



**HSNC University Mumbai**  
(2021-2022)

Ordinances and Regulations

With Respect to

Choice Based Credit System  
(CBCS)

For the Programmes Under

**The Faculty of Science and Technology**

For the Course

**Biotechnology**

**Semester-III and Semester –IV**

**With effect from the Academic year 2021-2022**

## Part –I

### Outline of Choice Based Credit System as outlined by University Grants Commission:

R. \*\*\*\*: The Definitions of the Key Terms Used in The Choice Based Credit System and Grading System

Introduced from The Academic Year 2020-2021 Are as Under:

**1.Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

**2.Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

**2.1Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

**2.2Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

**2.3 Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

**P.S.:** A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

**3.Choice Base Credit System:** CBCS allows students to choose inter- disciplinary, intra-disciplinary courses, skill-oriented papers (even from other disciplines according to their learning needs, interests and aptitude) and more flexibility for students.

**4.Honours Program:** To enhance employability and entrepreneurship abilities among the learners, through aligning Inter Disciplinary / Intra Disciplinary courses with Degree Program. Honours Program will have 40 additional credits to be undertaken by the learner across three years essentially in Inter / Intra Disciplinary course.

A learner who joins Regular Undergraduate Program will have to opt for Honours Program in the first year of the Program. However, the credits for honours, though divided across three years can be completed within three years to become eligible for award of honours Degree.

**5. Program:** A Program is a set of course that are linked together in an academically meaningful way and generally ends with the award of a Degree Certificate depending on the level of knowledge attained and the total duration of study, B.Sc. Programs.

**6. Course:** A 'course' is essentially a constituent of a 'program' and may be conceived of as a composite of several learning topics taken from a certain knowledge domain, at a certain level. All the learning topics included in a course must necessarily have academic coherence, i.e., there must be a common thread linking the various components of a course. A number of linked courses considered together are in practice, a 'program'.

**7. Bridge Course:** Bridge course is visualized as Pre semester preparation by the learner before commencement of regular lectures. For each semester the topics, whose knowledge is considered as essential for effective and seamless learning of topics of the Semester, will be specified. The Bridge Course can be conducted in online mode. The Online content can be created for the Bridge Course Topics.

**8. Module and Unit:** A course which is generally an independent entity having its own separate identity, is also often referred to as a 'Module' in today's parlance, especially when we refer to a 'modular curricular structure'. A module may be studied in conjunction with other learning modules or studied independently. A topic within a course is treated as a Unit. Each course should have exactly 3 Units.

**9. Self-Learning:** 20% of the topics will be marked for Self-Learning. Topics for Self-Learning are to be learned independently by the student, in a time-bound manner, using online and offline resources including online lectures, videos, library, discussion forums, fieldwork, internships etc.

Evaluative sessions (physical/online), equivalent to the credit allocation of the Self Learning topics, shall be conducted, preferably, every week for each course. Learners are to be evaluated real time during evaluative sessions. The purpose of evaluative sessions is to assess the level of the students' learning achieved in the topics earmarked for Self-Learning.

The teacher's role in these evaluative sessions will be that of a Moderator and Mentor, who will guide and navigate the discussions in the sessions, and offer concluding remarks, with proper reasoning on the aspects which may have been missed by the students, in the course of the Self-Learning process.

The modes to evaluate self-learning can be a combination of the various methods such as written reports, handouts with gaps and MCQs, objective tests, case studies and Peer learning. Groups can be formed to present self-learning topics to peer groups, followed by Question-and-Answer sessions and open discussion. The marking scheme for Self-Learning will be defined under Examination and Teaching.

The topics stipulated for self-learning can be increased or reduced as per the recommendations of the Board of Studies and Academic Council from time to time. All decisions regarding evaluation need to be taken and communicated to the stakeholders preferably before the commencement of a semester. Some exceptions may be made in exigencies, like the current situation arising from the lockdown, but such adhoc decisions are to be kept to the minimum possible

**10. Credit Point:** Credit Point refers to the 'Workload' of a learner and is an index of the number of learning hours deemed for a certain segment of learning. These learning hours may include a variety of learning activities like reading, reflecting, discussing, attending lectures / counseling sessions, watching especially prepared videos, writing assignments, preparing for examinations, etc. Credits assigned for a single course always pay attention to how many hours it would take for a learner to complete a single course successfully. A single course should have, by and large a course may be assigned anywhere between 2 to 8 credit points wherein 1

credit is construed as corresponding to approximately 30 to 40 learning hours.

**11.Credit Completion and Credit Accumulation:** Credit completion or Credit acquisition shall be considered to take place after the learner has successfully cleared all the evaluation criteria with respect to a single course. Thus, a learner who successfully completes a 4 CP (Credit Point) course may be considered to have collected or acquired 4 credits. learner level of performance above the minimum prescribed level (viz. grades / marks obtained) has no bearing on the number of credits collected or acquired. A learner keeps on adding more and more credits as he completes successfully more and more courses. Thus, the learner 'accumulates' course wise credits.

**12.Credit Bank:** A Credit Bank in simple terms refers to stored and dynamically updated information regarding the number of Credits obtained by any given learner along with details regarding the course/s for which Credit has been given, the course-level, nature, etc. In addition, all the information regarding the number of Credits transferred to different programs or credit exemptions given may also be stored with the individual's history.

**13.Credit Transfer:** (performance transfer) When a learner successfully completes a program, he/she is allowed to transfer his/her past performance to another academic program having some common courses and Performance transfer is said to have taken place.

**14.Course Exemption:** Occasionally, when two academic programs offered by a single university or by more than one university, may have some common or equivalent course-content, the learner who has already completed one of these academic programs is allowed to skip these 'equivalent' courses while registering for the new program. The Learner is 'exempted' from 'relearning' the common or equivalent content area and from re-appearing for the concerned examinations. It is thus taken for granted that the learner has already collected in the past the credits corresponding to the exempted courses.

## Part-II

**O\*\*\*\*\* The fees for transfer of credits or performance will be based on number of credits that a learner has to complete for award of the degree.**

### **The Scheme of Teaching and Examination:**

The performance of the learners shall be evaluated in two components: Internal Assessment with 40% marks by way of continuous evaluation and by Semester End Examination with 60% marks by conducting the theory examination.

**INTERNAL ASSESSMENT:- It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the credit based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.**

### **A). Internal Assessment–40% 40marks**

#### **Practical's (internal Components of the Practical Course**

### **1. For Theory Courses**

Sr. No.	Particulars	Marks
1	<b>ONE</b> class test / online examination to be conducted in the given semester	15 Marks
2	One assignment based on curriculum (to be assessed by the teacher Concerned	10 Marks
3	Self-Learning Evaluation	10 Marks
4	Active participation in routine class instructional deliveries	05 Marks

## 2. For Courses with Practicals

Each practical course can be conducted out of 50 marks with 20 marks for internal and 30 marks for external

### Practical's (Internal component of the Practical Course)

Sr. No	Evaluation type	Marks
1	Two Best Practicals /Assignments/Presentation /Preparation of models/ Exhibits  <b>Or</b> One Assignment/ project/presentation to be assessed by teacher concerned	10
2	Journal	05
3	Viva	05

**The semester end examination (external component) of 60 % for each course will be as follows:**

- i) **Duration – 2 Hours** ii) **Theory**

#### **Question Paper Pattern:-**

1. There shall be four questions each of 15 marks. On each unit there will be one question and the fourth one will be based on entire syllabus.
2. All questions shall be compulsory with internal choice within the questions. (Each question will be of 20 to 23 marks with options.)
3. Question may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

The marks will be given for all examinations and they will be converted into grade (quality) points. The semester-end, final grade sheets and transcripts will have only credits, grades, grade points, SGPA and CGPA.

## 3. Project and Assignment:

- **Project or Assignment, which can in the following forms**
  - **Case Studies**
  - **Videos**
  - **Blogs**
  - **Research paper (Presented in Seminar/Conference)**
  - **Field Visit Report**

- Presentations related to the subject (Moot Court, Youth Parliament, etc.)
- Internships (Exposition of theory into practice)
- Open Book Test
- any other innovative methods adopted with the prior approval of Director Board of Examination and Evaluation.

#### **4. Self-Learning Evaluation**

- 20% OF THE TOPICS OF CURRICULUM ARE LEARNED BY THE STUDENT THROUGH SELF LEARNING USING ONLINE / OFFLINE ACADEMIC RESOURCE SPECIFIED IN THE CURRICULUM.
- HENCE 20% OF THE LECTURES SHALL BE ALLOCATED FOR EVALUATION OF STUDENTS ON SELF LEARNING TOPICS
- The identified topics in the syllabus shall be learnt independently by the students in a time bound manner preferably from online resources. Evaluative sessions shall be conducted by the teachers and will carry 10 Marks.

**CLUB The self-learning topics into 3-4 GROUPS OF TOPICS ONLY FOR EVALUATION.**

- **PRESCRIBE TIME DURATION (IN DAYS) FOR COMPLETION OF EACH GROUP OF TOPIC AND EARMARK SELF LEARNING EVALUATION LECTURES IN THE TIMETABLE. HENCE EACH GROUP OF TOPIC CAN BE ASSIGNED 3 REGULAR LECTURES FOR THIS EVALUATION FOR ENTIRE CLASS**

##### **3 Sub Topics**

**Each evaluative session shall carry 3 Marks (3 x 3 Units = 9 Marks). Students who participate in all evaluative sessions shall be awarded 1 additional Mark.**

##### **4 Sub Topics**

**Each evaluative session shall carry 2.5 Marks (2.5 x 4 Units = 10 Marks)**

- **EVALUATION OF SELF LEARNING TOPICS CAN COMMENCE IN REGULAR LECTURES ASSIGNED FOR SELF LEARNING EVALUATION IN THE TIMETABLE**

##### **3 Evaluative sessions**

**Each evaluative session shall carry 3 Marks (3 x 3 = 9 Marks). Students who participate in all evaluative sessions shall be awarded 1 additional Mark.**

##### **4 Evaluative sessions**

Each evaluative session shall carry 2.5 Marks (2.5 x 4 = 10 Marks). Methods for Evaluation of Self-learning topics:

- Seminars/presentation (PPT or poster), followed by Q&A – Objective questions /Quiz / Framing of MCQ questions.
- Debates
- Group discussion
- You-Tube videos (Marks shall be based on the quality and viewership)
- Improvisation of videos
- Role Play followed by question-answers

TEACHERS CAN FRAME OTHER METHODS OF EVALUATION ALSO PROVIDED THAT THE METHOD, DULY APPROVED BY THE COLLEGE EXAMINATION COMMITTEE, IS NOTIFIED TO THE STUDENTS AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION AND IS FORWARDED FOR INFORMATION AND NECESSARY ACTION AT LEAST 3 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION

- Viva Voce
- Any other innovative method

**SEMESTER END EXAMINATION:** - It is defined as the examination of the learners on the basis of performance in the semester end theory / written examinations.

**B. Semester End Examination- 60 %     60 Marks**

- 1) Duration – These examinations shall be of 2 Hours duration.
- 2) Question Paper Pattern: -
  - i. There shall be four questions each of 15 marks. ii. All questions shall be compulsory with internal choice within the questions.
  - iii. Question may be sub-divided into sub-questions a, b, c, d & e only and the allocation of marks depends on the weightage of the topic.

THE MARKS OF THE INTERNAL ASSESSMENT SHOULD NOT BE DISCLOSED TO THE STUDENTS TILL THE RESULTS OF THE CORRESPONDING SEMESTER IS DECLARED.



## **Biotechnology**

### **Part 1- Preamble**

The world today is living and benefiting from the present 'Era of Biotechnology'. Biotechnology is one of the recent branches of Life Sciences, which has extended and built up as a progressed multidisciplinary applied science in most recent couple of years. Biotechnology at its heart conceives a far reaching investigation of the building blocks of life and this has prompted a novel status for Biotechnology in research and industry. The financial capability of Biotechnology is settled which has nearly gotten synonymous with current improvement. Biotechnology has its applications in pretty much every field contacting basically every human action. Applied Biotechnology is presently a work in press finding applications in Industry, Agriculture, Health and Environment. Biotechnology necessitates well trained and duly skilled individuals to constitute Industry and Research divisions. The field is novel and thus requests contributions to Infrastructure and Technology from all fields. The worldwide focus is now growing around inventions that can ease life and purpose. Biotechnology is destined to introduce a paradigm shift in the world's technologies and human perspective. The interest for prepared workforce in Biotechnology is regularly developing in Fundamental Research and Industry Sector. Scholastic and Research Sectors likewise require interdisciplinary prepared labor to facilitate the Biotechnology Revolution. The need of great importance is to configure a prospectus which keeps pace with changing occasions and innovation with stresses on applications while clarifying innovation top to bottom. The present syllabus is drafted foreseeing the future needs of Biotechnology Sector with more accentuation on granting hands-on aptitudes. The central purpose is laid on making schedule perfect with improvements in academics, research and commercial divisions. The theory and practical course introduced will prompt range of abilities to advance Biotechnology Sector. The rebuilt prospectus consolidates fundamental knowledge of Physics, Chemistry and Biology considering headways in innovation. The educational program plans to grant essential information with accentuation on its applications to prepare the understudies business To comply with the education policy of Government of India, we have included Online Courses (OLC) which is available on NPTEL or SWAYAM portals under MOOCS programme being

developed by MHRD. The online courses would inculcate the habit of self-study at their own pace by the students and also acclimatize them to future technologies of learning processes.

## **1. Course Objectives:**

### **Semester III**

#### **US-SBT-301**

##### **Molecular Biology**

The objective of this course is to provide insights into the mechanism of gene expression and its regulation. The coursework deals with the molecular mechanisms of Transcription, Translation and their regulation amongst Prokaryotic and Eukaryotic organisms.

#### **US-SBT-302**

##### **Industrial biotechnology**

The coursework allows students to learn various aspects of applied and industrial microbiology. It also aids in learning upstream and downstream components of fermentation process. Additionally, the course can help in the basic knowledge acquisition of fermenter design, different types of fermentations and the current trends in fermentation process in Industrial Biotechnology.

#### **US-SBT-303**

##### **Immunology**

The course introduces the students to the cells and organs of immune system and membrane receptors. Additionally the coursework will allow the students to learn various immunoassay techniques.

#### **US-SBT-304**

##### **Cell biology and cytogenetics**

Coursework allows the students to learn basics of cell biology with respect to cytoskeleton, cell membrane and cytogenetics. The course work will enable students to gain knowledge associated with advanced cytogenetics techniques.

#### **US-SBT-305**

##### **Biophysics**

The coursework allows students to develop an understanding of the different aspects of classical Physics. The Biophysics coursework provide knowledge of various principles of Physics to applications and techniques in the field of Biology such as Microscopy, Spectroscopy and Electrophoresis.

#### **US-SBT-306**

##### **Applied Chemistry I**

The coursework introduces the students to organic reaction and its types. The course also provides basic knowledge of Chemical Synthesis, Green Chemistry and Nanotechnology.

**US-SBT-307****Research methodology**

The objective of this course is to acquaint the students with concepts of research methodology which will enable them to perform systematic scientific research in Biotechnology.

## **Semester IV**

### **US-SBT-401**

#### **Biochemistry**

The objective of this course is to gain an insight into the Metabolic Processes associated with Catabolism of Carbohydrates, Amino Acids, Lipids and Nucleotides

### **US-SBT-402**

#### **Molecular Diagnostics**

The objective of this course is to provide an understanding of the basic molecular processes and the techniques of molecular diagnostics. The course also provides the insight towards modern diagnostic techniques.

### **US-SBT-403**

#### **Medical Microbiology**

The coursework helps students to learn about systemic diseases, affecting factors and processes associated with their clinical manifestations.

### **US-SBT-404**

#### **Environmental Biotechnology**

The objective of the coursework is gaining awareness about the sustainable environmental strategies using Phytoremediation techniques. The coursework also provides the students with various examples of applications developed for better environmental control.

### **US-SBT-405**

#### **Bioinformatics and Biostatistics**

The course allows students to learn and understand the basic concepts in Bioinformatics and Biostatistics applicable in the field of Biotechnology.

### **US-SBT-406**

#### **Applied Chemistry-II**

The objective of this course is to have a firm foundation of the fundamentals and applications of current chemical theories for the real World applications.

### **US-SBT-407**

#### **Entrepreneurship development**

The course enables the students to develop and systematically apply an Entrepreneurial way of thinking that will allow identification and creation of Business Opportunities.

### **1. Process adopted for curriculum designing:**

The curriculum was designed in a stepwise manner, firstly on the basis of feedback obtained from department teachers and students. Later several meetings were conducted with representatives from academia, industries and research institutions to assure that the syllabus is enriched in all the aspects.

### **2. Salient features, how it has been made more relevant.**

While designing of the syllabus, care has been taken to balance biotechnological techniques with entrepreneurship skills. The course would help the students to develop creativity in designing products and build research skills and provide better employment opportunities in areas like health care, agriculture, industry and environment.

### **3. Learning Outcomes.**

The curriculum is planned in a manner to instruct the student about different fields of Biotechnology like Environmental Biotechnology, Biophysics, Cytogenetics, Bioinformatics, Entrepreneurship, and Research Methodology. The program would assist the student with applying their reasoning power and computer skills to sum up, break down, and ingrain critical thinking approach in the most recent turns of events and advancements later on. The program plan, the teaching pedagogy, and the assessment manner would assist the student with creating insightful and thoroughly considering abilities. The program is developed with the aim of inculcating research interest, entrepreneurial abilities, and computational operations among the learners.

1. Students shall learn the process of generating a research question, establishing a plan of action and executing their practical skills for the research work.
2. During the Course of this Program Students will be able to design products and materials of commercial value whilst also learning to promote their products in the market.
3. Students will be capable of applying statistical tests to research problems and produce a scientifically valid solution.
4. The course will cater the students with essential concepts of immunology, and medical Microbiology, along with techniques and instrumentation in the diagnosis of the disease and detection of pathogen.

5. The course will acquaint the Students with basic to medial knowledge on the concept of Bioinformatics and the use of various web based and offline tools to analyse biological problems and solve it through bioinformatics platform.
6. The Program shall further build into the Learners the affection for interdisciplinary fields of biology, such as biophysics and bioanalytical sciences, generating interest in the functions and use of laser, optics, heat and magnetism.
7. Students would be equipped with knowledge and understanding of intermediate and advanced skills in laboratory techniques viz. Immunological assays, lab scale fermentation of industrially important materials, extraction and analysis of genomic content.

#### **4. Input from stakeholders**

The curriculum received profound augmentations from industry, and academic experts, catapulting the effects of learning outcome to new heights. The academic experts suggested introducing advanced instrumentation topics, which would bridge the present year and third year B.Sc. The inclusion of bibliography and referencing tools was a critical modification made by the academic experts. The incorporation of experimental methods in cytogenetics was a key refinement to the existing curriculum by the industry and academic expert committee. The practical syllabus was modified to include database searching, referencing tools, pattern identification, and virtual laboratory visits. All the members agreed to pump creativity and reading habit among students to get them adapted to the language of science.

**Part 2- The Scheme of Teaching and Examination is as under:**  
**Semester – III**  
**Summary**

Sr. No.	Choice Based Credit System		Subject Code	Remarks
1	Core Course ( <b>Biotechnology</b> )		US-SBT-301, US-SBT-302, US-SBT-3P1, US-SBT-303, US-SBT-304, US-SBT-3P2	
2	Elective Course	Discipline Specific Elective (DSE) Course		
		2.1 Interdisciplinary Specific Elective (IDSE) Course	US-SBT-305, US-SBT-3P3	
		2.2 Dissertation/Project		
		2.3 Generic Elective (GE) Course	US-SBT-306,US-SBT-3P3	
3	Ability Enhancement Courses (AEC)		US-SBT-307	
4	Skill Enhancement Courses (SEC)			



### Second Year Semester III Internal and External Detailed Evaluation Scheme

Sr. No	Subject Code	Subject Title	Periods Per Week						Internals				Total Marks
			Units	S.L.	L	T	P	Credit	S.L.E.	CT+AT=15+5	PA	SEE	
1	US-SBT-301	Molecular Biology	3	20%*	3	0	0	2	10	20	10	60	100
2	US-SBT-302	Industrial biotechnology	3	20%*	3	0	0	2	10	20	10	60	100
3	US-SBT-303	Immunology	3	20%*	3	0	0	2	10	20	10	60	100
4	US-SBT-304	Cell biology and cytogenetics	3	20%*	3	0	0	2	10	20	10	60	100
5	US-SBT-305	Biophysics	3	20%*	3	0	0	2	10	20	10	60	100
6	US-SBT-306	Applied Chemistry I	3	20%*	3	0	0	2	10	20	10	60	100
7	US-SBT-307	Research methodology	3	20%*	3	0	0	2	10	20	10	60	100
8	US-SBT-3P1	Practicals Based US-SBT-301 + Practical Based US-SBT-302			0		6	2				100 (80+20)	100
9	US-SBT-3P2	Practicals Based US-SBT-303 + Practical Based US-SBT-304			0		6	2				100 (80+20)	100
10	US-SBT-3P3	Practicals Based US-SBT-305 + Practical			0		6	2				100	100

		Based US-SBT-306										(80 +20 )	
	Total Hours / Credit							20	Total Marks			1000	

**\*One to two lectures to be taken for CONTINUOUS self -learning Evaluation.**

**Second Year Semester III - Units – Topics – Teaching Hours**

<b>S. N</b>	<b>Subject Code</b>	<b>Subject Unit Title</b>		<b>Hou rs/L ectu res</b>	<b>Total No. of hours/lec tures</b>	<b>Cre dit</b>	<b>Total Marks</b>
<b>1</b>	US-SBT-301	1	Gene Expression- Transcription	15	45 L	2	100 (60+40)
		2	Gene Expression-Translation	15			
		3	Regulation of Gene expression	15			
<b>2</b>	US-SBT-302	1	Microorganisms in Industrial Process	15	45L	2	100 (60+40)
		2	Fermenter and Fermentation Process	15			
		3	Downstream processing and analysis of industrial products	15			
<b>3</b>	US-SBT-303	1	Cells and Organs of Immune System	15	45L	2	100 (60+40)
		2	Immune Cell Receptors	15			
		3	Immunotechniques	15			
<b>4</b>	US-SBT-304	1	Cytoskeleton	15	45L	2	100 (60+40)
		2	Cell Membrane Transport	15			
		3	Cytogenetics	15			
<b>5</b>	US-SBT-305	1	Optics and Electromagnetic radiation	15	45L	2	100 (60+40)
		2	Heat, sound, Magnetism and Fluid dynamics	15			
		3	Electrophoresis	15			
<b>6</b>	US-SBT-306	1	Organic Chemistry	15	45L	2	100 (60+40)
		2	Synthesis of Organic compounds	15			
		3	Green Chemistry and Nanomaterials	15			
<b>7</b>	US-SBT-307	1	Introduction to Research Introduction Methodology and Research Problem	15	45L	2	100 (60+40)
		2	Research Design and Data Collection	15			
		3	Writing and Communication Skills	15			
<b>8</b>		1	Practicals based on US-SBT-301	3	45x2=	2	100

	US-SBT-3P1	2	Practicals based on US-SBT-302	3	90 lectures per batch		(80+10+10)
<b>9</b>	US-SBT-3P2	1	Practicals based on US-SBT-303	3	45x2=90 lectures per batch	2	100 (80+10+10)
		2	Practicals based on US-SBT-304	3			
<b>10</b>	US-SBT-3P3	1	Practicals based on US-SBT-305	3	45x2=90 lectures per batch	2	100 (80+10+10)
		2	Practicals based on US-SBT-306	3			
			TOTAL			20	1000

- **Lecture Duration – 45 Minutes = 0.75 Hours. (45 Lectures equivalent to 33.75 hours)**
- **One Credit =16.87 hours equivalent to 17 Hours**

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination , PA-Project Assessment, AT- Attendance

### Part -3 Detailed Scheme Theory

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

Course code: US-SBT-301 Molecular Biology

Unit	Content	No. of Lectures
1	<p style="text-align: center;"><b>Gene Expression- Transcription</b></p> <p><b>1.1. Gene Expression - General Overview (1L)</b></p> <p><b>1.2. Transcription Process in Prokaryotes (6L)</b></p> <p>1.2.1 Promoters and Enhancers;</p> <p>1.2.2 Initiation of Transcription at Promoters</p> <p>1.2.3 Elongation of RNA chain</p> <p>1.2.4 Termination of RNA Chain.</p> <p>1.2.5 RNA Synthesis</p> <p><b>1.3. Transcription Process in Eukaryotes (6L)</b></p> <p>1.3.1 Types of Eukaryotic RNA Polymerase</p> <p>1.3.2 Eukaryotic Promoters and Enhancers</p> <p>1.3.3 Transcription of Protein Coding Genes by RNA Polymerase</p> <p>1.3.4 Eukaryotic mRNAs</p> <p>1.3.5 Transcription of other genes</p> <p><b>1.4 Spliceosomes; RNA editing (2L)</b></p>	15
2	<p style="text-align: center;"><b>Gene Expression-Translation</b></p> <p><b>2.1. Nature of Genetic Code(2L)</b></p> <p>2.1.1. The Genetic code is a triplet code</p> <p>2.1.2 Deciphering the Genetic code</p> <p>2.1.3 Characteristics of Genetic code</p> <p><b>2.1 Wobble Hypothesis (2L)</b></p> <p><b>2.2 Translation: The process of protein synthesis (7L)</b></p> <p>2.3.1. Transfer RNA</p> <p>2.3.2 Ribosomes</p> <p>2.3.3 Initiation of Translation</p> <p>2.3.4 Elongation of polypeptide chain</p> <p>2.3.5 Termination of translation</p> <p><b>2.4 Post Translational Modification(2L)</b></p> <p><b>2.5 Protein sorting(2L)</b></p>	15
3	<p style="text-align: center;"><b>Regulation of Gene expression</b></p> <p><b>3.1. Regulation of gene expression in Prokaryotes</b></p> <p><b>3.1.1. Regulation of gene expression in Bacteria (5L)</b></p> <p>3.1.1.1. lac Operon of <i>E.coli</i></p> <p>3.1.1.2. trp Operon of <i>E.coli</i></p>	15

	3.1.1.3. ara operon of <i>E.coli</i> <b>3.1.2. Regulation of Gene Expression in Phage Lambda (2L)</b> 3.1.2.1. Early Transcription Events 3.1.2.2. The Lysogenic Pathway 3.1.2.3. Role of lambda repressor 3.1.2.4. The Lytic Pathway <b>3.2. Regulation of gene expression in Eukaryotes</b> <b>3.2.1. Operons in Eukaryotes (1L)</b> <b>3.2.2. Control of Transcriptional Initiation: (3L)</b> 3.2.2.1. By activators 3.2.2.2. By repressors 3.2.2.3. Role of chromatin in regulating gene transcription <b>3.2.3. Gene Silencing and Genomic Imprinting (3L)</b> 3.2.3.1. Gene silencing at a telomere 3.2.3.2. Gene silencing by DNA methylation 3.2.3.3. Genomic Imprinting <b>3.2.4. Post-Transcriptional Control; RNA Interference (1L)</b> 3.2.4.1. Si RNA 3.2.4.2. mi RNA	
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#### Self-Learning topics (Unit wise):

Sub- unit	Topic
1.1	Prokaryotic and Eukaryotic transcription, Eukaryotic RNA Polymerase
2.1	Eukaryotic gene expression , Wobble hypothesis
3.3	Regulation of gene expression in eukaryotes

#### Online Resources

<a href="https://nptel.ac.in/content/storage2/courses/104108056/module1/PNR%20lecture%201.pdf">https://nptel.ac.in/content/storage2/courses/104108056/module1/PNR%20lecture%201.pdf</a>
<a href="http://www.siumed.edu/~bbartholomew/-lectures/Transcription%2009.pdf">http://www.siumed.edu/~bbartholomew/-lectures/Transcription%2009.pdf</a>
<a href="https://nptel.ac.in/content/storage2/courses/104108056/module4/PNR%20lecture%2012.pdf">https://nptel.ac.in/content/storage2/courses/104108056/module4/PNR%20lecture%2012.pdf</a>
<a href="http://www.jiwaji.edu/pdf/ecourse/biochemistry/Wobble%20Hypothesis.pdf">http://www.jiwaji.edu/pdf/ecourse/biochemistry/Wobble%20Hypothesis.pdf</a>
<a href="https://nptel.ac.in/courses/104/108/104108056/">https://nptel.ac.in/courses/104/108/104108056/</a>

**Course code: US-SBT-302 Industrial biotechnology**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
1	<p style="text-align: center;"><b>Microorganisms in Industrial Process</b></p> <p><b>1.1. Types of Microorganisms used in Industrial Processes (2L)</b></p> <ul style="list-style-type: none"><li>1.1.1. Bacteria</li><li>1.1.2. Actinomycetes</li><li>1.1.3. Fungi</li><li>1.1.4. Algae</li></ul> <p><b>1.2. Screening and Maintenance of Strains (4L)</b></p> <ul style="list-style-type: none"><li>1.2.1. Primary screening</li><li>1.2.2. Secondary screening</li></ul> <p><b>1.3. Strain development (7L)</b></p> <ul style="list-style-type: none"><li>1.3.1. Improvement of industrial microorganisms.</li><li>1.3.2. Selection of induced mutants synthesizing improved levels of primary metabolites</li><li>1.3.3. Improvement of strains producing secondary biosynthetic products.</li></ul> <p><b>1.4. Preservation of Industrial Microbial Strains (2L)</b></p>	15
2	<p style="text-align: center;"><b>Fermenter and Fermentation Process</b></p> <p><b>2.1. Design of a Fermenter (3L)</b></p> <ul style="list-style-type: none"><li>2.1.1. Basic design of a fermenter</li><li>2.1.2. Parts of a typical fermenter</li></ul> <p><b>2.2. Fermentation Media (2L)</b></p> <ul style="list-style-type: none"><li>2.2.1. Components</li><li>2.2.2. Design and Optimization</li></ul> <p><b>2.3. Process Parameters (2L)</b></p> <ul style="list-style-type: none"><li>2.3.1. pH</li><li>2.3.2. Temperature</li><li>2.3.3. Aeration</li><li>2.3.4. Agitation</li><li>2.3.5. Foam</li></ul> <p><b>2.4. Types of Fermentation(4L)</b></p> <ul style="list-style-type: none"><li>2.4.1. Surface and Submerged</li><li>2.4.2. Batch and Continuous</li><li>2.4.3. Aerobic and Anaerobic</li></ul> <p><b>2.5. Study of Representative Fermentation Process (4L)</b></p> <ul style="list-style-type: none"><li>2.5.1. Penicillin Production</li><li>2.5.2. Ethanol Production</li></ul>	15
3	<p style="text-align: center;"><b>Downstream processing and analysis of industrial products</b></p> <p><b>3.1. Downstream processing(DSP) (10L)</b></p> <ul style="list-style-type: none"><li>3.1.1. Introduction of DSP</li></ul>	15

	3.1.2. Foam separation 3.1.3. Types of Precipitation 3.1.4. Downstream processing Filtration 3.1.5. Centrifugation 3.1.6. Chromatography - physical and chemical methods 3.1.7. Solvent recovery 3.1.8. Membrane processes 3.1.9. Drying, 3.1.10. Crystallization 3.1.11. Whole broth processing <b>3.2. Types of Assays of industrial products: (5L)</b> 3.2.1. Chemical 3.2.2. Biological 3.2.3. Types and subtypes of assays 3.2.4. Kinetics of assays	
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#### Self-Learning topics (Unit wise):

Sub- unit	Topic
1.3	Strain development
2.1	Design of fermenter
3.1	Downstream processing

#### Online Resources

<a href="https://nptel.ac.in/courses/102/105/102105058/">https://nptel.ac.in/courses/102/105/102105058/</a>  <a href="https://nptel.ac.in/content/storage2/courses/102103015/module6/lec3/1.html">https://nptel.ac.in/content/storage2/courses/102103015/module6/lec3/1.html</a>  <a href="https://nptel.ac.in/courses/102/106/102106022/">https://nptel.ac.in/courses/102/106/102106022/</a>
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**Course Code: US-SBT-303 Immunology**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>1</b>	<p align="center"><b>Cells and Organs of Immune System</b></p> <p><b>1.1. Overview of immune system (1L)</b></p> <p><b>1.2. Cells and Organs of Immune System(2L)</b></p> <p>1.2.1. Primary and secondary lymphoid organs</p> <p>1.2.2. Lymphoid cells</p> <p>1.2.3. Natural Killer cells</p> <p>1.2.4. Mononuclear Phagocytes</p> <p>1.2.5. Granulocytes</p> <p>1.2.6. Mast cells ,</p> <p>1.2.7. Dendritic cells</p> <p><b>1.3. Haematopoiesis (2L)</b></p> <p><b>1.4. Phagocytosis(2L)</b></p> <p><b>1.5. Inflammation (2L)</b></p> <p><b>1.6. Complement System (6L)</b></p> <p>1.6.1. Classical,</p> <p>1.6.2. Alternate</p> <p>1.6.3. Lectin</p> <p>1.6.4. Regulation and Biological Effects of Complement System</p> <p>1.6.5. Deficiencies of Complement System</p>	<b>15</b>
<b>2</b>	<p align="center"><b>Immune Cell Receptors</b></p> <p><b>2.1. B-Cell receptor (3L)</b></p> <p>2.1.1. Structure</p> <p>2.1.2. Activation</p> <p>2.1.3. Maturation</p> <p><b>2.2. T-cell Receptor(2L)</b></p> <p>2.1.1. Structure of T cell and TCR-CD3 complex</p> <p>2.1.2. Activation</p> <p><b>2.2. B-T Cell Interaction (B-T cell Cooperation)(1L)</b></p> <p><b>2.3. MHC Classes(5L)</b></p> <p>2.1.1. General Organization and Inheritance</p> <p>2.1.2. Structures and Peptide Interactions</p> <p>2.1.3. Class I and Class II MHC Molecules</p> <p>2.1.4. Class I and Class II Diversity and Polymorphism</p> <p>2.1.5. MHC Restriction</p> <p><b>2.2. Antigen Presenting Cells(4L)</b></p> <p>2.1.1. Types of Antigen Presenting Cells</p> <p>2.1.2. Endocytic Pathways</p> <p>2.1.3. Exocytic Pathways</p>	<b>15</b>

3	<p style="text-align: center;"><b>Immunotechniques</b></p> <p><b>3.1. Principles of Antigen-Antibody interaction (1L)</b></p> <p><b>3.2. Types of reaction: Precipitation, Agglutination, Flocculation (1L)</b></p> <p><b>3.3. Precipitation Reactions(5L)</b></p> <p>3.3.1. Immunoprecipitation</p> <p>3.3.2. Immunoelectrophoresis: Counter, Rocket, 2-D</p> <p><b>3.4. Agglutination Reactions (5L)</b></p> <p>3.4.1. Passive, Reverse Passive</p> <p>3.4.2. Agglutination Inhibition</p> <p>3.4.3. Coomb's Test</p> <p>3.4.4. Complement Fixation Tests</p> <p>3.4.5. RIA</p> <p>3.4.6. ELISA</p> <p>3.4.7. ELISPOT</p> <p>3.4.8. Chemiluminescence</p> <p>3.4.9. Immunofluorescence</p> <p><b>3.5. Flocculation reaction: VDRL(1L)</b></p> <p><b>3.6. Alternatives to Antigen-Antibody Reactions(2L)</b></p>	15
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**Self-Learning topics (Unit wise):**

Sub- unit	Topic
1.2,1.6	Cells and organs of immune system, complement system
2.1, 2.2	Antigen presenting cells, T-cells
3.4	ELISA , RIA

**Online Resources**

<https://nptel.ac.in/courses/104/108/104108055/>

<https://nptel.ac.in/courses/102/103/102103038/>

**Course Code: US-SBT-304 Cell biology and cytogenetics**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
1	<p align="center"><b>Cytoskeleton</b></p> <p><b>1.1 Overview of major functions of cytoskeleton (1L)</b>  <b>1.2 Microtubules (5L)</b>  1.2.1 Microtubule associated proteins  1.2.2 Microtubule as agents of Intracellular Motility  1.2.3 Microtubule Organizing Centre  1.2.4 Dynamic Properties of Microtubules  1.2.5 Microtubule Nucleation  1.2.6 Structural cap model of Dynamic Instability  <b>1.3 Microtubules in Cilia and Flagella (2L)</b>  1.3.1 Importance of Dynein arm  1.3.2 Mechanism of ciliary and flagellar locomotion  <b>1.4 Intermediate Filaments: (2L)</b>  1.4.1 Assembly and Disassembly  1.4.2 Types and Function of Intermediate filaments  <b>1.5 Microfilaments : Assembly , Disassembly(1L)</b>  <b>1.6 Molecular Motors- Mechanism: Kinesin, Dynein, Myosin(1L)</b>  <b>1.7 Muscle contractility: Sliding filament model(2L)</b>  <b>1.8 Actin Binding Proteins : Examples of non-muscle motility(1L)</b></p>	15
2	<p align="center"><b>Cell Membrane Transport</b></p> <p><b>2.1. Cell Permeability(1L)</b>  <b>2.2. Uptake of Nutrients by Prokaryotic Cells(1L)</b>  <b>2.3. Principles of Membrane Transport(3L)</b>  2.1.1. Transporters and Channels  2.1.2. Types of Transporters  2.1.3. Active transport  2.1.4. Passive transport  <b>2.2. Types of ATP Driven Pumps (2L)</b>  2.2.1. Na<sup>+</sup> Pump  2.2.2. K<sup>+</sup> Pump  <b>2.3. Cell Junctions(6L)</b>  2.3.1. Cell Adhesion  2.3.2. Microvilli  2.3.3. Tight Junctions  2.3.4. Gap Junctions  2.3.5. Desmosomes  <b>2.4. Cellular interaction (1L)</b>  <b>2.5. Cell Coat and Cell Recognition (1L)</b></p>	15

3	<p style="text-align: center;"><b>Cytogenetics</b></p> <p><b>3.1. Cytogenetics: (5L)</b>  3.1.1. Sex Determination ,mechanism and Sex Linkage : Mechanisms of Sex Determination (XX-XY, ZZ-ZW, XX-XO)  3.1.2. Dosage Compensation and Barr Body.  <b>3.1.3. Genetic Linkage, Crossing Over and Chromosomal Mapping</b>  <b>3.2. Tetrad Analysis (2L)</b>  <b>3.3. Two-point Cross (2L)</b>  <b>3.4. Three point Cross (2L)</b>  <b>3.5. Cytogenetic Methods and Disease: Flow Cytometry, Microarrays, CGH, and FISH (4L)</b></p>	15
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**Self-Learning topics (Unit wise):**

Sub- unit	Topic
1.2,1.6	Microtubes, Molecular motors
2.3	Membrane transport
3.4	Tetrad analysis, gene mapping

**Online Resources**

<a href="https://www.youtube.com/watch?v=7G29wxWMkCQ">https://www.youtube.com/watch?v=7G29wxWMkCQ</a> <a href="https://nptel.ac.in/courses/115/101/115101121/">https://nptel.ac.in/courses/115/101/115101121/</a> <a href="https://nptel.ac.in/courses/102/103/102103012/">https://nptel.ac.in/courses/102/103/102103012/</a> <a href="https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/lecture8.pdf">https://ocw.mit.edu/courses/biology/7-03-genetics-fall-2004/lecture-notes/lecture8.pdf</a> <a href="https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod6.pdf">https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod6.pdf</a>
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**Course Code: US-SBT-305 Biophysics**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>1</b>	<p align="center"><b>Optics and Electromagnetic radiation</b></p> <p><b>1.1. Introduction to Optics :(2L)</b>  1.1.1. Properties of Light - Reflection, Refraction,  1.1.2. Dispersion, Interference  <b>1.2. Introduction to Lasers :(2L)</b>  1.2.1. Properties of Lasers  1.2.2. Applications of Laser  <b>1.3. Introduction to Electromagnetic Radiation: properties of spectra (3L)</b>  <b>1.4. Spectroscopy :Principle, Instrumentation and application(3L)</b>  1.4.1. UV-Vis Spectrophotometer: Single and Dual Beam Spectrophotometer  <b>1.5. Microscopy :(5L)</b>  1.5.1. Types of Microscopy  1.5.2. Electron Optics  1.5.3. Electron Microscopy- Preparation of Specimen  1.5.4. SEM, TEM  <b>1.5.5. Immuno-Electron Microscopy</b></p>	<b>15</b>
<b>2</b>	<p align="center"><b>Heat, sound, Magnetism and Fluid dynamics</b></p> <p><b>2.1. Heat:(3L)</b>  2.1.1. Concept of Temperature  2.1.2. Modes of Heat Transfer  2.1.3. Measuring Temperature  2.1.4. Platinum Resistance Thermometer  2.1.5. Thermocouple and Thermistors  2.1.6. Biological applications of heat  <b>2.2. Sound:(3L)</b>  2.2.1. Types of Sound Waves - Audible, Ultrasonic, Infrasonic Waves  2.2.2. Doppler Effect  2.2.3. Applications of Ultrasonic Waves in biology  <b>2.3. Magnetism:(3L)</b>  2.3.1. Magnetic Field  2.3.2. Magnetism of Earth  2.3.3. Paramagnetism  2.3.4. Diamagnetism  2.3.5. Ferromagnetism  2.3.6. Nuclear Magnetism and Biomagnetism  2.3.7. Biological applications</p>	<b>15</b>

	<b>2.4. Viscosity:(3L)</b> 2.4.1. Definition Flow of Liquids through Capillaries 2.4.2. Stokes' Law 2.4.3. Terminal Velocity 2.4.4. Determination of 'η' by Falling Sphere Method 2.4.5. Viscosity Estimation by Oswald's Viscometer 2.4.6. Biological applications <b>2.5. Surface Tension:(3L)</b> 2.5.1. Definition - Surface Tension and Surface Energy 2.5.2. Capillary Action 2.5.3. Angle of Contact 2.5.4. Wettability 2.5.5. Temperature Dependence of Surface Tension 2.5.6. Biological applications of Surface Tension	
3	<p style="text-align: center;"><b>Electrophoresis</b></p> <b>3.1. Principle of Electrophoresis (1L)</b> <b>3.2. Migration of Ions in an applied electric field(1L)</b> <b>3.3. Factors affecting Electrophoretic Mobility(1L)</b> <b>3.4. Moving Boundary Electrophoresis(1L)</b> <b>3.5. Supporting Matrices (1L)</b> <b>3.6. Types of electrophoresis(6L)</b> 3.6.1. Paper Electrophoresis 3.6.2. Agarose Gel Electrophoresis 3.6.3. Native and SDS Polyacrylamide agarose gel electrophoresis (reducing and non-reducing, continuous and discontinuous) 3.6.4. Isoelectric focusing 3.6.5. 2D PAGE. 3.6.6. Pulse field electrophoresis 3.6.7. Capillary electrophoresis <b>3.2. Staining and Detection Methods(1L)</b> <b>3.3. Gel-Documentation (1L)</b> <b>3.4. Applications of electrophoresis in biology(2L)</b>	15

**Self-Learning topics (Unit wise):**

Sub- unit	Topic
1.1,1.5	Dispersion , refraction ,SEM
2.4	Viscosity, Stokes law
3.6	Electrophoresis, 2D gel electrophoresis

## Online Resources

<https://nptel.ac.in/courses/122/107/122107035/>

<https://nptel.ac.in/content/storage2/courses/117101054/downloads/lect2.pdf>

<https://nptel.ac.in/courses/113/106/113106064/>

<https://nptel.ac.in/content/storage2/courses/102103047/PDF/mod3.pdf>

<https://nptel.ac.in/courses/102/101/102101049/>

**Course Code: US-SBT-306 Applied Chemistry I**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
1	<p align="center"><b>Organic Chemistry</b></p> <p><b>1.1. Introduction to Types of Organic Reactions : (5L)</b></p> <p>1.1.1. Addition - Markovnikov and Anti Markovnikov's rule with mechanism</p> <p>1.1.2. Elimination - E1 &amp; E2 mechanism</p> <p>1.1.3. Substitution- SN1 &amp; SN2 mechanisms</p> <p>1.1.4. Rearrangement- Pinacol pinacolone rearrangement</p> <p>1.1.5. Role of Metal Ions in Biological Systems.</p> <p><b>1.2. Metal Coordination in Biological Systems :(5L)</b></p> <p>1.2.1. Enzymes, Apo enzymes and Coenzymes.</p> <p>1.2.2. Biological Role of Metalloenzymes -Myoglobin, Hemoglobin.</p> <p>1.2.3. Biological Role of Carboxypeptidases, Catalases and Peroxidases</p> <p><b>1.3. Structure and Function :(4L)</b></p> <p>1.3.1. Dioxygen Binding, Transfer and Utilization</p> <p><b>1.4 Metal Complexes in Medicines (1L)</b></p>	15
2	<p align="center"><b>Synthesis of Organic compounds</b></p> <p><b>2.1. Criteria for Ideal Synthesis; Selectivity and Yield.(2L)</b></p> <p><b>2.2. Linear and Convergent Synthesis(2L)</b></p> <p><b>2.3. Multicomponent Reactions(2L)</b></p> <p><b>2.4. Microwave Assisted Organic Synthesis(2L)</b></p> <p><b>2.5. Ultrasound in Synthesis and Polymer supported Synthesis(2L)</b></p> <p><b>2.6. Use of organocatalysts in organic synthesis(3L)</b></p> <p>2.6.1. First generation organocatalysts</p> <p>2.6.2. Second generation organocatalysts</p> <p><b>2.2. Retrosynthesis (2L)</b></p>	15
3	<p align="center"><b>Green Chemistry and Nanomaterials</b></p> <p><b>3.1. Introduction to Green Chemistry</b></p> <p><b>3.2. Root of innovation, limitations</b></p> <p><b>3.3. Tools and Principles of Green Chemistry.</b></p> <p><b>3.4. Green Synthesis in Industry using Green Materials, Reagents, Green Solvents , Green Catalysts</b></p> <p><b>3.5. Biological applications of Green Chemistry</b></p> <p>3.5.1. Supercritical fluids and biocatalysts</p> <p>3.5.2. Waste water treatment using green materials</p> <p>3.5.3. Biopesticide and Biofertilizer</p> <p><b>3.6 Nanomaterials :</b></p> <p><b>3.6.1. Introduction to Nanomaterials.</b></p>	15



	<b>3.6.2. Forms of Nanomaterials : Nanoparticles, Nanofilms and Nanotubes</b> <b>3.6.3. Synthesis and Characterization of Nanomaterials</b> <b>3.6.4. Applications of Nanomaterials</b>	
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**Self-Learning topics (Unit wise):**

<b>Sub- unit</b>	<b>Topic</b>
1.1,1.5	SN2 reaction, Elimination reaction
2.4,2.6	Microwave assisted organic synthesis, organocatalysis
3.4, 3.6	Nanomaterials, green solvents

**Online Resources**

<https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%206.pdf>  
<https://nptel.ac.in/content/storage2/courses/104101005/downloads/LectureNotes/chapter%207.pdf>  
<https://nptel.ac.in/content/storage2/courses/104103067/pdf/mod7.pdf>  
<https://nptel.ac.in/courses/118/104/118104008/>  
<https://www.ch.ic.ac.uk/marshall/4I10/4I104.pdf>

**Course code: US-SBT-307 Research methodology**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
1	<p align="center"><b>Introduction to Research Introduction Methodology and Research Problem</b></p> <p><b>1.1. Meaning of Research Methodology (1L)</b>  <b>1.2. Objectives of Research(1L)</b>  <b>1.3. Motivation in Research(1L)</b>  <b>1.4. Types of Research(3L)</b>  1.4.1. Basic Research  1.4.2. Applied Research  1.4.3. Descriptive Research  1.4.4. Analytical Research  1.4.5. Empirical Research  <b>1.5. Quantitative Research Approaches(2L)</b>  1.5.1. Experimental  1.5.2. Inferential  1.5.3. Simulation  <b>1.6. Significance of Research(1L)</b>  <b>1.7. Research Methods versus Methodology(1L)</b>  <b>1.8. Stages in Scientific Research Process(4L)</b>  1.8.1. Identification and Selection of Research Problem  1.8.2. Formulation of Research Problem  1.8.3. Review of Literature  1.8.4. Formulation of Hypothesis  1.8.5. Formulation of research Design  1.8.6. Sample Design  1.8.7. Data Collection  1.8.8. Data Analysis  1.8.9. Bibliography  <b>1.9. Criteria of Good Research(1L)</b></p>	15
2	<p align="center"><b>Research Design and Data Collection</b></p> <p><b>2.1. Research Design- Meaning, Types, Significance(1L)</b>  <b>2.2. Important concepts relating to research designs(1L)</b>  <b>2.3. Basic principles of experimental designs(1L)</b>  <b>2.4. Different research designs(3L)</b>  <b>2.5. Types of Data(1L)</b>  2.5.1. Primary Data – Meaning, Significance and Limitations  2.5.2. Secondary Data – Meaning, Significance and Limitations  <b>2.6. Collection of Primary Data(2L)</b>  2.6.1. Observation method  2.6.2. Interview Method  2.6.3. Questionnaire Method  2.6.4. Schedule Method</p>	15

	<b>2.7. Collection of Secondary Data(2L)</b> <b>2.8. Selection of appropriate method for data collection(2L)</b> <b>2.9. Case study Method(2L)</b>	
3	<p style="text-align: center;"><b>Scientific Writing and Communication Skills</b></p> <b>3.1. Interpretation- Meaning, Technique, Precaution, Significance (1L)</b> <b>3.2. Introduction to Scientific reports and Writing(1L)</b> <b>3.3. Significance of report writing(1L)</b> <b>3.4. Different steps in Report Writing(1L)</b> <b>3.5. Research Report(2L)</b> 3.5.1. Layout of report 3.5.2. Types of reports 3.5.3. Mechanics of writing a report 3.5.4. Precautions for writing research reports <b>3.6. Oral presentation(2L)</b> 3.6.1. How to make oral presentation of your research <b>3.6.2. Sample Oral Presentation Outline</b> <b>3.7. Plagiarism: Introduction and examples(1L)</b> <b>3.8. Scientific Writing(3L)</b> 3.8.1. What is Scientific Writing 3.8.2. Process of Scientific Writing <b>3.9. Communication skills(3L)</b> 3.9.1. Concept, components and barriers of communication 3.9.2. Methods of communication 3.9.3. Oral communication 3.9.4. Written communication 3.9.5. Verbal communication 3.9.6. Non Verbal communication	15
Internal	Evaluation Submission of Research Report/ Project/ Case Study/ Assignment	

**Self-Learning topics (Unit wise):**

<b>Sub- unit</b>	<b>Topic</b>
1.1,1.2	Meaning of research methodology
2.3,2.5	Basic principles of experimental designs, types of data
3.6	Plagiarism , communication skills

**Online Resources**

<https://nptel.ac.in/courses/121/106/121106007/>

<https://nptel.ac.in/courses/109/105/109105115/>

[https://nptel.ac.in/content/storage2/courses/109104044/lecture\\_pdf/Lecture%209.pdf](https://nptel.ac.in/content/storage2/courses/109104044/lecture_pdf/Lecture%209.pdf)

<https://nptel.ac.in/content/storage2/courses/111104073/Module1/Lecture2.pdf>

<https://nptel.ac.in/courses/110/105/110105091/>

<https://nptel.ac.in/content/storage2/courses/109104030/Module6/Lecture17.pdf>

## Part 4 - Detailed Scheme Practicals

Course Code: US-SBT-3P1

Practical I	Title of Paper: Molecular Biology And Industrial Biotechnology	Total Credits: 2
Unit	Content	No. of Lectures
1	<ol style="list-style-type: none"><li>1. Study of <i>E.coli</i> Diauxic Growth Curve- (Lactose and Glucose).</li><li>2. Study of lac Gene Expression using Blue-White Selection.</li><li>3. Expression of <math>\beta</math>-galactosidase and measurement of its activity.</li><li>4. Screening for an antibiotic producing strain of microorganism.</li><li>5. Screening for an alcohol producing strain of microorganism.</li><li>6. Lab Scale Production of Penicillin (Static and Shaker).</li><li>7. A. Purification of Penicillin from Broth Culture of <i>Penicillium</i> sp. using downstream processing techniques (Filtration and Centrifugation and Solvent Extraction) B. Estimation of penicillin by Chemical (Iodometric) and Biological (Bioassay) Method.</li><li>8. Lab Scale Production and purification of Ethanol from Broth Culture of <i>Saccharomyces spp.</i> by Distillation.</li></ol>	90

**Course Code: US-SBT-3P2**

<b>Practical II</b>	<b>Title of Paper: Immunology, Cell Biology and Cytogenetics</b>	<b>Total Credits: 2</b>
<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>1</b>	<ol style="list-style-type: none"><li>1. Study of complement Fixation Test (CFT)</li><li>2. To detect the RA factor (Passive agglutination)</li><li>3. Demonstration of ELISA (Kit-based) - HEPALISA.</li><li>4. Demonstration of Western Blotting</li><li>5. Demonstration of flow cytometer instrument</li><li>6. Study of rheumatoid arthritis detection test</li><li>7. Induction of Polyploidy by PDB Treatment using Suitable Plant Material.</li><li>8. Mapping based on Tetrad Analysis and Three Point Cross.</li><li>9. Pedigree Analysis- Autosomal and Sex-Linked</li><li>10. Mapping based on Tetrad Analysis and Three Point Cross</li><li>11. Analysis of Barr body using swabs</li></ol>	

**Course Code: US-SBT-3P3**

<b>Practical III</b>	<b>Title of Paper: Basic Chemistry &amp; Bio organic Chemistry</b>	<b>Total Credits: 2</b>
<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
	<ol style="list-style-type: none"><li>1. Study of Absorption Spectra of Coloured Compounds (CuSO<sub>4</sub>, CoCl<sub>2</sub>, KMnO<sub>4</sub>).</li><li>2. Extraction of Plasmid DNA and Separation by Agarose Gel Electrophoresis.</li><li>3. Determination of Purity of Plasmid DNA using UV Spectrophotometry.</li><li>4. Electrophoresis of Proteins by PAGE and SDS-PAGE.</li><li>5. Study of the Structure and Function of an Electron Microscope (Visit /Video Demonstration - including Sample Preparation and Staining).</li><li>6. Purification of any TWO Organic Compounds by Recrystallization selecting Suitable Solvent.</li><li>7. Organic Estimations: Acetone, Amide, Benzoic Acid.</li><li>8. Organic Preparations: a) Acetylation of Primary Amine (Preparation of Acetanilide). b) Base Catalysed Aldol Condensation (Synthesis of Dibenzalpropanone)</li></ol>	<b>90</b>

**Part 5- The Scheme of Teaching and Examination is as under:**  
**Semester – IV**  
**Summary**

Sr. No.	Choice Based Credit System		Subject Code	Remarks
1	Core Course ( <b>Biotechnology</b> )		US-SBT-401, US-SBT-402, US-SBT-4P1, US-SBT-403, US-SBT-404, US-SBT-4P2	
2	Elective Course	Discipline Specific Elective (DSE) Course		
		2.1 Interdisciplinary Specific Elective (IDSE) Course	US-SBT-405, US-SBT-4P3	
		2.2 Dissertation/Project		
		2.3 Generic Elective (GE) Course	US-SBT-406,US-SBT-4P3	
3	Ability Enhancement Courses (AEC)		US-SBT-407	
4	Skill Enhancement Courses (SEC)			



## Second Year Semester IV Internal and External Detailed Evaluation Scheme

Sr. No.	Subject Code	Subject Title	Periods Per Week					Credit	Internals				Total Marks
			Units	S.L.	L	T	P		S.L.E.	CT+AT=15+5	PA	SEE	
1	US-SBT-401	Biochemistry	3	20%*	3	0	0	2	10	20	10	60	100
2	US-SBT-402	Molecular Diagnostics	3	20%*	3	0	0	2	10	20	10	60	100
3	US-SBT-403	Medical Microbiology	3	20%*	3	0	0	2	10	20	10	60	100
4	US-SBT-404	Environmental Biotechnology	3	20%*	3	0	0	2	10	20	10	60	100
5	US-SBT-405	Bioinformatics and Biostatistics	3	20%*	3	0	0	2	10	20	10	60	100
6	US-SBT-406	Applied Chemistry II	3	20%*	3	0	0	2	10	20	10	60	100
7	US-SBT-407	Entrepreneurship development	3	20%*	3	0	0	2	10	20	10	60	100
8	US-SBT-4P1	Practicals Based US-SBT-401 + Practical Based US-SBT-402			0		6	2				100 (80+20)	100
9	US-SBT-4P2	Practicals Based US-SBT-403 + Practical Based US-SBT-404			0		6	2				100 (80+20)	100
10	US-SBT-4P3	Practicals Based US-SBT-405 + Practical Based US-SBT-406			0		6	2				100 (80+20)	100
Total Hours / Credit								20	Total Marks				1000

**\*One to two lectures to be taken for CONTINUOUS self-learning Evaluation.**

**Second Year Semester IV - Units – Topics – Teaching Hours**

<b>S. N</b>	<b>Subject Code</b>	<b>Subject Unit Title</b>		<b>Hou rs/L ectu res</b>	<b>Total No. of hours/lec tures</b>	<b>Cre dit</b>	<b>Total Marks</b>
<b>1</b>	US-SBT-401	1	Bioenergetics and metabolism	15	45 L	2	100 (60+40)
		2	Amino acid metabolism	15			
		3	Lipid metabolism	15			
<b>2</b>	US-SBT-402	1	Basics of Molecular Diagnostics	15	45L	2	100 (60+40)
		2	Nucleic acid amplification methods	15			
		3	Modern molecular diagnostics	15			
<b>3</b>	US-SBT-403	1	Medical Virulence/ Host parasite Relationship	15	45L	2	100 (60+40)
		2	Medical Microbiology- Causative Organisms I	15			
		3	Medical Microbiology- Causative Organisms II	15			
<b>4</b>	US-SBT-404	1	Industrial waste treatment and management	15	45L	2	100 (60+40)
		2	Bioremediation	15			
		3	Integrated applications for sustainable development	15			
<b>5</b>	US-SBT-405	1	Biological Databases	15	45L	2	100 (60+40)
		2	BLAST and Sequence Alignment	15			
		3	Biostatistics	15			
<b>6</b>	US-SBT-406	1	Sampling and Separation Techniques	15	45L	2	100 (60+40)
		2	Natural Product Chemistry	15			
		3	Polymers and Tracer techniques	15			
<b>7</b>	US-SBT-407	1	Introduction to Entrepreneurship Development	15	45L	2	100 (60+40)
		2	Setting-up of an Enterprise and Planning	15			
		3	Marketing, Sales, Advertising and International Market research	15			
<b>8</b>		1	Practicals based on US-SBT-301	3	45x2=	2	100

	US-SBT-4P1	2	Practicals based on US-SBT-302	3	90 lectures per batch		(80+10+10)
<b>9</b>	US-SBT-4P2	1	Practicals based on US-SBT-303	3	45x2=90 lectures per batch	2	100 (80+10+10)
		2	Practicals based on US-SBT-304	3			
<b>10</b>	US-SBT-4P3	1	Practicals based on US-SBT-305	3	45x2=90 lectures per batch	2	100 (80+10+10)
		2	Practicals based on US-SBT-306	3			
			TOTAL			20	1000

- **Lecture Duration – 45 Minutes = 0.75 Hours. (45 Lectures equivalent to 33.75 hours)**
- **One Credit =16.87 hours equivalent to 17 Hours**

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination , PA-Project Assessment, AT- Attendance

## Part -6 - Detailed Scheme Theory

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

### Course Code: US-SBT-401 Biochemistry

Unit	Content	No. of Lectures
1	<p><b>Bioenergetics and metabolism</b></p> <p><b>1.1 Metabolic pathways and oxidative phosphorylation (9L)</b></p> <p>1.1.1 Glycolysis (pathway regulation and energetics)</p> <p>1.1.2. Citric acid cycle (pathway regulation and energetics)</p> <p>1.1.3. Electron transport &amp; oxidative phosphorylation.</p> <p>1.1.4. Inhibitors of electron transport system</p> <p>1.1.5 Anaerobic metabolism</p> <p>1.1.6 Homolactic fermentation</p> <p>1.1.7 Heterolactic fermentation</p> <p>1.1.8. Alcoholic fermentation</p> <p><b>1.2 Glyoxylate pathway (1L)</b></p> <p><b>1.3 Pentose phosphate pathway (1L)</b></p> <p><b>1.4 Reductive TCA (1L)</b></p> <p><b>1.5 Energy Rich Compounds (3L)</b></p> <p>1.5.1 ATP- energy currency, structure, hydrolysis.</p> <p>1.5.2 Other energy rich compounds (Phosphoenol pyruvate, Creatine phosphate)</p>	15L

<p><b>2</b></p>	<p style="text-align: center;"><b>Amino acid metabolism</b></p> <p><b>2.1 Amino acid catabolism(7L)</b></p> <p>2.1.1. Deamination  2.1.2. Transamination  2.1.3. Urea cycle  2.1.4. Catabolism of carbon skeletons (Glucogenic and ketogenic amino acids).</p> <p><b>2.2 Biosynthesis of compounds derived from amino acids and their significance(8L)</b></p> <p>2.2.1. Biosynthesis of Epinephrine  2.2.2. Biosynthesis of Dopamine  2.2.3. Biosynthesis of Serotonin  2.2.4. Biosynthesis of GAB  2.2.5. Biosynthesis of Histamine  2.2.6. Biosynthesis of Glutathione</p>	<p><b>15L</b></p>
<p><b>3</b></p>	<p style="text-align: center;"><b>Lipid metabolism</b></p> <p><b>3.1 Synthesis and storage of fatty acids(5L)</b></p> <p>3.1.1. Synthesis and storage of triacylglycerol  3.1.2. Digestion and transport of triacylglycerol  3.1.3. Biosynthesis of saturated fatty acid- Palmitic acid</p> <p><b>3.2 Fatty acid oxidation(7L)</b></p> <p>3.2.1. Oxidation of <math>\beta</math> -saturated fatty acids  3.2.2. Oxidation of <math>\alpha</math> -saturated fatty acids.  3.2.3. Oxidation of <math>\omega</math> -saturated fatty acids  3.2.4. Oxidation of unsaturated fatty acids.  3.2.5. Oxidation of odd chain fatty acids.  3.2.6. PUFA oxidation with physiological significance</p> <p><b>3.3 Ketogenesis (3L)</b></p>	<p><b>15L</b></p>

**Self-Learning topics (Unit wise):**

<b>Sub- unit</b>	<b>Topic</b>
1.1,1.2	Glyoxalate pathway, Anaerobic metabolism, Lactic acid fermentation
2.1, 2.2	Biosynthesis of glutathione, urea cycle
3.1	Stages of fatty acid synthesis

**Online Resources**

[http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp\\_content/S000002BI/P000982/M017766/ET/1495004678ETextModule13-GlyoxylatecycleE-text.pdf](http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000002BI/P000982/M017766/ET/1495004678ETextModule13-GlyoxylatecycleE-text.pdf)

<https://nptel.ac.in/content/storage2/courses/102103015/module6/lec3/1.html>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3549305/>

<https://nptel.ac.in/courses/103/105/103105054/>

<https://www.cerc.uga.edu/~rcarlson/bcmb3100/Chap28.pdf>

[https://www.chem.uwec.edu/chem454\\_s03/pages/Overheads/C454\\_lect9\\_view.pdf](https://www.chem.uwec.edu/chem454_s03/pages/Overheads/C454_lect9_view.pdf)

## Course Code: US-SBT-402 Molecular Diagnostics

Unit	Content	No. of Lectures
1	<p style="text-align: center;"><b>Basics of Molecular Diagnostics</b></p> <p><b>1.1 Introduction to Molecular Diagnostics(1L)</b></p> <p><b>1.2 Nucleic Acid Extraction Methods(6L)</b></p> <p>1.2.1. Isolation of DNA</p> <p>1.2.2. Isolation of RNA</p> <p>1.2.3. Measurement of nucleic acid quality and quantity</p> <p><b>1.3 Analysis and Characterization of Nucleic Acids and Proteins(6L)</b></p> <p>1.3.1. Restriction Enzyme Mapping</p> <p>1.3.2 Overview of Southern, Northern, Western Hybridization</p> <p>1.3.3 FISH</p> <p>1.3.4. Markers</p> <p>1.3.5. Probes</p> <p>1.3.6.DNA</p> <p>1.3.7.RNA</p> <p>1.3.8. Nucleic acid probes</p> <p>1.3.9. Protein Probes</p> <p>1.3.10. Hybridization conditions and stringency</p> <p>1.3.11. Interpretation of results</p> <p><b>1.4 CRISPR technology for diagnostics(2L)</b></p>	15L
2	<p style="text-align: center;"><b>Nucleic acid amplification methods</b></p> <p><b>2.1 Overview of PCR(1L)</b></p> <p><b>2.2 Components of typical PCR reaction(3L)</b></p> <p>2.2.1. Primers</p> <p>2.2.2. DNA source</p> <p>2.2.3. DNA Polymerase</p> <p>2.2.4. Deoxyribonucleotides</p> <p>2.2.5. Buffer</p> <p>2.2.6. MgCl<sub>2</sub></p> <p><b>2.3 Experiment designing(1L)</b></p> <p><b>2.4 Primer designing(2L)</b></p> <p><b>2.5 Control of PCR Contamination &amp; Mispriming (1L)</b></p> <p><b>2.6 PCR product cleanup &amp; detection(1L)</b></p> <p><b>2.7 PCR types (Principle , Working &amp; Applications)(4L)</b></p> <p>2.7.1. Real time PCR</p> <p>2.7.2. Reverse transcriptase PCR</p> <p>2.7.3. Nested PCR</p> <p>2.7.4. Multiplex PCR</p>	15L

	<p>2.7.5 Sequence specific PCR</p> <p><b>2.8 Whole genome amplification: Emulsion PCR(1L)</b></p> <p><b>2.9 Probe amplification: Ligase chain reaction(1L)</b></p>	
<b>3</b>	<p><b>Modern molecular diagnostics</b></p> <p><b>3.1.Modern Diagnostic approach for pathogens (Conventional v/s Modern)(2L)</b></p> <p>3.1.1 Overview of Conventional and modern techniques</p> <p>3.1.2 Conventional Diagnostic methods</p> <p>3.1.3. Modern Diagnostic Methods- Signal Amplification assay, Nucleic acid testing and sequencing, Nucleic Acid amplification test (NAT), Point of care diagnostic kits.</p> <p><b>3.2. Uses of DNA polymorphism in Genetic analysis(3L)</b></p> <p>3.2.1. Classes of DNA polymorphism-SNP, STR, VNTR</p> <p>3.2.2. DNA molecular testing for Human genetic disease mutations (Testing using RFLP,PCR, DNA microarrays)</p> <p><b>3.3.Molecular diagnostics for prenatal disease(3L)</b></p> <p>3.3.1 Sample collection, processing, advantages &amp; disadvantages</p> <p>3.3.2 Molecular prenatal diagnosis using advanced techniques</p> <p><b>3.4.Genetic counseling(4L)</b></p> <p>3.4.1.Brief overview of genetic counseling</p> <p>3.4.2. Importance of genetic counseling</p> <p>3.4.3. Case studies of genetic counseling( cystic fibrosis, carrier testing, fragile X diagnostic)</p> <p><b>3.5 Ethical, Social &amp; Legal issues to molecular -genetic testing(3L)</b></p>	<b>15L</b>



**Self-Learning topics (Unit wise):**

<b>Sub- unit</b>	<b>Topic</b>
1.1,1.3	Nucleic acid isolation, FISH, Hybridization techniques
2.7	Types of PCR
3.1, 3.2	Human genetic diseases, Cystic fibrosis

**Online Resources**

<https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod3.pdf>  
<https://nptel.ac.in/content/storage2/courses/102103041/module5/lec29/1.html>  
<https://nptel.ac.in/courses/102/104/102104052/>

**Course Code: US-SBT-403 Medical Microbiology**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>1</b>	<p><b>Medical Virulence/ Host parasite Relationship</b></p> <p><b>1.1 Normal flora(1L)</b> 1.1.1. Beneficial and Harmful effects of Normal Flora 1.1.2. Relationship between Normal Flora and Host</p> <p><b>1.2 Host- Parasite Interaction (2L)</b> 1.2.1 Attachment and Penetration 1.2.2 Portals of Entry 1.2.3 Koch's Postulate</p> <p><b>1.3 Microbial Virulence Factors (5L)</b> 1.3.1 Antiphagocytic Factors 1.3.2 Enzymes - Mucinase, Keratinase, Collagenase, Hyaluronidase, Coagulase, Bacterial Kinases 1.3.3 Exotoxins- Hemolysin, Diphtheria, Tetanus, Botulinum, Cholera Toxin 1.3.4 Endotoxin - Structure and Function, Limulus Assay for endotoxin 1.3.5 Requirement of Infectious Dose</p> <p><b>1.4 Clinical Infection in Host (4L)</b> 1.4.1 Effect of Infection on organ and body system 1.4.2 Occurrence ,Spread and Transmission of Diseases 1.4.3 Patterns of Infections 1.4.4 Signs and Symptoms 1.4.5 Acquisition of Infection 1.4.6 Portals of Exit</p> <p><b>1.5 Epidemiology(3L)</b> 1.5.1 Epidemiological Terminology 1.5.2 Types of Epidemiologic investigation 1.5.3 Types of Epidemiology 1.5.4 Epidemiological Statistics 1.5.5 Hospital Epidemiology and Nosocomial Infections</p>	<b>15L</b>
<b>2</b>	<p><b>Medical Microbiology- Causative Organisms I</b></p>	<b>15 L</b>

	<p><b>(With respect to Cultural Characteristics of the etiological agent, pathogenesis, clinical features , laboratory diagnosis, treatment and prevention)</b></p> <p><b>2.1 Study of skin infections (6L)</b></p> <p>2.1.1. Pyogenic skin infections -<i>S.aureus</i>, <i>Pseudomonas</i></p> <p>2.1.2 Leprosy-<i>Mycobacterium leprae</i></p> <p>2.1.3 Fungal infection - <i>Candida albicans</i></p> <p>2.1.4 Viral infections- <i>Herpes simplex</i></p> <p><b>2.2 Study of respiratory tract infections (6L)</b></p> <p>2.2.1 Upper respiratory tract infection - <i>S.pyogenes</i></p> <p>2.2.2. Tuberculosis-<i>Mycobacterium tuberculosis</i></p> <p>2.2.3. Pneumonia - <i>Klebsiella pneumoniae</i></p> <p>2.2.4. Viral Infection-<i>Influenza virus</i>, <i>SARS</i></p> <p>2.2.5 Fungal infection-<i>Mucormycosis</i></p> <p><b>2.3 Study of urinary tract infections (3L)</b></p> <p>2.3.1. <i>Escherichia coli</i></p> <p>2.3.2. <i>Proteus</i></p>	
3	<p><b>Medical Microbiology- Causative Organisms II</b></p> <p><b>(With respect to Cultural Characteristics of the etiological agent, pathogenesis, clinical features , laboratory diagnosis, treatment and prevention)</b></p> <p><b>3.1 Study of gastrointestinal infections (6L)</b></p> <p>3.1.1.Infections due to Enteropathogenic <i>E.coli</i> strains</p> <p>3.1.2 Enteric fever- <i>Salmonella sp.</i></p> <p>3.1.3 Shigellosis-<i>Shigella sp.</i></p> <p>3.1.4 Diarrhoea-Rotavirus</p> <p>3.1.5 Dysentery- <i>Entamoeba histolytica</i></p> <p><b>3.2.Study of sexually transmitted infectious disease(6L)</b></p> <p>3.2.1. Syphilis-<i>Treponema pallidum</i></p> <p>3.2.2. AIDS-<i>Human immunodeficiency virus</i></p> <p>3.2.3. Gonorrhoea-<i>Neisseria gonorrhoea</i></p> <p><b>3.3. Study of vector borne infections (3L)</b></p> <p>3.3.1 Malaria - <i>Plasmodium spp</i></p> <p>3.3.2 Chikungunya</p> <p>3.3.3 Dengue</p>	15

**Self-Learning topics (Unit wise):**

Sub- unit	Topic
1.2	Host parasite relationship
2.2, 2.3	Tuberculosis, Pneumonia, Urinary tract infection
3.1, 3.2	Diarrhea, Dysentery, Malaria

**Online Resources**

<https://nptel.ac.in/courses/102/103/102103015/>

<https://nptel.ac.in/courses/109/106/109106095/>

<https://dth.ac.in/medical/courses/Microbiology/block-9/1/index.php>

<https://dth.ac.in/medical/courses/Microbiology/block-1/2/index.php>

<https://dth.ac.in/medical/course-inner.php?id=141>

<https://nptel.ac.in/courses/127/106/127106003/>

<https://dth.ac.in/medical/course-inner.php?id=146> , <https://dth.ac.in/medical/course-inner.php?id=147>

<https://dth.ac.in/medical/courses/Microbiology/block-5/1/index.php>

[https://nptel.ac.in/content/storage2/courses/109101007/downloads/LECTURE\\_NOTES/Module%2017/lec27.pdf](https://nptel.ac.in/content/storage2/courses/109101007/downloads/LECTURE_NOTES/Module%2017/lec27.pdf)

[https://nptel.ac.in/content/storage2/courses/126104004/LectureNotes/Week-7\\_02-Diet%20during%20diarrhoea.pdf](https://nptel.ac.in/content/storage2/courses/126104004/LectureNotes/Week-7_02-Diet%20during%20diarrhoea.pdf)

<https://dth.ac.in/medical/courses/Microbiology/block-8/5/index.php>

**Course Code: US-SBT-404 Environmental Biotechnology**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>1</b>	<p><b>Industrial waste treatment and management</b></p> <p><b>1.1 Biological processes for industrial effluent treatment (4L)</b></p> <p>1.1.1. Aerobic biological treatment- activated sludge process</p> <p>1.1.2. CASP</p> <p>1.1.3. Advanced activated sludge processes (any two)</p> <p>1.1.4. Biological filters- RBC, FBR</p> <p><b>1.2 Anaerobic biological treatment- (2L)</b></p> <p>1.2.1 Contact digesters</p> <p>1.2.2. Packed bed reactors</p> <p>1.2.3. Anaerobic baffled digesters, UASB</p> <p><b>1.3 Solid waste treatment (1L)</b></p> <p><b>1.4 Biodegradation of waste from industries(8L)</b></p> <p>1.4.1. Tanning industry</p> <p>1.4.2. Petroleum industry</p> <p>1.4.3 Paper &amp; pulp industry</p> <p>1.4.4 Dairy industry</p>	<b>15L</b>
<b>2</b>	<p><b>Bioremediation</b></p> <p><b>2.1 Remediation Technologies (2L)</b></p> <p><b>2.2 Introduction to Bioremediation(2L)</b></p> <p><b>2.3 Types of Bioremediation(6L)</b></p> <p>2.3.1 In-situ Bioremediation</p> <p>2.3.2 Ex-situ Bioremediation</p> <p><b>2.4 Phytoremediation(5L)</b></p> <p>2.4.1 Introduction to Phytoremediation</p> <p>2.4.2 Factors Influencing Phytoremediation</p> <p>2.4.3 Types of Phytoremediation</p>	<b>15</b>

<b>3</b>	<b>Integrated applications for sustainable development</b> <b>3.1 Sustainable energy:(5L)</b> 3.1.1. Bioenergy from Wastes 3.1.2. Biofuels- Biodiesel, Bioalcohols 3.1.3. MFCs <b>3.2 Pollution abatement and odour control(5L)</b> 3.2.1. Biosorbents 3.2.2. Bioscrubbers 3.2.3. Biobeds <b>3.3 Eco-friendly products:(5L)</b> 3.3.1. Biosurfactants 3.3.2. Biopolymers 3.3.3. Bioplastics	<b>15L</b>
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**Self-Learning topics (Unit wise):**

<b>Sub- unit</b>	<b>Topic</b>
1.2	Activated sludge process, primary and secondary treatment of waste water
2.1	Bioremediation
3.1	Bioenergy, Biomass, Bioalcohol

**Online Resources**

<https://nptel.ac.in/content/storage2/courses/105104102/wastewater%20CThtm%20new.htm>  
<https://nptel.ac.in/courses/105/105/105105048/>  
<https://nptel.ac.in/courses/105/107/105107181/>  
<https://nptel.ac.in/courses/120/108/120108005/>  
<https://nptel.ac.in/courses/102/104/102104057/>  
[https://onlinecourses.nptel.ac.in/noc21\\_ch15/preview](https://onlinecourses.nptel.ac.in/noc21_ch15/preview)

## Course Code: US-SBT-405 Bioinformatics and Biostatistics

Unit	Content	No. of Lectures
1	<p style="text-align: center;"><b>Biological Databases</b></p> <p><b>1.1 Biological Databases :Classification of Databases (5L)</b></p> <p>1.1.1 Raw and Processed Databases</p> <p>1.1.2. Primary (NCBI)</p> <p>1.1.3. Secondary (PIR)</p> <p>1.1.4. Tertiary or Composite (KEGG) Databases</p> <p>1.1.5. Structure and Sequence Databases</p> <p><b>1.2 Specialized Databases:(4L)</b></p> <p>1.2.1. Protein Pattern Databases</p> <p>1.2.2. Protein Structure and Classification Databases (CATH/SCOP)</p> <p><b>1.3 Genome Information Resources: DNA Sequence Databases Specialized Genomic Resources.(1L)</b></p> <p><b>1.4 Protein Databases based on :(3L)</b></p> <p>1.4.1. Composition</p> <p>1.4.2. Motifs</p> <p>1.4.3. Patterns.</p> <p><b>1.5 Biomolecule Structure Visualization Software(2L)</b></p> <p>1.5.1. Rasmol</p> <p>1.5.2. Jmol</p>	15
2	<p style="text-align: center;"><b>BLAST and Sequence Alignment</b></p> <p><b>2.1 Pairwise alignment (4L)</b></p> <p>2.1.1. Identity and Similarity</p> <p>2.1.2. Global and Local Alignment</p> <p>2.1.3. Pairwise Database Searching</p> <p><b>2.2 FASTA ,BLAST(2L)</b></p> <p>2.2.1. FASTA</p> <p>2.2.2. Types of BLAST</p> <p>2.2.3. Retrieval of Information using Blast</p> <p><b>2.3Multiple Sequence Alignment (MSA) (4L)</b></p> <p>2.3.1. Introduction and Goal</p> <p>2.3.2. MSA Definition and Consensus</p> <p>2.3.3. Computational Complexity</p> <p>2.3.4. Manual Methods</p> <p>2.3.5. Simultaneous Methods</p> <p>2.3.6. Progressive Methods</p> <p>2.3.7. Databases for MSA</p> <p>2.3.8. PSI BLAST</p>	15L

	<b>2.4 Secondary Database Searching(1L)</b> <b>2.5 Analysis Packages(2L)</b> 2.5.1. What is an analysis package? 2.5.2. Commercial databases and softwares 2.5.3. Comprehensive packages 2.5.4. Packages specializing DNA analysis 2.5.5. Internet and Intranet Packages <b>2.6 Phylogenetic Trees(2L)</b>	
<b>3</b>	<p style="text-align: center;"><b>Biostatistics</b></p> <b>3.1 Definition &amp; Importance of Statistics in Biology (1L)</b> <b>3.2 Types of Data, Normal and Frequency Distribution(1L)</b> <b>3.3 Representation of Data and Graphs (Bar Diagrams, Pie Charts and Histogram, Polygon and Curve)(2L)</b> <b>3.4 Types of Population Sampling (1L)</b> <b>3.5 Measures of Central Tendency (For Raw, Ungroup &amp; Group Data) (1L)</b> <b>3.6 Mean, Median, Mode(2L)</b> <b>3.7 Measures of Dispersion Range (1L)</b> <b>3.8 Variance and Coefficient of Variance (1L)</b> <b>3.9 Standard Deviation and Standard Error(2L)</b> <b>3.10 Theory and Problems based on- Coefficient of Correlation and Regression Analysis(2L)</b> <b>3.11 Use of computers and statistical packages: MS Excel(1L)</b>	<b>15L</b>

**Self-Learning topics (Unit wise):**

<b>Sub- unit</b>	<b>Topic</b>
1.1	Biological databases, DNA sequence analysis
2.2	BLAST
3.1	Mean , Median , Mode , Regression analysis

**Online Resources**

<https://nptel.ac.in/content/storage2/courses/102103044/pdf/mod6.pdf>  
<https://nptel.ac.in/courses/102/106/102106065/>  
<https://nptel.ac.in/content/storage2/courses/111104032/module3/lecture16.pdf>  
<https://nptel.ac.in/courses/111/105/111105042/>



## Course Code: US-SBT-406 Applied Chemistry-II

Unit	Content	No. of Lectures
1	<p style="text-align: center;"><b>Sampling and Separation Techniques</b></p> <p><b>1.1 Sampling (3L)</b></p> <ul style="list-style-type: none"><li>1.1.1. Importance of Sampling and Sampling Techniques</li><li>1.1.2. Types of Sampling Random , Non-Random</li><li>1.1.3. Sampling of Solids, Liquids and Gases</li></ul> <p><b>1.2 Separation Techniques: Types of Separation Techniques(4L)</b></p> <ul style="list-style-type: none"><li>1.2.1 Filtration</li><li>1.2.2. Zone Refining</li><li>1.2.3 Distillation<ul style="list-style-type: none"><li>1.2.3.1 Vacuum Distillation</li><li>1.2.3.2 Steam Distillation</li></ul></li></ul> <p><b>1.3 Solvent Extraction(4L)</b></p> <ul style="list-style-type: none"><li>1.3.1. Partition Coefficient and</li><li>1.3.2. Distribution Ratio</li><li>1.3.3. Extraction Efficiency</li><li>1.3.4. Separation Factor</li><li>1.3.5. Role of Complexing Agents</li><li>1.3.6. Chelation</li><li>1.3.7. Ion Pair Formation, Solvation</li><li>1.3.8. Soxhlation.</li></ul> <p><b>1.4 Centrifugation - Basic Principles of Sedimentation.(4L)</b></p>	15L
2	<p style="text-align: center;"><b>Natural Product Chemistry</b></p> <p><b>2.1 Primary and Secondary Metabolites.(3L)</b></p> <p><b>2.2 Classification of Natural Products based on Biosynthesis (6L)</b></p> <ul style="list-style-type: none"><li>2.2.1. Classification of Natural Products based on</li><li>2.2.2. Structure- Alkaloids, Phenolics, Essential Oils, Steroids.</li><li>2.2.3. Structure Determination of Natural Products.</li><li>2.2.4. Commercial Synthesis of Natural Products.</li></ul> <p><b>2.3 Chromatographic Separation of Natural Products(6L)</b></p> <ul style="list-style-type: none"><li>2.3.1. Gas Chromatography and its Applications.</li><li>2.3.2. Liquid Chromatography: HPLC and its Applications.</li><li>2.3.3. HPTLC for Separation and Analysis of Natural Products</li></ul>	15L

<b>3</b>	<p style="text-align: center;"><b>Polymers and Tracer techniques</b></p> <p style="text-align: center;"><b>3.1 Polymers (8L)</b></p> <p style="text-align: center;">3.1.1. Introduction to Polymers.</p> <p style="text-align: center;">3.1.2. Types of Polymers - Monomer, Polymer, Homopolymer, Copolymer</p> <p style="text-align: center;">3.1.3. Thermoplastics and Thermosets, Addition and Condensation Polymers (Examples and Uses)</p> <p style="text-align: center;">3.1.4. Stereochemistry of Polymers</p> <p style="text-align: center;">3.1.5. Biodegradable Polymers</p> <p style="text-align: center;">3.1.6. Applications of Polymers in Biology</p> <p style="text-align: center;"><b>3.2 Tracer techniques(2L)</b></p> <p style="text-align: center;">3.2.1. Introduction:</p> <p style="text-align: center;">3.2.2. Significance of radioisotope techniques.</p> <p style="text-align: center;">3.2.3 Nature of radioactivity</p> <p style="text-align: center;"><b>3.3 Detection and measurement of radioactivity:(3L)</b></p> <p style="text-align: center;">3.3.1. Methods based upon Gas ionization (GM counters).</p> <p style="text-align: center;">3.3.2. Excitation of solids and solutions (Scintillation counting). Exposure to photographic emulsions (Autoradiography).</p> <p style="text-align: center;">3.3.3. Practical and safety aspects of counting radioactivity:</p> <p style="text-align: center;">3.3.4. Analysis of data;</p> <p style="text-align: center;">3.3.5. Safety measures in handling tracers.</p> <p style="text-align: center;"><b>3.4. Biological Applications of Tracer techniques (2L)</b></p>	<b>15L</b>
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**Self-Learning topics (Unit wise):**

Sub- unit	Topic
1.1	Random sampling, Separation techniques, centrifugation
2.2	Natural products synthesis
3.1, 3.2	Types of polymers, scintillation counting, autoradiography

**Online Resources**

<https://nptel.ac.in/courses/111/104/111104073/>  
[https://nptel.ac.in/content/storage2/courses/103105060/Sde\\_pdf/Module-2.pdf](https://nptel.ac.in/content/storage2/courses/103105060/Sde_pdf/Module-2.pdf)  
<https://www.youtube.com/watch?v=3HAW3rhXKic>  
<https://www.youtube.com/watch?v=-ihQY7ZuPKk>  
[https://nptel.ac.in/content/storage2/courses/103105060/Sde\\_pdf/Module-7.pdf](https://nptel.ac.in/content/storage2/courses/103105060/Sde_pdf/Module-7.pdf)  
<https://nptel.ac.in/courses/104/103/104103068/>  
<https://nptel.ac.in/courses/103/106/105106205/>  
<https://nptel.ac.in/courses/102/107/102107028/>

**Course Code: US-SBT-407 Entrepreneurship development**

<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>1</b>	<p align="center"><b>Introduction to Entrepreneurship Development</b></p> <p><b>1.1 Concept of Entrepreneur (3L)</b></p> <p><b>1.2 Entrepreneurship; Need and Importance (3L)</b></p> <p><b>1.3 Factors Influencing Entrepreneurship (3L)</b></p> <p><b>1.4 Types of entrepreneurs -Entrepreneur, Intrapreneur, Competencies of Entrepreneurs (3L)</b></p> <p><b>1.5 Essentials of a Successful Entrepreneur (3L)</b></p>	<b>15L</b>
<b>2</b>	<p align="center"><b>Setting-up of an Enterprise and Planning</b></p> <p><b>2.1 Location of Enterprise (1L)</b></p> <p><b>2.2 Real Estate and Human Resource Planning, Financial Planning (1L)</b></p> <p><b>2.3 Role of Government and Financial Institutions in Entrepreneurship Development (1L)</b></p> <p><b>2.4 Raising Money from Venture Capitalists (1L)</b></p> <p><b>2.5 Government Grants (1L)</b></p> <p><b>2.6 Product Selection and Ideas (1L)</b></p> <p><b>2.7 Project Planning and Formulation (1L)</b></p> <p><b>2.8 Project Feasibility Assessment (1L)</b></p> <p><b>2.9 Regulatory Affairs (1L)</b></p> <p><b>2.10 Corporate Laws (1L)</b></p> <p><b>2.11 Innovation (1L)</b></p> <p><b>2.12 IPR generation and Protection (1L)</b></p> <p><b>2.13 Preparation of a Business Plan (1L)</b></p> <p><b>2.14 Characteristics and Importance of Planning (2L)</b></p>	<b>15L</b>

3	<b>Marketing, Sales, Advertising and International Market research</b> <b>3.1 Marketing Plan for an Entrepreneur (2L)</b> <b>3.2 Strategic Alliances (2L)</b> <b>3.3 Product branding (1L)</b> <b>3.4 Product labeling (1L)</b> <b>3.5 Product pricing (1L)</b> <b>3.6 Marketing mix (1L)</b> <b>3.7 Marketing segmentation (1L)</b> <b>3.8 Advertising and Sales Promotion (1L)</b> <b>3.9 Market Assessment (1L)</b> <b>3.10 Need for International Market Research (1L)</b> <b>3.11 Domestic vs. International Market Research (1L)</b> <b>3.12 Cost and Methodology of Market Research (1L)</b> <b>3.13 Desk and Field Research (1L)</b>	15L
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**Self-Learning topics (Unit wise):**

Sub- unit	Topic
1.1	Concept of entrepreneurship
2.5, 2.11	Government grants , India as startup nation, innovation
3.12	Cost management, economics

**Online Resources**

<a href="https://nptel.ac.in/courses/110/106/110106141/">https://nptel.ac.in/courses/110/106/110106141/</a> <a href="https://nptel.ac.in/courses/127/105/127105007/">https://nptel.ac.in/courses/127/105/127105007/</a> <a href="https://nptel.ac.in/courses/110/107/110107094/">https://nptel.ac.in/courses/110/107/110107094/</a> <a href="https://nptel.ac.in/courses/110/105/110105067/">https://nptel.ac.in/courses/110/105/110105067/</a> <a href="https://nptel.ac.in/courses/109/105/109105176/">https://nptel.ac.in/courses/109/105/109105176/</a>
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**Part – 7- Detailed Scheme Practicals**

**Course Code: US-SBT-4P1**

<b>Practical I</b>	<b>Title of Paper: Biochemistry and molecular diagnostics</b>	<b>Total Credits: 2</b>
<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
	1. Handling and Calibration of Micropipette. 2. Isolation, Quantitative Analysis and detection of nucleic acids A) Genomic DNA B) RNA from Bacteria and Yeast. 4. Restriction Enzyme Digestion 5. Restriction fragment length polymorphism - Kit Based method. 6. Determination of Total, LDL and HDL Cholesterol in Serum. 7. Organ Function Tests: Liver (SGPT, SGOT); Kidney (Urea from Serum). 8. Estimation of Uric Acid and Creatinine in Urine. 9. Qualitative Detection of Ketone Body in Urine. 10. Isolation of Mitochondria and Demonstration of ETC using a Marker Enzyme.	<b>90</b>

**Course Code: US-SBT-4P2**

<b>Practical II</b>	<b>Title of Paper: Medical microbiology &amp; Environmental Biotechnology</b>	<b>Total Credits: 2</b>
<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
<b>1</b>	<ol style="list-style-type: none"><li>1. Identification of <i>S.aureus</i>-Isolation, Catalase, Coagulase Test.</li><li>2. Identification of <i>E.coli</i>-Isolation, Sugar Fermentations, IMViC.</li><li>3. Identification of <i>Salmonella and Shigella</i>- Isolation, Sugar Fermentations, TSI Slant.</li><li>4. Identification of <i>Proteus</i>- Isolation, Sugar Fermentations, IMViC.</li><li>5. Identification of <i>Pseudomonas</i> - Isolation, Urease test, Oxidase Test, TSI Slant.</li><li>6. Demonstration of malarial parasite on blood smear</li><li>7. RPR Test (Kit Based).</li><li>8. Study of Permanent Slide- <i>Mycobacterium spp.</i></li><li>9. Evaluation of quality of water using Biological oxygen demand (BOD)and Chemical oxygen demand (COD)</li><li>10. Isolation of Bacteria from Air by Gravity Sedimentation Method.</li><li>11. Determination of potability of drinking water .</li><li>12. Bioremediation of Metal.</li><li>13. Visit to STP / CETP</li></ol>	<b>90</b>

**Course Code: US-SBT-4P3**

<b>Practical III</b>	<b>Title of Paper: Bioinformatics and Biostatistics &amp; Applied Chemistry II</b>	<b>Total Credits: 2</b>
<b>Unit</b>	<b>Content</b>	<b>No. of Lectures</b>
	<ol style="list-style-type: none"><li>1. Familiarization with NCBI, EMBL, DDBJ, PIR, KEGG Databases.</li><li>2. Use of NCBI BLAST Tool.</li><li>3. Pairwise and Multiple Sequence Alignment and Phylogeny.</li><li>4. Classification of Proteins using CATH/SCOP.</li><li>5. Visualization PDB Molecules using Rasmol/Raswin</li><li>6. Separation of Binary (Solid-Solid) Mixture (Minimum 4 Compounds).</li><li>7. Identification of Organic Compound of Known Chemical Type (Min 4 Compounds).</li><li>8. Demonstration of HPLC, HPTLC and GC instruments.</li><li>9. Chemical and Biological Synthesis of Silver Nanoparticles and its Characterization by UV- VIS Spectrophotometer.</li></ol>	

## Reference Books – Semester I

### US-SBT-301

1. iGenetics- Peter Russell -Pearson Education
2. Microbial Genetics- Freifelder –Narosa Publishing House

### US-SBT-302:

1. Principles Of Fermentation Technology, Stanburry ,Whittaker And S.J.Hall
2. Principles Of Fermentation Technology, Arindam Kuila And Vinay Sharma, Wiley

### US-SBT-303

1. Kuby immunology, Judy Owen, Jenni Punt, Sharon Stanford., 7th edition (2012), Freeman and Co., NY 28.
2. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India 29.
3. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA. 21 30.
4. Introduction to Immunology- C V Rao- Narosa Publishing House

### US-SBT-304

1. Cell and Molecular Biology – De Robertis- Lippincott Williams& Wilkins
2. Cell and Molecular Biology- Concepts and Experiments—Karp – Wiley International

### US-SBT-305

1. Methods in Molecular Biophysics, Igor N S, N Zaccai & J Zaccai, (2007) Cambridge
2. Advanced Methods in Protein Microsequencing, Witmann
3. Essential Biophysics, Narayanan, New Age Publications.
4. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley
5. Principles & techniques of Biochemistry & Molecular Biology, Wilson & Walker
6. Molecular Biotechnology- Glick and Pasternan ASM Press
7. Optics, Light and Lasers The Practical Approach to Modern Aspects of Photonics and Laser Physics, Dieter Meschede, Wiley-VCH
8. Chemical Analysis and Material Characterization by Spectrophotometry, Bhim Prasad Kafle, Elsevier
9. Introduction to Green Chemistry, Second Edition,

### US-SBT-306

1. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, 7th Edition, Pearson Education (2011).
2. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 9th Edition, John Wiley & Sons, (2008)
3. A guide to mechanism in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education
4. Fundamentals of Organic Chemistry, G. Marc Loudon, 4th Edition Oxford



5. Organic Chemistry, L.G. Wade Jr and M.S. Singh, 6th Edition, 2008
6. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008
7. Organic Chemistry, J.G. Smith, 2nd Edition Special Indian Edition, Tata 21 McGraw Hill
7. Organic Chemistry, S.H. Pine, McGraw Hill Kogakusha Ltd

**US-SBT-307:**

1. Research methodology- C.R. Kothari
2. Fundamentals of research methodology and statistics-Yogesh Kumar

## Reference Books – Semester II

### US-SBT-401

1. Outlines of Biochemistry: 5th Edition, (2009), Erice Conn & Paul Stumpf ; John Wiley and Sons, USA
2. Principles of Biochemistry, 4th edition (1997), Jeffery Zubey, McGraw-Hill College, USA
3. Lehninger , Principles of Biochemistry. 7th Edition (2008), David Nelson & Michael Cox, W.H. Freeman and company, NY.
4. Fundamentals of Biochemistry. 3rd Edition (2008), Donald Voet & Judith Voet , John Wiley and Sons, I. USA
5. Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H.Freeman and company, NY
6. An Introduction to Practical Biochemistry.3rd Edition, (2001), David Plummer, Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
7. Biochemical Methods.1st , (1995), S.Sadashivam, A.Manickam, New Age International Publishers, India
8. Textbook of Biochemistry with Clinical Correlations, 7th Edition, Thomas M. Devlin, January 2010,
9. Proteins: biotechnology and biochemistry, 1st edition (2001), Gary Walsch, Wiley, USA
10. Biochemical Calculations, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
11. Enzymes: Biochemistry, Biotechnology & Clinical chemistry, (2001) Palmer Trevor, Publisher: Horwood Pub. Co., England.

### US-SBT-402:

1. Cell and Molecular Biology – De Robertis- Lippincott Williams& Wilkins
2. Cell and Molecular Biology- Concepts and Experiments—Karp – Wiley International
3. iGenetics- Peter Russell -Pearson Education
4. Microbial Genetics- Freifelder –Narosa Publishing House
5. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
6. Molecular diagnostics- Fundamentals, methods and clinical applications – Buckingham and Flaws F.A. Davis Company Philadelphia.
7. Molecular diagnostics for the clinical laboratorian by coleman and Tsongalis , Humana press
8. Human Genetics- A. M. Winchester – MacMillan Press

### US-SBT-403:

1. Text book of Medical Microbiology, Anantnarayan 7th edition
2. Textbook of basic and clinical immunology, 1st edition (2013), Sudha Gangal and Shubhangi Sontakke, University Press, India
3. Tortora's Principles of Anatomy and Physiology
4. Immunology, 7th edition (2006), David Male, Jonathan Brostoff, David Roth, Ivan Roitt, Mosby, USA. 21
5. Introduction to Immunology- C V Rao- Narosa Publishing House
6. Kuby immunology, Judy Owen , Jenni Punt , Sharon Stranford., 7th edition (2012), Freeman and Co., NY
7. 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

#### **US-SBT-404:**

8. Industrial Microbiology- A. H. Patel
9. Industrial Microbiology- L. E. Casida- John Wiley & Sons
10. Biotechnology: Environmental Processes- Rehm and Reed- Wiley
11. Environmental Biotechnology Allan Scragg Oxford University press
12. Environmental Biotechnology Indu shekar Thakur IK International (Basic concepts and applications)

#### **US-SBT-405:**

1. Introductory Biostatistics. 1st edition. (2003), Chap T. Le. John Wiley, USA
2. Methods in Biostatistics- B. K. Mahajan– Jaypee Brothers
3. Bioinformatics- methods and S.C.Rastogi, N. Mendiratta, PHL learning Pvt. Ltd. applications Genomics, Proteomics P.Rastogi 3rd edition and Drug discovery,

#### **US-SBT-406**

1. Phytochemical methods- J.C. Harbone
2. Plant drug analysis- Wagner and Blandt
3. Organic Chemistry, R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, 7th Edition, Pearson Education (2011).
4. Organic Chemistry, T.W.G. Solomon and C.B. Fryhle, 9th Edition, John Wiley & Sons, (2008)
5. A guide to mechanism in Organic Chemistry, 6th Edition, Peter Sykes, Pearson Education
6. Organic Chemistry, L.G. Wade Jr and M.S. Singh, 6th Edition, 2008
7. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008
7. Organic Chemistry, J.G. Smith, 2nd Edition Special Indian Edition, Tata 21 McGraw Hill
8. Organic Chemistry, S.H. Pine, McGraw Hill Kogakusha Ltd

9. Methods in Molecular Biophysics, Igor N S, N Zaccai & J Zaccai, (2007) Cambridge 2.
10. Advanced Methods in Protein Microsequencing, Witmann
11. Essential Biophysics, Narayanan, New Age Publication
12. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley
13. Principles & techniques of Biochemistry & Molecular Biology, Wilson & Walker. 22 E

**US-SBT-407:**

1. Entrepreneurship – Kurup
2. Handbook of Entrepreneurship development- Basotia and Sharma