REGULATIONS, CURRICULUM AND SYLLABI

M.Sc.
BIOCHEMISTRY AND MOLECULAR BIOLOGY

(As approved by the 9th Academic Council)

JULY 2016

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)
Rated with A Grade by National Assessment and Accreditation Council
Seethakathi Estate, G.S.T. Road, Vandalur, Chennai - 600 048
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UNIVERSITY VISION AND MISSION

VISION

B.S. Abdur Rahman Institute of Science and 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 DEPARTMENT OF SCHOOL OF LIFE SCIENCES

VISION

To be a leader in providing quality education and to carryout research in the field of Mathematics and its application in Science, Engineering and Technology

MISSION

- To provide quality education in higher mathematics through well designed programs
- To provide quality mathematical foundation for all science and engineering programs
- To offer programs in specialized areas such as Actuarial Science to meet the needs of Insurance and other Industries
- To undertake fundamental, applied and interdisciplinary research

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

M. Sc. (Biochemistry and Molecular Biology)

PROGRAMME EDUCATIONAL OBJECTIVES:

The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and Molecular Biology, 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 biochemistry and molecular biology necessary for biochemical and biotechnology studies.
- For the basic understanding, this course includes biochemistry, cell and molecular biology, animal and plant biochemistry and immunology which will impart basic understanding of the biochemistry and molecular biology.
- Moreover, several laboratory courses given in the individual sections of the curriculum with detailed information on the importance of biochemistry and molecular biology in various fields of biological importance.
- Finally this course explains the advanced sections of molecular biology like Immunology, recombinant DNA technology, nanobiotechnology, stem cells research, Pharmaceutical biotechnology and bioinformatics which will strengthen the academic foundation of the student.
- This course provides necessary theoretical and practical experience in all divisions of biochemistry and molecular biology to become an effective professional in biotechnology sector.
- To provide broad exposure to various societal, ethical and commercial issues in the biochemistry and molecular biology.

PROGRAMME OUTCOMES:

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

- Demonstrate a clear understanding of the properties of biomolecules and be able to predict behavior of molecules from in various biological environments.
- Apply their knowledge of cell and molecular biology into high end research.

- Advanced subject areas like Immunology, bioinformatics, nano-biotechnology will give broad information on applications and opportunities in the field of biochemistry and molecular biology.
- Identify research and solve biochemistry and molecular biology related problems related to the different types of human diseases.
- Ability to communicate and function effectively in multi-disciplinary team related to the biochemistry and molecular biology.

REGULATIONS – 2016
FOR
M. Tech. / MCA / M.Sc. DEGREE PROGRAMMES

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires

i. **"Programme"** means a 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, which is the apex body on all academic matters of this University

vi. **"Dean (Academic Affairs)"** means Dean (Academic Affairs) of B.S. Abdur Rahman University, who administers the academic matters.

vii. **"Dean (P.G. Studies)"** means Dean (P.G. Studies) of B.S. Abdur Rahman University who administers all P.G Programmes of the University in coordination with Dean (Academic Affairs)

viii. **"Dean (Student Affairs)"** means Dean (Student Affairs) of B.S. Abdur Rahman University, who looks after the welfare and discipline of the students.

ix. **"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. / M.C.A. / M.Sc.	Full Time & Part Time – Day / Evening / Weekends

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 Project work in part-time mode for valid reasons, shall apply to the Dean (Academic Affairs) through the Head of the Department. 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

In this mode of study, the students are required to attend classes for the courses in the time slots selected by them, during the daytime (or) evenings (or) weekends.

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 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. (Part Time)	9	18
M.C.A. (Full Time) – (Lateral Entry)	4	8
M.C.A. (Part Time) – (Lateral Entry)	6	12
M.Sc. (Full Time)	4	8
M. Sc. (Part Time)	6	12

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

i. Core courses
ii. General Elective courses
iii. Professional Elective courses
iv. Project work / thesis / dissertation
v. Laboratory Courses
vi. Case studies
vii. Seminars
viii. Mini Project
ix. 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. Mechanical / 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)	B.E / B.Tech (EEE / ECE / E&I / I&C / Electronics / Instrumentation)
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. (ECE / Electronics / E&I / I&C / EEE)

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
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 Science and Engineering with specialization in Big Data Analytics)	B.E. / B. Tech. (CSE / IT / ECE / EEE / EIE / ICE / Electronics / MCA)
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)	B.E / B. Tech. (IT / CSE / ECE / EEE / EIE / ICE / Electronics) MCA
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. – (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	BE / B. Tech. (Any Branch) or M.Sc., (Maths / Physics / Statistics / CS / IT / SE) or M.C.A.
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)	B.Sc.(Physics / Applied Science / Electronics / Electronics Science / Electronics & Instrumentation)
13	Chemistry	M.Sc.(Chemistry)	B.Sc. (Chemistry / Applied Science)

Sl. No.	Name of the Department	P.G. Programmes offered	Qualifications for admission
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 credits
M. Tech.	73
M.C.A.	120
M.Sc.	72

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 (or) 15 periods per semester
- 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
- One credit for 15 periods of lecture (can even be spread over a short span of time)

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	Full Time		Part Time	
	Non-project Semester	Project semester	Non-project Semester	Project semester
M. Tech.	9 to 28	12 to 28	6 to 12	12 to 28
M.C.A.	9 to 29	12 to 29	6 to 12	12 to 29
M.Sc.	9 to 25	12 to 20	6 to 12	12 to 20

3.9 The student may choose a course prescribed in the curriculum from any department depending on his / her convenient time slot. All attendance will be

maintained course-wise only.

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

3.11 A student may be permitted by the Head of the Department to choose electives from other PG programmes either within the Department or from other Departments up to a maximum of nine credits during the period of his/her study, with the approval of the Head of the Departments offering such courses.

3.12 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.

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

3.14 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.

3.15 Project Work / Thesis / Dissertation

3.15.1 Project work / Thesis / Dissertation shall be carried out under the supervision of a Faculty member in the concerned Department.

3.15.2 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.

3.15.3 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.

3.15.4 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.

3.15.5 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.

3.15.6 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.

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 for the courses within one week from the commencement of the semester

7.2 For the subsequent semesters registration for the courses will be done by the student one week before the last working day 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 Advisor for the choice of courses. The Registration form shall be filled in and signed by the student and the Faculty Advisor.

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 Advisor. 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 undergoing a full time PG Programme should have enrolled for all preceding semesters before registering for a particular semester

7.9 A student undergoing the P.G. programme in Part Time mode can choose not to register for any course in a particular semester with written approval from the head of the department. However the total duration for the completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1)

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 / Part time)	18
M.C.A. (Full time / Part time)	45
M.C.A. (Full time / Part time) – (Lateral Entry)	22
M.Sc.(Full time / Part time)	18

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.

11.0 ATTENDANCE

11.1 Attendance rules for all Full Time Programme and Part 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 of Full Time mode of study, 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.

12.5 The summer term courses are not applicable for the students of Part Time mode.

13.0 ASSESSMENTS AND EXAMINATIONS

13.1 The following rule shall apply to all the 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.

13.3 In one (or) two credit courses that are not spread over the entire semester, the evaluation will be conducted at the completion of the course itself. Anyhow approval for the same is to be obtained from the HoD and the Dean of Academic Affairs.

13.4 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.

13.5 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

$$GPA = \frac{\sum_{i=1}^{n}(C_i)(GP_i)}{\sum_{i=1}^{n}(C_i)}$$

where n = number of courses

where C_i 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:

20.3.1 For students under full time mode of study

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.

20.3.2 For students under part time mode of study

CGPA	Classification
8.50 and above, having completed all courses in first appearance	First class with Distinction
6.50 and above	First Class
All others	Second Class

For the purpose of classification, the CGPA will be rounded to two 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. Sc. (Actuarial Science)
(Four Semesters / Full Time)

Curriculum

Sl. No.	Course Code	Course Title	L	T	P	C
		SEMESTER I				
1	LSC6101	Advanced Biochemistry	**4**	**0**	**0**	**4**
2	LSC6102	Cell and Molecular Biology	**4**	**0**	**0**	**4**
3	LSC6103	Genetic Engineering	**4**	**0**	**0**	**4**
4		Elective I	**3**	**0**	**0**	**3**
5		Elective II	**3**	**0**	**0**	**3**
6	LSC6104	Lab I (Biochemistry, Molecular Biology and Genetic Engineering)	**0**	**0**	**6**	**3**
		Total				**21**
		SEMESTER II				
1	GEC6202	Research Methodology	**3**	**0**	**0**	**3**
2	LSC6201	Immunology	**4**	**0**	**0**	**4**
3	LSC6202	Bioinformatics	**4**	**0**	**0**	**4**
4		Elective II	**3**	**0**	**0**	**3**
5		Elective III	**3**	**0**	**0**	**3**
6	LSC6203	Lab II (Immunology/ Bioinformatics)	**0**	**0**	**6**	**3**
7	LSC6241	Industrial Internship	**0**	**0**	**0**	**1**
8	LSC6242	Mini Project	**0**	**0**	**0**	**1**
		Total				***22***
		SEMESTER III				
1	LSC7141	Project Phase I	**0**	**0**	**2**	**2**
2	LSC7142	Clinical Biochemistry	**4**	**0**	**0**	**4**
3	LSC7143	Genomics, Proteomics and Metabolomics	**4**	**0**	**0**	**4**
4		Elective V	**3**	**0**	**0**	**3**
5		Elective VI	**3**	**0**	**0**	**3**
6	LSC7144	Lab III (Clinical Biochemistry /Omics)	**0**	**0**	**6**	**3**
		Total				**17**

Sl. No.	Course Code	Course Title	L	T	P	C
		SEMESTER IV				
1	LSC7141	Project Phase II	**0**	**0**	**36**	**18**
		Total			**2+18=20**	
					Total Credits: 80	

Note: Two credits earned in the Project Phase 1 will be added when the complete the Phase II project

LIST OF ELECTIVES

Sl. No.	Course Code	Course Title	L	T	P	C
		SEMESTER I				
1	LSCY101	Biosafety, Bioethics, Bioentrepreneurship, Intellectual Property rights	**3**	**0**	**0**	**3**
2	LSCY102	Microbiology	**3**	**0**	**0**	**3**
3	LSCY103	Food Process Technology	**3**	**0**	**0**	**3**
4	LSCY104	Analytical Methods	**3**	**0**	**0**	**3**
5	LSCY105	Environmental Biotechnology	**3**	**0**	**0**	**3**
6	LSCY106	SiRNA/RNA Interference	**3**	**0**	**0**	**3**
		SEMESTER II				
1	LSCY201	Recombinant DNA Technology	**3**	**0**	**0**	**3**
2	LSCY202	Advanced Instrumentation	**3**	**0**	**0**	**3**
3	LSCY203	Molecular Diagnostics	**3**	**0**	**0**	**3**
4	LSCY204	Omics	**3**	**0**	**0**	**3**
5	LSCY205	Biofuel and Bioenergy	**3**	**0**	**0**	**3**
6	LSCY206	Molecular Farming	**3**	**0**	**0**	**3**
		SEMESTER II				
1	LSCY111	Biopharmaceuticals	**3**	**0**	**0**	**3**
2	LSCY112	Molecular and immuno Diagnostics	**3**	**0**	**0**	**3**
3	LSCY113	Tissue andAntibody Engineering	**3**	**0**	**0**	**3**
4	LSCY114	Bio-nanotechnology	**3**	**0**	**0**	**3**
5	LSCY115	Protein Engineering	**3**	**0**	**0**	**3**
6	LSCY116	Stem Cell Technology	**3**	**0**	**0**	**3**

SEMESTER I

LSC6101	ADVANCED BIOCHEMISTRY	L	T	P	C
		4	0	0	4

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 05

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 09

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 07

Feedback 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 Lubert Stryer 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.

LSC6102 CELL & MOLECULAR BIOLOGY

L	T	P	C
4	0	0	4

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 08

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 07

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

LSC6103 GENETIC ENGINEERING

L	T	P	C
4	0	0	4

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 09

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 Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseIfootprinting

MODULE II CLONING VECTORS 09

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 09

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; Southwestern 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 09

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 09

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:

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
6. 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

LSC6104	LAB I (BIOCHEMISTRY, MOLECULAR BIOLOGY AND GENETIC ENGINEERING)	L	T	P	C
		0	0	6	3

OBJECTIVES:

- To learn basic techniques in molecular biology
- To study and differentiate the electrochemical properties of nucleic acids
- To learn the preliminary methods in biochemistry by preparing buffer and adjusting pH.
- To estimate various biomolecules by biochemical assays

EXPERIMENTS:

1. Laboratory safety guidelines.
2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
3. Effect of temperature on enzyme activity.
4. Separation techniques for amino acids and sugar:
    a. paper chromatography
    b. thin layer chromatography.
5. Separation of proteins by native and SDS-PAGE.
6. Preparation of slides from onion root tip for mitosis
7. Isolation & Purification of genomic DNA from bacteria
8. Isolation & Purification of plasmid DNA
9. Isolation of RNA
10. Agarose gel electrophoresis of chromosomal & plasmid DNA
11. Restriction Digestion of chromosomal & plasmid DNA
12. Isolation of DNA fragment from agarose gel
13. Competent cell preparation
14. Transformation and Efficiency of competent cells
15. SDS PAGE
16. Polymerase Chain Reaction
17. Isolation of Genomic DNA from Plants

REFERENCES:

1. Michel R. G and Sambrook J. Molecular Coning- A laboratory manual. Cold spring harbor laboratory press, 2012.
2. Laboratory Exercises in Microbiology, Fifth Edition by Harley−Prescott, The McGraw−Hill Companies, 2002
3. Wilson K and Walker J, Principles and Techniques in Practical Biochemistry, 5th Ed., Cambridge University Press, 2000.
4. Holtzhauer M, Basic Methods for the Biochemical Lab, Springer, 2006.

Nigam, Lab Manual in Biochemistry: Immunology and Biotechnology, Tata McGraw-Hill Education, 2007.

5. Lab manual

OUTCOME:

- On the completion of the above experiments students will be able to handle DNA samples and also to isolate, purify and visualize nucleic acid.
- On performing the above experiments students will be able to know and perform the routine biochemical assays.
- Students will be able to isolate culture and identify microbes and also to efficiently use light microscope.

SEMESTER II

GEC6202 RESEARCH METHODOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

MODULE I RESEARCH METHODOLOGY-AN INTRODUCTION 09

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers. Ethics and scientific conduct, Introduction to ethics, scientific conduct and misconduct, Misconduct and why it occurs, Fabrication, Authorship issues, The investigation and punishment of scientific misconduct.

MODULE II GOOD LABORATORY PRACTICES AND SAFETY 09

Introduction: History, definition, Principles, Good Laboratory Practices (GLP) and its application GLP training: Resources, Rules, Characterization, Documentation, quality assurance, Resources, Facilities: building and equipment, Personnel, GLP and FDA, Stepwise implementation of GLP and compliance monitoring.

MODULE III LABORATORY SAFETY AND EXPERIMENTAL RESEARCH 09

Safety in the Biology Laboratory, Safety Symbols, Science Safety Rules- Dress Code, First Aid, Heating and Fire Safety, Using Chemicals and glassware's, Handling living organisms, handling human blood and some other body fluids and tissue, disposal of bio hazardous waste.Precision, accuracy, sensitivity and specificity; variables, experimental planning – general guidelines

MODULE IV INTERPRETATION OF RESULTS AND ANALYSIS: 09

Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective) and cross verification, correlation with published results, discussion, outcome as new idea, hypothesis, concept, theory, model etc. Data analysis using Excel, Origin and Sigma plot Analyzing the chemical data and drawing chemical structures using Chemdraw and Chemsketch. Conceptions of error of measurement, true score theory and generalisability theory. Measures of central tendency or averages – mean median and mode. Measures of dispersion – range,

variance, and standard deviation: The normal distribution and the normal probability curve.

MODULE V SCIENTIFIC WRITING, TECHNICAL PUBLICATION AND RESEARCH PROPOSAL 09

Different types of scientific and technical publications in the area of research, and their specifications, Ways to protect intellectual property – Patents, technical writing skills, definition and importance of impact factor and citation index - assignment in technical writing, The research problem, finding related literature, computer generated references sources and the research project, model research proposal.

Total hours: 45

TEXT BOOKS AND REFERENCES:

1. Essentials of Research Design and Methodology Geoffrey R. Marczyk, David DeMatteo, David Festinger, 2005 John Wiley & Sons Publishers, Inc
2. Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Irwin H. Segel, 1976 John Wiley & Sons Publishers, Inc
3. Guide to Publishing a Scientific paper, Ann M. Korner, 2004, Bioscript Press.
4. P Laake, H B Benestad, B R Olsen. Research Methodology in the medical and biological sciences. Academic Press, 2007.
5. R Arora. Encyclopaedia of Research Methodology in Biological Sciences. Anmol Publishing, 2004.
6. Kothari C.R., Research Methodology, Methods and Techniques, Wiley Eastern Ltd., New, Delhi, 1991.
7. Coghill M. and Gardson L.R., The ACS Style Guide Effective Communication of Scientific, Information, 3rd Edn., Oxford University Press, 2006.
8. Willa Y. Garner, Maureen S. Barge, James, P, Good Laboratory Practice Standards:
9. Applications for Field and Laboratory Studies (ACS Professional References Book).

OUTCOMES:

LSC6201 IMMUNOLOGY

L	T	P	C
4	0	0	4

OBJECTIVES:

- The course is aimed at introducing the science of immunology and detailed study of various types of immune systems and their classification structure and mechanism of immune activation**.**

MODULE I OVERVIEW OF IMMUNE SYSTEM 04

Innate, adaptive and Comparative ImmModule y, Immune dysfunction and its consequences, Cells & Tissues of Immune System: Hematopoisesis, Apoptosis and Necrosis, systemic function of Immune system, organs of immune systems, Lymphoid cells and organs Evolutionary comparision. Cytokines- Properties of Cytokines, Cytokine Receptors, Cytokine Antagonists, Cytokine Secretion by TH1 and TH2 Subsets, Cytokine-Related Diseases, Therapeutic Uses of Cytokines and Their Receptors, Cytokines in Hematopoiesis

MODULE II MOLECULAR IMMUNOLOGY 05

Immunogenicity Versus Antigenicity, Factors that influence immunogenicity, Epitopes, Haptens and the Study of Antigenicity, Pattern-Recognition Receptors, drugs allegies-when medicine become immunogens, Molecular structure of antibody, Obstacles to Antibody Sequencing, Immunoglobulin Fine Structure, Antibody-Mediated Effector Functions, Antibody Classes and Biological Activities, Antigenic Determinants on Immunoglobulins, The B-Cell Receptor, The Immunoglobulin Superfamily, Monoclonal Antibodies.

MODULE III ORGANIZATION AND EXPRESSION OF IMMUNOGLOBULIN GENES 09

Genetic Model Compatible with Ig Structure, Multigene Organization of Ig Genes, Variable-Region Gene Rearrangements, Mechanism of Variable-Region DNA Rearrangements, Generation of Antibody Diversity, Class Switching among Constant-Region Genes, Expression of Ig Genes, Synthesis, Assembly, and Secretion of Immunoglobulins, Regulation of Ig-Gene Transcription, Antibody Genes and Antibody Engineering

MODULE IV ANTIGEN PROCESSING AND PRESENTATION 09

General organization and inheritance of the major histocompatibility complex (MHC), MHC molecules and genes, detailed genomic map of MHC genes, cellular distribution of MHC molecules, regulation of MHC expression, MHC and immune responsiveness, MHC and disease susceptibility self-MHC restriction of T cells, role of antigen-presenting cells,

evidence for two processing and presentation pathways, endogenous antigens: the cytosolic pathway,exogenous antigens: the endocytic pathway presentation of nonpeptide antigens

MODULE V GENERATION OF T AND B CELL RESPONSE 09

T-Cell Receptor, Early Studies of the T-Cell Receptor and αβ andγΔ T-Cell Receptors: Structure and Roles, Organization and Rearrangement of TCR Genes, T-Cell Receptor Complex: TCR-CD3,T-Cell Accessory Membrane Molecules, Three-Dimensional Structures of TCR-Peptide-

MHC Complexes,Alloreactivity of T Cells, T-Cell Maturation and the Thymus,Thymic Selection of the T-Cell Repertoire,T_H-Cell Activation, T-Cell Differentiation, Cell Death and T-Cell Populations Peripheral γΔ T-Cells, B-Cell Maturation,B-Cell Activation and Proliferation, The Humoral Response, In Vivo Sites for Induction of Humoral Responses, Germinal Centers and Antigen-Induced B-Cell Differentiation, Regulation of B-Cell Development, Regulation of the Immune Effectors Response.

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 immModule y
- 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

LSC6202 BIOINFORMATICS

L	T	P	C
4	0	0	4

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 09

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 09

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 09

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 09

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 09

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.

LSC6203 LAB II (IMMUNOLOGY / BIOINFORMATICS)

L	T	P	C
0	0	6	3

OBJECTIVES:

- To acquire knowledge on immunological techniques
- To train in various techniques involving antigen and antibody reactions
- To get hands on experience on plasmid construction, mappings and analysis.
- To explore to various tools in bioinformatics.

LIST OF EXPERIMENTS:

1. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
2. Antibody titre by ELISA method.
3. ELISA for detection of antigens and antibodies-DOT ELISA
4. Blood group mapping
5. Preparation of antigens from pathogens and parasites
6. Slide and tube agglutination reaction
7. Plasmid Construction/Restriction Mapping
8. PCR Primer Designing
9. Sequence Retrieval and Format Conversion
10. Homology Search/ Multiple Sequence Alignment
11. Motif finding in DNA and Protein Sequences
12. Protein Secondary Structure Prediction
13. Accessing Data- Use FORMATTED, LIST and COLUMN input to read raw data files, Combine SAS data sets using the DATA step.
14. Creating Data Structures- Create temporary and permanent SAS data sets, Control with observations and variables in a SAS data set are processed and output Managing Data- Investigate SAS data libraries using base SAS utility procedures.
15. Generating Reports- Generate list reports using the PRINT and REPORT procedures, Generate HTML reports using ODS statements.
16. Handling Errors- Identify and resolve programming logic errors, syntax errors, data errors.

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
4. Rashidi H, Buehler L. K. Bioinformatics Basics: Applications in Biological Science and Medicine. 2nd Ed., CRC Press, 2005.

5. 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.
6. Krawetz S. A, Womble D. D. Introduction to Bioinformatics: A Theoretical and Practical Approach. Humana press, 2003

OUTCOMES:

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

SEMESTER III

LSC7142 CLINICAL BIOCHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course aims to elucidate the clinical implications of the different metabolic pathways of biochemistry thus enable the students to understand the physiological implications of the different biochemical pathways.

MODULE I CELL STRUCTURE AND CLINICAL CORRELATION OF ORGANELLES 09

Eukaryotic Cell Compartments and Their Major Functions. Clinical correlations of Mitochondrial (Luft's disease), Lysosomal (Gout, lysosomal acid lipase deficiency) and Peroxisomal (Zellweger Syndrome) disfunction. Membrane fluidity in diseases conditions. Ion Channels and cystic fibrosis and Mitochondrial Myopathies.

MODULE II PROTEINS AND ENZYMES—CLINICAL CORRELATIONS 09

Plasma Proteins in Diagnosis of Disease. Use of Amino Acid Analysis in Diagnosis of Disease—Phenylketoneuria, Cystinuria, Hartnup disease and Fanconi's syndrome. Clinical implications of abnormal protein synthesis-- Ehlers–Danlos syndrome, osteogenesis imperfecta, and scurvy. Alteration in protein structure and its clinical impact—Sickle Cell Anemia and Glycosylated Hemoglobin.

Physiological effect of Km (alcohol sensitivity), Coenzyme Binding Site (Cystathioninuria), thermal stability (Hemolytic Anemia), pH optima (alcohol sensitivity) of an enzyme.

MODULE III CARBOHYDRATE METABOLISM—CLINICAL CORRELATIONS 09

Impaired glycolysis and TCA cycle-- Arsenic Poisoning, Lactic Acidosis, Pyruvate Kinase Deficiency and Hemolytic Anemia, Pyruvate Dehydrogenase Deficiency, Fumarase Deficiency, Leigh disease, Cyanide Poisoning and Hypoxic Injury. Glycogen Storage Diseases and Von Gierke's Disease.

MODULE IV LIPID METABOLISM—CLINICAL CORRELATIONS 09

Genetic Deficiencies in—Carnitine Transport or Carnitine Palmitoyltransferase, AcylCoA Dehydrogenases and Diabetic Ketoacidosis.

Physiological implications of lipid levels—Respiratory Distress Syndrome, Atherosclerosis and Treatment of Hypercholesterolemia.

MODULE V METABOLIC INTERRELATIONSHIP 09

Pathogenesis, laboratory diagnosis, prophylaxis and treatment of the diseases caused by Bacteria, (Staphylococcus; Streptococcus; Neisseria; Bacillus; Corynebacterium; Clostridium; Enterobacteriaceae family) fungi (Entamoeba; Giardia; Trichomonas; Plasmodium; Trypanosoma) and viruses (Chicken pox, Rabies virus, common cold, hepatitis, meningitis, encephalitis, AIDS, SARS).

Total Hours: 45

REFRENCES

1. Textbook of Biochemistry with Clinical Correlations: Fourth Edition; Edited by Thomas M. Devlin, Ph.D. WileyLiss, Inc.
2. Nelson D.L, Cox M. M. Lehninger's Principle of Biochemistry. 5th Ed.,W. H. Freeman, 2008.
3. Biochemistry by LubertStryer 7th ed. W. H. Freeman & Company.

OUTCOMES:

- At the end of the course students will be able to demonstrate an in-depth knowledge about the role of the various metabolic processes involving the different biomolecules and their role in maintaining the physiological homeostasis of human body.

LSC7143 GENOMICS, PROTEOMICS AND METABOLOMICS

L	T	P	C
4	0	0	4

OBJECTIVES:

- Genomics, proteomics and metabolomics with their applications deals with a rapidly evolving scientific area that introduces students into genomes, proteomes and metabolites that store various data about genes, proteins, genomes and proteomes. The main objective is to organize the large amount of information about genomics, proteomics and metabolomics and offer basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes, basic proteomics and its applications.

MODULE I STRUCTURAL PROPERTIES 09

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of 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 GENOMICS 09

Genome sequencing projects Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

MODULE III PROTEOMICS 09

Proteomics, Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; 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.

MODULE IV PHARMACOGENETICS 05

Pharmacogenetics High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

MODULE V FUNCTIONAL GENOMICS, PROTEOMICS AND METABOLOMICS 13

Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics, Proteomics and metabolomics, Medical focus: Ovarian cancer. How proteomics can be used to find biomarkers for

diseases for which none exist., Different spectroscopic methods, Data produced by each method, Protein identification, quantitation, function. The US Food and Drug Administration criteria for biomarkers,Future technologies.

Total Hours:

REFERENCES:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and
4. Bioinformatics, 2nd Edition. Benjamin Cummings 2007
5. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition,

OUTCOMES:

- The information obtained during the course should be helpful to those students who want to work in core facilities and commercial biological laboratories as well as in postgraduate studies.

LSC7144	LAB III (CLINICAL BIOCHEMISTRY / OMICS)	L	T	P	C
		0	0	6	3

OBJECTIVES:

- To give hands-on training on the clinical biochemistry parameters like SGOT, SGPT, alkaline phosphatase, acid phosphatase, bilirubin etc….
- To understand the mechanism of enzyme reactions,

EXPERIMENTS:

1. Estimation of SGOT in blood sample
2. Estimation of SGPT in blood sample
3. Estimation of alkaline phosphatase in blood sample
4. Estimation of acid phosphatase in blood sample
5. Estimation of bilirubin in blood sample
6. Estimation of Na+, K+ & Ca++
7. Estimation of common parameters in urine
8. Biochemical tests for anemia.
9. Detection / Estimation of C-reactive proteins.
10. Preparation of DNA from prokaryotes and eukaryotes.
11. Synthesis and sequencing of DNA.
12. Isolation of plasmids from E.coli cells.
13. Agarose gel electrophoresis of plasmid and chromosomal DNA.
14. Restriction endonuclease digestion of plasmid and chromosomal DNA of E. coli cells.
15. DNA ligation methods. Construction of recombinant DNA.
16. Transformation of competent E. coli cells. Colony hybridisation. Southern blotting.

REFERENCES:

1. Lab Manual

OUTCOMES:

- At the end of the course students will be able to demonstrate an in-depth knowledge about the role of the various metabolic processes involving the different biomolecules and their role in maintaining the physiological homeostasis of human body.

LIST OF ELECTIVES

SEMESTER I

		L	T	P	C
LSCY101	**BIOSAFETY, BIOETHICS, BIOENTREPRENEURSHIP, INTELLECTUAL PROPERTY RIGHTS**	**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 09

The legal and socioeconomic impacts of biotechnology - Public education of the processes of biotechnology involved in generating new forms of life for informed decision making - Biosafety regulation and national and international guidelines - rDNA guidelines

MODULE II BIOSAFETY 09

Experimental protocol approvals - levels of containment - Environmental aspects of biotech applications - Use of genetically modified organisms and their resistance in environment - Special procedures for r-DNA based product production

MODULE III MARKETING 09

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 IV INTELLECTUAL PROPERTY RIGHTS 09

Intellectual property rights - TRIP International conventions patents and methods of application of patents - Legal implications - Biodiversity and farmers rights - Beneficial applications' and development of research focus to the need of the poor - Identification of directions for yield effect in agriculture, aquaculture Bioremediation etc.

MODULE V PATENT SYSTEM 09

Objectives of the patent system - basic principles and general requirements of patent law - biotechnological inventions and patent law - legal development - patentable subjects and protection in biotechnology - The patentability of microorganisms - IPR and WTO

regime - consumer protection and IPR - IPR and plant genetic resources - GATT and TRIPS.

Total Hours: 45

REFERENCES:

1. Beier,F.K.,Crespi,R.S. and Straus,J. *Biotechnology and Patent protection*-Oxford and IBH Publishing Co.New Delhi.
2. Sasson A, *Biotechnologies and Development*, UNESCO Publications.
3. Singh K, *Intellectual Property rights on Biotechnology*, BCIL,NewDelhi.

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 awareness about the basic fundamental safety measures that a researcher should follow in laboratory.

LSCY102 MICROBIOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To expose the fundamentals and scope of microbiology.
- To learn the classification of bacteria, Virus, Fungi & Protozoa
- Learn microbial culture and disease related to microbes.

MODULE I INTRODUCTION TO MICROBIOLOGY 09

History and scope of microbiology- Classification of microorganisms-bacteria, fungi, virus, alga, protozoa- sterilization techniques, disinfectant and antiseptic agents. Microscopy - types of microscopes and their applications-simple and compound, bright field, dark field, fluorescence, phase-contrast and electron microscopes.

MODULE II BACTERIOLOGY 09

Major groups of bacteria- Archaebacteria, Actinomycetes, chemoautotrophs, eubacteria, Pseudomonads, cyanobacteria, rickettsias, chlamydias and spirochetes- Bacterial cell-structure and functions of cellular components cell wall composition of Gram positive and Gram negative bacteria, sub-cellular organizations, flagella, capsule and spores-bacterial staining-antimicrobial
agents-antibiotics, chemotherapeutic drugs-antibacterial agents-mode of action-antibiotic resistance.

MODULE III VIROLOGY 09

Classification, morphology and characteristics of virus, fungi and Protozoa. Structure of DNA and RNA viruses, viral replication, Bacteriophages- lysogeny and lytic cycle- virus like agents-satellites, viroids and prions, antiviral and antifungal drugs. Classification of Helminthic parasites- Life cycle of malarial and filarial parasites.

MODULE IV CULTURING OF MICROORGANISMS 08

Microbial culture, continuous and synchronous culture- composition of culture media - solid and liquid media, chemically defined media, complex and differential media- Effect of PH, temperature and radiation on microbial growth.

MODULE V MICROBES AND DISEASES 10

Major human diseases caused by bacterial, viral and fungal pathogens Diseases of the respiratory tract-diphtheria, tuberculosis, pneumonia, influenza, mumps- Diseases of the skin-systemic mycoses, candidiasis- herpes viral infections, chicken pox, zoster and small pox- Genito-urinary infections- Gonorrhea, syphilis, leptospirosis, and AIDS-

trichomoniasis- Diseases of GITCholera, ETEC and EIEC infections- shigellosis- Typhoid- Hepatitis,
gasteroenteritis. Major human protozoan diseases-Malaria, Amebiasis, Toxoplasmiases.

Total Hours: 45

REFERENCES:

1. Prescott, Harley and Klein, Microbiology, 5th Edition- Publisher: mcgraw Hill science 2002.
2. Gerard J. T, Berdell R. F, Christine L. C, Microbiology: An Introduction, 8th Edition, Benjamin Cummings, 2004.
3. Kenneth J. R,George R, John C. S, Medical Microbiology: An Introduction to Infectious Diseases, mcgraw-Hill Professional, 2003.

OUTCOMES:

- On the completion of the above objectives student will be able to learn the fundamentals and scope of microbiology, classification of Protozoa, bacteria, Fungi Virus, microbial culture and diseases.

LSCY10 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 STORAGE AND HANDLING OF CEREALS 09

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 09

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 09

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 09

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 09

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 Fennma Karrel
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.

LSCY104 ANALYTICAL TECHNIQUES

L	T	P	C
3	0	0	3

OBJECTIVES:

- The students will be exposed to basic concepts related with techniques and instrumentation widely used in Biotechnology.

MODULE I CALORIMETRY AND SPECTROSCOPY 09

Properties of electromagnetic radiations, interaction with matter. Ultraviolet spectroscopy: Origin of UV spectra, types of transition, chromophore & related terms, choice of solvent, instrumentation and applications Infra-red spectroscopy: Origin of infra-red spectra, modes of vibrations, instrumentation, sampling technique and applications; Nuclear magnetic resonance spectroscopy: Mass Spectroscopy: Origin, Instrumentation, types of ions produced, interpretation and applications of mass spectra GCMS, LCMS & MSMS.

MODULE II CENTRIFUGATION AND MICROSCOPY 09

Principle of centrifugation, rotors, different types of centrifuges, preparative and analytical centrifugation, ultra centrifugation. Optical microscopy, Bright field, Dark field, phase contrast and fluorescence microscopy. Electron microscopy: Transmission and scanning electron microscopy, Atomic force microscopy.

MODULE III ELECTROPHORESIS 09

General principle, support media. Agarose gels, polyacrylamide gels. SDS PAGE, 2D PAGE Pulsed field gel electrophoresis Iso-electric focusing Capillary electrophoresis

MODULE IV RADIOISOTOPE TECHNIQUES 09

Study of radioisotopes in biological samples, proportional and GM counter, scintillation counters, autoradiography, radio –immunoassay.

MODULE V CHROMATOGRAPHY 09

Introduction: Chromatography theory and practice. Paper chromatography. Thin layer chromatography. Ion exchange chromatography. Affinity chromatography. Partition chromatography. Adsorption chromatography. Introduction to gas chromatography and HPLC. Permeation.

Total Hours:

REFERENCES:

1. Pierre C. ORD and CD in chemistry and biochemistry: An Introduction. Academic Press, 1972.

2. Paddock S. W. Confocal Microscopy methods & protocols.1st Ed., Human Press, 1999.
3. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st Ed., Wiley-Liss, 2001.

OUTCOMES:

- At the end of the course, the students will have sufficient scientific understanding of the basic concepts in instrumentation used in Biotechnology.

LSCY105 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 09

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 09

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 09

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 09

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 09

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 (14 th 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.

LSCY106 SIRNA/RNA INTERFERENCE

L	T	P	C
3	0	0	3

OBJECTIVES:

- To get overview of gene regulation by gene silencing.
- To develop a detailed knowledge of siRNA and miRNA.
- To develop skill to understand molecular aspects of RNAi biology.
- To get familiar with technical applications of RNAi.

MODULE I INTRODUCTION TO GENE SILENCING 09

History of RNA interference, antisense RNA, mechanism, cosuppression in Petunia

MODULE II BASIC MECHANISM 09

dsRNA cleavage, RISC activation, dicer, argonaute, gene regulation by silencing,

MODULE III PHYSIOLOGY OF RNA INTERFERENCE 09

RNAi and immunity- antiviral mechanisms in plants, Drosophila, C. elegans, Downregulation and upregulation of genes

MODULE IV APPLICATIONS 09

Gene knockdown, functional genomics, medicine, therapeutic gen modulation, antiviral therapies, cancer, biosafety issues

MODULE V RNAI BIOTECHNOLOGY 09

Food industry- production of plant toxins, production of non-narcotic natural products, development as an insecticide, generation of transgenic plants, genome wide screening

Total Hours:

REFERENCES:

1. RNAi Technology. R K Gaur, CRC Press, 2011
2. RNA Interfernce: From biology to clinical applications by Wei Ping Min. Humana Press
3. RNA Silencing by Esra Galun. World Scientific Publishing Co. Pte. Ltd.

OUTCOMES:

At the end of this course students will be able to:

- Understand gene silencing mechanisms
- Understand types of RNAi
- Understand the applications of RNAi

SEMESTER II

LSCY201 RECOMBINANT DNA TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE:

- To understand the basics of Recombinant DNA
- To learn applications of Recombinant DNA Technology

MODULE I CLONING & CLONING VECTOR 09

Types of cloning vectors viz. Plasmids, cosmids, ssDNA Phages, Yeast cloning vectors, Animal viruses, Ti plasmids and Cauliflower Mosaic Virus. Structural and Functional Organization of Plasmids, Plasmid Replication, Stringent and Relaxed Plasmids, Incompatibility of Plasmid Maintenance.

MODULE II MANIPULATION OF PURIFIED DNA 09

Enzymes involved in DNA Manipulation- Nucleases, Ligases, Polymerases and DNA modifying enzymes, Restriction endonucleases-Types, Blunt and sticky ends, Liagtion-Mode of action of DNA Ligase.

MODULE III CONSTRUCTION OF RECOMBINANT DNA 09

Preparation of competent cell-Transformation, transfection – Recombinant selection and screening- Genomic DNA library- cDNA synthesis strategies - Linkers - Adapters - Homopolymer tailing- Making genomic and cDNA libraries in plasmids and phages. PCR product cloning (TA cloning). Cloning strategies in yeast, E. coli and B. subtilis.

MODULE IV HYBRIDIZATION TECHNIQUES & MUTAGENESIS 09

DNA hybridization, colony hybridization and in-situ hybridization (Southern, Northern and Dot blots and immunological techniques Western blotting), Mutagenesis - Deletion mutagenesis, Oligonucletoide derived mutagenesis, Site directed mutagensis - Its applications- Applications of rDNA technology in Diagnostics.

MODULE V APPLICATIONS OF RDNA TECHNOLOGY 09

Gene Cloning and DNA analysis in Agriculture, Forensic Science and Medicine-Production of Recombinant pharmaceuticals, identification of genes responsible for human disease, Genetic Finger printing, Gene Therapy, Plant Genetic engineering, Problems with Genetically modified plants.

Total Hours: 45

REFERENCES:

1. Recombinat DNA Second eition by Watson
2. Gene Cloning and DNA analysis: An Introduction by T. A. Brown.

OUTCOMES:

- This course will introduce the students with the basics about genes, and approaches to manipulate the gene according to need such as production of therapeutic proteins in plants.

LSCY202 ADVANCED INSTRUMENTATION

L	T	P	C
3	0	0	3

OBJECTIVES:

- To learn the electrochemical techniques and principles of centrifugation and spectrophotometry.
- To learn the principles of chromatography and microscopy and their several aspects.
- To understand the information of radioactive methods, detection and measurement of radioactivity.

MODULE I ELECTROCHEMICAL TECHNIQUES 09

Basic principles of Electrochemical Techniques- - pH electrode, Ion selective- gas-sensing and oxygen electrodes- biosensors. Centrifugation- basic principles-instrumentation- Centrifugation- centrifugation units-types of centrifuges-colloidal nature of particles-centrifugation methods and accessories- sedimentation velocity-sedimentation equilibrium-cell fractionation methods.

MODULE II SPECTROPHOTOMETRY 09

Principles and techniques of colorimetry and spectrophotometry-Beer-Lamberts Law -instrumentation - qualitative and quantitative methods of analysis- hypo and hyper chromicity- coupled assays –Spectrofluorimetry-Turbidimetry - Flame and Atomic absorption Spectrophotometer and Mass spectrometer. Chromatography- types- column, thin layer, paper, adsorption, partition, gas, liquid, ion exchange, affinity, HPLC-principles of each type- instrumentation and accessories- detection methods and systems qualitative and quantitative aspects-applications.

MODULE III MICROSCOPY 09

Basic principles of Microscopy and application of Light, Compound, Phase contrast inverted microscopy; Scanning Electron Microscopy (SEM)- Transmission Electron Microscopy, (TEM)- Fluorescence Microscopy- Scanning Tunneling Microscopy-(STM)- Automated Fluorescence Microscopy - Confocal Microscopy.

MODULE IV ELECTROPHORESIS 09

Types of Electrophoresis- paper and gel-agarose and PAGE-pulsed field-capillary - isoelectric focusing- 2 D electrophoresis; blotting methods-Western- Southern and Northern- application-methods in life sciences.

MODULE V RADIOACTIVE METHODS 09

Types of radioisotopes-half life- units of radioactivity- uses of radioisotopes in life

sciences and biotechnology- detection and measurement of Radioactivity- liquid scintillation counting- solid state counting- Geiger counter - Radiation hazards Techniques and applications of Electron spin resonance- Nuclear magnetic resonance- Circular Dichroism (CD) - Optical Rotary Dispersion (ORD).

Total Hours:

REFERENCES:

1. Pierre C. ORD and CD in chemistry and biochemistry: An Introduction. Academic Press, 1972.
2. Paddock S. W. Confocal Microscopy methods & protocols.1st Ed., Human Press, 1999.
3. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st Ed., Wiley-Liss, 2001.
4. Horst F. Basic One and Two-dimensional spectroscopy. VCH Publisher, 1991.
5. West E. S, Todd W. R, Mason H. S, Bruggen J. Textbook of Biochemistry. 4th Ed, Oxford and IBH Publishing Co, 1995.
6. Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd Ed., W.H. Freeman, 1982.

OUTCOMES:

- On the completion of the above objectives student will be able to know the electrochemical techniques and principles of centrifugation, spectrophotometry, chromatography and microscopy. They will have the information of radioactive methods.

LSCY203 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 09

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 09

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 Ascaris lumbricoides. Filariasis and Schistosomiasis. Diagnosis of chicken guinea and swine flu.

MODULE III CLINICAL GENETICS 09

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 09

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 09

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 Aisa Pvt. 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..

LSCY204 OMICS

L	T	P	C
3	0	0	3

MODULE I GENOMICS: **09**

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of 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. Physical and Genetic Map, Genome Sequencing, Next generation sequencing methods, Genome Annotation, Functional Genomics.

MODULE II TRANSCRIPTOMICS AND PHARMACOGENETICS 09

Search for transcription factor binding sites,RNA-Seq, Microarrays, Regulatory RNAs: small or large, Computational prediction of miRNA target genes, RNA Darkmatter. High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

MODULE III PROTEOMICS 09

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein identification by peptide mass fingerprinting, Protein-protein interactions, Yeast two hybrid system, Applications of proteomics.

MODULE IV METABOLOMICS AND LIPIDOMICS 09

Fundamental concept - Carbohydrate, Lipid, Protein and Nucleic Acid metabolism. Plant Metabolism. Tools of metabolomics- Capillary electrophoresis, Gas chromatography, Electrochemical detectors, mass spectrometry, Case studies. Lipidomics - Basic concepts and tools Case studies

MODULE V SYSTEMS BIOLOGY AND BIOINFORMATICS. DEGRADOMICS 09

Techniques and concepts, Approaches to identify the protease and protease-substrate repertoires, or 'degradomes', on an organism-wide scale, Uncover new roles for proteases in vivo. Identification of new pharmaceutical targets to treat disease (Emerging degradomics)

Total Hours:

REFERENCES:

1. Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press.
2. Mass Spectrometry for Biotechnology by Gary Siuzdak, Academic Press.
3. Proteomics for Biological Discovery by Timothy Veenstra and John Yates, Wiley.
4. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press.
5. Lipidomics- Technologies and Applications by Kim Ekroos, Wiley-VCH.
6. Web/Journal Resources.
7. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, 2009 – Science

OUTCOMES:

LSCY205 BIOFUELS AND BIOENERGY

L	T	P	C
3	0	0	3

OBJECTIVE

- This course will provide learning in various The course will provide students, with hands-on technical exposure to various Biofuels related science & technology topics, background & literature information besides addressing the environmental, economical, social and other Biofuels related issues.

MODULE I BIOCHEMISTRY OF BIOMASS 09

biomass (e.g. wood waste, forestry residues, agricultural residues, perennial annual crops, organic municipal solid waste). Long-term sustainability and reliability of feedstock supply; feedstock quality, minimizing feedstock cost and regional/climatic considerations of the process chain. Composition of lignocellulose (lignin, hemicellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment; degradation of lignocellulose by fungi and bacteria; degradation of lignin; the role of peroxidases; degradation of cellulose; trichoderma cellulases; bacterial cellulases; and comparison with degradation of high starch crops.

MODULE II BIO DIESEL 09

sources and processing of biodiesel (fatty acid methyl ester); nature of lipids, especially fatty acids and triglycerides. Sources and characteristics of lipids for use as biodiesel feedstock; and conversion of feedstock into biodisel (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO). Engineering, economics and environmental issues of biodisel; components and operation of a biodiesel processing system; standards for biodiesel quality; safety procedures needed to work with biodiesel in both domestic and shop environments; and major policies and regulations pertaining to the production, distribution, and use of biodiesel.

MODULE III BIOENERGY SYSTEMS 09

Course content includes overview of bioenergy systems from resource, conversion technologies to final product. Bioenergy conversion technologies and systems for heat, power, and bio-fuels. Cogeneration and polygeneration. Innovative cycles (such as biomass integrated gasification combined cycles, biomass air turbines, humid air turbines etc) for biomass resources. Evaluation of the bioenergy system performance. Economic and environmental assessments of bioenergy systems.

MODULE IV BIOFUELS & ALCOHOL TECHNOLOGY 09

Introduction to Alcohol Technology, Raw Material of AlcoholIndustry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Study

of yeastproduction as single protein cell. Study of different recycling process, Biochemistry of alcoholproduction, The management of fermentation in the production of alcohol.

MODULE V POLICIES AND FUTURE R&D OF BIOFUELS & BIOENERGY 09

Course content includes analysis of both current and future EU regulations and directives on biofuels and bioenergy. Tax regulations. Evaluation of different production alternatives to produce bioenergy; competitiveness of bioenergy alternatives in agriculture compared to other energy sources. Evaluation of current and future R&D needs; legal framework to support sustainable development and increased use of biofuels; government policies and programs with regard to biofuels and investment opportunities worldwide. Biomass feedstocks - how do we produce them cost-effectively and for which end-use? Biofuels for transportation - what will make them technically and economically competitive? Market penetration of biofuels - how do we remove barriers?

Total Hours:

REFERENCES:

1. Biorenewable Resources: Engineering New Products from Agriculture. Robert C. Brown. Wiley-Blackwell Publishing (2003).
2. Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Samir K. Khanal. Wiley-Blackwell (2008).

OUTCOMES:

Students will be able to describe:

- How petroleum and bio-based fuels affect the global carbon cycle
- The attributes of biofuels that make them suitable as a fuel for a specific application
- Limitations of biofuels
- Global impacts of biofuels on food and energy supplies
- Technological advances and challenges to be overcome for wide-scale biofuel adoption

LSCY206 MOLECULAR FARMING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce molecular farming.
- To create complete knowledge about the recombinant protein production.
- To create awareness about the production of pharmaceutical proteins in plants.

MODULE I INTRODUCTION AND FOREIGN PROTEIN EXPRESSION 09

Introduction, foreign protein production systems- plant tissue culture, suspended cultures, hairy root cultures, shoot teratoma cultures. Strategies for improving FP production in tissue culture, expression systems, modifications to existing expression constructs, secretion of foreign proteins, foreign protein stability, stability inside the cells.

MODULE II RECOMBINANT PROTEIN PRODUCTION 09

Biology of sprouting, dicotyledonous seeds, germination, sprout, rubisco synthesis, rubisco promoters, inhibition of endogenous gene expression, expression cassette design, sprouting- equipments, conditions, sterilization, time and temperature, light, inhibition of endogenous gene expression, growth regulators, nitrogen fertilizer, seed production,quality and environmental aspects.

MODULE III PLANT VIRAL EXPRESSION SYSTEMS 10

Cereal production crops, Technical aspects, cereal transformation, expression construct design, Prodigene and Maize. Recombinant proteins expressed in Rice, Wheat, Barley. Plant RNA viruses as expression vectors- TMV, PVX, CPMV, AIMV. Biological activity of target molecules, efficacy of plant virus antigens, vaccine antigens- particle based.

MODULE IV ANTIBODIES, BIOPHARMACEUTICALS AND EDIBLE VACCINES 10

Introduction, expression of therapeutic and human proteins in plants, transgenic chloroplast system, chloroplast derived human antibodies, biopharmaceuticals, Human Serum Albumin, Human insulin like growth factor-1, Human interferon, Antimicrobial peptides, chloroplast derived vaccine antigens, cholera toxin B subModule , Bacillus anthracis protective antigen, Yersinia pestis F1-V fusion antigen, Canine Parvovirus VP2 protein.

MODULE V PLANT DERIVED RECOMBINANT THERAPEUTIC PROTEINS 07

Similarities and differences in the processing of pharmaceutical proteins from different sources, process scale, individual steps of a Downstream process, Initial processing and

extraction, chromatographic purification, regulatoryrequirements for downstream processing of plant derived products.

Total Hours: 45

REFERENCES:

1. Molecular Farming – Plant-made Pharmaceuticals and Technical Proteins, Rainer Fischer and Stefan Schillberg.
2. Wiley.VCH Verlag GmbH and Co. KGaA. 2004.

OUTCOMES:

SEMESTER III

LSCY111 BIOPHARMACEUTICALS

L	T	P	C
3	0	0	3

OBJECTIVE:

- The purpose of this course is to provide a framework of the drug development process and its regulation as well as its impact on workers and the environment. Graduate students in toxicology, pharmaceutics, comparative medicine, bioengineering, occupational and environmental health as well as professional disciplines such as medicine, pharmacology, and nursing interested in working with the biotechnology industry will find this course particularly useful.

MODULE I INTRODUCTION TO BIOPHARMACEUTICAL 09

Introduction to Biopharmaceutical, Biogenerics and Biosimilars; The role of patents in the drug industry; Protein-based biopharmaceuticals; Manufacturing processes; Global market; International Non-proprietary Names (INN) nomenclature system biosimilars.

MODULE II CONCEPTS OF BIOPHARMACEUTICAL 09

Approved follow-on proteins/Biosimilars; Characteristics of high-selling peptides and proteins,; Products with expired patents; Challenging originator's patents; Target products for FOB (follow-on biologicals)/ Biosimilars development peptides; Recombinant non-glycosylated proteins; Recombinant glycosylated proteins; Industries dealing with biogenerics and its market value; World scenario; Indian scenario.

MODULE III PHARMACOKINETICS; PHARMACODYNAMICS 09

Problems in characterizing biologics (Types of biologic, Peptides, Non-glycosylated proteins, Glycosylated proteins, Monoclonal antibodies); Equivalence issues; Post-translational modifications; Effect of microheterogeneity; Pharmacokinetics; Pharmacodynamics; and Clinical efficacy; Analytical methods for the characterization of biosimilars (Chromatography, Protein sequencing, Mass spectrometry, UV absorption, Circular dichroism, X-ray techniques, Nuclear magnetic resonance, Electrophoresis, Western blotting, Bioassays, ELISA, Immunoprecipitation and other procedures)

MODULE IV IMMUNOGENICITY OF BIOPHARMACEUTICALS 09

Immunogenicity of biopharmaceuticals: Immunogenicity; Factors contributing to immunogenicity (product- related factors, host- related factors), Consequence of immunogenicity to biopharmaceuticals; Measurement of immunogenicity

MODULE V CASE STUDIES 09

Case studies: Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon Granulocyte-macrophage- CSF, DNase, Factor VIIa, Factor IX, Factor VIII, Activated protein C, Tissue plasminogen activator, Monoclonal antibodies etc.

Total Hours:

REFERENCES:

1. Sarfaraz K. Niazi, Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, andPatent Issues, CRC Press, 2006.
2. Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes intodrugs, 1stEdition, Wiley Liss, 2003.

OUTCOMES:

- Explain the therapeutic mode of action, and understand structural considerations of at least four classes of biopharmaceutical agent.
- Outline the drug manufacturing process including the role of quality control and quality assurance in protecting the public, workers, and the environment.
- Give an oral presentation to scientific audience on the biological mechanism of action and proposed evaluation of safety, efficacy and manufacturing controls on a biopharmaceutical age

L	T	P	C
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OBJECTIVE:

- Identify the important parameters in the design of a laboratory to conduct the most commonly-used molecular diagnostics protocols.
- Identify the important parameters in the design of a quality system for molecular analyses.
- Become proficient with the techniques required in order to perform the most commonly-used molecular diagnostics protocols.
- Identify the important parameters in the design of a molecular diagnostic test.
- Identify the components of a well-controlled diagnostic test.
- Use critical thinking skills to trouble shoot problems as they occur and determine possible causes.

MODULE I OLECULAR BIOLOGY AND DIAGNOSTICS 09

Molecular Biology and Diagnostics: Atomic bonds and Molecular interactions; Small organic molecules, Macromolecules; Compartmentalization of cells: transport of molecules between nucleus and cytosol, Transport of proteins into mitochondria and chloroplasts, Endoplasmic Reticulum; General principles of cell communication: Signalling - Extracellular, Intracellular, Autocrine, Signaling through G-protein- linked cell surface receptors, Signaling through enzyme-linked cell surface receptors, Signaling pathways that depend on regulated proteolysis; Cell Cycle; DNA repair pathways and methods of detection – Flow cytometry

MODULE II GENETICS AND DIAGNOSTICS 09

Genetics and Diagnostics: Origin and direction of human cytogenetics; General features of chromosomes, Chemistry and packaging of chromosomes, Chromosome bands, banding techniques and their molecular correlates; Structural and numerical abnormalities of chromosomes and their causes, Sex determination and differentiation, Y chromosome evolution and variations and X-inactivation mechanism and phenotypic effects of sex chromosome imbalances, Fragile sites, Trinucleotide repeat expansion, mechanism and associated disorders, Genomic imprinting and their disorders; Fluorescence In situ hybridization, chromosome Comparative Genomic Hybridization arrays; Genetic linkage and chromosome and genetic mapping in human diseases.

MODULE III BIOCHEMISTRY IN DIAGNOSTICS 09

Biochemistry in Diagnostics: Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis; Metabolism of lipids, carbohydrates, amino acids; In-born errors of metabolism; energy requirements,

nutritional disorders; vitamins & minerals - biochemical function and deficiency manifestation. GLP and GMP.

MODULE IV TECHNIQUES IN DIAGNOSTICS 09

Nucleic acid extraction – principle and methods; Polymerase Chain Reaction – principle, types (including RT-PCR, real-time PCR, QF-PCR) and applications; DNA sequencing methods – principle, types, automated process, DNA sequencers; Hybridization techniques – Southern, Northern, in-situ (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot

MODULE V IMMUNODIAGNOSTICS 09

Immunodiagnostics : Introduction, antigen-antibody binding interactions and assays; Immunoassays – types [RIA, ELISA, Chemiluminescent, IA, FIA] and specific applications; Immunohistochemistry – principle and techniques. Various drug delivery systems, targeting potentials; systems used for delivery of biotechnological products (Liposomes, microspheres, nanoparticles, immobilization techniques, etc.)

Total Hours:

REFERENCE:

1. Molecular Diagnostics: George P Patrinos and Wilhelm Ansorge, Elsevier Academic Press

OUTCOMES:

- Gain knowledge of cellular structure and function, especially DNA and RNA, to molecular diagnostic procedures.
- Gain a thorough working knowledge of nucleic acid extraction, resolution and detection.
- Gain a solid foundation in the most commonly utilized molecular diagnostic testing protocols.
- Apply the knowledge of molecular testing to the most commonly performed applications in the clinical laboratory such as: nucleic acid extraction, resolution and detection, analysis and characterization of nucleic acids and proteins, nucleic acid amplification and DNA sequencing.

LSCY113 TISSUE AND ANTIBODY ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- Understand the fundamental and quantitative principles of tissue and antibody engineering and the basic elements of the tissue engineering approach. Appreciate the important contribution of tissue and antibody engineering in producing/growing organs that can be used for therapeutic applications.Be able to discuss the use of stem cell in tissue engineering for wound healing. Appreciate the need for compatible biomaterials to support growth and differentiation of stem cells into functional organ.

MODULE I INTRODUCTION TO TISSUE ENGINEERING 09

Introduction to tissue engineering, Cells as therapeutic Agents with examples, Cell numbers and growth rates. Tissue organization, Tissue Components, Tissue types, Functional subunits. Tissue Dynamics, Dynamic states of tissues, Homeostasis in highly prolific tissues and Tissue repair. Angiogenesis. Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.

MODULE II CELL-EXTRACELLULAR MATRIX INTERACTIONS 09

Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Direct Cell-Cell contact - Cell junctions in tissues, malfunctions in direct cell-cell contact signaling. Response to mechanical stimuli. Cell and tissue culture - types of tissue culture, media, culture environment and maintenance of cells in vitro, cryopreservation. Basis for Cell Separation, characterization of cell separation, methods of cell separation.

MODULE III BIOMATERIALS IN TISSUE ENGINEERING 09

Biomaterials in tissue engineering - biodegradable polymers and polymer scaffold processing. Growth factor delivery, Stem cells. Gene therapy. In vivo cell & tissue engineering case studies: Artificial skin, Artificial blood vessels. Bioreactors for Tissue Engineering.

MODULE IV IMMUNOGLOBULIN 09

Immunoglobulin Genetic Locus: Generation of antibody diversity, Antibody Discovery Methodologies: Hybidoma, Display, and Direct B-cell cloning technology, Antibody structure and function.

MODULE V ANTIBODY ENGINEERING 09

Antibody engineering: humanization, Affinity maturation, Effector function, Generation of high titer cell lines1: Expression vector and Host systems, Cell culture optimization, Downstream processing , Analytical characterization, : Cell line genetic analysis Purification, formulation and stability, Antibody composition

Total Hours:

REFERENCES:

1. "Tissue Engineering", Bernhard O. Palsson, Sangeeta N. Bhatia, Pearson Prentice Hall Bioengineering.
2. Nanotechnology and Tissue engineering - The Scaffold", Cato T. Laurencin, Lakshmi S. Nair, CRC Press.

OUTCOMES:

- Execute the engineering design process: identify problem, identify design constraints on bioengineering problem, create solutions, and evaluate solutions with respect to these constraints.) In this course, students learn and then execute key steps of the engineering design process, including identification of the problem, exploration of the problem, and design of a solution. Students will learn how to identify and conduct thorough research on current tissue engineering and antibody problems, and will ultimately work in teams to propose solutions to those identified problems.

LSCY114 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 09

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 09

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 09

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 09

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 09

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.

LSCY115 PROTEIN ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

This course aims to develop in the students' mind a concept regarding the structure and function of proteins of particular importance, the student will know the production of recombinant protein and in general how to engineer protein to be used as therapeutics.

MODULE I INTRODUCTION TO PROTEIN ENGINEERING 09

Forces stabilizing proteins – Van der waals, electrostatic, hydrogen bonding and weakly polar interactions, hydrophobic effects; Entropy – enthalpy compensation, Protein engineering and its applications, features or characteristics of proteins that can be engineered (definition and methods of study) – affinity and specificity; Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, etc.

MODULE II TECHNIQUES FOR PROTEIN ENGINEERING 09

Methods of measuring the stability of a protein; Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UV CD; Fluorescence; UV absorbance; ORD; Hydrodynamic properties–viscosity, hydrogen-deuterium exchange.

MODULE III SITE DIRECTED MUTAGENESIS AND PROTEIN ENGINEERING 09

Altering Proteins by mutagenesis methods, techniques for Oligonucleotide directed mutagenesis by using single stranded DNA as template, Denatured double stranded DNA as template, PCR based mutagenesis, Engineering proteins by chemical modifications, Genetic fusion of domains, alteration of function by selection and screens, deletion mutagenesis. Introduction of selected mutagenesis by Oligonucleotide directed mutagenesis, Scanning mutagenesis, Insertion of unnatural mutagenesis.

MODULE IV ENGINEERING PROTEINS FOR PURIFICATION 09

Introducing cleavage sites, engineering Proteins for Chromatography, Immunoaffinity chromatography, Ion exchange chromatography, Metal affinity chromatography.

MODULE V STABILIZATION AND MODIFICATION OF PROTEINS 09

Principles of structure stabilization by solvent components, sources of exclusion, Balance between cosolvent exclusion and binding, cosolvent intertactions in the denaturation reaction, Practical considerations, Post translational modifications- Involving peptide

bond, C-terminal, side chain. Modification methods- Enzymatic, Non enzymatic, Specificity, chaperones mediated. Applications of Post translational modifications.

Total Hours:

REFERENCE:

1. Andreas D. Baxevanis& B.F. Francis Ouellellette, Bioinformatics. A Practical Guide to the Analysis of Genes and Proteins, John Wiley & Sons, UK, 1998.
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.

OUTCOMES:

- After the completion of the course the student will have the basic concept regarding the structure and function of proteins of particular importance, the student will know the production of recombinant protein and in general how to engineer protein to be used as therapeutics.

LSCY116 STEM CELL TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To obtain knowledge on wide-ranging topics related to stem cell
- To learn about the application of stem cells in health care
- To get familiar with the issues and challenges of stem cell political and ethical issues surrounding the stem cell debate.

MODULE I GENESIS OF CELLS 09

Concept of stem cells: types, self-renewal and pluripotency, isolation and characterization, Niche and its role on differentiation of stem cells, Stem cells and restorative biology, Reprogramming of genome function through epigenetic inheritance.

MODULE II STEM CELLS 09

Embryonic stem cells, Stem Cells from adults. Pluripotency necessary, or is unipotency enough? What are the mechanisms? Stem-cell plasticity, Regulators of pluripotency and differentiation of stem cell. The isolation, expansion, genetic manipulation, genomic reprogramming, and cloning of stem cells. The problem of differentiation of stem cells. Stem Cells and imprinted genes. Differences between adult and embryonic stem cells, what types of cells adult stem cells can become.

MODULE III CELL & TISSUES 09

From single to multicellular components **-** Regulation of cell division and cytoskeleton, Stem cells in regeneration, Cell specification and early signaling events during morphogenesis, Development of cell adhension and motility , Cellular imprinting**.**

MODULE IV CELL GROWTH & DEVELOPMENT 09

Factors controlling cell development **-** Environmental factors like temperature, oxeygen, location, time, cell number , Chemical factors like growth factors, hormones, cytokines, microRNAs , Genetic factors**.**

MODULE V STEM CELLS AND THERAPEUTICS 09

Cancer stem cells , Stem cells treatment to diseases , Current stem cell therapies, how we can use stem cells for studying cancer and finding cures to other diseases, Correlation between stem cells and cancer, Stem cells and aging. Clinical applications of hematopoietic stem cells from cord blood first successful transplantation of cord blood in a child with Fanconi’s anemia. Treatment of neural diseases such as Parkinson's disease,

Huntington's disease and Alzheimer's disease. Repair of damaged organs such as the liver and pancreas. Ethical issues associated with stem cells.

Total Hours: 45

REFERENCES

1. Kiessling A. A, Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential, Jones and Bartett, 2003.
2. Quesenberry P. J. Stem Cell Biology and Gene therapy, 1st Edition, Willy- Less, 1998.
3. Lanja L, Essential of stem cell Biology, 2nd Edition, Academic Press, 2006.
4. Ho A. D. and Hoffiman R. Stem Cell Transplantation Biology Processes Therapy, Willy-VCH, 2006.
5. Potten C. S. Stem Cells, Elsevier, 2006.

OUTCOMES:

- After the completion of the course the student will have overall knowledge of scientific research, management, implications and exploitation in Stem Cells in Health care.