UNIVERSITY VISION AND MISSION

VISION

B.S. Abdur Rahman Institute of Science & Technology aspires to be a leader in Education, Training and Research in Engineering, Science, Technology and Management and to play a vital role in the Socio-Economic progress of the Country.

MISSION

- To blossom into an internationally renowned University.
- To empower the youth through quality education and to provide professional leadership.
- To achieve excellence in all its endeavors to face global challenges.
- To provide excellent teaching and research ambience.
- To network with global Institutions of Excellence, Business, Industry and Research Organizations.
- To contribute to the knowledge base through Scientific enquiry, Applied Research and Innovation.

VISION AND MISSION OF THE SCHOOL OF LIFE SCIENCES

VISION

To attain new heights in biotechnology research, shaping life sciences into a premier precision tool for the future for creation of wealth and ensuring social justice-specially for the welfare of the poor.

MISSION

- The mission of the school of life sciences and Technology is to maximize the benefits of biotechnology to the University, the nation and the globe by being an excellent quality, comprehensive, multidisciplinary school that supports, coordinates, disseminates and advances biotechnology in the areas of social welfare and entrepreneurship.

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES
M.Tech. BIOTECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES

The course aims to provide an advanced understanding of the core principles and topics of Biotechnology and their experimental basis, and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of a lecture series and a research project. Hence, the main objectives of the program are:

- To provide an introduction to the basic concepts of Biotechnology and its recent advances.
- For the basic understanding, this course includes advanced biochemistry, cell and molecular biology, immunotechnology, and microbial biotechnology.
- Moreover, several laboratory courses given in the individual sections of the curriculum with detailed information on the importance of biotechnology in basic and applied research.
- Finally this course explains the advanced sections of biotechnology like genetic engineering, nanobiotechnology, computational biology and medical biotechnology.
- This course provides necessary theoretical and practical experience in all divisions of biotechnology to pursue a professional career in this field.
- To provide broad exposure to various societal, ethical and commercial issues in the various aspects of biotechnology.

PROGRAMME OUTCOMES

After successfully completing this course, the student should be able to:

- Apply their knowledge of biotechnology into high end research.
- Advanced sections of like Immunology, bioinformatics, nano-biotechnology will give broad information on applications and opportunities in the field of biotechnological research.

- Identify research and solve biochemistry, cell and molecular biology related problems related to the different types of animal and plant diseases.
- Ability to work with multidisciplinary subjects in industries and research.
- Ability to communicate and function effectively in multi-disciplinary team related to the biochemistry and molecular biology.

B.S.ABDUR RAHMAN
UNIVERSITY
B.S. ABDUR RAHMAN INSTITUTE OF SCIENCE & TECHNOLOGY
(Estd.u/s 3 of the UGC Act, 1956)
(FORMERLY B.S.ABDUR RAHMAN CRESCENT ENGINEERING COLLEGE)
Seethakathi Estate, G.S.T. Road, Vandalur, Chennai - 600 048.

REGULATIONS 2013
FOR
M.TECH. DEGREE PROGRAMMES
(WITH AMENDMENTS INCORPORATED TILL JUNE 2015)

B.S. ABDUR RAHMAN UNIVERSITY, CHENNAI 48.
REGULATIONS -2013 FOR M.TECH / MCA / M.Sc. DEGREE PROGRAMMES

(With amendments incorporated till June 2015)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires

i) **"Programme"** means Post Graduate Degree Programme (M.Tech./ MCA / M.Sc.)

ii) **"Course"** means a theory or practical subject that is normally studied in a semester, like Applied Mathematics, Structural Dynamics, Computer Aided Design, etc.

iii) **"University"** means B.S.Abdur Rahman University, Chennai, 600048.

iv) **"Institution"** unless otherwise specifically mentioned as an autonomous or off campus institution means B.S.Abdur Rahman University.

v) **"Academic Council"** means the Academic Council of this University.

vi) **"Dean (Academic Affairs)"** means Dean (Academic Affairs) of B.S.Abdur Rahman University.

vii) **"Dean (Student Affairs)"** means Dean(Student Affairs) of B.S.Abdur Rahman University.

viii) **"Controller of Examinations"** means the Controller of Examinations of B.S.Abdur Rahman University who is responsible for conduct of examinations and declaration of results.

2.0 PROGRAMMES OFFERED, MODE OF STUDY AND ADMISSION REQUIREMENTS

2.1 P.G. Programmes Offered

The various P.G. Programmes and their modes of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
M.Tech.	Part Time – Day / Evening
M.C.A.	Full Time
M. Sc.	Full Time
M. Sc.	Full Time

2.2 MODES OF STUDY

2.2.1 Full-time

Students admitted under "Full-Time" shall be available in the Institution during the complete working hours for curricular, co-curricular and extra-curricular activities assigned to them.

2.2.2 A full time student, who has completed all non-project courses desiring to do the Projectwork in part-time mode for valid reasons, shall apply to the Dean (Academic Affairs) through the Head of the Department, if the student satisfies the clause 2.3.4 of this Regulation. Permission may be granted based on merits of the case. Such conversion is not permitted in the middle of a semester.

2.2.3 Part time - Day time

In this mode of study, the students are required to attend classes for the courses registered along with full time students.

2.2.4 Part time - Evening

In this mode of study, the students are required to attend normally classes in the evening and on Saturdays, if necessary.

2.2.5 A part time student is not permitted to convert to full time mode of study.

2.3 ADMISSION REQUIREMENTS

2.3.1 Students for admission to the first semester of the Master's Degree Programme shall be required to have passed the appropriate degree examination of this University as specified in the Table shown for eligible entry qualifications for admission to P.G. programmes or any other degree examination of any University or authority accepted by this University as equivalent thereto.

2.3.2 Eligibility conditions for admission such as class obtained, number of attempts in the qualifying examination and physical fitness will be as prescribed by this Institution from time to time.

2.3.3 All part-time students should satisfy other conditions regarding experience, sponsorship etc., which may be prescribed by this Institution from time to time.

2.3.4 A student eligible for admission to M.Tech. Part Time / Day Time programme shall have his/her permanent place of work within a distance of 65km from the campus of this Institution.

2.3.5 Student eligible for admission to M.C.A under lateral entry scheme shall be required to have passed three year degree in B.Sc (Computer Science) / B.C.A / B.Sc (Information Technology)

3.0 DURATION AND STRUCTURE OF THE P.G. PROGRAMME

3.1 The minimum and maximum period for completion of the P.G. Programmes are given below:

Programme	Min.No.of Semesters	Max.No.of Semesters
M.Tech. (Full Time)	4	8
M.Tech.(Part Time)	6	12
M.C.A. (Full Time)	6	12
M.C.A. (Full Time) – (Lateral Entry)	4	8
M.Sc. (Full Time)	4	8

3.2 The PG. programmes consist of the following components as prescribed in the respective curriculum

i. Core courses
ii. Elective courses
iii. Project work / thesis / dissertation
iv. Laboratory Courses
v. Case studies
vi. Seminars
vii. Industrial Internship

3.3 The curriculum and syllabi of all PG. programmes shall be approved by the Academic Council of this University.

3.4 The minimum number of credits to be earned for the successful completion of the programme shall be specified in the curriculum of the respective specialization of the P.G. programme.

3.5 Each academic semester shall normally comprise of 80 working days. Semester-end examinations will follow immediately after the last working day.

ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO P.G. PROGRAMMES

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
01.	Civil Engineering	M.Tech. (Structural Engineering)	B.E / B.Tech. (Civil Engineering) / (Structural Engineering)
		M.Tech. (Construction Engineering and Project Management)	
02.	Mechanical Engineering	M.Tech. (Manufacturing Engineering)	B.E. / B.Tech. (Mechanical / Auto / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace / Aeronautical / Material Science / Marine Engineering)
		M.Tech. CAD / CAM	
03.	Polymer Engineering	M.Tech. (Polymer Technology)	B.E./ B.Tech. degree Mech./Production/ Polymer Science or Engg or Tech / Rubber Tech / M.Sc (Polymer Sc./ Chemistry Appl. Chemistry)
04.	Electrical and Electronics Engineering	M.Tech. (Power Systems Engg)	B.E / B.Tech (EEE / ECE / E&I / I&C / Electronics / Instrumentation)
		M.Tech. (Power Electronics & Drives)	
05.	Electronics and Communication Engineering	M.Tech. (Communication Systems)	B.E / B.Tech (EEE/ ECE / E&I / I&C / Electronics / Instrumentation)
		M.Tech.(VLSI and Embedded Systems)	B.E./ B.Tech. in ECE / Electronics / EIE / ICE / EEE
		M.Tech.(Signal Processing)	
06.	ECE Department jointly with Physics Dept	M.Tech. (Optoelectronics and Laser Technology)	B.E./B.Tech. (ECE / EEE / Electronics / EIE / ICE) M.Sc (Physics / Materials Science / Electronics / Photonics)
07.	Electronics and Instrumentation Engineering	M.Tech. (Electronics and Instrumentation Engineering)	B.E./ B.Tech. (EIE/ICE/Electronics/ ECE/EEE)
08.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. /B.Tech. (CSE/IT/ECE/EEE/EIE/ ICE/Electronics) MCA
		M.Tech. (Software Engineering)	B.E. / B.Tech. (CSE / IT) MCA
		M.Tech (Network Security)	B.E. /B.Tech. (CSE/IT/ECE/EEE/EIE/ ICE/Electronics) MCA
		M.Tech (Computer and Predictive Analytics)	
		M.Tech. (Computer Science and Engineering with specialization in Big Data Analytics)	
09	Information Technology	M.Tech. (Information Technology)	B.E /B.Tech. (IT/CSE/ECE/EEE/EIE/ ICE/ Electronics) MCA
		M.Tech. (Information Security & Digital Forensics)	

ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO P.G. PROGRAMMES

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
10	Computer Applications	M.C.A.	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level
		M.C.A. (Full Time) – (Lateral Entry)	B.Sc Computer Science / B.Sc Information Technology / B.C.A
		M.Tech. (Systems Engineering and Operations Research)	BE / B.Tech. (Any Branch) or M.Sc., (Maths / Physics / Statistics / CS / IT / SE) or M.C.A.
		M.Tech. (Data & Storage Management)	
11	Mathematics	M.Sc. (Actuarial Science)	Any Degree with Mathematics / Statistics as one of the Subjects of Study.
		M.Sc. Mathematics	B.Sc. (Mathematics)
12	Physics	M.Sc.(Physics)	B.Sc.(Physics / Applied Science / Electronics / Electronics Science / Electronics & Instrumentation)
		M.Sc. (Material Science)	
13	Chemistry	M.Sc.(Chemistry)	B.Sc (Chemistry) of B.Sc. (Applied Science)
14	Life Sciences	M.Sc. Molecular Biology & Biochemistry	B.Sc. in any branch of Life Sciences
		M.Sc. Genetics	B.Sc. in any branch of Life Sciences
		M.Sc. Biotechnology	B.Sc. in any branch of Life Sciences
		M.Sc. Microbiology	B.Sc. in any branch of Life Sciences
		M.Sc. Bioscience	B.Sc. in any branch of Life Sciences
		M.Tech. Biotechnology	B.Tech. (Biotechnology / Chemical Engineering) / M.Sc. in any branch of Life Sciences

3.6 The curriculum of PG programmes shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits specified below:

Programme	Minimum prescribed credit range
M.Tech.	75 to 85
M.C.A.	120 to 130
M.Sc.	75 to 85

3.7 Credits will be assigned to the courses for all P.G. programmes as given below:

* One credit for one lecture period per week
* One credit for one tutorial period per week
* One credit each for seminar/practical session/project of two or three periods per week
* One credit for two weeks of industrial internship.

3.8 The number of credits registered by a student in non-project semester and project semester should be within the range specified below:

P.G. Programme	Non-project Semester	Project semester
M.Tech. (Full Time)	15 to 29	12 to 20
M.Tech. (Part Time)	6 to 18	12 to 16
M.C.A. (Full Time)	15 to 29	12 to 20
M.Sc. (Full Time)	15 to 25	12 to 20

3.9 The electives from the curriculum are to be chosen with the approval of the Head of the Department.

3.10 A student may be permitted by the Head of the Department to choose electives offered from other PG programmes either within the Department or from other Departments up to a maximum of three courses during the period of his/her study, provided the Heads of the Departments offering such courses also agree.

3.11 To help the students to take up special research areas in their project work and to enable the department to introduce courses in latest/emerging areas in the curriculum, "Special Electives" may be offered. A student may be permitted to register for a "Special Elective" up to a maximum of three credits during the period of his/her study, provided the syllabus of this course is recommended by the Head of the Department and approved by the Chairman, Academic Council before the commencement of the semester, in which the special elective course is offered. Subsequently, such course shall be ratified by the Board of Studies and Academic Council.

3.12 The medium of instruction, examination, seminar and project/thesis/ dissertation reports will be English.

3.13 Industrial internship, if specified in the curriculum shall be of not less than two weeks duration and shall be organized by the Head of the Department.

3.14 PROJECT WORK/THESIS/DISSERTATION

3.14.1 Project work / Thesis / Dissertation shall be carried out under the supervision of a qualified teacher in the concerned Department.

3.14.2 A student may however, in certain cases, be permitted to work for the project in an Industrial/Research Organization, on the recommendation of the Head of the Department. In such cases, the project work shall be jointly supervised by a faculty of the Department and an Engineer / Scientist from the organization and the student shall be instructed to meet the faculty periodically and to attend the review committee meetings for evaluating the progress.

3.14.3 Project work / Thesis / Dissertation (Phase - II in the case of M.Tech.) shall be pursued for a minimum of 16 weeks during the final semester, following the preliminary work carried out in Phase-1 during the previous semester.

3.14.4 The Project Report/Thesis / Dissertation report / Drawings prepared according to approved guidelines and duly signed by the supervisor(s) and the Head of the Department shall be submitted to the concerned department.

3.14.5 The deadline for submission of final Project Report / Thesis / Dissertation is within 30 calendar days from the last working day of the semester in which Project / Thesis / Dissertation is done.

3.14.6 If a student fails to submit the Project Report / Thesis / Dissertation on or before the specified deadline he / she is deemed to have not completed the Project Work / Thesis / dissertation and shall re-register the same in a subsequent semester.

3.14.7 A student who has acquired the minimum number of total credits prescribed in the Curriculum for the award of Masters Degree will not be permitted to enroll for more courses to improve his/her cumulative grade point average (CGPA).

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 CLASS ADVISOR

A faculty member will be nominated by the HOD as Class Advisor for the whole class.

He/she is responsible for maintaining the academic, curricular and co-curricular records of all students throughout their period of study.

4.2 FACULTY ADVISOR

To help the students in planning their courses of study and for general counseling on the academic programme, the Head of the Department of the students will attach a certain number of students to a faculty member of the department who shall function as Faculty Advisor for the students throughout their period of study. Such Faculty Advisor shall offer advice to the students on academic and personal matters, and guide the students in taking up courses for registration and enrolment every semester.

5.0 CLASS COMMITTEE

5.1 Every class of the PG Programme will have a Class Committee constituted by the Head of the Department as follows:

i. Teachers of all courses of the programme

ii. One senior faculty preferably not offering courses for the class, as Chairperson.

iii. Minimum two students of the class, nominated by the Head of the Department.

iv. Class Advisor / Faculty Advisor of the class - Ex-Officio Member

v. Professor in-charge of the PG Programme - Ex-Officio Member.

5.2 The Class Committee shall be constituted by the respective Head of the Department of the students.

5.3 The basic responsibilities of the Class Committee are to review periodically the progress of the classes to discuss problems concerning curriculum and syllabi and the conduct of classes. The type of assessment for the course will be decided by the teacher in consultation with the Class Committee and will be announced to the students at the beginning of the semester. Each Class Committee will communicate its recommendations to the Head of the Department and Dean (Academic Affairs). The class committee, without the student members, will also be responsible for finalization of the semester results and award of grades.

5.4 The Class Committee is required to meet at least thrice in a semester, first within a week of the commencement of the semester, second, after the first assessment and the third, after the semester-end examination to finalize the grades.

6.0 COURSE COMMITTEE

Each common theory course offered to more than one group of students shall have a "Course Committee" comprising all the teachers teaching the common course with one of them nominated as Course coordinator. The nomination of the Course coordinator shall be made by the Head of the Department / Dean (Academic Affairs) depending upon whether all the teachers teaching the common course belong to a single department or to several departments. The Course Committee shall meet as often as possible and ensure uniform evaluation of the tests and arrive at a common scheme of evaluation for the tests. Wherever it is feasible, the Course Committee may also prepare a common question paper for the test(s).

7.0 REGISTRATION AND ENROLMENT

7.1 For the first semester every student has to register and enroll for all the courses.

7.2 For the subsequent semesters registration for the courses will be done by the student during a specified week before the semester-end examination of the previous semester. The curriculum gives details of the core and elective courses, project and seminar to be taken in different semester with the number of credits. The student should consult his/her Faculty Adviser for the choice of courses. The Registration form shall be filled in and signed by the student and the Faculty Adviser.

7.3 From the second semester onwards all students shall pay the prescribed fees and enroll on a specified day at the beginning of a semester.

7.4 A student will become eligible for enrolment only if he/she satisfies clause 9 and in addition he/she is not debarred from enrolment by a disciplinary action of the Institution. At the time of enrolment a student can drop a course registered earlier and also substitute it by another course for valid reasons with the consent of the Faculty Adviser. Late enrolment will be permitted on payment of a prescribed fine up to two weeks from the date of commencement of the semester.

7.5 Withdrawal from a course registered is permitted up to one week from the date of the completion of the first assessment test.

7.6 Change of a course within a period of 15 days from the commencement of the course, with the approval of Dean (Academic Affairs), on the recommendation of the HOD, is permitted.

7.7 Courses withdrawn will have to be taken when they are offered next if they belong to the list of core courses.

7.8 A student should have registered for all preceding semesters before registering for a particular semester.

8.0 TEMPORARY BREAK OF STUDY FROM THE PROGRAMME

A student may be permitted by the Dean (Academic Affairs) to avail temporary break of study from the programme up to a maximum of two semesters for reasons of ill health or other valid grounds. Such student has to rejoin only in the same semester from where he left. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1).

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT / THESIS / DISSERTATION

9.1 A student is permitted to register for project semester, if he/she has earned the minimum number of credits specified below:

Programme	**Minimum No. of credits to be earned to enroll for project semester**
M.Tech. (Full time)	18 (III semester)
M.Tech. (Part time)	18 (V semester)
M.C.A. (Full time)	45 (V semester)
M.C.A. (Full time) – (Lateral Entry)	22 (V semester)
M.Sc.(Full time)	30 (IV semester) if project is in IV semester 18 (III semester) if project is in III semester

9.2 If the student has not earned minimum number of credits specified, he/she has to earn the required credits, at least to the extent of minimum credits specified in clause 9.1 and then register for the project semester.

10.0 DISCIPLINE

10.1 Every student is required to observe discipline and decorous behavior both inside and outside the campus and not to indulge in any activity, which will tend to bring down the prestige of the Institution.

10.2 Any act of indiscipline of a student reported to the Head of the Institution will be referred to a Discipline and Welfare Committee for taking appropriate action.

10.3 Every student should have been certified by the HOD that his / her conduct and discipline have been satisfactory.

11.0 ATTENDANCE

11.1 Attendance rules for all Full Time Programme and Part time - day Time Programmes are given in the following sub-clause.

11.2 Ideally every student is expected to attend all classes and earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% for genuine reasons like on medical grounds, representing the University in approved events etc., to become eligible to appear for the semester-end examination in that course, failing which the student shall be awarded "I" grade in that course. If the course is a core course, the student should register for and repeat the course when it is offered next. If the course is an elective, either he/she can register and repeat the same elective or can register for a new elective.

11.3 The students who have not attended a single hour in all courses in a semester and awarded 'I' grade are not permitted to write the examination and also not permitted move to next higher semester. Such students should repeat all the courses of the semester in the next Academic year.

12.0 SUMMER TERM COURSES

12.1 Summer term courses may be offered by a department on the recommendation of the Departmental Consultative Committee and approved by the Dean (Academic Affairs). No student should register for more than three courses during a summer term.

12.2 Summer term courses will be announced by the Head of the department at the end of the even semester before the commencement of the end semester examinations. A student will have to register within the time stipulated in the announcement. A student has to pay the fees as stipulated in the announcement.

12.3 The number of contact hours and the assessment procedure for any course during summer term will be the same as those during regular semesters.

Students with U grades will have the option either to write semester end arrears exam or to redo the courses during summer / regular semesters, if they wish to improve their continuous assessment marks subject to the approval of the Head of the department.

12.4 Withdrawal from a summer term course is not permitted. No substitute examination will be conducted for the summer term courses.

13.0 ASSESSMENTS AND EXAMINATIONS

13.1 The following rule shall apply to the full-time and part-time PG programmes (M.Tech./ M.C.A. / M.Sc.)

For lecture-based courses, normally a minimum of two assessments will be made during the semester. The assessments may be combination of tests and assignments. The assessment procedure as decided in the Class Committee will be announced to the students right from the beginning of the semester by the course teacher.

13.2 There shall be one examination of three hours duration, at the end of the semester, in each lecture based course.

13.3 The evaluation of the Project work will be based on the project report and a Viva-Voce Examination by a team consisting of the supervisor concerned, an Internal Examiner and External Examiner to be appointed by the Controller of Examinations.

13.4 At the end of industrial internship, the student shall submit a certificate from the organization and also a brief report. The evaluation will be made based on this report and a Viva-Voce Examination, conducted internally by a Departmental Committee constituted by the Head of the Department.

14.0 WEIGHTAGES

14.1 The following shall be the weightages for different courses:

(i) Lecture based course

Two continuous assessments	- 50%
Semester-end examination	- 50%

(ii) Laboratory based courses

Laboratory work assessment	- 75%
Semester-end examination	- 25%

(iii) Project work

Periodic reviews	- 50%
Evaluation of Project Report by External Examiner	- 20%
Viva-Voce Examination	- 30%

14.2 Appearing for semester end examination for each course (Theory and Practical) is mandatory and a student should secure a minimum of 40% marks in semester end examination for the successful completion of the course.

14.3 The markings for all tests, tutorial, assignments (if any), laboratory work and examinations will be on absolute basis. The final percentage of marks is calculated in each course as per the weightages given in clause 13.1.

15.0 SUBSTITUTE EXAMINATION

15.1 A student who has missed for genuine reasons any one of the three assessments including semester-end examination of a course may be permitted to write a substitute examination. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accident or admissions to a hospital due to illness, etc.

15.2 A student who misses any assessment in a course shall apply in a prescribed form to the Dean (Academic Affairs) through the Head of the department within a week from the date of missed assessment. However the substitute tests and examination for a course will be conducted within two weeks after the last day of the semester-end examinations.

16.0 COURSEWISE GRADING OF STUDENTS AND LETTER GRADES

16.1 Based on the semester performance, each student is awarded a final letter grade at the end of the semester in each course. The letter grades and the corresponding grade points are as follows, but grading has to be relative grading

Letter grade	Grade points
S	10
A	9
B	8
C	7
D	6
E	5
U	0
W	-
I	-
AB	-

Flexible range grading system will be adopted

“W” denotes withdrawal from the course.

"I" denotes inadequate attendance and hence prevention from semester-end examination

"U" denotes unsuccessful performance in a course.

“AB” denotes absent for the semester end examination

16.2 A student is considered to have completed a course successfully if he / she secure five grade points or higher. A letter grade ‘U’ in any course implies unsuccessful performance in that course.

16.3 A course successfully completed cannot be repeated for any reason.

17.0 AWARD OF LETTER GRADE

17.1 A final meeting of the Class Committee without the student member(s) will be convened within ten days after the last day of the semester end examination. The letter grades to be awarded to the students for different courses will be finalized at the meeting.

17.2 After finalization of the grades at the class committee meeting the Chairman will forward the results to the Controller of Examinations, with copies to Head of the Department and Dean (Academic Affairs).

18.0 DECLARATION OF RESULTS

18.1 After finalization by the Class Committee as per clause 16.1 the Letter grades awarded to the students in the each course shall be announced on the departmental notice board after duly approved by the Controller of Examinations.

18.2 In case any student feels aggrieved about the results, he/she can apply for revaluation after paying the prescribed fee for the purpose, within one week from the announcement of results.

A committee will be constituted by the concerned Head of the Department comprising of the Chairperson of the concerned Class Committee (Convener), the teacher concerned and a teacher of the department who is knowledgeable in the concerned course. If the Committee finds that the case is genuine, it may jointly revalue the answer script and forward the revised marks to the Controller of Examinations with full justification for the revision, if any.

18.3 The “U” and “AB” grade once awarded stays in the grade sheet of the students and is not deleted when he/she completes the course successfully later. The grade acquired by the student later will be indicated in the grade sheet of the appropriate semester.

19.0 COURSE REPETITION AND ARREARS EXAMINATION

19.1 A student should register to re-do a core course wherein "I" or "W" grade is awarded. If the student is awarded "I" or "W" grade in an elective course either the same elective course may be repeated or a new elective course may be taken.

19.2 A student who is awarded "U" or "AB" grade in a course shall write the semester-end examination as arrear examination, at the end of the next semester, along with the regular examinations of next semester courses.

19.3 A student who is awarded "U" or "AB" grade in a course will have the option of either to write semester end arrear examination at the end of the subsequent semesters, or to redo the course whenever the course is offered. Marks earned during the redo period in the continuous assessment for the course, will be used for grading along with the marks earned in the end-semester (re-do) examination.

19.4 If any student obtained "U" or "AB" grade, the marks earned during the redo period for the continuous assessment for that course will be considered for further appearance as arrears.

19.5 If a student with "U" or "AB" grade prefers to redo any particular course fails to earn the minimum 75% attendance while doing that course, then he/she will not be permitted to write the semester end examination and his / her earlier 'U' grade and continuous assessment marks shall continue.

20.0 GRADE SHEET

20.1 The grade sheet issued at the end of the semester to each student will contain the following:

(i) the credits for each course registered for that semester.

(ii) the performance in each course by the letter grade obtained.

(iii) the total credits earned in that semester.

(iv) the Grade Point Average (GPA) of all the courses registered for that semester and the Cumulative Grade Point Average (CGPA) of all the courses taken up to that semester.

20.2 The GPA will be calculated according to the formula

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GPi)}{\sum_{i=1}^{n} C_i} \qquad Where\ \ n = number\ of\ courses$$

where Ci is the number of credits assigned for i^{th} course

GP_i - Grade point obtained in the i^{th} course

For the cumulative grade point average (CGPA) a similar formula is used except that the sum is over all the courses taken in all the semesters completed up to the point of time.

'I' and 'W' grades will be excluded for GPA calculations.

'U', 'AB' 'I' and 'W' grades will be excluded for CGPA calculations.

20.3 Classification of the award of degree will be as follows:

CGPA	Classification
8.50 and above, having completed all courses in first appearance	First class with Distinction
6.50 and above, having completed within a period of 2 semesters beyond the programme period	First Class
All others	Second Class

However, to be eligible for First Class with Distinction, a student should not have obtained U or I grade in any course during his/her study and should have completed the PG Programme within a minimum period covered by the minimum duration (clause 3.1) plus authorized break of study, if any (clause 8). To be eligible for First Class, a student should have passed the examination in all courses within the specified minimum number of semesters reckoned from his/her commencement of study plus two semesters. For this purpose, the authorized break of study will not be counted. The students who do not satisfy the above two conditions will be classified as second class. For the purpose of classification, the CGPA will be rounded to two decimal places. For the purpose of comparison of performance of students and ranking, CGPA will be considered up to three decimal places.

21.0 ELIGIBILITY FOR THE AWARD OF THE MASTERS DEGREE

21.1 A student shall be declared to be eligible for the award of the Masters Degree, if he/she has:

i) successfully acquired the required credits as specified in the Curriculum corresponding to his/her programme within the stipulated time,

ii) no disciplinary action is pending against him/her.

21.2 The award of the degree must be approved by the University.

22.0 POWER TO MODIFY

Notwithstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

CURRICULUM & SYLLABI FOR M.TECH. (BIOTECHNOLOGY) (FOUR SEMESTERS / FULL TIME)

SEMESTER I

Sl. No	Course Code	Course Title	L	T	P	C
1	LSB6101	Advanced Biochemistry	4	0	0	4
2	LSB6102	Cell & Molecular Biology	3	0	0	3
3	LTB6101	Applied Biostatistics for Biotechnologists	3	0	0	3
4	LTB6102	Immunotechnology	4	0	0	4
5	LSB6105	Biomedical Instrumentation Technology	3	0	0	3
6	LTB6103	Microbial Biotechnology	3	0	0	3
7	LSB6107	Biochemistry Lab	0	0	3	1
8	LSB6108	Cell Biology Lab	0	0	3	1
9 1	LSB6109	Immunotechnology Lab		0	0	3
		Credits				**23**

SEMESTER II

Sl. No	Course Code	Course Title	L	T	P	C
1	LTB6201	Genomics & Proteomics	4	0	0	4
2	LTB6202	Bioprocess Engineering & Downstream Processing	4	0	0	4
3	LSB6203	Genetic Engineering	3	0	0	3
4	LSB6204	Computational Biology	3	0	0	3
5	LTB6203	Environmental Biotechnology	3	0	0	3
6	LSB6205	Computational Biology Lab	0	0	3	1
7	LSB6206	Genetic Engineering Lab	0	0	3	1
8	LTB6204	Mini Project	0	0	3	1
		Credits				**20**

SEMESTER III

Sl. No	Course Code	Course Title	L	T	P	C
1	LTB7101	Pharmacogenomics	3	0	0	3
2	LSB7102	Plant & Medical Biotechnology	4	0	0	4
3		Elective II	3	0	0	3
4		Elective III	3	0	0	3
5	LTB7102	Mini Project	3	0	0	6
		Credits				**19**

SEMESTER IV

Sl. No	Course Code	Course Title	L	T	P	C
1	LTB7201	Project work	0	0	20	8
		Credits				**18**
		TOTAL CREDITS				**80**

ELECTIVES

Course Code	Electives I	L	T	P	C
LSBY021	Bioenterpreneurship	3	0	0	3
LSBY022	IPR and Patent Law	3	0	0	3
LSBY023	Biosafety & Bioethics	3	0	0	3
LSBY028	Bionanotechnology	3	0	0	3
	Electives II				
LSBY024	Molecular Diagnostics	3	0	0	3
LSBY025	Food Process technology	3	0	0	3
LSBY026	Animal Biotechnology	3	0	0	3
LSBY029	Industrial Biotechnology	3	0	0	3

SEMESTER I

LSB6101	**ADVANCED BIOCHEMISTRY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

This course aims to develop in the students' mind a concept regarding

- The diversity of metabolic processes occurring in biological system.
- The effect of the structural and functional role of the enzymes governing the metabolic processes.
- Importance of the metabolic pathways in maintaining homeostasis in biological system.
- The clinical implications of the metabolic pathway.

MODULE I AMINO ACIDS & PROTEIN: STRUCTURE AND FUNCTIONS 5

Amino acids- Classification, structure and function, proteins- primary, secondary, tertiary and quaternary structure, Ramachandran plot, super secondary structures and helix loop.

MODULE II ENZYMOLOGY 10

Classification of enzymes. How do enzymes work: activation energy, substrate specificity. Enzyme-substrate interaction: Lock and Key mechanism and Induced Fit mechanism. Effect of temperature and pH on enzyme action. Enzyme Kinetics: Michaelis-Menten Equation, Km, Measurement of Km and Vmax (Lineweaver-Burk equation). Kinetics of multisubstrate reaction: Sequential reactions and ping-pong reactions. Enzyme inhibition: reversible (competitive, uncompetitive and mixed) and irreversible. Allosteric regulation of enzyme activity.Multienzyme complex and multifunctional enzymes.

MODULE III ENERGY PRODUCTION AND OXIDATIVE PHOSPHORYLATION 14

Introduction to metabolism: Anabolism, catabolism, metabolic pathways. Characteristics of metabolic pathways

Glycolysis: glycolytic pathway. Molecular mechanism of action of the glycolytic enzymes.Energetic of glycolysis. Glycolysis and cancer biology—Warburg

Hypothesis and PET scanning. Fates of Pyruvate under anaerobic conditions: alcohol and lactic acid fermentation. Importance of lactic acid fermentation.

TCA Cycle: Formation of Acetyl CoA and reactions of citric acid cycle. Molecular mechanism of pyruvate dehydrogenase complex and enzymes involved in Kreb's cycle.Energetic of TCA cycle and substrate level phosphorylation.

Lipid metabolism: Hormonal regulation of the mobilization of triglycerides from adiposities. Transport of fatty acid into mitochondria.Beta oxidation of saturated fatty acid (both even and odd).Regulation.Energetic.

Electron Transport Chain: structure and function of Electron carriers: Complex I—V. Passage of electrons from complex I to IV. Mitchell's chemiosmotic hypothesis and proton gradient.Structure of complex V or ATP synthase, Catalytic sites of ATP synthesis. Mechanism of ATP generation by Boyer's binding change mechanism—rotational catalysis. Energetic of ATP synthesis and efficiency of ATP synthase.

MODULE IV METABOLIC INTERRELATIONSHIP 9

Starve-Fed cycle.Glucose homeostasis. Switching of metabolism of liver between starve and fed cycle. Metabolic relationship of tissues in various nutritional and hormonal states—insulin resistance, diabetes, exercise, pregnancy, lactation, stress, liver and renal diseases, alcohol consumption.

MODULE V REGULATORY MECHANISMS OF METABOLIC PATHWAYS 7

Feed back inhibition by allosteric modulation of enzymes. Covalent modifications of enzymes.Isozymes.Propetolytic cleavage.Regulationg the amount of enzyme—regulation gene expression in prokaryotes and eukaryotes.

Total Hours : 45

REFERENCE:

1. Nelson D.L, Cox M. M. Lehninger's Principle of Biochemistry. 5th Ed.,W. H. Freeman, 2008.
2. Biochemistry by LubertStryer 7th ed. W. H. Freeman & Company.
3. Textbook of Biochemistry with Clinical Correlations. 4th Ed. Thomas M. Devlin. Wiley-Liss publication. 1997.

OUTCOMES:

At the completion of the course the student will develop an understanding about the

- Various metabolic processes occurring in biological system and their role in governing homeostasis and normal physiology.
- The importance of enzymes as a regulatory molecule in metabolism.
- The interrelationship of metabolic pathways different physiological conditions.
- The role of liver in regulating metabolism.

LSB6102 CELL & MOLECULAR BIOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To get overview of classes of cells and structural and function aspects of plasma membrane and cell organelle.
- To develop skill to understand molecular aspects of cell cycle and cell division.
- To get familiar with transcription and translation in details.
- To understand the signaling pathways in cell functioning

MODULE I INTRODUCTION TO CELL 8

Basic properties of cell, Different classes of cell: Prokaryotic, animal and plant cell.Plasma membrane- structure and function, Chemical composition of membranes, membrane lipids and proteins,fluid mosaic model, Transport across the membranes- diffusion, osmosis, facilitated diffusion,passive and active transport; membrane potential and nerve impulses.

MODULE II MEMBRANE TRANSPORT 7

Endoplasmic Reticulum, Golgi complex- glycosylation, Vesicle transport- COPI and COPII; Lysosomes-autophagy;Endocytic pathway- endocytosis and phagocytosis,transport of proteins into peroxisomes, mitochondria and chloroplast.

MODULE III ENERGY CONVERSION 10

Structure of mitochondria and organization of respiratory chain; Proton Pump and ATP generation in mitochondria; Structure of chloroplast and Photosynthesis, photorespiration; Genetic system of mitochondria and chloroplast.

MODULE IV BASIC GENETIC MECHANISMS 10

The structure and function of DNA, DNA packaging and Chromosomes, chromatin structure and function, DNA replication mechanisms, DNA damage and repair and homologous recombination and transposable elements, Telomeres, telomerase and end replication.Role of telomerase in aging and cancer.

MODULE V TRANSCRIPTION AND TRANSLATION 10

Transcription- Prokaryotic and eukaryotic Transcription- RNA polymerases- general and specific transcription factors- regulatory elements- mechanism of transcription, Transcription termination Post transcriptional modification- splicing- editing- nuclear export of mRNA- mRNA stability; Translation- Genetic code, Mechanism of initiation- elongation andtermination- Regulation of translation.

Total Hours : 45

REFERENCES

1. Molecular Biology of Cell by Alberts et.al. John Wiley & Sons, 6th Ed, 2015
2. The Cell by Cooper. ASM Press, 4th Ed, 2007
3. Cell and Molecular Biology by Karp. John Wiley & Sons, 7th Ed, 2013
4. Lodish H. F.Cell and Molecular Biology. W.H. Freeman & Co Ltd, 7th Ed, 2000.

OUTCOMES:

- On the completion of the above objectives student will be able to get the overview of classes of cells and structural and function aspects of plasma membrane and cell organelle. They can develop skill to understand molecular aspects of cell cycle, cell division, transcription and translation.

LTB6101 APPLIED BIOSTATISTICS FOR BIOTECHNOLOGISTS **L T P C**

3 0 0 3

OBJECTIVES:

This course aims to provide students with fundamental knowledge of statistical issues arising in biomedical research, and of important methods for the analysis of biostatistical data.

- Students will be able to make informed decisions based on data
- Students will be able to correctly apply a variety of statistical procedures and tests
- Students will know the uses, capabilities and limitations of various statistical procedures
- Students will be able to interpret the results of statistical procedures and tests

MODULE I CONCEPTS IN STATISTICS **9**

Population and sample, qualitative and quantitative data, nominal, ordinal, ratio, interval data; cross sectional and time series data; discrete and continuous data. Descriptive statistics and Random variables; Measures of central tendency: mean, median, mode; the uses of measure of central tendency, Measures of spread: range, percentile, standard deviation, some properties of variance and standard deviation, the coefficient of variation, group data.

MODULE II INFERENTIAL STATISTICS **9**

Displaying data: frequency table, line graph, bar chart, histograms, stem and-leaf plots, dot plot, scatter plot, box plots, frequency distributions; definition of probability, rules for calculating probability, definition from epidemiology, Bayes' theorem, probability in sampling, Bernoulli, Binomial, Poisson; Geometric distributions; Continuous random variables: Normal; Exponential distributions; Standard normal distribution. Counting and Probability, Permutations; Combinations.

MODULE III INTERVAL ESTIMATION **9**

Prediction, confidence and tolerance Intervals, distribution free interval, confidence interval based on normal distribution, confidence interval and

sample size, Point and interval estimates; the relation between population and sample, Random-Number tables, randomized clinical trials, estimation of the Mean of Distribution, estimation of -variance of distribution, binominal distribution and poisson distribution.

MODULE III HYPOTHESIS TESTING 9

Hypothesis testing: null and alternative hypotheses, decision criteria, critical values, type I and type II errors, Meaning of statistical significance; Power of a test; One sample hypothesis testing: Normally distributed data: z, t and chi-square tests; Binomial proportion testing, nonparametric hypothesis testing, Two sample hypothesis testing; Nonparametric methods: signed rank test, rank sum test; Kruskal-Wallis test;

MODULE IV CURVE FITTING AND ANOVA 9

Regression and correlation: simple linear regression; Least squares method; Analysis of enzyme kinetic data; Michaelis-Menten; Lineweaver-Burk and the direct linear plot; Logistic Regression; Polynomial curve fitting. Analysis of variance: One-way ANOVA, two-way ANOVA. Fixed effect model, Random effect model, the intraclass correlation coefficient.

MODULE V ANALYSIS OF SURVEY DATA 9

Introduction, study design, measures of effect for categorical data, attribution risk, confounding and standardization, methods of inference for stratified categorical data-The Mantel-Haenszel test, power and sample, multiple logistic regression, meta Analysis, equivalence study, the cross-over design, longitudinal data analysis, measurement-error Methods.

Total Hours : 45

REFERENCES:

1. Bernard Rosner, Fundamentals of Biostatistics, 5th Edition, Thomson Brooks/ Cole, 2000.
2. Richard A. Johnson, Probability and Statistics for Engineers, 6th Edition, Prentice Hall, 2000.
3. Morris H. DeGroot, Mark J. Schervish, Probability and Statistics, 3rd Rev. Edition, Addison-Wesley, 2002.
4. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley, 2006.

OUTCOMES:

At the end of the course students will be able to

- Explain how the Central Limit Theorem applies in inference
- Interpret the meaning of condence intervals in context
- Interpret the results of hypothesis tests
- Make an informed decision, based on the results of inferential procedures

LTB6102 IMMUNOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- Learn the structural features of the components of the immune system and their functions.
- Understanding the mechanisms involved in immune system development and responsiveness.
- To understand about how immunologists think and work.

MODULE I IMMUNOLOGY: CONCEPT AND COMPONENTS OF IMMUNE SYSTEM 7

Overview and Concepts, Discovery of humoral and cellular immunity, Components of innate and acquired immunity, Hematopoiesis, Organs and cells of the immune system- primary and secondary lymphoid organs, Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid Tissue.(MALT&CALT); Mucosal Immunity.

MODULE II ANTIGENS & ANTIBODY: BASIC PROPERITIES AND THEIR INTERACTIONS 9

Properities of antigens and antibodies, Epitopes, Heptens, Immunogenicity versus antigenecity, Antibody structure, classes and subclasses of Immunoglobulin, Theories of antibody formation.structural basis of antibody diversity; properties of immunoglobulins, subtypes. Immunoglobulins as antigens, monoclonal antibody techniques Hybridoma, Production of murine hybridoma, antigen antibody interactions.

MODULE III REGULATION OF IMMUNE RESPONSE BY B AND T LYMPHOCYTES 10

Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing, Cellular distribution of MHC molecule, Antigen processing and presentation – exogenous and endogenous antigen processing. Self -MHC restriction of T cells. Presentation of non-peptide antigens. B-cell receptor; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets;

MODULE III UNDERSTANDING CLINICAL IMMUNOLOGY 9

Cellular Immunity, Immune Tolerance and suppression, Immunity to infection : Bacteria, viral, fungal and parasitic infection. Hypersensitivity Reactions, Types of Hypersensitivity, Autoimmunity, Immune Dysfunction and Its component Cytokines -Properties, receptors, antagonists, diseases, Cytokine secretion by TH1and TH2 subsets therapeutic use of Cytokines. Cytokine related diseases, Cytokines in hematopoisesis. Complement system - Activation, Regulation, Biological consequence of complement activation and Complement deficiency, inflammation, and opsonization

MODULE V IMMUNOTECHNIQUES 10

Introduction: scope of Immunotechnology, Strength of antigen and antibody reaction- cross reactivity, precipitation and agglutination reactions, Radioimmunoassay and ELISA, Markers of immunocompetant cells, separation and purification of immunocompetant cells. Functional tests for immunocompetant cells and histocompatibility testing.Immunological assays- Complementfixation tests, In-vivo tests/ neutralization tests, immunodiffusion, immunoblotting, immunohistochemistry and immunofluorescenece techniques. Biosenor assays for assessing ligand –receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Microarrays, Transgenic mice, Gene knock outs

Total Hours : 45

REFERENCES:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippenco

OUTCOMES:

After completing the course students will:

- have a detailed understanding of Component of immunity
- know antigen presentation on a detailed molecular level
- understand the concept immunology and the immune system .
- have a in depth knowledge of the cellular and molecular basis for autoimmune disease and allergies.
- have basic knowledge of tumor immunology and the development of novel recombinant antibodies for treatment of cancer and autoimmune disease.

LSB6105 BIOMEDICAL INSTRUMENTATION L T P C

3 0 0 3

OBJECTIVES:

- To understand the application of Biomedical instrumentation.
- To introduce the student to the various devices of electrical origin and non electrical origin.
- To provide awareness of electrical safety of medical equipments.
- To know the important and modern methods of imaging techniques.

MODULE I FUNDAMENTALS OF MEDICAL INSTRUMENTATION 10

Role of technology in medicine, landmark developments in biomedical instrumentation, physiological systems of the body, sources of biomedical signals, basic medical instrumentation system, performance requirements of medical instrumentation systems, intelligent medical instrumentation systems, consumer and portable medical equipment, implantable medical devices, Basic components of a biomedical system, Transducers, Piezoelectric, ultrasonic transducers, Temperature measurements, Fibre optic temperature sensors. Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers Isolation amplifier.

MODULE II BIOELECTRIC SIGNALS AND ELECTRODES 9

Origin of bioelectric signals, recording electrodes, silver-silver chloride electrodes, Electrodes, Limb electrodes, floating electrodes, pregelled disposable electrodes, electrodes for ECG, electrodes for EEG, electrodes for EMG, electrical conductivity of electrode jellies and creams, microelectrodes, Micro, needle and surface electrodes, Typical waveforms, Electrical safety in medical environment: shock hazards, leakage current-Instruments for checking safety parameters.

MODULE III BIOMEDICAL RECORDER 8

Measurement of blood pressure, Heart rate, Pulmonary function measurements, spirometer, Photo Plethysmography, Body Plethysmography, Blood Gas analysers : pH of blood measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements, Electrocardiograph, vector cardiograph (VCG), phonocardiograph (PCG),digital stethoscope,

electroencephalograph (EEG), electromyography, other biomedical recorders, biofeedback instrumentation.

MODULE IV CLINICAL INSTRUMENTS AND PATIENT MONITORING SYSTEMS 9

Medical diagnosis with chemical tests, spectrophotometry, spectrophotometer type instruments, colorimeters, spectrophotometers, clinical flame photometers, selective-ion electrodes based electrolytes analyser, automated biochemical analysis systems, Radio graphic and fluoroscopic techniques, Computer tomography, MRI, Ultrasonography, X-ray Machines and Digital Radiography, Blood cell counter.

MODULE V THERAPEUTIC EQUIPMENTS AND PATIENT SAFETY 9

Audiometers and Hearing Aids, Pacemakers, Defibrillators, Ventilators, Nerve and muscle stimulators, Diathermy, Heart – Lung machine, Dialysers, Lithotripsy, electric shock hazards, leakage currents, safety codes for electromedical equipment, electrical safety analyzer, testing of biomedical equipment.

Total Hours : 45

OUTCOMES:

After the completion of the course

- The student acquires an adequate knowledge and could co relates the human body to the parameters that have clinical importance.
- The student learn the fundamental principles of medical equipment and patient safety.

REFERENCES:

1. R.S.Khandpur, 'Hand Book of Bio-Medical instrumentation', McGraw Hill Publishing Co Ltd. 2003.
2. M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.
3. L.A. Geddes and L.E.Baker, 'Principles of Applied Bio-Medical Instrumentation', John Wiley & Sons, 1975.
4. J.Webster, 'Medical Instrumentation', John Wiley & Sons, 1995.
5. C.Rajarao and S.K. Guha, 'Principles of Medical Electronics and Bio-medical Instrumentation', Universities press (India)

LTB6103 MICROBIAL BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To learn the microbial growth kinetics, isolation and screening
- To understand the principles of bioprocess
- To get the protein expression strategies &recombinant production
- To give basic idea on metagenomics & risk management
- To inform students about application in microbial biotechnology

MODULE I MICROBIAL GROWTH KINETICS, ISOLATION AND SCREENING 9

Microbial growth kinetics: batch cultures, continuous cultures, fed-batch culture. Isolation and screening of industrially important microbes; Large scale cultivation of industrial microbes; Strain improvement to improve yield of selected compounds e.g. antibiotics, enzymes or recombinant proteins. Biofilms, immobilized enzymes and immobilized cells as biocatalysts.

MODULE II PRINCIPLES OF BIOPROCESS 9

Basic principles of bioprocess as applied to selected microbes; Process optimization of selected products. Thermo-bacteriology: Thermal microbial destruction kinetic. Decimal reduction time.

MODULE III PROTEIN EXPRESSION STRATEGIES&RECOMBINANT PRODUCTION 9

Overview of protein expression strategies – choosing a heterologous host. Protein folding and inclusion bodies – the problem of protein refolding. Protein expression in E. coli and other Gram negative hosts.Recombinant protein production in microbes; Commercial issues pertaining to the production of recombinant products from microbes; Downstream processing approaches; Industrial microbes as cloning hosts (Streptomyces/Yeast).

MODULE IV METAGENOMICS & RISK MANAGEMENT 9

Culture Collections and Gene Banks. Microbial resources.Establishment of culture collections.Taxonomic Terminology. How are the strains preserved

Patent depository. Seed lot and cell bank system. Metagenomics in Biotechnology: understanding and exploiting microbial diversity. Risk management solutions to indoor biological contamination.Risk management solutions to indoor biological contamination.

MODULE V APPLICATION IN MICROBIAL BIOTECHNOLOGY 9

Pathways of microbial biotech product development, compliance, and regulation.Microbial monitoring during bacterial vaccine manufacturing processes and rapid microbial identification in a pharmaceutical Quality Control (QC) microbiology laboratory. Industrial enzymes for biopolymer degradation: starch, pectin, biomass applications. Industrial biocatalysis: sweetener, detergent, textile, lipid hydrolysis applications. Environmental application of microbes; Ore leaching; Toxic waste removal; soil remediation.

Total Hours : 45

REFERENCES:

1. Basic Biotechnology, Third Edition 2006. Colin Ratledge, Bjorn Kristiansen Editors. ISBN 0521840317, Cambridge University Press.
2. Demain AL, Davies JE, editors in chief 1999. Manual of Industrial Microbiology and Biotechnology. ASM Press Washington, D.C. second edition.
3. Microbial Biotechnology, Second Edition, 2007. Alexander N. Glazer, Hiroshi Nikaido. ISBN 9780521842105, Cambridge University Press.

OUTCOMES:

At the end of this course, students will:

- Describe microbial growth kinetics, isolation and screening and metabolic pathway engineering approaches to engineer microbes for the over-production of metabolic intermediates and to generate novel compounds.
- Explain how microbial enzymes and genetically engineered microbes are used in industrial biocatalysis.
- The capability to apply principles of bioprocess to the enzyme production.
- Explain the advantages and disadvantages of production of peptides, proteins, glycoproteins, in Gram negative, Gram positive, yeast expression systems.

- Mathematically describe microbial growth and product formation in batch, fed-batch, continuous cultures and immobilized cells. Explain how each of these methods is used in microbial biotechnology and environmental remediation.
- An understanding of how science relates application in microbial biotechnology

LSB6107	BIOCHEMISTRY LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To learn the preliminary methods in biochemistry by preparing buffer and different solutions.
- To learn about the factors affecting enzymatic activity.
- learn about several techniques of separations of sugar and amino acids.

1. Laboratory safety guidelines.
2. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
3. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
4. Determination of pH optima of an enzyme.
5. Determination of Km and Kcat of a particular enzyme.
6. Effect of temperature on enzyme activity.
7. Separation techniques for amino acids and sugar:
   (a) paper chromatography
   (b) thin layer chromatography.
8. Separation of proteins by native and SDS-PAGE.
9. Quantification of reducing sugar in different food material.
10. Estimation of different biochemical parameters of blood
    (a) sugar (b) cholesterol (c) urea.

OUTCOMES:

On performing the above experiments students will be able to:

- quantify different biomolecules from unknown samples.
- develop an idea about the separation of different biomolecules like proteins and carbohydrate.

- develop an idea about the factors regulating enzyme activity.
- determine the various parameters defining enzyme activity.
- estimate the concentration of various biomolecules in a wide range of samples.

REFERENCES:

1. Wilson K and Walker J, Principles and Techniques in Practical Biochemistry, 5th Ed., Cambridge University Press, 2000.
2. Holtzhauer M, Basic Methods for the Biochemical Lab, Springer, 2006.
3. Nigam, Lab Manual in Biochemistry: Immunology and Biotechnology, Tata McGraw-Hill Education, 2007.

LSB6108	CELL BIOLOGY LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To learn basic techniques in molecular biology
- To study and differentiate the electrochemical properties of nucleic acids

EXPERIMENTS **30**

1. Preparation of competent cell by calcium chloride method and checking its efficiency
2. Preparation of slides from onion root tip for mitosis
3. Isolation & Purification of genomic DNA from bacteria
4. Isolation & Purification of plasmid DNA
5. Isolation of RNA
6. Agarose gel electrophoresis of chromosomal & plasmid DNA
7. Restriction Digestion of chromosomal & plasmid DNA
8. Isolation of DNA fragment from agarose gel

REFERENCES

1. Michel R. G and Sambrook J. Molecular Coning- A laboratory manual. Cold spring harbor laboratory press, 2012.

OUTCOMES:

- On the completion of the above experiments students will be able to handle DNA samples and also to isolate, purify and visualize nucleic acid.

LSB6109	IMMUNOTECHNOLOGY LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To acquire knowledge on immunological techniques
- To train in various techniques involving antigen and antibody reactions

LIST OF EXPERIMENTS:

1. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
2. Rocket electrophoresis
3. Antibody titre by ELISA method.
4. ELISA for detection of antigens and antibodies-DOT ELISA
5. Sandwich ELISA
6. Blood group mapping
7. Separation of leucocytes by dextran method
8. Separation of mononuclear cells by Ficoll-Hypaque
9. Preparation of antigens from pathogens and parasites
10. Slide and tube agglutination reaction
11. Complement fixation test.
12. Immunofluorescence technique
13. Lymphoproliferation by mitogen / antigen induced
14. SDS-PAGE, Immunoblotting, Dot blot assays

REFERENCES:

1. Rose et al., Manual of Clinical laboratory Immunology, 6th Ed ASM Publications, 2002.
2. Lefkovis and Pernis. Immunological methods. Academic Press, 1978.
3. Hudson L. and Hay F.C. Practical Immunology. Black Well publishers, 1989

OUTCOMES:

- Students could independently perform diagnostics assays involving antigen-antibody reaction. They also learn to perform the qualitative and quantitative analysis using antibody.

SEMESTER II

LTB6201	GENOMICS AND PROTEOMICS	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To provide information about genomics and proteomics and
- To offer basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes.
- To understand the basic proteomics and its potential application of both genomics and proteomics.

MODULE I INTRODUCTION **10**

Genomics classification, Prokaryotic and Eukaryotic genome; mitochondrial and chloroplast genome; DNA sequencing-principles and methods, Sanger Dideoxy and fluorescence method; coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

MODULE II GENOME SEQUENCING PROJECTS **8**

Gene database for Microbes, plants and animals; Accessing and retrieving genome project; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

MODULE III PROTEOMICS TECHNIQUES **9**

Introduction to proteomics; Protein separation techniques: chromatography-ion-exchange, size-exclusion and affinity chromatography; Protein analysis-Polyacrylamide gel electrophoresis, Isoelectric focusing (IEF), Two dimensional PAGE for proteome analysis and image analysis of 2D gels; measurement of protein concentration, amino-acid composition, N-terminal sequencing.

MODULE IV PROTEIN ENGINEERING **9**

Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system. High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development.

MODULE V FUNCTIONAL GENOMICS AND PROTEOMICS 9

Recombinant DNA technology: Fundamentals of DNA cloning, Polymerase chain reaction, Human genome project; Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays.

Total Hours : 45

OUTCOMES:

- After completing the course the student will have a better understanding to the basics of the genomic and proteomic principles.
- The course will provide an updated knowledge about the different tools and applications of genomics and proteomics.

REFERENCES:

1. Brown TA, Genomes, 3rd Edition. Garland Science 2006
2. Campbell AM &Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
3. Primrose S &Twyman R, Principles of Gene Manipulation and Genomics, 7th Ed, Blackwell, 2006.
4. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

LTB6202 BIOPROCESS TECHNOLOGY & DOWNSTREAM PROCESSING

L	T	P	C
4	0	0	4

OBJECTIVES:

- To develop the skills in the area of bioprocess technology and downstream processing and understand different types of fermentors, the separation and isolation steps involved in downstream process and methods in product purification and formulation.

MODULE I BIOPROCESS TECHNOLOGY **9**

Design features of bioreactors / fermenters, Fundamentals of bioprocess technology, Principles underlying product formation, Principles underlying product recovery and purification, Large scale production of fermentation products, Fermentation kinetics: Reaction kinetics, Scale up of fermentation process, Downstream processing, Biosynthetic pathways for some secondary metabolites.

MODULE II MODELING AND DESIGN OF FERMENTATION PROCESSES **9**

Principles of model building for biotechnological processes, modeling of recombinant systems. biomass growth and product formation, Kinetics of substrate utilization, inhibition on cell growth and product formation. Design and operation of continuous cultures, chemostat in series, batch and fed batch cultures, total cell retention cultivation, Case studies on Production of green chemicals, algal biofuels, recombinant Insulin. Case studies should deal with medium design, reactor design & process optimization etc.

MODULE III DOWNSTREAM PROCESSING **9**

Introduction-downstream processing, biomolecules and bioprocesses, biomass removal and disruption technique- centrifugation, sedimentation, flocculation, ficrofiltration, sonication, Homogenizers, chemical lysis, enzymatic lysis , pretreatment and stabilisation of bioproducts.

MODULE IV SEPERATION AND ISOLATION **9**

Unit operations for solid-liquid separation - filtration and centrifugation. Membrane based purification: Ultrafiltration; Reverse osmosis; Dialysis; Diafiltration; Pervaporation; Perstraction Adsorption and chromatography: size,

charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds)

MODULE V PRODUCT PURIFICATION AND FORMULATION 9

Ammonium Sulfate-precipitation, solvent),Chromatography, principles, instruments and practice, adsorption, reverse phase, ionexchange, size exclusion, hydrophobic interaction, bioaffinity and pseudo affinity chromatographic techniques. Crystallization, drying and lyophilization in final in product formulation.

Total Hours : 45

OUTCOMES:

After the completion of the course

- The student will be able to learn about bioprocess techniques and downstream processing.
- The student will learn types of fermentors
- The student will be able to understand various techniques involved in the a product isolation, purification and formulation.

REFERENCES:

1. P.A. Belter, E.L. CusslerAnd Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pub. (1988).
2. R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
3. Shuler, M.L. and Kargi, F. Bioprocess Engineering : Basic concepts, 2nd ed., Prentice-Hall, 2002.
4. Doran Pauline M, Bioprocess Engineering Principles, Academic Press, 1995
5. Nielsen, J. and Villadsen, J. “Bioreaction Engineering Principles”. Springer, 2007.
6. Blanch, H.W and Clark D.S., “Biochemical Engineering”, Marcel Dekker, 1997.

LTB6203 GENETIC ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

- To learn about genetic engineering, principles involved in manipulating genes and DNA.
- To know about cloning strategies and expression systems.
- To acquire basic understanding of techniques in genetic engineering.

MODULE I BASICS CONCEPTS 9

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immuno precipitation; DNA-Protein Interactions-Electromobility shift assay; DNaselfootprinting.

MODULE II CLONING VECTORS 9

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Expression vectors; pMal; GST; pET-can be omitted vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors. Criteria for selection of vectors.

MODULE III CLONING METHODOLOGIES 9

Insertion of Foreign DNA into Host Cells; Transformation; Transfection, Transduction, Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; South western and Far-western cloning;

Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression. Methods to confirm cloning and reporter genes and proteins.

MODULE IV PCR AND ITS APPLICATIONS 9

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; Tvectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis detection. Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides.

MODULE V APPLICATION OF GENETIC ENGINEERING 9

Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array. Ethics in genetic engineering and global policy.

Total Hours : 45

TEXT/REFERENCES

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006.
4. Selected papers from scientific journals.
5. Desmond S. T. Nicholl An Introduction to Genetic Engineering Cambridge University Press 2008.

5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

OUTCOMES:

- On completion of the course the scholars will acquire knowledge on the concepts and terminology in genetic engineering.
- Students will be familiar with various cloning strategies in prokaryotes as well as in eukaryotes.
- Students will learn various techniques in genetic engineering.
- They will also get awareness about the social and ethical issues concerning cloning by genetic engineering

LSB6204 COMPUTATIONAL BIOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To understand the programming languages applied in computational biology.
- To understand the methods and applications for sequence analysis, Phylogenetics and Protein modelling.

MODULE I INTRODUCTION TO PROGRAMMINB LANGUAGE 9

Introduction –Programming languages – Problem solving Technique: Algorithm, Flowchart, Compiling, Testing and Debugging - Basic Perl Data Types, File handle and File Tests – Perl Modules – SQL.

MODULE II PROGRAMMING IN C, C++ AND OOPS 9

C language Introduction – Tokens – Keywords, Identifier, Variables, Constants, Operators – Structure of a 'C' program - Expression – Data types – Control Statement - C++programming – Object Oriented Concept: Encapsulation, Inheritance, Polymorphism.

MODULE III COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS 9

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

MODULE IV PHYLOGENETICS 9

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

MODULE V PROTEIN STRUCTURE, MODELLING AND SIMULATIONS 9

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

Total Hours : 45

REFERENCES:

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press.
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
4. Tisdall, James, Beginning PERL for Bioinformatics, O'Reilley Publications, 2001.
5. Andrew R. Leach, Molecular Modeling Principles and Applications, Second Edition, Prentice Hall.
6. Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003
7. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002

OUTCOMES:

- At the end of this course, students will have been familiarized with language skills and their applications in analyzing Protein structure , sequence analysis which can be used in analyzing the binding effect of drugs on proteins.

LTB6204 ENVIRONMENTAL BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To learn the environment protection Act and Law related to environmental biotechnology
- To give basic idea on environmental sample analysis
- To understand the basic principles involved in waste water management
- To get the information on usage of Bioremediation-biotechnology
- To inform students about Biooxidation& microbial leaching

MODULE I INTRODUCTION TO ENVIRONMENTAL BIOTECHNOLOGY 9

Water, Soil and Air: their sources and effects. Removal of Specific Pollutants: Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal Accumulation, Biosorption& detoxification mechanisms. Environment protection Act: Environmental laws, Environmental policies, Environmental ethics. UN declaration.Environmental protection and conservation. Environmental Impact Assessment, Ecoplanning and Sustainable Development.

MODULE II ENVIRONMENTAL SAMPLE ANALYSIS 9

Physicochemical and bacteriological analysis of soil and water, Problems associated with soil alkali soils, sodic soils, and solid waste, Fate of insecticides fungicides, pesticides in soil, use of genetically modified (insect- , pest- and pathogen resistant) plants. Ecotoxicology of soil pollutants, Municipal solid waste treatment strategies.

MODULE III WASTE WATER MANAGEMENT 9

Waste water constituents, Analysis and selection of flow rates and loadings, Process Selection, Physical unit operations, Chemical unit operations, Fundamentals of biological treatment, Role of biotechnology in water purification systems. Types and kinetics of biological treatment, Advanced waste water treatment, Biological Processes for Industrial and domestic effluent, Treatment, Aerobic Biological Treatment,Anaerobic Biological Treatment.

MODULE IV BIOREMEDIATION-BIOTECHNOLOGY 9

Bioremediation-Biotechnology for clean environment, Biomaterials as substitutes for non-degradable materials, Metal microbe interactions: Heavy Metal Pollution and impact on environment, Microbial Systems for Heavy Metal Accumulation, Biosorption, molecular mechanisms of heavy metal tolerance Bioindicators and biosensors for detection of pollution. Biotechnology for Hazardous Waste Management, Persistent organic pollutants, Xenobiotics, Biological Detoxification of PAH, Biotechniques for Air Pollution Control. Solid Waste Management.

MODULE V BIOOXIDATION & MICROBIAL LEACHING 9

Biooxidation – Direct and Indirect Mechanisms – Biooxidation Kinetics; Bacterial oxidation of Sphalerite, Chalcopyrite and Pyrite.; Extraction of metals from ores; Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal.

Total Hours : 45

REFERENCES:

1. Amann, R.I. Stromley, J. Stahl : Applied & Environmental Microbiology.
2. Environmental Microbiology, W.D. Grant & P.E. Long, Blakie, Glassgow and London.
3. Microbial Gene Technology, H. Polasa (ED.) South Asian Publishers, New Delhi.
4. Biotreatment Systems, Vol. 22, D. L. Wise (Ed.), CRC Press, INC.
5. Standard Methods for the Examination of Water and Waste Water (14th Education), 1985. American Public health Association

OUTCOMES:

On successful completion of this module, learners will be able to have:

- An understanding of environment protection regulations and source of environmental pollutions.
- The capability to apply advanced knowledge on environmental sample analysis
- The capability to apply avalanched discipline in waste water management
- The ability to formulate technique for bioremediation process
- An understanding of how biooxidation& microbial leaching helping in the industries.

LSB6205	COMPUTATIONAL BIOLOGY LAB	L	T	P	C
		0	0	3	1

OBJECTIVES:

- To get hands on experience on plasmid construction, mappings and analysis.
- To explore to various tools in bioinformatics.

EXPERIMENTS **30**

1. Plasmid Construction
2. Restriction Mapping
3. PCR Primer Designing
4. Sequence Retrieval and Format Conversion
5. ORF Finding
6. Homology Search
7. Multiple Sequence Alignment
8. Gene Prediction in prokaryotes
9. Motif finding in DNA and Protein Sequences
10. Structure Visualization
11. Phylogenetic Analysis
12. Protein Secondary Structure Prediction

REFERENCES

1. Rashidi H, Buehler L. K. Bioinformatics Basics: Applications in Biological Science and Medicine. 2nd Ed., CRC Press, 2005.
2. Baxevanis A. D, Ouellette B. F. F. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 3nd edition Wiley, John & Sons, Incorporated, 2004.
3. Krawetz S. A, Womble D. D. Introduction to Bioinformatics: A Theoretical and Practical Approach. Humana press, 2003.

OUTCOMES:

- Students will be familiar with various soft skills/tool used in understating modern biology. They will also be able to analyze and interpolate data starting from PCR primer designing to structure predictions.

LSB6206	GENETIC ENGINEERING LABORATORY	L	T	P	C
		0	0	3	3

OBJECTIVES:

- To practice the earned theoretical knowledge in genetic engineering techniques
- To get acquainted with DNA/gene products know about cloning strategies and expression systems.
- To get familiarize with the sequential processes in genetic engineering.

LIST OF EXPERIMENTS:

1. Isolation of desired DNA/gene by PCR or restriction enzymes
2. Gel elution and purification of inserts
3. Ligation
4. Transformation
5. Verification of cloning by PCR or reporter gene or by patching the positive colonies
6. Plasmid isolation from PCR positive colonies
7. Confirmation of cloning by restriction digestion
8. Set up DNA sequencing reaction
9. Cleaning the sequencing reaction product
10. Automated DNA sequencing
11. Sequence Editing
12. Sequence analysis by BLAST

REFERENCES:

Laboratory Manual

OUTCOMES:

- Students will be familiar with various techniques globally used in engineering DNA and gene.
- Students will also be able to analyze the successfully cloned products.
- Students will be able to independently plan and execute the cloning of desired gene.

SEMESTER III

LTB7101	**PHARMACOGENOMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- Learn the basic principles of genetic variation in treatment response.
- Learn the molecular and cellular biology to explain the genetic basis of variability in drug response.
- Understand the concept of pharmacogenomics in different therapeutic areas.
- To identify important sources and reliable databases with pharmacogenomics knowledge base.

MODULE I GENOMIC APPROACHES TO BIOLOGY 9

Principles of Human Genomics, Organization, human Population Genomics, Application of Population Genomics to Genomic Medicine, Genomic Approaches to Complex Disease, Identifying Common and Rare Genomic Variations in the Population, Relating DNA Variation to Phenotypes, Human Health and Disease: Introduction to basic concept of pharmacogenomics. Importance, clinical application and challenges in Pharmacogenomics. Basic principles and paradigms of molecular biology (DNA?RNA?Protein) information on gene promoters, miRNA, identification of targets, splicing/ alternate splicing. Introduction to genetic variation, types of variants, SNPs, coding and cis/trans regulatory variants, insertion/deletions, copy number variants SNPs, allele nomenclature, databases, National pharmacogenetics resources/efforts (PGRN).

MODULE II EPIGENETICS AND THE ENVIRONMENT 9

DNA Methylation Patterns Chromatin Modification DNA Methylation and Chromatin StatesCo-operatively Determine the State of Activityof Genes, Epigenetics and Human Disease, Systems Biology and the Emergence of Systems Medicine, Multi -parameter Blood-bourne Biomarkers, Emerging in vivo and in vitro Technologies,Technology Platforms for GenomicMedicine, DNA Sequencing for the Detection of Human Genome Variation and Polymorphism, DNA Sequencing, Other Methodologies for Polymorphism

Detection, Genome-Wide Association Studies and Genotyping, Copy Number Variation and Human Health, Detecting CNVs in a Genome-wide Manner, Association of CNVs to Disease and Disease Susceptibility, Implications of CNVs.

MODULE III PROTEOMICS: THE DECIPHERING OF THE FUNCTIONAL GENOME 9

Gel-based and Solution-based Proteomics, Mass Spectrometry, Bioinformatics, Impact of Proteomics on Understanding Diseases, Comprehensive Metabolic Analysis for Understanding of Disease Mechanisms Comparison of NMR and MS Technologies for Unbiased Metabolic Profiling, MS Methods for Targeted Metabolic Profiling, Examples of NMR-based Metabolic Profiling in, Disease Research, Examples of Targeted MS-based Metabolic Profiling for Understanding of Disease Mechanisms, Comprehensive Analysis of Gene Function: RNAinterference and Chemical Genomics Chemical Genomics Gene Function Studies.

MODULE IV INFLUENCE OF PHARMACOGENOMICS BASED DRUG INTERACTIONS 9

Introduction to proteins of importance in drug pharmacokinetics. Understanding the role of proteins involved in phase I drug metabolism in pharmacogenomics, Proteins Involved in Pharmacogenetics, Pharmacogenetics of Phase I drug metabolizing enzymes, CYP2C9 Pharmacogenetic, CYP2D6 Pharmacogenomics, CYP2D19 Pharmacogenetics, PhaseII Drug Metabolizing Enzymes, The role of proteins involved in phase I drug metabolism in pharmacogenomics, drug transporter pharmacogenetics, how genetic variation in drug transporters contribute to inter-individual differences in drug PK and PD.

MODULE V PHARMACOGENOMICS IN THERAPEUTIC AREAS 9

Role of Pharmacogenomics in Drug Development, Pharmacokinetic profiles for metabolic CYP2D6 metabolizers (Metoprolol as Example Compound), Pharmacodynamic response profiles for metabolic CYP2D6 metabolizers (Metoprolol as Example Compound) Combined consideration and Clinical interpretation of significance of CYP2D6 metabolizer status for metoprolol, Cardiovascular Example of pharmacogenomic based drug drug interaction differential for statin based therapy, Other Cardiovascular based examples

of the significance of pharmocogenomics, Pharmacogenomics of Tamoxifin Epidermal Growth Factor Receptors and KRAS,Irinotecan and UGT1A1 Capecitabine and 5-FU in solid tumors, pharmacogenomics and adverse drug reaction, Carbamazepine and Abacavir induced ADRs

Total Hours : 45

REFERENCE:

1. McLeod, et. al (eds.) (2009). Pharmacogenomics: Applications to Patient Care, 2nd Ed. American Association of Colleges of Pharmacy

OUTCOMES:

- After the completition of the course the student will be able
- Understand and use pharmacogenomic concepts to a particular drug therapy.
- Recognize ethical implication of genetic testing and the resultant individualization of drug therapy.
- Understand how variability in genes encoding drug metabolizing enzymes, drug transporting proteins, and drug receptors (targets) may result in drug disposition leading to changes in pharmacokinetics, pharmacodynamics, and clinical outcome.

LSB7102 PLANT AND MEDICAL BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- to learn about embryogenesis and other type of hybridization techniques.
- to know about genetic transformation and techniques about gene delivery.
- to have an idea about gene mapping and cloning and different type of biotic and abiotic stress.
- to know about protein engineering and different type of bioinformatics analysis.

MODULE I PLANT TISSUE CULTURE 9

Totipotency, organogenesis, somatic embryogenesis, artificial seed production, Micropropagation, somaclonal variation, Germplasm conservation and cryopreservation.Protoplast Culture and Somatic Hybridization Protoplast isolation- its culture and usage, Somatic hybridization and its applications.

MODULE II AGROBIOLOGY 9

Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer, Genetic Transformation Agrobacterium-mediated gene delivery, Direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers, Characterization of transgenics, Gene targeting.

MODULE III MOLECULAR MAPPING & MARKER ASSISTED SELECTION (MAS) 9

Marker assisted selection for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield, Molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP markers; Construction of genetic and physical map, Gene mapping and cloning, strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance Bacterial resistance; Viral resistance; Fungal resistance; Insects and pathogens resistance; Herbicide resistance; Drought, salinity, thermal stress, flooding and submergence tolerance.

MODULE IV MOLECULAR THERAPEUTICS **9**

Basic concept of stem cell therapy, neutraceuticals, nanotechnology and clinical trials, revolution in diagnosis, changing approaches of therapy, FDA Organization chart and regulatory measures for drug discovery. Drug discovery - Overview, rational drug design, combinatorial chemistry in drug development, computer assisted drug design, role of bioinformatics in genome based therapy, antisense DNA technology for drug designing. Stem cells in therapy.

MODULE V VACCINES **9**

Biotechnological approaches to obtain blood products: Tissue plasminogen activator and erythropoietin, Vaccine technology: Subunit vaccines, drawbacks of existing vaccines, criteria for successful vaccine, peptide vaccine, minicells as vaccines, impact of genetic engineering on vaccine production, viral vector vaccines and AIDS vaccine chiral technology.

Total Hours : 45

REFERENCES:

1. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press, 2003.
2. Edited by BR Jordan, 2nd Edition, The Molecular Biology and Biotechnology of Flowering, CABI, 2006.
3. Neil Wille, Phytoremediation: Methods and Reviews, 1st Edition, Humana Press, 2007.
4. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.

OUTCOMES:

On the completion of course student will be able to understand

- different hybridization techniques and basics of embrogenesis.
- they will be able to learn about different gene delivery techniques.
- they will learn about genomics, protein engineering and other bioinformatics tools.

ELECTIVES-I

LSBY021	BIO-ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

OBJECTIVES:

The objective of the course is to

- To understand concepts and process involved with bio-entrepreneurship
- To make the students aware of the importance of entrepreneurship opportunities available in the society for the entrepreneur.
- Acquaint them with the challenges faced by the entrepreneur

MODULE I ACCOUNTING AND FINANCE 9

Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks; Funds from bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management; Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping; Estimation of income, expenditure, profit, income tax etc.

MODULE II MARKETING 9

Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/ Competition; Promotion/ Advertising; Services Marketing.

MODULE III NEGOTIATIONS/STRATEGY 9

With financiers, bankers etc.; with government/law enforcement authorities; with companies/ Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/ Avoiding/Managing; Broader vision– Global thinking

MODULE IV INFORMATION TECHNOLOGY &HUMAN RESOURCE DEVELOPMENT 9

How to use IT for business administration; Use of IT in improving business performance; Available software for better financial management; E-business setup, management. Human Resource Development (HRD)- Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up.

MODULE V ROLE OF KNOWLEDGE CENTRE AND R&D 9

Support mechanism for entrepreneurship in India; Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies.

Total Hours : 45

REFERENCES:

1. Roy Rajeev, Entrepreneurship Oxford Latest Edition.
2. E. Gordon & K. Natarajan Entrepreneurship Development Himalaya 2008.
3. Coulter Entrepreneurship in Action PHI 2nd Edition.
4. P. C. Jain Handbook For New Entrepreneur .Oxford Latest Edition.
5. S. S. Khanka Entrepreneurial Development S. Chand, Latest Edition.
6. Thomas W. Zimmerer& Norman M. Scarborough Essentials of Entrepreneurship and small business management, PHI 4th Edition.
7. Dr.VidyaHattangadi Entrepreneurship, Himalaya 2007.
8. Vasant Desai Small Scale Industries and Entrepreneurship, Himalaya 2008.
9. Dr. V. B. Angadi, Dr. H. S. Cheema & Dr. M. R. Das Entrepreneurship, Growth, and Economic Integration A linkage, Himalaya 2009.

OUTCOMES:

On successful completion of this module, learners will be able to have:

- An understanding of accounting and finance related to bio-entrepreneurship.
- The capability to apply advanced assessment strategies on marketing of product.
- The capability to apply knowledge on negotiations strategy related to bio-entrepreneurship.
- The ability to apply and handle information technology & human resource development.
- Addressing the problems associated with role of knowledge centre and R&D.

LSBY022 INTELLECTUAL PROPERTY RIGHTS & PATENT LAW L T P C

3 0 0 3

OBJECTIVES:

- To learn about the Intellectual Property Rights
- To understand about criteria in applying and maintaining patents.
- To be familiarized with the law and enforcement in Intellectual Property Rights

MODULE I INTRODUCTION TO IPR 9

General regime of intellectual property rights and law.Theories of Intellectual Property Rights, Kinds of Intellectual Property.Intellectual Property as an Instrument of Development, Economic importance of Intellectual Property.Need for Protecting Intellectual Property.National and international perspectives.

MODULE II TRADE MARK 9

Introduction to Trade mark, Trade mark registration and maintenance Process, Transfer of Rights, Inter parties Proceeding, Infringement, Dilution Ownership of Trade mark, Likelihood of confusion, Trademarks claims, Trademarks Litigations and International Trade mark Law. Trade Secret, Employee Limitation, Unfair Competition and Trade Secret Litigations.

MODULE III COPYRIGHTS 9

Introduction to Copyrights, Principles of Copyright, Copyright Law, Copy right Ownership, Transfer and duration, Right to prepare Derivative works, Rights of Distribution, Rights of Perform the work Publicity Copyright Formalities and Registrations, Limitions, Copyright disputes and International Copyright Law.

MODULE IV GEOGRAPHICAL INDICATIONS 9

Registration, Duration of Protection and Renewal; Infringement, Penalties and Remedies. Layout designs of Integrated Circuits- Semiconductor Integrated Circuits Layout-Design Act, 2000, Registration and Effect of Registration, Assignment and Transmission. Protection of Plant Varieties and Farmers' Rights - Authority and Registry, Duration, Effect of Registration and

Benefit Sharing, Farmers' Rights, Plant Varieties Protection Appellate Tribunal, Infringement, Offences and Penalties.

MODULE V IPR LEGISTLATION AND PATENTING 9

World Intellectual property organization WIPO – establishment, role, membership, etc., Indian IPR legislation, Indian patent act, national intellectual property policy. Rationale for Intellectual Property Protection in Biotechnology, Patenting Biotechnology Inventions-Objective, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions. Protection of Plant Varieties.Protection of Traditional Knowledge. Case studies on Basmati rice, turmeric, neem and also current cases.

Total Hours : 45

REFERENCES:

1. Debirag E. B. Intellectual Property. Cengage learning, New Delhi.
2. Prabhuddha G. Intellectual Property Rights. Tata Mc-Graw–Hill, New Delhi.
3. Gopalakrishnan N. S. and Agitha, T. G. Principles of Intellectual Property, Eastern Book Company, Lucknow 2009.
4. Subbaram N. R. Handbook of Indian patent law and practice, S. Viswanathan printers and publishers Pvt Ltd, 1998.

OUTCOMES:

- On the completion of the above objectives student will be able to know about IPR and also the importance of protecting their innovation. They will be familiar with international and national law practiced and also recent issues on it.

LSBY023	BIOSAFETY AND BIOETHICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Developing a good work ethics and laboratory working condition.
- Understanding the importance of following and maintaining laboratory safety guidelines.

MODULE I ETHICS IN BIOLOGY **9**

Principles and purpose of studying bioethics, legal, moral and ethical issues in biological research, human rights, privacy and justice, IPR and technology transfer.

MODULE II BIOSAFETY **9**

Biosafety in laboratory practices, laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, biosafety regulations in handling of recombinant DNA processes and products.

MODULE III GENETICALLY MODIFIED CROPS AND FOOD **9**

Genetically modified food and biosafety assessment procedures for GM foods and related consumables, including transgenic food crops, ecological safety assessment of recombinant organisms and transgenic crops, case studies of relevance (e.g. BT cotton).

MODULE IV ETHICAL ISSUES IN LABORATORY RESEARCH **9**

Ethical issues and guidelines for research with laboratory animals, current uses of laboratory animals in biomedical research, animal experimentation using hazardous chemicals, animal care and maintenance, CPSEA guidelines for laboratory animals.

MODULE V ETHICAL ISSUES IN CLINICAL RESEARCH **9**

Ethical issues and guidelines for research with clinical samples and humans studies, Role of Institutional Human ethical board, ICMR's ethical guidelines and clinical trials registration in India and challenges in clinical trials.

Total Hours : 45

REFERENCES:

1. Thomas, J.A., Fuch, R.L. Biotechnology and Safety Assessment (3rd Ed). Academic Press, 2002

2. Fleming, D.A., Hunt, D.L. Biological safety Principles and practices (3rd Ed). ASM Press, Washington, 2000.

3. H.-J. Rehm and G. Reed, Biotechnology - A comprehensive treatise (Vol. 12). Legal economic and ethical dimensions VCH.

OUTCOMES:

- At the end of the course student will develop an idea about the importance of good laboratory practice in high quality research. They will also develop an awareness about the basic fundamental safety measures that a researcher should follow in laboratory.

LSBY028 BIONANOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To provide an introduction to nanobiotechnology.
- To make the students understand about the functional principles of nanobiotechnology

MODULE I FUNDAMENTALS OF NANOSCIENCE 9

Introduction, the nanoscale dimension and paradigm, definitions and historical evolution (colloids etc.) and current practice, types of nanomaterials and their classifications (1D, 2D and 3D etc. nanocrystal, Nanoparticle, Quantum dot, Quantum Wire and Quantum Well etc), Polymer, Carbon, Inorganic, Organic and Biomaterials –Structures and characteristics.

MODULE II CHARACTERIZATIONS IN BIONANOTECHNOLOGY 9

Optical (UV-Vis/Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, light scattering, Zeta potential), Surface and composition (ECSA, EDAX, AFM/STM etc), Vibration (FT-IR and RAMAN), SERS -3, Magnetic, Electrical and Electrochemical.

MODULE III APPLICATIONS OF BIONANOTECHNOLOGY 9

Materials in Biosystems: Proteins - Lipids - RNA and DNA, Protein Targeting – Small Molecule/Nanomaterial - Protein Interactions Nanomaterial-Cell interactions-Manifestations of Surface Modification (Polyvalency), Drugs-Photodynamic therapy, molecular motors, neuroelecronic interphases, development of nanoluminiscent tags.

MODULE IV NANOMATERIALS AND DIAGNOSTICS 9

Drug Delivery and Therapeutics, MRI, Imaging, Surface Modified Nanoparticles, MEMS/NEMS, based on Nanomaterials, Peptide/DNA Coupled Nanoparticles, Lipid Nanoparticles For Drug Delivery, Inorganic Nanoparticles For Drug Delivery, Metal/Metal Oxide Nanoparticles (antibacterial/anti fungal/ anti viral), Anisotropic and Magnetic Particles (Hyperthermia).

MODULE V NANOMATERIALS AND TOXICITY EVALUATION 9

Designer biopolymers, Procollagen, DNA Polynode, RNA topoisomerase, Protein –magnetic materials, Cyto-toxicity, Geno-toxicity, In vivo tests/assays.

Total Hours : 45

REFERENCES:

1. C.M. Niemeyer, C.A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspective, Wiley – VCH, 2004.
2. 2 T. Pradeep, Nano: The Essentials, McGraw – Hill education, 2007.
3. Nicholas A. Kotov, Nanoparticle Assemblies and Superstructures, CRC, 2006.
4. David S Goodsell, “Bionanotechnology”, John Wiley & Sons, 2004.

OUTCOMES:

- After the completion of the course the student will have the basic knowledge of nanotechnology in biotechnology. In detail understanding of the application of Nanomaterials in biotechnology and acquire the knowledge about the DNA, proteins, amino acids, drug delivery, biomedicine etc.

ELECTIVES II

LSBY024	MOLECULAR DIAGNOSTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Developing the basic concept of molecular diagnostics
- Understanding the common procedures and which are used in disease diagnosis.
- To be familiar with various types of diseases diagnosis methods and progression of diagnosed disease.

MODULE I INTRODUCTION TO MOLECULAR DIAGNOSTICS 9

Collection, preservation and storage of clinical samples, biopsy, Principles, application and limitations of Biological assays used in diagnosis- PCR, ELISA, FISH, gene sequencing, microarrays, protein arrays. GLP, SOP and ethics in molecular diagnostics.

MODULE II INFECTIONS 9

Infection and mode of transmission, types of infectious diseases- bacterial and fungal infections, diagnosis of infections caused by Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium- diagnosis of fungal infections, major fungal diseases, Dermetophytoses, Candidiosis and Aspergillosis. Diagnosis of DNA and RNA viruses- pox virus, rhabdo virus, hepatitis; virus diagnosis of protozoan diseases- amoebiosis, malaria, trypanosomiosis, leishmaniasis- study of helminthic diseases- Fasciola hepatica and Ascarislumbricoides. Filariasis and Schistosomiasis.Diagnosis of chicken guinea and swine flu.

MODULE III CLINICAL GENETICS 9

Chromosomes chemistry and packaging, Cytogenetic, Structural and numerical abnormalities of chromosomes, Chromosome bands, banding techniques , mutation and polymorphism analysis, human genome project, cancer genetics- oncogenes, tumor suppressor genes- gene therapy, genetic counseling, nucleic acid hybridization techniques, Disease linked with mitochondrial DNA Genetic linkage and chromosome and genetic mapping in human diseases, Prenatal.

MODULE IV IMMUNODIAGNOSTICS **9**

Introduction to immunodiagnostics, antigen-antibody reactions, antibody production, antibody markers, CD markers, FACS, Human Leukocyte Antigen (HLA) typing, agglutination (ABO/Bacterial), immunoprecipitation, immunodiffusion, flocytometer.

MODULE V FORENSIC SCIENCE **9**

Introduction to Forensic Science, DNA fingerprinting / DNA Profiling / DNA Testing in Forensic Science; Ethics, Rules and Procedures in DNA analysis. Autopsy and toxicological diagnosis.Determination of Paternity- Human identification and sex determination.semen analysis, Case study.

Total Hours : 45

REFERENCES:

1. Tietz Textbook of Clinical Chemistry, Carl A. Burtis, Edward R. Ashwood,
2. Harcourt Brace & Company AisaPvt. Ltd.
3. Essentials of Diagnostic Microbiology, Lisa Anne Shimeld
4. The Science of Laboratory Diagnosis, Crocker Burnett

OUTCOMES:

- Learners will be able to define basic terminology and describes basic concepts in molecular diagnostics
- The students will know the importance and the relevance of molecular diagnostic techniques and applications of molecular diagnostics in various field including medical, forescenic, etc..

LSBY025 FOOD PROCESS TECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To explore about food process and technology.
- To get overview of processing of various types of food
- To expose themselves to storage and handling of food and food products.

MODULE I STORAGEA & HANDLING OF CEREALS 9

Infestation control; Drying of grains, Processing of rice and rice products.Milling of wheat and production of wheat products, including flour and semolina.Milling of corn, barley, oat, coarse grains including sorghum, ragi and millets; Processing of tea, coffee and cocoa.

MODULE II FRESH FRUITS AND VEGETABLES 9

Preservation of fruits and vegetable by heat treatment.Production and preservation of fruits and vegetable juices, preservation of fruit juice by hurdle technology.Non-alcoholic beverages; Food Laws, food rules and standards, Statistical Quality Control; Various types of packaging.

MODULE III SEA FOOD 9

Commercial handling, storage and transport of raw fish; Average composition of fish; Freshness criteria and quality assessment of fish; Spoilage of Fish; Methods of Preservation of fish: Canning, Freezing, Drying, Salting, Smoking and Curing. Quality control of processed fish; Fish processing industries in India.

MODULE IV ANIMAL PRODUCT 9

Slaughtering technique of animal; Meat cuts and portions of meat, muscle; Color of meat; Post mortem changes of meat; Meat processing - curing and smoking; fermented meat products (meat sausages & sauces); Frozen meat & meat storage. Classification of poultry meat; Composition and nutritional value of poultry meat &eggs ; Processing of poultry meat and eggs; Spoilage and control; Byproduct utilization and future prospects; Poultry farms in India.

MODULE V DIARY PRODUCT **9**

Composition of milk; Varieties of milk; Checks for purity of milk; Handling of fresh milk.Pasteurization of milk; HTST and UHT techniques; Packaging of milk; Fermentation of milk and fermented milk products. Manufacture of milk products like evaporated milk, powder milk, condensed milk, cream butter, cheese, yogurt, ice cream, ghee, baby food and sweet meat. Quality control of milk and milk products; Milk plant hygiene and sanitation.

Total Hours : 45

REFERENCES

1. Principles of Food Science, Vol-I by FennmaKarrel
2. Modern Dairy Products, Lampert LH; 1970, Chemical Publishing Company.
3. Developments in Dairy Chemistry – Vol 1 & 2;
4. Processed Meats; Pearson AM & Gillett TA; 1996, CBS Publishers.
5. Meat; Cole DJA & Lawrie RA; 1975, AVI Pub.
6. Post Harvest Technology of cereal pulse and oil seeds by Chakraborty, AC
7. Egg and poultry meat processing; Stadelman WJ, Olson VM, Shemwell GA & Pasch S; 1988, Elliswood Ltd.
8. Preservation of Fruits & Vegetables by Girdhari Lal, Sidhapa and Tandon
9. Developments in Meat Science – I & II, Lawrie R; Applied Science Pub. Ltd.
10. Egg Science & Technology; Stadelman WJ &Cotterill OJ; 1973, AVI Pub.
11. Technology of Food Preservation by Desrosier Fish as Food; Vol 1 & 2; Bremner HA; 2002, CRC Press.
12. Fish & Fisheries of India; Jhingram VG; 1983, Hindustan Pub Corp.
13. Robinson RK; 1996; Modern Dairy Technology, Vol 1 & 2; Elsevier Applied Science Pub.
14. Milk & Milk Processing; Herrington BL; 1948, McGraw-Hill Book Company.
15. Fox PF; Applied Science Pub Ltd. Outlines of Dairy Chemistry, De S; Oxford.

OUTCOMES:

- On the completion of the above objectives student will have a sound knowledge on the various techniques involved in food processing, storage and handling of food and food products.

LSBY026 ANIMAL BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

The student will learn about

- The basic idea about animal cell culture, drug toxicity and its application.
- Vaccines production and other technology related to antibody production.
- The basic concept of cloning and several issues related with that.
- Genomics and the role of DNA forensics.

MODULE I ANIMAL CELL CULTURE 9

Morphology and ultra-structure of animal cell, requirements for animal cell culture, media and reagents, Primary culture, secondary culture, maintaining cell line, Suspension cultures, Somatic cell cloning and hybridization, transfection and transformation, Stem cells and their application, Animal cell culture application for in vitro testing of drugs, toxicity of environmental pollutants in cell culture.

MODULE II ANIMAL HEALTH BIOTECHNOLOGY 9

Introduction to immune system, History of vaccines development, concept of vaccines, vaccine production, conventional methods and recombinant approaches, technology for antibody production, Phage display technology, radio immunoassays and enzyme immunoassays, Immunoblotting, Nucleic acid based diagnostic methods including nucleic acid probe hybridization.

MODULE III ANIMAL REPRODUCTIVE BIOTECHNOLOGY 9

Culture of embryos, Cryopreservation of embryos, Embryo transfer, Micromanipulation of animal embryos, Artificial insemination, in vitro fertilization, Transgenic animal technology and its different applications, Animal cloning- basic concepts, Cloning from embryonic cells and adult cells; Cloning of farm animals; Cloning for conservation of endangered species, Ethical, social and moral issues related to cloning, Human Cloning.

MODULE IV ANIMAL GENOMICS **9**

Introduction to animal genomics; Different methods for characterization of animal genomes, SNP, STR, QTLS, RFLP, RAPD, proteomics, metobolomics, different breeds of cattle, buffalo, sheep, goats, pigs, camels, horses, canines and poultry, characterization of livestock breeds; Marker assisted breeding of livestock and poultry, Genetic basis for disease resistance; Gene knock out technology and animal models for human genetic disorders.

MODULE V DNA FORENSICS **9**

Nucleic acid based methods for identification of animal species, Detection of food/feed adulteration with animal protein, adulteration detection in meat using DNA based methods, Identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts confiscated by anti-poaching agencies; Human forensics; Microbial forensics; Bioterror agents; Biocrimes and Bioterrorism.

Total Hours : 45

REFERENCES:

1. Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University, Ed. John R.W. Masters, Press, 2000.
2. Ed. Martin, Clynes Animal Cell Culture Techniques, Springer, 1998.
3. Animal Cell Biotechnology. Portner, 2nd Edition, Humana Press, 2007.
4. A. Puller (ed), Genetic engineering in Animals, VCH Publishers.
5. Gordon, Reproductive Technologies in Farm Animals, CAB Intl., 2005.
6. Pinkert, Transgenic animal technology, Academic Press, 2006.

OUTCOMES:

On the completion of the above course student will learn about

- basic of animal cell culture and the production of antibodies.
- how vaccines is being produced and its importance in several aspects
- the social and moral issues related to cloning.
- the importance of studying Forensic science.

LSBY029 INDUSTRIAL BIOTECHNOLOGY L T P C

3 0 0 3

OBJECTIVES:

- To obtain knowledge on wide-ranging topics related to applications of biotechnology in industries.
- To learn about bioprocess technology and its applications
- To get familiar with enzymes and microbes used for industrial purposes.

MODULE I FERMENTATION & PROCESSING 7

Introduction to fermentation technology: Upstream and downstream processing of biomolecules. Isolation, Preservation and Improvement of Industrial Micro-Organisms; Medium requirements for fermentation process; Criteria for good medium; Sterilization - batch and continuous heat sterilization of liquid media, filter sterilization of liquid media and Air. Design of sterilization equipment

MODULE II KINETICS OF SUBSTRATE UTILIZATION, PRODUCT FORMATION AND BIOMASS PRODUCTION 10

Phases of cell growth in batch cultures - transient growth kinetics, Simple unstructured kinetic Models for microbial growth, Growth of filamentous organisms; Environmental conditions affecting growth kinetics, substrate and product inhibition on cell growth and product formation; structured kinetic Models, segregated kinetic Models of growth. Production of primary and secondary metabolites. The production of some commercially important Organic acids, amino acids and alcohols, study of production processes for various classes of low molecular weight secondary metabolites: Antibiotics, quinones, aromatics, Vitamins and Steroid.

MODULE III BIOPROCESSING 9

Industrial use of micro organisms; Microbes exploited commercially-Saccharomyces, Lactobacillus, Penicillium, Acetobactor, Bifidobacterium, Lactococcus, Streptococcus etc; Fermentation-process, media and systems; Upstream and downstream processing; Product development; Dairy fermentation and fermented products.

MODULE III BIOREACTORS **9**

Animal Cells as bioreactors, characteristics of bioreactors, expression and over production of targeted proteins –human growth hormones – production of α and interferon's. Good manufacturing practice bio safety issues bioethics, Intellectual Property patenting issues.

MODULE V INDUSTRIAL APPLICATION OF ENZYMES **10**

Immobilized enzymes - principles & techniques of immobilization - commercial production of enzymes; amylases, proteases, cellulose, artificial enzymes, industrial applications, fermentation, enzymes Modification, site directed mutagenesis; immobilized enzyme in industrial processes.Structure and function of coenzyme - reactions involving TPP, pyrodoxal phosphate, nicotinamide, flavin nucleotide, coenzyme A and biotin.Industrial utilization of enzymes, food, detergents, energy, waste treatment, pharmaceuticals and medicine.

Total Hours : 45

REFERENCES:

1. Maheshwari, D.K. et. al., Biotechnological applications of microorganisms, IK . International, New Delhi, 2006.
2. Stanbury, P.F. et. al., Principles of Fermentation Technology, 2nd Edition, Elsevier, UK, 1995.
3. Waites, M.J. et. al., Industrial Biotechnology: An Introduction, Blackwell publishing, UK, 2007.

OUTCOMES:

- After the completion of the course the student will have overall knowledge of scientific industrial biotechnology and applications of microbes and enzymes used in industry.