Medline, PubMed, PubMed Central, PubMed Health, MESH and Google Scholar etc.	02
6	<b>Chemical Databases:</b> PubChem BioAssay, PubChem Compound, PubChem Substance, ChEMBL, ChEBI, Complex Portal	02
7	<b>Pathway databases:</b> Reactome, WikiPathway, KEGG	01
<b>UNIT-II</b>		
8	<b>Nucleotide Sequence Databases:</b> Primary Nucleotide Sequence Databases: GenBank, ENA, ARSA Secondary Nucleotide Sequence Databases: Gene, Genome, EST, STS, GSSDerived/Composite Nucleotide Sequence Databases: GaP, ClinVar, PopsetSpecialized Nucleotide Sequence databases: SGD, MGI, Flybase, SILVA Genomic Disorder Databases: OMIM, OMIA Knowledgebase Nucleotide Sequence Databases: GO	02
9	<b>Protein Databases</b> Primary Databases: NCBI Protein database, PIR-PSD, UniProt KB, ExPasy	03
10	<b>Secondary Databases:</b> Concept of Motifs, pattern & Profiles Databases: PROSITE, PRODOM, CDD, InterPro	02
11	<b>Structure Databases:</b> PDB, NDB, CSD, SCOP, CATH	03
12	<b>3D structure visualization tools:</b> Cn3D, Rasmol, SPDBV	01
<b>UNIT-III</b>		
13	Overview/concepts in sequence analysis: Local & Global alignment, DotPlot, Gap Penalties	03
14	Dynamic Programming, Heuristic Methods	02
15	Pairwise Sequence Alignment algorithms: Needleman & Wunsch, Smith & Waterman	03
	Tools: <u>EMBOSS dotmatcher</u> , <u>EMBOSS water</u> , <u>EMBOSS stretcher</u>	
16	Scoring matrices for Nucleic acids and proteins: PAM/MDM, BLOSUM	03
17	Database Similarity Searches:	

BLAST: All versions and types of BLAST  
FASTA: All versions and types of FASTA  
LALIGN

<b>18</b>	Alignment Analysis tools: CINEMA, MaxAlign	02
<b>19</b>	Phylogenetic Analysis Methods: UPGMA, NJ method, Maximum Likelihood method	02
<b>20</b>	Multiple Sequence Alignment: <u>Clustal Omega</u> , <u>Kalign</u> , <u>MAFFT</u> , <u>MUSCLE</u>	02

#### **References**

- 01** Introduction to Bioinformatics by Attwood, T.K. & Parry-Smith, D.J., Delhi, Pearson Education (Singapore) Pte.Ltd. (2001)
- 02** Bioinformatics: Sequence and Genome Analysis by Mount, David, New York, Cold Spring Harbor Laboratory Press, (2004).
- 03** Lesk, A.M. 2002 Introduction to Bioinformatics. Oxford University Press
- 04** Rastogi, S.C., Mendiratta, N. and Rastogi, P. 2004 Bioinformatics: Concepts, Skills & Applications. CBS Publishers & Distributors, New Del





**Subject: BBT21-503 Recombinant DNA Technology****Core – Theory; 3 Credits****Total Lectures 45**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	Cutting and joining DNA: Enzymes used in gene manipulation, Nucleases Restriction Endonucleases, ligases, DNA Polymerases, DNA modifying enzymes, Topoisomerase.	09
<b>2</b>	Tools used in joining of DNA : Linker, Adaptor, Homopolymer tailing	02
<b>UNIT-II</b>		
<b>3</b>	Cloning vectors: Plasmid vectors (pBR 322 pUC 18), phage (M13 and lambda phage), cosmids, BAC and YAC vectors, expression vectors	08
<b>4</b>	Cloning strategies: Introduction of plasmid DNA into bacterial cells, Transformation, identification of recombinant cells, introduction of phage DNA into bacterial cells, identification of recombinant phages.	04
<b>UNIT-III</b>		
<b>5</b>	Genomic libraries: Isolation, insertion and selection of gene, Genomic and cDNA libraries, Full length cDNA cloning, screening of libraries.	05
<b>6</b>	Gene manipulation in animals: Transgenic mice (Gene targeting and applications) Gene manipulation in plants: Transgenic Plants (Agrobacterium Mediated gene transfer, Direct DNA transfer and Applications)	06
<b>UNIT-IV</b>		
<b>7</b>	Sequencing of genome: Sanger sequencing, Automated DNA sequencing, Pyrosequencing, Sequencing using capillary array electrophoresis, Shotgun sequencing, High throughput sequencing Genome Mapping RFLP, AFLP, RAPD, SNPs, RH mapping.	06
<b>8</b>	Applications of recombinant DNA Technology for the a. Production of useful molecules and b. Improvement in agrogenomic traits c. Prevention and cure of diseases	05

**References**

- 01** Principles of Gene Manipulation and genomics, (2006), 7th Edn., Primrose, S. B., Twyman, R.M. and Old, R. W., Blackwell Publishing, USA.
- 02** Gene Cloning and DNA analysis, 5th Edn., Brown, T. A., Blackwell Publishing, USA (2006)
- 03** An introduction to Genetic Engineering – Desmond S T Nicholl, Cambridge university press, 2<sup>nd</sup> Ed (2012)
- 04** Molecular Biotechnology Principles & Applications of Recombinant DNA, Bernard R Glick & Jack J Pasternak, ASM press. (2002)

**B.Sc. Biotechnology: Sem-V; (2021 Course)**  
**Subject: BBT21-504 Applied Microbiology**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
<b>1</b>	<b>Food Microbiology:</b> Food Spoilage, Causes, factors affecting the growth of microorganisms, Chemical changes caused by microorganisms	05
<b>2</b>	Principles of food preservation: High Temperature (Canning pasteurization) and Low Temperature, drying and radiations	04
<b>3</b>	Fermented Food and beverages: Beer, Cheese, Sauerkraut	03
<b>UNIT-II</b>		
<b>4</b>	<b>Industrial Microbiology</b> Antibiotics: Streptomycin , Enzymes- protease, Organic Acid: Citric Acid, Biopolymers: Xanthan, Amino acid: Lysine, Organic Solvent: Ethanol, Vitamin: Vitamin B12, SCP, Biosurfactants, Microbial Transformation, Mushroom Cultivation, Biosensors	11
<b>UNIT-III</b>		
<b>5</b>	<b>Environmental and Agricultural Microbiology:</b> Soil microorganisms, Rhizosphere, Role of microorganisms in Transformation of Nitrogen Compounds: Nitrogen fixation (Symbiotic and non symbiotic) Nitrification, Ammonification, denitrification, Transformation of Carbon compounds (Co2 Fixation, cellulose degradation) Sulfur and Sulfur compounds, PGPB: Mechanisms of Plant-Growth-Promoting Bacteria, Biocontrol agents, Mechanism of their action, Biodegradation of herbicides and pesticides, Techniques for enumeration of air microflora.	11
<b>UNIT-IV</b>		
<b>6</b>	<b>Pharmaceutical Microbiology and Quality Control:</b> Overview of Bacterial and viral vaccine production. Microbiological Quality Control: Spoilage, Infection risk, Contamination and control, Sterilization procedure and Sterility assurance	11
<b>References</b>		
<b>01</b>	Food Microbiology, Frazier & Westhoff, 4th edition, (2008) Tata McGraw Hill Publications	
<b>02</b>	L. E. Casida jr., Industrial Microbiology	
<b>03</b>	James Monroe Jay, Martin J. Loessner, David Allen Golden, (2005) Modern Food Microbiology, 7 <sup>th</sup> edition, Springer Science + Business Media Inc. USA.	
<b>04</b>	Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY	
<b>05</b>	Good Manufacturing Practices (2009), Mindy J. Allport-Settle, PharmaLogica	
<b>06</b>	Microbial Biotechnology, Fundamentals of Applied Microbiology, Second Edition Alexander N. Glazer (2007)	

**Subject: BBT21-505 Bioinformatics Lab****Core – Practical; 3 Credits****Total Practical 20**

Sr. No.	Topic	p
1	<b>Primary Resource Institutes:</b> NCBI/EMBL/DDBJ	03
2	<b>Bibliographic databases:</b> Medline, PubMed, PubMed Central, PubMed Health, MESH and Google Scholar etc.	01
3	<b>Chemical Databases:</b> <u>PubChem BioAssay</u> , <u>PubChem Compound</u> , <u>PubChem Substance</u> , ChEMBL, ChEBI, <u>Complex Portal</u>	01
4	<b>Pathway databases:</b> Reactome, WikiPathway, KEGG	01
	<b>5 Nucleotide Sequence Databases:</b>	04
	Primary Nucleotide Sequence Databases: GenBank, ENA, ARSA	
	Secondary Nucleotide Sequence Databases: Gene, Genome, EST, STS, GSS	
	Derived/Composite Nucleotide Sequence Databases: GaP, ClinVar, Popset	
	Specialized Nucleotide Sequence databases: SGD, MGI, Flybase, SILVA	
	Genomic Disorder Databases: OMIM, OMIA	
	Knowledgebase Nucleotide Sequence Databases: GO	
	<b>6 Protein Databases</b>	02
	Primary Databases: NCBI Protein database, PIR-PSD, UniProt KB, ExPasy	
7	<b>Secondary Databases:</b> PROSITE, PRODOM, CDD, InterPro	01
8	<b>Structure Databases:</b> PDB, NDB, CSD, SCOP, CATH	02
9	<b>3D structure visualization tools:</b> Cn3D, Rasmol, SPDBV	01
10	<b>Pairwise sequence alignment tools:</b> <u>EMBOSS dotmatcher</u> , <u>EMBOSS water</u> , <u>EMBOSS stretcher</u>	01
	<b>11 Database Similarity Searches:</b>	<b>Dat</b> 01
	BLAST: All versions and types of BLAST	
	FASTA: All versions and types of FASTA	
12	<b>Alignment Analysis tools:</b> CINEMA, MaxAlign	01
13	<b>Multiple Sequence Alignment:</b> <u>Clustal Omega</u> , <u>Kalign</u> , <u>MAFFT</u> , <u>MUSCLE</u>	01

**References**

- 01 Practical Bioinformatics , Book by Michael Agostino, 26 September 2012, *Paperback*
- 02 Introduction to Bioinformatics: **A Theoretical And Practical** Approach Hardcover – Illustrated, 31 January 2003 by Stephen A. Krawetz (Editor), David D. Womble (Editor), Humana press
- 03 Bioinformatics: A Practical Handbook of Next **Generation Sequencing And Its** Applications Hardcover – Import, 11 September 2017 by Lloyd Wai Yee Low (Editor), Martti Tapani Tammi (Editor), World Scientific Publishing Co Pte Ltd
- 04 Bioinformatics, A Practical Approach Edited By Shui Qing Ye, Copyright Year 2008, ISBN 9780367388751, Published October 7, 2019 by Chapman and Hall/CRC, 648 Pages

**Subject: BBT21-506 Recombinant DNA Technology Lab**  
**Core – Practical; 3 Credits** **Total Practical 20**

<b>Sr. No.</b>	<b>Topic</b>	<b>p</b>
1	Preparation of competent <i>E. coli</i> cells	01
2	Transformation of plasmid DNA for antibiotic resistance	03
3	Plasmid isolation from <i>E. coli</i>	03
4	Restriction digestion	02
5	Ligation of DNA fragment with cloning vector	03
6	Amplification of DNA by PCR	02
7	Analysis of genetic variation by RFLP	02
8	Tools for design of PCR primer	02
9	Agrobacterium mediated gene transfer in plants	03

**References**

- 01 Molecular cloning: A laboratory Manual, Sambrook and Russell, Wiley New York, Volume I – III.
- 02 Microbiology: A Laboratory Manual, (2004), 6th Edn. Cappuccino, J.G. and Sherman, N., Pearson Education Pvt. Ltd., Singapore.

**Subject: BBT21-507 Applied Microbiology Lab**  
**Core – Practical; 3 Credits** **Total Practical 20**

<b>Sr. No.</b>	<b>Topic</b>	<b>p</b>
1	MBRT of Milk samples	01
2	Sauerkraut Fermentation	02
3	Standard Plate Count (SPC) of food samples	02
4	Screening of industrially important microorganisms	03
5	Isolation of N <sub>2</sub> fixing bacteria (Rhizobium) from legumes	02
6	Isolation of Phosphate Solubilizing bacteria from soil	02
7	Enumeration of Air microflora	02
8	Isolation of coliform from various food samples	03
9	Sterility testing of pharmaceutical products	03

**References**

- 01 Source Book for Experiments for the Teaching of Microbiology, (1982) Primrose, S. B. and Wardlow, A. C. Academic Press, London
- 02 Microbiology: A Laboratory Manual, (2004), 6th Edn. Cappuccino, J.G. and Sherman, N., Pearson Education Pvt. Ltd., Singapore.  
Practical Microbiology: Principles and Techniques, (2005), 1st Edn., Kale, V and Bhusari, K. Himalaya Publishing House, New Delhi  
Introductory Practical Microbiology, (2007), Mu dili, J., Narosa Publ. House P.Ltd., New Delhi  
Experiments in Microbiology, Plant Pathology and Biotechnology, (2007), 4<sup>th</sup> Edn., Aneja, K. R., New Age International Publishers, New Delhi

**Subject: BBT21-508 Python**

**Elective V-I ; Vocational Course- Practical 2 Credits**

**Total Practical 20**

<b>Sr</b>	<b>No.</b>	<b>Topic</b>	<b>p</b>
<b>1</b>		<b>Introduction and Overview of Python</b>	<b>03</b>
<b>2</b>		<b>Data types and Program Flow Structures</b>	<b>04</b>
<b>3</b>		<b>String , Lists, Tuples &amp; Dictionaries</b>	<b>03</b>
<b>4</b>		<b>Pathway databases: Reactome, WikiPathway, KEGG</b>	<b>01</b>
<b>5</b>		<b>Functions , Modules &amp; Packages</b>	<b>03</b>
<b>6</b>		<b>File Handling &amp; Exceptional Handling</b>	<b>03</b>
<b>7</b>		<b>Python Database Interaction</b>	<b>04</b>

**References**

- 01** Python: The Complete Reference Paperback – 20 Mar 2018, Martin C. Brown
- 02** Python Programming: A modular approach by Pearson Paperback – 26 Sep 2017, by Taneja Sheetal , Kumar Naveen
- 03** Python Machine Learning By Example Paperback – Import, 31 May 2017, by Yuxi (Hayden) Liu
- 04** Artificial Intelligence with Python Paperback – Import, 27 Jan 2017, by Prateek Joshi

**Subject: BBT21-508 Biodiversity**

**Elective V-I ; Vocational Course- Theory 2 Credits**

**Total Lectures 30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	<b>Plant Diversity: Introduction- definition, species diversity, ecosystem diversity, genetic diversity</b>	<b>02</b>
<b>2</b>	<b>The species &amp; Individual in the Ecosystem</b>	<b>02</b>
<b>3</b>	<b>Biodiversity and major Biomes of World</b>	<b>01</b>
<b>4</b>	<b>Species extinction, population, individuals and genetic diversity</b>	<b>02</b>
<b>5</b>	<b>Loss of biodiversity and its ecological significance</b>	<b>02</b>
<b>6</b>	<b>Threats to biodiversity: Habitat loss, Poaching of Wildlife, Man-wildlife conflicts</b>	<b>02</b>
<b>7</b>	<b>Extinct and Threatened species, Agro biodiversity</b>	<b>02</b>
<b>8</b>	<b>The Global biodiversity strategy and its significance for sustainable Agriculture</b>	<b>02</b>

**UNIT-II**

<b>9</b>	<b>Conservation of Biodiversity:</b> Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values	<b>02</b>
<b>10</b>	<b>Biodiversity at global, national and local levels</b>	<b>02</b>
<b>11</b>	<b>Hot-spots of biodiversity</b>	<b>01</b>
<b>12</b>	<b>Endangered, and endemic Species; threatened species; Categories of IUCN, threatened species of plants and animals in Northeast India, Red data books</b>	<b>02</b>
<b>13</b>	<b>Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity</b>	<b>02</b>
<b>14</b>	<b>Future strategy for the conservation of biological diversity</b>	<b>02</b>
<b>15</b>	<b>Biodiversity conservation: Indian Scenario</b>	<b>02</b>
<b>16</b>	<b>Biodiversity conservation: value addition through Biotechnology</b>	<b>02</b>

**References**

<b>01</b>	<b>K. V. Krishnamurthy An Advanced Textbook on Biodiversity: Principles And Practice (2018) Oxford &amp; IBH Publishing Co Pvt. Ltd</b>
<b>02</b>	<b>Kevin J Gaston and John I Spicer, Biodiversity an introduction (2004), Blackwell Publications, USA</b>
<b>03</b>	<b>G. K. Singh, Biodiversity, Taxonomy and Ecology, (2009), ALP Books, New Delhi</b>
<b>04</b>	<b>Heywood, V.H &amp; Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press.</b>



**Subject: BBT21-509 Nanobiotechnology**

**Elective V-II ; Value added Course-Theory 2 Credits**

**Total Lectures 30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	Introduction to nanotechnology, Properties of nanoparticles, Types of NP, Nanocomposites, Carbon based nanoparticles. Nanomaterial in biotechnology - nanoparticles, quantum dots, nanotubes and nanowires etc.	<b>05</b>
<b>2</b>	Synthesis of nanoparticles: (Physical , Chemical and biological Methods of synthesis), Biological nanoparticles production - plants and microbial Characterization of NP by Spectroscopy (UV Vis, Photoluminescence, EDX) Microscopy (STM, EM) ,XRD technique.	<b>10</b>
<b>UNIT-II</b>		
<b>3</b>	<b>Nanoscale bioassemblies:</b> Functionalization of Nanomaterials  Biosensors: Different classes - molecular recognition elements, transducing elements Miniaturized devices in nanobiotechnology - types and applications, lab on a chip concept.	<b>05</b>
<b>10</b>	<b>Application of nanotechnology in health and disease:</b> For imaging and drug delivery  Application of nanotechnology in Agriculture Application of nanotechnology for environmental desalination, monitoring water quality, detection of pollutants Miniaturized devices in nanobiotechnology - types and applications, lab on a chip concept.	<b>10</b>
<b>References</b>		
<b>01</b>	T. Pradeep, Nano, The Essentials, Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill Publishing Company Limited, 2007	
<b>02</b>	Victor E. Borisenko and Stefano Ossicini What is What in the Nanoworld A Handbook on Nanoscience and Nanotechnology 2008 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim	
<b>03</b>	Nanotechnologies for the Life Sciences Vol. 1, Biofunctionalization of Nanomaterials. Edited by Challa S. S. R. Kumar, 2005 WILEYVCH Verlag GmbH & Co. KGaA, Weinheim ISBN: 3-527-31381-8 XIII	

**Subject: BBT21-509 Organic Farming****Elective V-II ; Value added Course-Theory 2 Credits****Total Lectures 30**

<b>Sr. No.</b>	<b>Topic</b>	<b>L</b>
<b>UNIT-I</b>		
<b>1</b>	Concept of organic farming, goal, principles, objectives, characteristics, components, advantages, constrains and relevance. International Federation of Organic Agriculture Movements (IFOAM), Nutrient management, organic manure, farmyard manure.	<b>04</b>
<b>2</b>	Green manuring: types, advantages. Principles of composting, organic resources, essential requirements, methods and benefits. Vermicomposting: Preparation, benefits, maintenance of base cultures and methods. Recycling of organic residues: Introduction and classification.	<b>04</b>
<b>3</b>	Biofertilizers: Introduction, definition, importance, benefits. Mineral fertilizers. Soil improvements and amendments: Saline and alkali soil, sodic soil, acid soils.	<b>03</b>
<b>4</b>	Soil cultivation and tillage: Creating good growing condition for plants, minimum disturbance, soil compaction and types of soil cultivation. Mulching: Definition, sources, applications	<b>04</b>
<b>UNIT-II</b>		
<b>3</b>	<b>Weed management:</b> Prevention practices, biological and mechanical control. Pest and disease management: Inducing plant resistance, biological control, natural pesticides, curative methods, Water management: Water retention, harvesting and storing	<b>05</b>
<b>10</b>	<b>Organic food quality:</b> Introduction, chemical food contents. Aims of organic production and processing. Quality control standards, certification process and procedures. Considerations for conversion of organic farming: Analysis of location, climate related challenges to step by step conversion. Mitigating contamination risks by pesticides and genetically modified crops. Status of organic farming in India.	<b>05</b>
<b>References</b>		
<b>01</b>	T Organic farming manual: A comprehensive guide to starting and running a certified organic farm by Ann Larkin Hansen, 2010.	
<b>02</b>	Principles of organic farming by P.L.Maliwal, 2022	
<b>03</b>	Possibilities of organic farming in India by Chandan R, S.K. Jain, Rajpal Singh, Ajay Kumar, 2022	
<b>04</b>	Organic farming: Theory and Practice by S.P. Palaniappan and K. Annadurai, 2022	

**Subject: BBT21-601: Clinical Biochemistry**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
<b>1</b>	<i>Clinical significance of biochemical tests- <b>concept of health and disease, factors</b> causing diseases, clinical significance of biochemical tests and their role in diagnosis, monitoring and therapy of disease</i>	<b>03</b>
<b>2</b>	<i>Specimen collection and processing- <b>collection of blood vein puncture, collection</b> with syringe, collection with evacuated tube, skin puncture, arterial puncture and anticoagulants, plasma and serum. Collection of urine:-Timed urine specimens, urine preservatives.</i>	<b>04</b>
<b>3</b>	<b>Blood analysis-</b> Significance of hemogram, total and differential count, clinical significance of packed RBCs, platelets and erythrocyte sedimentation rate (ESR), blood groups: matching and cross matching	<b>04</b>
<b>UNIT-II</b>		
<b>4</b>	<i>Blood coagulation- <b>Clotting factors, coagulation: tests-clotting time and</b> prothrombin time, diseases associated with blood clotting/ blood lysis</i>	<b>04</b>
<b>5</b>	<b>Urine analysis-</b> Structure and functions of kidney, abnormal constituents of urine and their significance: glucose, acetone bodies, urea, creatinine, uric acid, bilirubin, protein, Na <sup>+</sup> , K <sup>+</sup> and calcium oxalate.	<b>04</b>
<b>6</b>	<i>Acid-Base Balance: <b>Acids, bases and buffers, normal pH of the body fluids,</b> regulation of blood pH, acidosis and alkalosis, anion gap</i>	<b>03</b>
<b>UNIT-III</b>		
<b>7</b>	<b>Lipid profile-</b> Determination of triglycerides, cholesterol, VLDL, LDL, HDL, significance of deviation from normal range.	<b>04</b>
<b>8</b>	<b>Status of liver:</b> Structure and functions of liver, liver function tests, metabolism of RBC, free and conjugated bilirubin, types of Jaundice - hemolytic, hepatic, post-hepatic, neonatal and jaundice of genetic origin.	<b>04</b>
<b>9</b>	<i>Significance of enzymes in diagnosis: <b>assay and significance of enzyme levels in</b> heart, liver, kidney and pancreatic disorders. SGPT, SGOT, alkaline phosphatase, lactate dehydrogenase, creatine phosphokinase, α – amylase.</i>	<b>03</b>
<b>UNIT-IV</b>		
<b>10</b>	<b>Carbohydrates pathophysiology: Regulation of Blood Sugar, Insulin and Diabetes Mellitus:</b> Regulation of blood glucose, insulin, glucagon, prediabetes, types of diabetes mellitus, glucose tolerance test, clinical presentation, diabetic keto acidosis, chronic complications	<b>04</b>
<b>11</b>	<i>Lipids pathophysiology:<b>Metabolism of adipose tissue, Hormone sensitive lipase,</b> Obesity, Fatty liver, Lipotropic factors, Ketone bodies, Plasma cholesterol, Atherosclerosis, Coronary artery disease</i>	<b>04</b>
<b>12</b>	<i>Protein pathophysiology- <b>determination of Hb, glycosylated Hb, definition of</b></i>	<b>04</b>

anemia, types of anemia – iron deficiency anemia, Pernicious anemia, hemolytic anemia, aplastic anemia, sickle cell anemia. Thalaessaemia

## **References**

- 01** Text book of Biochemistry: Clinical Correlations, Delvin, T. M., John Wiley & Sons Inc (2007)
- 02** Human biochemistry and diseases, Litkwack, G., Academic Press/ Elsevier, Amsterdam(2008)
- 03** Clinical Chemistry: Theory, Analysis and Correlations.Kaplan, L .A and Pesce, A. J., Mosby and co., St. Louis (2009)



**Subject: BBT21-602: Fermentation Technology**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
1	Screening and Maintenance of industrially important micro organisms: Isolation, Screening methods, Selection of the desired characteristics, Different methods of culture preservation, Strain improvement techniques	09
2	Development of inocula for industrial fermentation (Bacteria, Yeast and Fungi)	03
<b>UNIT-II</b>		
3	Medium formulation Water, Energy sources, Carbon sources, Nitrogen sources, Minerals, Chelators, Growth factors , Buffers, Precursors, Inhibitors, Inducers, Oxygen requirements Antifoams, media sterilization	06
4	Types of fermentation: Batch culture , Continuous culture, Fed-batch culture, Design of typical bioreactor , Basic functions of a fermenter Aeration and agitation, Temperature control, maintenance of aseptic conditions	05
<b>UNIT-III</b>		
5	Methods of measuring process variables Temperature , Flow measurement and control Pressure, Rate of stirring Foam sensing and control Microbial biomass, Measurement and control of dissolved oxygen Inlet and exit-gas analysis, pH measurement and control Control systems, Manual control, Automatic control Computer applications in fermentation technology	06
6	Types of bioreactors: continuous stirred tank reactors (CSTR), Packed bed reactors, Fluidized bed reactors, Air lift fermenter, Stirred fermenters	05
<b>UNIT-IV</b>		
7	Downstream processing: General steps Recovery And Purification of Fermentation Products  Removal of microbial cells and other solid matter , Foam separation , Precipitation , Filtration , Centrifugation  Cell disruption Physical-mechanical methods , Chemical methods  Liquid-liquid extraction , Solvent recovery, Two-phase aqueous extraction, Supercritical fluid extraction, Chromatography, packaging, By-products (Distilleries, Breweries)	09
8	Fermentation Economics Market Potential, Plant and Equipment, Media Recovery Costs	02
<b>References</b>		

Principles of Fermentation Technology, Stanbury, P. F., Whitaker, A. and Hall, S. J.,  
Alexander N. Glazer (2007)

**01** Butterworth-Heinemann, Burlington, MA, USA (2005)

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**02** Fermentation Microbiology and Biotechnology, 2nd Edn., El-Mansi, E.M.T., Bryce,  
C.F.A., Demain, A.L. and Allman, A.R., CRC Taylor and Francis Group, Boca Raton,  
Florida (2007).





**Subject: BBT21-603 Plant Tissue culture and Applications**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
<b>UNIT-I</b>		
<b>1</b>	<b>Introduction:</b> Historical review of plant tissue culture. Basic facilities and guidelines for tissue culture laboratory. Methodology, scope and limitations. Standard nutrient media, composition and their importance. Plant growth regulators and their role in differentiation. Types of explants, their respective cultures and advantages. Pathways of <i>in vitro</i> plant regeneration and different stages involved in regeneration. Microtechniques for plant cultures.	09
<b>UNIT-II</b>		
<b>2</b>	<b>Cellular totipotency :</b> Callus cultures, dedifferentiation and redifferentiation, suspension cultures, types, culture medium, synchronization, assessment of growth, viability of cultured cells, techniques of single cell culture, factors affecting single cell culture, Plant cell reactors, selection of bioreactors. Organogenic differentiation, factors affecting shoot-bud differentiation , rhizogenesis, Somatic embryogenesis, factors affecting somatic embryogenesis, induction, development, maturation of somatic embryos, their synchronization and large scale production.	12
<b>UNIT-III</b>		
<b>3</b>	<b><i>In vitro</i> approaches for plant genetic improvement:</b> Callus cultures for the selection of somaclonal variants. Mature and immature embryo culture for novel hybrids. Anther and microspore culture for double haploid plants, Endosperm culture for triploid and polyploid plants, Protoplast culture and their fusion for somatic hybrid plants. Direct and indirect methods for gene transfer in plants for the production of transgenic plants	12
<b>UNIT-IV</b>		
<b>4</b>	<b>Applications of Plant tissue culture:</b> Micropropagation via axillary shoot proliferation, direct and indirect organogenesis, direct and indirect somatic embryogenesis of commercially important plants, their stages and advantages with examples. Artificial seeds production and their applications. Secondary metabolites and their <i>in vitro</i> production. Plant genetic resources, short term and long term storage. Genetically engineered plants for enhanced nutritive values, biofuel, biopharmaceuticals and production of biotic, abiotic stress tolerant or resistant plants with examples.	12
<b>References</b>		
<b>01</b>	Plant Tissue Culture : Theory and Practice a Revised Edition, S.S. Bhojwani and A. Razdan	
<b>02</b>	Plant Tissue Culture and its Biotechnological Applications, W. Barz, E. Reinhard, M.H. Zenk	
<b>03</b>	General Techniques of Plant Tissue Culture, Gaurav Kumar Sharma, Snehlata Jagetiya, Riddhi Dashora 2015, Editor: Lulu Press Inc. Raleigh, North Carolina, United States.	
<b>04</b>	Introduction to Plant Tissue Culture, M.K. Razdan, Science Publishers, 2003	
<b>05</b>	Plant Biotechnology, S. Umesha TERI press, New Delhi	

**B.Sc. Biotechnology: Sem-VI; (2021 Course)**  
**Subject: BBT21-604 Animal Tissue culture and Applications**  
**Core – Theory; 3 Credits** **Total Lectures 45**

Sr. No.	Topic	L
	<b>UNIT-I</b>	
	<b>1 Animal Tissue Culture</b>	02
	Introduction, Historical review and important discoveries	
	<b>2 Systems of Animal Tissue Culture</b>	06
	Organ, Explant and Cell Culture Systems; Advantages and Limitations; Introduction to organotypic culture system	
	<b>3 Biology of Cultured Cells</b>	04
	Growth characteristics of cells in tissue culture, Important definitions, Progression of normal diploid and continuous cell lines	
	<b>UNIT-II</b>	
	<b>4 Aseptic Techniques</b>	02
	Laboratory set up and aseptic techniques	
	<b>5 Culture Media</b>	06
	Balanced salt solution, Sodium bicarbonate – CO <sub>2</sub> buffering system, metabolic role of constituents in culture medium and supplements, commercially available important media formulations, Role of Serum; advantages and limitations	
	<b>6 Primary culture</b>	03
	Explant, enzymatic and mechanical disaggregation techniques for preparation of primary culture; advantages and applications of primary culture	
	<b>UNIT-III</b>	
	<b>7 Development and maintenance of cell line</b>	06
	Subculture and maintenance of cell lines; Methods for counting of cells; estimation of viability; Design of stirrer flask; Method and subculture of cells in suspension; Overview of cryopreservation and revival	
	<b>8 Applications in Drug Screening, Therapeutics and Diagnostics</b>	03
	<b>Cytotoxicity Assays</b>	
	Viability, Metabolic and survival assays	
	<b>9 Stem cells</b>	03
	Introduction; Types; Properties and Applications	
	<b>UNIT-IV</b>	
	<b>10 Vaccines</b>	04
	Types of vaccines; method of production; Recommended childhood immunization schedule in India	
	<b>11 Monoclonal antibodies</b>	04
	Hybridoma technique for production of monoclonal antibodies; applications of monoclonal antibodies	
	<b>12 Growth factors and therapeutic proteins</b>	03

Important growth factors and therapeutic proteins approved for pharmaceutical use

### References

- 01** Freshney's Culture of Animal Cells: A manual of basic techniques and specialized applications (8<sup>th</sup> Edition) March 2021; Wiley-Liss publication
- 02** Principles and practices of Animal Tissue Culture, Gangal S., University Press (India) Pvt. Ltd., Hyderabad (2009)
- 03** Kuby's Immunology, 6<sup>th</sup>Edn., T. J., Goldsby, R. A. and Osborne B. A., W. H. Freeman & Co. New York (2007)

**B.Sc. Biotechnology: Sem-VI; (2021)**

**Subject: BBT21-605 Clinical Biochemistry Lab**

**Core – Practical; 3 Credits**

**Total Practical 20**

<b>Sr. No.</b>	<b>Topic</b>	<b>p</b>
1	Peripheral blood smear for total and differential count	01
2	Haemoglobin estimation using hematocrit	01
3	Estimation of glucose and ketone bodies in blood and urine	02
4	Glucose tolerance test	02
5	Determination of lipid profile	02
6	Kidney function test by estimation of urea, creatinine and protein from urine	03
7	Liver function test by SGPT and SGOT analysis	03
8	Urine Analysis	02
9	CSF Analysis	02
10	Separation of Serum proteins by electrophoresis	02

**References**

- 01 Industrial Enzymology, 2nd Edn., Godfrey, T. and Reichelt, J.R., McMillan Publ. Co., London (1997).
- 02 Laboratory Manual in Biochemistry, Jayaraman, J., New Age International (P) Ltd., New Delhi (2007).
- 03 Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2005).
- 04 Clinical Biochemistry, 2nd Edn., Godkar, P. B. and Godkar D. P., Bhalani Publishing House, Mumbai (2003).

**Subject: BBT21-606 Fermentation Technology Lab****Core – Practical; 3 Credits****Total Practical 20**

<b>Sr. No.</b>	<b>Topic</b>	<b>p</b>
1	Study - Culture of Yeast and Mass cultivation of yeast	02
2	Culture Media Preparation.	02
3	Fermentation for the production of primary metabolites (Citric acid)	02
4	Fermentation for the production of secondary metabolites (antibiotics)	02
5	Solid state fermentation for production of enzymes	02
6	Shake flask fermentation (Effect of agitation)	02
7	Industrial production of Alcohol by using various raw materials.	02
8	Estimation of alcohol Concentration	01
9	Anatomy of Fermentor, cleaning of Fermentor, Assembling and final pre-sterilization of Fermentor	02
10	Anatomy and calibration of fermentor electrodes / probes.	01
11	Aseptic sampling from fermentors	01
12	Techniques to determine microbial contaminations	01
<b>References</b>		
01	Industrial Fermentations: L.A. Under Koeffler, Chemica Pub.Co.,Newyork	
02	Comprehensive Biotechnology Vol.3 By M. M. Young, Pergamon Press Ltd., Oxford	
03	Cruger. W., Cruger. A., "Biotechnology: A Textbook of Industrial Microbiology", Panima Publishing ,2000	
04	Vogel. H.C., Todaro. C.L., "Fermentation and Biochemical Engineering Handbook - Principles, Process design, and Equipment", Noyes Publications,1997	

**Subject: BBT21-607 Plant Tissue Culture Lab**  
**Core – Practical; 3 Credits** **Total Practical 20**

Sr. No.	Topic	p
1	Facilities for the establishment of laboratory	02
2	Preparation of nutrient media.	02
3	Selection of explants for initiating organ cultures	02
4	Micro-propagation of monocot and dicot plants via axillary shoot proliferation, organogenesis and somatic embryogenesis	03
5	Callus cultures for plant cell suspension	02
6	Cytological studies of callus cells	02
7	Anther/microspore cultures for plant regeneration.	03
8	<i>Agrobacterium</i> -mediated leaf disc transformation	02
9	Visit to organization or commercial tissue culture industry	02

**References**

- 01 Plant Biotechnology: Practical Manual, Giri, C. C. and Giri, A., I. K. International Publ.Pvt. Ltd., New Delhi (2007).
- 02 Plant Biotechnology: Laboratory Manual of Plant Biotechnology, Chawla, H.S., International Book Distr. Co.,New Delhi
- 03 Plant Tissue Culture: Theory and Practice, Bhojwani, S. S. and Razdan, M.K., Elsevier Publishers, Amsterdam (2004)

**Subject: BBT21-608 Animal Tissue Culture Lab**  
**Core – Practical; 3 Credits** **Total Practical 20**

Sr. No.	Topic	L
1	Study of requirements, important equipments and maintenance of aseptic conditions in tissue culture laboratory	02
2	Preparation of reagents, formulation of tissue culture growth medium and sterility testing	04
3	Subculture and routine maintenance of cell lines using split ratio	04
4	Cell counting and estimation of viability and seeding of flask with specific cell count	02
5	Seeding of cells in 96 well plate, preparation of replicate cultures	02
6	Testing effect of drug using MTT assay	03
7	Observation of cells and maintenance of records	02
8	Fixation and staining of cells	01

**References**

- 01 Freshney's Culture of Animal Cells: A manual of basic techniques and specialized applications (8<sup>th</sup> Edition) March 2021; Wiley-Liss publication
- 02 Principles and practices of Animal Tissue Culture. Gangal S., University Press (India) Pvt. Ltd., Hyderabad (2009)
- 03 Animal Cell Culture Methods, Methods in Cell Biology, Vol 57, Mather, J. P. and Bernes, D. Eds., Academic Press, New York (1998)
- 04 Animal Cell Culture – Practical Approach, Masters, J. R. W. Ed., Oxford Press, London (2003)

**Subject: BBT21-609 Innovative Ideas**

**Elective VI-I ; Project Based Learning Course - 2 Credits**

**Total 30**

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**Objectives**

- To understand how ideas/discoveries and inventions are commercialized,
  - Apply the understanding and knowledge of the basics of biotechnology to find solution for the current issues/problems to their own field of study,
  - Use the new skills and continue to independently learn more about the area of innovations,
  - Express this knowledge of the innovation system in the form of oral/poster presentation
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**Teaching methods**

- Orientation lecture, seminars / workshops as well as project assignments on group and individual level.
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**References**

- 01** Christensen, Clayton. The Innovator's Dilemma. Harper Business; (January 7, 2003), ISBN: 0060521996
- 02** Innovation and Entrepreneurship in Biotechnology, an International Perspective: Concepts, Theories and Cases. Damian Hine, John Kapeleris. Edward Elgar Publishing (2006).



**Subject: BBT21-609 Scientific Writing Skills**

**Elective VI-I ; Project Based Learning Course - 2 Credits**

**Total 30**

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**Technical and scientific writing skills**

The course will involve developing technical and scientific writing skills of students in clear and concise English. Students will select a relevant topic for which they will perform a literature search and write a review under the guidance of his tutor.

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**Objectives**

- To understand the technical ways of literature search
- To experience the mining of information relevant to the selected topic
- Learn to analyze and concise the information gathered on the selected topic in the form of review
- Building reading and writing skills

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**Teaching methods**

- Selection of a suitable topic of interest. Search the relevant literature on the topic and write a review article with assistance from the tutor/guide

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**References**

- 
- 01** The Mayfield handbook of technical and scientific writing. Perelman LC, Paradis J., Baret E. The McGraw Hill Publ.
- 
- 02** Scientific writing: A reader & writer's guide. Jean Luc Lebrun. World Scientific Publ. 2014

**Subject: BBT21-609 Group Project**

**Elective VI-I ; Project Based Learning Course - 2 Credits**

**Total**

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**30**

Few professionals can expect work in isolation. Successful projects are always implemented by group of people working together as a team. Students therefore need to learn about the mechanics and dynamics of effective team participation as part of their education. To ensure that students have the opportunity to acquire these skills, students in groups of 3 or 4 are expected to undertake a project. Students in a group are expected to spend about 30 hours on the project. The guide should simulate a team environment and assess each student's

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performance **Method:**

Selection of a suitable topic of interest. Work with assistance from the tutor/guide. Prepare a presentation and report

**Evaluation methods**

Groups will be evaluated on the basis of project presentation and the report.

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**References**

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**01** The Mayfield handbook of technical and scientific writing. Perelman LC, Paradis J., Barrett E. The McGraw Hill Publ.

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**02** Scientific writing: A reader & writer's guide. Jean Luc Lebrun. World Scientific Publ. 2014





**BHARATI VIDYAPEETH  
(DEEMED TO BE UNIVERSITY), PUNE**

**FACULTY OF SCIENCE  
B.Sc - Biotechnology  
Old Syllabus**

**BHARATI VIDYAPEETH DEEMED UNIVERSITY**

**PUNE**

**Proposes a Revised**

**BACHELOR OF SCIENCE (B.Sc.)**

**IN**

**BIOTECHNOLOGY**

**SYLLABUS OF SEM I – SEM VI UNDER**

**CHOICE BASED CREDIT SYSTEM**

**To Be Introduced In Academic Year**

**2015 – 2016**

## **INTRODUCTION**

The curriculum of Bachelor of Science (B. Sc.) in Biotechnology Course is revised and the new curriculum is framed according to the choice based credit system adapted by Bharati Vidyapeeth Deemed University. It is a full time 156 Credits program to be offered in its constituent units. Bharati Vidyapeeth Deemed University has been accredited with 'A' Grade by National Assessment and Accreditation Council (NAAC) (2004, 2011). Also, Ministry of HRD, Govt. of India has awarded "A" Category to the University in 2012 based on parameters including innovative programs, research and infrastructural facilities. Further, University Grants Commission (UGC), New Delhi has bestowed u/s 12B status to the university.

The programme will be offered at Rajiv Gandhi Institute of IT and Biotechnology, Pune with effect from the academic year 2015-2016. Rajiv Gandhi Institute of IT and Biotechnology is a constituent unit of BVDU that was established in the year 2003. The institute has excellent infrastructure, state-of-the-art laboratories, and competent faculty facilitating appropriate learning environment. The Institute offers five programmes in Biotechnology - one at undergraduate (B.Sc.) level and four at post graduate (M.Sc) level.

### **OBJECTIVES of the B.Sc. Biotechnology Programme**

The programme focuses on

1. Fundamental concepts in various allied subjects
2. Building of interdisciplinary approach
3. Developing skills in relevant areas to enhance employment opportunities
4. Inculcating social values, sense of scientific responsibilities and environmental awareness

### **ELIGIBILITY FOR ADMISSION TO THE COURSE**

Candidates satisfying the following conditions are eligible to apply for admission to B.Sc. Biotechnology programme

- i. The candidate should have passed Higher Secondary School Certificate (10+2) or its equivalent examination with at least 40% (35% for SC/ST) marks in aggregate.
- ii. Subject to the above conditions, the final admission is based solely on the merit at the all India entrance test (BBT) conducted by Bharati Vidyapeeth Deemed University.

## **DURATION OF THE COURSE**

The minimum credits required to complete the programme are 156 which normally takes a three years or six semesters. The medium of instruction and examination is English.

## **RULES AND REGULATIONS**

1. The entire course is of 156 credits and will be executed in 6 semesters.
2. One credit for theory course is equivalent to 15 lectures/tutorials while one credit for practical course is equivalent to 25-35 hrs. of lab /field work / or demonstration.
3. The curriculum comprises of Core Courses, Open courses and General Courses.
4. The entire syllabus consists of a total of 24 core theory (72 credits), 20 core practical (60 credits), 12 open (24 credits), and 6 general (12 credits) courses. Of these, the core courses are mandatory while the Open and General Courses are elective.
5. The Core Courses are aimed at imparting fundamental knowledge in various allied disciplines of biotechnology. The Open Courses are value addition courses intending skill development in commercial biotechnology sector. The General Courses are designed to develop relevant soft skills of students to compete in the global market.
6. There is a provision for opting Open and General Courses offered by other

constituent units of BVDU. In such case, the courses will be evaluated as per the rules of evaluation of the course undertaken and credits earned will be transferred from the respective constituent unit.

## **RULES FOR EXAMINATION**

### **A: Nature of Examination:**

1. For all subjects, there shall be an Internal Assessments (IA) conducted by the Institute and an end-of-the term University Examination (UE) conducted by the university. The UE will be based on the entire syllabus.
2. The performances at UE and IA will be combined to obtain the Grade Point Average (GPA) for the course. **The respective weights for performance at UE and IA shall be 60% and 40%.**

## **STANDARD OF PASSING**

**A: Grading System:** A **10-point absolute grading system** will be adapted for grading in each head of passing. The system will have seven grade points, the highest being 10. The grading system shall be as shown in Table-1 below. The performance indicators O, A+, A, B+, B, C, and D shall respectively mean Outstanding, Excellent, Very Good, Good, Average, Satisfactory, and Poor.

**Table-1: The grading system under CBCS**

Range of Marks (out of 100)	Grade Point	Grade
$80 \leq \text{Marks} \leq 100$	10	O
$70 \leq \text{Marks} \leq 80$	9	A+
$60 \leq \text{Marks} \leq 70$	8	A
$55 \leq \text{Marks} \leq 60$	7	B+
$50 \leq \text{Marks} \leq 55$	6	B
$40 \leq \text{Marks} \leq 50$	5	C
$\text{Marks} < 40$	0	D



1. The grade point average (GPA) for a course shall be calculated by first finding the total marks **out of 100 for the course. The corresponding GP (as per the table) shall be the GPA for the course.**
2. Two kinds of performance indicators, namely, the Semester Grade Point Average (SGPA) and the Cumulative Grade Point Average (CGPA) shall be computed at the end of each term. The SGPA measures the cumulative performance of a learner in all the courses in a particular semester, while the CGPA measures the cumulative performance in all courses up to and including the current semester. The CGPA of a student when he/she completes the programme is his/her final result.
3. The SGPA is calculated by the formula , 
$$SGPA = \frac{\sum C_k \times GPA_k}{\sum C_k}$$
 where  $C_k$  is the credit-value assigned to a course and  $GPA_k$  is the GPA obtained by the student in the course. In the above, the sum is taken over all the courses that the student has undertaken for the study during the semester, including those in which he/she might have failed or those for which he/she remained absent. **The SGPA shall be calculated up to two decimal place accuracy.**
4. The CGPA is calculated by the formula , 
$$CGPA = \frac{\sum C_k \times GPA_k}{\sum C_k}$$
 where  $C_k$  is the credit-value assigned to a course and  $GPA_k$  is the GPA obtained by the student in the course. In the above, the sum is taken over all the courses that the student has undertaken for the study from the time of his/her enrolment and also the during the semester for which CGPA is calculated, including those in which he/she might have failed or those for which he/she remained absent. **The CGPA shall be calculated up to two decimal place accuracy.**
5. The CGPA, calculated after the minimum credits specified for the programme are 'earned', will be the final result.
6. Grace marks of 1, 2 or 3 may be awarded to a candidate at UE as per the university rules.

## **B: Standards of Passing and ATKT rules:**

1. For all Core Courses, both UE and IE constitute separate heads-of-passing (HoP). In order to pass in such courses and to 'earn' the assigned credits

(a) the learner must obtain a minimum grade point of 5.0 (40% marks) at UE and also a minimum grade point of 5.0 (40% marks) at IA;

**OR**

(b) If he/she fails in IA, then also the learner passes in the course, **provided that a minimum of 25% is obtained in IA and GPA for the course is at least 6.0 (50%marks ) in aggregate.** The GPA for a course will be calculated only if the learner passes in that course.

1. A student who fails at UE in a course has to reappear only at UE as a backlog candidate and clear the HoP. Similarly, a student who fails in a course at IA has to reappear only at IA as a backlog candidate and clear the HoP. **A student who passes in aggregate in a course need not reappear even if he failed at IA if he/she obtains 25% at IA.**
2. The students of Semester I and II will be admitted to Semester III and IV even if they get backlog in any of the course. They can reappear in the next semester examination as a backlog candidate. The students will however not be admitted to Semester V **unless he/she clears all heads in Semesters I & II.** In case the candidate gets backlog in Sem III to Sem VI, then he will be admitted to Semester V and may improve the grade by reappearing in the next semester examination as a backlog candidate.

## **C: Award of Honours:**

1. A student who has completed the minimum credits specified for the programme shall be declared to have passed in the programme. The final result will be in terms of letter grade and CGPA only and is based on the CGPA of all courses studied and passed. The criteria for the award of honours are given in Table 2.

**Table 2: Criteria for the award of honours at the end of the programme**

Range of CGPA	Final Grade	Performance Descriptor	Equivalent Range of Marks (%)
$9.50 \leq CGPA \leq 10.00$	O	Outstanding	$80 \leq Marks \leq 100$
$9.00 \leq CGPA \leq 9.49$	A+	Excellent	$70 \leq Marks \leq 80$
$8.00 \leq CGPA \leq 8.99$	A	Very Good	$60 \leq Marks \leq 70$
$7.00 \leq CGPA \leq 7.99$	B+	Good	$55 \leq Marks \leq 60$
$6.00 \leq CGPA \leq 6.99$	B	Average	$50 \leq Marks \leq 55$
$5.00 \leq CGPA \leq 5.99$	C	Satisfactory	$40 \leq Marks \leq 50$
CGPA Below 5.00	F	Fail	Marks below 40

### THE FORMAT OF THE TRANSCRIPTS

The transcripts may be acquired by the students indicating his/her performance in every semester examination. The transcript shall show the performance indicators given in the following table, in addition to any other information.

Course Number	Course Description	Number of Credits	University Examination		IA/CA		Grade Point Average (GPA)	Result
			Grade	Grade Point	Grade	Grade Point		
Total Cumulative Credits Completed		SGPA	CGPA	Equivalent Marks (%)	<b>Note: GPA is calculated by adding the UE marks out of 60 and IA marks out of 40. The total marks out of 100 are converted to Grade Point, which will be GPA</b>			

## **PATTERN FOR ASSESSMENT**

### **A: Pattern of Evaluation for Internal Assessment of Theory Courses:**

The weightage for Internal Assessment is 40%. Students for IA of every theory course will be assessed for total of 40 marks which will be cumulative marks obtained in three separate assessments specified below.

1. Two internal examinations of 25 marks each. An average of the two tests will be considered.
2. One Assignment/Oral, Open book examination of 10 Marks
3. 05 Marks are assigned for the attendance of students in regular classes (lectures and tutorials). The students will acquire marks in the range of 01- 05 equating to the percent attendance of student in respective theory course

### **B. Pattern of Evaluation for Internal Assessment of Practical Courses:**

The Internal Assessment for every practical course will be of 40 Marks. The students for IA will be assessed on the basis of;

1. The average of two internal oral examinations of 25 marks each
2. One Assignment/Tour report of 10 Marks
3. 05 Marks are assigned for attendance of students in practical sessions. The students will acquire marks in the range of 01- 05 equating to the percent attendance of the student in respective practical course

### **C: Pattern of question paper at University Examination**

University Examination for every theory course will be of 60 Marks. The question paper will comprise of 8 questions of 10 marks each distributed equally in two sections. Students will appear for 3 questions out of 4 in each section. The pattern of question paper will be as given on next page.

**Pattern of question paper for university theory examination of B.Sc. Biotechnology 2015 CBCS Course**  
**(Total Marks:60, Tme:2.00 Hrs.)**

**Note:**

- I. Q.1 & Q.5 are compulsory. Answer Any Two from Questions 2,3 & 4 and from 6,7 & 8.
- II. Answers the questions of Section I and Section II in separate answer books

**SECTION I**

**Q. 1** Attempt **Any Five** of the following (10)

- a.
- b.
- c.
- d.
- e.
- f.

**Q. 2** a. (5)  
b. (5)

**Q.3** Explain the following/ Give reasons/ Differentiate between/Explain diagrammatically/ ---- (10)

- a.
- b.

**Q. 4** Write short notes on **Any Two** of the following (10)

- a.
- b.

**SECTION II**

**Q. 5** Attempt the following questions (Based on fundamental aspects of the course of Unit II & Unit III) (10)

- a.
- b.

**Q. 6** a. (5)  
b. (5)

**Q. 7** Give reasons/ write short notes/ differentiate between/----- (10)

- a.
- b.

**Q. 8** Describe the applications/ Give an account on/Any other (10)

- a.
- OR
- a.

-----

**D: Pattern for question paper of University Practical Examination of B.Sc. Biotechnology 2015 CBCS Course**

**(Total Marks:60, Tme:6.00 Hrs.)**

Q.1 Major Practical	(25)
Q.2 Minor Practical	(15)
Q.3 Viva	(10)
Q.4 Journal	(10)

**E: Pattern of continuous assessment for evaluation open courses**

The Open courses will be evaluated by continuous assessment mode. The students will be evaluated for 100 marks to be obtained in three separate assessments specified below conducted during the course of semester.

- 1) An assignment for 30 marks
- 2) Project / Seminar for 30 marks
- 3) One assessment, written test at end of the term for 30 marks
- 4) 05 Marks are assigned for attendance of students in practical sessions. The students will acquire marks in the range of 01- 05 equating to the percent attendance of the student in respective open course

**F: Pattern of continuous assessment for evaluation for General Courses**

The General courses of every semester will be evaluated by continuous assessment mode. The students will be evaluated for total of 100 marks to be obtained in three separate assessments specified below conducted during the course of semester.

- 1) An activity/project of 60 marks to be conducted during the course of the semester.
- 2) The presentation of above project/activity for 30 marks
- 3) 05 marks to be given on the basis of percent attendance of students to the respective general course

**Course structure of three- year B.Sc. Degree Course in Biotechnology  
Under Choice Based Credit System**

**SEMESTER I**

<b>Course No. &amp; Description</b>	<b>Title</b>	<b>Credits</b>	<b>IA</b>	<b>Univ. Exam</b>	<b>Total Credits</b>
<b>BBT 101</b> Core Course-Theory	Animal Science	3	40	60	28
<b>BBT 102</b> Core Course –Theory	Plant Science	3	40	60	
<b>BBT 103</b> Core Course –Theory	Foundations of Chemistry & Biochemistry	3	40	60	
<b>BBT 104</b> Core Course –Theory	Basics of Computer	3	40	60	
<b>BBT 105</b> Core Course –Practical	Animal Science Lab	3	40	60	
<b>BBT 106</b> Core Course –Practical	Plant Science Lab	3	40	60	
<b>BBT 107</b> Core Course –Practical	Foundations of Chemistry & Biochemistry Lab	3	40	60	
<b>BBT 108</b> Core Course –Practical	Computer Fundamentals & C-Programming Lab	3	40	60	
<b>BBT 109</b> Open Course I	Elective	2	Continuous Assessment		
<b>BBT 110</b> General Course I	Elective	2	Continuous Assessment		

**Elective Courses in Sem I: 1) BBT 109: Elective Open Course I; Option I:** General English. **Option II:** Basic Programming for Bioinformatics. **Option III.** Open course offered in other constituent units of BVDU.

**2) BBT 110: Elective General Course; Option I.** Yoga & Meditation, **Option II.** An appropriate General course offered in other constituent units of BVDU.

## SEMESTER II

Course No. & Description	Title	Credits	IA	Univ. Exam	Total Credits
<b>BBT 201</b> Core Course –Theory	Introduction to Microbiology	3	40	60	28
<b>BBT 202</b> Core Course –Theory	Biochemistry I	3	40	60	
<b>BBT 203</b> Core Course –Theory	Cell Biology	3	40	60	
<b>BBT 204</b> Core Course –Theory	Genetics	3	40	60	
<b>BBT 205</b> Core Course -Practical	Introduction to Practical Microbiology	3	40	60	
<b>BBT 206</b> Core Course-Practical	Biochemistry I Lab	3	40	60	
<b>BBT 207</b> Core Course –Practical	Cell Biology Lab	3	40	60	
<b>BBT 208</b> Core Course –Practical	Genetics Lab	3	40	60	
<b>BBT 209</b> Open Course II	Elective	2	Continuous Assessment		
<b>BBT 210</b> General Course II	Elective	2	Continuous Assessment		

**Elective Courses in Sem II: 1) BBT 209: Elective Open Course II; Option I:** Ecology, **Option II:** Gardening & Landscaping, **Option III:** An appropriate Open course offered in other constituent units of BVDU.

**BBT 210: Elective General Course II; Option I:** Human Values, **Option II:** An appropriate General course offered in other BVDU constituent units



### SEMESTER III

Course No. & Description	Title	Credits	IA	Univ. Exam	Total Credits
<b>BBT 301</b> Core Course –Theory	Concepts in Microbiology	3	40	60	25
<b>BBT 302</b> Core Course –Theory	Biochemistry II	3	40	60	
<b>BBT 303</b> Core Course –Theory	Principles & Techniques in Molecular Biology	3	40	60	
<b>BBT 304</b> Core Course –Theory	Immunology	3	40	60	
<b>BBT 305</b> Core Course-Practical	Practicals in Microbiology	3	40	60	
<b>BBT 306</b> Core Course-Practical	Practicals in Biochemistry II	3	40	60	
<b>BBT 307</b> Core Course-Practical	Practicals in Molecular Biology & Immunology	3	40	60	
<b>BBT 308</b> Open Course III	Elective	2	Continuous Assessment		
<b>BBT 309</b> General Course III	Elective	2	Continuous Assessment		

**Elective Courses in Sem III: 1) BBT 308: Elective Open Course III; Option I:** Patent & IPR, **Option II:** Nutrition, **Option III:** An appropriate Open course offered in other disciplines of BVDU.

**2) BBT 309: Elective General Course III; Option I:** Communication skills& Personality Development, **Option II:** An appropriate General course offered in other constituent units of BVDU

## SEMESTER IV

Course No. & Description	Title	Credits	IA	Univ. Exam	Total Credits
<b>BBT 401</b> Core Course –Theory	Environmental Biotechnology	3	40	60	
<b>BBT 402</b> Core Course –Theory	Fundamentals in Molecular Biology	3	40	60	
<b>BBT 403</b> Core Course –Theory	Developmental Biology	3	40	60	
<b>BBT 404</b> Core Course –Theory	Analytical Techniques	3	40	60	
<b>BBT 405</b> Core Course-Practical	Environmental Biotechnology Lab	3	40	60	
<b>BBT 406</b> Core Course-Practical	Practicals in Molecular & Developmental Biology	3	40	60	
<b>BBT 407</b> Core Course-Practical	Analytical Techniques Lab	3	40	60	
<b>BBT 408</b> Open Course IV	Elective	2	Continuous Assessment		
<b>BBT 409</b> General Course IV	Elective	2	Continuous Assessment		

### Elective Courses in Sem IV: 1) BBT 408: Elective Course IV Option I:

Nanotechnology, **Option II:** Bio fertilizer Technology, **Option III:** An appropriate Open course offered in other disciplines of BVDU.

**2) BBT 409: General Course IV; Option I:** Seminar & Journal Club, **Option II.** An appropriate General course offered in other BVDU constituent units.

## SEMESTER V

Course No. & Description	Title	Credits	IA	Univ. Exam	Total Credits
<b>BBT 501</b> Core Course –Theory	Biostatistics	3	40	60	
<b>BBT 502</b> Core Course –Theory	Clinical Biotechnology	3	40	60	
<b>BBT 503</b> Core Course –Theory	Recombinant DNA Technology	3	40	60	
<b>BBT 504</b> Core Course –Theory	Food Biotechnology	3	40	60	
<b>BBT 505</b> Core Course-Practical	Practicals in Clinical Biotechnology	3	40	60	
<b>BBT 506</b> Core Course-Practical	Practicals in Recombinant DNA Technology	3	40	60	
<b>BBT 507</b> Core Course-Practical	Practicals in Food Biotechnology	3	40	60	
<b>BBT 508</b> Open Course V	Elective	2	Continuous Assessment		
<b>BBT 509</b> General Course V	Elective	2	Continuous Assessment		

**Elective Courses in Sem V: 1) BBT 508: Elective Course V; Option i.** Biotechnology for forensics, **Option II:** Biodiversity, **Option III:**Information security

**2) BBT 509: Elective General Course V; Option I:** Innovative ideas in Biotechnology, **Option II:** An appropriate General course offered in other BVDUconstituent Unit

## SEMESTER VI

Course No. & Description	Title	Credits	IA	Univ. Exam	Total Credits
<b>BBT 601</b> Core Course –Theory	Animal Biotechnology	3	40	60	25
<b>BBT 602</b> Core Course –Theory	Bioprocess Technology & Quality Control	3	40	60	
<b>BBT 603</b> Core Course –Theory	Plant Biotechnology	3	40	60	
<b>BBT 604</b> Core Course –Theory	Basics of Bioinformatics	3	40	60	
<b>BBT 605</b> Core Course-Practical	Practicals in Animal Tissue Culture	3	40	60	
<b>BBT 606</b> Core Course-Practical	Practicals in Plant Tissue Culture	3	40	60	
<b>BBT 607</b> Core Course-Practical	Exercises in Computer Applications & Bioinformatics	3	40	60	
<b>BBT 608</b> Open Course VI	Elective	2	Continuous Assessment		
<b>BBT 609</b> General Course VI	Elective	2	Continuous Assessment		

### Elective Courses in Sem VI: 1) BBT 608: Elective Open Course VI; Option i.

Entrepreneurship in Biotechnology, **Option II:** Business management in Biotechnology, **Option III:** Cyber Law

2) **BBT 609: Elective General Course VI; Option i:** Scientific Writing, **Option ii:** An appropriate General course offered in other BVDU constituent unit

**Total Credits: 28+28+25+25+25+25 = 156**

**B.Sc. Biotechnology Detail Curriculum  
SEMESTER I**

**BBT 101: Animal Science** **Total**  
**Core Course – Theory; 3 Credits** **45L**

**UNIT I**

- |   |  |     |
|---|--|-----|
| 1 | <b>Introduction</b> to Kingdom Animalia, Principles of classification of non chordates and chordates with representative examples.   | 4 L |
| 2 | <b>Type study: Non chordate: Earthworm (<i>Pheretima posthuma</i>)</b><br>Systematic position, habitat and habits, external morphology, digestive system, vascular system, excretory system, reproductive system, cocoon formation, nervous system.  | 5L  |
| 3 | <b>Type study: Chordates: Rat</b><br>Systematic position, habitat and habits, external characters and sexual dimorphism, Digestive system (functional anatomy and dentition), Respiratory system and mechanism of respiration, Circulatory system, (Heart, Arterial, Venous and Portal system), Nervous system (brain and its functions), reproductive system (male & female), excretory system (structure of kidney and uriniferous tubules). Rat as a food pest. | 6L  |

**UNIT II**

- |   |   |     |
|---|---|-----|
| 4 | <b>Endocrinology and Physiology</b><br>Basic concept of neural and endocrine regulation of physiological processes; important endocrine glands and hormones of mammals, an overview; structure of pituitary gland and its secretions, (Pars distalis- STH/GH; Prolactation, TSH, FSH, LH/ ICSH, ACTH; Pars intermedia- MSH; Pars nervosa- Oxytocin, ADH), thyroid gland, adrenal gland ,pancreas (Islets of Langerhans)- insulin, glucagon; gonadotropic hormones, feedback mechanism in hormone secretion, impact of hormones on different physiological processes | 10L |
| 5 | <b>Parasitology</b><br>Study of parasites with reference to <i>Entamoeba histolytica</i> , <i>Plasmodium vivax</i> , <i>Taenia solium</i> , <i>Ascaris lumbricoides</i> : systematic position, habitat and habits, morphology, life cycle, pathogenicity, mode of infection, control measures, effects on host and host response, brief introduction to human defense mechanism.  | 5L  |

**UNIT III**

- |   |   |    |
|---|---|----|
| 6 | <b>Vermi-composting</b><br>Types of earthworms in vermi-composting; ( <i>Eudriuseugeniae</i> , <i>Eisenia foetida</i> , <i>Perionyx excavates</i> ); soil processing worms; | 3L |
|---|---|----|

(*Heretimaposthuma*, *Pheretima elongate*); economic and ecological importance of vermi-composting for garden, agriculture and industry. Vermi-wash applications.

- |    |  |    |
|----|--|----|
| 7  | <b>Apiculture</b><br>Wild species of honey bees: <i>Apis dorsata</i> , <i>Apis florea</i> ; domesticated species of honeybees: <i>Apis indica</i> , <i>Apis mellifera</i> , castes of honeybees, bee pollination and food plants, bee products (Pollen, glue, honey wax, venom, royal jelly) and their applications. | 3L |
| 8  | <b>Sericulture</b><br>Types of silkworms: Mulberry, Eri, Tasar, Muga; mulberry plant cultivation, rearing house, silkworm rearing, economic importance of wild and new silk moth.  | 3L |
| 9  | <b>Fisheries</b><br>Fish as nutritive human food, fish oil, fish glue, fish leather, fish manure, aqua culture industry, biological control in fish farming, fish preservation methods, pearl fishery and economic value of fishes, fish as bio-control agent.   | 3L |
| 10 | <b>Overview of use of animal and animal products for industrial applications</b>   | 3L |

#### References

- 1) Biology – Life on earth, 5th Edn., Audesirk, T. and Audesirk, G., Prentice Hall, New Jersey (1999).
- 2) Parasitology, 1st Edn., Chernin, J., Taylor & Francis Publ., London (2000).
- 3) Modern Textbook of Invertebrate Zoology, 8th Edn., Kotpal, R. L., Rastogi Publication, Meerut (2002).
- 4) Modern Textbook of Vertebrate Zoology, 2nd Edn., Kotpal, R. L., Rastogi Publication, Meerut (2003).
- 5) Invertebrates (Protozoa to Echinodermata), 1st Edn. Verma, A., Narosa Publishing House, New Delhi (2005).
- 6) Nonchordata II, 1st Edn., Arora, M.P., Himalaya Publishing House, Mumbai (2006).
- 7) Biology of Understanding Life, 1st Edn., Alters, S. and Alters, B., John Wiley & Sons Inc., USA (2006).

**Core Course – Theory; 3 Credits** **45L**

**UNIT I**

- 1 **Plant diversity: Plant kingdom** 4 L  
General characteristics of plant kingdom; classification system; concept of binomial nomenclature; genus and species; diversity in habitat and habit; life span; mode of nutrition.
- 2 **Algae, Fungi and Lichens** 3 L  
General characteristics, classification with examples. Life history and uses of *Chlorella/Spirogyra*, *Aspergillus* & *lichens*. Biotechnological significance.
- 3 **Bryophytes and Pteridophytes** 4 L  
General characteristics, classification up to class with examples, alternation of generations, life history of *Riccia*, *Selaginella* and their economic importance.
- 4 **Gymnosperms and Angiosperms** 4 L  
General characteristics, classification up to orders with examples, life history of *Pinus*, difference between monocots & dicots, causes of phenomenal success of angiosperms; economic importance

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**UNIT II**

- 4 **Plant Morphology: General organization of plant body** 3 L  
Underground, axis; aerial parts; morphology and functions of roots and leaves with their biotech significance
- 5 **Inflorescences and Flowers** 3 L  
Definition; major types with examples; significance of inflorescence; parts of flower and their functions; types based on symmetry and whorls; stalk and bracts; significance in Biotechnology industry.
- 6 **Fruits** 3 L  
Definition and formation of fruit parts; major types: simple, aggregate and composite fruits with examples; preservation of fruits and commercial applications
- 7 **Embryology** 3 L  
Male and female gametophytes; fertilization; endosperm; embryogenesis (monocot, dicot); polyembryony; apomixis
- 8 **Seeds** 3 L  
Definition; structure and types; seed preservation and germination methods; Concept of seed dormancy

### UNIT III

- 6 **Anatomy: Study of plant tissues** 7 L  
Types, structures and functions of plant tissues. Significance of anatomy in ecological interpretation, pharmacognosy and wood identification.  
Structure of root, stem, bark and leaves
- 7 **Plant physiology** 8 L  
Mineral nutrition and deficiency diseases, overview of nitrogen fixation, photosynthesis and respiration, phloem transport, photoperiodism and flowering, stress physiology (heat, water, salinity and metal), phytohormones and their role in fruit and seed development.

### References

- 1) College Botany, Vol. I-II Gangulee, H.C., Das, K.S and Dutta, C., New Central Book Agency (P) Ltd., Kolkata (2002).
- 2) Botany for Degree Students Part-I-III, Alage, Fungi & Bryophyta-Vashishta, B.R., Sinha, A.K. and Singh, V.P., S Chand & Company Ltd., New Delhi (2002).
- 3) A Textbook of Botany-Fundamentals of Botany (Plant diversity), Dhumal, K.N., More, T.N., Gadekar, S.S. and More, A.D. NiraliPrakashan, Pune(2002).
- 4) A Textbook of Botany-Plant Anatomy and Plant Morphology, Dhumal, K.N., More, T.N., Gadekar, S.S. and More, A.D. NiraliPrakashan, Pune(2002).
- 5) Plant Physiology, 3rd Edn., Taiz, L., Zeiger, E., Panima Publishing Corp., New Delhi (2003).



<b>BBT 103: Foundations of Chemistry &amp; Biochemistry</b>	<b>Total</b>
<b>Core Course – Theory; 3 Credits</b>	<b>45L</b>

**UNIT I**

<b>1</b>	<b>Introduction</b>	3 L
	Scope and contributions of biochemistry to human welfare; The cell as a unit of life, functions of plasma and cell membrane; water as a universal solvent –shape of H <sub>2</sub> O molecule, properties of water (B.P., M.P., solubility, polarity, adhesion-cohesion), diffusion, osmosis, osmotic pressure, surface tension	
<b>2</b>	<b>Carbohydrates</b>	3 L
	Occurrence/sources; Classification-on basis of carbon no & functional grs.; Structure with molecular formulae; Stereochemistry (structural and conformational isomers); isomers with one and more chiral centres, properties of stereoisomers; cyclization of sugars; conformations of cyclic forms (chair & boat forms).	
<b>3</b>	<b>Important monosaccharides</b>	3 L
	6 C sugars- glucose, fructose, mannose, galactose, 5 C sugars- ribose, deoxyribose, important modified monosaccharides (2-keto-3-deoxy-D- <i>manno</i> -octulosonic acid (KDO), 2-keto-3-deoxy-D- <i>glycero</i> -D- <i>galacto</i> -nonulosonic acid (KDN), sialic acids, aminosugars, sugar acids (their biological role/ occurrence)	
<b>4</b>	<b>Linkages in Sugars</b>	3 L
	Structure and functions of important di-saccharides (sucrose, lactose, maltose, cellobiose) and poly-saccharides (homo and heteropolymers, storage and structural polymers – starch, glycogen, cellulose, chitin, peptidoglycan)	
<b>5</b>	<b>Physico-chemical properties of carbohydrates</b>	2 L
	Reducing-non-reducing properties; Exploitation for detection and separation –Benedict’s test; Introduction to conjugate sugars (Glycoproteins and glycolipids and their importance)	
<b>6</b>	<b>Significance of carbohydrates in microbial, plant and animal system</b>	1 L
	ABO blood groups, heparin, lectins, carbohydrate vaccines	

**UNIT II**

<b>7</b>	<b>Lipids</b>	1 L
	Occurrence/sources: plant derived oils, ghee	
<b>8</b>	<b>Structure</b>	2 L
	Structure of fatty acids, triglycerides; Classification viz., simple and compound, structural and storage with examples; unsaturated-saturated, Oils (refined/unrefined significance); fats, waxes, rancidity/spoilage of fats (microbial, oxidative)	
<b>9</b>	<b>Functions</b>	2 L
	Functions in a living system: significance of hydrophobicity and water immiscibility for compartmentalisation, in vitamins, cofactors, for	

- signalling, pigments
- 10 **Lipid conjugates** 3 L  
 Important conjugates and their functions: phospholipids, glycerophospholipids, sphingolipids; structure of membranes, micellar structures
- 11 **Cholesterol** 2 L  
 Structure, function and significance
- 12 **Liposomes** 2 L  
 Liposomes in drug delivery, soaps, biosurfactants
- 13 **Physico-chemical properties of carbohydrates and lipids** 3 L  
 Compare and contrast of properties arising due to differences in C:O ratio; Comparison of carbohydrate & lipid as fuel molecule of the cell (Glycolysis and beta oxidation in brief, without detailed steps/enzymes)

### UNIT III

- 15 **Temperature profiles of carbohydrates & lipids** 4 L  
 B.P., M. P.; morphology (amorphous/crystalline), solubility in polar/nonpolar solvents; Polarity and dipole moment, hydrophilic/hydrophobic interactions
- 16 **Properties of their solutions** 5 L  
 True solutions, recap of colligative properties- (lowering of vapour pressure, elevation of boiling point, depression in freezing point); effects of temperature and pressure on solutions; viscosity, osmotic pressure, surface tension.  
 Effect of temperature and pressure on interfacial tension; its significance on biological systems; colloids, dispersion, suspension, colloidal system; their stabilization in biological system; properties of colloids and emulsions
- 17 **Physico-chemical measurements** 6 L  
 Concept of buffers, how to prepare normal/molar solutions (examples), standard buffers, measuring pH with pH-meter: Working, Calibration, maintenance of electrodes, effect of molarity on pH maintenance  
 Spectroscopy – colorimetry; Beer-Lambert law  
 Chromatography – adsorption – TLC, paper

### References

- 1) Biochemistry, Berg, J.M., Tymoczko, J. L. and Stryer, L. W.H. Freeman and Co., New York, USA (2003).
- 2) Principles of Biochemistry by Lehninger, A., Nelson, D. L. and Cox, M.M. W.H. Freeman and Co., New York, USA (2008).
- 3) Biochemistry, Satyanarayan, U. Books and Allied (P) Ltd., Kolkata, India(2008).

**BBT 104: Basics of Computers** **Total**  
**Core Course – Theory; 3 Credits** **45L**

**UNIT I**

<b>1</b>	<b>Fundamentals</b> Introduction, History, Evolution, Characteristics of Computers, Block diagram of computer, Computer Generations	2 L
<b>2</b>	<b>Computer Organization</b> I/O units, Storage units (primary and Secondary), ALU, CU, CPU, Complete System	3 L
<b>3</b>	<b>Number Systems</b> Positional, Non-Positional, Binary , Octal , Hexadecimal, Conversion from one number system to another	4 L
<b>4</b>	<b>Classification of computers and features</b> Notebook, Personal, Workstations, Mini, Micro, Mainframe and Super	4 L
<b>5</b>	<b>Computer Networks: LAN, WAN and MAN</b>	2 L

**UNIT II**

<b>6</b>	<b>Types of Programming Languages</b> Machine, Assembly and High Level	2 L
<b>7</b>	<b>Computer software</b> Software and hardware relationship, System and Application software	2 L
<b>8</b>	<b>Algorithm and Flowcharts</b> Definition, characteristics, Advantages and limitations, example	3 L
<b>9</b>	<b>Operating System and Services</b> Introduction, Functions and performance Windows and Linux – Features and Windows Accessories MS Word, MS Powerpoint, MS Excel, MS Access	8 L

**UNIT III**

<b>10</b>	<b>Introduction to C Programming</b> Introduction	2 L
<b>11</b>	Character sets, Constants, variables, Keywords, Comments	3 L
<b>12</b>	Operators, Statements, I/O Operations, Preprocessor Directives	3 L
<b>13</b>	Pointers, Arrays, Strings	3 L
<b>14</b>	User defined data types: Structure and Union	2 L
<b>15</b>	Control structure, loop structures and Functions	2 L

**References**

- 1) Computer Fundamentals by Pradeep Sinha and Priti Sinha
- 2) Fundamentals of Computers by V Rajaraman
- 3) Linux : The Complete Reference 6th Edition by Richard Petersen,

Tata McGraw-Hill Education (2007)

- 4) Let Us C by YashavantKanetkar, BPB Publications.
- 5) The C programming language by Kerighan and Richie, PHI Publication.
- 6) Programming in ANSI C by Balaguruswamy, Tata McGraw-Hill Education.

<b>BBT 105: Animal Science Lab</b>		<b>Total</b>
<b>Core Course – Practical; 3 Credits</b>		<b>20 P</b>
1	<b>Animal Classification</b> Study of general and distinguishing characteristics; classification of chordates and non-chordates up to class level with examples	6 P
2	Demonstration of earthworm for visceral organs and various systems	1 P
3	Demonstration of rat for visceral organs and various systems	2 P
4	Study of slides of <i>Paramecium</i> and <i>Hydra</i> .	2 P
5	<b>Study of parasites</b> Morphology, mode of infection, pathogenicity and control measures: <i>Entamoebahistolytica</i> , <i>Plasmodium vivax</i> , <i>Taeniasolium</i> , <i>Ascaris lumbricoides</i> .	2 P
6	<b>Study of external morphology of honey bee</b> Mouth parts, legs, sting apparatus and wings. Observation of bee products: honey, wax, bee venom and royal jelly.	1 P
7	<b>Main fresh water cultivable fishes and their economic importance</b> <i>Catlacatla</i> , <i>Labeorohita</i> , <i>Cirrhinamrigala</i> , <i>Cyprinusbatrachus</i> , <i>Clarias batrachus</i> , <i>Tilapia mosambica</i> .	1 P
8	<b>Study of human blood groups</b>	1 P
9	<b>Histology</b> Observation of permanent slides of important mammalian organs	1 P
10	<b>Excursion Tour</b> Visit to sericulture industry/ Apiculture centre/Aquaculture industry/ Sea shore/Vermiculture Center.	3 P

### References

- 1) Modern textbook of Invertebrate Zoology, 8<sup>th</sup>Edn, Kotpal R. L., Rastogi Publication, Meerut.
- 2) Modern textbook of Vertebrate Zoology, 2<sup>th</sup>Edn. Kotpal R L., Rastogi Publication, Meerut.
- 3) Invertebrates (Protozoa To Echinodermata), 2<sup>nd</sup> Edn, Verma, A., Narosa publishing house, New Delhi.
- 4) Nonchordata II, 1<sup>st</sup>Edn., Arora m.p., Himalaya Publishing House, Mumbai.
- 5) Biology of Understanding Life, 1<sup>st</sup>Edn., Alters, S and Alters B., John Wiley & Sons Inc., USA.
- 6) Parasitology, 1<sup>st</sup>Edn., Chernin, J., Taylor & Francis Publ. London.

<b>BBT 106: Plant Science Lab</b>		<b>Total</b>
<b>Core Course – Practical; 3 Credits</b>		<b>20 P</b>
<b>1</b>	<b>Study of modes of nutrition in plants</b> Autotrophs (Chlorophyllous plants), photo-autotrophs (Nitrifying bacteria), chemo-autotrophs ( <i>Rhizobium</i> ); Heterotrophs: total parasite ( <i>Cuscuta</i> ) partial parasite ( <i>Loranthus</i> ), insectivorous ( <i>Drosera</i> , <i>Utricularia</i> ); saprophyte: <i>Rhizopus</i> , mushrooms; symbiotic: symbionts (Lichens, Corolloid root of <i>Cycas</i> )	1 P
<b>2</b>	<b>Study of algae and life history of a typical alga</b> Chrysophyta (Diatoms and Desmids), Chlorophyta ( <i>Oedogonium</i> , <i>Chlorella</i> ), Phaeophyta ( <i>Sargassum</i> , <i>Ectocarpus</i> ), Rhodophyta ( <i>Batrachospermum</i> ), Cyanophyta ( <i>Nostoc</i> , <i>Oscillatoria</i> )	2 P
<b>3</b>	<b>Study of fungi and life history of a typical fungus</b> Phycomycota ( <i>Mucor</i> ), Ascomycota ( <i>Penicillium</i> ), Basidiomycota ( <i>Pleurotus</i> ), Rust ( <i>Puccinia</i> ), Smut ( <i>Ustilago</i> ) and Puffballs ( <i>Lycoperedon</i> ), Deuteromycota ( <i>Alternaria</i> )	2 P
<b>4</b>	<b>Study of Lichens</b> <i>Usnea</i>	1 P
<b>5</b>	<b>Study of bryophyta and life history of a typical bryophyte</b> <i>Anthoceros</i> , <i>Funaria</i> , <i>Riccia</i>	1 P
<b>6</b>	<b>Study of pteridophyta and life history of a typical pteridophyte</b> <i>Psilotum</i> , <i>Lycopodium</i> , <i>Equisetum</i> , <i>Selaginella</i> .	2 P
<b>7</b>	<b>Study of gymnosperms and life history of a typical gymnosperm</b> <i>Cycas</i> , <i>Pinus</i>	2 P
<b>8</b>	<b>Study of general organization of plant body</b> Underground (root and rhizome) and aerial parts (stem, leaves, fruits and seeds), Types and morphology	2 P
<b>9</b>	<b>Study of inflorescence and morphology of a typical flower</b> Racemose (raceme, spike & capitulum), cymose (solitary helicoids, dichasial <i>polychasial</i> ) and special types ( <i>cyanthium</i> , <i>hypanthium</i> , <i>verticillaster</i> ). Structure and types of flowers based on sexuality and symmetry, structure of a typical stamen and carpel.	2 P
<b>10</b>	<b>Study of types of fruits and structure of seeds</b> Simple fruits: Dehiscent (Legume and capsule), Indehiscent: dry (Caryopsis and Cepsella), indehiscent fleshy (Berry & drupe). Aggregate fruits (Etario of berry & etario of follicle). Albuminous seed	2 P

(castor), ex-albuminous seed(bean), types of seed germination

- 11 **Anatomy of dicot and monocot.** 2 P  
Dicot -Root, stem and leaf (Sunflower).  
Monocot-Root,stem and leaf (Maize and Jowar)  
Study of Vascular bundles (Maize stem sunflower, Cucurbita stem,  
Fern rachis and Dracaena stem, Monocot root.  
Study of types of stele (Permanent slide)
- 12 **Visit to forest** 1 P  
To study plant diversity

### References

- 1) College Botany, Vol. I-II, Gangulee, H. C., Das, K. S. and Dutta, C., New Central Book Agency (P) Ltd., Kolkata (2002).
- 2) Botany for Degree Students Part-I-III: Algae, Fungi and Bryophyta Vashishta, B. R., Sinha, A. K. and Singh, V.P., S Chand & Co. Ltd., New Delhi (2002).
- 3) A Textbook of Botany: Plant Anatomy and Plant Morphology: Dhumal, K. N., More, T. N., Gadekar, S. S. and More, A. D., Nirali Prakashan, Pune (2002).
- 4) A Text Book of Plant Diversity and Plant Resources (Management and Utilization), Dhumal, K. N., More, T. N., Gadekar, S. S. and More, A. D., Nirali Prakashan, Pune (2002)
- 5) A Text book of Practical Botany-2, Bendre, A. M. and Ashok Kumar, Rastogi Publication, Meerut (2006).

<b>BBT 107: Foundations of Chemistry &amp; Biochemistry Lab</b>		<b>Total</b>
<b>Core Course – Practical; 3 Credits</b>		<b>20 P</b>
1	Significance of good laboratory practices (GLP) Safe handling of equipments/ Instruments. Introduction to volume and weight measurements, Personal safety, accuracy and reliability.	2 P
2	Safety in the use of acids, alkalies and organic solvents. Distillation of water, Preparation of de-mineralized water, Preparation of washing solution/ disinfectant	2 P
3	Preparation of buffers-acetate buffer & Preparation of biochemical reagents (Benedict's reagent)	2 P
4	Isolation of commercially important biomolecules 4.1 Isolation of starch from corn (separation on the basis of density) 4.2 Extraction of triglycerides from oilseeds (separation on the basis of differential solubility)	2 P
5	Color reactions (qualitative determination) for identification Sugars and starch	2 P
6	To determine $\lambda$ max and extinction coefficient of coloured compounds using spectrophotometer & validation of Beer-Lambert Law (Varying concentrations of $\text{KMnO}_4$ ).	2 P
7	Determination of glucose by DNSA method.	2 P
8	Thin layer chromatography (TLC) Separation of plant pigments	2 P
9	Preparation of soap	2 P
10	Acid value or saponification value. Determination with reference to fatty acids.	2 P

### References

- 1) Introductory Practical Biochemistry, Sawhney, S. K. and Singh, R. Narosa Publishing House, New Delhi (2000).
- 2) An Introduction to Practical Biochemistry, Plummer, D.T., Tata-McGraw-Hill Publishing Co., New Delhi (2005).
- 3) Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J., Cambridge University Press, New York (2005).
- 4) Laboratory Manual in Biochemistry, Jayraman J., New Age International (P) Ltd., New Delhi (2007).



**BBT 108: Computer Fundamentals & C-Programming Lab** **Total**  
**Core Course – Practical; 3 Credits** **20 P**

**1 Computer fundamental:** 05 P

1. MS office Packages: MS Word, MS Powerpoint, MS Excel, MS Access
2. DOS Commands
3. Number Systems: Binary , Octal , Hexadecimal, Conversion from one number system to another
4. Use of Internet in Biological sciences

**2 C-Programming:** 15 P

1. Data types, operators and expressions, Hierarchy of operators,
2. control statements including decision (if, if-else), loops (while, do-while, for), branching statements (switch, break, continue),
3. Functions,
4. Arrays (1D, 2D- all matrix operations including inverse of a matrix),
5. Strings,
6. File handling etc.
7. Utilization of C-Programming in Biological Sciences

**References**

1. Fundamental of Computers – By V. Rajaraman B.P.B. Publications
2. Fundamental of Computers – By P. K. Sinha
3. Computer Today- By Suresh Basandra
4. Unix Concepts and Application – By Sumitabha Das
5. MS- Office 2000(For Windows) – By Steve Sagman
6. Computer Networks – By Tennenbum Tata Mac Grow Hill Publication
7. Let Us C by Yashavant Kanetkar, BPB Publications.
8. The C programming language by Kerighan and Richie, PHI Publication.
9. Programming in ANSI C by Balaguruswamy, Tata McGraw-Hill Education.
10. Sams Teach Yourself C in 21 Days Peter Aitken and Bradley L. Jones, Macmillan Computer publishing.
11. Schaum's outline of programming with C by Byron Gottorfried.

**BBT: 109- Open Course I; Elective Course; Option I - General English** **Total**  
**Open Course I; 2 Credits** **30L**

**UNIT I**

- |   |   |     |
|---|---|-----|
| 1 | Listening, Speaking, Essential Grammar, Undergraduate writing, Writing PG Assignments   | 5 L |
| 2 | Writing descriptions of places, objects etc.: Describing location and direction, Writing definitions, Classifying / categorizing, Comparing and contrasting: similarities and differences, Reporting and narrating  | 5 L |
| 3 | Answering exam questions: Understanding the question, Planning the answer, The exam answer, Evaluating the answer   | 2 L |
| 4 | <b>Research and using the library:</b> Finding relevant information, Using catalogues, Using books and periodicals, Using bibliographies and indexes, Using sources, Making notes, Paraphrasing and writing up notes, Summarizing, Quoting directly, Referring to sources, Writing a references list. | 3 L |

**UNIT II**

- |   |   |     |
|---|---|-----|
| 5 | <b>Describing processes and developments:</b> Expressing purpose, means and method, Expressing degrees of certainty, Expressing reasons and explanations / cause and effect, Describing developments and changes, Describing a sequence of events / time relations, Writing instructions  | 5 L |
| 6 | <b>Developing an argument:</b> Presenting arguments, ideas and opinions, Expressing certainty and doubt, Supporting an argument: illustrating and exemplifying ideas, Refuting arguments, ideas and opinions, Offering evaluative comments on opinions and arguments, Drawing conclusions | 5 L |
| 7 | <b>Writing an essay:</b> Essay organization: presentation and layout, Spelling and punctuation, Including graphs, charts and tables, Writing paragraphs, Writing introductions and conclusions, Academic writing style, Revising the essay – proofreading                                 | 5 L |

**References:**

- 1) Essential English Grammar by Raymond Murphy, Cambridge Publication (Available in paper back)
- 2) Practical English Usage by Michael Swan, Oxford University Press.
- 3) Practical English Grammar by Thomson, A J & Martinet, A V. Oxford University Press. 1986. Paperback. Intermediate. ISBN 0194313425

<b>BBT 109: Open Course II; Option II- Basic Programming for Bioinformatics, Open Course I; 2 Credits</b>	<b>Total 30L</b>
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**UNIT I**

<b>1</b>	Introduction to Perl programming	1 L
<b>2</b>	Numbers, Strings, Arithmetic and Logical operators	2 L
<b>3</b>	Control statements and Loops, Functions (push, pop, length, log etc)	2 L
<b>4</b>	Scalar variables	2L
<b>5</b>	Working with Arrays	2 L
<b>6</b>	Input/output in Perl	3 L
<b>7</b>	<b>Subroutine:</b> Defining subroutine, Invoking subroutine, Passing, arguments to subroutine, Return values	3 L

**UNIT II**

<b>8</b>	<b>Working with files:</b> File handle, Opening file, Reading contents of file, Writing into files etc.	3 L
<b>9</b>	Regular Expression, Pattern Matching, Hashes	2L
<b>10</b>	<b>Object-Oriented Programming in Perl:</b> Objects, Methods, and Classes in Perl	4L
<b>11</b>	<b>Perl Modular Programming:</b> Use of Perl Modules, Namespaces, Packages, Defining modules, Storing modules, First Perl module, Using modules, CPAN modules, Bioperl module	6L

**References:**

- 1) Beginning Perl for Bioinformatics by James Tisdall, O-Reilly publication.
- 2) Perl: Complete Reference Perl by Martin C. Brown, McGraw-Hill publication.
- 3) Mastering Perl for Bioinformatics by James D. Tisdall, O-Reilly Publication.
- 4) Teach Yourself Perl 5 in 21 days by David Till, Sams publishing.
- 5) Mastering Algorithms with Perl by Jon Orwant, JarkkoHietaniemi and John Macdonald, O-Reilly Publication.
- 6) Professional Perl Programming by Peter Wainwrigth, Published by Wrox Press Ltd.
- 7) Beginning Web Development with Perl by Steve Suehring, Apress publication.

**BBT 110: General Course I Elective; Option I – Yoga & Meditation  
General Course I; 2 Credits,**

**Total  
20L/Act.**

As a school of philosophy, Yoga is a way of life, and incorporates its own epistemology, metaphysics, ethical practices, systematic exercises and self-development techniques for body, mind and spirit. Yoga and meditation when practiced together strengthen the mind body connection, improving overall fitness and well-being. Many styles of yoga combine meditation with the physical routines, which use controlled breathing throughout the yoga poses. Meditation is practiced by relaxing, clearing your mind and concentrating on controlled breathing. Both yoga and meditation, when used consistently, have proven health benefits. Meditation is also an effective stress reducer that is used to help reduce anxiety, panic disorders and agoraphobia, an anxiety disorder commonly seen in student life.

### **Unit I**

1. Overview of history of yoga, its origin and claimed benefits
2. Aasana alignment and the human anatomy and physiology explained in connection with yoga techniques like pranayama and meditation teaching methodology with practice

### **Unit II**

3. The science of meditation and current scientific research
4. What is meditation? Techniques of meditation
5. Different kinds of yoga
6. Overview of current styles, forms and purposes of meditation
7. Techniques for cultivation of inner calm, insight and wisdom through Yoga and meditation

### **References**

1. Jeevanved. Shri Shri Anand Murtii. Anand Marg Publ. 1955
2. Yoga psychology. Shri Prabhat Ranjan Sarkar; Anand Marg Publ., Calcutta, India, ISBN 10 817251138; 1990.
3. Yoga for health. Avd Anandmitra, 1999.

## SEMESTER II

**BBT 201: Introduction to Microbiology** **Total**  
**Core Course – Theory; 3 Credits** **45L**

### UNIT I

- |  |     |
|--|-----|
| <b>1 History of Microbiology</b><br>Important experiments and discoveries, Golden age of Microbiology, Koch's postulates. .  | 5 L |
| <b>2 Introduction to Microscopy</b><br>Principle, instrumentation and applications of bright field, dark field, phase contrast, fluorescence and electron microscope | 10L |

### UNIT II

- |  |     |
|--|-----|
| <b>4 General properties and structure of prokaryotes</b><br>Bacterial cell structure and function; cell wall, cell membrane, endospore, capsule, flagella, fimbriae & pili, nucleoid, ribosomes, plasmids, cell inclusions, chemotaxis           | 8 L |
| <b>5 Taxonomy of bacteria</b><br>Nomenclature, its objectives, rules and regulations, taxometrics, intra-subspecific ranks-biovar, serovar, pathovar, phagovar, morphovar, <b>Salient features of Bergey's Manual of Systematic Bacteriology</b> | 7 L |

### UNIT III

- |  |     |
|--|-----|
| <b>6 Microbial growth</b><br>Growth curve, introduction to kinetics of growth, generation time, reproduction in microorganisms   | 4 L |
| <b>7 Microbial nutrition</b><br>Nutritional types of microorganisms, growth factors, macro and microelements, media ingredients, Different types of culture media: complex, defined, selective, differential media, pure culture techniques  | 3 L |
| <b>8 Microbial metabolism</b><br>Aerobic & anaerobic, respiratory, fermentative  | 3 L |
| <b>9 Control of microorganisms:</b><br><b>Physical agents</b> - Heat, Radiations, Filtration<br><b>Chemical agents and their mode of action</b> - Aldehydes, halogens, quaternary ammonium compounds, phenolic compounds, ethylene oxide, heavy metals, alcohol, soaps and detergents<br>Sterility checking- chemical and biological indicators. | 5L  |

### References

- 1) Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg

- N.R., The McGraw Hill Companies Inc. NY
- 2) General Microbiology - Stanier R.Y., 5th edition, (1987)Macmillan Publication UK.
  - 3) Prescott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, ChrisWoolverton, McGrawHil Science Engineering, USA
  - 4) Biology of Microorganisms, Madigan, M. T., Martinko, J. M. and Parker, J. B., Prentice-Hall Publ., New York (2001).
  - 5) Introduction to Microbiology, 2nd Edn. Ingraham, J. L. and Ingraham C. A., Thompson Asia Pvt. Ltd., Singapore (2002).
  - 6) Microbiology: An Introduction, 8th Edn. Tortora, G. J., Funke, B. R.and Case, C. L., Pearson Education Inc., New Jersey (2004).

**BBT 202: Biochemistry I**  
**Core Course – Theory; 3 Credits**

**Total**  
**45L**

**UNIT I**

- |          |   |     |
|----------|---|-----|
| <b>1</b> | <b>Amino acids, peptides and proteins</b><br>Occurrence/sources, Naturally occurring amino acids; structures; abbreviated names; stereoisomerism; amphoteric nature of amino acids; modified amino acids and their role in nature; Classification of amino acids (on basis of functional groups, essential/non-essential); Chemical reactivity due to functional group (amide, acid, amine); peptides & proteins (peptide bond, bond properties, N-Terminal, C-Terminal); importance of sequence of amino acids for structure and function of protein (eg. Sickle cell anaemia) | 5 L |
| <b>2</b> | <b>Protein structure</b><br>Primary, secondary ( $\alpha$ helix and $\beta$ conformation), tertiary and quaternary structure. Forces stabilizing molecular structure (covalent bond, ionic bond, hydrogen bond, salt linkage, van der Waal's forces) a brief over view of Ramchandran plot  | 4 L |
| <b>3</b> | <b>Classification of Proteins according to function</b><br>Structural proteins, transport proteins, chromoproteins, phosphoproteins, glycoproteins and their structures and significance in microbial, plant and animal systems   | 4 L |
| <b>4</b> | <b>Introduction to enzymes as biocatalysts</b>  | 2 L |

**UNIT II**

- |          |  |     |
|----------|--|-----|
| <b>6</b> | <b>Nucleic acids</b><br>Occurrence; Structures of purines and pyrimidines; nucleosides, nucleotides - as components of DNA & RNA; Spectrophotometric estimation of purines and pyrimidines-theory; Structure of DNA- Watson-Crick model; denaturation-renaturation of DNA;<br>Types of RNA- their structures and functions | 4 L |
| <b>7</b> | <b>AMP and cAMP, ADP &amp; ATP, NAD &amp; NADP, FMN &amp; FAD-</b> structure, function and biological role.  | 4 L |
| <b>8</b> | <b>Vitamins</b><br>Occurrence/sources; rich sources of different vitamins; Classification and general structural features, Role as coenzymes; Functions & Deficiency symptoms  | 4 L |
| <b>9</b> | <b>Minerals</b><br>Role of Na, K, Mg, Fe, Zn, Co, Cu, P and I in physiology; General electronic configurations and their shapes/preferred geometries and its significance in metalloenzymes  | 3L  |

### UNIT III

- |    |  |    |
|----|--|----|
| 10 | <b>Analytical tools for separation of biomolecules</b>   | 4L |
|    | Separation techniques: Filtration (gross, mini, micro and ultra-filtration), dialysis, specific gravity, sedimentation, density gradient ultracentrifugation |    |
| 11 | <b>Flame photometry:</b> Estimation of Na and K, principle and procedure, accuracy   | 1L |
| 12 | <b>Kjeldahl method of nitrogen estimation</b> Soil /fertilizer/ water/ plant analysis  | 1L |
| 13 | <b>Chromatography:</b> - gel, affinity, ion exchange, applications; purification of water, streptomycin, proteins and enzymes and DNA/RNA fractionation.     | 4L |
| 14 | <b>Electrophoresis:</b> Principle of separation, factors affecting separation, types-paper, agarose gel, PAGE, 2D- gel electrophoresis.                      | 2L |
| 15 | <b>Estimation of important minerals:</b> Calcium and Iron from industrial effluents (gravimetry); modern methods of estimation.                              | 1L |
| 16 | <b>Estimation of inorganic phosphate:</b> Analysis of soil for phosphate fertilizer (colorimetry)  | 1L |
| 17 | <b>Estimation of purity of water:</b> Fluoride, chloride, sulphate and arsenic from potable water (titrimetry)   | 1L |

### References

1. Industrial Enzymology, 2nd Edn., Godfrey, T. and Reichelt, J.R.,McMillan Publ. Co., London(1997).
2. Principles of Fermentation Technology, Stanbury, P. F., Whitaker, A. and Hall, S. J., Butterworth-Heinemann, Burlington, MA, USA (2005).
3. Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2005).
4. Laboratory Manual in Biochemistry, Jayraman, J., New Age International (P) Ltd., New Delhi (2007).



<b>BBT 203: Cell Biology</b>	<b>Total</b>
<b>Core Course – Theory; 3 Credits</b>	<b>45L</b>

**UNIT I**

- |          |   |     |
|----------|---|-----|
| <b>1</b> | <b>Introduction to Cell</b><br>Evolution of cell from molecules to first cell, from prokaryotes to eukaryotes and from single to multicellular organisms. Cell size, shapes, morphology and cell theory, General structure of prokaryotic and eukaryotic cell (plant and animal).   | 3 L |
| <b>2</b> | <b>Organelles of eukaryotic cells</b><br>Nucleus, Mitochondria, Endoplasmic Reticulum, Golgi apparatus, Lysosomes, Chloroplast and Plant Cell Wall; Structure and function of different organelles, comparison between prokaryotic and eukaryotic cell structure. Types of cells (neurons, RBC and muscle cells) and their functions. | 6 L |
| <b>3</b> | <b>Membrane Structure</b><br>Components of membrane, Structure (Fluid Mosaic Model), properties and functions of membrane. Function of lungs as membranous bags.  | 6 L |

**UNIT II**

- |          |   |     |
|----------|---|-----|
| <b>3</b> | <b>Transport across the membrane</b><br>Passive diffusion, facilitated diffusion, Active transport. Structure, function and significance of Na <sup>+</sup> / K <sup>+</sup> ATPase and Ca <sup>+</sup> ATPase;<br>Ion channels – leak channels, gated channels, voltage gated and ligand gated channels. Ionophores, phosphotransferase system, transport antibiotics. Endocytosis and exocytosis , receptor mediated endocytosis. | 8 L |
| <b>4</b> | <b>Cytoskeleton</b><br>Actin filaments, Intermediate filaments, Microtubules, their structure, organization and functions, its polar nature, assembly and disassembly, regulators and role in cellular activities, tread milling. Muscle contraction, relevance of microtubules in anticancer treatment.  | 7 L |

**UNIT III**

- |          |  |     |
|----------|--|-----|
| <b>5</b> | <b>Cell cycle and cell division</b><br>Cell cycle: steps and regulation. Cell division – mechanism of cell division, mitosis and meiosis, significance and comparison between two nuclear divisions. | 6 L |
| <b>6</b> | <b>Cell- cell interaction</b><br>Tight junctions, gap junctions, desmosomes & hemidesmosomes, plasmodesmata and extracellular matrix. Significance in neural transmission.                           | 3 L |

- 7 **Cell signaling** 3 L  
Types of cell signaling Signal molecules, receptors and mechanism of signal transduction.
- 8 **Cell death** 3 L  
Mechanism of apoptosis, its failure leading to cancer development, necrosis.  
Comparison between apoptosis and necrosis

### **References**

- 1) Molecular Biology of the Cell, Alberts, B., Johnson, A., Lewis, J., Raff, K., Roberts, K. and Walter, P., Garland Science, Taylor and Francis Group, New York, USA (2002).
- 2) Biochemistry, Berg, J. M., Tymoczko, J. L. and Stryer, L. W. H. Freeman & Co., New York (2003).
- 3) The Cell: A Molecular Approach, Cooper, G. M. and Hausman, R. ASM Press, Washington, USA (2004).
- 4) Cell and Molecular Biology, Karp, G., John Wiley & Sons Inc., New Jersey 2005).

<b>BBT 204: Genetics</b>	<b>Total</b>
<b>Core Course – Theory; 3 Credits</b>	<b>45L</b>

**UNIT I**

- |   |  |     |
|---|--|-----|
| 1 | <p><b>Heredity</b><br/> <b>Mendelian inheritance</b><br/>         Segregation, independent assortment, test cross, dominant and recessive traits, multiple alleles, patterns of inheritance; Autosomal, X-linked, Y Linked<br/>         Prenatal and parental diagnosis; pedigree analysis and norms of genetic Counseling</p>           | 5 L |
| 2 | <p><b>Non-Mendelian inheritance</b><br/>         Gene interactions; cooperative interactions, epistasis; Cytoplasmic inheritance; mitochondrial and chloroplast horizontal gene transfer</p>   | 5 L |
| 3 | <p><b>Arrangement of genetic material</b><br/>         Chromosomes: Structure, types, staining, FISH, banding, nomenclature and karyotyping, polytene and lampbrush chromosomes; Prokaryotic genetic material, Plasmids; Linkage and recombination, gene mapping in diploids, tetrad analysis, other methods of gene mapping (RFLP).</p> | 5 L |

**UNIT II**

- |   |   |     |
|---|---|-----|
| 6 | <p><b>Applied genetics</b><br/>         Significance of genetics in breeding for improved food; Interactions of genes and environment; Model study organisms - <i>E. coli</i>, <i>S. cereviceae</i>, <i>Arabidopsis</i>, <i>C. elegans</i>, <i>Drosophila</i> and mice.</p> | 7 L |
| 7 | <p><b>Sex determination</b><br/>         Chromosomal pattern of sex determination, sex determination in human, environment-dependent sex determination, dosage compensation; Sex linked inheritance</p>   | 8 L |

**UNIT III**

- |    |   |     |
|----|---|-----|
| 10 | <p><b>Changes in genetic material</b><br/>         Variation: continuous and discontinuous; Chromosomal aberrations: Numerical (aneuploidy in human and polyploidy in plants); Structural (deletion, duplication, inversion and translocation); Related human diseases; Gene mutation, types, congenital diseases; Transposones</p>                             | 7 L |
| 11 | <p><b>Evolutionary genetics</b><br/>         Theories of evolution: Pre-Darwenian theories, Darwin's theory of evolution and Modern evolutionary synthesis; The Hardy-Weinberg Law; Genetic equilibrium; changes in allelic frequencies: Mutation, Migration, Genetic Drift, Natural Selection; Co-evolution; Co-operation; Speciation; Molecular evolution</p> | 8 L |

## References:

- 1) Practical Genetic Counseling, 6th Edn., Harper, P. S. Butterworth-Heinemann, Oxford (2004).
- 2) Fundamentals of Bacterial Genetics, Trun, N. and Trempy, J., Blackwell Science Ltd, Oxford (2005).
- 3) Genetics, Singh, B.D., Kalyani Publications, New Delhi (2005).
- 4) An Introduction to Genetic Analysis, Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C. and Gilbert, W. M., W. H. Freeman and Co., New York (2005).
- 5) Principles of Genetics 8<sup>th</sup>Edn. Gardner, E. J., Snustad, D. P. and Simmons, M. J., John Wiley & Sons (Asia) Pvt. Ltd, New Delhi (2006).
- 6) Genetics, A Molecular Approach, Russell, P. J., 2nd Edn., Pearson Education Inc., San Fransisco (2006).
- 7) Genetics, Strickberger, M. W., Pearson Education, India (2007).

<b>BBT 205: Introduction to Practical Microbiology</b>		<b>Total</b>
<b>Core Course – Practical; 3 Credits</b>		<b>20 P</b>
1	Safety precautions in microbiology laboratory	1 P
2	Introduction to laboratory instruments used in microbiology	1 P
3	Sterilization techniques	2 P
4	Introduction to microscopy :Demonstration of compound microscope	2 P
5	Preparation of media and its application: selective and differential media	2 P
6	Pure culture techniques Pour plate, streak plate, spread plate, observation o cultural characters	3 P
7	Staining techniques: Monochrome staining, Gram staining, Negative staining	3 P
8	Staining of cell organelles: Staining of capsule, spore, cell wall and metachromatic granule	2 P
9	Observation of bacterial motility- hanging drop, swarming growth methods	2 P
9	To study the growth curve of bacteria	2 P

### References

- 1) Source Book for Experiments for the Teaching of Microbiology, (1982) Primrose, S. B. and Wardlow, A. C. Academic Press, London.
- 2) Microbiology: A Laboratory Manual, (2004),6thEdn. Cappuccino, J.G. and Sherman, N., Pearson Education Pvt. Ltd., Singapore.
- 3) Practical Microbiology: Principles and Techniques, (2005), 1st Edn., Kale, V and Bhusari, K. Himalaya Publishing House, New Delhi.
- 4) Introductory Practical Microbiology, (2007),Mu dili, J., Narosa Publ. House P.Ltd., New Delhi
- 5) Experiments in Microbiology, Plant Pathology and Biotechnology, (2007),4<sup>th</sup>Edn., Aneja, K. R., New Age International Publishers, New Delhi.

**BBT 206: Biochemistry I Lab** **Total**  
**Core Course - Practical; 3 Credits** **20 P**

1	Isolation of casein from milk (separation on the basis of isoelectric pH)	2 P
2	To determine $\lambda$ max and extinction coefficient of bio-molecules Tyrosine, purine and pyrimidine using spectrophotometer. Identification of purines from $\lambda$ max	2P
3	Color reactions for identification. Amino acids and proteins	2 P
4	Estimation of proteins. Determination of albumin concentration by Biuret method	2 P
5	Paper chromatography/TLC for the separation of amino acids	2P
6	Determination of pKa values of solutions.	2 P
7	Titration curve of acidic, basic and neutral amino acids	2P
8	Quantitative estimation of ascorbic acid	2 P
9	Separation of dyes on the basis of ion exchange chromatography	2 P
10	Adsorption chromatography Separation of leaf pigments	2 P

**References**

- 1) Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2005).
- 2) Laboratory Manual in Biochemistry, Jayraman, J., New Age International (P) Ltd. New Delhi (2007).

**BBT 207: Cell Biology Lab** **Total**  
**Core Course – Practical; 3 Credits** **20 P**

1	Study of compound microscope	1 P
2	Cell structure- Prokaryotes and eukaryotes	4 P
3	Study of sub cellular organelles	4 P
4	Study of mitochondria from oral mucosal cells with Janus green B	2 P
5	Study of mitosis and meiosis by onion root tip chromosomes	2 P
6	Determination of total erythrocytes (RBCs)from given blood sample	2 P
7	Determination of total leucocytes (WBCs)from given blood sample	2P
8	Temporary preparation of Polytene chromosomes from Chironomus salivary gland	2 P
9	Effect of organic solvents on cell membrane permeability of a cell	1 p

**References:**

- 1) Alberts B. and Jhonson A.4<sup>th</sup> edition (2002) Molecular Biology of the cell, Garland science.
- 2) Berg J., Tymoczko J, and Stryer L, 5<sup>th</sup>edition(2002) Biochemistry, W. H. Freeman and company, New York.
- 3) Cooper G.M., Hausman R. E. The cell: A molecular approach. 5th edition. ASM Press and Cinauer Associates Inc. 2009

<b>BBT 208: Genetics Lab</b>		<b>Total</b>
<b>Core Course – Practical; 3 Credits</b>		<b>20 P</b>
1	Staining of yeast, plant and animal chromosome	3 P
2	Survey of genetic traits in human	3 P
3	Analysis of karyotypes of various genetic disorders	3 P
4	Bacterial conjugation	3 P
5	Effect of mutagenic agents on seeds	3 P
6	Isolation and Cultivation of <i>C elegance</i>	2 P
7	Study of <i>Drosophila</i> life cycle	3P

### References

- 1) *Drosophila*, Methods and Protocols (2008) Edited by Christian Dahmann Max Planck Institute of Molecular Cell Biology and Genetics, Dresden, Germany
- 2) S. Harisha. *Biotechnology Procedures and Experiments Handbook*(2007) Infinity Science Press.
- 3) Antoine Barrière and Marie-Anne Félix§, Institut Jacques Monod Isolation of *C. elegans* and related Nematodes CNRS - Universities of Paris, 75251 Paris cedex 05, France
- 4) Theresa Stiernagle Maintenance of *C. elegans*-, *Caenorhabditis* Genetics Center, University of Minnesota, Minneapolis, MN 55455 USA



**BBT 209: Open Course II: Elective; Option I - Ecology**  
**Open Course II; 2 Credits**

**Total**  
**30L**

**UNIT I**

<b>1</b>	Definition and scope of ecology; ecological factors	3 L
<b>2</b>	Ecosystem - concept, characteristics, kinds and structure	3 L
<b>3</b>	Ecosystem diversity	3 L
<b>4</b>	The species & Individual in the Ecosystem	3 L
<b>5</b>	An overview on different types of ecosystem. Structure and function of ecosystem, energy flow through ecosystem	3 L

**UNIT II**

<b>6</b>	Definition and concept of community, community diversity, structure, dominance, stratification and periodicity; Community interdependence, Ecotone, Edge effect and Ecological Niche	3 L
<b>7</b>	Ecological succession – characteristics, types of succession, concept of climax, significance of succession	3 L
<b>8</b>	Plant communities: definition, classification, characteristics and function	3 L
<b>9</b>	Ecosystem functioning- food chain, food web; Ecological pyramids – pyramids of numbers, pyramids of biomass, pyramids of energy, inverted pyramids; Ecological energetic - energy flow, ecological efficiency	2 L
<b>10</b>	Definition, Types and examples of ecosystem- terrestrial (grassland) and aquatic (pond)	2 L
<b>11</b>	Application of the study of ecology in wild life conservation and sustainable development	2 L

**References**

1. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press

**BBT 209: Open Course II: Elective; Option II - Gardening and Landscaping, Open Course II; 2 Credits** **Total  
30L**

**UNIT I**

1	Scope and objectives of gardening	1 L
2	Style of gardens: Formal, Informal	1 L
3	Types of gardens: English, Mughal and Japanese	1 L
4	Components of garden	1 L
5	Planning of Indoor /outdoor gardens:	1 L
6	Residential, Larger Home Garden, Roof Garden, Terrace Garden, Children's garden, School and Institutional Garden, Park, Industrial garden, Housing complex, Hanging garden	3 L
7	Nursery production and management	2 L
8	Propagation of ornamental plants by seeds, layering, cuttings, grafting, budding & tissue culture.	2 L
9	Annuals & Biennials: Important Genera and Species, their importance in garden designs	2 L
10	Orchids: Environment, propagation, potting & compost, nutrient supply, watering important species	1 L

**UNIT II**

1	Landscape Design: Definition, objectives and scope, Landscape elements of construction and designing of Residential, Commercial, Bungalow, Public area, Hotel, Educational Institute and religious places	3 L
2	Computer application in landscape	2 L
3	Palms and Cycas: Characteristics, propagation, culture, pest and disease, importance and uses, genera and species of palms and Cycas.	2 L
4	Bamboo and conifers: Genera, species and varieties Shrubs: Different types	2 L
5	Climbers and Bougainvillea: Different types Hedges for gardens & farms	2 L
6	Lawns & Grasses: Planting methods, maintain Herb garden, Rose garden, Bog garden, Sunken garden, Topiary garden, Kitchen garden, Paved garden, Dish garden, Rock garden, Terrace garden, Water garden & Bottle garden (Terrarium)	3 L
7	Field Visit: Visit to various gardens (public and private) and plant nurseries	1 L

**References:**

- 1) Christine Wein-Ping Yu 1987. Computer-aided Design: Application to ConceptualThinking in Landscape Architecture. amazon.com
- 2) Arora J S ( 1990). Introductory Ornamental Horticulture, Kalyani Publication.
- 3) Bailey L H 1901. The Standard cyclopedia of Horticulture, volume ,2 and 3 Macmillan Publications.
- 4) Bose T K and Mukerjee D 1987, Gardening in India, Oxford Book House
- 5) Sue Wilson (Editor) E & F. N. Spon. 2001 Guidelines for Landscape and Visual Impact Assessment.

## **BBT 210: General Course II: Elective; Option I – Human Values General Course II; 2 Credits,**

Values are socially accepted norms to evaluate objects, persons, and situations that form part and parcel of sociality. A value system is a set of consistent values and measures. Knowledge of the values are inculcated through education. It contributes in forming true human being, who are able to face life and make it meaningful. There are different kinds of values like, ethical or moral values, doctrinal or ideological values, social values and aesthetic values. Values can be defined as broad preferences concerning appropriate courses of action or outcomes. As such, values reflect a person's sense of right and wrong or what "ought" to be.

The objectives of the course are:

- To lay a strong foundation in value education.
- To create awareness towards realizing self
- To inculcate in students the spirit of social responsibility
- To add value to human relations.
- To make students understand Salient values for life such as truth, commitment, honesty , integrity etc.

### **Unit I: Yam – Satya, Ahinsa, Brahmacharya, Asteya, Aparigraha**

Value education-its purpose and significance in the present world –Holistic living – Balancing the outer and inner –Body, Mind and Intellectual level- Duties and responsibilities. Environment and Ecological balance –interdependence of all beings – living and non-living. The binding of man and nature – Environment conservation and enrichment.

### **Unit II: Niyam – Soch, Santosh, Tapa, Swadhyaya, Ishwar Pranidhan**

- Social Evils – Corruption, Cyber crime, Terrorism – Alcoholism, Drug addiction – Dowry – Domestic violence – untouchability – female infanticide – atrocities against women-How to tackle them.
- Values for life : truth, commitment, honesty and integrity, forgiveness and love, empathy and ability to sacrifice, care, unity , and inclusiveness, Self esteem and self confidence, punctuality – Time, task and resource management – Problem solving and decision making skills- Interpersonal and Intra personal relationship – Team work – Positive and creative thinking

#### **References:**

1. M.G.Chitakra: Education and Human Values, A.P.H.Publishing Corporation, New Delhi, 2003
2. Chakravarthy, S.K. : Values and ethics for Organizations: Theory and Practice, Oxford University Press, New Delhi , 1999.
3. Das, M.S. & Gupta, V.K. : Social Values among Young adults: A changing Scenario, M.D. Publications, New Delhi, 1995
4. Bandiste, D.D.: Humanist Values: A Source Book, B.R. Publishing Corporation, Delhi, 1999

## SEMESTER III

**BBT 301: Concepts in Microbiology** **Total**  
**Core Course – Theory; 3 Credits** **45L**

### UNIT I

- 1 **Bacterial genetics:** Genetic exchanges in bacteria-Conjugation, Transformation, Transduction, Holliday model of Recombination 7 L
- 2 **Eukaryotic unicellular microorganisms:** Yeast and fungi: Distribution, classification, structure, reproduction, economic importance. Distinguishing characteristics of Archea, Actinomycetes, Rickettsia & Mycoplasma 8 L

### UNIT II

- 6 **Bacterial viruses:** General characteristics, classification, nomenclature, morphology and structure, life cycle (lytic & lysogenic) of  $\lambda$  phage. 7 L
- 7 **Plant and animal viruses:** Structure, classification, replication of plant viruses (TMV) and animal viruses (Influenza), methods of virus cultivation, viroids 8 L

### UNIT III

- 8 **Infection and pathogenicity:** Host parasite relationship, infection, sources of infection, mode of transmission, virulence factors, types of infectious diseases, epidemiology and public health microbiology, control of epidemics 7 L
- 9 **Antimicrobial chemotherapy:** Antibiotics and their mode of action, inhibition of cell wall synthesis, damage of cytoplasmic membrane, inhibition of nucleic acid & protein synthesis, inhibition of specific enzyme system, microbial assay. 8 L

### References:

- 1) Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
- 2) General Microbiology - Stanier R.Y., 5th edition, (1987) Macmillan Publication UK.
- 3) Prescott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Engineering, USA
- 4) Biology of Microorganisms, Madigan, M. T., Martinko, J. M. and Parker, J. B., Prentice-Hall Publ., New York (2001).

- 5) Microbiology–6th Edition (2006), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY
- 6) General Microbiology - Stanier R.Y., 5th edition, (1987) Macmillan Publication UK.
- 7) Prescott's Microbiology, 8th edition (2010), Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, ChrisWoolverton, McGrawHil Science Engineering, USA
- 8) Biology of Microorganisms, Madigan, M. T., Martinko, J. M. and Parker, J. B., Prentice-Hall Publ., New York (2001).

**BBT 302: Biochemistry II**  
**Core Course – Theory; 3 Credits**

**Total**  
**45L**

**UNIT I**

- 1 Thermodynamics** 7 L  
(Recap second law of thermodynamics, entropy, spontaneous change, free energy, enthalpy, reactions at equilibrium, interpretation of equilibrium constants, acid and bases, solubility equilibria, biological activity), Bioenergetics: Anabolism and catabolism. Energy transformations obey laws of thermodynamics, oxidation and reduction, redox potential, high energy bonds / compounds.
- 2 Enzymes** 8 L  
Introduction, classification and nomenclature, specificity of enzymes, mechanism of enzyme actions (Induced fit theory etc), factors affecting enzyme activity; enzyme kinetics-Michaelis–Menten rate equation; regulatory enzymes; enzyme inhibition- allosteric, feedback, competitive and non-competitive inhibition (double reciprocal plots).

**UNIT II**

- 3 Catabolism of carbohydrates** 8 L
- I. Carbohydrates from diet, its digestion, concept of cellular respiration
  - II. Glycolytic pathway, entry of pyruvate in citric acid cycle: site, enzymes, regulation, energetics
  - III. Glycogenolysis: site, enzymes, regulation, energetics
  - IV. TCA: pathway, site, enzymes, regulation, energetic, amphibolic nature of citric acid cycle; Glyoxylate cycle: site, enzymes, regulation, energetics
  - V. Electron transfer chain, enzymes, pathway and oxidative phosphorylation in mitochondria, energetic, regulation
  - VI. Overview of entry of other sugars
  - VII. Alternate pathways: Pentose phosphate pathway
- 4 Anabolism of carbohydrates** 7 L
- I. Photosynthesis (C3):Photosynthetic pigments, light reaction (absorption of light, ETC and cyclic and non-cyclic photophosphorylation) and dark reactions, photorespiration, C4 and CAM metabolism
  - II. Gluconeogenesis (C6): site, enzymes, regulation, energetics
  - III. Glycogenesis (C6 polymer): site, enzymes, regulation, energetics

## UNIT III

- 5 Lipid metabolism** 8 L
- I. Digestion, transport , absorption
  - II. Oxidation of fatty acids (saturated, unsaturated), regulation, energetics – compare with breakdown of carbohydrates
  - III. Ketone bodies
  - IV. Overview of anabolism
- 6 Nitrogen metabolism** 7 L
- I. Overview of nitrogen metabolism
  - II. Digestion of proteins to peptides and amino acids, essential amino acids, transamination of amino acids
  - III. Nitrogen excretion and urea cycle
  - IV. Molecules Derived from Amino Acids

### References:

- 1) Biochemistry, Berg, J.M., Tymoczko, J. L. and Stryer, L. W.H. Freeman and Co., New York, USA (2003).
- 2) Principles of Biochemistry, Lehninger, A., Nelson, D.L and Cox, M. M., W.H. Freeman and Co., New York, USA (2008).
- 3) Biochemistry, Satyanarayan, U., Books and Allied (P) Ltd., Kolkata, India (2008).

**BBT 303: Principles and techniques in Molecular Biology** **Total**  
**Core Course – Theory; 3 Credits** **45L**

**UNIT I**

- |  |     |
|--|-----|
| <b>1 Molecules of life</b><br>Introduction to molecular biology, structure and role of nucleotides and nucleic acids; evidence of DNA as genetic material, Watson and Crick's structure of DNA, A & Z forms of DNA; Properties of DNA                            | 4 L |
| <b>2 Types, structure and role of RNA</b><br>Types of RNAs, mRNA of prokaryotes and eukaryotes, tRNA structure and role as an adapter molecule, rRNA of prokaryotic and eukaryotic cells, structural and catalytic role of RNA                                   | 3 L |
| <b>3 Mutations</b><br>Types of mutations, effect of mutations, mutation related inherited human disorders, Physical and chemical mutagenic agents, frequency of mutations, measuring mutation rate, somatic & germline mutations, role of mutations in evolution | 4 L |
| <b>4 Genetic code</b><br>Salient features of genetic code, codon – anticodon recognition, Wobble hypothesis, exceptions to the universal genetic code  | 4 L |

**UNIT II**

- |  |     |
|--|-----|
| <b>4 Features of whole genome</b><br>Genome size of different organisms; C value, C value paradox, repetitive and nonrepetitive  | 4 L |
| <b>5 Organization of genome</b><br>Organization of bacterial nucleoid; structure of eukaryotic chromosome; structure and role of centromere and telomere; chromatin; structure of nucleosome and higher level organization | 5 L |
| <b>6 Genome sequences and gene number</b><br>Concept of gene, number and distribution of genes and other sequences in the genome, pseudogenes, clusters, repeats and satellite DNA sequences, polymorphism in genomes      | 4 L |
| <b>7 Extra chromosomal genomes</b><br>Organization of mitochondrial and chloroplast genomes; their significance, evolution of mitochondrial genome   | 2 L |



### UNIT III

- |           |   |     |
|-----------|---|-----|
| <b>8</b>  | <b>Basic Techniques in Molecular Biology</b><br>Nucleic acids isolation and separation techniques; nucleic acid detection: Quantification of DNA and RNA with absorption and fluorescence Spectroscopy techniques, blotting methods | 5L  |
| <b>9</b>  | <b>Polymerase chain reaction</b><br>Principle and applications of nested, multiplex, random amplified polymorphic DNA, Long PCR and Real time PCR   | 5 L |
| <b>10</b> | <b>Advance techniques</b><br>Creating mutation; random or specific, DNA sequencing, DNA microarrays; chromatin immunoprecipitation  | 5 L |

### References

- 1) Lewin's GENES XI. Krebs J.E., Kilpatrick S.T., Goldstein E. S., International Student Ed. Jones and Bartlett Publ. MA, USA, 01776, 2013.
- 2) Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Losick R., Molecular Biology of the Gene 7<sup>th</sup> Ed. Benjamin Cummings Publ. USA 2013.
- 3) Cooper G.M., Hausman R. E., The Cell: A molecular approach, Sixth Ed. Sinauer Associates, Inc., ASM Press., Washington DC. 2013
- 4) Prescott's Microbiology, 8th edition, Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, Chris Woolverton, McGrawHil Science Engineering, USA. 2010
- 5) Pal J.K., Ghaskadbi S.S., Fundamentals of Molecular Biology. Oxford University Press Incorporated 2009.

<b>BBT 304: Immunology</b>	<b>Total</b>
<b>Core Course – Theory; 3 Credits</b>	<b>45L</b>

**UNIT I**

1	<b>Introduction to basic immunology</b>	2
2	<b>Types of immune response</b> Innate immunity; adaptive immunity; humoral and cell mediated immune response	4
3	<b>Cells of adaptive immune system</b> Lymphocytes and antigen presenting cells	2
4	<b>Organs of the immune system</b> Bone marrow, thymus, lymphoid organs and spleen	2
5	<b>Antigens and antibodies</b> Antigens, nature and types; antibodies , molecular structure, classes and subclasses	5

**UNIT II**

5	<b>Molecular Immunology</b> Antigen presenting cells; antigen processing and presentation	3
6	<b>Major Histocompatibility complex</b> Class I, class II MHC molecules; Diversity of MHC molecules; role in thymic selection of T cells and in antigen presentation	4
7	<b>B cell differentiation</b> B cell maturation, activation and differentiation	4
8	<b>T cell differentiation</b> T cell maturation, activation and differentiation, T cell receptor, primary and secondary immune response	4

**UNIT III**

9	<b>Complement system</b> Classical pathway, alternative pathway	3
10	<b>Immunological diseases</b> Hypersensitivity; autoimmunity; immunodeficiency diseases	5
11	<b>Immuno – chemical techniques</b> Antigen – antibody reactions; immunoprecipitation; agglutination; ELISA; RIA; Western blotting; immune fluorescence; preparation of polyclonal antibodies; production of monoclonal antibodies	7

**References**

1. Gangal S, Sontakke S. Textbook of basic and clinical immunology. University Press 2013
2. Golddy A, Thomas JK, Barbara AO and Kuby J, Immunology, 6<sup>th</sup> Ed, 2006
3. Peter Patham, The immune system, 3<sup>rd</sup> Ed., Garland SC, 2009
4. Janeway C, Traverse, Walport and Shlomchic Immunology, 6<sup>th</sup> Ed, Garland SC.

<b>BBT 305: Practicals in Microbiology</b>		<b>Total</b>
<b>Core Course – Practical; 3 Credits</b>		<b>20 P</b>
1	Micrometry	2P
2.	Cell/ spore counting	2P
3	Biochemical Characterization of Bacteria	6 P
	I. Sugar fermentation Test	
	II. Catalase, Oxidase and Urease Tests	
	III. IMViC test	
	IV. Hydrogen Sulfide Test and Nitrate Reduction Test	
	Casein and Starch Hydrolysis	
4	Maintenance and revival of cultures through traditional and modern methods	3 P
5	Isolation of bacteriophages	3 P
6	Isolation of fungi and yeast from natural environment	2 P
7	Antibiotic susceptibility by disc diffusion assay	2 P

### References

- 1) Source Book for Experiments for the Teaching of Microbiology, (1982) Primrose, S. B. and Wardlow, A. C. Academic Press, London.
- 2) Microbiology: A Laboratory Manual, (2004),6thEdn. Cappuccino, J.G. and Sherman, N., Pearson Education Pvt. Ltd., Singapore.
- 3) Practical Microbiology: Principles and Techniques, (2005), 1st Edn., Kale, V and Bhusari, K. Himalaya Publishing House, New Delhi.
- 4) Introductory Practical Microbiology, (2007),Mu dili, J., Narosa Publ. House P.Ltd., New Delhi
- 5) Experiments in Microbiology, Plant Pathology and Biotechnology, (2007),4<sup>th</sup>Edn., Aneja, K. R., New Age International Publishers, New Delhi.

<b>BBT 306: Practicals in Biochemistry II</b>		<b>Total</b>
<b>Core Course – Practical; 3 Credits</b>		<b>20 P</b>
1	Detection of industrially significant enzymes: $\alpha$ - Amylase, protease, Lipase, invertase, phosphatase, cellulase.	2P
2	Enzymatic preparation of bio-molecules: 2.1 Dextrin: Production of malto-dextrin by using $\beta$ -amylase 2.2 Glucose: Production of glucose by bacterial $\alpha$ -amylase and amyloglucosidase 2.3 Production of invert sugar by invertase 2.4 Peptide preparation by proteolysis by using papain 2.5 Softening of chhole, rajma, idli using papain	5 P
3	Estimation of $\alpha$ - amylase enzyme activity	1 P
4	Study of parameters affecting enzyme activity 4.1 Effect of temperature (optimum temp). 4.2 Effect of pH (optimum pH). 4.3 Effect of incubation period. 4.4 Effect of substrate concentration ( $K_m$ & $V_{max}$ ). 4.5 Effect of enzyme concentration. 4.6 Effect of activators and inhibitors.	8 P
5	Laboratory Experiments on the Actions of Digestive Enzymes	2 P
6	Study of a metabolic pathway: the GPO–PAP triacylglycerol test	2 P

### References

- 1) Introductory Practical Biochemistry, Sawhney, S. K. and Singh, R. Narosa Publishing House, New Delhi (2000).
- 2) An Introduction to Practical Biochemistry, Plummer, D.T., Tata-McGraw-Hill Publishing Co., New Delhi (2005).
- 3) Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J., Cambridge University Press, New York (2005).
- 4) Laboratory Manual in Biochemistry, Jayraman J., New Age International (P) Ltd., New Delhi (2007).

<b>BBT 307: Practicals in Molecular Biology and Immunology</b>		<b>Total</b>
<b>Core Course – Practical; 3 Credits</b>		<b>20 P</b>
1	Introduction to important equipments used for molecular biology laboratory; clean handling practice; precision and reliability in liquid and weight measurements	1P
2	Preparation of buffers and stock solutions; learning of safety measures for hazardous chemicals	2 P
3	Isolation of genomic DNA from bacterial cells	3 P
	Isolation of DNA from plant cells	2 P
4	Determination of melting temperature of DNA	1 P
5	Quantitation of DNA and RNA preparations and determination of purity by UV spectrophotometry	1 P
6	Analysis of DNA and RNA preparations by agarose gel electrophoresis	2 P
7	Demonstration of blood groups	1 P
8	Differential count of WBC	1 P
9	Widal test, VDRL test	2 P
10	Dot ELISA	1 P
11	Ouchterlony double diffusion	2 P
12	Separation of serum from blood and precipitation of immunoglobulin	1 P

### References

1. Green M.R., Sambrook J., Molecular cloning: A laboratory manual (Fourth Ed.): Three volume set. Cold Spring Harbor Laboratory Press. New York. 2012
2. Pal J.K., Ghaskadbi S.S., Fundamentals of Molecular Biology. Oxford University Press Incorporated 2009.
3. Wilson K. and Walker J. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, New York. 2005
4. Gangal S, Sontakke S Textbook of basic and clinical immunology. University Press 2013
5. Golddy A, Thomas JK, Barbara AO and Kuby J, Immunology

**BBT 308: Patent & IPR, Open Course III; Option I**  
**Open Course III; 2 Credits**

**Total**  
**30L**

**UNIT I**

- |   |   |     |
|---|---|-----|
| 1 | Introduction – Invention and Creativity – Intellectual Property (IP) – Importance Protection of IPR – Basic types of property (i). Movable Property - Immovable Property and - Intellectual Property. | 3 L |
| 2 | Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs  | 3 L |
| 3 | International framework for the protection of IP; IP as a factor in R&D;Introduction to History of GATT, WTO, WIPO and TRIPS.   | 3 L |
| 4 | Patent databases; Searching International Databases; Country-wise patent searches   | 3 L |
| 5 | Case Studies on – Patents (Basmati rice, turmeric, Neem, etc.) Protection against unfair competition.   | 3 L |

**UNIT II**

- |    |  |     |
|----|--|-----|
| 6  | Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; | 3 L |
| 7  | PCT and convention patent applications; International patenting- requirement, procedures and costs;  | 3 L |
| 8  | financial assistance for patenting-introduction to existing schemes;   | 3 L |
| 9  | Role of a Country Patent Office ,Patent office in India, Role of patent Attorney .   | 3 L |
| 10 | Patent infringement- meaning, scope, litigation, case studies and examples   | 3 L |

**References: Important Links**

- 1) Intellectual property rights in agricultural biotechnology By Frederic H. Erbisch, Karim M. Maredia, Biotechnology in Agriculture Series No 28,
- 2) The role of intellectual property rights in biotechnology innovation By David Castle, Edward Elgar Publishing
- 3) <http://www.wipo.int/portal/index.html.en>
- 4) [http://www.ipr.co.uk/IP\\_conventions/patent\\_cooperation\\_treaty.html](http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html)
- 5) [www.patentoffice.nic.in](http://www.patentoffice.nic.in)
- 6) [www.iprlawindia.org](http://www.iprlawindia.org)

**BBT 308: Nutrition, Open Course III; Option II** **Total**  
**Open Course III, 2 Credits** **30 L**

- |  |     |
|--|-----|
| <b>1 Nutritional Biochemistry</b><br>Nutrition classification of food; Five-food group plan (ICMR),<br>Basic food groups; Fuel value of carbohydrates, fats and protein<br>(Unit of energy)  | 6 L |
| <b>2 Nutrition and its physiological role</b><br>Definition for nutrition, nutrients, body weight body composition,<br>measurement of energy expenditure – calorimeter, BMR, SDA and RQ.<br>Physico chemical properties and physiological actions of dietary fibre,<br>protein energy malnutrition | 9 L |

**UNIT II**

- |  |     |
|--|-----|
| <b>6 Significance of water in metabolism</b><br>Dehydration and oedema, Significance, preservation of physiological pH<br>and, anion and cation balance, Acid – base balance in body fluids.   | 5 L |
| <b>7 Vitamins and Minerals</b><br>Outlines of vitamins and minerals. Classification of vitamins – Fat soluble<br>and water soluble. Dietary source, structures, RDA, functions and<br>deficiency states. Dietary sources, structures, RDA, functions and<br>deficiency of Iron, Calcium, phosphorus and magnesium, Iodine, zinc<br>and copper. | 7 L |
| <b>8 Analytical techniques in food biochemistry; recent<br/>advances in food biotechnology research</b>  | 3 L |

**References:**

- 1) Food biochemistry and Food processing, Y. H. Hui, Blackwell publishing (2006),
- 2) Food: The chemistry and its components; Tom Coultate, RSC publishing (2008),

**BBT 309: General Course III, Elective; Option I - Communication Skills and Personality Development** **Total**  
**General Course III; 2 Credits** **30 L**

1	Preparation of presentation –principles and presentation technique (what, how, for whom etc).	3 L
2	Nonverbal communication during presentation – how to manage stress, what to do with hands, legs ..., activating the audience with nonverbal communication	3 L
3	Verbal communication –argumentation, usable and unsuitable phrases	2 L
4	Communication skills – listening, empathic reaction, how to question, stealing the show, opening door question	3 L
5	Conflict situation solving, attack from the audience – communication skills as a work experience, vicious circle of attack and defence	2 L
6	Work with audience – ice-breaking, get them in the mood, work with emotions, visualization tools, nonstandard situations	3 L
7	Improvisation and unprepared presentations	2 L
8	Paradigm of human cooperation – why there could be problems to start the communication and what to do with it	3 L
9	Defense against manipulation, how to say NO, stress management	3 L
10	Image and etiquette	2 L
11	Basics of Personality (Definationetc), Theories of Personality Development	3 L
12	Analysing Strengths & weaknesses, Body Language & Preparation of Self Introduction	3 L



## SEMESTER IV

### BBT 401: Environmental Biotechnology Core Course – Theory; 3 Credits

Total  
45L

#### UNIT I

- |   |  |     |
|---|--|-----|
| 1 | Environmental Components: Constituents of environment, biotic and abiotic factors.   | 2 L |
| 2 | Ecosystems: Aquatic, forest, marine life, mountain life and underground life.  | 3 L |
| 3 | Atmosphere: composition and structure. Green house effect, ozone depletion and problems of climate change, related international conventions | 3 L |
| 4 | Characteristics of hydrosphere, water resources, hydrological cycle  | 2 L |
| 5 | Composition of lithosphere/soil; Biogeochemical cycles, their Implications on living systems   | 3 L |
| 6 | Characteristics of the biosphere.  | 2 L |

#### UNIT II

- |    |  |     |
|----|--|-----|
| 7  | <b>Natural resources and environment</b><br>Types of resources, current status and conservation. Sustainable development   | 4 L |
| 8  | <b>Concept of biodiversity</b> and its conservation, present status and types of biodiversity; extinct and endangered species; red data book, steps to preserve biodiversity; concept of in-situ and ex-situ conservation of species; concept of gene and germplasm banks in conservation of endangered species. | 4 L |
| 9  | <b>History of Environmental Biotechnology:</b> Role of Environmental Biotechnology in Environment protection, Microbial interactions in the environment  | 4 L |
| 10 | <b>Biotechnological processes:</b> Bioconversion, Bioaccumulation  | 3 L |

#### UNIT III

- |    |   |     |
|----|---|-----|
| 11 | <b>Environmental pollution &amp; Control</b><br>Introduction: Definition and sources of pollution; Different types of pollution                                   | 2 L |
| 12 | <b>Air pollutants</b> , monitoring techniques, pollution control devices, effects on human health, plants & atmosphere, acid rain, and aerobiology                | 2 L |
| 13 | <b>Water pollution</b> , effects on human health, monitoring techniques (BOD, COD, TVC), eutrophication, waste water treatment, ground water and marine pollution | 2 L |
| 14 | <b>Soil erosion and remedial measures</b> to recover alkaline, acidic and   | 2 L |

- saline soils, bio-pesticides
- |    |  |                |
|----|--|----------------|
| 15 | <b>Solid waste and management:</b> Types of wastes (municipal, agricultural, industrial and mining), Hazardous wastes (electronic, nuclear and biomedical); Waste reduction for energy management - biomass, biogas, composting. | 2 L<br><br>1 L |
| 16 | <b>Bioremediation,</b> biodegradation, biosorption   | 1 L            |
| 17 | <b>Noise pollution:Sources,</b> measurement, effects on human health and control.  |                |
| 18 | <b>Radiation hazards:</b> Introduction, atomic radiation, effects of radiation, radioactive waste, radiation protection  | 2 L            |
| 19 | <b>Sustainable sources of energy</b>   | 1 L            |

### References

1. Waste water Engineering: Treatment, Disposal and Reuse. Metcalf and Eddy Revised by G. Tchobanoglous, Franklin L. Burton & H. David Stensel Tata Mcgraw Hill Publishing Company Limited, New Delhi (2003).
2. De, A K (2008) Environmental Chemistry, New Age International (P) Ltd., New Delhi.
3. Rittmann, BE and McCarty, P L(2001) Environmental Biotechnology: Principles and Applications ,International Edition, Mcgraw-Hill, New York.
4. Mohan Primalani (2005) WasteWater Treatment, Oxford and IBH Publishing Co.Pvt.Ltd. New Delhi
5. P. K. Goel (2006) Water Pollution: Causes, Effects and Control, 2<sup>nd</sup> Revised Ed., New Age International Publishers, New Delhi

**BBT 402: Fundamentals in Molecular Biology** **Total**  
**Core Course – Theory; 3 Credits** **45L**

**UNIT I**

- |   |     |
|---|-----|
| <b>1 DNA replication</b><br>DNA polymerases: types, structure and catalytic role, priming reactions, semi-conservative replication of DNA, synthesis of leading, lagging strands, okazaki fragments, termination of replication | 9 L |
| <b>2 DNA Repair</b><br>Damage to DNA, repair mechanisms (excision in prokaryotes and eukaryotes, mismatch, recombination, error prone), SOS response  | 6 L |

**UNIT II**

- |  |     |
|--|-----|
| <b>3 Prokaryotic transcription</b><br>Overview; RNA polymerase structure and role; typical bacterial promoter and its interaction with sigma factor, initiation, elongation and termination of transcription                                       | 6 L |
| <b>4 Eukaryotic transcription</b><br>Eukaryotic RNA polymerases, structure and types; initiation of rRNA, tRNA and mRNA synthesis; promoter elements; role of TBP; transcription factors and enhancers; post – transcriptional modification of RNA | 9 L |

**UNIT III**

- |  |     |
|--|-----|
| <b>5 Translation</b><br>Structure and role of ribosomes; initiation, peptide bond formation, translocation, elongation and termination of protein synthesis in prokaryotes and eukaryotes, post translational modification of proteins | 9 L |
| <b>6 Regulation of gene expression</b><br>Overview; regulation of lac, tryptophan and arabinose operon   | 6L  |

**References**

- 1) Lewin's GENES XI. Krebs J.E., Kilpatrick S.T., Goldstein E. S., International Student Ed. Jones and Bartlett Publ. MA, USA, 01776, 2013.
- 2) Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Losick R., Molecular Biology of the Gene 7<sup>th</sup> Ed. Benjamin Cummings Publ. USA 2013.

- 3) Cooper G.M., Hausman R. E., The Cell: A molecular approach, Sixth Ed. Sinauer Associates, Inc., ASM Press., Washington DC. 2013
- 4) Prescott's Microbiology, 8th edition, Joanne M Willey, Joanne Willey, Linda Sherwood, Linda M Sherwood, Christopher J Woolverton, ChrisWoolverton, McGrawHil Science Engineering, USA. 2010
- 5) Pal J.K., Ghaskadbi S.S., Fundamentals of Molecular Biology. Oxford University Press Incorporated 2009.

**BBT 403: Developmental Biology**  
**Core Course – Theory; 3 Credits**

**Total 45L**

**UNIT I**

1	Embryology: History & Concepts	4 L
2	Gametogenesis (Spermatogenesis, Oogenesis)	5L
3	Meiosis	2L
4	Types and patterns of cleavage, blastulation	4L

**UNIT II**

	Gastrulation in frog and chick up to formation of three germinal layers	6L
	Germ Layer Formation	3L
	Implantation	3L
	Fetal Membranes, Placenta	3L

**UNIT III**

6	Concepts of competence, determination, commitment and differentiation, dedifferentiation, redifferentiation, transdifferentiation, developmental plasticity in animal development	4L
7	Role of gene/s in patterning and development. Concept of Stem cells, Progenitor cells, cell lineages in plants and animals	4L
8	Ageing and apoptosis, abnormal development and teratogenesis in animals: cancer	4L
9	Cloning in mammals, transgenic technology in plants and animals	3L

**References**

- 1) Development Biology, 9<sup>th</sup> edition, (2010), Gilbert S.F.(Sinauer Associates, (USA)
- 2) Principles of Development, 4<sup>th</sup> edition (2010), Wilbert L and Tickle C, Publisher: Oxford University Press, USA.
- 3) Human Embryology and Developmental Biology, Author: [Carlson, Bruce M.](#) Edition: 3, Publisher: Elsevier - Health Sciences Division ISBN-13: 9780323014878
- 4) Developmental Biology, 6th ed., Gilbert, Scott F; Sunderland (MA): Sinauer Associates
- 5) An Introduction to Embryology, 9<sup>th</sup> edition, B. I. Balinsky. Publisher-Thomas Asia Pvt. Ltd
- 6) Balinsky : introduction to Embryology (CBS College Publishers)
- 7) Berril, NJ : Developmental biology (Tata-McGraw-Hill)
- 8) Davenport : An outline of animal development (Addison - Werley)
- 9) Subramanyan, T : Developmental Biology (Narosa Publishing House)

- 10) Rao, K.V. : Developmental Biology : A modern synthesis (Oxford - IBH Publishers)
- 11) Arumugam N.A. text book of embryology (Saras publication)

<b>BBT 404: ANALYTICAL TECHNIQUES</b>	<b>Total</b>
<b>Core Course – Theory; 3 Credits</b>	<b>45L</b>

**UNIT I**

- |   |  |     |
|---|--|-----|
| 1 | <b>Filtration techniques:</b> Gross filtration, steri-pad filtration, membrane filtration, milli-filtration, micro-filtration, ultra-filtration, reverse osmosis, dialysis, their applications in industry. Merits and limitations                   | 4 L |
| 2 | <b>Centrifugation-</b> Table top, high speed, microfuge, refrigerated, ultra, density gradient centrifugation. Basket centrifuges, cream separators, sharple centrifuge, continuous and batch-wise processing, applications in biochemical industry. | 4 L |
| 3 | <b>Lyophilization</b> Principle and practice, applications in R&D (cells and proteins) and nutraceuticals  | 4 L |
| 4 | <b>MALDI-TOF</b> - Introduction to mass spectrometry, applications in determining mass of peptides and proteins  | 3 L |

**UNIT II**

- |   |   |     |
|---|---|-----|
| 5 | <b>Chromatography-</b> Principle, types- (paper, thin layer, gel, affinity, ion exchange), applications; purification of proteins and enzymes and DNA/RNA fractionation | 4 L |
| 6 | <b>HPLC-</b> Concept, principle, procedure (analytical and preparatory), separation on the basis of detectors, accuracy, applications in research and quality control   | 4 L |
| 7 | <b>GC:</b> Concept, principle, procedure (analytical and preparatory), separation on the basis of detectors, accuracy, applications in research and quality control     | 4 L |
| 8 | <b>Introduction to NMR;</b> principle, <sup>1</sup> H and <sup>13</sup> C NMR, applications in determining structures of biomolecules, Magnetic resonance imaging (MRI) | 3 L |

**UNIT III**

- |    |  |     |
|----|--|-----|
| 9  | <b>Radioimmunoassays/MRI:</b> Definition of isotopes and radioisotopes, measurement (counters), half-life, useful isotopes for applications in health and research, carbon dating. Electromagnetic radiations (UV, IR, X-ray, α, β, γ rays, visible spectrum), their measurement. Applications for health and agriculture. | 4 L |
| 10 | <b>Electrophoresis</b> Principle of separation, factors affecting separation, types -paper, agarose gel, PAGE, 2D- gel electrophoresis   | 4 L |
| 11 | <b>AFM:</b> principle, method, applications  | 3 L |
| 12 | <b>X-ray diffraction</b> – principle, method, application for determining 3D structure of proteins - over view of Ramchandran plot.  | 4 L |

**References:**

- 1) Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2005).
- 2) Laboratory Manual in Biochemistry, Jayraman, J., New Age International (P) Ltd., New Delhi (2007).



<b>BBT 405: Environmental Biotechnology Lab</b>		<b>Total</b>
<b>Core Course – Practical; 3 Credits</b>		<b>20 P</b>
1	Preparation of vermin-compost	1 P
2	Study of ecosystems Aquatic, forest, river, hill slopes, etc.	1 P
3	Experiments based on Spectrometer and Flame Photometer Na/K	2 P
4	Determination of equivalent noise level (Leq) of the surrounding air	1 P
5	Determination of Dissolved Oxygen (DO) in given water sample	1 P
6	Determination of Biochemical Oxygen Demand (B.O.D) in given water sample	2 P
7	Determination of Chemical Oxygen Demand (C.O.D) in given waste water sample	1 P
8	Enumeration of coilform in water by Most Probable Number (MPN) test	1 P
9	Determination of Nitrate In Waste Water	1 P
10	Determination of organic matter from given soil sample	2 P
11	Estimation of biomass from Planktonic organisms	2 P
12	Study of production of biogas from municipal sewage & food waste	2 P
13	Determination PM <sub>10</sub> Concentration using High Volume Sampler (HVS)	1 P
14	Biodegradation of Environ friendly material	1 P
15	Visit to waste water treatment plant(Industrial visit)	1P

### **References**

- 1) Waste water Engineering: Treatment, Disposal and Reuse. Metcalf and Eddy Revised by G. Tchobanoglous, Franklin L. Burton & H. David Stensel Tata Mcgraw Hill Publishing Company Limited, New Delhi (2003).
- 2) Sharma, B K (2006) Environmental Chemistry, Krishna Prakashan Media (P) Ltd., Delhi.
- 3) Mohan Pramlani (2005) WasteWater Treatment, Oxford and IBH Publishing Co.Pvt.Ltd. New Delhi
- 4) Environmental Microbiology(Second Edition)Edited by:Ian L. Pepper, Charles P. Gerba, Terry Gentry and Raina M. Maier ISBN: 978-0-12-370519-8

<b>BBT 406 : Practicals in Molecular &amp; Developmental Biology</b>		<b>Total</b>
<b>Core Course- Practical; 3 Credits</b>		<b>20 P</b>
1	Isolation of DNA from mammalian cells	1 P
2	Isolation of RNA from mammalian cells	1 P
3	Quantitation of DNA and RNA preparations and determination of purity by UV spectrophotometry	1 P
4	Analysis of DNA and RNA preparations by agarose gel electrophoresis	1 P
5	Amplification of DNA segment by Polymerase Chain Reaction (PCR)	1 P
7	Temporary preparation of Polytene chromosome from chironomous larvae	1 P
8	Study of staging & staining of Chick embryos	1P
9	Study of frog development, observation of frog embryo different development stages	2 P
10	Study of different types of sperms by smear preparation.	1 P
11	Types of eggs (insect, amphioxus, frog & hen)	1 P
12	Types of blastulae and gastrulae (insect, amphioxus and hen)	1 P
13	Study of permanent histological slides of chick embryo: Primitive streak (T. S), 24h (T. S. through neural tube) and 33H (T. S. through heart).	2P
14	Study of chick embryo whole mounts with reference to staging method in chick development (By Hamburger & Hamilton, given the book by Balanskey): 18 h (primitive streak), 21h, 24h, 33h, 48h, 72h & 96h of incubation.	3 P
	Study of temporary preparation of whole mount of chick embryo	3 P

### References

1. Green M.R., Sambrook J., Molecular cloning: A laboratory manual (Fourth Ed.): Three volume set. Cold Spring Harbor Laboratory Press. New York. 2012
2. Pal J.K., Ghaskadbi S.S., Fundamentals of Molecular Biology. Oxford University Press Incorporated 2009.
3. Wilson K. and Walker J. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, New York. 2005
4. Development Biology, 9<sup>th</sup> edition, (2010), Gilbert S.F.(Sinauer Associates, (USA)
5. Principles of Development, 4<sup>th</sup> edition (2010), Wilbert L and Tickle C, Publisher: Oxford University Press, USA.

### BBT 407: Analytical Techniques Lab

**Total**

**Core Course – Practical; 3 Credits** **20 P**

1	Preparation of de-mineralized water	1 P
2	Separation and estimation of purine & pyrimidine bases, FAD & FMN and NAD & NADP by HPLC	3 P
3	Estimation of chlorophyll a and b on $\lambda_{max}$ basis	1 P
4	Validation of status of laminar air flow bench by direct count	2 P
5	Sterilization of vitamins by membrane filtration	2 P
6	Separation of proteins by polyacrylamide gel electrophoresis	2 P
7	Up-gradation of calcium gluconate by steri-pad filtration method	2 P
8	Sodium and potassium estimation by flame photometry	1 P
9	Reverse osmosis technique for desalination of water	1 P
10	Separation of biomolecules using dialysis technique	2 P
11	Preparation of food product using spray dryer	2 P
12	Visit to research institute or Biotechnology Industry	1P

**References**

1. Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2005).
2. Laboratory Manual in Biochemistry, Jayraman, J., New Age International (P) Ltd. New Delhi (2007).

**BBT 408: Open Course IV, Elective; Option I – Nanotechnology**  
**Open Course IV; 2 Credits**

**Total**  
**30L**

**UNIT I**

1	Introduction to nanotechnology	2 L
2	Types of nanoparticles	4 L
3	Characterization of nanoparticles UV/ VIS spectrophotometer, Scanning probe microscopy, XRD, FTIR	5 L
4	Nano-bio-assemblies	4 L

**UNIT II**

5	Application of nanotechnology in medicine: For imaging and drug delivery	4 L
6	Application of nanotechnology in Biological detection	4 L
7	Application of nanotechnology in Agriculture	3 L
8	Application of nanotechnology for environmental desalination, monitoring water quality, detection of pollutants	4 L

**References**

- 1) T. Pradeep, Nano, The Essentials, Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill Publishing Company Limited, 2007
- 2) Victor E. Borisenko and Stefano Ossicini What is What in the Nanoworld A Handbook on Nanoscience and Nanotechnology 2008 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim
- 3) Nan Yao, Zhong Lin Wang EDS. Handbook of Microscopy For Nanotechnology, KLUWER Academic Publishers Boston / Dordrecht / New York / London
- 4) Nanotechnologies for the Life Sciences Vol. 1, Biofunctionalization of Nanomaterials. Edited by Challa S. S. R. Kumar, 2005 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim ISBN: 3-527-31381-8 XIII
- 5) J. W. M. Bulte, M.M.J. Modo, Nanoparticles in Biomedical Imaging: Emerging Technologies and Applications, Springer Science Business Media, LLC, 2008
- 6) C.A. Mirkin and C.M. Niemeyer, Nanobiotechnology- II, More Concepts and Applications, WILEY-VCH, VerlagGmbH&Co, 2007
- 7) V. Renugopalakrishnan and R. V. Lewis Eds. Bionanotechnology- Proteins to Nanodevices, Springer.
- 8) D. S. Goodsell, Bionanotechnology- Lessons from Nature John Wiley & Sons, Inc 6. Bhushan Ed., Handbook of nanotechnology, Springer.

<b>BBT 408: Open Course IV, Elective; Option II – Biofertilizer Technology</b>	<b>Total</b>
<b>Open Course IV; 2 Credits</b>	<b>30L</b>

**UNIT I**

1	Soil microorganisms, composition and types of soil.	3 L
2	Rhizospheremicroflora and its role in the rhizosphere	3 L
3	Role of microorganisms in composting and humus formation; Bioinoculants and their agricultural importance	3 L
4	Biochemistry of symbiotic and non- symbiotic nitrogen fixation	3 L
5	Phosphate solubilization and Potassium mobilization	3 L

**UNIT II**

6	Methods of application ( liquid and carrier based)	3 L
7	Comparison of bioinoculants with chemical fertilizers	3 L
8	Methods of preparation – liquid and carrier based	3 L
9	Endomycorrhizae and Ectomycorrhizae – Non symbiotic microbes – Azotobacter – Associative Symbiosis - Azospirillum – Cyanobacteria (Nostoc. Gloeocapsa)	3 L
10	AzolaAnabena System. Microbial inoculants.	3 L

**References:**

1. Food Microbiology by Adams, M.R. and Moss, M.O.1995. The Royal Society of Chemistry, Cambridge.
2. Food Microbiology by Frazier, W.C. and Westhoff,D.C.1988. TATA McGraw Hill Publishing company ltd., New Delhi. 8
3. Modern Food Microbiology by Jay, J.M.1987. CBS Publishers and distributors, New Delhi.
6. Basic Food Microbiology by Banwart, G.J.1989. Chapman & Hall New York.
7. A Modern Introduction to Food Microbiology by Board, R.C.1983. Blackwell Scientific Publications, Oxford.
8. Dairy Microbiology by Robinson, R.K.1990. Elsevier Applied Science, London.
9. Food Poisoning and Food Hygiene, Hobbs, B.C. andRoberts, D.1993. Edward Arnold. London

## **BBT 409: General Course IV, Elective; Option I – Seminar & Journal Club General Course IV; 2 Credits**

Journal Club is a student-run institutional course that gives graduate students the opportunity to read, interpret and present literature critically to fellow peers, docs and faculty. This course helps students stay abreast of current knowledge in the field, develop presentation skills .

### **Course Objectives:**

1. Strengthens student's familiarity with and critical analysis of scientific publications and scientific writing. Seminars will emphasize student participation in discussion and evaluation of all journal articles presented.
2. Practices sound scientific thinking hypothesis construction and evaluation in terms of scientific method and merit.
3. Develops skills in critical evaluation through readings and discussions.
4. Improve written and oral communications skills.
5. Improve breadth of knowledge and of scientific topics, methods, and experimental approaches.
6. Introduces students to scientific writing techniques and manuscript reviewing

### **PRESENTATION GUIDELINES**

Papers need to be submitted one week before the JC presentation date.

In each class session, three students will individually give a 20 minute presentation, followed by a question and answer session from the audience.

While there is no strict format, presentations should:

- focus on a critical review of a published paper, from any biotechnology topic,
- review a paper, highlight its strengths and weaknesses, and discuss its scientific implications,
- include an introduction to the topic/field, as topics will inherently be from a wide range of disciplines within biotechnology, not necessarily familiar to all students.

**Evaluation and Grading Policy:** Students are expected to attend the class, do the required reading, participate and present one lecture. Each student will lead a discussion for at least one journal article or give a research talk. The class will be graded Pass/Fail. A passing grade requires an overall percentage of 80% or greater. % of total grade Grades will be based on the following

Attendance 10%

Participation: 40%

Discuss and provide feedback to other participants, Ask questions, :50%

## SEMESTER V

### BBT 501 : Biostatistics

#### Core Course – Theory; 3 Credits

	<b>Total</b>
<b>UNIT I</b>	<b>45 L</b>
1 <b>Central Tendency:</b> Mean (Simple, Geometric and Harmonic), Median (Grouped: Discrete and Continuous, Ungrouped data), Mode (Grouped: Discrete and Continuous, Ungrouped data)	3 L
2 <b>Graphical Representation of data:</b> Line Diagram , Pie Chart, Bar diagram, Histogram, Frequency polygon, Ogives	2 L
3 <b>Set Theory</b>	2 L
4 <b>Frequency distribution:</b> Simple, Grouped, cumulative	2 L
5 <b>Probability:</b> Space and Events, Axioms of Probability, Conditional Probability, Independent Events, Bayes' Theory	3 L
6 <b>Measures of Variation:</b> Dispersion, range, Mean Deviation (Grouped: Discrete and Continuous, Ungrouped data), Standard Deviation (Simple and Discrete series), Variance, Covariance, Coefficient of Variation	3 L
<b>UNIT II</b>	
7 <b>Theoretical Distribution:</b> Normal Distribution, Permutation & Combination, Binomial Distribution, Poisson Distribution, Skewness, Kurtosis and Moments	3 L
8 <b>Discrete and Continuous Distributions:</b> Chi-Square Test: Goodness of fit, Contingency Chi-square and Homogeneity , Chi square ,Student's T Distribution: Unpaired t test and Paired t test, Z Distributions or Z test, F-Test	3 L
9 <b>Correlation:</b> Co-efficient of correlation, Types, Karl Pearson's Co-efficient of correlation, Rank correlation, scatter diagram, partial correlation, Multiple correlation	2 L
10 <b>Regression:</b> Simple, multiple, Linear and Non-linear ,Least Squares Method	2 L
11 <b>Analysis of Variance (ANOVA):</b> One-way Anova and Two-way Anova	2 L
12 <b>Statistical Inference/ Estimation Theory:</b> Estimating With Confidence,	3 L

Confidence Intervals for Population Mean, Population Variance, Testing Hypotheses , Tests for a Mean

### UNIT III

- 13 **Spread sheet as Statistical Package I:** (Problems) Data Naming, Cross tabulation using pivot table for Numerical as well as Nominal data, Computing All Elementary statistics (Measures of Central tendency , Measures of dispersion, Histograms , Frequency tables ). Preparation of simple Quality Control Charts. 3 L
- 14 **Spread sheet as Statistical Package II:** (Problems) Curve fitting (and trends), Exponential, Power, Polynomial, Growth curve analysis, Moving averages and trends 3 L
- 15 **Spread sheet as Statistical Package III:** (Problems) Chisq-test, TTests ( Paired, Unpaired,) , Ztest, ANOVA( one way and two way : Ftest ) 3 L  
Note: Use Data Analysis Tool Pack of Spread Shhets.
- 16 **SPSS or PSPP I:** (Problems) Handling large data, Data Preparation, Elementary statistics, Testing of Hypothesis, Report generation with simple graphics 3 L  
Note: PSPP is Open source equivalent of SPSS and is adequate for beginners.
- 17 **SPSS or PSPP II :** Applications (Problems on) to Linear regression, Multiple regression , ANOVA (one way, two way) 3 L

### References

1. Biostatistics: A guide to design, Analysis and Discovery, Peter Fritz, Elsevier India.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B., Fundamental of Statistics – Vol. I & II, The World Press Pvt. Ltd
3. Biostatistics: A foundation for analysis 7<sup>th</sup> Edition, Ferric Darvas
4. Applied statistical designs for the researcher, Neil Ed Taylor and Francis Groop.
5. Medhi, J., Stochastic Process, Wiley Eastern Ltd.
6. 11. Anderson, T.W., An Introduction to Multivariate Statistical Analysis, John Wiley & Sons.
7. Devore, J.L., 2002 Probability and Statistics, 5<sup>th</sup> edition, Thomson Asia.
8. Hoel, Port and Stone, Introduction to Statistics.
9. Miller & Freund: Probability and Statistics for Engineers, 7<sup>th</sup> Edition.
10. Chung, Kai Lai, Elementry Probability Theory with Statistical Processes (Student Edition) Springer International



**BBT 502: Clinical Biotechnology**  
**Core Course – Theory; 3 Credits**

**Total**  
**45L**

**UNIT I**

- 1 **Clinical significance of biochemical tests-** concept of health and disease, factors causing diseases, clinical significance of biochemical tests and their role in diagnosis, monitoring and therapy of disease 3 L
- 2 **Specimen collection and processing-** collection of blood vein puncture, collection with syringe, collection with evacuated tube, skin puncture, arterial puncture and anticoagulants, plasma and serum. Collection of urine:-Timed urine specimens, urine preservatives. 3 L
- 3 **Blood analysis-** Significance of hemogram, total and differential count, clinical significance of packed RBCs, platelets and erythrocyte sedimentation rate (ESR), blood groups: matching and cross matching 3 L
- 4 **Blood coagulation-** Clotting factors, coagulation: tests- clotting time and prothrombin time, diseases associated with blood clotting/ blood lysis 3 L
- 5 **Urine analysis-** Structure and functions of kidney, abnormal constituents of urine and their significance: glucose, acetone bodies, urea, creatinine, uric acid, billirubin, protein, Na<sup>+</sup>, K<sup>+</sup> and calcium oxalate. 3 L

**UNIT II**

- 6 **Lipid profile-** Determination of triglycerides, cholesterol, VLDL, LDL, HDL, significance of deviation from normal range. 4 L
- 7 **Status of liver:** Structure and functions of liver, liver function tests, metabolism of RBC, free and conjugated billirubin, types of Jaundice - hemolytic, hepatic, post-hepatic, neonatal and jaundice of genetic origin. 4 L
- 8 **Significance of enzymes in diagnosis:** assay and significance of enzyme levels in heart, liver, kidney and pancreatic disorders. SGPT, SGOT, alkaline phosphatase, lactate dehydrogenase, creatine phosphokinase,  $\alpha$  – amylase. 4 L
- 9 **Radioisotopes in medicine-**Concept of radioactivity, use of radioisotopes in medicine, radiation hazards, radiation health safety and protection 3 L

**UNIT III**

- 10 **Acid-Base Balance:** Acids, bases and buffers, normal pH of the body fluids, regulation of blood pH, acidosis and alkalosis, anion gap 3 L

- 11 **Electrolyte balance and water metabolism-** Regulation of fluids and electrolytes, Water excess and depletion, Sodium balance, Potassium balance 3 L
- 12 **Carbohydrates pathophysiology: Regulation of Blood Sugar, Insulin and Diabetes Mellitus:**Regulation of blood glucose, insulin, glucagon, prediabetes, types of diabetes mellitus, glucose tolerance test, clinical presentation, diabetic keto acidosis, chronic complications 3 L
- 13 **Lipids pathophysiology:**Metabolism of adipose tissue, Hormone sensitive lipase, Obesity, Fatty liver, Lipotropic factors, Ketone bodies, Plasma cholesterol, Atherosclerosis, Coronary artery disease 3 L
- 14 **Protein pathophysiology-** determination of Hb, glycosylated Hb, definition of anemia, types of anemia – iron deficiency anemia, Pernicious anemia, hemolytic anemia, aplastic anemia, sickle cell anemia. Thalaessaemia. 3 L

## References

1. Human biochemistry, Frisell, W.R., Macmillan Publ. New York, (1982).
2. Basic Neurochemistry, Molecular, Cellular And Medical Aspects, Siegel, G. J., Albers, R. W., and Price, D. L., Lippincott Williams & Wilkins (2005).
3. Essentials of Clinical Immunology, Chapel, H., Ed., Blackwell Publ. (2006).
4. Kuby's Immunology, 6th Edn., Kindt, T. J., Goldsby, R. A. and Osborne, B. A., W. H. Freeman & Co. New York (2007).
5. Text book of Biochemistry: Clinical Correlations, Delvin, T. M., John Wiley & Sons Inc (2007).
6. Industrial Biochemistry, Dass, B. K., Oscar Publ. (2007).
7. Human biochemistry and diseases, Litkwack, G., Academic Press/ Elsevier, Amsterdam(2008)
8. Essentials of Clinical Immunology, Zobiriskie, J. U., Ed. Cambridge Univ. Press Publ., New York (2009).
9. Clinical Chemistry: Theory, Analysis and Correlations.Kaplan, L .A and Pesce, A. J., Mosby and co., St. Louis (2009).

**BBT 503 : Recombinant DNA technology** **Total**  
**Core Course – Theory; 3 Credits** **45L**

**UNIT I**

- |   |   |      |
|---|---|------|
| 1 | Scope and milestones in genetic engineering,  | 2 L  |
| 2 | Basic techniques in recombinant DNA technology: Agarose gel electrophoresis, Southern & Northern blot, PCR amplification. Principles of DNA Sequencing: analysis of sequence data, analysis of genetic variations | 13 L |

**UNIT II**

- |   |   |     |
|---|---|-----|
| 3 | Cutting and joining DNA:DNA manipulative enzymes, Purification and Separation of Nucleic Acids.   | 6 L |
| 4 | Cloning vectors: Plasmid vectors, phage (M13 and lambda phage), cosmids, phasmids, BAC and YAC vectors, cosmids, YAC and expression vectors | 9 L |

**UNIT III**

- |   |   |     |
|---|---|-----|
| 5 | Cloning strategies: Introduction of plasmid DNA into bacterial cells, Transformation, identification of recombinant cells,introduction of phage DNA into bacterial cells, identification of recombinant phages. | 5 L |
| 6 | Genomic libraries: Isolation, insertion and selection of gene Genomic and cDNA libraries cDNA libraries, screening libraries.   | 5 L |
| 7 | Applications of genetic engineering in agriculture, environment and medicine  | 5 L |

**References**

- 1) Principles of Gene Manipulation and genomics, (2006),7thEdn., Primrose, S. B., Twyman, R.M. and Old, R. W., Blackwell Publishing,USA.
- 2) Gene Cloning and DNA analysis, 5th Edn., Brown, T. A., Blackwell Publishing, USA (2006)
- 3) An introduction to Genetic Engineering –Desmond S T Nicholl ,Cambridge university press, 2<sup>nd</sup> Ed
- 4) Recombinant DNA: A short Course, Watson J.D, CSHL press
- 5) Molecular Biotechnology Principles & Applications of Recombinant DNA, Bernard R Glick & Jack J Pasternak, ASM press.

**BBT 504: Food Biotechnology** **Total**  
**Core Course; 3 Credits** **45L**

### UNIT I

- |   |      |
|---|------|
| <b>1 Introduction</b><br>Importance of food and dairy Micro biology – Types of microorganisms in food – Source of contamination (primary sources) – Factors influencing microbial growth in foods (extrinsic and intrinsic)   | 5 L  |
| <b>2 Food fermentations:</b> Cheese, bread, wine, fermented vegetables – methods and organisms used. Significance of fermented foods, Starter cultures for curd preparation and fermentation of idli batter, production of mushroom, single cell protein, assessment of microbiological quality of various foods. | 10 L |

### Unit II

- |  |      |
|--|------|
| <b>3 Food spoilage and General principles of food preservation</b><br>Preservation by Heat -Blanching, Pasteurization, Sterilization, Boiling and Canning. Refrigeration & Freezing of foods– Differences between -refrigeration and freezing, Preservation by Drying: Air convection dryers, Fluidized bed drier, roller drier, vacuum drier, spray drier, Freeze – Drying.Preservation by Concentration- Methods of concentration, Types of Evaporators. Preservation by Radiations - Types of Radiations, Effects of Radiations, Dose – Determining Factors, Status of Irradiated foods in India, Microwave, Ohmic heating. Preservation by Chemicals -GRAS, Food preservation by preservatives, Food Additives | 15 L |
|--|------|

### Unit III

- |  |     |
|--|-----|
| <b>4 Introduction to Tetrapack technology</b>  | 1 L |
| <b>5 Genetically modified foods –</b><br>Organic foods, Types of organic foods, identifying organic foods, organic food & preservatives.<br>Genetic modification in Food industry – Background, history, controversies over risks, application, future applications. | 7 L |
| <b>6 Industrial awareness:</b> Quality control and quality assurance in food industry, concept of current good manufacturing practices (Hazard Analysis and Critical Control Points)   | 7 L |

### References

1. Food Microbiology, Frazier & Westhoff, 4th edition, (2008) Tata

McGraw Hill Publications

2. James Monroe Jay, Martin J. Loessner, David Allen Golden, (2005) Modern Food Microbiology, 7<sup>th</sup> edition, Springer Science + Business Media Inc. USA.
3. Food Microbiology by Adams & Moss, 3rd edition,(2008) The Royal Society of Chemistry
4. A textbook on Biotechnology, R. C. Dubey, Illustrative edition,(2006) S. Chand Publications.
5. Advances in Biotechnology, S. N. Jogdand (2007), Himalaya Publishing House
6. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology (2009), Volume II V.K. Joshi, Ashok Pandey

**BBT 505: Practicals in Clinical Biotechnology**  
**Core Course – Practical; 3 Credits**

**Total**  
**20 P**

1	Peripheral blood smear for total and differential count	1P
2	Haemoglobin estimation using hematocrit	1 P
3	Estimation of glucose and ketone bodies in blood and urine	2 P
4	Glucose tolerance test	2 P
5	Determination of lipid profile	2 P
6	Kidney function test by estimation of urea, creatinine and protein from urine	3 P
7	Liver function test by SGPT and SGOT analysis	3 P
8	Urine Analysis	2 P
9	CSF Analysis	2 P
10	Separation of Serum proteins by electrophoresis	2 P

**References**

1. Industrial Enzymology, 2nd Edn., Godfrey, T. and Reichelt, J.R., McMillan Publ. Co., London (1997).
2. Clinical Biochemistry, 2nd Edn., Godkar, P. B. and Godkar D. P., Bhalani Publishing House, Mumbai (2003).
3. Principles and Techniques of Biochemistry and Molecular Biology, Wilson, K. and Walker, J. Cambridge University Press, New York (2005).
4. Laboratory Manual in Biochemistry, Jayraman, J., New Age International (P) Ltd., New Delhi (2007).

**BBT 506: Practicals in Recombinant DNA Technology  
Core Course – Practical; 3 Credits**

**Total  
20 P**

1	Preparation of competent <i>E. coli</i> cells	2P
2	Transformation of plasmid DNA for antibiotic resistance	3 P
3	Plasmid isolation from <i>E. coli</i>	3P
4	Restriction digestion	2 P
5	Ligation of DNA fragment with cloning vector	2 P
6	Southern Hybridization	3 P
7	PCR	2 P
8	Isolation of Plant DNA	3P

**References**

1. Molecular cloning: A laboratory Manual, Sambrook and Russell, Wiley New York, Volume I – III.

**BBT 507: Practicals in Food Biotechnology**  
**Core Course- Practical; 3 Credits**

**Total**  
**20 P**

1	Standard plate count of dairy products	2P
2.	Determination quality of milk sample by MBRT	2P
3	Microbiological examination of foods; detection of enteric pathogens.	4P
4	Microbiological examination of water; MPN	2P
5	Detection of food adulteration	2P
6	Oligodynamic action of metals	2P
7	Role of UV radiation in food preservation	3P
8	Cheese production	3P

**References**

- 1) Experiments in Microbiology, Plant Pathology and Biotechnology, (2007),4<sup>th</sup>Edn., Aneja, K. R., New Age International Publishers, New Delhi.
- 2) Source Book for Experiments for the Teaching of Microbiology, (1982) Primrose, S. B. and Wardlow, A. C. Academic Press, London.
- 3) Microbiology: A Laboratory Manual, (2004),6<sup>th</sup>Edn. Cappuccino, J.G. and Sherman, N., Pearson Education Pvt. Ltd., Singapore.



**BBT 508: Open Course V, Elective, Option I - Biotechnology for forensics** **Total**  
**Open Course V; 2 Credits** **30 L**

**Unit I**

1	Collection and storage of biological evidence	2L
2	Chemical and microscopic analysis of biological stains	3 L
3	Screening evidence for biological stains in forensic casework	3L
4	Species of origin and serology separation techniques	5L
5	ABO Grouping and secretor status	2 L

**Unit II**

6	Biological markers of forensic significance	3L
7	Introduction to blood spatter	3 L
8	Introduction to DNA analysis	6 L
9	Court room testimony	3 L

**References**

- 1) **Forensic Science: An Introduction to Scientific and Investigative Techniques, Third Edition**  
Author: Stuart H. James, Jon J. Nordby Ph.D.  
Publisher: CRC; 3 edition (February 20, 2009) CRC Press, Taylor & Francis Group LLC, Routledge , 6000 Broken Sound Pkwy, NW, Suite 300, Boca Raton FL 33487  
United States of America
- 2) **Criminalistics: An Introduction to Scientific and Investigative Techniques,**  
Author: Richard Saferstein  
Publisher: Prentice Hall College Div;  
10th Edition (1/13/2010)

<b>BBT 508 : Open Course V, Elective; Option II - Biodiversity</b>	<b>Total</b>
<b>Open Course V; 2 Credits</b>	<b>30L</b>

**UNIT I**

1	<b>Introduction:</b> Plant Diversity: Introduction- definition, species diversity, ecosystem diversity, genetic diversity,	2 L
2	The species & Individual in the Ecosystem	2 L
3	Biodiversity and major Biomes of World	1 L
4	Species extinction, population, individuals and genetic diversity	2 L
5	Loss of biodiversity and its ecological significance	2 L
6	Extinct and Threatened species	1 L
7	Threats to biodiversity	1 L
8	Agrobiodiversity	2 L
9	The Global biodiversity strategy and its significance for sustainable Agriculture	2 L

**UNIT II**

10	<b>Conservation of Biodiversity:</b> Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values	2 L
11	Biodiversity at global, national and local levels	1 L
12	Hot-spots of biodiversity	1 L
13	Endangered, and endemic Species; threatened species; Categories of IUCN,threatened species of plants and animals in Northeast India, Red data books	3 L
14	Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity	2 L
15	Future strategy for the conservation of biological diversity	2 L
16	Biodiversity conservation: Indian Scenario	1 L
17	Biodiversity conservation:value addition through Biotechnology	2 L

## References

- 1 Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad –380 013, India, Email:mapin@icenet.net (R)
- 2 U Kumar and Mahendra J A, Biodiversity Principles and conservations, (2007), Agrobios India Pvt. Ltd., Jodhpur
- 3 Kevin J Gaston and John I Spicer, Biodiversity an introduction (2004), Blackwell Publications, USA
- 4 G. K. Singh, Biodiversity, Taxonomy and Ecology, (2009), ALP Books, New Delhi
- 5 Heywood, V.H &Waston, R.T. 1995. Global Biodiversity Assessment. Cambridge Univ. Press 1140p.

**BBT 509: General Course V - Innovative ideas in Biotechnology  
General Course V; 2 Credits**

**Total  
30 Hrs.**

The knowledge of biotechnology is constantly advancing which has tremendous potential for applications in agriculture and medicine. From finding ways to fasten the essential processes eg. fermentation, diagnosis and slow down the unwanted process such as food spoilage, diseases; new applications and biotechnological inventions are continuously being developed to improve the society and world. The linkage between basic and applied research with new discoveries and innovations can find direct applications in agriculture, human health, environment etc.

**Objectives:**

- To understand how ideas/discoveries and inventions are commercialized,
- Apply the understanding and knowledge of the basics of biotechnology to find solution for the current issues/problems to their own field of study,
- Use the new skills and continue to independently learn more about the area of innovations,
- Express this knowledge of the innovation system in the form of oral/poster presentation.

**Teaching methods:**

- Orientation lecture, seminars / workshops as well as project assignments on group and individual level.

**References:**

1. Christensen, Clayton. The Innovator's Dilemma. Harper Business; (January 7, 2003), ISBN: 0060521996
2. Innovation and Entrepreneurship in Biotechnology, an International Perspective: Concepts, Theories and Cases. Damian Hine, John Kapeleris. Edward Elgar Publishing (2006).

**Animal Biotechnology  
Theory; 3 Credits**

**Total  
45L**

**Course Outcome**

- i. Gain knowledge of Biotechnology applications in animal and livestock welfare
- ii. Learn methods of animal cloning and development of transgenic animals for various applications
- iii. Gain knowledge of Animal Tissue Culture technique and its importance in basic and advance research
- iv. Understand the principle and methodologies for vaccine, monoclonal antibodies and therapeutic proteins
- v. Know the properties, types and applications of stem cells

**UNIT I**

<b>1 Introduction</b>	2 L
Animal biotechnology to advance animal health; to develop more nutritive food; to advance human health; to introduce specific characters in strains for experimental research	
<b>2 Biotechnology for improving animal health and welfare</b>	5 L
Biotechnology for developing improved varieties of animals for increasing livestock productivity and nutrition content; Biotechnology for improving quality of milk, eggs and meat	
<b>3 Animal cloning, genetic engineering</b>	4 L
Development of genetically engineered/ cloned animals; production of meat, milk from cloned animals	
<b>4 Transgenic animals</b>	4 L
Techniques and use of transgenic animals	

**UNIT II**

<b>3 Use of animals in life science research</b>	1 L
<b>4 Animal tissue culture</b>	3 L
Introduction; systems of animal tissue culture, advantages and limitations; applications	
<b>4 Simulating conditions for growth of cells</b>	3 L
Temperature, pH, nutrition, sterility	
<b>5 Culture media</b>	3L
Balanced salt solution, metabolic role of constituents of culture medium, serum and supplements, commercially available important media formulations	
<b>6 Technique of cell culture</b>	5 L
Disaggregation of tissue, preparation of primary culture, subculture and maintenance of cell lines, quantitation of cells and estimation of viability	

### UNIT III

7	<b>Biotechnology for improving detection, treatment and prevention of diseases</b>	1 L
	<b>Monoclonal antibodies</b>	4 L
	Hybridoma technique for production of monoclonal antibodies; applications of monoclonal antibodies	
6	<b>Vaccines</b>	4 L
	Commonly used vaccines for humans; Recommended childhood immunization schedule in India; Types of vaccines; method of production	
7	<b>Production of growth factors and therapeutic proteins</b>	3 L
	Important growth factors and therapeutic proteins approved for pharmaceutical use; method of production	
8	<b>Stem cells</b>	3 L
	Introduction, types, use in regeneration of tissues	

#### References

1. Animal biotechnology science based concern, Vandenberg JG, Alwynelle SA, Cuffin JM, National Academies Press Washington DC., 2002
2. Ian Freshney, Culture of Animal cells (5<sup>th</sup> edition)2006, Wiley-Liss publication
3. Principles and practices of Animal Tissue Culture, Gangal S., University Press (India) Pvt. Ltd., Hyderabad (2009)
4. Kuby's Immunology, 6<sup>th</sup>Edn., T. J., Goldsby, R. A. and Osborne B. A., W. H. Freeman & Co. New York (2007)

<b>BBT 602: Bioprocess Technology and Quality Control</b>	<b>Total</b>
<b>Core Course - Theory; 3 Credits</b>	<b>45L</b>

**UNIT I**

- |   |   |     |
|---|---|-----|
| 1 | Isolation & preservation of industrially important micro-organisms  | 5 L |
| 2 | Selection of the desired characteristics, Screening methods, different methods of culture preservation, improvement of industrial micro-organisms | 5 L |
| 3 | Media formulation: media ingredients, objectives and cost effectiveness   | 5 L |

**UNIT II**

- |   |  |     |
|---|--|-----|
| 4 | Types of fermentation, design of typical bioreactor and its various parts  | 5 L |
| 5 | Types of bioreactors: continuous stirred tank reactors (CSTR), packed bed reactors, fluidized bed reactors, air lift fermenter | 5 L |
| 6 | Online monitoring and computer control of fermentation process   | 3 L |

**UNIT III**

- |   |  |     |
|---|--|-----|
| 7 | Downstream processing: General steps, recovery of products, extraction and purification  | 08L |
| 8 | Quality control in pharmaceutical industry: Evolution of quality concepts: Quality, Quality control, Quality Assurance, GMP<br>Quality Assurance concepts & tools: Process approach, System approach, Statistical Quality control , Documentation<br>Input control: Contamination, Cross contamination, Raw Material/ Packaging material, Building, premises and Location, Utilities, Human resource,<br>Process control: Validation- Equipment/Instruments, process, Operators, Utilities, Materials, | 09L |

IPQC and Final quality testing and release of product  
Good Documentation Practices

**References**

- 1) Principles of Fermentation Technology, Stanbury, P. F., Whitaker, A. and Hall, S. J., Butterworth-Heinemann, Burlington, MA, USA (2005)
- 2) Biotechnology – A textbook of industrial microbiology by WulfCrueger, AnnelieseCrueger ,Panima Publishing Corporation. (2003)
- 3) Bioprocess Engineering Principle, Pauline Doran Elsevier Science & Technology Books (1995)
- 4) Good Manufacturing Practices , Mindy J. Allport-Settle, PharmaLogica (2009)



**BBT 603: Plant Biotechnology** **Total**  
**Core Course - Theory; 3 Credits** **45L**

**UNIT I**

- 1 **Introduction:** Historical review, methodology, scope and limitations. 2 L
- 2 **Types of cultures and their applications:** Organ, callus, cell, meristem, embryo, protoplast, endosperm, nucellus, microspore cultures and micro-techniques 8 L
- 3 **Micropropagation and strategies:** Axillary shoot proliferation, organogenesis and somatic embryogenesis. 5 L

**UNIT II**

- 4 **Molecular marker technology:** Various types and their applications in genome analysis, marker-assisted selection, germplasm analysis, taxonomic and evolutionary studies in plantbreeding. DNA finger printing. 5 L
- 5 **Conservation of plant genetic resources:** Germplasm preservation and cryopreservation 5 L
- 6 **Secondary metabolite production:** Various culture types (organized tissue, disorganized tissue, immobilized cultures and hairy root cultures), Strategies used to optimize secondary metabolite yield (Plant cell reactors, precursors, elicitors, metabolic engineering). 5 L

**UNIT III**

- 7 **Genetic engineering and applications:** Indirect methods (*Agrobacterium* and viral mediated transformation), direct methods (Chemical transformation, electroporation, microinjection, particle bombardment, sonication, whisker). *In planta* and chloroplast transformation. Selection of transformed cells (selectable markers, reporter genes and PCR). Recovery of transformed plants. Gene expression and validation. Genetic stability and field performance. 10 L

Production of transgenic plants tolerant to herbicide, resistant to virus and pathogens. Concerns regarding the GM plants.

- 8 **Commercial applications:** In floriculture, horticulture, forestry and 5 L medicine

## References

1. Plant Cell & Tissue Culture, Vasil, I.K. and Thorpe, T.A. (Eds.), Kluwer Academic Publishers, Amsterdam (1994).
2. Principles of Gene Manipulation: An Introduction to Genetic Engineering, Old, R.W. and Primerose, S.B., Blackwell Science, U.K. (1994)
3. Plant Tissue Culture, Applications and Limitations, Bhojwani, S. S., Elsevier Publishers, Amsterdam (1999).
4. Plant Tissue Culture: Concepts and Laboratory Exercises, Ttrigiano, R.N. and Gray, D. J. (Eds.), CRC Press LLC, Florida (2000).
5. Plant Biotechnology, Hammond, J., McGarvey, P. and Yusibov, V. (Eds), Springer Verlag, Berlin (2000).

<b>BBT 604:Basics of Bioinformatics</b>	<b>Total</b>
<b>Core Course - Theory; 3 Credits</b>	<b>45L</b>
	<b>15 L</b>

### UNIT I

1	<b>Introduction to Bioinformatics:</b> Introduction to Bioinformatics: Definition, History, Goal, Scope, Applications, Limitations	3 L
2	Introduction to Biological Databases: Nature of biological data, Introduction to database and types, Biological Databases, Biological Databases Pitfalls	3 L
3	Primary Resource Institutes: NCBI/EMBL/DDBJ	2 L
4	Database search engines: Entrez (GQuery), SRS	3 L
5	Bibliographic databases: Medline, PubMed, PubMed Central, PubMed Health, MESH and Google Scholar etc.	2 L
6	Nucleotide Sequence Databases: Primary Nucleotide Sequence Databases: GenBank, /EMBL Nucleotide/DDBJ Nucleotide, Secondary Nucleotide Sequence Databases: UniGene, SGD, EMI Genomes, Genome, SNP, EST, UniSTS, GSS etc., Specialized Genome databases: UCSC, SGD, TIGR, and ACeDB, Genomic Disorder Databases: OMIM, OMIA	2 L

### UNIT II

7	<b>Protein Databases</b> <b>Primary Databases:</b> Protein database on NCBI/ Protein database on EMBL, PIR-PSD, SwissProt, Uni Prot KB, TrEMBL	3 L
8	<b>Secondary Databases:</b> PROSITE, Profile, PRINTS, BLOCKS, PRODOM	3 L
9	Structure Databases: PDB, NDB, CSD, SCOP, CATH	5 L
10	3D structure visualization tools: Cn3D, Rasmol, Jmol, SPDBV	2 L
11	Pathway Databases: KEGG, Biosystem, BioCyc, PANTHER	2 L

### UNIT III

12	<b>Sequence Alignment &amp; Analysis</b> Overview/concepts in sequence analysis, DNA Sequence Analysis, Protein Sequence Analysis	5 L
13	Pairwise sequence alignment algorithms: Needleman & Wunsch, Smith & Waterman	3 L
14	Scoring matrices for Nucleic acids and proteins: PAM, BLOSUM	3 L
15	Database Similarity Searches: Dot Plot, BLAST, FASTA	2 L

## References

1. Introduction to Bioinformatics by Attwood, T.K. & Parry-Smith, D.J., Delhi, Pearson Education (Singapore) Pte.Ltd., 2001.
2. Bioinformatics: Sequence and Genome Analysis by Mount, David, New York, Cold Spring Harbor Laboratory Press, 2004.
3. Current Protocols in Bioinformatics by Baxevanis, A.D., Davison, D.B., Page, R. D. M. & Petsko, G.A., New York, John Wiley & Sons Inc., 2004
4. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers
5. Baldi, P. and Brunak, S. 1998 Bioinformatics. The MIT Press
6. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular Biology. PWS Publishing Co., Boston.
7. Lesk, A.M. 2002 Introduction to Bioinformatics. Oxford University Press.
8. Rastogi, S.C., Mendiratta, N. and Rastogi, P. 2004 Bioinformatics: Concepts, Skills & Applications. CBS Publishers & Distributors, New Delhi.
9. Vyas, S.P. and Kohli, D.V., Methods in Biotechnology and Bioengineering.
10. Genetic Library Construction and Screening: Advanced Techniques and Applications: Lab Manual
11. Mont, D.W., Bioinformatics: Sequence and Genome Analysis.
12. Pierre Baldi and Soren Brunak, Bioinformatics: The Machine Learning Approach

**BBT 605: Practicals in Animal Tissue Culture** **Total**  
**Core Course- Practical; 3 Credits** **20 P**

1	Study of requirements, important equipments and maintenance of aseptic conditions in tissue culture laboratory	2P
2	Preparation of reagents, formulation of tissue culture medium and sterility testing	4 P
3	Subculturing and routine maintenance of cell lines	4 P
4	Cell counting and estimate of viability	2 P
5	Seeding of cells in different culture vessels, preparation of replicate cultures	2 P
6	Testing effect of drug using MTT assay	3 P
6	Observation of cells and maintenance of records	2 P
7	Fixation and staining of cells	1 P

**References**

1. Ian Freshney, Culture of Animal cells (5<sup>th</sup> edition)2006, Wiley-Liss publication
2. Principles and practices of Animal Tissue Culture, Gangal S., University Press (India) Pvt. Ltd., Hyderabad (2009)
3. Animal Cell Culture Methods, Methods in Cell Biology, Vol 57, Mather, J. P. and Bernes, D. Eds., Academic Press, New York (1998)
4. Animal Cell Culture – Practical Approach, Masters, J. R. W. Ed., Oxford Press, London (2003)

**BBT 606: Practicals in Plant Tissue Culture** **Total**  
**Core Course- Practical; 3 Credits** **20 P**

1	Facilities for the establishment of laboratory	1P
2	Preparation of nutrient media.	4 P
3	Selection of explants for initiating organ cultures	1 D
4	Micro-propagation of monocot and dicot plants via axillary shoot proliferation, organogenesis and somatic embryogenesis	4 P
5	Callus cultures for plant cell suspension	3 P
6	Cytological studies of callus cells	2 P
7	Anther/microspore cultures for plant regeneration.	2 P
8	<i>Agrobacterium</i> -mediated leaf disc transformation	2 P
9	Visit to organization or commercial tissue culture industry	1 P

**References**

1. Plant Biotechnology: Practical Manual, Giri, C. C. and Giri, A., I. K. International Publ.Pvt. Ltd., New Delhi (2007).
2. Plant Biotechnology: Laboratory Manual of PlantBiotechnology, Chawla, H.S., International Book Distr. Co.,New Delhi
3. Plant Tissue Culture: Theory and Practice, Bhojwani, S. S. and Razdan, M.K., Elsevier Publishers, Amsterdam (2004)

<b>BBT 607: Exercises in Computer Applications &amp; Bioinformatics</b>		<b>Total</b>
<b>Core Course- Practical; 3Credits</b>		<b>20 P</b>
1	<b>Primary Resource Institutes:</b> NCBI/EBI/DDBJ	2 P
2	<b>Database Search Engines:</b> Entrez, SRS	2 P
3	<b>Bibliographic databases:</b> Medline, PubMed, PubMed Central, PubMedHealth, Mesh, Google Scholar etc.	3 P
4	<b>Nucleotide Sequence Databases:</b> Primary Nucleotide Sequence Databases: GenBank, /EMBL Nucleotide/DDBJ Nucleotide, Secondary Nucleotide Sequence Databases: UniGene, SGD, EMI Genomes, Genome, SNP, EST, UniSTS, GSS etc., Specialized Genome databases: UCSC, SGD, TIGR, and ACeDB, Genomic Disorder Databases: OMIM, OMIA, PubM	4 P
5	<b>Protein Databases:</b> Primary Databases: Protein database on NCBI/ Protein database on EMBL, PIR-PSD, SwissProt, UniProtKB, TrEMBL, ExPASy; Secondary Databases: Probe, <u>Protein Clusters</u> , <u>Conserved Domain Database</u> ; Composite Databases: NRDB, OWL, MIPX, Swiss-Prot/TrEMBL; Motif / Pattern Databases: PROSITE, Profile, PRINTS, BLOCKS, PRODOM; Structure Databases: PDB, PDBsum, SCOP, CATH; 3D structure visualization tools: Cn3D, Rasmol, Jmol, SPDBV; Pathway Databases: KEGG, Biosystem, BioCyc, PANTHER, MetaCyc	5 P
6	<b>Sequence Alignment &amp; Analysis;</b> Database Similarity Searches: Dot Plot, BLAST, FASTA; Multiple sequence alignment: PRAS, CLUSTALW, T-Coffee, COBALT;Sequence Analysis Tools: DNA Sequence Analysis tools, Protein Sequence Analysis tools	4 P

## References

1. Bioinformatics: A Practical Guide to the analysis of Genes and Proteins (2<sup>nd</sup> Ed.) by Baxevanis, A.D. &Ouellettee, B., F. F., New York, John Wiley & Sons, Inc. Publications, 2002.
2. Introduction to Bioinformatics by Attwood, T.K. & Parry-Smith, D.J., Delhi, Pearson Education (Singapore) Pte.Ltd., 2001.
3. Bioinformatics: Sequence and Genome Analysis by Mount, David, New York, Cold Spring Harbor Laboratory Press, 2004.
4. Current Protocols in Bioinformatics by Baxevanis, A.D., Davison, D.B., Page, R. D. M. &Petsko, G.A., New York, John Wiley & Sons Inc., 2004.
5. Introduction to Bioinformatics; Attwood
6. Bioinformatics; C,V. Murthy
7. Bioinformatics, Baxvanis
8. Claverie, J.M. and Notredame C. 2003 Bioinformatics for Dummies. Wiley Editor.
9. Letovsky, S.I. 1999 Bioinformatics. Kluwer Academic Publishers.
10. Baldi, P. and Brunak, S. 1998 Bioinformatics. The MIT Press.
11. Setubal, J. and Meidanis, J. 1996 Introduction to Computational Molecular

- Biology. PWS Publishing Co., Boston.
12. Lesk, A.M. 2002 Introduction to Bioinformatics. Oxford University Press.
  13. Rastogi, S.C., Mendiratta, N. and Rastogi, P. 2004 Bioinformatics: Concepts, Skills & Applications. CBS Publishers & Distributors, New Delhi.
  14. Vyas, S.P. and Kohli, D.V., Methods in Biotechnology and Bioengineering.
  15. Singer, M. and Barg, P. Exploring Genetic Mechanism.
  16. Fogel, G.B. and Corne, D.W., Evolutionary Computation in Bioinformatics.
  17. Genetic Library Construction and Screening: Advanced Techniques and Applications: Lab Manual
  18. Mount, D.W., Bioinformatics: Sequence and Genome Analysis.



**BBT608: Open Course VI, Elective; Option I - Entrepreneurship in Biotechnology** **Total 30L**

**Open Course VI; 2 Credits**

**UNIT I Opportunities in different Biotechnology Sectors**

1	Overview of Biotechnology industry and research sector	2 L
2	Agriculture based industries and opportunities	2 L
3	Herbal extracts and its applications	2 L
4	Major Industries in Health sector and opportunities	2 L
5	Bioprocess and core biotechnology industry and opportunities	2 L
6	Opportunities in Biotechnology research	2 L
7	Opportunities in other allied areas	3 L

**UNIT II Entrepreneurship Development in Biotechnology**

8	Meaning and importance, concepts of entrepreneurship, characteristics of successful entrepreneurs,	1 L
9	classification of entrepreneurs, myths of entrepreneurship, evolution of entrepreneurship, development of entrepreneurship,	1 L
10	stages in entrepreneurial process, role of entrepreneurs in the economic development	1 L
11	role of small scale industries in the national economy	1 L
12	Identification of business opportunities in Biotechnology	1 L
13	Criteria for the principles of product selection and development, Elements of marketing	2 L
14	Project identification - assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report	3 L
15	Market and technical, feasibility studies	2 L
16	Financial and social feasibility studies	1 L
17	Raising of capital	2 L

**References**

1. Forbat, John, "Entrepreneurship" New Age International. 2. Havinal, Veerbhadrappa, "Management and Entrepreneurship" New Age International
3. Joseph, L. Massod, "Essential of Management", Prentice Hall of India.
2. Principles of Management – P.C.Tripathi, P.N.Reddy – Tata McGraw Hill,
3. Dynamics of Entrepreneurial Development & Management – Vasant Desai – Himalaya Publishing House
3. Entrepreneurship Development – Poornima.M.Charantimath – Small Business Enterprises – Pearson Education – 2006 (2 & 4).
4. Management Fundamentals – Concepts, Application, Skill Development – RobersLusier – Thomson –
5. Entrepreneurship Development – S.S.Khanka – S.Chand& Co.
6. Management – Stephen Robbins – Pearson Education/PHI – 17 th Edition, 2003.

**BBT 608: Open Course VI, Elective; Option II - Business management in Biotechnology** **Total 30L**  
**Open Course VI; 2 Credits**

**UNIT I**

<b>1</b>	Nature and characteristics of Management, Scope and Functional areas of management.	<b>1 L</b>
<b>2</b>	Roles of Management, Levels of Management in Biotechnology	<b>1 L</b>
<b>3</b>	Evolution of management thought: early, contemporary and modern	<b>1 L</b>
<b>4</b>	Nature, purpose and importance of planning process	<b>2 L</b>
<b>5</b>	Types of plans and Decision making.	<b>2 L</b>
<b>6</b>	Importance of planning – steps in planning & planning premises.	<b>2 L</b>
<b>7</b>	Hierarchy of plans. Components of planning	<b>2 L</b>
<b>8</b>	Principles of organization, Types of organization. Departmentation Committees.	<b>1 L</b>
<b>9</b>	Nature and importance of staffing–Process of Recruitment and Selection.	<b>3 L</b>

**UNIT II**

<b>10</b>	Performance appraisals	<b>2 L</b>
<b>11</b>	Motivation and leadership	<b>1 L</b>
<b>12</b>	Business Communication – Meaning and importance	<b>1 L</b>
<b>13</b>	Sales Management Nature of product and market strategy	<b>1 L</b>
<b>14</b>	Packaging and advertising	<b>2 L</b>
<b>15</b>	After Sales Service	<b>1 L</b>
<b>16</b>	Pricing techniques	<b>2 L</b>
<b>17</b>	Financial functions and cost analysis in project planning and control	<b>2 L</b>
<b>18</b>	Structure of a Biotechnology Company	<b>2 L</b>
<b>19</b>	Start-up of Biotechnology Company	<b>1 L</b>

**References**

1. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
2. Marketing Management, 14/E Philip Kotler Kevin Keller
3. Principles of Management – P.C.Tripathi, P.N.Reddy – Tata McGraw Hill  
Management Fundamentals – Concepts, Application, Skill Development – RobersLusier – Thomson

**BBT 609: General Course VI; Elective; Option I- Scientific Writing  
General Course VI; 2 Credits**

**Total  
30 Hrs.**

**Technical and scientific writing skills**

The course will involve developing technical and scientific writing skills of students in clear and concise English. Students will select a relevant topic for which they will perform a literature search and write a review under the guidance of his tutor.

**Objectives:**

- To understand the technical ways of literature search
- To experience the mining of information relevant to the selected topic
- Learn to analyze and concise the information gathered on the selected topic in the form of review
- Building reading and writing skills

**Teaching methods:**

- Selection of a suitable topic of interest. Search the relevant literature on the topic and write a review article with assistance from the tutor/guide

**References:**

1. The Mayfield handbook of technical and scientific writing. Perelman LC, Paradis J., Barrett E. The McGraw Hill Publ.
2. Scientific writing: A reader & writer's guide. Jean Luc Lebrun. World Scientific Publ. 2014

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