



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)

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**M.Sc.**  
**(Microbiology)**



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

**M.Sc.  
MICROBIOLOGY**



## **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. (MICROBIOLOGY)**

#### **PROGRAMME EDUCATIONAL OBJECTIVES:**

The course aims to provide an advanced understanding of the core principles and topics of Microbiology and their experimental basis to enable students in acquiring a specialized knowledge by means of dedicated lecture series and subject-oriented research project. Hence, the main objectives of the program are:

- To communicate the basic knowledge in general microbiology with detailed subdivision of microbiology.
- For the basic understanding this course includes microbial biochemistry, physiology and molecular Biology to give basic understanding of the microbiology.
- Further bacteriology, virology, mycology give individual sections of microbiology with detailed information on economic importance of microbiology.
- Finally this course explains the advanced sections of microbiology like Immunology, Microbial genetics, food microbiology, medical microbiology, Environmental microbiology, industrial microbiology and bioinformatics.
- This course provides necessary theoretical and practical experience in all divisions of microbiology to become an effective professional.
- This course provides broad exposure to various communities, ecological and commercial issues in the field microbiology.

**PROGRAMME OUTCOMES:**

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

- On completion of the program the graduates will have applied knowledge in microbiology and the subdivision of microbiology.
- Microbial Biochemistry, Physiology and Molecular Biology will give basic understanding of the microbiology.
- Individual sections like bacteriology, virology, mycology give will give knowledge detailed information on economic importance of microbiology. develop ability to independently carry out a complete scientific work process, such as understanding of theoretical background, hypothesis generation, collection and analysis of data, and interpretation and presentation of results.
- Assess and predict the technological, ethical and social effects of their own work /disciplines and of microbiology.

**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:

<b>Degree</b>	<b>Mode of Study</b>
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.

<b>Programme</b>	<b>Non-project semester</b>	<b>Project semester</b>
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 than 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:

<b>Letter Grade</b>	<b>Grade Points</b>
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 reevaluation 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 reevaluation 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  $i^{\text{th}}$  course and  $GP_i$  is the Grade Point in the  $i^{\text{th}}$  course

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

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**

Notwithstanding 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. MICROBIOLOGY  
CURRICULUM & SYLLABUS, REGULATIONS 2019**

<b>S.No</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester-I</b>						
1	LSD 6102	Cell and Molecular Biology	4	0	0	4
2	LSD 6121	Biochemistry	4	0	0	4
3	LSD 6122	Microbial Genetics	4	0	0	4
4		Elective 1	3	0	0	3
5		Elective 2	3	0	0	3
6	LSD 6123	Lab 1 (Biochemistry/Molecular Biology/ Microbial Genetics)	0	0	4	2
						<b>21</b>
<b>Semester – II</b>						
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 6221	Industrial Internship	0	0	0	1
8	LSD 6222	Mini Project	0	0	0	1
						<b>22</b>

S.No	Course Code	Course Title	L	T	P	C
<b>Semester – III</b>						
1	LSD 7121	Project Phase 1	0	0	2	2
2	LSD 7122	Industrial, Food and Agricultural Microbiology	4	0	0	4
3	LSD 7123	Environmental and Medical Microbiology	4	0	0	4
4		Elective 5	3	0	0	3
5		Elective 6	3	0	0	3
6	LSD 7124	Lab III (Industrial, Food and Medical Microbiology)	0	0	4	2
						17
<b>Semester – IV</b>						
1	LSD 7121	Project Phase 2	0	0	36	18
<b>Credits (Phase I 2+ Phase II 18)</b>						<b>20</b>
<b>Total Credits</b>						<b>80</b>

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

**ELECTIVES**

<b>Course Code</b>	<b>Electives I Semester</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
LSDY 101	Biosafety, Bioethics, Bioentrepreneurship, Intellectual Property rights	3	0	0	3
LSDY 104	Analytical Methods	3	0	0	3
LSDY 121	Animal Biotechnology	3	0	0	3
LSDY 122	Plant Biotechnology	3	0	0	3
LSDY 123	Parasitology	3	0	0	3
LSDY 124	Virology	3	0	0	3
<b>Electives II Semester</b>					
LSDY 201	Recombinant DNA Technology	3	0	0	3
LSDY 203	Molecular Diagnostics	3	0	0	3
LSDY 205	Biofuel and Bioenergy	3	0	0	3
LSDY 211	Diagnostics of Infectious Diseases	3	0	0	3
LSDY 212	Metagenomics	3	0	0	3
LSDY 213	Bioprocess (Microbial)	3	0	0	3
<b>Electives III Semester</b>					
LSDY 111	Biopharmaceuticals	3	0	0	3
LSDY 112	Molecular and Immuno 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 131	Bioremediations	3	0	0	3

**SEMESTER I**

<b>LSD 6102</b>	<b>CELL &amp; MOLECULAR BIOLOGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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 12**

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 12**

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 12**

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 12**

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                      12**

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 and termination- Regulation of translation.

**Total Hours: 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 6121****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 5**

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

**MODULE II ENZYMOLOGY****10**

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

**MODULE III ENERGY PRODUCTION AND OXIDATIVE****PHOSPHORYLATION****14**

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

Glycolysis: glycolytic pathway. Molecular mechanism of action of the glycolytic enzymes. Energetic of glycolysis. Glycolysis and cancer biology—Warburg Hypothesis and PET scanning. Fates of Pyruvate under anaerobic conditions: alcohol and lactic acid fermentation. Importance of lactic acid fermentation.

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

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

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

#### **MODULE IV METABOLIC INTERRELATIONSHIP 9**

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

#### **MODULE V REGULATORY MECHANISMS OF METABOLIC PATHWAYS 7**

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

**Total Hours: 45**

#### **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 6122****MICROBIAL GENETICS****L T P C****4 0 0 4****OBJECTIVES:**

- To get overview on microbial genetics, concepts, theories and genetic tools.
- To learn about the genetics of bacteriophage
- To get knowledge on fungal and viral genetics.
- To understand the concept of operon gene expression and different types of operons.

**MODULE I BACTERIOPHAGE 12**

Structure, Life Cycle and Lytic-Lysogenic Options of A Bacteriophage. The lambda Lifecycle, Genes involved in lysogeny and lytic cycle of lambda phage. Lifecycle Of M13-M13 Adsorption And Injection, Protection of The M13 Genome. Lifecycle of P1, Adsorption, Injection And P1 Transducing Particles. Lifecycle of T4-T4 Adsorption And Injection.

**MODULE II METHODS OF GENE TRANSFER IN BACTERIA 12**

Genetics of Bacteria, Mutations and growth in bacteria. Mechanisms of Genetic Exchange in Bacteria- Transformation, conjugation, Properties of the F plasmid, F+ x F - mating, F' x F- conjugation. Hfr bacteria and chromosome mapping, Transduction: Generalized and specialized transduction.

**MODULE III TRANSPOSABLE GENETIC ELEMENTS 12**

Transposable elements in bacteria and yeast, Insertion sequences- structure and occurrence, Mechanism of transpositions –Replicative, Non replicative, regulation and activation. Conjugative transpositions, Phase variation.

**MODULE IV FUNGAL GENETICS 12**

Fungi as Model for genetic studeis, Structure and Organization of Fungal Genome, Life Cycles, Mating Systems and Genetic Exchange in Fungi: Life cycles and sexual process, Mating system and promotion of outcrossing, Systems restricting outcrossing, Sexual differentiation and relationship to outcrossing, Hetrokaryosis, the parasexual cycle and Vegetative incompatibility, Role and consequences of Vegetative incompatibility, Sex and Outcrossing, Neurospora and Classical Genetics, Applied molecular genetics of fungi.

**MODULE V                      REGULATION OF GENE EXPRESSION                      12**

Constitutive, Inducible, and Repressible Gene expression, positive and negative control of gene expression operons: coordinately regulated units of gene expression. The lactose operon in e. coli: induction and catabolite repression. The tryptophan operon in E. coli: repression and attenuation. Translational control of gene expression, posttranslational regulatory mechanisms

**Total Hours: 60****REFERENCES**

1. Snyder L and Champness W. Molecular Genetics of Bacteria. 3rd Ed, ASM Press, Washington, 2002.
2. Baumberg S. Prokaryotic gene expression. Oxford University Press 2002.
3. Watson J. D, Hopkins N. H, Roberts J. W,SteitzJ. A and WeinerA. M. Molecular Biology of the Gene, 4th Ed., Benjamin/Cummings, 1987.
4. Streips U. N, Yasbin R. E. Modern Microbial Genetics, 2<sup>nd</sup> Ed., Wiley-Liss, Inc. 2002.

**OUTCOMES:**

After completion of this course, the students will

- Understand the structure of viruses, know about the different forms based on life cycle
- Introduced to the concept of transfer of genetic information between viruses and host cells
- Will get information on jumping genes, their occurrence in different life forms
- Understand the use of fungus in carrying out the genetic studies
- Also learn about genetic regulation of essential life processes.

<b>LSD 6123</b>	<b>Lab 1 (Biochemistry, Molecular Biology and Microbial Genetics)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**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. Staining Techniques (Gram staining, spore staining )
14. Antibiotic Assay - Antimicrobial Sensitivity Test (Disc Diffusion Method)
15. Growth Kinetics (Bacterial Growth Curve)
16. Isolation of antibiotic resistant mutants by chemical mutagenesis.
17. Ampicillin selection method for isolation of auxotrophic mutant. 5. Extraction and Purification of RNA from *S. cerevisiae*.
18. Studies on gene expression in *E.coli* with reference to lac operon.
19. Study of conjugation in *E. coli*.
20. Restriction digestion and agarose gel electrophoresis of DNA.
21. Generalized transduction in *E. coli* using P1 phage.

## REFERENCES

1. Michel R. G and Sambrook J. Molecular Cloning- 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**

<b>GEC 6202</b>	<b>RESEARCH METHODOLOGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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 Chems sketch. 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., NewDelhi, 1991.

7. Coghill M. and Gardson L.R., The ACS Style Guide Effective Communication of Scientific Information, 3rd Edn., Oxford University Press, 2006.
8. Willa Y. Garner, Maureen S. Barge, James, P, Good Laboratory Practice Standards: 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.

**LSD 6201****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 Immunology, Immune dysfunction and its consequences, Cells & Tissues of Immune System: Hematopoiesis, Apoptosis and Necrosis, systemic function of Immune system, organs of immune systems, Lymphoid cells and organs Evolutionary comparison. 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 allergies-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  $\alpha\beta$  and  $\gamma\delta$  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  $\gamma\delta$  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**

- a. Kubly, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
- b. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
- c. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
- d. 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.

**LSD 6202****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 PROGRAMMING 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.
6. Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., East West Press, 2003
7. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002

**OUTCOMES:**

At the end of this course,

- students will 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.

<b>LSD 6203</b>	<b>Lab II (Immunology/ Bioinformatics)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**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.

**REFERENCES:**

1. Rose et al., Manual of Clinical laboratory Immunology, 6th Ed ASM Publications, 2002.
2. Lefkovic 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. 3rd 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.
- They will also learn about different types of errors obtained during data collection and analysis

**SEMESTER III**

<b>LSD 7122</b>	<b>INDUSTRIAL, FOOD, AGRICULTURAL MICROBIOLOGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**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
- To get understanding of fermentation process and its industrial application
- To understand the properties and reactions of various microorganisms and their various development strategies with a clear understanding in terms of agricultural and food Biotechnology.

**MODULE I INDUSTRIAL BIOTECHNOLOGY- AN INTRODUCTION 12**

Exploitation of microorganisms and their products, screening, strain development strategies, immobilization methods, fermentation media, raw material used in media production, antifoaming agents, buffers, downstream processing.

**MODULE II FERMENTATION 12**

Fermentation equipment and its uses, fermentor design, Types of fermentors and fermentations- single, batch, continuous, multiple, surface, submerged and solid state.

**MODULE III MICROORGANISMS IN AGRICULTURE AND PLANT DISEASES 12**

Microorganisms as biofertilizers (Rhizobial, Cyanobacterial, Mycorrhizal, Azotobacter): production and application of Microbial biopesticides, recombinant pesticides, GMO and their impact. Microbial diseases of crops: transmission of pathogens, Citrus canker, little leaf of brinjal, red rot of sugarcane, brown rot of potato, black rot, mosaic virus, tomato spot, early and late blight, wilt disease. Control of plant diseases.

**MODULE IV MICROORGANISMS IN FOOD 12**

Microorganisms important in food microbiology – molds, yeasts, bacteria, principles of food preservation – high and low temperatures, drying, chemical preservatives,

food additives. Food spoilage and food borne infections, general principles underlying food spoilage and contamination, canned food spoilage, spoilages of vegetables, fruits, meat and meat products, milk and milk products, fish, seafood and poultry.

## **MODULE V FOOD PRODUCTS**

**12**

Food produced by microbes: bread, cheese, fermented dairy products, microbial cells as food – single cell proteins, mushroom, fermented Indian foods.

**Total Hours: 60**

### **REFERENCES:**

1. Fennema Karrel, Principles of Food Science, Vol-I, 1985.
2. Modern Dairy Products, Lampert LH; 1970, Chemical Publishing Company
3. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968.
4. Prescott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005.

### **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, prevention of growth of microorganisms in food products
- Familiarize with alternative sources of food

**LSD 7123****ENVIRONMENTAL AND MEDICAL  
MICROBIOLOGY****L T P C****4 0 0 4****OBJECTIVES:**

- To learn the basic principles of environment and medical microbiology and be able to apply these principles to understanding and solving problems in water quality.
- To become familiar with current research in environmental microbiology and its applications.
- Develop knowledge of microbial organisms and their relevance of infectious diseases.
- Understand the principles of prevention and treatment of pathogenic microorganism infection in humans.

**MODULE I INTRODUCTION TO ENVIRONMENTAL MICROBIOLOGY 12**

Environmental Microbiology: Waste treatment - Wastes - types and characterization. Treatment of solid wastes - composting, vermiform composting, silage, pyrolysis and saccharifications. Treatment of liquid wastes - primary, secondary (anaerobic and aerobic) - trickling, A-9 21 activated sludge, oxidation pond, and oxidation ditch-tertiary - disinfection.

**MODULE II DEGRADATION USING MICROBES 12**

Degradation of of Xenobiotic compounds: Simple aromatics, chlorinated polyaromatic petroleum products, pesticides and surfactants. Biodeterioration of materials - paper, leather, wood, textiles and paint. Metal corrosion - Bioaccumulation of heavy metals. Biofouling and Bioleaching.

**MODULE III MICROBIAL ASSESMENT OF WATER 12**

Physical, chemical and microbial assessment of water and potability test for water. Physical and chemical - colour, pH, alkalinity, acidity, COD, BOD, anions and cations. Microbiological - MPN index - presumptive, completed and confirmatory tests.

**MODULE IV                    EPIDEMIOLOGY AND PATHOGENECITY OF DISEASES                    12**

Epidemiology, pathogenicity and treatment of diseases caused by Haem. influenzae, C. diphtheriae, E. coli, Pseudomonas, Bacillus anthracis, Cl. tetani, Cl. walchi, Leptospira icterohaemorrhagiae, N. gonorrhoea, Mycoplasma, campylobacter. Rickettsia -cox, burneti, Chlamidiae -trachoma, New Bacterial diseases- Helicobacter, Lyme diseases, Legionella.

**MODULE V                    INFECTION & DRUGS                    12**

Infections in Vulnerable hosts, antimicrobial drugs, Bauer Kirby test, Broth dilution test, minimum inhibitory and lethal concentrations. Mechanism of action and activity spectrum of penicillin, streptomycin, tetracycline, sulfonamides, rifampicin, polymixin - B, Amphotericin – B. Drug resistance.

**Total Hrs: 60**

**REFERENCES:**

1. Ashok Kumar Chauhan, Ajit Varma, Microbes: Health and Environment (Microbiology), Anshan Publishing; 1 edition, 2006.
2. Ian Pepper Charles Gerba Jeffrey Bredecke, Environmental Microbiology, Elsevier, 1995.
3. Patrick Murray Ken Rosenthal Michael Pfaller, Medical Microbiology, Elsevier, 2015

**OUTCOMES:**

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

- The concept and principles of waste management, types and uses
- The concept and principles of degradation of xenobiotic compounds and applications
- The concept and principles of physical, chemical and microbial analysis of water bodies
- The concept and principles of disease epidemiology
- The concept and principles infectious diseases and development of vaccines

**LSD 7124****LABORATORY 3  
(Industrial, Food and Medical Microbiology)****L T P C**

0 0 4 2

**OBJECTIVES:**

- To understand the principles of the underlying the properties and reactions of various Microorganisms and their various development strategies with a clear understanding in terms of agricultural and food Biotechnology and to update students knowledge of new developments in biology of industrial relevance.
- To learn the basic principles of environment and medical microbiology and be able to apply these principles to understanding and solving problems in water quality. To become familiar with current research in environmental microbiology and its applications. Develop knowledge of microbial organisms and their relevance of infectious diseases. Understand the principles of prevention and treatment of pathogenic microorganism infection in humans.

**EXPERIMENTS:**

1. Production and estimation of lactic acid by Lactobacillus Sp. Or Streptococcus Sp.
2. Extraction and estimation of diacetyl.
3. Sauerkraut fermentation
4. Isolation of food poisoning bacteria from contaminated foods, Dairy products
5. Extraction and detection of afla toxin for infected foods.
6. Preservation of potato/onion by UV radiation
7. Production of fermented milk by Lactobacillus acidophilus.
8. Rapid analytical techniques in food quality control using microbial Biosensors.
9. Microbial production , Extraction , purification and Confirmation of alpha amylase/ Lipase
10. Immobilization of cells and enzyme using Sodium alginate and egg albumin and measurement of enzyme activity [ amylase/ /Lipase ]
11. Cell disruption for endoenzymes by sonication.
12. Physical analysis of sewage/industrial effluent by measuring total solids, total dissolved solids and total suspended solids.
13. Determination of indices of pollution by measuring BOD/COD of different effluents. 3. Bacterial reduction of nitrate from ground waters
14. Microbial dye decolourization/adsorption.

15. Comparison of ethanol production using various Organic wastes /raw Material [Free cells/ immobilized cells].

**REFERENCES:**

1. Martin Adams, Maurice Boss, Food Microbiology. 2nd Edition, 2000.
2. Banwart George J , Basic Food Microbiology, Springer, 1989.
3. Michael Doyle, Francisco Diez-Gonzalo, Food Microbiology: Fundamentals and Frontiers , American Society for Microbiology, 2013
4. V. K. Joshi, Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2, 2009.
5. J. B. Prajapati, Fundamentals of Dairy Microbiology, Nadiad Akta Prakashan, 1995.
6. John, Garbutt, Essentials of Food Microbiology, Arnold International Students Edition, 1997.
7. Brian J. Wood, Microbiology of Fermented Foods. Volume II and I, Springer US, 1998.
8. John C. Ayres. J. Orwin Mundt. William E. Sandinee, Microbiology of Foods by. W. H. Freeman and Co., 1980.
9. Richard K Robinson, Dairy Microbiology Handbook: The Microbiology of Milk and Milk Products, Volume II and I, 2002.
10. Michael P. Doyle, Larry R. Beuchat and Thomas I. Montville, Food Microbiology: Fundamentals and Frontiers. 2nd Edition (Eds.), ASM Publications, 2001.
11. Abigail A. Salyers and Dixie D. Whitt, Bacterial Pathogenesis A Molecular Approach. 2nd Edition. ASM Publications, 2001.
12. D. Pearlman, Advances in Applied Microbiology, Academic Press, 1980.

**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.
- The concept and principles of degradation of xenobiotic compounds and applications
- The concept and principles of physical, chemical and microbial analysis of water bodies
- Will gain the working knowledge of enzyme immobilization used in industries

**ELECTIVES I SEMESTER**

<b>LSDY 101</b>	<b>BIOSAFETY, BIOETHICS, BIOENTREPRENEURSHIP, INTELLECTUAL PROPERTY RIGHTS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**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.

**LSDY 104****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.

### 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

<b>LSDY 121</b>	<b>ANIMAL BIOTECHNOLOGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		3	0	0	3

**OBJECTIVES:**

The student will learn about

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

**MODULE I ANIMAL CELL CULTURE 9**

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

**MODULE II ANIMAL HEALTH BIOTECHNOLOGY 9**

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

**MODULE III ANIMAL REPRODUCTIVE BIOTECHNOLOGY 9**

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

**MODULE IV ANIMAL GENOMICS 9**

Introduction to animal genomics; Different methods for characterization of animal genomes, SNP, STR, QTLS, RFLP, RAPD, proteomics, metabolomics, different



<b>LSDY 122</b>	<b>PLANT BIOTECHNOLOGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

## OBJECTIVES

The course is tailored to provide an understanding of the basic concepts and state of art techniques and methods underlying plant biotechnology research including the genetic bases of several important plant properties and the molecular basis of plant breeding. The students will gain an understanding of theoretical principles enabling them to employ the knowledge to solve problems related to plant production and protection through biotechnological approaches.

### **MODULE I PLANT TISSUE CULTURE 9**

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

### **MODULE II AGROBIOLOGY 9**

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

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

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

### **MODULE IV PLANT ARCHITECTURE AND METABOLISM 9**

Protein engineering, Post-harvest bioengineering, Plants as Biofactories, concept of biofactories, Fermentation and production of industrial enzymes, vitamins and



**LSDY 123****PARASITOLOGY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVES:**

- To understand animal association, parasitic diseases, lifecycle and mode of infection.
- To get an overview on important parasites and characteristics.
- To understand survival adaptations and significance of important parasites.

**MODULE I                    FUNDAMENTAL OF PARASITOLOGY                    8**

Introduction to parasitology; type of parasites, animal associations and host – parasite relationship; distribution of diseases and Zoonoses caused by animal parasites.

**MODULE II                    COMMON PARASITES                    10**

Plasmodium - morphology, life-cycle and mode of infection. Molecular biology of Plasmodium – drug targets, mechanism of drug resistance, vaccine strategies and proteomic approaches; Leishmania - morphology, life-cycle and mode of infection. Molecular biology of Leishmania – drug targets, drug resistance and vaccine strategies.

**MODULE III                    COMMON PARASITES                    9**

Entamoeba - morphology, biology, life-cycle and mode of infection. Giardia - morphology, biology, life-cycles, mode of infection. Gastro-intestinal nematodes - morphology, biology, life-cycles and modes of entry of Schistosoma, Wuchereria, Brugia, Ancylostoma, Trichinella and Dracunculus; molecular biology of nematodes and vaccine strategies.

**MODULE IV                    PARASITE IMMUNOLOGY                    9**

Immune response and self-defense mechanisms, immune evasion and biochemical adaptations of parasites; parasites of veterinary importance.

**MODULE V            INSECT PARASITES****9**

Parasites of insects and their significance; nematode parasites of plants, morphology, biology, lifecycle and infection of crop plants by plant parasitic nematodes, plant parasitic nematodes, host parasite interactions.

**Total Hours: 45****REFERENCES:**

1. Roberts L.S. and Janovy J. Foundations of Parasitology. McGraw-Hill Publishers, New York, 2008.
2. Cox F. E. G. Modern Parasitology: A Textbook of Parasitology, FEG Cox., Wiley-Blackwell, 1993.

**OUTCOMES:**

After finishing this course the students will be able to

- Understand the basic concepts of parasitology as a field of science
- Get knowledge of some common parasites, their structure, life cycle and associated diseases
- Understand the basic immune response mounted by organism as defense against parasites
- Get knowledge about insect parasites, lifecycle, survival adaptations and also to prevention and treatment strategies.

**LSDY 124****VIROLOGY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVES:**

This course aims to develop in the students' mind a concept regarding scope of virology, Diagnostic virology, Emerging virus and challenges and applied virology.

**MODULE I                    CONCEPT AND SCOPE OF VIROLOGY                    9**

Foundations of virology: Virus prehistory, discovery of viruses. Definitive properties of viruses: Morphology, Ultra structure, Chemical composition -proteins, nucleic acids, and enzymes. Classification and nomenclature of viruses; Trends in virology; Evolutionary importance of viruses. Epidemiology of Virus infection. Principles of diagnosis of virology.

**MODULE II                    DIAGNOSTIC VIROLOGY                    9**

Biological activity of viruses, Physical, chemical and structural components of viruses, Visualization and enumeration of virus particles, Detection of viruses: physical, biological, immunological and molecular methods. Cultivation of viruses in embryonated eggs, laboratory animals and cell cultures. Serological methods – haemagglutinin and HAI, complement fixation, immunofluorescence methods, ELISA and RIA: Physical, chemical and molecular methods- protein, radioactive tracers, electron microscopy, nucleic acid - PCR based assays, flowcytometry and immunohistochemistry. Infectivity assays for phages and plant viruses. Characterization of viral product expressed in the infected cells. Isolation and purification of viruses.

**MODULE III                    STUDY OF VIRUS                    9**

Morphology, ultra structure, chemical composition and replication of: Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – HBV. Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions. Cellular interactions—clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms. Oncogenesis: oncogenic viruses, viral transformation by activation of cellular signal transduction pathways, viral transformation via cell cycle control pathways.

**MODULE IV APPLIED VIROLOGY 9**

General aspects of plant and animal viral diseases. Introduction to viral vaccines, preparation of vaccines, new vaccine technology; antiviral drugs, antiviral gene therapy, antiviral libraries, antiretrovirals—mechanism of action and drug resistance. Modern approaches of virus control: Antisense RNA, siRNA, ribozymes, in silico approaches for drug designing. T-phages, Cyanophages, Baculovirus.

**MODULE V EMERGING VIRUS AND CHALLENGES 9**

Mechanism of host cell damage- Host cell 'shut off', apoptosis, necrosis, alteration of signaling pathways. Viruses and the future: Promises and problems. Emerging diseases, sources and causes of emergent virus diseases. Prospectus using medical technology to eliminate specific viral and other infectious diseases. Silver lining: viruses as therapeutic agents, viruses for gene delivery, viruses to destroy other viruses. Importance of studying modern virology.

**Total Hours: 45****REFERENCES:**

1. B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, Fields Virology Vol 1 and 2. Lippincott-Raven, Philadelphia, PA. 1996.
2. K. Wagner, Martinez J. Hewlett, David C. Bloom, David Camerini, Basic Virology Edward, Willey Blackwell, 2007.
3. John Carter, Venetia Saunders, Virology: Principles and Applications, John Wiley & Sons, 2013.
4. Black JG, 2002 Microbiology-Principles and Explorations. John Wiley & Sons Inc. New York.
5. Dimmock, N. J., Easton, A. J., and Leppard, K. N. 2001. Introduction to Modern Virology. 5th edn. Blackwell publishing, USA.
6. Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington, D.C.
7. Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology. Blackwell Science. Inc.

**OUTCOMES:**

After finishing this course the students will be able to

- Understand the basic concepts of virology as a field of science

- Get knowledge of some common viruses, their structure, life cycle and associated diseases
- Understand the basic immune response mounted by organism as defense against viruses
- Get knowledge about diagnostic procedures for viruses
- development of treatment strategy for viruses and emerging and re-emerging viruses.



**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, Recombinant DNA, 2<sup>nd</sup> Edition, Scientific American; Second Edition edition, 1998.
2. T. A. Brown, Gene Cloning and DNA analysis: An Introduction, 7<sup>th</sup> 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 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, Dermatophytoses, 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 immunodiagnosics, antigen-antibody reactions, antibody production, antibody markers, CD markers, FACS, Human Leukocyte Antigen (HLA) typing, agglutination (ABO/Bacterial), immunoprecipitation, immunodiffusion, floctometer.

**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 princples 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, foescenic, etc.

<b>LSDY 205</b>	<b>BIOFUELS AND BIOENERGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### OBJECTIVE

- 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 biodiesel (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO). Engineering, economics and environmental issues of biodiesel; 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.



- 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

<b>LSDY 211</b>	<b>DIAGNOSTICS OF INFECTIOUS DISEASES</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

## OBJECTIVE

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

- Diagnostic bacteriology- diagnosing disease, principles and techniques
- Principle and technique of serological methods
- Serological methods for detection and quantitation of viruses
- Systematic study of following parasites
- Epidemiology, Pathogenesis, Laboratory Diagnosis of Fungal Infections

## MODULE I                      DIAGNOSTIC BACTERIOLOGY                      9

Epidemiology of bacterial infections, Guidelines for the collection, Transport, Processing analysis, isolation of bacterial pathogens and reporting of cultures from specimens for bacterial infections Bacterial infections of respiratory tract. Bacterial infections of gastro intestinal tract and food poisoning. Bacterial urinary tract infections. Bacterial infections of genital tract and reproductive organs. Bacterial infections of central nervous system. Skin and soft tissue infections. Bone and joint infections Eye ear and sinus infections Cardiovascular infections Tissue samples for culture Anaerobic infections Zoonotic infections. Infections associated with immunodeficiency and immune suppression Pyrexia of unknown origin.

## MODULE II                      BACTERIAL IMMUNO SEROLOGY                      9

Enteric fever Streptococcal infections Syphilis Rickettsial infections B rucellosis Primary atypical pneumonia; New rapid serological diagnostic methods for bacterial infections.

## Module III                      DIAGNOSTIC BACTERIOLOGY VIROLOGY                      9

Immunodiagnosics and immunotherapy in virology – Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others. Immuno-assays: SRID, ELISA, ELISA-PCR, RIA, Western Blotting, Immunofluorescence and their application. Immune deficiencies and autoimmunity.

## MODULE IV                      DIAGNOSTIC PARASITOLOGY                      9

Systematic study of following parasites (Geographical distribution, habitat, morphology and life cycle, risk of infection, pathogenesis, laboratory diagnosis prophylaxis and serological diagnosis)

**MODULE V                    DIAGNOSTIC MYCOLOGY****9**

Epidemiology, Pathogenesis, Laboratory Diagnosis of Fungal Infections. Specimen collection, preservation, Transportation & Identification of Mycological Agent. Biochemical tests for fungal identification Anti fungal agents, invitro tests. Serological tests for mycotic infections. Use of laboratory animals in Mycology.

**Total Hours: 45****REFERENCES:**

1. Washington C. Winn, Stephen D. Allen, Stephen Allen, William M Janda, Elmer W. Koneman, Paul C. Schreckenberger, Gary W. Procop, Gail L. Woods Colour atlas of & text book of Diagnosis Microbiology Wolters Kluwer; 6th Revised edition edition,2005.

**OUTCOMES:**

After finishing this course the students will be able to

- Understand the basic concepts of bacteriology as a field of science
- Get knowledge of some common bacteria, their structure, life cycle and associated diseases
- Understand the basic immune response mounted by organism as defense against bacteria
- Get knowledge about diagnostic procedures for bacteria
- development of treatment strategy for bacteria and emerging and re-emerging diseases.

**LSDY 212****METAGENOMICS**

L	T	P	C
3	0	0	3

**OBJECTIVES**

- Provide focus on next generation DNA sequencing technology to describe the ecological roles of microbial communities in different environments.
- To use metagenomic data to describe the taxonomic make-up, functional potential and ecological processes of microbial communities from a range of environments
- To apply next generation sequencing technology.
- To assemble and annotate genomes by identifying genes.

**MODULE I ENVIRONMENTAL GENOMICS 9**

Environmental Metagenomics – Introduction; Pure culture and in consortium ; Cultivable and Non-cultivable microbial analysis; Recombination DNA technology and DNA cloning; Types of vectors, applications of recombination DNA technology; Molecular fingerprinting techniques (RFLP, T-RFLP, ARISA, DGGE, rDNA library, and FISH); Stable isotope probing (SIP); Suppressive subtractive hybridization (SSH); Differential expression analysis (DEA); Microarrays & Metagenome sequencing; Next-generation sequencing approaches to metagenomics.

**MODULE II ISOTOPE PROBING & OLIGONUCLEOTIDE MICROARRAYS 9**

Direct linking of microbial populations to specific biodegradation and biotransformation processes by stable isotope probing of biomarkers- PhyloChip & GeoChip-Detection of xenobiotic-degrading bacteria by using oligonucleotide microarrays

**MODULE - III CONSTRUCTION & ANALYSIS OF METAGENOMIC LIBRARIES 9**

Cataloging microbes: phylogenetic tree and construction - Construction of a metagenomic library; Analysis of Metagenomic Libraries; Sequence-based Metagenomics Analysis; Functionbased Metagenomics Analysis; Phylogenetic analysis and Comparative genomics Softwares & Tools.

**MODULE IV METAGENOMICS CASE STUDIES 9**

Metagenomic analysis of soil microbial communities; Metagenomic analysis of marine microbial communities; Metagenome of the Microbial Community in Acid Mine Drainage ; Metagenomic Analysis of Bacteriophage; Metagenomics and Its Applications to the Study of the Human Microbiome; Archaeal Metagenomics: Bioprospecting Novel Genes and Exploring New Concepts.

**MODULE V METAGENOMICS IN ENVIRONMENTAL STUDIES 9**

Application of Metagenomics to Bioremediation; Applications of Metagenomics for Industrial Bioproducts; Escherichia coli host engineering for efficient metagenomic enzyme discovery; Next-generation sequencing approaches to metagenomics; Stable isotope probing: uses in metagenomics; DNA sequencing of uncultured microbes from single cells.

**Total Hours: 45**

**REFERENCES:**

1. Diana Marco Universidad Nacional de Cordoba, Argentina, "Metagenomics: Theory, Methods and Applications", Caister Academic Press,2010.
2. Diana Marco Universidad Nacional de Cordoba,Argentina "Metagenomics: Current Innovations and Future Trends",Caister Academic Press,2011.
3. Joanna R. Freeland, Heather Kirk, Stephen Petersen, "Molecular Ecology", Mc Graw Hill, 2nd Edition "2012.
4. Beebee T.J.C., D G. Rowe," An Introduction to Molecular Ecology", Mc Graw Hill, 2004.

**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.

<b>LSDY 213</b>	<b>BIOPROCESS (MICROBIAL)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVES:**

This course is formulated with an objective to familiarize the students with the fundamentals of material balance, energy balance, media optimization techniques and various models of microbial growth.

**MODULE I INTRODUCTION TO MICROBIAL BIOTECHNOLOGY 9**

Introduction to biotechnology and biochemical engineering, bioprocess techniques, biotechnology products. Thermodynamic preliminaries, system and process, steady state and equilibrium, law of conservation of mass, types of material balance problem, material balances with recycle and bypass streams.

**MODULE II MATERIAL BALANCE 9**

Stoichiometry of bioreaction and energetic of microbial growth, ATP and redox potential balance, Yield coefficients, productivity and the correlation with the stoichiometry, Growth stoichiometry and elemental balances, electron balances, Biomass yield, product stoichiometry, Theoretical oxygen demand, Maximum possible Yield. Energy Balance: Basic energy concepts, intensive & extensive properties, Studies of enthalpy for reactive & non reactive processes. Heat of combustion, heat of reaction at Non standard conditions. Thermodynamics of microbial growth, energy balance equation for cell culture, unsteady state energy balance equations.

**MODULE III MEDIUM OPTIMIZATION 9**

Medium optimization techniques with special emphasize on statistical techniques, placket-Burman design, ANOVA, central; composite design, response surface methodology. Sterilization:

Media sterilization, kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilization, coupling of Arrhenius equation and cell death kinetics, sterilization of air and filter design, Radiation and chemical sterilization.

**MODULE IV UNSTRUCTURED MODEL FOR MICROBIAL GROWTH 9**

The development of different microbial growth kinetics like Malthus, Pearl and read, Monod Model, Konark Model. The limitation of Monod model and development of

other constitutive models. Multisubstrate model, inhibition models for substrate, Product and toxic substances. Development of logistic equation. Maintenance and endogenous metabolism kinetics.

## **MODULE V STRUCTURED MODEL FOR MICROBIAL GROWTH 9**

Kinetics based on molecular mechanism, Compartment models, Model of cellular Energetics and metabolism, Model of product formation, singles cell model, Model of gene expression and regulation, Plasmid Expression and Replication, Model of plasmid stability, parameter estimation, Model validation and bioprocess optimization.

**Total Hours: 45**

### **REFERENCES:**

1. Jay Bailey, James Edwin Bailey, David F. Ollis, Richard J. Simpson, David F Ollis, Biochemical Engineering Fundamentals, Mc. Graw Hill, 1986.
2. Pauline M. Doran: Bioprocess Engineering Principles, Elsevier Publications, 2013.
3. Schugerl K; Bellgardt K H (Eds); Bioreaction Engineering, Modeling and control; Springer –verlog, berlin (2000)
4. Introduction to Biochemical Engineering by D G Rao. Tata, Mc Graw Hill, New Delhi, 2010.

### **OUTCOMES:**

After the completion of the course students will gain

- awareness of various media optimization techniques
- awareness of protein expression, extraction and purification
- will gain expertise in quantitative estimation of the biomass growth and product formation rate, which will help them to design bioreactor and product
- knowledge of development of different microbial growth kinetics models
- knowledge of kinetics based on molecular mechanism

**ELECTIVES III SEMESTER**

<b>LSDY 111</b>	<b>BIOPHARMACEUTICALS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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 agent

**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, and Patent Issues, CRC Press, 2006.
2. Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes into drugs, 1st Edition, 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 agent

<b>LSDY 112</b>	<b>MOLECULAR &amp; IMMUNO DIAGNOSTICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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**

Immunodiagnosics : 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:**

At the end of the course the students will be

- Familiar with the theoretical working principles 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, forensic, etc.

<b>LSDY 113</b>	<b>TISSUE AND ANTIBODY ENGINEERING</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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 proliferic 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: Hybridoma, 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 lines: Expression vector and Host systems, Cell culture optimization, Downstream processing, Analytical characterization, Cell line genetic analysis Purification, formulation and stability, Antibody composition

**Total Hours: 45**

**REFERENCES**

1. "Tissue Engineering", Bernhard O. Palsson, Sangeeta N. Bhatia, Pearson Prentice Hall Bioengineering, 2003.
2. "Nanotechnology and Tissue engineering - The Scaffold", Cato T. Laurencin, Lakshmi S. Nair, CRC Press, 2008.

**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.

<b>LSDY 114</b>	<b>BIONANOTECHNOLOGY</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**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, neuroelectronic interphases, development of nanoluminescent 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 environmental problems that can be solved using nanobiotechnology.
- focus on advanced nanobiotechnology techniques to facilitate nanoparticles and toxicity evaluation

**LSDY 115****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 interactions in the denaturation reaction, Practical considerations, Post translational modifications- Involving peptide bond, C-terminal, side chain. Modification methods- Enzymatic, Non enzymatic, Specificity, chaperones mediated. Applications of Post translational modifications.

**Total Hours: 45**

#### **REFERENCES:**

1. Andreas D. Baxevanis & B.F. Francis Ouellette, 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. 3rd 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.

**LSDY 131****BIOREMEDIATION****L T P C****3 0 0 3****OBJECTIVES**

- To impart sufficient scientific understanding of the current environmental tribulations and global concern.
- To focus the process of bioremediation, mechanisms, types, success stories & monitoring strategies.
- To focus the advance molecular techniques to facilitate bioremediation technology.
- To focus on advanced nuclear remediation program.
- To apply the concepts of bioremediation technology to the real time problems.

**MODULE I****BIOREMEDIATION****9**

Introduction to Bioremediation: Types of Bioremediation, Factors affection Bioremediation. Bioremediation - Mechanisms.Limitations of Bioremediations. Microbes for Bioremediation: Essential Chararacteristics of Microbes for Bioremediation, Microbial Adapadation for Adverse conditions. Microbes involved in Bioremediation. Metabolic process involved in bioremediation. Bioremediation Techniques: Insitu & Exsitu bioremediation techniques. Phytoremediation.

**MODULE II****SPECIFIC BIOREMEDIATION TECHNOLOGIES****9**

Application, specific advantages and disadvantages of specific bioremediation technologies - land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wet lands, use of bioreactors for bioremediation.

**MODULE III****BIOREMEDIATION OF CHLORINATED COMPOUNDS AND MOLECULAR TECHNIQUES IN BIOREMEDIATION****9**

Bioremediation of phenols, chlorinated phenols, chlorinated aliphatic compounds, heterocyclic compounds, cyanides, dyes; Rhizoremediation: a beneficial plant-microbe interaction; Molecular techniques in bioremediation- Enhanced biodegradation through pathway engineering; Biodegradation of polyhalogenated compounds by genetically engineered bacteria.

**MODULE IV                    NUCLEAR WASTE BIOREMEDIATION                    9**

Spent fuel characterisation, storage and disposal; Partitioning, transmutation and conditioning; Measurement of Radioactivity in the environment; Basic actinide research.

**MODULE V                    HEAVY METAL AND OIL SPILL BIOREMEDIATION                    9**

Heavy metal pollution & sources; Microbial interactions with heavy metals - resistance & tolerance; Microbial transformation; Accumulation and concentration of metals. Biosorption of heavy metals by microbial biomass and secondary metabolites – Biosurfactants. Advantages of biosurfactants over chemical surfactants; Biotechnology and oil spills; Improved oil recovery.

**Total Hours: 45**

**REFERENCES**

1. Bruce E. Rittmann, Perry L. McCarty, "Environmental Biotechnology: Principles and Applications" McGraw-Hill, 2001.
2. Phillip L. Buckingham, Jeffrey C. Evans," Hazardous Waste Management" Waveland Pr Inc; Reissue edition 1, 2010.
3. S. K. Agarwal, "Environmental Biotechnology", APH Publishing, 2000
4. Martin Alexander, "Biodegradation & Bioremediation", Academic press, 1999.
5. Karrely D., Chakrabarty K., Omen G.S, "Biotechnology and Biodegradation", Portfolio Pub. Co., 1990. 6. P. Rajendran, P. Guansekaran, "Microbial Bioremediation", Mjp Publishers, 2011

**OUTCOMES:**

After the completion of the course the student will have sufficient scientific understanding

- The concepts, types and factors affecting natural bioremediation processes
- Of applications, specific advantages and disadvantages of specific bioremediation technologies
- Of molecular techniques in bioremediation
- Bioremediation of nuclear waste
- Bioremediation of heavy metals and oil