PONDICHERRY UNIVERSITY
PUDUCHERRY

B.Sc. BIOTECHNOLOGY

(Choice Based Credit System)

Syllabus & Regulations

2021-2022 ONWARDS

REGULATIONS
Choice Based Credit System

1. AIM OF THE COURSE

The degree of Bachelor of Science in Biotechnology (Choice Based Credit System) aims to introduce various aspects of Biotechnology and interdisciplinary subjects to the students. At the end of the course, the students are expected to have good working knowledge in the field of Biotechnology and in addition knowledge gained from courses of interdisciplinary in nature.

2. ELIGIBILITY FOR ADMISSION

Candidate for admission to B.Sc. Biotechnology shall be required to have passed H.Sc. or 10+2 or equivalent course conducted by the Government of Tamilnadu / Andhrapradesh/ Kerala / CBSE with Botany / Zoology / Biology as one of the subjects of study or an examination accepted as equivalent thereto and 35 percentage of marks in part III (aggregate / part III), subject to such conditions as may be prescribed therefore. Maximum age for the duration into B.Sc. Biotechnology programme is 22.

3. DURATION OF THE COURSE

The course shall be of Three years duration spread over six semesters. The maximum duration to complete the course shall be six years (including the completion of arrears, if any).

4. ELIGIBILITY FOR ADMISSION TO EXAMINATION

Seventy-five (75) percentage of attendance for theory.
Seventy-five (75) percentage of attendance for practical
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5. MEDIUM

The medium of instruction shall be English.

6. CHOICE BASED CREDIT SYSTEM (CBCS)

The Choice Based Credit System (CBCS) is being introduced in affiliated colleges of Pondicherry University for select UG courses, including B.Sc. Biotechnology, from the academic year 2017-2018 onwards in accordance with the directives of University Grants Commission (UGC). The system provides an opportunity to students to design curriculum to suit individual needs, mobility across related disciplines and institutions in both horizontal and vertical manner.

This System enables a student to obtain a degree in a subject by earning required number of credits prescribed for that degree. Number of credits earned by the student reflects knowledge or

skill acquired and performance in each course is reflected in grades. The grade points earned for each course reflect the student's performance in that course.

The students should study prescribed courses like Discipline Specific Core Courses, Ability Enhancement Compulsory Courses, Skill Enhancement Courses, Public Administration, Environment Awareness etc. They are allowed to exercise choices in selection of courses that are Discipline Specific Elective Courses, General Electives, and Modern Indian Language etc., out of those offered by departments within college or any other college/institution affiliated to Pondicherry University (PU) or any other PU recognized institutions. While allowing students to exercise choices, Pondicherry University notifies regulations by taking into account the practicality. Overall, CBCS is meant to promote student centric education instead of system centric education that is in vogue at present.

7. DEFINITIONS OF KEYWORDS

7.1 **Programme**: An educational program leading to award of a degree/ diploma/ certificate.

7.2 **Programme Committee**: Each Program of Study shall have a Programme Committee to oversee implementation of the program.

7.3.1 **Course**: Usually a course referred to as 'subject' is a component of the Programme of Study. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/term papers/assignments/ presentations/ self-study etc., or a combination of some of these.

7.3.2 **Core Course**: There shall be Core Courses in the first four semesters. These courses shall be compulsorily studied by a student.

7.3.3 **Elective Course**: Elective Course is a course which can be chosen from a pool of papers. It may be:

- Supportive to the discipline of study
- Providing an expanded scope
- Enabling an exposure to some other discipline/domain
- Nurturing student's proficiency/skill.

An elective may be "Generic Elective" focusing on those courses which add generic proficiency to the students. An elective may be "Discipline Centric" or may be chosen from an unrelated discipline. It may be called an "Open Elective."

7.3.4 **Foundation Course**: The Foundation Courses may be of two kinds: Compulsory Foundation and Elective foundation. "Compulsory Foundation" courses are the courses based upon the content that leads to Knowledge enhancement. They are mandatory for all disciplines. Elective Foundation courses are value-based and are aimed at providing ethical and humanistic education.

7.3.5 **Repeat Course:** If a student gets (i) less than 40% in the internal assessment and fails in the course or (ii) fails to get the required attendance, the student shall repeat the course when offered.

7.4 **Choice Based Credit System** (CBCS): The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses etc.).Under the CBCS, the requirement for awarding a degree / diploma / certificate is prescribed in terms of number of credits to be completed by the students.

7.5 **Credit**: It is a unit by which the course work is measured. It determines the number of hours of instructions required per week:

Course Name	**Credit**	**Hours of instruction**	**Weightage (credit/ hours)**
MIL	1	1.5	0.66
ENGLISH	1	1.5	0.66
DSC (Main Theory)	1	1	1.0
DSC (Practical)	1	2	0.5
SEC	1	1	1.0
DSE (Theory)	1	1.5	0.66
DSE (Practical)	1	2	0.5
GE	1	1.3	0.75

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

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

7.8 **Credit Point**: It is the product of grade point and number of credits for a course.

7.9 **Semester Grade Point Average** (SGPA): It is a measure of performance of work done in a semester. SGPA is the ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

7.10 **Cumulative Grade Point Average** (CGPA): It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

7.11 **Transcript or Grade Card or Certificate**: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

7.12 **Academic Year:** Two consecutive (one odd + one even) semesters constitute one Academic year.

7.13 **Semester**: Each semester consist of 15-18 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be scheduled from July to December and even semester from January to June.

8. SCOPE AND COVERAGE

8.1 The CBCS is applicable to all full-time UG Biotechnology approved by the Academic Council.

8.2 Teaching, learning and evaluation shall follow Semester pattern.

8.3 Students who have passed their Higher Secondary Examination under 10+2 system conducted by the Government of Tamil Nadu or any other equivalent system recognized by the Government of Puducherry based on the admission criteria laid down by Pondicherry University are eligible to apply to B.Sc. Biotechnology. The exact eligibility criteria will be as prescribed in the regulations approved by the Academic Council of Pondicherry University on the recommendation of the BOS of the respective Departments from time to time.

8.4 Prescribed B.Sc. Biotechnology consists of six consecutive semesters (three years). The maximum duration allowed for each student to acquire prescribed number of credits in order to complete the Programme of Study shall be twelve consecutive semesters (six years).

8.5 The academic year consists of two consecutive (one odd and one even) semesters.

8.6 The medium of instruction for all the courses, excepting Arabic, Bengali, French, Hindi, Malayalam, Sanskrit, Tamil, and Telugu, shall be English.

9. COURSE STRUCTURE

At least 60% (72 Credits) of the total minimum credit requirement must be earned by the student in DSC and DSE courses put together in order to obtain a degree in a specific discipline.

10. CREDITS

10 .1 One teaching period shall be for 60 minutes duration.

10.2 The minimum number of credits to be earned by a student for the award of B.Sc. Biotechnology is 120**.** Out of these, minimum 72 credits are mandatory from Discipline Specific Core Courses (DSC) and Discipline Specific Elective Courses (DSE) put together for obtaining a degree in a particular discipline. The minimum number of credits in each semester is 20.

11. REGISTRATION

11.1 Every student will be assigned a Faculty Advisor after his/her completion of admission procedure.

11.2 Based on the advice and consent of the Faculty Advisor the student shall register for a set of courses that he/she plans to take up in each semester from among those denoted by the Principal/ HOD.

11.3 The student must take the consent of the course teacher offering course(s) for registration.

11.4 The student is permitted to register for courses not exceeding 30 credits per semester. However, registration for Repeat Courses is allowed in excess of this limit.

11.5 A student, in order to retain his/her status, should register for at least a minimum of 12 credits in a semester.

11.6 Students shall have to register for the courses within the first week of a semester.

11.7 The maximum number of students to be registered in each course shall depend upon the physical/ laboratory facilities available.

11.8 The information concerning the courses to be offered in every department in a semester with credits and pre-requisites, if any, along with the time-slot shall be made available by the Biotechnology Department of the Institution.

11.9 A student shall not be denied registration for whom the courses are Discipline Specific Core Course (DSC) or Discipline Specific Elective (DSE).

11.10 The registration for all other courses shall be done in the spirit of accommodating as many students as possible in the interest of the students.

11.11 Dropping of courses may be allowed to enable students to opt for the courses of their choice within three weeks from the date of registration.

12. INTRODUCTION OF COURSES

12.1 The course code consists of four alphabets representing the discipline of study followed by three numerals. The first numeral ‘1’ stands for level/ year of the course (year of collegiate education), 2 for second year course and 3 for third year course. The second numeral stands for semester (odd or even) and the third numeral is for the serial number of the course.

12.2 The Course Structure and Syllabus for each UG programme shall be finalized and recommended by the Board of Studies (BOS) to be placed in the School Board, and then, in the Academic Council, for consideration and approval.

12.3 The syllabi of B.Sc. Biotechnology course shall be revised at least once in three years, to keep in tune with recent developments in knowledge and innovations. Minor revisions in the already approved syllabus of a particular course may be approved by the Chairman of the Academic Council provided there is proper justification and recommendations by the Chairpersons of the BOS and School Board.

13. WORKLOAD OF TEACHERS

13.1 Every faculty member shall be assigned workload as per UGC norms.

13.2 In addition to regular handling of classes, teachers are required to participate in preparation of detailed syllabus, designing of the teaching plan, invigilation, paper setting, evaluation of answer scripts during continuous assessment and any other duties as and when assigned by the Principal or University authorities.

13.3 Teachers shall associate with organizing practical lab sessions, field visits, industrial tours, and guided project work etc., as per directions of the Principal/ Head of the institution.

13.4 Faculty to Students Ratio: The Faculty to Student Ratio in all the practical/ laboratory classes shall be maintained at 1:25.

14. PATTERN OF EXAMINATION

14.1 The End-Semester examination (**ESE**) for each course in B.Sc. Biotechnology shall be conducted by the Pondicherry University for a maximum of **75 marks** and Internal Continuous Assessment (**ICA**) for **25 marks.**

14.2 Internal assessment for all theory courses shall be done on the basis of at least two Internal Assessment tests (15 marks), term papers/assignments/seminars/case demonstrations/ presentations/ write-ups/viva etc. (5 marks) and attendance (5 marks). The following weightage shall be given to attendance:

95% - 100% (5 marks)
90% - 94% (4 marks)
85% - 89% (3 marks)
80% - 84% (2 marks)
75% - 79% (1 mark)

14.3 Internal Assessment for practical courses involving Laboratory/Field work/Project work is 15, marks for Practical Record is 10, 25 marks for Practical end-semester exam.

14.4 A schedule of Internal Assessment tests shall be prepared by each College commonly to all departments in the beginning of each semester. Internal Assessment marks shall be displayed a week before the commencement of end-semester examinations.

14.5 End-semester examination shall be conducted for all courses offered. The duration of the end-semester examination shall be 3 hours.

14.6 Every student has to pay examination fee per Credit basis as fixed by the University.

14.7 A schedule of end-semester examinations will be prepared and displayed by the University much in advance.

14.8 No student with less than 75% in any particular course shall be permitted to attend the end-semester examination and shall be given grade FA-failure due to lack of attendance. However, an overall condonation of 10% is permitted for valid reasons (NCC, NSS, Swachh Bharat) or medical reasons. A student who has been awarded FA shall repeat the course when offered. The Principal/ Head of the Department shall ensure that the candidate is informed about the lack of attendance before the commencement of end-semester examination and confirm that such candidates are not permitted to write the examination.

14.9 To pass a course the student must secure minimum of 40 out of 100 marks (40%) in the internal and the end-semester examination put together.

14.10 A student who has earned the required number of 120 credits by clearing all the required courses shall be declared as pass even if he/she could not clear optional courses which were taken in excess of the required number of courses.

14.11 Result Passing Board for each Programme of Study shall be constituted by the Pondicherry University from time to time.

14.12 Revaluation and re totaling of the answer scripts shall be allowed within the stipulated period of time as decided by the Controller of Examinations (COE) after paying the required amount of fee.

15. SUPPLEMENTARY EXAMINATION

15.1 A failed student who meets the attendance requirement may be permitted to register for the next end-semester examination in the following semester itself for theory paper. (eg. for practical papers, those who failed in odd semester practical paper may be permitted to register for next odd end-semester examination).

15.2 Students who have failed due to insufficient attendance and /or less than 40% Internal Assessment marks should repeat the course as and when offered.

16. PROGRAMME COMMITTEE

16.1 The Programme Committee (PC) of each department shall be chaired by the Principal / Head of the institution. The HOD, all the faculty members offering DSC and DSE course and two students (one male and one female, where possible) from each class shall be Members of PC.

16.2 The PC shall meet at least once in a semester to discuss implementation of the program. The discussions and resolutions should be on adherence to time-table, proper syllabus coverage, introduction of new courses and all other issues concerning academic matters.

16.3 The minutes of the PCM must be communicated to the Chairman of BOS, Controller of Examinations and Dean, College Development Council of Pondicherry University.

17. GRADING AND GRADE CARD

17.1 Letter grades shall be used to assess the performance of students in each course by converting final marks (out of 100) into grades. In case of fractions the marks shall be rounded off to next integer. The following shall be used to convert marks into awarding grades:

Range of Marks	**Letter Grade**	**Grade Point**
96-100	0	10
86-95	A+	09
76-85	A	08
66-75	B+	07
56-65	B	06
46-55	C	05
40-45	P	04
Below 40	F	00
Lack of attendance	FA	00

17.2 The SGPA shall also be calculated by taking all courses taken by the student in the semester and CGPA shall also be calculated by taking all the courses taken by the student in all the semesters (refer 16and 17).

17.3 The University shall award “class” to students who acquired 120 (see 5.6) according to the following:

CGPA	**Class**
9.00 – 10.00	First Class with Distinction (should not have failed in any course)
7.00 – 8.99	First Class
5.50 – 6.99	Second Class
4.00 – 5.49	Pass

17.4 The Grade card shall be issued to the students containing grades obtained by the student in the previous semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA).

The Grade card shall list the following:

a. Title of the course taken by the student

b. Number of credits allotted to the course
c. The grades secured by the student in each course
d. Total number of credits earned by the student in that semester
e. SGPA of the student
f. Total number of credits earned by the student till that semester
g. CGPA of the student

18. FAIRNESS IN ASSESSMENT

To ensure fairness of examination and evaluation following shall be followed.

18.1 In case of at least 50% of core courses offered in different programmes across the disciplines, the assessment of the theoretical component towards the end of the semester should be undertaken by external examiners from outside the university conducting examination, who may be appointed by the Controller of Examinations. In such courses, the question papers will be set as well as assessed by external examiners.

18.2 In case of the assessment of core practical courses, the team of examiners should be constituted on 50 – 50 % basis. i.e., half of the examiners in the team should be invited from outside the University for conducting examination.

18.3 In case of the assessment of project reports / thesis / dissertation etc. the work should be undertaken by internal as well as external examiners.

19. COMPUTATION OF SGPA AND CGPA

Following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) shall be followed:

19.1 The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.,

$$SGPA\ (Si) = \Sigma\ (Ci \times Gi) / \Sigma Ci$$

where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

19.2 The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \Sigma\ (Ci \times Si) / \Sigma\ Ci$$

where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester.

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

20. ILLUSTRATION OF COMPUTATION OF SGPA AND CGPA AND FORMAT FOR TRANSCRIPTS

20.1 Computation of SGPA and CGPA

20.1.1 Illustration 1 for calculation of SGPA

The illustration is for a student who has taken six courses of given credits in a semester and performance is given in grade letter which carry certain grade point.

Course	Credit	Grade letter	Grade point	Credit Point Credit x Grade
Course 1	3	A	08	3x08 = 24
Course 2	4	B+	07	4x07 = 28
Course 3	3	B	06	3x06 = 18
Course 4	3	O	10	3x10 = 30
Course 5	3	C	05	3x05 = 15
Course 6	4	B	06	4x06 = 24
	20			139

SGPA = 139/20 = 6.95

20.1.2 Illustration 2 for calculation of SGPA

A student registered for 6 (six) courses in a semester. At the end of the semester the student got A grade in a 4 credit course , A grade in 2 credit course B+ in a 3 credit course another B+ in a 3 credit course, B in a 3 credit course and F grade in a 3 credit course. Calculation of SGPA of this student is:

SGPA = (8x4+8x2+7x3+7x3+6x3+0x3)/(4+2+3+3+3+3) = (32+16+21+21
+18+00)/18= 108/18 = 6.00 0ut of 10.00.

SGPA of the student is 6.00.

20.2 Illustration for calculation of CGPA (Example)

The illustration is for calculation of CGPA of a student who studied six semesters in a UG program.

Semester	Credits	SGPA
Semester 1	20	6.95
Semester 2	22	7.80
Semester 3	18	5.65
Semester 4	21	6.04

Semester 5	19	7.21
Semester 6	20	7.85
	Total = 120	

CGPA =

(20 x 6.95 + 22 x 7.80 + 18 x 5.65 + 21 x 6.04 + 19 x 7.21 + 20 x 7.85) divided by 120	= 139.00 + 171.60 + 101.70 + 126.84 + 136.99 + 157.00 = 833.13/120 = 6.94275 Rounded off to 6.94

CGPA = 6.94. The student has passed in the program and is placed in 2nd Class.

20.3 **Transcript:** the University shall issue a transcript for each semester as given in 14.7 and a consolidated transcript indicating the performance in all semesters.

2020-2021 ONWARDS SYLLABUS PROPOSED FOR

B.Sc. BIOTECHNOLOGY

UNDER CBCS AND CFSD FRAMEWORK

PONDICHERRY UNIVERSITY
2020

Course structure for B.Sc Biotechnology
To be implemented from 2020-2021
onwards

COURSE	SUBJECT CODE	TITLE OF THE PAPER	CREDITS ALLOTED		Hours Per Week	
			Lecture	Tutorial/Lab	Lecture	Tutorial/Lab
SEMESTER – I		**23 Credits**				
MIL - 1	LARA/ LBEN/ LHIN/ LMAL/ LSAN/ LTAM/ LTEL 111	Arabic/Bengali/ Hindi/ Malayalam/ Sanskrit/ Tamil/ Telugu	03		05	
ENGLISH - 1	ENGL 112	English – I	03		05	
DSC - 1A	UBIOT 111	Cell biology	04		04	
DSC - 2A	UBIOT 112	Microbiology	04		04	
DSC - 3A	UBIOT 113	Chemistry for Biology	04		04	
AECC - 1	PADM 113	Public administration	02		02	
Practical	UBIOT 111 (P)	Cell biology		01		02
	UBIOT 112 (P)	Microbiology		01		02
	UBIOT 113 (P)	Chemistry for Biology		01		02
SEMESTER – II		**23 Credits**				
MIL - 2	LARA/ LBEN/ LHIN/ LMAL/ LSAN/ LTAM/ LTEL 121	Arabic/ Bengali/ Hindi/ Malayalam/ Sanskrit/ Tamil/ Telugu	03		05	
ENGLISH - 2	ENGL 122	English – II	03		05	
DSC - 1B	UBIOT 121	Analytical techniques in Biology	04		04	
DSC - 2B	UBIOT 122	Immunology	04		04	
DSC - 3B	UBIOT 123	Biochemistry	04		04	
AECC - 2	ENVS 123	Environmental science	02		02	
Practical	UBIOT 121 (P)	Analytical techniques in Biology		01		02
	UBIOT 122 (P)	Immunology		01		02
	UBIOT 123 (P)	Biochemistry		01		02

SEMESTER – III		**23 Credits**				
MIL - 3	LARA/ LBEN/ LHIN/ LMAL/ LSAN/ LTAM/ LTEL 231	Arabic/ Bengali/ Hindi/ Malayalam/ Sanskrit/ Tamil/ Telugu	03		05	
ENGLISH - 3	ENGL 232	English – III	03		05	
DSC - 1C	UBIOT 231	Molecular Biology	04		04	
DSC - 2C	UBIOT 232	Bioprocess technology and Downstream processing	04		04	
DSC - 3C	UBIOT 233	General Biology	04		04	
SEC - 1	UBIOT 234	Parasitology and Entomology	02		02	
Practical	UBIOT 231(P)	Molecular Biology		01		02
	UBIOT 232 (P)	Bioprocess technology and Downstream processing		01		02
	UBIOT 233 (P)	General Biology		01		02
SEMESTER – IV		**23 Credits**				
MIL - 4	LARA/ LBEN/ LHIN/ LMAL/ LSAN/ LTAM/ LTEL 241	Arabic/ Bengali/ Hindi/ Malayalam/ Sanskrit/ Tamil/ Telugu	03		05	
ENGLISH - 4	ENGL 242	English – IV	03		05	
DSC - 1D	UBIOT 241	Genetic Engineering	04		04	
DSC - 2D	UBIOT 242	Enzyme Technology	04		04	
DSC - 3D	UBIOT 243	Evolution and Genetics	04		04	
SEC - 2	UBIOT 244	Developmental Biology	02		02	
Practical	UBIOT 241(P)	Genetic Engineering		01		02
	UBIOT 242 (P)	Enzyme Technology		01		02
	UBIOT 243 (P)	Evolution and Genetics		01		02

SEMESTER – V		**20 Credits**			
SEC - 3* (any one)	UBIOT 351	Scientific writing and communication/Presentation Skills	02	02	
	UBIOT 352	Molecular diagnostics	02	02	
DSE - 1A* DSE - 2A* DSE - 3A* (any three)	UBIOT 353	Animal Biotechnology	04	06	
	UBIOT 354	Marine Biotechnology	04	06	
	UBIOT 355	Environmental Biotechnology	04	06	
	UBIOT 356	Medical Biotechnology	04	06	
GE - 1	UBIOT 357	Genomics and Proteomics	03	04	
Practical	UBIOT 353 (P)	Animal Biotechnology		01	02
	UBIOT 354 (P)	Marine Biotechnology		01	02
	UBIOT 355 (P)	Environmental Biotechnology		01	02
	UBIOT 356 (P)	Medical Biotechnology		01	02
SEMESTER – VI		**20 Credits**			
SEC - 4* (any one)	UBIOT 361	Skills in Biotechnology	02	02	
	UBIOT 362	Industrial Visit	02	02	
DSE - 1B* DSE - 2B* DSE - 3B* (any three)	UBIOT 363	Pharmaceutical Biotechnology	04	06	
	UBIOT 364	Bioinformatics	04	06	
	UBIOT 365	Plant Biotechnology	04	06	
	UBIOT 366	Microbial Biotechnology	04	06	
GE - 2	UBIOT 367	Biosafety, Bio-ethics, IPRs and Entrepreneurial Development	03	04	
Practical	UBIOT 363 (P)	Pharmaceutical Biotechnology		01	02
	UBIOT 364 (P)	Bioinformatics		01	02
	UBIOT 365 (P)	Plant Biotechnology		01	02
	UBIOT 366 (P)	Microbial Biotechnology		01	02

DSE* - Any 3 in semester V & VI
SEC* - Any 1 in semester V & VI

Total Number of Credits 132
Course code ending with (P) denotes practical paper.
Number of Courses:

B.Sc. Biotechnology	**Course with Credit**						
Semester	MIL	ENG	DSC	DSE	SEC	AECC	GE
I	01	01	03		-	01	-
II	01	01	03		-	01	-
III	01	01	03		01	-	-
IV	01	01	03		01	-	-
V	-	-	-	03	01	-	01
VI	-	-	-	03	01	-	01
Total	**04**	**04**	**12**	**06**	**04**	**02**	**02**
Total No. of Papers = 34							

DETAILS OF COURSES FOR B.Sc. BIOTECHNOLOGY

I. **DSC 1** - DISCIPLINE SPECIFIC CORE – (for Biotechnology main) (COMPULSORY) (Four papers)

1. Cell biology
2. Analytical techniques in Biology
3. Molecular Biology
4. Genetic Engineering

DSC 2- DISCIPLINE SPECIFIC CORE- (for Biotechnology main) (COMPULSORY) (Four papers)

1. Microbiology
2. Immunology
3. Bioprocess technology and Downstream processing
4. Enzyme Technology

DSC 3- DISCIPLINE SPECIFIC CORE- (for Biotechnology main) (COMPULSORY) (Four papers)

1. Chemistry for Biology
2. Biochemistry
3. General Biology
4. Evolution and Genetics

II. **SEC**- SKILL ENHANCEMENT COURSES (also for Non-Biotechnology main) (Four papers)

1. Parasitology and Entomology
2. Developmental Biology
3. Scientific writing and communication/Presentation Skills or Molecular Diagnostics
4. Skills in Biotechnology or Industrial Visit

For Skill Enhancement Course of Semester V (SEC-3* UBIOT 351: Scientific writing and communication/Presentation Skills) and Semester VI (SEC-4* UBIOT 361: Industrial Visit) course's End-Semester examination (75 marks) shall be internally conducted and evaluated by the Department of Biotechnology.

III. **DSE** - DISCIPLINE SPECIFIC ELECTIVES (for Biotechnology main)*

DSE-1A, 2A, 3A
(Three papers)

1. Animal Biotechnology
2. Marine Biotechnology
3. Environmental Biotechnology
4. Medical Biotechnology

DSE-1B, 2B, 3B
(Three papers)

1. Pharmaceutical Biotechnology
2. Bioinformatics
3. Plant Biotechnology
4. Microbial Biotechnology

IV. **GE** - GENERIC ELECTIVE (also for Non-Biotechnology main)

GE - 1

1. Genomics and Proteomics

GE - 2

1. Biosafety, Bio-ethics, IPRs and Entrepreneurial Development

V. **MIL** - MODERN INDIAN LANGUAGES

Arabic/ Bengali/ Hindi/ Malayalam/ Sanskrit/ Tamil/ Telugu

VI. ENGLISH

VII. AECC- ABILITY ENHANCEMENT COURSES- (COMPULSORY)

1. Public Administration
2. Environmental Studies

Programme Educational Objectives (PEOs):

I. To prepare students for successful career in industry and research institutes.
II. To develop the ability amongst the students to apply modern biotechnological techniques in industry and research.
III. To enable students to work in a team with multidisciplinary approach.
IV. To provide students with fundamental strength in analyzing and solving biotechnological related problems.
V. To promote and inculcate ethics and code of professional practice among students.

Programme Outcomes:

I. After successful completion of Bachelor of Science in Biotechnology, the students will be able to demonstrate basic knowledge in biological sciences
II. The students would acquire basic knowledge of science and skills to design and conduct experiments, analyse data and interpret the results.
III. The students will be able to demonstrate understanding of basic knowledge in modern biology disciplines
IV. The students will be able to demonstrate understanding of modern techniques used in biotechnology
V. The student will be able to demonstrate ability to provide technological solutions in the fields of biotechnological applications
VI. The students will be able to reinforce technological skills and high-end recent advances in biotechnology
VII. The students will be able to communicate effectively and demonstrate professional and ethical responsibilities
VIII. The graduates will acquire first-hand experience in working on projects at individual level and exposure to industrial and research environment.

DISCIPLINE SPECIFIC CORE COURSES
(COMPULSORY)

Discipline Specific Core (DSC) – 1A
CELL BIOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 111 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course objectives:

The course is aimed to impart knowledge of structural and functional aspects of cells as unit of living systems.

To understand functions of various organelles and transport of information and matter across cell membrane and classical genetics comprising Mendelian laws of inheritance and their significance in genetic diseases.

UNIT – I (10 hours)

History of cell Biology, cell as basic unit of life, Cell theory, Protoplasm theory, Organismal theory, Classification & characterization of cell types – Prokaryotes & Eukaryotes, Organization, Ultrastructure of plant cell, animal cell, bacterial cell and viruses.

UNIT – II (10 hours)

Structure and function of cell wall - Bacterial and Plant. Ultra structure of plasma membrane – fluid mosaic model, membrane fluidity, Transport across membranes - Symport, antiport, uniport, active and passive transport, Differentiation of cell surface: Basement membrane, tight junction, gap junctions, Desmosomes, hemidesmosomes. Cytoskeletal structures – microtubules, microfilaments (actin, myosin), Intermediate filament.

UNIT –III (10 hours)

Structure & Functions of cell organelles: Endoplasmic Reticulum (SER & RER), golgi apparatus, lysosomes, microbodies (peroxysomes and glyoxysomes), ribosomes and its types, centrioles, basal bodies. Structure and functions of mitochondria, chloroplast, organization of respiratory chain in mitochondria, photophosphophorylation in chloroplast.

UNIT – IV (15 hours)

Structure and organization of nucleus, nuclear membrane, organization of chromosomes-structural organization of chromatids, centromere, chromatin, telomere, nucleosomes, euchromatin and heterochromatin, specialized structures- polytene and lambrush chromosomes

UNIT – V (15 hours)

Cell division - Cell cycle, mitosis and meiosis, regulations of cell cycle and check points and proteins involved in cell cycle check points. Basics in cell signaling- signaling molecules and receptors, G protein coupled receptors, Tyrosine kinase receptor, apoptosis and necrosis.

Course Learning Outcomes (CLO):

Students will be able to

1. acquire knowledge about the organizational and functional aspects of cell and cell organelles

2. learn about the interactions of the cells with outside environment through exchange of information and transport of molecules.
3. learn about the classical genetics and transmission of characters from one generation to the next which will make foundation for the advanced genetics.
4. develop innovative research ideas for curing genetic disorders in humans

CELL BIOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Microscopic techniques- light microscopy.
2. Observation of permanent slides
3. Measurement of cell using ocular micrometer and stage micrometer
4. Cell types- Microbial, animal and plant cells
5. Cell counting method- animal cell: Haemocytometer
6. Cell counting method- plant cells-stomatal density
7. Mitosis in onion root tip.
8. Meiosis in Pollen mother cells of plants

Text Books:

- E.D. P. De Robertis and E.M.F. De Robertis, Jr. 2012 Cell and Molecular Biology (Eighth edition). B.I. Waverly Pvt.Ltd. New Delhi.
- Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore and James Dernell, 2009. Molecular Cell Biology (Fourth Edition). Media Connected – W.H.Freeman and Company.
- P.S. Verma and V.K. Agarwal, 2012, Concepts of Cell Biology. S.Chand & Company Ltd., New Delhi;

Further Reading:

- D.E Sadava, 1993. Cell Biology - Organelle Structure and Function. Jones and Bartlett Publishers
- B Alberts, 2009 Essential Cell Biology (Third Edition), Garland Science; publishers
- Alberts Bruce, 2008 Molecular Biology of the Cell (Fifth Edition), Garland Science; publishers

Discipline Specific Core (DSC) – 2A
MICROBIOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 112 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course objective:

To understand the basics of microbiology and to know the role in environment.
To provide fundamental understanding of the microbial world, basic structure and functions of microbes, metabolism, nutrition, their diversity, physiology and relationship to environment and human health.
To impart practical skills of isolation and manipulating conditions for their propagation.
To ensures the students to understand about the structure and function of microorganisms.

UNIT - I (10 hours)

Microbial Diversity: Basics of microbiology, History and Scope of microbiology, General features and Classification of Archaea, Bacteria, Fungi, Algae, Protozoa, Viruses and Prions. Differences between prokaryotic and eukaryotic organisms.

UNIT- II (15 hours)

Ultrastructure of Bacteria: Sub-cellular structures - Cell wall of bacteria and its biosynthesis, Cell envelope - capsule and slime layer, Cellular appendages - pili, flagella and fimbriae, Cell membrane, inclusion bodies, Plasmid DNA and chromosomal DNA. **Bacterial genetics** - conjugation, transduction (generalized and specialized), and transformation.

UNIT - III (15 hours)

Microscopy: Staining - Principles and types of staining (simple and differential) **Microscopy -**Instrumentation, principles and applications of light microscopes (bright field, dark field, phase contrast, fluorescent microscopes) and electron microscopes (transmission and scanning electron microscopes)

UNIT - IV – (10 hours)

Microbial Nutrition: Classification of microorganisms based on their nutritional types, Preparation of media, types of media, culturing of microbes, Microbial growth curve, viral replication: lytic and lysogenic cycles, Isolation, preservation and maintenance of microorganisms, Aerobic and Anaerobic culturing of bacteria, Effect of biotic and abiotic factors on the growth of organisms.

UNIT - V (10 hours)

Microbial Control: Sterilization, disinfection, antisepsis, fumigation. Physical control: Temperature (moist heat, autoclave, dry heat, hot air oven and incinerators), desiccation, osmotic pressure, radiation, UV-light, electricity, ultrasonic sound waves, filtration. Chemical control: Antiseptics and disinfectants (halogens, alcohol, gaseous sterilization)

Course Learning Outcomes (CLO):

Students will be able to
1. define the science of microbiology, its development and importance in human welfare.

2. describe historical concept of spontaneous generation and the experiments performed to disprove.
3. describe some of the general methods used in the study of microorganisms.
4. recognize and compare structure and function of microbes and factors affecting microbial growth.
5. demonstrate aseptic microbiological techniques in the laboratory and check sources of microbial contamination and their control.

MICROBIOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Microscopic examination of Bacteria, Yeasts & Fungi
2. Motility of bacteria.
3. Simple staining of bacteria
4. Gram staining.
5. Preparation of media – solid, liquid media and semi-solid.
6. Methods of inoculation.
7. Isolation and maintenance of pure cultures.
8. Enrichment culture techniques.
9. Growth curve of microbes

Text Books:

- M.J. Pelczar Jr. E.C.S. Chan and N.R. Kreig, Microbiology (5th edition), Tata MaCraw-Hill, New Delhi;
- R. Ananthanarayanan. and C.K.Jayaram Panickar, Text book of Microbiology (9th edition), Orient Longman Publications, New Delhi
- Lansing M. Prescott, John. P. Harley, Donald A. Klein, 1999. Microbiology (9th edition) WCB MaCraw-Hill, New York;

Further reading:

- Sundararajan S (2003). College Microbiology, revised edition, Vardhana publications, Banglore.
- R.C. Dubey, D.K.Maheswari, A Text book of Microbiology (2005), S.Chand & C7ompany Ltd. New Delhi

Discipline Specific Core (DSC) – 3A
CHEMISTRY FOR BIOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 113 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course objective:

The Students will know the basics of organic chemistry, how the collection of thousands inanimate molecules that constitute living organisms interact to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the nonliving thing.
To emphasize the role of biomolecules by providing basic information on metabolism.

UNIT-I (10 hours)

Bio Organic Chemistry: Functional groups of Biomolecules, Geometry of C bonding, chirality and 3D structure- configuration, confirmations, steric hinderance. Setero isomers and geometric isomers. Stereo specific interactions, chemical bonding and intramolecular forces.

UNIT-II (15 hours)

Chemistry of Carbohydrates: Definition, nomenclature and classification. Monosaccharides - Optical isomers and configurations (D&L), Fischer's, Haworth Projections and Conformations (chair and boat), Formation of Hemiacetyl / Hemiketyl linkage, Cyclic structures (α & β) and Mutarotation. Hexose derivatives. Disaccharides and glycosidic bonds. Polysaccharides - Starch, Bacterial Peptidoglycan and Extracellular matrix (Glycosaminoglycans). Glycoconjugates.

UNIT-III (15 hours)

Chemistry of Amino acids & Proteins: Classification, Structure and Properties of amino acids, proteogenic and non proteogenic aminoacids, unusual aminoacids, amphoteric nature, Zwitter ion, isoelectric point and pK_a Value, Ramachandran plot for amino acids. Peptide bond formation - Planar structure, stabilization & peptide conformation (φ & ψ). Peptide hormones (glucagon) and antimicrobial peptides. Structural classification of proteins, Forces stabilizing the 3D structure of proteins, Protein denaturation and folding. Molecular chaperons, Protein misfolding and genetic disorders. Oxygen binding proteins (Hemoglobin & Myoglobin) and Histones.

UNIT-IV (10 hours)

Chemistry of Lipids: Nomenclature and Classification, Structure and function of storage lipids (Triacylglycerols), membrane lipids (Phospholipids, Glycolipids and Archeal ester lipids), Intracellular signals (Phosphatidyl inositol), Cofactors (Vitamins) and natural pigments (β- carotene). Biomembranes: Behavior of amphipathic lipids in water- formation of micelles, bilayers, vesicles, liposomes. Membrane composition and organization – Fluid mosaic model.

UNIT-V (10 hours)

Chemistry of Nucleic acids: Occurrence, Composition & structure of DNA and RNA, Chargaff's rules, Nucleotides as energy carrier, cofactors & regulatory molecules (cyclic AMP). Unusual structures in DNA (Palindrome, mirror repeats, hairpins and cruciform), Structural polymorphism in DNA, DNA stability, DNA Denaturation (C_ot value and T_m), DNA hybridization, Molecular Concept of prokaryotic and eukaryotic genes: introns, exons, spacers. Chromosomes: chromatin, centromere & Telomere, Role of telomere and centromere, telomeric and centromeric repeat sequences, karyotyping. Central dogma of life.

Course Learning Outcomes (CLO):

Students will be able to

1. know the chemical constituents of cells, the basic units of living organisms.
2. explain various types of weak interactions between the biomolecules.
3. know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids, nucleic acids.
4. correlate the structure-function relationship in various biomolecules
5. know the role of biomolecules for orderly structures of the cells/tissues.

CHEMISTRY FOR BIOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Extraction and Characterization of Starch
2. Qualitative test for Carbohydrates
3. Isoelectric precipitation of proteins
4. Precipitation of Immunoglobin from serum
5. Intracellular total protein precipitation by TCA/ Acetone method
6. Qualitative analysis of proteins
7. Separation of Amino acids by chromatography
8. Karyotyping

Text Books:

- Nelson and Cox, Lehninger. Principles of Biochemistry (7th Edition), W.H Freeman Publishers (2010).
- Voet D. Biochemistry (4th Edition), Academic Press (2012).
- Dubey R.C, A Textbook of Biotechnology (6th Edition), S. Chand Publishing, reprint, 2014.

Further Readings:

- Zubey G. Principles of Biochemistry, Oscar Publication (2000).
- Devlin T. M. Text Book of Biochemistry with Clinical Correlations (4th Edition) Wiley & Sons Publication (2005).
- Roy Tasker, Carl Rhodes. Stryer's Biochemistry (7th Edition) W. H. Freeman publishers(2012).

Discipline Specific Core (DSC) – 1B
ANALYTICAL TECHNIQUES IN BIOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 121 **Lectures: 60**
Max. Marks =100 (ICA = 25 + ESE = 75)

Course objective:
The objective of this course is to provide the students with the understanding of various analytical techniques used in biotechnology-based research and industry.
The course will acquaint the Students with the various instruments, their configuration and principle of working, operating procedures.
In this course, the students will be exposed to basic concepts related with techniques and instrumentation widely used in Biotechnology.

UNIT – I (12 hours)

Solutions: Water- Structure and interaction, water as solvent, pH, Bronsted- Lowry concept of acid and bases, ionization, Buffer: Henderson-Hasselbalch equation, Biological buffer system (bicarbonate, phosphate buffers and Tris buffers), Determination of molecular weight- molarity, molality, normality, equivalent weight.

UNIT – II (14 hours)

Spectroscopy: Colorimetry, Basic principles, Beer-Lamberts law, instrumentation and application of UV-Vis and IR spectroscopy, Centrifugation – Principle & types, sedimentation co-efficient, sedimentation velocity, ultra centrifugation, separation of macromolecules, subcellular fractionation.

UNIT – III (15 hours)

Chromatography – Basic principle & types – paper chromatography, thin layer chromatography, column chromatography: gel exclusion, adsorption, ion exchange, affinity. Application of chromatographic technique – separation of biomolecules

UNIT – IV (14 hours)

Electrophoresis – Principle, DNA and RNA gel electrophoresis, Protein gel electrophoresis – SDS PAGE, native-PAGE, documentation, 2D-electrophoresis, Isoelectric focusing.

Tracer techniques: nature of radioactivity, isotopes, radioactive decay, α, β and γ radiation, Scintillation counter, application of radioisotopes in biological sample.

UNIT – V (18 hours)

Bio-Physical Techniques: Crystallography: basic concepts & laws, symmetry of elements in crystal X–ray crystallography, determination of crystal structure. Fluorescence: concepts, emission, chemi-luminescence, luminometry. NMR-2D & 3D structure prediction.

Course Learning Outcomes (CLO):
At the end of the course students will be able perform biochemical assays, electrochemical techniques, spectrophotometry and chromatography.
1. Apply basic principles of different analytical techniques in analytical work.
2. Use spectroscopy and radioactivity in biotechnological applications
3. Use microscopy, centrifugation and electrophoretic techniques.

4. Demonstrate principle and working of various instruments.
5. Use various techniques for solving industrial and research problems.

ANALYTICAL TECHNIQUES IN BIOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Operation of shakers, incubators, pH meters and centrifuges
2. Buffer preparation- Phosphate/Acetate/Citrate
3. Density gradient centrifugation
4. Agarose gel electrophoresis of DNA
5. Poly Acrylamide Gel Electrophoresis of Proteins
6. Staining of SDS- PAGE: coomassie brilliant blue and silver staining.
7. Column chromatography
8. Thin layer Chromatography.
9. Estimation of nuclei acid by colorimetric method.

Text Books:

- Wilson, K. and Walker, J. Practical Biochemistry – Principles and techniques 7th edition, 2010, Cambridge University Press,
- Brawer, I M., Perce, A.M., Experimental techniques in Biochemistry. Prentice Hall Foundation, New York 2012.

Further Readings:

- Joseph Sambrook and David. W. Russel, Molecular Cloning- A laboratory manual, 4th edition, 2012, Cold spring harbor press.

Discipline Specific Core (DSC) – 2B
IMMUNOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 122 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

COURSE OBJECTIVES:

To introduce the science of immunology and detailed study of various types of immune systems and their classification, structure and mechanism of immune activation. And to get conceptual views about transplantation and its necessity.

UNIT - I (10 hours)

Immunology - History & Milestones, Microbial infections and host resistance. Immune response: Innate & Adaptive responses, Humoral and cell mediated Immune Responses. Structures, composition and functions of cells and organs of immune system.

UNIT- II: (10 hours)

Antigens & Immunogenicity. Antigens - Types, properties, Haptens, Adjuvants, Toxoids, Immunoglobulins- structure, types and properties, Theories of antibody formation, Structural and genetic basis of antibody formation.

UNIT - III (12 hours)

Antigen and antibody reactions, Immunodiagnostic methods - Agglutination, precipitations, complement fixation, RIA, ELISA and its types, Immunofluorescence, Production of Monoclonal Antibodies and Hybridoma technique.

UNIT - IV (13 hours)

Cytokines & Chemokines - Classification, types and its functions, Complement system: - structure, properties, functions of complement components and its pathways.

UNIT - V (15 hours)

Immune disorders and tumors: Types of tumors, tumor antigens, immune response to tumors. Immunodeficiency and Auto immune diseases, MHC - Structure and function of class I and class II MHC molecules, Hypersensitivity reactions: Type I, II, III and IV Transplantation immunology - types and mechanisms involved.

Course Learning Outcomes (CLO):

Students will be able to

1. describe and explain the fundamental principles of modern immunology.
2.understand and apply related immunological techniques in medical laboratory.
3. relate and apply medical laboratory science knowledge to immunological changes in healthy and disease contexts.

IMMUNOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Single Immunodiffusion analysis
2. Double Immunodiffusion analysis.
3. Rocket Immuno-electrophoresis.
4. Separation of PBMC from the blood sample.
5. Slide & Tube Agglutination Reaction
6. Extraction of antigens from microbes
7. Purification of Antibodies.
8. Preparation of murine splenolymphocytes
9. Enzyme-Linked Immunosorbent Assay

Text Books

- Roit, I.M., Delves P.J., Essential Immunology (10th edition), Blackwell Science, Oxford 2001
- Immunology by Kuby, J. (8th edition) W.H. Freeman and Company, New York, 2013
- Kumar. M.S, Leela K Sai, Microbiology and Immunology (2nd edition) Jaypeebooks 2014

Further Reading:

- Male. D and Roth. D, Immunology (8 edition), Reed Elsevier India Pvt Limited 2013.
- Khan. F.H. The Elements of Immunology, Pearson Education India, 2009
- Hay. F.C, Olwyn. M.R West wood, Practical Immunology (4th edition), Blackwell science 2002

Discipline Specific Core (DSC) – 3B
BIOCHEMISTRY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 123 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course objective:
The course aims to introduce the theories and concepts of biomolecules, provide an advanced understanding of the core principles and topics of biomolecule metabolism and their experimental basis and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of lecture series

UNIT-I (10 hours)

Bioenergetics: Laws of thermodynamics, free energy change, enthalpy, entropy, equilibrium constant, flow of electrons, electron carriers, redox potential, redox coupling & ATP bioenergetics, High energy compounds.

UNIT-II (10 hours)

Introduction to Metabolism: Anabolic, catabolic and amphibolic pathways. Enzymes in metabolism: Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, active site, allosteric site, apoenzyme, holoenzyme, substrate inhibitor, modulator. IUBMB classification of enzymes, Fischer's and Koshland's hypothesis.

UNIT-III (10 hours)

Metabolism in mitochondria: Biological oxidation - enzymes involved in oxidation and reduction, reactions catalyzed by dehydrogenases, oxidases, peroxidases and oxygenases; removing of H_2O_2 from the biologic systems. Macroergic compounds. Respiratory chain, oxidative phosphorylation, inhibitors of the respiratory chain. The action of uncouplers; chemiosmotic theory. Glycolysis, Citric acid cycle, central role of Acetyl CoA, localization of TAC in the cell, Inborn errors: Type 1 Diabetes mellitus.

UNIT-IV (15 hours)

Metabolism of lipids: Biosynthesis of fatty acids, membrane phospholipids, fatty acid synthase complex, regulation, Microsomal & Mitochondrial system of chain elongation & synthesis of unsaturated fatty acids. β-oxidation of fatty acids, role of carnitine, oxidation of unsaturated fatty acids & odd carbon fatty acids. Inborn errors: Disorders of Fatty acid oxidation metabolism– Medium chain acyl coenzyme A dehydrogenase deficiency.

UNIT-V (15 hours)

Metabolism of Nitrogenous Compounds: Transamination (mechanism). Oxidative & Non-oxidative deamination. Urea cycle, linkage of urea & TCA cycle. Transmethylation & Decarboxylation, physiologically important products of decarboxylation. Synthesis and degradation of nucleotides (DNA). Disorders of Amino acid metabolism-Phenylketonuria, Disorders of Urea cycle– Carbamoyl phosphate synthetase I deficiency. Disorders of nucleotide metabolism – Lesch-Nyhan syndrome.

Course Learning Outcomes (CLO):

Students will be able to

1. Demonstrate broad knowledge of the biomolecules, machinery and information that flow within living cells and an appreciation of how these underpin all biological processes, in both normal and diseased states.
2. Demonstrate proficiency in core biochemical laboratory techniques, understanding both the principles and applications of these methods within the molecular biosciences.
3. Understand enzyme actions and kinetics

BIOCHEMISTRY PRACTICALS
(1 Credit)

Practicals:

1. Estimation of proteins:
   (a) Lowry's method, (b) Bradford's method
2. Estimation of enzyme activity by reducing sugar method
3. Effect of substrate concentration on salivary amylase activity
4. Estimation of amino acids
5. Estimation of carbohydrates by Anthrone method
6. Estimation of total Cholesterol by Zak method
7. Estimation of RNA by Orcinol method
8. Determination of unsaturated fatty acids

Text Books:

- Voet. D. Biochemistry (4th Edition), Academic Press2012.
- Zubey.G - Principles of Biochemistry (4th edition) Oscar Publication 2000.
- Wilson and Walker Principles and Techniques of Practical Biochemistry, (7th edition), Cambridge University Press 2010.

Further reading:

- Nelson and Cox, Lehninger. Principles of Biochemistry (7th Edition), W.H Freeman Publishers 2010
- Roy Tasker, Carl Rhodes. Stryer's Biochemistry (7th Edition). W. H. Freeman publishers 2012.

Discipline Specific Core (DSC) – 1C
MOLECULAR BIOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 231 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course objective:
The aim is to extend the understanding of molecular mechanisms of cell through which genetic information is stored, expressed and transmitted among generations.

UNIT - I (10 hrs)

Introduction to Molecular Biology, Types of genetic materials- Experiments of Griffith, Avery, MacLeod and McCarty, Hershey and chase, John Cairns experiment, Meselson-Stahl experiment, Central dogma of life.

UNIT- II (10 hrs)

Replication of DNA, Models of DNA replication, Mechanism of DNA replication in prokaryotes (initiation, elongation, replication fork, replication machinery, termination), Enzymes and proteins involved in DNA replication (nucleases, DNA polymerases, DNA helicases, gyrases, SSBP, topoisomerase, primase).

UNIT - III (15 hrs)

Mechanism of transcription in prokaryotes and eukaryotes. Enzymes and proteins involved in transcription, post transcriptional modifications. Inhibitors of transcription.

UNIT- IV (15 hrs)

Genetic code - characteristics and properties, Wobble hypothesis. Protein biosynthesis in prokaryotes and eukaryotes, post translational modifications, protein degradation, Inhibitors of protein synthesis. Regulation of gene expression (*lac*, *trp* and *gal* operons).

UNIT- V (10 hrs)

Mutation and its types- spontaneous, induced, reverse, suppressor mutations; chemical mutagens- alkylating agent, nitrous acid, hydroxylamine; physical mutagen- radiation. DNA repair- mismatch repair, base excision repair, nucleotide excision, direct repair and SOS repair.

Course Learning Outcomes (CLO):
Students will be able to get the overview of Molecular Biology and understand the process involved in replication, transcription and translation and regulation of gene expression and the molecular functions of antibiotics.

MOLECULAR BIOLOGY PRACTICALS
(1 Credit)

Practicals

1. DNA isolation from prokaryotes- *E.coli*
2. DNA isolation from eukaryotes- *Saccharomyces cerevisiae*
3. Protein extraction from *E.coli*
4. Molecular weight determination of DNA
5. Physical mutations: UV irradiation
6. Quantification of DNA
7. Total RNA isolation from bacteria
8. Melting curve analysis of DNA

Text books

- Lodish. H, Berk. A, Lawrence, A, Matsudaira. A, Baltimore. D and Dernell. J. Molecular Cell Biology (Fourth Edition). – W.H.Freeman and Company. 2009
- Cooper G M & Hausman E, The Cell - A Molecular Approach. (6th edition), Sinauer Associates 2013

Further readings

- P.S. Verma and V.K. Agarwal, 2012, Concepts of Cell Biology. S.Chand & Company Ltd., New Delhi. 2012
- Lewin. B , GENES X, (10th edition), Jones & Bartlett Learning, 2011
- David L. Nelson & Michael M. Cox. (2017) Lehninger principles of biochemistry (7th Edition) W H Freeman & Co.

Discipline Specific Core (DSC) – 2C
BIOPROCESS TECHNOLOGY AND DOWNSTREAM PROCESSING
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 232 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course objective:

This course updates students' knowledge of new developments in biology of industrial relevance. To make the students understand the fermentation process, using these tools and its combination of bioprocess engineering. In addition, this provides broad understanding and experience of technological processes involved in biotechnological industries.

UNIT I (15 Hours)

Principles of Bioprocess technology – Introduction and history of traditional and modern bioprocess technology. General concepts of fermentation technology – Outline of an integrated bioprocess and various unit operations. Industrially important microbes: Isolation, Screening & Preservation techniques – Slant culture, spore culture, overlaying culture with mineral oil, Lyophilization, Cryopreservation – Strain improvement – mutation, protoplast fusion & rDNA techniques for strain development – Maintenance of Industrially important microbes.

UNIT II (10 Hours)

Introduction to fermentation - Types of fermentation processes (Submerged & solid static) - Media formulation - Synthetic and complete media, Sterilization (batch & continuous) – Air, Filter and Media sterilization – Operation: Inoculum preparation and sampling. Fermenters: Design of a fermenter – Types: Stirred tank, Fluidized bed, Immobilized bed bioreactors, Photo bioreactors, Air lift bioreactors and its other types.

UNIT III (10 Hours)

Microbial growth and death kinetics - Bioprocess control & monitoring of various factors, temperature, agitation, pressure, pH, dissolved oxygen and foam sensing – online measurements, Control systems – Manual control, Automatic control - on/off control & PID control, Computer applications in fermentation technology - Scale up & Scale down of microbial reactions.

UNIT IV (10 Hours)

Down- stream processing: Removal of microbial cells and solid matter – Precipitation, Filtration, Centrifugation, Liquid – Liquid extraction, Chromatography and membrane processes, BOD and COD measurements, Disposal of industrial wastes.

UNIT V (15 Hours)

Industrial waste water treatment and disposal: Physical treatment, chemical treatment and biological treatments. Aerobic processes - trickling filter, towers, biologically aerated filters, rotating drums, fluidized bed systems, activated sludge process. Anaerobic treatment - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blankets. Disposal - seas and rivers, lagoons, spray irrigation, well-disposal, landfilling, incineration, disposal of effluents to sewers.

Course Learning Outcomes (CLO):

At the end of the course students will be able to acquire knowledge on the types of fermentation process, bioprocess and the preparation of media and anaerobic digesters, current themes and insights, informed by the forefront of the Biotechnology industry and its related disciplines, understand and apply scale-up methods for designing bioreactors. Become familiar with principles of recovery and purification techniques of bioprocess.

BIOPROCESS TECHNOLOGY AND DOWNSTREAM PROCESSING PRACTICALS
(1 Credit)

Practical:

1. Fermenter design and structure.
2. Inoculum preparation and sterilization
3. Preparation of Wine
4. Isolation of lactic acid bacteria from curd
5. Isolation of amylase producing microorganisms
6. Isolation of antibiotic producing microorganisms from soil
7. Estimation of COD.
8. Estimation of BOD.
9. Immobilization of bacterial cells.

Text Books:

- Stanbury P.F., Whitaker. A & Hall. S. J. Principles of fermentation technology (2^{nd} edition), Aditya Books Private ltd., 2000.
- Crueger, W. and Crueger, A, Biotechnology: A Textbook of Industrial Microbiology. (2nd Ed.), Panima Publishing Corporation, New Delhi. 2000.
- Waites M.J., Morgan N.L., Rockey J.S., Industrial Microbiology. 2^{nd} edition, Blackwell Science, 2002.

Further Reading:

- Demain L. & Davies E. Manual of Industrial Microbiology and Biotechnology (2^{nd} edition), ASM Press, Washington, 2004.
- Emt El Mansi, Bryce, CFA, Demain, AL (Eds). Fermentation Microbiology and Biotechnology (2nd Edition), CRC Press. 2006.

Discipline Specific Core (DSC) –3C
GENERAL BIOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 233 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objectives: To understand the diversity, complexity and integrity of the system and behavior of the living organisms.

UNIT - I (10 hours)

Diversity of Life forms: Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals. Important criteria used for classification in each taxon. Classification of plants and animals. Evolutionary relationships among taxa.

UNIT - II (13 hours)

Tissues: Meristematic, simple permanent tissues – parenchyma, collenchyma, sclerenchyma, and complex permanent tissues – xylem and phloem. Types of vascular bundles. Growth and differentiation in plants - Primary growth, secondary growth, arithmetic growth, geometric growth, determinate growth, indeterminate growth, absolute growth and relative growth. Animal tissues – Epithelial, connective, muscular and nervous tissues.

UNIT - III (12 hours)

Integrative Physiology: An overview of neuronal structure and function; Sensory physiology –mechano, chemo, thermo, photo and electro receptors; Endocrine systems in animals and their physiological effects; Plant hormones and their physiological effects; Regulation of metabolism and response to environmental cues; Neuronal basis of behaviour; Behaviour concepts and measurements

UNIT – IV (13 hours)

Regulatory Physiology: Regulation of water in aquatic and terrestrial animals; Water and solute excretion in organisms; osmoregulatory organs; Transpiration in plants; Excretion of nitrogenous wastes in animals; Patterns of Thermoregulation : Ectotherms and Endotherms; Structural and functional adaptation to stress.

UNIT – V (12 hours)

Ethology: Introduction to Animal Behaviour Origin and history of Ethology. Methods and recording of a behavior. Patterns of Behaviour Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

Course outcome: Students will come to know the diversity, complexity and integrity of the system and behavior of the living organisms.

GENERAL BIOLOGY PRACTICALS (1 Credit)

Practicals

1. Preparation of herbarium.
2. Culture of plant (explants).
3. Calculation of the stomatal index, stomatal frequency and percentage of leaf area open through Stomata.
4. Cross section of dicot leaf, stem and root.
5. Cross section of monocot leaf, stem and root.
6. Study of the mechanism of stomatal opening and closing.
7. Study of transpiration in plants using Ganong's potometer.
8. Experiment on plasmolysis of *Tradescantia* leaf.
8. Study of the developmental stages and life cycle of Drosophila from stock culture.
9. To study geotaxis behavior in earthworm.
10. To study the phototaxis behavior in insect larvae.

Text Books

- D. J. Taylor, N.P.O. Green, G.W. Stout. Biological Science (3rd Edition) – Cambridge University Press. 2008.
- Raven, Johnson, Mason, Losos & Singer. Biology (9th edition). Tata McGraw Hill Education, New Delhi. 2011.
- Taiz, L & Zeiger, E. Plant physiology (5th edition), Sinauer Associates, Inc. Sunderland. 2010.
- Knut Schmidt-Nielsen. Animal physiology (5th edition). Cambridge University Press. 1997.

Reference Books

- Scott. F. Gilbert, Developmental Biology (6th ed.) Sinauer Associates, INC., Publishers, Sunderland, Massachusetts. 2000.
- Mc Farland David, Animal Behavior: Psychobiology, Ethology and Evolution. 3rd Ed. Benjamin Cummings. 1998.
- An A. Manning & MS Dawkins, Introduction to Animal Behavior, Cambridge University, Press. 2012.
- W. Paul, Sherman and J Alcock, Exploring Animal Behavior, Sinauer Associate Inc., Massachusetts. 2013.
- Knut Schmidt – Nielsen. Animal Physiology 5th Ed., Cambridge University Press. 2005.
- Randall D, Burggren W & K French, EcKert Animal Physiology, 5th Ed. W.H. Freeman. 2002.

Discipline Specific Core (DSC) – 1D
GENETIC ENGINEERING
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 241 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objective:

To provide knowledge in Basics Genetic engineering.
This course would familiarize students with facile molecular techniques involved in isolation and manipulation of genetic material for achieving the desired goal.
To train the students in various techniques involved in Genetic engineering.

UNIT-I (10 hours)

History and basic steps involved in genetic engineering, Enzymes involved in genetic engineering (Nucleases, Restriction enzymes and their types, DNA ligases and ligation, Kinases, Phosphatases, Reverse transcriptase, Deoxynucleotidyl transferases, DNA polymerase), Restriction mapping.

UNIT -II (10 hours)

Basic design of cloning vectors - plasmid (pBR322 and pUC 18/19), cosmids, phage vectors (lambda and M13), phagemid, yeast vectors (YEp, YRp, YIp), shuttle vectors, BAC and YAC

Expression of cloned genes - general features of an expression vector, expression of eukaryotic gene in prokaryotes - advantages and limitations.

UNIT - III (15 hours)

Gene transfer techniques - physical (Electroporation, microinjection and biolistic transformation), chemical ($CaCl_2$ mediated transformation and Lipofection), transduction.

Selection of recombinants - blue and white screening and plus and minus screening.

UNIT –IV (15hours)

Construction of genomic and cDNA library, PCR- steps involved, Guidelines for PCR primer designing, variants of PCR (multiplex, nested, quantitative real time, RT- PCR), applications and limitations.

Blotting - southern, northern and western blotting; Nucleic acid and immuno probes.

UNIT -V (10 hours)

Manipulation of gene sequences by random mutations and site directed mutagenesis, Applications of Genetic engineering in industry, medicine and agriculture. Bioethics and Biosafety.

Course Learning Outcomes (CLO):

Students will be able to
1. apply landmark discoveries in developing a number of facile molecular techniques used in rDNA technology.
2. learn how to select the suitable hosts for the individual vectors for different purposes.
3. know the extraordinary power of restriction and other enzymes in molecular cloning and genetic manipulations.
4. perform application of PCR in rDNA technology.

5. perform expression of the cloned gene (s) for basic and applied research.
6. gain hands-on training in various molecular techniques for gene manipulation.

GENETIC ENGINEERING PRACTICALS
(1 Credit)

Practicals:

1. Plasmid DNA isolation.
2. Restriction digestion of pBR322
3. Ligation using pET vector
4. Southern hybridization.
5. Preparation of Competent Cell.
6. Transformation & blue white screening.
7. Isolation of total RNA from Bacteria.
8. Polymerase chain reaction.
9. SDS-PAGE of Bacterial Proteins.
10. Plasmid curing.

Text books

- Primrose Sandy B. and Richard Twyman, Principles of Gene Manipulation and Genomics (7th Edition), Wiley-Blackwell 2006.
- Brown T. A, Gene Cloning and DNA Analysis: An Introduction, (6th Edition) Wiley-Blackwell, 2010.
- Winnacker L Ernst, From genes to clones -Introduction to gene technology (4th edition), Panima Publishing Corporation, 2003.

Further readings:

- **Dubey R.C, Advanced Biotechnology (1st edition),** Chand and Company**, 2014.**
- Watson D James; et al Recombinant DNA: genes and genomes, (3rd edition), Basingstoke: Palgrave pacmillan, 2007.
- Sathyanarayanan U, Biotechnology (2013) Books and allied (P) ltd.
- Michael R. Green, Molecular Cloning: A Laboratory Manual (4th Edition), Cold Spring Harbor Laboratory Press.

Discipline Specific Core (DSC) – 2D
ENZYME TECHNOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 242 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objective:

To make the students understand the concepts of in detail
To make Students function and kinetics of enzymes
To provide basic knowledge of enzyme technology and use of enzymes as tools in industry, agriculture and medicine.
To study about the industrially important enzymes

UNIT I (15 hours)

I**ntroduction to Enzymes:** General introduction and historic background- General Terminology, Nomenclature and Classification of Enzymes. Criteria of purity of enzymes- Specific activity. Enzyme units-Katal and IU. Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNAzymes. Metalloenzymes and metal activated enzymes. Coenzymes and Cofactors- Prosthetic group.

UNIT II (10 hours)

Enzyme Catalysis: Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects etc. Mechanism of Serine proteases- Chymotryspin, Lysozyme, Carboxypeptidase A and Ribonuclease., Proenzymes (Zymogens).

UNIT III (15 hours)

Enzyme Kinetics and Inhibition: Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition. Kinetics Allosteric enzymes. Factors affecting the enzyme activity- Concentration, pH and temperature. Reversible Inhibition- Competitive, Non Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition.

UNIT IV (10 hours)

Enzyme Regulation: Feedback Regulation, Allosteric Regulation, Reversible Covalent Modification and Proteolytic Activation. Enzymes in the cell, localization, compartmentation of metabolic pathways, enzymes in membranes, concentrations. Mechanisms of enzyme degradation, lysosomal and nonlysosomal pathways, examples.

UNIT V (10 hours)

Industrial and Clinical uses of Enzymes (Applied Enzymology): Industrial Enzymes- Thermophilic enzymes, amylases, lipases, enzymes in industry, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes.

Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflamatory agents, strptokinasae, asparaginase, Isoenzymes like CK and LDH, Transaminases (AST, ALT), Cholinesterases, Phosphatases. Immobilization of enzymes. Enzyme Engineering and site directed mutagenesis.

Course Learning Outcomes (CLO):
Students will be able to
know the basic concept of enzyme.
know the principles of isolation and purification of enzymes from various sources
comprehend various methods involved in enzyme technology and their commercial applications.

ENZYME TECHNOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Screening of microorganisms for enzyme production.
2. Effect of pH on enzyme activity.
3. Effect of Temperature on enzyme activity.
4. Ammonium sulphate precipitation of enzymes
5. Partial purification of enzymes by dialysis.
6. Colorimetric assay for enzyme activity
7. Determination of K_m and V_{max} of the enzymes.
8. Electrophoretic separation of isoenzymes.

Text Book:

1. Nelson.D.L, Cox. M. M. Lehninger's Principle of Biochemistry. 4th ed. Freeman, 2004
2. Berg.J.M, Tymoczko.J.L, Stryer, L. Biochemistry. 6th ed. Freeman, 2006.

Suggested Reading:

1. Dixon & Webb. Enzymes. 3rd ed. Longmans, 1979.
2. Murray. R.K, Granner.D.K, Mayes. P.A, Rodwell. V.W.Harper's Biochemistry. 27th ed. McGraw Hill, 2006.

Discipline Specific Core (DSC) – 3D
EVOLUTION AND GENETICS
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 243 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

COURSE OBJECTIVES:

To understand the transfer of characters and its expression in relation to the changing environment and the evolution of organisms.

UNIT – I (12 hours)

Inheritance Biology: History of Genetics, Mendel's laws of inheritance, Deviations from Mendelian laws, dominance, relationships, incomplete dominance, co- dominance, lethal genes, multiple alleles, epistasis, complementary, supplementary, duplicate and inhibitory genes.

UNIT – II (12 hours)

Linkage & Crossing Over: Chromosomal Mapping Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization. Sex determination and dosage compensation. Pedigree analysis.

UNIT – III (12 hours)

Origin of Life: Historical and theories: special creation theory, theories of spontaneous generation or abiogenesis, theory of abiogenesis, hypothesis of panspermia, theory of chemical evolution and spontaneous origin of life at molecular level, experimental support of Oparin's hypothesis — Miller's experiment. Theories of Organic Evolution - Theory of inheritance of acquired characters (Lamarckism); theory of natural selection (Darwinism), modern synthetic theory; Weismann's germ plasm theory

UNIT – IV (12 hours)

Evidences of evolution: Direct Evidences of Evolution - Palaeontological evidences, Indirect Evidences of Evolution - Evidences from classification (taxonomy); evidences from comparative anatomy; evidences from comparative embryology; evidences from comparative physiology and biochemistry; evidences from comparative cytology; evidences from genetics.

UNIT – V (12 hours)

Population Genetics: Gene pool and gene frequency; Hardy-Weinberg law. Selection in Action - Types of Natural Selection: directional selection, stabilizing selection, disruptive or diversifying selection, sexual selection, group and kin selection. Speciation – sympatric, allopatric, parapatric.

Course Outcome: Students will come to know the transfer of characters and its expression in relation to the changing environment and the evolution of organisms.

EVOLUTION AND GENETICS PRACTICALS
(1 Credit)

Practicals:

1. Study of Linkage, recombination, gene mapping using marker based data from Drosophila.
2. Study of *Allium* Karyotype (normal and abnormal).
3. Study of blood grouping in humans.
4. PTC testing in a population and calculation of allele and genotype frequencies.
5. To determine a minimal quadrat area for sampling in the given simulation sheet
6. To determine density/frequency/abundance of the vegetation by quadrat method in the field or on given simulation sheet.
7. Selection Exemplifying Adaptive strategies (Colouration, Mimetic form, Co-adaptation and co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life) using Specimens.
8. Phylogeny (study from chart)
    a. Digit reduction in horse phylogeny
    b. Study of horse skull to illustrate key features in equine evolution
    c. Study of monkey and human skull - A comparison to illustrate common primate and unique Hominin features

Text Books:

1. Brooker, R.J. Genetics: Analysis & Principles (4th edition). Tata McGraw Hill Education. 2011.
2. Wilkinson, D.M. Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A. 2007.
3. M. Ridley, Evolution,. 3rd Ed.. Blackwell Scientific Publishing. 2004.

Reference Books

1. Gardner EJ, Simmons MJ, Snustad DP. Principles of Genetics. 8th Ed. Wiley- India. 2008.
2. Snustad DP, Simmons MJ. Principles of Genetics. 6th Ed. John Wiley and Sons Inc. 2011.
3. Smith R.L. Elements of ecology. 9th Ed., Benjamin Cummings. 2014.
4. Odum, E.P. Fundamentals of ecology. 5th Ed. Cengage Learning India Pvt. Ltd., (New Delhi).
   2005.
5. B. K Hall & B. Hallgrimson Strickberger's Evolution,. 4 th Ed.. Jones and Barlett. 2008.
6. C. Zimmer & D. J. Emlen. Evolution: Making Sense of Life, 1 st Ed. Roberts & Co. Publishers. 2013.

DISCIPLINE SPECIFIC ELECTIVES

Discipline Specific Elective (DSE)
ANIMAL BIOTECHNOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 353

Lectures: 60
Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objective
The course provides the basic knowledge and understanding of cell culture techniques. The students will learn the maintenance and various *in vitro* applications of cell and molecular techniques.

UNIT - I (10 hours)

Introduction, history, basic concepts of animal cell culture, primary cell culture and established cell lines, maintenance of cultures, requirements of animal cell culture, media - natural (clots, biological fluids and tissue extracts) and synthetic (serum containing media, serum free media, chemically defined media, protein free media).

UNIT – II (15 hours)

Basic techniques of mammalian cell culture, disaggregation of animal tissues - mechanical, enzymatic and EDTA, evolution of cell line, monolayer culture, suspension culture, immobilized culture, organ culture - plasma clot, raft method, agar gel, grid method, embryo culture, maintenance of cell culture.

UNIT – III (15 hours)

Artificial insemination, Super ovulation, In vitro fertilization and embryo transfer, applications and limitation, Transgenic animals (avian, rodent & ruminants), Transgenic methods, Embryonic Stem cell transfer, Targeted Gene Transfer, Detection of transgenic animals, Production of useful proteins in transgenic animals, Sericulture basics and production of useful proteins through sericulture.

UNIT – IV (10 hours)

Role of Animal models in Experimentation. Molecular markers - RFLP, RAPD, VNTR, AFLP. Somatic and Reproductive cloning - Definition, history and types. Somatic cell nuclear transfer, story of dolly, Therapeutic cloning and its significance**.**

UNIT – V (10 hours)

Animal diseases (cattle) -Mad cow, Anthrax, Foot and Mouth, Lumpy skin, Bluetongue; (Poultry)- Newcastle; Bird flu, Avian Influenza, Marek's disease – Vaccines; Bioethics and biosafety in animal handling.

Course Learning Outcomes (CLO):
Students will be able to

1. explain the fundamental scientific principles that underlie cell culture and acquire knowledge for isolation, maintenance and growth of cells.
2. the students will gain an insight into the concepts and techniques of genetically modified animals and its applications in various fields of science.

ANIMAL BIOTECHNOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Isolation of chick emryos
2. Isolation of CAM from chick embryo for culture
3. Isolation of organ rudiments for primary culture from chick embryos.

Effect of drugs on PBMCs:

4. Dye exclusion assay- Trypan blue assay and cell counting using Hemocytometer.
5. Effect of various drugs on hPBMCs- lymphocyte proliferation assay.

Protein profiling from hPBMCs:

6. Protein isolation from drug treated hPBMCs
7. SDS-PAGE of proteins isolated from drug treated hPBMCs
8. Western blotting

Text Books:

- Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th edition), ASM publisher(2009).
- Michael wink, An Introduction to Molecular Biotechnology: Fundamentals, methods and applications, (2nd edition) , John Wiley and sons 2013.
- Ganga. G & Slochanachetty, An Introduction to Sericulture, (2nd edition), Oxford and IBH publishers Pvt.Ltd.Delhi (2012).
- Old R.W, Primrose S.B, Twyman R. M, Principles of Gene manipulation (6th edition), Blackwell Sciences, (2001)

Further Reading:

- Tom Strachan & Andrew P. Read, Human Molecular Genetics, 2nd edition. Garland Science, (2004).
- Maule J.P, The Semen of Animals and Artificial Insemination, Commonwealth Agricultural Bureaux, 1962
- John R.W. Masters, Animal Cell Culture, 3rd edition, OUP Oxford, (2000).

Discipline Specific Elective (DSE)
MARINE BIOTECHNOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 354 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objective

To Know and to understand the essential facts and concepts related to marine biotechnology.
To Know the marine organisms of interest in biotechnology, their basic functions and role in the ecosystem.
To Acquire the ability to analyze and determine those marine organisms that may be useful in biotechnology.

UNIT - I (10 hours)

The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal & deep sea ecosystems. Hydrothermal vents - biodiversity of organisms. Marine microbes - unculturable bacteria, occurrence, characteristics and exploitation,
Barophilic organisms and their potential gene application for Marine Biotechnology Industry

UNIT - II (15 hours)

Bioactive compounds from marine organisms, GFP, RFP characteristics and their applications, Green mussel adhesive protein, Marine hydrocolloids - Agar, Agarose, Chitosan, Chitin, Alginate, Carrageen and its applications, Marine enzymes and their applications in food processing, Marine Pharmaceuticals – Zinconotide, Dolostain, Bryostain.

UNIT - III (15 hours)

Aquaculture - Culturing of shrimp, edible mollusks, oysters, pearl oysters, sea cucumbers. Culture of live feed organisms - brine shrimp, rotifers, marine algae. Techniques for identification of bacterial & viral pathogens in aquaculture Methods of diagnosis of SEMBV, MBV and Vibrio diagnosis, Probiotic bacteria and their importance in aquaculture; Vaccines in aquaculture: Fish, shrimps & prawns

UNIT - IV (10 hours)

Chromosome manipulation in aquaculture – hybridization; Ploidy induction; Gynogenesis, Androgenesis and sex reversal in commercially important fishes; Cryopreservation of fish gametes and embryo; Transgenic fishes - Antifreeze and metalothionine gene.

UNIT - V (10 hours)

Biofouling, biofilms, corrosion and antifouling treatment. Ballast water: consequences & management. Red tides: causative organisms and control. Control of oil spills and bioremediation.

Course Learning Outcomes (CLO):

Students will be able to
1. explain the fundamentals of marine ecosystem , and deep sea organism,
2. maintenance and growth of commercial important marine organism and their feed organism,

3. the students will gain an insight into the concepts and techniques of genetically modified fishes for ornamental and commercial purpose.
4. understand the concept of Biofouling and antifouling , their maritime economic loss

MARINE BIOTECHNOLOGY PRACTICAL
(1 Credit)

Practicals

1. Biochemical tests for identification of Marine bacteria.
2. Measurement of growth of microorganisms.
3. Plankton analysis.
4. Isolation, characterization and antagonistic effects of probiotic bacteria against fish pathogens.
5. Identification of Shrimp/Oysters/Sea cucumber (Spotters)
6. Estimation of Ammonia from shrimp pond
7. Disease identification in shrimps and fishes.
8. Isolation of chitin and chitosan from shrimp waste.

Text Books:

- Milton Fingerman, Nagabhushanam. R, Recent Advances in Marine Biotechnology, Vol. 8: January 1, Science Publisher, (2003).
- Kim, Se-Kwon, Springer Handbook of Marine Biotechnology, Springer Handbooks, (2014) Pillay T V R; Kutty M N, Aquaculture: Principles and practices, 2nd edition, Blackwell Pub., (2005).

Further readings:

- Ronald M. Atlas , Richard Bartha, Microbial Ecology: Fundamentals and Applications (4th edition), Benjamin Cummings, (1997).
- Marco Saroglia, Zhanjiang Liu, Functional Genomics in Aquaculture, Wiley-Blackwell, (2012).
- Laboratory manual on methodologies for assessing Biodiversity in estuaries, mangroves and coastal waters – Annamalai University.

Discipline Specific Elective (DSE)
ENVIRONMENTAL BIOTECHNOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 355 **Lectures: 60**
Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objective:
To provide sound knowledge about ecosystem, bioremediation and metal mining.
The course content aims to make the Students understand how biotechnology can help in monitoring or removing the pollutants and developing an understanding of new trends such as biofuels, renewable energy sources, or microbial technologies which can minimize the harmful impact of pollutants in the environment.
To make students understand the environmental crisis and about its control measures.

UNIT - I (10 hours)

Introduction to environmental biotechnology, Non Renewable resources - coal, petroleum, and natural gas. Renewable resources - solar, wind, tidal, biomass, nuclear, geothermal and hydroelectric resources. Current status and environmental impact of renewable and non-renewable resources

UNIT- II (10 hours)

Methanogenic bacteria and biogas, microbial hydrogen production, conversion of sugars to alcohols, plant-based petroleum industry, cellulose as the source of energy, Environmental impact of modern fuels.

UNIT - III (10 hours)

Principles of waste management, types, sources and effects of solid waste, Physical and biological treatment methods, Concept of composting and vermicomposting, Waste to energy conversion, Disposal of wastes.

UNIT- IV (15 hours)

Basics and types of bioremediation, Bioremediation of oil, heavy metals, pesticides contaminated soil and water, Phytoremediation and its types, Biochemical and genetic basis of biodegradation, Xenobiotic compounds and recalcitrance, Biodegradation of pesticides and petroleum products, Biotransformation of heavy metals, Biopolymers and Biodegradable plastics.

UNIT - V (15 hours)

Biomonitoring - Bioassays, Biosensors, Biochips, Biological indicators and Biomarkers, Biorestoration of waste land, Bioleaching – microbes involved, Role of Biotechnology in pollution abatement.

Course Learning Outcomes (CLO):
Students will be able to
1. comprehend environmental issues and role of biotechnology in the cleanup of contaminated environments
2. comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals
3. apply biotechnological processes in waste water and solid waste management.

4. comprehend biofuels/bioenergy systems; attributes for biofuel / bioenergy production.
5. demonstrate innovative biotechnological interventions to combat environmental challenges.

ENVIRONMENTAL BIOTECHNOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Biodiesel production from vegetable oil (Lipase-Catalysis method)
2. Bioethanol production from organic waste.
3. Enumeration of microorganisms from sewage samples.
4. Isolation of cellulolytic organisms from soil.
5. Isolation of phage from sewage.
6. Preparation of phage stock.
7. Estimation of total hardness in water.
8. Estimation of nitrite in water sample.
9. Estimation of salinity in water samples.
10. A Visit to Waste water treatment (Sewage and Industrial effluents treatment)

Text Books:

- Scragg A. H, Environmental Biotechnology, (2nd revised edition), Oxford University Press 2005
- Jogdand S. N, Environmental Biotechnology (3rd edition), Himalaya publishing house pvt.ltd 2012.
- Thakur. I. S, Environmental Biotechnology: Basic Concepts and Applications, (2nd revised edition), I K International Publishing House Pvt. Ltd, 2011.

Further readings:

- Varnam A. H - Environmental Microbiology (1st Edition), ASM Press 2001
- Wang, L.K., Ivanov, V., Tay, J.H., Hung, Y.T, Environmental Biotechnology (Volume 10), Humana Press 2010

Discipline Specific Elective (DSE)
MEDICAL BIOTECHNOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 356 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objectives:

To enlighten the knowledge of the Students on different areas of Medical Biotechnology.
To train the Students in a hospital based setup and familiarize them with the clinical diagnostics of diseases.
To make Students acquainted with the fundamental concepts of nanotechnology and develop an understanding to employ its principles in modern biotechnology applications.

UNIT – I (10 hours)

Introduction – Origin, significance & worldwide market of Medical Biotechnology. Revolution in clinical diagnosis, Antibody and Nucleic Acid Hybridization techniques, Imaging techniques (Nanodiagnosis).

UNIT – II (15 hours)

Genetic & Metabolic Disorders – Introduction, Classification, Impact of genetic diseases on human health - Chromosome errors - Down syndrome, Klinefelter's and Turner's syndrome. Metabolic disorders – Phenylketonuria, Homocystinuris, Mucopolysaccharidosis, Gangliosidosis, Gaucher's disease, Diabetes, Hemophilia and sickle cell anemia. Treatment of Genetic diseases - prenatal diagnosis, Genetic Counseling - Ethical, Legal and Social Issues.

UNIT – III (10 hours)

Revolution in treatment – Recombinant DNA technology for human insulin, Hepatitis B vaccine. Therapeutic proteins and peptides – Erythropoietin, Tissue plasminogen activator, clotting factor VIII. Antibody Engineering and Therapeutic Antibodies. Phage therapy.

UNIT – IV (15 hours)

Cancer - Molecular, cellular and genetic basis of cancer, tumor virus and oncogenes, tumor suppressor genes and mechanism of action of p53 proteins. Stem Cells - Sources and types of stem cells, Stem cell transplant and its types, Potential targets for stem cell treatment, Therapeutic applications of stem cells, Regenerative medicine and Stem cell ethics.

UNIT – V (10 hours)

Gene therapy- basic approaches and types of gene therapy, vectors used in gene therapy, application of gene therapy in medicine. Nanobiotechnology - Introduction, types and structures of nanoparticles, biosynthesis of nanoparticles, application of nanoparticles in treatment.

Course Learning Outcomes:

Students will be able to

1. Explain insights about genetic diseases and also about the molecular aspects related to human disease
2. Gain new insights into molecular mechanisms of nucleic acid and gene therapy
3. Gain knowledge about therapeutic recombinant proteins and immunotherapy for the treatment of different diseases.

MEDICAL BIOTECHNOLOGY PRACTICALS

(1 Credit)

Practicals:

1. Biochemical test for identification of bacteria
2. Extraction and separation of Antigen proteins from Bacteria & protozoa
3. Estimation of blood glucose.
4. Estimation of cholesterol in blood.
5. Estimation of iron in blood.
6. Biological synthesis of nanoparticles
7. Detection of plasmodium pathogen using peripheral smear
8. Widal test.

Text Books:

- Glick B.R. and Pasurank..Molecular biotechnology – Principle and Applications of Recombinant DNA- J.I.(4th edition), ASM Press. 2010.
- Anthony D. Ho, Hoffman. R, and Esmail D. Zanjani, Stem Cell Transplantation (4th edition), Wiley – liss publishers, 2006.
- Hornyak. G.L , Moore. J.J. Tibbals H.F., Dutta. J. Fundamentals of Nanotechnology (1st edition), CRC press, 2008.

Further Reading:

- Jogdand. S. N. Medical Biotechnology –, (4th edition), Himalayan publishing house, 2004.
- Freshney.I, Stacey. G. N, Auerbach.J.M, Culture of Human Stem Cells (1st edition) , Wiley – Liss publishers, 2007.

Discipline Specific Elective (DSE)
PHARMACEUTICAL BIOTECHNOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 363 **Lectures: 60**
Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objectives:
The objective of this course is to make Students understand the basic concepts involved in pharmaceutical industry.
The course will give knowledge about new drug development and approval process, ADMET of drugs, about the manufacturing and quality control of conventional, new type of dosage forms and biotechnology derived pharmaceuticals.

UNIT- I (10 hours)

Definition and scope of Pharmaceutical Biotechnology, sources of drugs, classification of pharmacological agents (based on chemistry, mode of action, dosage forms), route of administration, absorption and bioavailability of drugs, distribution and liver detoxification metabolism and drug excretion.

UNIT- II (10hours)

General classes and properties of phytopharmaceuticals, Extraction of phytochemicals, Phytochemical screening of medicinal plants. Bioassay guided fractionation methods-TLC, HPTLC, GC, and HPLC, Role of NMR and Mass spectrometry in drug discovery.

UNIT- III (15 hours)

Antimicrobial agents, Antibiotics - source, classification, mode of action, Antimicrobial resistance, and Antimicrobial activity studies (antibacterial, antiviral, antifungal and antiparasitic activity).
Pharmacological Assays - In-vitro assays - chemical (anti-oxidant), Biological (anti-cancerous and assay system based on enzymes and cells), and immunological (RIA and ELISA) - In vivo assays (Anti-inflammatory and Anti-analgesic).

UNIT- IV (15 hours)

Process of drug discovery and development- Target identification and validation, Assay development, lead optimization, pre-clinical testing, clinical trials involved in drug discovery and development, regulatory approvals and phase IV trials, High throughput screening, CPCSEA guidelines, ICMR guidelines for drug testing.

UNIT- V (10 hours)

Vaccines: concept, production and types - Inactivated, Attenuated, toxoid, Recombinant vaccines, Peptide and DNA vaccines, Edible vaccines, nanodrugs.
Recombinant proteins, approved rDNA drugs in market, Probiotics, Nutraceuticals, Economic and legal considerations in Pharmaceutical Biotechnology

Course Learning Outcomes (CLO):
Students will be able to
1. explain the strategies and various steps of new drug discovery process.
2. explain the concept of pharmacodynamics and pharmacokinetics

3. apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins and hormones
4. carry out the quality control procedures in the production of various biopharmaceuticals
5. explain the regulatory aspects in the development of pharmaceuticals.

PHARMACEUTICAL BIOTECHNOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Preparation of different methods of medicinal plant extracts.
2. Antibacterial activity.
3. Antifungal activity.
4. Total antioxidant activity.
5. Phytochemical screening of Primary metabolites.
6. Phytochemical screening of Secondary metabolites.
7. Separation of medicinal plant extracts by chromatography.
8. Estimation of ascorbic acid in multivitamin formulations.

TEXT BOOKS

- Satoskar R.S, Nirmala N. Rege, and Bhandarkar S. D, Pharmacology and Pharmacotherapeutics (Revised 23rd Edition), Popular Prakashan, Mumbai.
- *Tripathy K. D, Essentials of Medical Pharmacology (6th edition), Jaypee publishers*
- Shoba rani R Hiremath, Text book of industrial pharmacy, orient longman Pvt ltd 2008.
- Crommelin Daan J. A., Sindelar D. Robert (3rd edition) Pharmaceutical Biotechnology: Fundamentals and Applications, CRC Press, 2007.

FURTHER READINGS

- Trease, G.E.and Evans, W.C., 2011, Pharmacognosy (12th edition), Bailliere Tindall Eastbourne, U.K
- Mukherje P.K.,Quality Control Herbal Drugs–An approach to evaluation of botanicals. Business Horizons Pharmaceutical Publishers, 2005
- Sambamurthy K., Pharmaceutical Biotechnology (1st edition) New Age International

Discipline Specific Elective (DSE)
BIOINFORMATICS
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 364 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objectives:

To understand the basics of computational analysis and its applications.
To make them aware of the applications of various computational tools and databases in biological research.

UNIT-I (10 hours)

Bioinformatics: an overview - Introduction to Computational Biology and Bioinformatics; some of the biological problems that require computational methods for their solutions; Role of internet and www in bioinformatics. Biological Databases Acquisition –Primary and Secondary databases, Nucleotide sequence databases.
Types of DNA sequences – genomic DNA, cDNA, recombinant DNA, Expressed sequence tags (ESTs).

UNIT-II (15 hours)

Sequence Analysis – Methods of sequence alignment: Dot plots; Scoring matrices – identify matrix, genetic code matrices (GCM); Substitution matrices, Percentage accepted Mutation (PAM). Block Substitution Matrices (BLOSUM), dynamic programming algorithms; Needlman-Wunch and Smith Waterman; alignment scores and gap penalties; Database searching (BLAST and FASTA). Multiple Sequence alignment (MSA) – signifiance. Softwares : ClustalW and Meme.

UNIT-III (15 hours)

Phylogenetic analysis – Phylogenetics, cladistics and ontology; Phylogenetic representations – graphs, trees and cladograms; Classification and ontologies; Steps in phylogenetic analysis; Methods of phylogenetic analysis – similarity and distance tables, distance matrix method; Method of calculation of distance matrix (UPGMA, WPGMA); The Neighbor Joining Method; The Fitch/Margoliash method; Steps in constructing alignments and phylogenies; Phylogenetic softwares –PHYLIP

UNIT-IV (10 hours)

Structure prediction: protein- Methods for prediction of secondary and tertiary structures of proteins – knowledge-based structure prediction; fold recognition; *ab initio* methods for structure prediction, Comparative protein modeling. Identification of motifs and domains, protein family database. RNA structure prediction.

UNIT-V (10 hours)

Applications of bioinformatics in Drug discovery: Finding new drug targets to treat diseases – Pharmacophore identification - Structure based drug design. Mining of sequence data: Mining data from Yeasts. Microarray and genome wide expression analysis: transcriptomes, proteome: Genomics in medicine, disease monitoring, profile for therapeutic molecular targeting.

Course Learning Outcomes (CLO):

The students will understand the theoretical approaches used in modelling and analyzing the complex biological system.
They gain knowledge on structure prediction and drug designing using Bioinformatics tools.

BIOINFORMATICS PRACTICALS
(1 Credit)

Practicals:

1. Open access bibliographic resources and literature databases: PubMed, BioMed Central
2. Nucleic acid sequence databases: GenBank, EMBL, DDBJ;
3. Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL
4. Genome Databases at NCBI, EBI, TIGR, SANGER
5. Sequence file formats: GenBank, FASTA, GCG, MSF.
6. Pairwise sequence alignment: BLAST
7. Multiple sequence alignment: ClustalW, MEGA
8. Protein structure database: PDB, Rasmol.
9. Sequence editing and manipulation: Bioedit and Sequence manipulation suite.

Text books:

- Mount, D. Bioinformatics: Sequence and Genome Analysis; Cold Spring Harbor Laboratory Press, New York. 2004
- Baxevanis, A.D. and Ouellellette. B.F. Bioinformatics – a practical guide to the analysis of Genes and Proteins; John Wiley and Sons, New Jersey, USA. 1998
- Lesk, A.M. Introduction to Bioinformatics, First edition, Oxford University Press, UK. 2002
- Rastogi, S.C, Mendiratta. N and Rastogi. R. Bioinformatics: Concepts, Skills and Applications, CBS Publishers, New Delhi, India. 2006

Further reading:

- Pevzner, P.A. Computational Molecular Biology; Prentice Hall of India Ltd, New Delhi. 2004
- Sensen, C.W. Essentials of Genomics and Bioinformatics. Wiley-VCH Publishers, USA. 2002
- Andrew R. Leach Molecular Modeling – Principles and Applications Second Edition, Prentice Hall, USA. 2001
- Creighton, T.E. Proteins: structure and molecular properties Second edition, W.H. Freeman and Company, New York, USA. 1993

Discipline Specific Elective (DSE)
PLANT BIOTECHNOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 365 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objective:

The course curriculum helps in the understanding of the plant tissue culture and applications in the culture techniques.

The Students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.

The Students will acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

UNIT – I (10 hours)

Conventional breeding for crop improvement- Introduction, Domestication, Methods of Plant Breeding- Hybridization, Clonally Propagated Species, Breeding Enhancements- Marker-Assisted Selection, Mutation Breeding. Plant genome organization, organization of chloroplast genome, cytoplasmic male sterility, genetic male sterility.

UNIT –II (15hours)

Basics of Plant tissue culture, Sterilization – Surface and Dry, Components(inorganic, organic and plant hormones) and types of nutrient media, Callus and Suspension cultures, Micropropagation, Somatic embryogenesis and Germplasm conservation. Embryo culture, Rapid clonal propagation, somaclonal variations and synthetic or artificial seeds, embryo rescue, production of haploid plants (microspores and ovules). Applications and limitations of haploid plants. Secondary metabolites from plants.

UNIT- III (10hours)

Introduction and Principles of Somatic Hybridization – Protoplast Isolation, Protoplast fusion, Selection of hybrid cell, Regeneration of hybrid plants, Somatic hybrids and cybrids – cytoplasm transfer, Genetic transformation, Advantages and Limitations, Molecular makers – RFLP, RAPD, DNA fingerprinting.

UNIT – IV (15hours)

Genetic engineering of plants - Gene constructs, Vectors- Plasmid vectors and plant viral vectors (CaMV, Gemini virus, Tobacco Mosaic virus), cloning vectors for higher plants - Genetic manipulation using *Agrobacterium tumefaciens*. Gene transfer in plants - Electroporation, Particle Gun Method, Microinjection, Polyethylene glycol mediated transformation, Chloroplast transformation, terminator seed technology.

UNIT –V (10hours)

Applications of transgenic plants- Pest resistance, Herbicide resistance, virus resistance, Fungal and bacterial resistance, Delay of fruit ripening, Salt & drought tolerance, improvement of crop yield and Quality, Improved nutrition. Biocontrol and biofertilizers.

Course Learning Outcomes (CLO):

Students will be able to:

1. A good understanding of r-DNA technology, methods of gene transfer, molecular markers and marker assisted selection
2. Develop transgenics resistant to biotic & abiotic stresses & quality characteristics and their role in crop improvement.

PLANT BIOTECHNOLOGY PRACTICALS
(1 Credit)

Practicals:

1. Isolation of total genomic DNA from leaves by CTAB method
2. Extraction of total protein from leaves and PAGE analysis.
3. Amplification of a plant gene by polymerase chain reaction
4. Plant Tissue culture technique - Preparation of Media
5. Callus Induction and shoot regeneration.
6. Shoot multiplication
7. Anther culture.
8. Isolation of endophytic bacteria/fungi from plants
9. Microbial population in rhizospheric soil of various crops.
10. Characterization of PGPR in rhizosperic bacreria.

Text Books:

- Trivedi P.C. **Plant Biotechnology: Perspectives and Prospects,** Pointer Publishers **(2007)**.
- Slater. A, Scott. N, Fowler. M., Plant Biotechnology: The genetic manipulation of plants, Oxford University Press (2008).
- Hans-Walter Heldt, Plant Biochemistry (4th ed.), Academic Press. (2010).

Further reading:

- Old R.W, Primrose S.B, Twyman R. M, Principles of Gene manipulation (6^{th}ed.), Wiley-Blackwell, 2002.
- **Bailey. L.H,** Plant-Breeding **,** Read Books, **(2009)**.
- Buchanan. B, Gruissem. W, Jones.W, Plant Biochemistry and Molecular Biology (2^{nd} edition) ,Wiley-Blackwell, (2002).

Discipline Specific Elective (DSE)
MICROBIAL BIOTECHNOLOGY
(Credits: Theory-4, Practicals-1)
THEORY

Course Code: UBIOT 366 **Lectures: 60**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objective:

To understand the use of living cells such as bacteria, yeast, algae or component of cells like enzymes, plants and animals to generate industrial products and processes. To study techniques for genetic improvement of micro-organisms to improve yield of bioproducts.

UNIT – I (10 hours)

General concepts of microbial biotechnology. Genetic engineering of microbes for the production of antibiotics, enzymes, insulin, growth hormone and monoclonal antibodies. Synthetic bacteria. Microorganisms as factories for the production of novel compounds.

UNIT – II (10 hours)

Biofertilisers and their importance in crop productivity. Bacterial, algal and fungal biofertilisers - their significance and practice. Biopesticides - Bacterial, fungal and viral pesticides. Production of biofertilisers and biopesticides for large scale applications.

UNIT – III (15 hours)

Industrial production of alcohol, acetic acid, antibiotics (Penicillin and streptomycin), enzymes (Amylases and Proteases), amino acids (lysine and glutamic acid), vitamin B12. Microbial biomass production - algal (SCP), fungal (mushroom), yeast (baker's yeast).

UNIT – IV (10 hours)

Role of microorganisms in fermented products - organisms used for fermented food products. Microbial production of yoghurt, cheese, beer and wine. Microbial fermentation of tea, coffee and cacao. Health aspects of fermented foods.

UNIT – V (15 hours)

Microbial leaching of ores, Bioweapons and Bioshields, Microial biocatalyst and microbial fuel cells. Microbial fuels (biohydrogen, bioethanol and biomethane), Nutraceuticals from algae, Algal Pigments and Genetics of secondary metabolite production.

Course Learning Outcome (CLO)

At the end of the course students will be able to

1. Comprehend role of industrial biotechnology in improving microbial cells as factories
2. Know the production aspects of commodity chemicals, pharmaceuticals and fine chemicals.
3. Apply knowledge of microorganisms in commercial production of flavours, fragrance, and microbial pigment in textile and industry.
4. Apply the process for commercial production of enzyme.

MICROBIAL BIOTECHNOLOGY PRACTICALS
(1 Credit)

Practical:

1. Measurement of Microbial growth kinetics
2. Effect of pH and Temperature on microbial growth.
3. Microbial spoilage of Milk/fruits/foods.
4. Screening for auxotrophic mutants in bacteria
5. Microbial production of Wine.
6. Mushroom cultivation
7. Screening for secondary metabolite production by microbes
8. Bacteriological testing of water.

Reference Books:

1. Microbial biotechnology (1995) Alexander N.Glazer Hiroshi Nikaido W.H.Freeman & Company
2. Fungal ecology and biotechnology (1993) Rastogi Publications, Meerut

SKILL ENHANCEMENT COURSES (SEC)

Skill Enhancement Course (SEC)
PARASITOLOGY AND ENTOMOLOGY
(Credits: Theory- 2)
THEORY

Course code: UBIOT 234 **Lectures: 40**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objective

The students will understand the basic information on parasites and its various laboratory diagnostic techniques.

They will know the life cycle and the disease transmission of various endo and ecto-parasites.

UNIT I (10 hours)

General Consideration: Taxonomy, Transmission of parasites, Pathogenesis and pathology, Host immunity in parasitic infections, Clinical manifestations of parasitic infections, Laboratory diagnosis of parasitic infections, Prevention and control of parasitic infections.

UNIT II (8 hours)

Protozoa: *Plasmodium falciparum*- Habitat, Morphology, Pathogenesis and pathology, Host immunity in parasitic infections, Clinical manifestation and laboratory diagnosis of *P. falciparum*, its prevention and control.

UNIT III (7 hours)

Platyhelminthes: *Fasciola hepatica*- Habitat, Morphology, Pathogenesis and pathology, Host immunity in parasitic infections, Clinical manifestation and laboratory diagnosis of *F. hepatica*, its prevention and control.

UNIT IV (8 hours)

Nematodes: *Wuchereria bancrofti*- Habitat, Morphology, Pathogenesis and pathology, Host immunity in parasitic infections, Clinical manifestation and laboratory diagnosis of *W. bancrofti*, its prevention and control.

UNIT V (7 hours)

Entomology and disease transmission: Life cycles of arthropod vectors - ticks, mites, fleas, mosquitoes and flies. Vector transmitted diseases in India and control measures.

Course Learning Outcomes (CLO):

The course has given knowledge about the diagnostic techniques and their association with the human beings in their day today life.

They acquire idea on control and preventive measures that should be taken in routine life.

Text Books:

Parija SC, Text Book of Medical Parasitology, Protozoology & Helminthology (3rd edition), All India Publishers & Distributors (2008).

- Arora. D.R. and Arora, B, Medical Parasitology, (1st edition), CBS Publishers & Distributors, New Delhi (2002).
- Easwari Nayar, Hand Book on Medical Entomology, Kalpana Printing House, Delhi (1994).

Further Readings:

- Garcia LS, Bruckner DA. Diagnostic Medical Parasitology. American Society for Parasitology, Washington DC, (2004).
- Colle Jc, Duguid JP, Fraser AC and Marimon BP, Mackie and McCartney's Practical Medical Microbiology, 14th edition, Churchill Livingstone (2004).

Skill Enhancement Course (SEC)
DEVELOPMENTAL BIOLOGY
(Credits: Theory- 3)
THEORY

Course code: UBIOT 244 **Lectures: 40**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objectives:
This course aims to provide a thorough grounding in animal and plant developmental biology with particular emphasis on the role of cell-cell interactions.
The genetic regulation of cell behaviour as the main determinant of development.
The significant role of post-embryonic regulation in the plant development.

UNIT I - (5 hours)

Basic concepts of development biology - Cell fate and commitment; Mechanisms of development commitment, mosaic and regulative development, maintenance of differentiation, pattern formation and compartments, morphogenesis

UNIT II - (10 hours)

Vegetative and Reproductive anatomy of Plants: Root apical meristem – Root cap, Root hairs, Root architecture; Shoot apical meristem- vascular tissue, Shoot architecture; Leaf-structure and types ; Flower- structure, sepal and petal, stamans, carpels, nector; Pollen and ovules- structure of pollen, embryo sac, pollination and fertilization; seed- definition, seed coat, endosperm, embryo; fruit- fruit structure, indehiscent fruits, seed dispersal.

UNIT III - (10 hours)

Plant Embryology: Anther structure and development, anther wall, tapetum- types and function, Microsporogenesis - Successive division, dehiscense of anther; microsporangium-structure of pollen grain, development, nemec phenomenon. Megasoprangium - structure of ovule, types and development of ovule. Megasoprogenesis - female gamete structure and development; Double fertilization-process, porogamy, chalozogamy, mesogamy.

UNIT IV - (10 hours)

Animal development - Gametogenesis – Spermatogenesis: formation of spermatids - multiplication phase, growth phase, maturation phase, spermiogenesis, formation of head of spermatozoan, changes in nucleus, acrosome formation, tail formation and other events, structure of sperm cell. **Oogenesis** – multiplication phase, growth phase – perivitellogenesis, Growth of nuclear substance, gene amplification, vitellogenesis, cortical differentiation, maturation of egg, menstrual cycle, structure of ovum.

UNIT V - (5 hours)

Fertilization: Acrosome reaction, fertilization, fertilization membrane formation, post fertilization changes, zygote. **Cleavage and gastrulation**: Cleavage, blastula, morula, gastrulation, formation of three germ layers – ectoderm, endoderm and mesoderm.

Course Learning Outcomes (CLO):
The Students will be able to:

• Describe how fundamental process in cell Differentiation and developmental processes in animal model systems and recognise the importance of cell-cell interactions.
• Describe the life cycle and particular advantages of using plant.
• Recognize embryonic polarity systems and the importance of cell lineage and position in embryonic pattern formation.
• Recognize the ways in which analysis of plant morphogenesis is being used to manipulate the growth and development of crop plants.

Skill Enhancement Course (SEC)
SCIENTIFIC WRITING AND COMMUNICATION/PRESENTATION SKILLS
(Credits: 2)

Course code: UBIOT 351 **Lectures: 40**
Max. Marks =100
(ICA = 25 + Presentation = 40+Report=35)

Course objective:

The objective of the course is to enhance the communication skill of student and to introduce students to the latest upcoming updates of the field.

Syllabus:

Identifying suitable topic in Biotechnology and Literature survey. Preparation of report for the seminar presentation and Presentation of the seminar in PPT format. Discussion on the topic and evaluation.

Course outcome:

The students will be able to acquire knowledge on latest outcome of the biotechnology field.

Skill Enhancement Course (SEC)
MOLECULAR DIAGNOSTICS
(Credits: Theory- 2)
THEORY

Course code: UBIOT 352 **Lectures: 40**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objective:

The objective of the course is to make Students aware of the various medical diagnostic techniques and their use in diagnosing various disorders in humans.

UNIT-I (8 hours)

Genetics and diagnostics: General features of Chromosomes, chromosome banding patters, banding techniques and their correlates, karyotyping, DNA profiling hybridization arrays. Early detection of diseases.

UNIT-II (10 hours)

Molecular methods: Nucleic acid extraction: principles and methods. Assessing purity and concentration of nucleic acids, PCR- basic and applied - Alu-PCR, Hot start PCR, PCR-ELISA, Arbitrarily primed PCR, *in situ* PCR.

UNIT-III (10 hours)

Nuclear hybridization methods, Single nucleotide polymorphisms and plasmid finger printing in infections, PFGE, DGGE. Detection of mutation using ARMS-PCR and microsatellite markers.

UNIT-IV (8 hours)

Allele susceptibility test for multifactorial disorders (Neural tube defect, cleft-lip and palate, cardiovascular disorder, male infertility). Diagnosis of inborn errors.

UNIT-V (4 hours)

Cell sorting- Flow cytometry and FACS. Neonatal and prenatal diagnosis. Sex identification in forensics.

Course Learning Outcomes (CLO):

The Students will be able to:

1. receive insights about genetic diseases and its detection
2. gain new insights into medical genetics and pre-natal diagnosis
3. gain knowledge about different diagnostic procedures.

Text Books:

- Wilson, K. and Walker, J. Practical Biochemistry – Principles and techniques 7th edition, 2010, Cambridge University Press,
- Primrose Sandy B. and Richard Twyman, Principles of Gene Manipulation and Genomics (7th Edition), Wiley-Blackwell 2006.
- Brown T. A, Gene Cloning and DNA Analysis: An Introduction, (6th Edition) Wiley-Blackwell, 2010.

Further Reading:

- Terence A. Brown, Genomes 2, (2nd edition) – Garland Science publishing, 2002.
- Old R.W, Primrose S.B, Twyman R. M, Principles of Gene manipulation (6^{th}ed.), Wiley-Blackwell, 2002.

Skill Enhancement Course (SEC)
SKILLS IN BIOTECHNOLOGY
(Credits: Theory- 2)
THEORY

Course code: UBIOT 361 **Lectures: 40**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objectives

Students will have information on
the general introduction about different skills in biotechnology.
The methods involved food processing, fish preservation, production of fertilizers, vermicomposting and mushroom cultivation.

UNIT- I: (8 hours)

Food technology: Scope of food processing; historical developments; principles of food processing and preservation. Types of micro-organism normally associated with food - mold, yeast and bacteria. Micro-organisms in natural food products and their control, food poisoning and microbial toxins. Principles and methods of food preservation. Packaging principles and operation - package functions and design, shelf life of packaged foodstuffs - methods to extend shelf life.

UNIT- II : (8 Hours)

Fish processing: Principles of fish preservation - precautions taken in handling fish in the fishing vessel - landing center and processing plant – Importance of hygiene and sanitation in fish handling – quality of water and ice – common equipment and tools used in the processing plant: rafter, ovens, dryers. Principles, process and applications in fish processing technologies: Drying, salt curing, marinating, freeze drying, canning and irradiating methods.

UNIT- III (8 hours)

Biofertilizer technology: An introduction to fertilizers-inorganic fertilizers, organic fertilizers, bio-fertilizers - importance, advantages and constraints. Identification of microbial species - *Rhizobium, Azospirillum Azotobacters*, blue green algae and phosphate solubilisers. Preparation of microbial inoculants - large-scale production of microbes - their application as biofertilizers - crop responses to biofertilizers. Organic matter and composting - method of processes, applications and limitations.

UNIT- IV: (8 Hours)

Vermiculture: Vermicomposting - Definition, introduction and scope: Ecological classification: Humus feeders, Humus formers, leaf mold, top soil and sub soil types. Optimal conditions for Vermiculture - temperature, moisture, pH, soil type, organic matter, Basic components for vermiculture - Culture practices - Vermi wash. Composting - Vermicomposting - Required conditions - Methods - Advantages - Cost-Benefit analysis of Vermicomposting.

UNIT- V: (8 hours)

Mushroom culture: Introduction to mushroom fungi, nutritional value, edible and poisonous type, edible mushrooms -- *Pleurotus*, *Volvariella* and *Agaricus*, medicinal value of mushrooms, preparation of culture, mother spawn production, multiplication of spawn, cultivation techniques, harvesting, packing and storage; Equipment and sterilization techniques for culture media, isolation of mother culture, spawn preparation and maintenance of mushroom beds of oyster mushroom, *Volvariella* and *Agaricus.* Processing and preservation of mushrooms, economics of spawn and mushroom production and mushroom recipes.

Course Learning Outcomes (CLO):

Students will acquire knowledge on the different skills in biotechnology.

Students will know the basics of different skills like food processing, fish processing, fertilizers, vermicomposting and mushroom cultivation.

Text Books

- Food Processing and Preservation- Subbulaksmi G., and Udipi S.
- Balachandran KK. 2001. Post-harvest Technology of Fish and Fish Products. Daya Publ. House.
- Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and Usage- A Source Book-cum-glossary. FDCO, New Delhi.
- Borkar,S,G, and Patil N.M. 2016.Mushroom,A nutritive food and its cultivation. Astral International Pvt.Ltd,New Delhi
- Edwards, C.A. and J.R. Lofty (1977) "Biology of Earthworms" Chapman and Hall Ltd., London.
- Lee, K.E. (1985) "Earthworms: Their ecology and Relationship with Soils and Land Use" Academic Press, Sydney.

Reference Books

- Principles of Food Science, Vol. II- G. Borgstron, Mc. Millan Co. Ltd. London.
- Rahman MS. 2007. Handbook of Food Preservation. 2nd Ed. CRC Press. Sen DP. 2005.
- Advances in Fish Processing Technology. Allied Publ. Wheaton FW & Lawson TB. 1985. Processing Aquatic Food Products. John Wiley & Sons.
- Steven L. Stephenson (2010), The Kingdom Fungi: The Biology of Mushrooms, molds and lichens.
- Bergerson FJ. 1980. Methods for Evaluating Biological Nitrogen Fixation. John Wiley and Sons.
- Satchel, J.E. (1983) "Earthworm Ecology" Chapman Hall, London.

Skill Enhancement Course (SEC)
Industrial Visit
(Credits: 2)

Course code: UBIOT 362 **Lectures: 40**
Max. Marks =100
(ICA = 25 + Visit = 35+Report=30)

Course Objectives
The student will gain indept insight on the various research activities carried out in various institutions/industries through industrial visit.

Syllabus:
The concept of industrial visit is to encourage students to interact with nearby industries or research institution to develop the knowledge of recent advancement and industrial application of Biotechnology.
Industrial visit to Small, medium or large scale industries accompanied by faculty members can also be encouraged. In such case faculty members can be assigned as advisor for the visit. The advisor can identify appropriate industry or research institution and co-ordinate the visit according to the hours and the time allotted by the collaborating institution.

A detailed report based on the industrial visit will be prepared and submitted for valuation to the department and will be valuated by the concern faculty member.

Course Learning Outcomes (CLO):
The students will get exposure of various research institute and industries.

GENERIC ELECTIVES (GE)

Generic Elective GE - 1
GENOMICS AND PROTEOMICS
(Credits: Theory- 2)
THEORY

Course code: UBIOT 357 **Lectures: 40**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objectives:

To understand the concept of genomics and its relevance to biotechnology. The course aims to make Students know about various components of genome and to compare genomes of organisms of different phylogenetic lineages.

The objectives also include knowledge of transcriptomics and proteomics and their applications. In addition, they will learn about methods of studying genetic materials obtained from various environmental samples.

UNIT - I (8 hours)

Definition: Genome organizations, Principles of gene expression, C-value paradox, Genome mapping – Physical mapping and Genetic mapping, Chromosome walking, Linkage analysis

UNIT- II (8 hours)

Comparative genomics - genome annotation and analysis, Genome-based search for mutations.

UNIT - III (8 hours)

Functional genomics: protein-nucleic acid interactions, RNA interference, Microarrays, Sequencing – Maxam Gilbert and Sanger's methods, Next Generation Sequencing technologies, whole genome sequencing.

UNIT - IV (8 hours)

Proteomics – Introduction, Protein detection & Methods of Analysis of Proteins, Protein purification and Separation techniques, Two dimensional PAGE for proteome analysis; Image analysis of 2D gels

UNIT-V (8 hours)

Protein characterization – MALDI-TOF and Peptide mass finger printing, Protein sequencing, Protein-protein interactions (Two hybrid interaction screening), Protein arrays, Applications of proteome analysis to drug development.

Course learning Outcomes:

At the end of the course students will be able to

1. Explain the properties of genetic materials and storage and processing of genetic information.
2. Analyze genomic data.
3. Explain biological phenomena based on comparative genomics
4. Design transcriptomics and proteomics experiments for studying differential gene expression and related analysis

Text Books:

- Terence A. Brown, Genomes 2, (2nd edition) – Garland Science publishing, 2002.
- Old R.W & Primrose S. B, Principles of gene manipulation – An introduction to genetic Engineering, Black well publishers, (5th Edition), 2000.
- Helen Kreuzer and Adrianne Massey, Recombinant DNA and Biotechnology (2nd edition), ASM Press, 2001

Further Readings:

- Primrose S.B. & Twyman R.M. Principles of Genome Analysis and Genomics (3rd edition) Blackwell publishing. 2003.
- Mike Bailey and Keith Hirst, Advanced Molecular Biology, Haeper Collins Publisher Limited,(2^{nd} edition) 2000.

Generic Elective GE -2

BIOSAFETY, BIO-ETHICS, IPRS AND ENTREPRENEURIAL DEVELOPMENT

(Credits: Theory- 2)

THEORY

Course code: UBIOT 367 **Lectures: 40**

Max. Marks =100 (ICA = 25 + ESE = 75)

Course Objectives:

The aim of this course is to teach factors influencing to start business and legal, and administrational aid for the entrepreneurial venture,

To clarify the requisite of Biosafety measures in biotechnological applications in the laboratory and its waste management, registration, national and international regulations, bio-ethical issues in medicine, environment and genetics, related regulations and laws.

UNIT- I (8 hours)

Concept of GLP and GMP. Bioethics – social and legal issues. Biosafety and its types, environmental fallout. Principles and practices – containment facilities, Disposal of biowaste.

UNIT- II (8 hours)

Indian Patenting Act 2003, Patent Registration procedure. Information and services. Patent Application US /EU patent procedures, WIPO, copy rights, conflict of interest and trademarks.

UNIT- III (7 hours)

IPRs convention on Biological Diversity (DBD), Geographical Indicators, procedures. Biodiversity Protection Act 2003 (GOI).

UNIT- IV (8 hours)

Introduction– Demand survey of a product – Identifying a product line – Design and Developing the process – Economics of scale – Essentials of a project report in business.

UNIT- V (9 hours)

Resources – Choice of location – Energy requirement – skilled manpower government interface / laws, excise duty, sales tax – Labour, Factories / industries; Department compliance – Licenses – Permissions – rules and regulations of export – import.

Course Learning Outcomes (CLO):

The Students will be able to:

Start a business venture for the economical empowerment and can provide self employment opportunities

• Explain the international and national controls with regards to biosafety, biosecurity and bioethics applicable to facilities and associated scientists handling pathogens.

• Apply a framework for risk assessment to biosafety, biosecurity and dual use risks and hazards associated with pathogens.

• Analyse the ethical and social responsibilities of life scientists with reference to the responsible conduct of research and other work

• Integrate dual-use biosecurity, biosafety and bioethical issues and concerns into their program.

• Contribute to the development and implementation of relevant country-specific and institutional mechanisms, guidelines, regulations and legislation.

Text Books:

- Hisrich R D and Peters M P, "Entrepreneurship", (5th ed), Tata Mc Graw-Hill, 2002.
- Narayanaswamy S., Youth development in the new millennium, (1sted), Discovery publishing house, 2003.
- Satheesh. M. K. Biosafety and Bioethics, (1st edition), I.K. International publishing house pvt. ltd., 2008

Further Reading:

- Anand Saena, Sharma R. A, Entrepreneurship motivation performance rewards, (2nd ed) Deep and Deep publications, 2005.
- Verma S.B, Entrepreneurship and employment - Strategies for human recourse development, (2nd ed) Deep and deep publications, 2005.
- Ignacimuthu. S, Bioethics, (1st edition), Alpha Science International, 2009