B.S. Abdur Rahman Crescent Institute of Science & Technology

Deemed to be University u/s 3 of the UGC Act, 1956

Regulations 2019
Curriculum and Syllabi

(Amendments updated upto June 2020)

M.Sc.
(Biotechnology)

B.S. Abdur Rahman Crescent Institute of Science & Technology
Deemed to be University u/s 3 of the UGC Act, 1956

REGULATIONS 2019
CURRICULUM AND SYLLABI
(Amendments updated upto June 2020)

M.Sc.
BIOTECHNOLOGY

VISION AND MISSION OF THE INSTITUTION

VISION

B.S.Abdur Rahman Crescent Institute of Science and Technology aspires to be a leader in Education, Training and Research in multidisciplinary areas of importance and to play a vital role in the Socio-Economic progress of the Country in a sustainable manner.

MISSION

- To blossom into an internationally renowned Institute.
- To empower the youth through quality and value-based education.
- To promote professional leadership and entrepreneurship.
- 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.

SCHOOL OF LIFE SCIENCES

VISION AND MISSION

VISION

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

MISSION

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

PROGRAMME EDUCATIONAL OBJECTIVES AND OUTCOMES

M.Sc. (BIOTECHNOLOGY)

PROGRAMME EDUCATIONAL OBJECTIVES:

The course aims to provide an advanced understanding of the core principles and topics of Modern day Biotechnology, 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 strong fundamentals of biotechnology and its industrial application.
- To discover in depth knowledge of animal and plant biotechnology, and also broad area of biochemistry, Immunology and molecular biology
- It will provide the students to develop independent learning skills all biochemical and biotechnology studies.
- This course will provide the students to apply their knowledge and skills in their future professional areas.
- This course will help in contributing to the education of academics which impart its effect for university to play an active role in other advanced studies

PROGRAMME OUTCOMES:

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

- Understand the basic knowledge and concepts of biotechnology and other related areas.
- Understand the ability to apply their knowledge for practical which they can conduct independently.
- Apply their knowledge in other advanced subject area like nanobiotechnology, immunotechnology, and animal and plant biotechnology for the betterment and advancement of their professional career.
- Learn the theoretical and practical exposure to the basic and the advanced fields of biotechnology.

B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE & TECHNOLOGY, CHENNAI – 600 048.

REGULATIONS - 2019 FOR

M.Tech. / MCA / M.Sc. DEGREE PROGRAMMES

(Under Choice Based Credit System)

1.0 PRELIMINARY DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires **"Programme"** means Post Graduate Degree Programme (M.Tech. / MCA / M.Sc.)

"Course" means a theory / practical / laboratory integrated theory / mini project / seminar / internship / Project and any other subject that is normally studied in a semester like Advanced Concrete Technology, Electro Optic Systems, Financial Reporting and Accounting, Analytical Chemistry, etc.,

"Institution" means B.S. Abdur Rahman Crescent Institute of Science & Technology.

"Academic Council" means the Academic Council, which is the apex body on all academic matters of B.S. Abdur Rahman Crescent Institute of Science & Technology.

"Dean (Academic Affairs)" means Dean (Academic Affairs) of B.S. Abdur Rahman Crescent Institute of Science & Technology who administers the academic matters.

"Dean (Student Affairs)" means Dean (Student Affairs) of B.S. Abdur Rahman Crescent Institute of Science & Technology, who looks after the welfare and discipline of the students.

"Controller of Examinations" means the Controller of Examinations of B.S. Abdur Rahman Crescent Institute of Science & Technology who is responsible for the conduct of examinations and declaration of results.

2.0 PROGRAMMES OFFERED AND ADMISSION REQUIREMENTS

2.1 Programmes Offered

The various programmes and their mode of study are as follows:

Degree	Mode of Study
M.Tech.	Full Time
MCA	
M.Sc.	

2.2 ADMISSION REQUIREMENTS

2.2.1 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 Institution as specified in the clause 3.2 [Eligible entry qualifications for admission to P.G. programmes] or any other degree examination of any University or authority accepted by this Institution as equivalent thereto.

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

3.0 DURATION, ELIGIBILITY AND STRUCTURE OF THE PROGRAMME

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

Programme	Min. No. of Semesters	Max. No. of Semesters
M.Tech.	4	8
MCA (3 years)	6	12
MCA (Lateral Entry)	4	8
MCA (2 years)	4	8
M.Sc.	4	8

3.1.1 Each academic semester shall normally comprise of 90 working days. Semester End Examinations shall follow within 10 days of the last Instructional day.

3.1.2 Medium of instruction, examinations and project report shall be in English.

3.2 ELIGIBLE ENTRY QUALIFICATIONS FOR ADMISSION TO PROGRAMMES

Sl. No.	Name of the Department	Programmes offered	Qualifications for admission
1.	Aeronautical Engineering	M. Tech. (Avionics)	B.E. / B. Tech. (Aeronautical Engineering)
2.	Civil Engineering	M. Tech. (Structural Engineering)	B.E. / B. Tech. (Civil Engineering) / (Structural Engineering)

		M. Tech. (Construction Engineering and Project Management)	B.E. / B. Tech. (Civil Engineering) / (Structural Engineering) / B. Arch.
3.	Mechanical Engineering	M.Tech. (Manufacturing Engineering)	B.E. / B.Tech. (Mechanical / Automobile / Manufacturing / Production / Industrial / Mechatronics / Metallurgy / Aerospace /Aeronautical / Material Science / Marine Engineering)
		M.Tech. (CAD/CAM)	
4.	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 and Drives)	
5.	Electronics and Communication Engineering	M.Tech. (Communication Systems)	B.E. / B. Tech. (EEE/ ECE / E&I / CSE IT / I&C / Electronics / Instrumentation)
		M.Tech. (VLSI and Embedded Systems)	B.E. / B. Tech. (ECE / E&I / I&C / EEE / CSE / IT)
6.	Electronics and Instrumentation Engineering	M.Tech. (Electronics and Instrumentation Engineering)	B.E. / B. Tech. (EIE/ICE/Electronics/ECE/EEE)
7.	Computer Science and Engineering	M.Tech. (Computer Science and Engineering)	B.E. / B. Tech. (CSE/IT/ECE/EEE/EIE/ICE/ Electronics / MCA)
8.	Information Technology	M.Tech. (Information Technology)	B.E. / B. Tech. (IT/CSE/ECE/EEE/EIE/ICE/ Electronics / MCA)

9.	Computer Applications	MCA (3 years)	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level
		MCA – (Lateral Entry)	B.Sc. Computer Science / B.Sc. Information Technology / BCA
		MCA (2 years)	Bachelor Degree in any discipline with Mathematics as one of the subjects (or) Mathematics at +2 level or B.Sc. Computer Science / B.Sc. Information Technology / BCA
10.	Mathematics	M.Sc. (Actuarial Science)	Any Degree with Mathematics / Statistics as one of the subjects of study
11.	Physics	M.Sc.(Physics)	B.Sc. (Physics / Applied Science / Electronics / Electronics Science / Electronics & Instrumentation)
12.	Chemistry	M.Sc.(Chemistry)	B.Sc. (Chemistry / Applied Science)
13.	Life Sciences	M.Sc. Molecular Biology & Biochemistry	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.Tech. Biotechnology	B.Tech. (Biotechnology / Chemical Engineering) / M.Sc. in any branch of Life Sciences

3.3. STRUCTURE OF THE PROGRAMME

3.3.1 The PG. programmes consist of the following components as prescribed in

the respective curriculum

i. Core courses
ii. Elective courses
iii. Laboratory oriented core courses
iv. Project work / thesis / dissertation
v. Laboratory Courses
vi. Seminars
vii. Mini Project
viii. Industrial Internship
ix. Value Added Courses
x. MOOC Courses (NPTEL, SWAYAM, etc.,)

3.3.2 The curriculum and syllabi of all programmes shall be approved by the Academic Council of this Institution.

3.3.3 For the award of the degree, the student has to earn a minimum total credits specified in the curriculum of the respective specialization of the programme.

3.3.4 The curriculum of 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	Range of credits
M.Tech.	74 - 80
MCA (3 years)	118 - 126
MCA (Lateral Entry)	80 - 85
MCA (2 years)	85 - 90
M.Sc.	77- 82

3.3.5 Credits will be assigned to the courses for all programmes as given below:

- One credit for one lecture period per week or 15 periods of lecture per semester
- One credit for one tutorial period per week or 15 periods per semester
- One credit each for seminar/practical session/project of two or three periods per week or 30 periods per semester
- One credit for four weeks of industrial internship or 160 hours per semester.

3.3.6 The number of credits the student shall enroll in a non-project semester and

project semester is as specified below to facilitate implementation of Choice Based Credit System.

Programme	Non-project semester	Project semester
M.Tech.	9 to 28	18 to 26
MCA	12 to 33	12 to 26
M.Sc.	9 to 32	10 to 26

3.3.7 The student may choose a course prescribed in the curriculum from any department offering that course without affecting regular class schedule. The attendance will be maintained course wise only.

3.3.8 The students shall choose the electives from the curriculum with the approval of the Head of the Department / Dean of School.

3.3.9 Apart from the various elective courses listed in the curriculum for each specialization of programme, the student can choose a maximum of two electives from any other similar programmes across departments, during the entire period of study, with the approval of the Head of the department offering the course and parent department.

3.4. ONLINE COURSES

3.4.1 Students are permitted to undergo department approved online courses under SWAYAM up to 20% of credits of courses in a semester excluding project semester with the recommendation of the Head of the Department / Dean of School and with the prior approval of Dean Academic Affairs during his/ her period of study. The credits earned through online courses ratified by the respective Board of Studies shall be transferred following the due approval procedures. The online courses can be considered in lieu of core courses and elective courses.

3.4.2 Students shall undergo project related online course on their own with the mentoring of the faculty member.

3.5 PROJECT WORK / DISSERTATION

3.5.1 Project work / Dissertation shall be carried out by the student under the supervision of a Faculty member in the department with similar specialization.

3.5.2 A student may however, in certain cases, be permitted to work for the project in an Industry / Research Organization, with the approval of the Head of the Department/ Dean of School. 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 meetings for evaluating the progress.

3.5.3 The timeline for submission of final project report / dissertation is within 30 calendar days from the last Instructional day of the semester in which Project / Dissertation is done.

3.5.4 If a student does not comply with the submission of project report / dissertation on or before the specified timeline he / she is deemed to have not completed the project work / dissertation and shall re-register in the subsequent semester.

4.0 CLASS ADVISOR AND FACULTY ADVISOR

4.1 CLASS ADVISOR

A faculty member shall be nominated by the HOD / Dean of School 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 / Dean of School of the students shall 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 in every semester.

5.0 CLASS COMMITTEE

5.1 A class committee comprising faculty members handling the classes, student representatives and a senior faculty member not handling the courses as chairman will be constituted in every semester:

5.2 The composition of the class committee will be as follows:

i) One senior faculty member preferably not handling courses for the concerned semester, appointed as chairman by the Head of the Department

ii) Faculty members of all courses of the semester
iii) All the students of the class
iv) Faculty advisor and class advisor
v) Head of the Department – Ex officio member

5.3 The class committee shall meet at least three times during the semester. The first meeting shall be held within two weeks from the date of commencement of classes, in which the nature of continuous assessment for various courses and the weightages for each component of assessment shall be decided for the first and second assessment. The second meeting shall be held within a week after the date of first assessment report, to review the students' performance and for follow up action.

5.4 During these two meetings the student members, shall meaningfully interact and express opinions and suggestions to improve the effectiveness of the teaching-learning process, curriculum and syllabus.

5.5 The third meeting of the class committee, excluding the student members, shall meet within 5 days from the last day of the semester end examination to analyze the performance of the students in all the components of assessments and decide their grades in each course. The grades for a common course shall be decided by the concerned course committee and shall be presented to the class committee(s) by the concerned course coordinator.

6.0 COURSE COMMITTEE

6.1 Each common theory / laboratory course offered to more than one group of students shall have a “Course Committee” comprising all the teachers handling 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 handling the common course belong to a single department or from several departments. The Course Committee shall meet as often as possible to prepare a common question paper, scheme of evaluation and ensure uniform evaluation of the assessment tests and semester end examination.

7.0 REGISTRATION AND ENROLLMENT

7.1 The students of first semester shall register and enroll at the time of admission by paying the prescribed fees.

7.2 For the subsequent semesters registration for the courses shall be done by the student one week before the last working day of the previous semester.

7.3 A student can withdraw from an enrolled course at any time before the first assessment test for genuine reasons, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

7.4 A student can change an enrolled course within 10 working days from the commencement of the course, with the approval of the Dean (Academic Affairs), on the recommendation of the Head of the Department of the student.

8.0 TEMPORARY BREAK OF STUDY FROM THE PROGRAMME

8.1 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. A student can avail the break of study before the start of first assessment test of the ongoing semester. However the total duration for completion of the programme shall not exceed the prescribed maximum number of semesters (vide clause 3.1). If any student is debarred for want of attendance or suspended due to any act of indiscipline, it will not be considered as break of study. A student who has availed break of study has to rejoin in the same semester only in the subsequent year. The student availing break of study is permitted to write arrear examinations by paying the prescribed fees.

9.0 MINIMUM REQUIREMENTS TO REGISTER FOR PROJECT / 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.	18
MCA (3 years)	45
MCA (Lateral Entry)	22

MCA (2 years)	22
M.Sc.	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 ATTENDANCE

10.1 A student shall earn 100% attendance in the contact periods of every course, subject to a maximum relaxation of 25% (for genuine reasons such as medical grounds, representing for the institution 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. The courses in which the student is awarded "I" grade, shall register and redo the course when it is offered next.

10.2 The faculty member of each course shall cumulate the attendance details for the semester and furnish the names of the students who have not earned the required attendance in that course to the Class Advisor. The Class Advisor will consolidate and furnish the list of students who have earned less that 75% attendance, in various courses, to the Dean (Academic Affairs) through the Head of the Department / Dean of School. Thereupon, the Dean (Academic Affairs) shall announce the names of such students prevented from writing the semester end examination in each course.

10.3 A student who has obtained 'I' grade in all the courses in a semester is not permitted to move to next higher semester. Such student shall redo all the courses of the semester in the subsequent academic year. However he / she is permitted to redo the courses awarded with 'I' grade / arrear in previous semesters. They shall also be permitted to write arrear examinations by paying the prescribed fee.

10.4 A student shall register to redo 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 chosen with the approval of Head of the Department / Dean of School.

11.0 REDO COURSES

11.1 A student can register for a maximum of two redo courses per semester in the evening after regular working hours, if such courses are offered by the concerned department. Students may also opt to redo the courses offered during regular semesters, without affecting the regular academic schedule and not exceeding prescribed maximum credits.

11.2 The Head of the Department with the approval of Dean (Academic Affairs) may arrange for the conduct of a few courses in the evening after regular working hours, depending on the availability of faculty members and subject to a specified minimum number of students registering for each of such courses.

11.3 The number of contact hours and the assessment procedure for any redo course will be the same as those during regular semesters except that there is no provision for any substitute examination and withdrawal from an evening redo course.

12.0 ASSESSMENTS AND EXAMINATIONS

12.1 Every theory course shall have a total of three assessments during a semester as given below:

Assessments	Weightage of Marks
Continuous Assessment 1	25%
Continuous Assessment 2	25%
Semester End Examination	50%

12.2 Appearing for semester end theory examination for each course is mandatory and a student should secure a minimum of 40% marks in each course in semester end examination for the successful completion of the course.

Every practical course shall have 75% weightage for continuous assessments and 25% for semester end examination. However a student should have secured a minimum of 50% marks in the semester end practical examination for the award of pass grade.

12.3 For laboratory integrated theory courses, the theory and practical components shall be assessed separately for 100 marks each and consolidated by assigning a weightage of 75% for theory component and 25% for practical component. Grading shall be done for this consolidated mark. Assessment of

theory component shall have a total of three assessments with two continuous assessments having 25% weightage each and semester end examination having 50% weightage. The student shall secure a separate minimum of 40% in the semester end theory examination for the award of pass grade. The evaluation of practical component shall be through continuous assessment.

12.4 The components of continuous assessment for theory/practical/laboratory integrated theory courses shall be finalized in the first class committee meeting.

12.5 In the case of Industrial training, the student shall submit a report, which shall be evaluated along with an oral examination by a committee of faculty members constituted by the Head of the Department. The student shall also submit an internship completion certificate issued by the industry / research organisation. The weightage for Industry internship report shall be 60% and 40% for viva voce examination.

12.6 In the case of project work, a committee of faculty members constituted by the Head of the Department will carry out three periodic reviews. Based on the project report submitted by the student, an oral examination (viva voce) shall be conducted as semester end examination by an external examiner approved by Controller of Examinations. The weightage for periodic reviews shall be 50%. Of the remaining 50%, 20% shall be for the project report and 30% for the Viva Voce examination.

12.7 For the first attempt of the arrear theory examination, the internal assessment marks scored for a course during first appearance shall be considered for grading along with the marks scored in the semester end arrear examination. From the subsequent appearance onwards, full weightage shall be assigned to the marks scored in the semester end examination to award grades and the internal assessment marks secured during the course of study shall not be considered.

In case of laboratory integrated theory courses, after one regular and one arrear appearance, the internal mark of theory component is invalid and full weightage shall be assigned to the marks scored in the semester end arrear examination for theory component. There shall be no arrear or improvement examination for lab component.

13.0 SUBSTITUTE EXAMINATIONS

13.1 A student who is absent, for genuine reasons, may be permitted to write a substitute examination for any one of the two continuous assessment tests of a course by paying the prescribed substitute examination fee. However, permission to take up a substitute examination will be given under exceptional circumstances, such as accidents, admission to a hospital due to illness, etc. by a committee constituted by the Head of the Department / Dean of School for that purpose. However there is no substitute examination for semester end examination.

13.2 A student shall apply for substitute exam in the prescribed form to the Head of the Department / Dean of School within a week from the date of assessment test. However the substitute examination will be conducted only after the last working day of the semester and before the semester end examination.

14.0 SUPPLEMENTARY EXAMINATION

14.1 Final Year students can apply for supplementary examination for a maximum of three courses thus providing an opportunity to complete their degree programme. Likewise students with less credit can also apply for supplementary examination for a maximum of three courses to enable them to earn minimum credits to move to higher semester. The students can apply for supplementary examination within three weeks of the declaration of results in both odd and even semester.

15. PASSING, DECLARATION OF RESULTS AND GRADE SHEET

15.1 All assessments of a course shall be made on absolute marks basis. However, the Class Committee without the student members shall meet within 5 days after the semester end examination and analyze the performance of students in all assessments of a course and award letter grades. The letter grades and the corresponding grade points are as follows:

Letter Grade	Grade Points
S	10
A	9
B	8
C	7
D	6

E	5
U	0
W	0
I	0
AB	0

"W" denotes withdrawal from the course.

"I" denotes inadequate attendance and hence prevented from appearing for semester end examination

"U" denotes unsuccessful performance in the course.

"AB" denotes absence for the semester end examination.

15.2 A student who earns a minimum of five grade points ('E' grade) in a course is declared to have successfully completed the course. Such a course cannot be repeated by the student for improvement of grade.

15.3 The results, after awarding of grades, shall be signed by the Chairman of the Class Committee and Head of the Department / Dean of School and it shall be declared by the Controller of Examinations.

15.4 Within one week from the date of declaration of result, a student can apply for revaluation of his / her semester end theory examination answer scripts of one or more courses, on payment of prescribed fee to the Controller of Examinations. Subsequently the Head of the Department/ Dean of School offered the course shall constitute a revaluation committee consisting of Chairman of the Class Committee as convener, the faculty member of the course and a senior faculty member knowledgeable in that course as members. The committee shall meet within a week to re-evaluate the answer scripts and submit its report to the Controller of Examinations for consideration and decision.

15.5 After results are declared, grade sheets shall be issued to each student, which contains the following details: a) list of courses enrolled during the semester including redo courses / arrear courses, if any; b) grades scored; c) Grade Point Average (GPA) for the semester and d) Cumulative Grade Point Average (CGPA) of all courses enrolled from first semester onwards.

GPA is the ratio of the sum of the products of the number of credits of courses registered and the grade points corresponding to the grades scored in those

courses, taken for all the courses, to the sum of the number of credits of all the courses in the semester.

If C_i, is the number of credits assigned for the i^{th} course and GP_i is the Grade Point in the i^{th} course

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

Where n = number of courses

The Cumulative Grade Point Average (CGPA) is calculated in a similar manner, considering all the courses enrolled from first semester.

“I” and "W" grades are excluded for calculating GPA.

"U", “I”, "AB" and **"W"** grades are excluded for calculating CGPA.

The formula for the conversion of CGPA to equivalent percentage of marks is as follows:

Percentage Equivalent of Marks = CGPA X 10

15.6 After successful completion of the programme, the Degree shall be awarded upon fulfillment of curriculum requirements and classification based on CGPA as follows:

Classification	CGPA
First Class with Distinction	8.50 and above and passing all the courses in first appearance and completing the programme within the minimum prescribed period.
First Class	6.50 and above and completing the programme within a minimum prescribed period plus two semesters.
Second Class	Others

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 period of study and should have completed the P.G. programme within a minimum period (except break of study). To be eligible for First Class, a student should have passed the examination in all the 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 is not considered. The students who do not satisfy the above two conditions shall be classified

as second class. For the purpose of classification, the CGPA shall 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.

16.0 DISCIPLINE

16.1 Every student is expected to observe disciplined and decorous behaviour both inside and outside the campus and not to indulge in any activity which tends to affect the reputation of the Institution.

16.2 Any act of indiscipline of a student, reported to the Dean (Student Affairs), through the HOD / Dean shall be referred to a Discipline and Welfare Committee constituted by the Registrar for taking appropriate action.

17.0 ELIGIBILITY FOR THE AWARD OF THE MASTERS DEGREE

17.1 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.
iii. Enrolled and completed at least one value added course.
iv. Enrollment in at least one MOOC / SWAYAM course (non-credit) before the final semester.

17.2 The award of the degree must have been approved by the Institute.

18.0 POWER TO MODIFY

Not withstanding all that have been stated above, the Academic Council has the right to modify any of the above regulations from time to time.

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B.S. ABDUR RAHMAN CRESCENT INSTITUTE OF SCIENCE AND TECHNOLOGY

M.Sc. BIOTECHNOLOGY

CURRICULUM & SYLLABUS, REGULATIONS 2019

S.No	Course Code	Course Title	L	T	P	C
		Semester-I				
1	LSD 6101	Advanced Biochemistry	4	0	0	4
2	LSD 6102	Cell and Molecular Biology	4	0	0	4
3	LSD 6103	Genetic Engineering	4	0	0	4
4		Elective 1	3	0	0	3
5		Elective 2	3	0	0	3
6	LSD 6104	Lab 1 (Biochemistry/Molecular Biology/ Genetic Engineering)	0	0	4	2
			Credits			**20**
		Semester – II				
1	GED 6202	Research Methodology	3	0	0	3
2	LSD 6201	Immunology	4	0	0	4
3	LSD 6202	Bioinformatics	4	0	0	4
4		Elective 3	3	0	0	3
5		Elective 4	3	0	0	3
6	LSD 6203	Lab II (Immunology/ Bioinformatics)	0	0	4	2
7	LSD 6204	Industrial Internship	0	0	0	1
8	LSD 6205	Mini Project	0	0	0	1
			Credits			**21**

Semester – III

1	LSD 7101	Project Phase 1	0	0	2	2
2	LSD 7102	Plant and animal Biotechnology	4	0	0	4
3	LSD 7103	Bioprocess Technology	4	0	0	4
4		Elective 5	3	0	0	3
5		Elective 6	3	0	0	3
6	LSD 7104	Lab III (Plant and animal Biotechnology/ Bioprocess Technology)	0	0	4	2
					Credits	**16**

Semester – IV

1	LSD 7101	Project Phase 2	0	0	36	18

Credits (Phase I 2+ Phase II 18) 20

TOTAL CREDITS 80

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

ELECTIVES

Course Code	Electives I Semester	L	T	P	C
LSDY101	Bio safety and Bioethics, Bio entrepreneurship and IPR	3	0	0	3
LSDY 102	Microbiology	3	0	0	3
LSDY 103	Food Process Technology	3	0	0	3
LSDY 104	Analytical Methods	3	0	0	3
LSDY 105	Environmental Biotechnology	3	0	0	3
LSDY 106	SiRNA/RNA Interference	3	0	0	3
	Electives II Semester				
LSDY 201	Recombinant DNA Technology	3	0	0	3
LSDY 202	Advanced Instrumentation	3	0	0	3
LSDY 203	Molecular Diagnostics	3	0	0	3
LSDY 204	Omics	3	0	0	3
LSDY 205	Biofuel and Bio energy	3	0	0	3
LSDY 206	Molecular Farming	3	0	0	3
	Electives III Semester				
LSDY 111	Biopharmaceuticals	3	0	0	3
LSDY 112	Molecular and Immune Diagnostics	3	0	0	3
LSDY 113	Tissue and Antibody Engineering	3	0	0	3
LSDY 114	Bio nanotechnology	3	0	0	3
LSDY 115	Protein Engineering	3	0	0	3
LSDY 116	Stem Cell Technology	3	0	0	3

SEMESTER I

LSD 6101	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 15

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 15

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 15

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 Hrs: 60

REFERENCES:

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, 2012
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.

LSD 6102	CELL AND 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 15

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 15

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 15

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 Hrs: 60

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:

At the end of the course, student will be able to

- Appreciate the basic organization of organisms and living being
- Understand the machinery of the cell that is ultimately responsible for various daily activities
- Understand the basic organization of DNA
- Appreciate the core genetic process of synthesis of mRNA and proteins
- Acquire knowledge about biological problems that requires engineering expertise to solve them

LSD 6103	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 12

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 12

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 12

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 12

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 12

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 Hrs: 60

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

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

LSD6104	Lab 1 (Biochemistry, Molecular Biology and Genetic Engineering)	L	T	P	C
		0	0	4	2

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. 2. 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

OUTCOMES:

- understand the importance of laboratory safety and standard operating procedures of common laboratory equipment's
- The students will be trained in performing routine biochemical assays.
- The students will be trained in isolation and purification of nucleic acids from different sources.
- The students will be trained in basic molecular biology techniques.
- 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
		4	0	0	4

OBJECTIVES

The course is designed

- To outline the methodology for research in biotechnology
- Provide an understanding of the ethical issues underlying biotechnology research and innovation
- The student will gain an understanding research methodology, the ethical issues underlying biotechnology research
- The student will develop the art of result and data analysis
- The student will develop the skill of scientific writing

MODULE 1: RESEARCH METHODOLOGY-AN INTRODUCTION 12

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 2: GOOD LABORATORY PRACTICES AND SAFETY 12

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 3: LABORATORY SAFETY AND EXPERIMENTAL RESEARCH 12

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 4: INTERPRETATION OF RESULTS AND ANALYSIS 12

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 5: SCIENTIFIC WRITING, TECHNICAL PUBLICATION AND RESEARCH PROPOSAL 12

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 Hrs: 60

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, 1976.
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 ScientificInformation, 3rd Edn., Oxford University Press, 2006.

8. Willa Y. Garner, Maureen S. Barge, James, P, Good Laboratory Practice Standards: Applications for Field and Laboratory Studies (ACS Professional References Book), 1992.

OUTCOMES:

- To conceptualise a novel idea / technique into a project.
- To think in terms of multi-disciplinary environment
- To understand the management techniques of implementing a project
- To develop the skill of analyzing data
- To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.

LSD6201	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 12

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 12

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 12

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 12

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 12

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 Hrs : 60

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, , Lippincott Williams & Wilkins; 4th edition, 1999.

OUTCOMES:

After completing the course students will:

- be introduced to the science of immunology and a detailed understanding of various types of immune cells, immune systems and their classification, structure.
- get thorough knowledge of mechanism of immune system activation.

- have an understanding of antibody structure, the origin of variations in its structure and role in imparting immunity.
- get a thorough understanding for the mechanisms involved in mounting the immune response .
- edge of the cellular and molecular basis for autoimmune disease and allergies.

LSD6202	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 12

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 12

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 12

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 12

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 12

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

Total Hrs: 60

REFERENCES:

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press, 1997.
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, 2001.
1. 6 . Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003
2. 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 be familiarized with language skills, basic Perl data modules
- skilled to make basic programs using C language
- will be able to handle computational methods for data analysis
- skilled to handle phylogenetic data and application part
- students will be able to analyze Protein structure , sequence analysis which can be used in analyzing the binding effect of drugs on proteins.

LSD6203	Lab II (Immunology/ Bioinformatics)	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To train the students involving antigen and antibody reactions
- To train in basic techniques involved in serology and molecular biology
- To inculcate skill of plasmid construction, mappings and analysis.
- To inculcate the skill of handling different bioinformatic database
- To train the students in protein structure prediction, sequence homology mapping.

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.

Total Hours: 60

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 will develop the skill to perform diagnostics assays involving antigen-antibody reaction.
- They will also learn to perform the qualitative and quantitative analysis using antibodies.
- Students will be trained with various soft skills/tool used in bioinformatics
- They will also become skilled to be able to analyze and interpolate data starting from PCR primer designing to structure predictions.
- Thye will also learn about different types of errors obtained during data collection and analysis

Semester III

LSD7102	PLANT AND ANIMAL BIOTECHNOLOGY	L	T	P	C
		4	0	0	4

OBJECTIVES

This course gives students about the fundamentals of totipotency, plant tissue and animal cell culture techniques for in vitro manipulations and transgenic technology. It also familiarizes them with the use of plants for production of biologically active therapeutic proteins. The students will get an idea about animal cell culture their preservation and stem cells.

MODULE I PLANT TISSUE CULTURE 12

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

MODULE II AGROBIOLOGY 12

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

MODULE III MOLECULAR MAPPING & MARKER ASSISTED SELECTION (MAS) 12

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

MODULE IV INTRODUCTION TO ANIMAL BIOTECHNOLOGY 12

Animal cell culture; media composition and growth conditions; Animal cell and tissue preservation; Anchorage and non-anchorage dependent cell culture; Kinetics of cell growth; Micro & macro-carrier culture; Hybridoma technology; Stem cell technology; Animal cloning; Transgenic animals

MODULE V PRESERVATION AND APPLICATION 12

Cryopreservation, IVF, Cell banking, Gene transfer technology in animals, Stem cells, Application,Disease, Management through biotechnology, Genetic councelling. Hybridomas, human hybridoma, commercial scale production of monoclonal antibodies.

Total Hrs: 60

REFERENCES:

1. Animal Biotechnology: Recent concepts and developments - P.Ramadas, MJP Publications, 2015
2. Animal Biotechnology – M.M.Ranga, IIIrd edition, 2007.
3. Culture of animal cells; a manual of basic technique - R.Ian Freshney, Vth edition, Wiley publications, 2006.
4. Vogel. H.C., Todaro. C.L., “Fermentation and Biochemical Engineering Handbook - Principles, Process design, and Equipment”, Noyes Publications,1997.
5. Lee. Y.K., “Microbial Biotechnology: Principles and Applications”, World Scientific Publishing, 2006.

OUTCOMES:

On the completion of course student will be able to understand

- Understand the principle and concepts related to totipotency, embryogenesis, protoplast culture, applications of somatic hybridization, etc
- Get knowledge about agrobacterium mediated creation of transgenic plants.
- Understand the effect of biotic and abiotic stress components on different life forms and know the techniques to create plants that can circumvent such conditions
- The concept and application of stem cell,nanotechnology, pharmacology in treatment of disease
- Understand different classes of vaccines and the use of biotechnology in new vaccine development.

LSD7103	BIOPROCESS TECHNOLOGY	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To learn about the History and scope of bioprocess technology.
- To understand the mechanism of enzyme reactions,
- To know about the Bioreactors

MODULE I INTRODUCTION 12

Types, cells, production strains, preservation- history, industrial applications, chemical technology vis-a-vis biotechnology, commercial evalution potential.

MODULE II ENZYMES 12

Mechanism of enzyme reactions, Michaelis Menten kinetics, enzyme inhibition, factors affecting rate, parameter estimations, growth characterstics of microbial cells, Monod model, batch culture.

MODULE III PHYSICAL FACTORS FOR BIOPROCESS 12

Agitation and mixing, transport in cells, transfer resistances, mass transfer coefficients, enhancement of oxygen transfer, heat transfer correlations, batch and continuous sterilisation.

MODULE IV BIOREACTORS 12

Ideal bioreactors, Batch, fed batch, CSTR, PFR, Multiphase bioreactors,packed bed, bubble column fluidized trickle bed, immobilization. Aseptic, septic and anaerobic fermentors.

MODULE V DOWN STREAM METHODS 12

Filtration, centrifugation, sedimentation, extraction, sorption, reverse osmosis, ultra filtration, electrophoresis, waste water treatment.

Total Hours: 60

REFERENCES:

1. Shuler M and Kargi F. Bioprocess Engineering. Prentice Hall (I) Ltd., 2002.
2. Doran P. M. Bioprocess Engineering Principles. Academic Press,1995

3. Bailey J. E and Ollis D. F. Biochemical Engineering fundamentals. 2nd Ed., McGraw-Hill 1986.

OUTCOMES:

On Completion of the course the students will be able to

- Understand the design and operation of fermenter and types of fermentation process
- Acquire knowledge about formulation of medium and its prerequisites
- Interpret stoichiometry and energetics of cell growth and product formation
- Analyze the modes of operation of bioreactor and its design equations
- Evaluate the kinetics and mechanism of microbial growth by using various models

LSD7104	Lab III (Plant and animal Biotechnology/ Bioprocess Technology)	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To establish animal cell line cultures
- To test drugs toxicity in the cultured cells
- To study cell morphology and also to perform different staining procedures to
- Identify the active status of the cells.

EXPERIMENTS:

1. MTT assay
2. Morphological characterization of cell death
3. Acridine orange/Ethidium bromide staining
4. Biochemical characterization of cell death
5. Isolation of proteolytic organism from soil sample
6. Glucose assay by DNS method
7. Evaluations of enzyme kinetic parameters
8. Enzyme activity calculation
9. Determination of optimum pH for enzyme
10. Determination of optimum temperature for an enzyme
11. Enzyme immobilized by alginate gel method
12. Hydrolysis of starch by immobilized method
13. Effect of substrate concentration on biomass yield
14. Solvent extraction techniques for product recovery
15. Micropropagation of plant by leaf disc culture
16. Electroelution of insert DNA from agarose gel slice.
17. Molecular analysis of putative transformed plants by Polymerase Chain Reaction

REFERENCES:

1. Yadav P. R, Tyagi R. Biotechnology of Animal Tissues. Discovery Publishing House, 2006.
2. Freshney R. I, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Edition, John Wiley & Sons, Inc. 2010.

3. Freshney R. I, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell. 6th Edition, 2010.
4. Razdan M. K. Introduction to Plant Tissue Culture . Science Publishers, 2003
5. Laimer M, Rcker. W. Plant Tissue Culture. Springer, 2003.
6. Reinert J, Yeoman M. M. MacDonald P. Plant Cell and Tissue Culture: A Laboratory Manual. Springer. 2012

OUTCOMES:

At the end of the course, student will be able to

- carry out experiments related to representative plant tissue culture techniques and explore their applications.
- employ advanced techniques in plant biotechnology such as gene manipulation and molecular genetics.
- discuss and appreciate the potential applications of plant biotechnology for the benefit of mankind
- Develop practical skills in enzyme kinetics and immobilization techniques
- Optimize the environmental conditions for maximal enzyme activity

ELECTIVES I SEMESTER

		L	T	P	C
LSDY101	BIOSAFETY, BIOETHICS, BIOENTREPRENEURSHIP, INTELLECTUAL PROPERTY RIGHTS	3	0	0	3

Objectives:

The course is designed to provide an understanding of the ethical issues underlying biotechnology research and innovation in addition to protection of the acquired intellectual property. The student will gain an understanding research methodology, the ethical issues underlying biotechnology research and the importance of protection of intellectual property

MODULE I ETHICS IN BIOLOGY 9

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 9

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 9

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

MODULE IV INTELLECTUAL PROPERTY RIGHTS 9

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 9

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, 1985.
2. Sasson A, Biotechnologies and Development, UNESCO Publications, 1988.
3. Singh K, Intellectual Property rights on Biotechnology, BCIL, New Delhi, 1993.

OUTCOMES:

At the end of course the student will be able to :

- understand the nature of hazards related to biotechnology and the importance of biosafety in research.
- debate on ethical issues related to biotechnology research.
- understand methods used in scientific research and to emphasize on the importance of statistical concepts.
- realize the importance of intellectual property and its protection under the constitution.

LSDY102	MICROBIOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

This course introduces the fundamentals of Microbiology, characteristics of microorganisms, infectious diseases and applications of microorganisms in various fields.

MODULE I INTRODUCTION TO MICROBIOLOGY 9

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 9

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 9

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 8

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.

OUTCOME:

On the completion of the above objectives student will be able to

- Highlight the roles and characteristics of microorganisms
- Acquire knowledge in the growth of microorganisms and impact of environment on their growth and theoretical knowledge on the applications of advanced microscopic techniques
- Understand the role of microbes in public health and antimicrobial agents
- Acquire the knowledge on the applications of microbes and their products in various field
- Gain knowledge on the host-microbe interactions

LSDY103	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 9

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

MODULE II FRESH FRUITS AND VEGETABLES 9

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

MODULE III SEA FOOD 9

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

MODULE IV ANIMAL PRODUCT 9

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

MODULE V DIARY PRODUCT 9

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

Total Hours: 45

REFERENCES:

1. Fennma Karrel, Principles of Food Science, Vol-I, Marcel Dekker, 1975.
2. Modern Dairy Products, Lampert LH; 1970, Chemical Publishing Company.
3. P. F. Fox, Developments in Dairy Chemistry – Vol 1 & 2; Elsivier Applied Science Publishers, London & New York, 1985.
4. Processed Meats; Pearson AM & Gillett TA; 1996, CBS Publishers.
5. Meat; Cole DJA & Lawrie RA; AVI Pub, 1975.
6. A. C. Chakraborty, Post Harvest Technology of cereal pulse and oil seeds, OXFORD & IBH PUBLISHING; 3rd Revised edition edition, 2019.
7. Egg and poultry meat processing; Stadelman WJ, Olson VM, Shemwell GA & Pasch S; 1988, Elliswood Ltd.
8. Egg Science & Technology; Stadelman WJ & Cotterill OJ; 1973, AVI Pub.
9. Technology of Food Preservation by Desrosier Fish as Food; Vol 1 & 2; Bremner HA; CRC Press 2002.
10. Fish & Fisheries of India; Jhingram VG; Hindustan Pub Corp, 1983.
11. Robinson RK; 1996; Modern Dairy Technology, Vol 1 & 2; Elsevier Applied Science Pub.
12. Milk & Milk Processing; Herrington BL; McGraw-Hill Book Company, 1948.

OUTCOMES:

On the completion of the above objectives student will

- Know the equipments and their preliminary operations in food processing
- Understand the physical principles involved in the food processing techniques and the equipments used.
- Equip themselves to trouble shoot the problems arises in drying process to preserve the foods
- Familiarize with preservation of foods at low temperature
- Know the unit operations involved in processing of solid and liquid foods

LSDY104	ANALYTICAL TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

The course aims at imparting knowledge on the theoretical principles, practical details and applications of the key experimental techniques that are routinely used in biotechnology. To establish the basics of practical biochemistry and to provide a platform for understanding and analyzing biomolecules.

MODULE I: CALORIMETRY AND SPECTROSCOPY 9

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 9

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 9

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 9

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

MODULE V CHROMATOGRAPHY 9

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.

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.

OUTCOME

At the end of the course, the students will

- understand the importance of laboratory safety and standard operating procedures of common laboratory equipment's
- theoretically trained to with working knowledge of different instruments and be able design experiments
- understand the importance of preparation of biological buffers and Regants
- analyze and estimate biomolecules in normal and diseased conditions
- apply modern separation techniques for biomolecules

LSDY105	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

MODULE I INTRODUCTION TO ENVIRONMENTAL BIOTECHNOLOGY **9**

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

MODULE II ENVIRONMENTAL SAMPLE ANALYSIS **9**

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

MODULE III WASTE WATER MANAGEMENT **9**

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

MODULE IV BIOREMEDIATION-BIOTECHNOLOGY 9

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

MODULE V BIOOXIDATION & MICROBIAL LEACHING 9

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

Total Hours: 45

REFERENCES:

1. Amann, R.I. Stromley, J. Stahl : Applied & Environmental Microbiology, *61*, 1013-1019,1995
2. W.D. Grant & P.E. Long, Environmental Microbiology, Blakie, Glassgow and London, 1981
3. Ray T. B. Microbial Gene Technology, H. Polasa (ED.) South Asian Publishers, New Delhi, 1984.
4. Biotreatment Systems, Vol. 22, D. L. Wise (Ed.), CRC Press, INC, 1986.
5. Standard Methods for the Examination of Water and Waste Water (14 th Education), American Public health Association, 1985.

OUTCOMES:

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

- Understand the biotechnological solutions for the treatment of industrial liquid and solid wastes
- Acquire knowledge in aerobic and anaerobic biological treatment technologies
- Understand the bioconversion pathways for the degradation of various xenobiotic compounds

- Gain knowledge on the recovery of high value-added bioproducts from industrial wastes
- An understanding of environment protection regulations and source of environmental pollutions.

LSDY106	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 9

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

MODULE II BASIC MECHANISM 9

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

MODULE III PHYSIOLOGY OF RNA INTERFERENCE 9

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

MODULE IV APPLICATIONS 9

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

MODULE V RNAI BIOTECHNOLOGY 9

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: 45

REFERENCES:

1. RNAi Technology. R K Gaur, CRC Press, 2011
2. Wei Ping Min, RNA Interfernce: From biology to clinical applications, Humana Press, 2006.
3. Esra Galun, RNA Silencing, World Scientific Publishing Co. Pte. Ltd, 2005.

OUTCOMES:

At the end of this course students will

- Introduced to the concept of gene silencing mechanisms
- Have the knowledge of different types of RNAi existing in the living systems
- Have the knowleged on the applications of RNAi

- Introduced to the physiology of RNAi interference in different life forms
- Able to apply the knowledge to pharmaceutical, food and other biotechnology industries

ELECTIVES II SEMESTER

LSDY 201	RECOMBINANT DNA TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVE:

- To introduce the students to different vectors for genetic manipulation of cells
- To give a working knowledge for techniques involved in DNA extraction, purification and manipulation
- Make the students understand the principle of techniques used in the creation of recombinant DNA molecules and the selction of the cells harbouring them
- To learn applications of Recombinant DNA Technology

MODULE I CLONING & CLONING VECTOR 9

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 9

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 9

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 9

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 9

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. James D. Watson, Recombiant DNA, 2nd Edition, Scientific American; Second Edition edition, 1998.

2. T. A. Brown, Gene Cloning and DNA analysis: An Introduction, 7th edition,Willey-Blackwell, 2016.

OUTCOMES:

At the end of the course the student will be able to

- Familiarize with the basic concepts and principles of utilization of different expression vectors for cloning in prokaryotic and eukaryotic organisms
- Understand the different strategies of gene cloning and construction of genomic and cDNA libraries for applications of recombinant DNA technology
- Familiarize the concepts of structural and functional genomics
- Understand utilization and principle of mutagenesis studies and hybridization probes
- will be skilled enough to use these techniques in different fields, such as forensic science, agriculture, medicine , industry, etc.

LSDY 202	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 9

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 9

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 9

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 9

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 9

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).

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:

At the end of the course, the students will

- understand the importance of laboratory safety and standard operating procedures of common laboratory equipment's
- theoretically trained to with working knowledge of different instruments and be able design experiments
- understand the importance of preparation of biological buffers and Regants
- analyze and estimate biomolecules in normal and diseased conditions
  apply modern separation techniques for biomolecules

LSDY 203	MOLECULAR DIAGNOSTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

MODULE I INTRODUCTION TO MOLECULAR DIAGNOSTICS 9

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

MODULE II INFECTIONS 9

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

MODULE III CLINICAL GENETICS 9

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

MODULE IV IMMUNODIAGNOSTICS 9

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

MODULE V FORENSIC SCIENCE 9

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

Total Hours: 45

REFERENCES:

1. Carl A. Burtis, Edward R. Ashwood, Tietz Textbook of Clinical Chemistry, eds. Philadelphia, PA: WB Saunders, 1998
2. Lisa Anne Shimeld , Anne T. Rodgers, Essentials of Diagnostic Microbiology, Delmar Cengage Learning; New edition edition, 1998
3. John Crocker, David Burnett, The Science of Laboratory Diagnosis, Wiley, 2005

OUTCOMES:

At the end of the course the students will be

- Familiar with the theoretical working princlles of clinical biochemistry.
- Understand the causes and spread of infection and design strategy to stop their spread.
- Understand the aspects of genetic disease, their causes and design strategy to diagnose them at earlier stages.
- Learners will be able to define basic terminology and describes basic concepts in molecular diagnostics
- will know the importance and the relevance of molecular diagnostic techniques and applications of molecular diagnostics in various field including medical, forescenic, etc.

LSDY 204	OMICS	L	T	P	C
		3	0	0	3

OBJECTIVES

- The course is aimed to introduce the students to field of genomics. They will be made familiar to different tools and databases used in the field.
- The students will get working knowledge of transcriptomics and its application to pharmogeentics and drug development
- The students will be introduced to the field of proteomics. Its application in forensic science
- The students will be made familiar to some latest techniques in omics.

MODULE 1 GENOMICS: **9**

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 9

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 9

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 9

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 9

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)

REFERENCES:

1. Introduction to Proteomics -Tools for the New Biology by Daniel C. Liebler, Humana Press, 2002.
2. Mass Spectrometry for Biotechnology by Gary Siuzdak, Academic Press, 1996.
3. Proteomics for Biological Discovery by Timothy Veenstra and John Yates, Wiley, 2006.
4. Metabolomics- Methods and Protocols by Wolfram Weckwerth, Humana Press, 2007.
5. Lipidomics- Technologies and Applications by Kim Ekroos, Wiley-VCH, 2012.
6. Web/Journal Resources.
7. Transcriptomics: Expression Pattern Analysis, Virendra Gomase, Somnath Tagore; VDM Publishing, Science, 2009.

OUTCOMES:

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

- Apply the knowledge of omics to biological system of interest to obtain a snapshot of the underlying biology at a great resolution
- Able to design drugs at the level of transcriptome
- Understand the interaction of drugs at proteome level.
- Able to design strategies that can integrate genomics, proteomics, transcriptomics to understand the living systems
- Recognize proteases as the next target for treatment of emerging diseases.

LSDY205	BIOFUELS AND BIOENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The students will be introduced to the petroleum and bio-based fuels and their affect on the global carbon cycle
- The students will be made familiar to the attributes of biofuels that make them suitable as a fuel for a specific application
- The students will be made aware of limitations of biofuels
- The students will be asked to report on global impacts of biofuels on food and energy supplies
- The students will demonstrate understanding on technological advances and challenges to be overcome for wide-scale biofuel adoption

MODULE I BIOCHEMISTRY OF BIOMASS 9

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 9

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 9

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.

MODULEIV BIOFUELS & ALCOHOL TECHNOLOGY 9

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 9

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?

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

- Advancement of integrated technologies for the production of lingo cellulosic derived biofuel
- 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

LSDY206	MOLECULAR FARMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The students will be given an overview of the field of molecular farming.
- The students will be taught the basic principles and techniques of exogenous and endogenous protein production.
- To create an awareness among students regarding different host that can be used for the recombinant production of proteins and biomolecules of industrial relevance

MODULE I INTRODUCTION AND FOREIGN PROTEIN EXPRESSION 9

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 9

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 7

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, 2006.
2. Wiley.VCH Verlag GmbH and Co. KGaA. 2004.

OUTCOMES:

The students will be

- Acquainted concepts of expression of recombinant protein in different hosts.
- Familiarized with concepts of sprouting of different seed type, effect of different parameters on the sprouting process.
- Knowing the current molecular methods of transforming plants for the production of industrially relevant protein
- Understand the bioprocessing of clinically important protein in plants
- acquire knowledge about biological problems that requires engineering expertise to solve them.

ELECTIVES III SEMESTER

LSDY111	BIOPHARMACEUTICALS	L	T	P	C
		3	0	0	3

OBJECTIVE:

The purpose of this course is to

- 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

MODULE I INTRODUCTION TO BIOPHARMACEUTICAL 9

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 9

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 9

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 9

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 9

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: 45

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:

The students will be

- Acquainted with parameters desired in an ideal drug.
- Familiarized with mechanism of action and clinical uses of few Pharmaceutical agents.
- Knowing the current industrial methods of preparing certain special Pharmaceutical agents,
- Aware of laws and regulations of Pharmaceutical sector in India
- 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

LSDY112	MOLECULAR & IMMUNO DIAGNOSTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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 MOLECULAR BIOLOGY AND DIAGNOSTICS 9

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 9

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 9

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 9

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 9

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: 45

REFERENCE:

1. Molecular Diagnostics: George P Patrinos and Wilhelm Ansorge, Elsevier Academic Press, 2005.

OUTCOMES:

The students will be able to

- understand cellular structure and function, especially DNA and RNA, to molecular diagnostic procedures.
- understand the different mechanisms of cell signaling and transport of molecules in cell. The importance of these processes in maintaining homeostasis.

- Skilled in the working knowledge of nucleic acid extraction, resolution and detection.
- have a solid foundation in the most commonly utilized molecular diagnostic testing protocols.
- theoretically skilled to apply the knowledge of molecular testing to the most commonly performed applications in the clinical laboratory.

LSDY113	TISSUE AND ANTIBODY ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

The students will be made to

- 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.
- 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 9

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 9

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 ` 9

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 9

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 9

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

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

On the completion of course the students will

- Execute the engineering design process: identify problem, identify design constraints on bioengineering problem, create solutions, and evaluate solutions with respect to these constraints.)
- understand and then execute key steps of the engineering design process, including identification of the problem, exploration of the problem, and design of a solution.
- Skilled 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.
- understand the structure, variation, genetic loci and gene structure of antibody molecules.
- understand the concepts and techniques utilized in antibody engineering.

LSDY114	BIONANOTECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

MODULE I FUNDAMENTALS OF NANOSCIENCE 9

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

MODULE II CHARACTERIZATIONS IN BIONANOTECHNOLOGY 9

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

MODULE III APPLICATIONS OF BIONANOTECHNOLOGY 9

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

MODULE IV NANOMATERIALS AND DIAGNOSTICS 9

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

MODULE V NANOMATERIALS AND TOXICITY EVALUATION 9

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

Total Hours: 45

REFERENCES:

1. C. M. Niemeyer, C. A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspective, Wiley – VCH, 2004.
2. 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 nanoparticles and the field of bionanotechnology.
- Understanding the techniques used for the characterization of nanoparticles
- understanding the application of Nanomaterials in biotechnology and acquire the knowledge about the DNA, proteins, amino acids, drug delivery, biomedicine etc.
- it will also impart correct scientific understanding of current evironmnetal problems that can be solved using nanobiotechnology.
- focus on advanced nanobiotechnology techniques to facilitate nanoparticles and toxicity evaluation

LSDY115	PROTEIN ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Learn the levels of structure of protein and forces stabilizing this structure
- Learn the principles and techniques involved in studying protein structure
- Learn the principles and techniques for modifying proteins or production of recombinant protein
- Learn the principles and techniques for homologous and heterologous protein production in different sources
- Knowledge of molecules and techniques for increasing protein stability for industrial use

MODULE I INTRODUCTION TO PROTEIN ENGINEERING 9

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 9

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 9

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 9

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

MODULE V STABILIZATION AND MODIFICATION OF PROTEINS 9

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.

REFERENCES:

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

- Understand the structure function correlation and the prediction of properties of protein based on its sequence.
- Observe the similarities in structure at basal level in a group of having similar function, thereby predicting the strategies to modify and design novel proteins.
- Understand different analytical methods to determine protein structure and protein – protein interactions.
- Understand the basic concepts related to protein extraction and purification
- Understand the basic concepts involving protein structure stabilization and modification.

LSDY116	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

To acquire knowledge in stem cell proliferation, differentiation and characterization to apply this concept on tissue engineering and organ regeneration

MODULE I GENESIS OF CELLS 9

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 9

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 9

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 9

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 9

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

- Gain basic knowledge in stem cells and understand the importance of stem cell research
- Acquire the essentials of culturing and differentiation of stem cells
- Understand the role of signal pathways in cancer stem cell proliferation
- Conceptualize the therapeutic applications of stem cells in tissue engineering and organ regeneration