SRI SANKARA ARTS AND SCIENCE COLLEGE

(AUTONOMOUS)

ENATHUR, KANCHIPURAM - 631561

B.Sc., BIOTECHNOLOGY

REGULATION & SYLLABUS

(Effective from the academic year 2022 – 2023)

Choice Based Credit System

Preamble

Biotechnology is technology that utilizes biological systems, living organisms or parts of this to develop or create different products. Biotechnology at the core envisages the comprehensive study of Life and the Interdisciplinary potential of Biotechnology has led to a unique status for Biotechnology in Research and Industry. The socio-economic potential of Biotechnology is well established which has almost become synonymous with modern development. Biotechnology has its applications in almost every field touching practically every human activity. The applied aspect of Biotechnology is now getting established with its applications in Industry, Agriculture, Health and Environment, Biotechnology demands a trained, skilled human resource to establish the Industry and Research sectors. The field is novel and still expanding which demands inputs in Infrastructure and Technology. The global and local focus is on developing new technological applications is fast growing. Biotechnology sector in Research and Industry is expanding which is set to augur the next major revolution in the world. Several discoveries in the last two to three decades, which significantly impact these area have put Biotechnology on the centre stage of teaching, research and development all over the globe. The Choice Based Credit System (CBCS) curriculum for Biotechnology at the undergraduate level has now been developed into a new system called Learning Outcome Curriculum Framework (LOCF) under the recommendations and guidance of University Grants Commission (UGC). The LOCF approach first envisioned the programme learning outcomes of the B.Sc. (Hons) program in Biotechnology as well as the learning outcomes of the courses being taught under this programme, keeping in view the graduate attributes of the subject. The curriculum was then developed in tune with the learning outcomes. It is envisaged that the students trained under this curriculum will have the required attributes of knowledge, skills, temperament and ethics related to the subject of Biotechnology. Besides the contents of the curriculum, the teaching learning processes have also been designed to achieve these attributes. A variety of learning assessment tasks have been included in the curriculum. Besides assessing the knowledge/skills acquired by the students, these tasks would also help to supplement the teaching learning processes.

The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biotechnology Sector. The restructured syllabus combines basic principles of Biological sciences in light of advancements in technology. The curriculum aims to impart basic knowledge with emphasis on its applications to make the students industry ready.

Introduction

A high priority task in the context of future education development agenda in India is fostering quality higher education. Improvement of quality of higher education is considered critical for enabling effective participation of young people in knowledge production, participation in the knowledge economy, improving national competitiveness in a globalized world and for equipping young people with skills relevant for global and national standards and enhancing the opportunities or social mobility. Sustained initiatives are required for institutionalizing an outcome-oriented higher education system and enhancing employability of graduates through curriculum reform based on a learning outcomes-based curriculum framework, improving/upgrading academic resources and learning environment, raising the quality of teaching and research across all higher education institutions; technology use and integration to improve teaching-learning processes and reach a larger body of students through alternative learning modes such as open and distance learning modes and use of MOOCs. Other priority areas of action for fostering quality higher education include translation of academic research into innovations for practical use in society and economy, promoting efficient and transparent governance and management of higher education system, enhancing the capacity of the higher education system to govern itself through coordinated regulatory reform and increasing both public and private sector investment in higher education, with special emphasis on targeted and effective equity-related initiatives.

Learning Outcomes based approach to Curriculum Planning:

Learning Outcome based approach to curriculum planning (LOCF) is almost a paradigm shift in the whole gamut of higher education such that it is based on first and foremost identifying the outcomes of the learning required for a particular subject of study, and then

planning all components of higher education so as to achieve these outcomes. The learning outcomes are the focal point of the reference to which all planning and evaluation of the end learning is compared and further modifications are made to fully optimize the education of the individuals in a particular subject. For the subject of Biotechnology the outcomes are defined in terms of the understanding and knowledge of the students in Biotechnology and the practical skills the students are required to have to be competitive Biotechnology so that they are able to play their role as biotechnologist wherever required in the society such as the role of biotechnologist in the biotechnology industry and how they may be able to fit the bill in the industry. The students are also trained in such a way that they develop critical thinking and problem solving as related to the Biotechnology. The curriculum developed and the teaching and the evaluation tasks are such that the students are able to apply their knowledge and training of Biotechnology to solve the problems of Biotechnology as these exist or appear from time to time in the society. The curriculum envisions that the student, once graduate as specialists in a discipline, have an important role to play in the newer developments and innovations in the future in the subject for advancement of the discipline.

Graduate Attributes in Biotechnology:

The students graduating in this degree must have through understanding of basic knowledge or understanding of the fundamentals of Biotechnology as applicable to wide ranging contexts. They should have the appropriate skills of Biotechnology so as to perform their duties as biotechnologists. They must be able to analyze the problems related to biotechnology and come up with most suitable solutions. As biotechnology is an interdisciplinary subject the students might have to take inputs from other areas of expertise. So the students must develop the spirit of team work. Biotechnology is a very dynamic subject and practitioners might have to face several newer problems. To this end, the biotechnologists must be trained to be innovative to solve such newer problems. Several newer developments are taking place in biotechnology. The students are trained to pick up leads and see the possibility of converting these into products through

entrepreneurship. To this end, the students are made to interact with industry experts so that they may able to see the possibility of their transition into entrepreneurs. They are also made aware of the requirements of developing a Biotechnology enterprise by having knowledge of patents, copyrights and various regulatory process to make their efforts a success. Besides attaining the attributes related to the profession of Biotechnology, the graduates in this discipline should also develop ethical awareness which is mandatory for practicing a scientific discipline including ethics of working in a laboratory work and ethics followed for scientific publishing of their research work in future. The students graduating in biotechnology should also develop excellent communication skills both in the written as well as spoken language which are must for them to pursue higher studies from some of the best and internationally acclaimed universities and research institutions spread across the globe. The graduate attributes reflect both disciplinary knowledge and understanding, generic skills, including global competitiveness all students in different academic fields of study should acquire/attain and demonstrate. Some of the characteristic attributes that a graduate should demonstrate are as follows

- ✓ Disciplinary knowledge.
- ✓ Communication Skills.
- ✓ Critical thinking.
- ✓ Problem solving.
- ✓ Research-related skills.
- ✓ Scientific reasoning.
- ✓ Reflective thinking.
- ✓ Self-directed learning.
- ✓ Moral and ethical awareness/reasoning.
- ✓ Lifelong learning.

Qualification Descriptors

Upon successful completion of the course, the students receive a M.Sc. degree in Biotechnology. Biotechnology postgraduates of this department are expected to branch out into different paths of seeking advanced research-based knowledge, professional

employment, or entrepreneurship that they find fulfilling. They will be able to demonstrate knowledge as well as skills in diverse fields of Biotechnology. This will provide a foundation, which shall help them to embark on research careers by attaining doctoral positions in coveted institutions, as well as securing employment in research projects in industry or institutes. Besides research, they can get suitable teaching positions in Colleges and Universities as an Assistant Professor after qualifying National Eligibility Test (NET). It is expected that besides the skills specific to the discipline, the wider life skills of analysis, logical reasoning, scientific aptitude, communication skills, research and life ethics, and moral values will be inculcated in the students. The list below provides a synoptic overview of possible career paths:

- ✓ Research
- ✓ Industry
- ✓ Biotechnology entrepreneurship
- ✓ Administration and Policy Making
- ✓ Scientific Communication
- ✓ Patents and Law
- ✓ Scientific Writing and Editing
- ✓ Document preparation and publication

Programme Specific Outcome

PSO-1 Enriching the Biotechnology knowledge in theoretical aspects at under graduate level.

PSO-2 Enriching the Biotechnology knowledge in practical aspects at under graduate level.

PSO-3 Developing research aptitude among the student community and encouraging them to pursue higher studies in Biotechnology.

PSO-4 Designing the syllabus in the manner which enables students to clear competitive exams in the life sciences.

PSO-5 Developing the student skills based on current trends in Biotechnology field by offering Job oriented certificate courses and Value-added courses

UNIVERSITY OF MADRAS

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(Effective from the academic year 2022 – 2023)

REGULATIONS

Choice based credit system.

1.DURATION OF THE PROGRAME

1.1. Three years (six semesters)

1.2. Each academic year shall be divided into two semesters. The odd semesters shall consist of the period from June to November of each year and the even semesters from December to April of each year.

1.3 There shall be not less than 90 working days for each semester.

2. ELIGIBILITY FOR ADMISSION

B.Sc., Biotechnology - Any subjects

3. CREDIT REQUIREMENTS AND ELIGIBILITY FOR AWARD OF DEGREE

3.1. A Candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed course of study in a College affiliated to the University for a period of not less than three academic years and passed the examinations of all the Six Semesters prescribed earning a minimum of

3.2. 140 credits as per the distribution given in Regulation 4 for PartI, II, III, IV& V and also fulfilled such other conditions as have been prescribed there of.

4. COURSE OF STUDY, CREDITS AND SCHEME OF EXAMINATION

4.1. The Course Components and Credit Distribution shall consist of the following:(Minimum Number of Credits to be obtained)

Course Component	Name of the Course	Credits
PART I	Tamil or Other Languages	**12**
PART II	English	**12**
PART III	Core Courses	**60**
	Allied Courses	**20**
	Project/ Three Elective Courses	**15**
PART IV	i. Basic Tamil/ Advanced Tamil/ NME	**04**
	ii.Soft Skill Courses	**12**
	iii.EnvironmentalStudies	**02**
	iv.Value Education	**02**
PART V	Extension Activities	**01**
Total Credits		**140**

4.2. DETAILS OF COURSE OF STUDY OF PARTS I – V

4.2.1 PART I: Tamil and Other Languages: Tamil or any one of the following Modern (Indian or Foreign) or Classical languages at the option of candidates and according to the syllabus and text-books prescribed from time to time:

a. **Modern*:***

Indian: Telugu, Kannada, Malayalam, Urdu & Hindi

Foreign: Chinese, French, German, Italian, Japanese & Russian

b. Classical: Sanskrit, Arabic & Persian

4.2.2 PART II: English: According to the syllabus andtext-books prescribed from time to time

4.2.3 PART III: Core, Allied and Project/Three Elective Courses: As prescribed by the concerned Board of Studies

4.2.4 PART IV:

i. Basic Tamil/ Advanced Tamil/ NME:

a.Students who have not studied Tamil up to XIISTD and have taken any Language other than Tamil in Part I shall take Basic Tamil comprising of Two Courses (level will be at 6^{th} Standard).

b.Students who have studied Tamil up to XIISTD and have taken any Language other than Tamil in Part I shall take Advanced Tamil comprising of Two Courses.

c.Students who have studied Tamil up to XII STD and also have taken Tamil in Part I shall take Non-Major Elective comprising of TwoCourses.

ii. Soft Skill Courses

iii. Environmental Studies

iv. Value Education

4.2.5 PART V: Extension Activities:

Students shall be awarded a maximum of 1 Credit for Compulsory Extension Service. All the Studentsshall have to enrol for NSS /NCC/ NSO (Sports & Games) Rotract/ Youth Red Cross or any other Service Organizations in the College and shall have to put in compulsory minimum attendance of 40 hours which shall be duly

certified by the Principal of the College before 31st March in a year. If a student lacks 40 hours attendance in the first year, he or she shall have to compensate the same during the subsequent years.

Those students who complete minimumattendance of 40 hours in one year will get 'half-a- credit and those who complete the attendance of 80 or more hours in Two Years will get 'one credit'. Literacy and Population Education and Field Work shall be compulsory components in the above extension service activities.

4.2.6 Scheme of Examinations

Course Component Name of the course	Inst. Hour	Credits	Exam Hours	Max. Marks		
				Ext. mark	Int. mark	Total
PART-I Language				**75**	**25**	**100**
PART-II English				**75**	**25**	**100**
PART-III Core subject :				**75**	**25**	**100**
Core Subject				**75**	**25**	**100**
Allied Subject				**75**	**25**	**100**

PART – IV 1.(a) Those who have not studied Tamil up to XII Std. and taken a Non-Tamil Language under Part-I shall take Tamil comprising of two course (level will be at 6th Standard). (b) Those who have studies Tamil up to XII Std. and taken a Non-Tamil Language under Part-I shall take Advanced Tamil comprising of two courses. (c) Others who do not						

come under a + b can choose non-major elective comprising of two courses.						
2*Skill based subjects(Elective) – (Soft Skill)						

4.3. Inclusion of the Massive Open Online Courses (MOOCs) available on SWAYAM, NPTEL and other such portals approved by the University Authorities.

4.3.1. The Chairperson, Board of Studies consider the available MOOCs and choose the courses to be included under Core, Elective and Soft Skill category and also the number of credits for such courses based on the content and duration of course. The credit for such courses shall be included as part of the Core, Elective and Soft Skill to award the Degree. The number of credit will be decide at the University level for such courses which are relevant to more than one department such as soft skills and elective courses.

5. INSTRUCTIONAL (TEACHING) HOURS

5.1 For First, Second, Third and Fourth semesters:

Course	B. Sc Biotechnology
Language	4 + 2 hours *****
English	4 + 2 hours **@**
Core Course I	5 hours Theory 3hours Practical
Allied Course	5 hours Theory 3 hours Practical
NME Course	2 hours
Total	30 hours

***** 2 hours for Part IV Basic Tamil/ Advanced Tamil/ Non-Major Elective Courses

@ 2 hours for Soft Skills Courses.

5.2 For Fifth and Six Semesters:

Course	B.Sc Biotechnology
Core Course (each)	6 hours
Elective Course (each)	5 hours

6. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTER

6.1 Eligibility: Students shall be eligible to go to subsequent semester only if they earn sufficient attendance as prescribed therefor by the Syndicate from time to time.

6.2 Attendance: All Students must earn 75% and above of attendance for appearing for the University Examination. (Theory/Practical)

6.3 Condonation of shortage of attendance: If a Student fails to earn the minimum attendance (Percentage stipulated), the principals shall condone the shortage of attendance up to a maximum limit of 10% (i.e. between 65% and above and less than 75%) after collecting the prescribed fee of Rs.250/-each for Theory/Practical examination separately, (Theory Rs.250/- Per semester/Per Student: Practical Rs.250/- Per semester/Per Student) towards the condonation of shortage of attendance. Such fees collected and should be remitted to the University.

6.4 Non-eligibility for condonation of shortage of attendance: Students who have secured less than 65% but more than 50 %of attendance are NOT ELIGIBLE for condonation of shortage of attendance and such Students will not be permitted to appear for the regular examination, but will be allowed to proceed to the next year/next semester of the program and they may be permitted to take next University examination by paying the prescribed condonation fee of Rs.250/- each for Theory/Practical separately. Such fees shall be remitted to the University. Name of such Students should be forwarded to the University along with their attendance details in the prescribed format mentioning the category (3 copies) Year wise/Branch wise/Semester wise together with the fees collected from them, so as to enable them to get permission from the University and to attend the Theory/Practical examination subsequently without any difficulty.

6.5 Detained students for want of attendance: Students who have earned less than 50% of attendance shall be permitted to proceed to the next semester and to complete the Program of study. Such Students shallhave to repeat the semester, which they have missed by rejoining after completion of final semester of the course, by paying the fee for the break of study asprescribed by the University from time to time.

6.6 Condonation of shortage of attendance for married women students: In respect of married women students undergoing UG programs, the minimum attendance for condonation (Theory/Practical) shall be relaxed and prescribed as 55% instead of 65% if they conceive during their academic career**.** Medicalcertificate from the Doctor(D.G.O) attached to the Government Hospital and the prescribed fee of Rs.250/-therefor together with the attendance details shall be forwarded to the principal to consider thecondonation of attendance mentioning the category.

6.7 Zero Percent (0%) Attendance: The Students, who haveearned 0% of attendance, have to repeat the program (by rejoining) without proceeding to succeeding semester and they have to obtain prior permission from the University immediately to rejoin the program.

6.8 Transfer of Students and Credits: The strength of the credits system is that it permits inter Institutional transfer of students. By providing mobility, it enables individual students to develop their capabilities fully by permitting them to move from one Institution to another in accordance with their aptitude and abilities.

6.8.1 Transfer of Students is permitted from one Institution to another Institution for the same program with same nomenclature.

Provided, there is a vacancy in the respective program of Study in the Institution where the transfer is requested.

Provided the Student should have passed all the courses in the Institution from where the transfer is requested.

6.8.2 The marks obtained in the courses will be converted and grades will be assigned as per the University norms.

6.8.3 The transfer students are eligible for classification.

6.8.4 The transfer students are not eligible for Ranking, Prizes and Medals.

6.8.5 Students who want to go to foreign Universities upto two semesters or Project Work with the prior approval of the Departmental/College Committee are allowed to get transfer of credits and marks which will be converted into Grades as per the University norms and are eligible to get CGPA and Classification; they are not eligible for Ranking, Prizes and Medals.

6.9 Students are exempted from attendance requirements for online courses of the University and MOOCs.

7. EXAMINATION AND EVALUATION

7.1 Register **for all subjects:** Students shall be permitted to proceed from the First Semester up to Final Semester irrespective of their failure in any of the Semester Examination. For this purpose, Students shall register for all the arrear subjects of earlier semesters along with the current (subsequent) Semester Subjects.

7.2 Marks for Internal and End Semester Examinations forPART I, II, III, and IV

Category	Theory	Practical
Internal Assessment	25	40
End semester (University) Examination	75	60

7.3 Procedure for Awarding Internal Marks

Course	Particulars	Marks
Theory Papers	Tests (2 out of 3)	10
	Attendance	05

	Seminars	05
	Assignments	05
	Total	**25**
Practical Papers	Attendance	05
	Test best 2 out of 3	30
	Record	05
	Total	**40**
Project	Internal Marks (best 2 out of 3 presentations)	60
	Viva-Voce	60
	Project Report	180
	Total	300

7.4 (i) Awarding Marks for Attendance (out of 5)

Attendance below 60% = 0 marks, 60 % to 75% = 3 marks,

75 % to 90% = 4 marks and above 90%= 5 marks

(ii) Conducting Practical and Project Viva-voce Examination:

By Internal and External Examiners

7.4.1 Improvement of Internal Assessment Marks.

a. Should have cleared end-semester University examination with more than 40 % Marks in UG.
b. Should have obtained less than 30 % marks in the Internal Assessment.
c. Should be permitted to improve internal assessment within N+2 years where N is denoted for number of years of the programme.
d. Chances for reassessment will be open only for 25% of all core courses in Colleges and only one chance per course will be given.
e. The Principal will decide based on the request for reassessment

and designate a faculty member of the department to conduct the examination and evaluation.

f. The reassessment may be based on a written test / assignment or any other for the entire internal assessment marks.

g. The candidate must register for examination in the on- line system along with prescribed examination fee for that course.

7.5 Question Paper Pattern for End Semester (University) Examination

SECTION-A			
10 questions out of 12 Questions	30 words	10 X 2	20 Marks
SECTION-B			
5 questions out of 7 Questions	200 words	5 X 5	25 Marks
SECTION – C			
3 questions out of 5 Questions	500 words	3 X 10	30 Marks
Total			**75 Marks**

7.6 PASSING MINIMUM

7.6.1 There shall be no passing minimum for Internal.

7.6.2 For external examination, passing minimum shall be 40% [Forty Percentage] of the maximum marks prescribed for the paper for each Paper/Practical/Project and Viva-Voce.

7.6.3 In the aggregate [External/Internal] the passing minimum shall be of 40%.

7.6.4 He/She shall be declared to have passed the whole examination, if he/she

passes in all the papers and practical wherever prescribed as per the schemeof the examinations by earning **140 CREDITS** inPartI, II, III, IV & V. He/she shall also fulfil the extension activities prescribed earning a minimum of 1 credit to qualify for the Degree.

7.7 INSTANT EXAMINATION: Instant Examinations isconducted for the students who appeared in the finalsemester examinations. Eligible criteria for appearing in the Instant Examinations are as follows:

7.7.1 Eligibility: A Student who is having arrear of only one theory paper in the current final semester examination of the UG Degree programme alone is eligible to appear for the Instant Examinations.

7.7.2 Non-eligibility for one arrear paper: A Student who is having more than one arrear paper at the time of publication of results is not eligible to appear for the Instant Examinations.

7.7.3 Non-eligibility for arrear in other semester: Student having arrear in any other semester is not eligible and a Student who is absent in the current appearance is also not eligible for appearing for the Instant Examinations and those Student who have arrear in Practical/Project are not eligible for the Instant Examinations.

7.7.4 Non-eligibility for those completed the program: Students who have completed their Program duration but having arrears are not eligible to appear for Instant Examinations.

7.8 RETOTALLING, REVALUATION AND PHOTOCOPY OF THE ANSWER SCRIPTS:

7.8.1. Re-totaling: All UG Students who appeared for their Semester Examinations are eligible for applying for re-totaling of their answer scripts.

7.8.2. Revaluation: All current batch Students who have appeared for their Semester Examinations are eligible for Revaluation of their answer scripts. Passed out candidates are not eligible for Revaluation.

7.8.3. Photocopy of the answer scripts: Students who have applied for revaluation can download their answer scripts from the University Website after fifteen days from the date of publication of theresults.

7.9 The examination and evaluation for MOOCs will be as per the requirements of the Courses and will be specified at the beginning of the Semester in which such courses are offered and will be notified by the University

8. CLASSIFICATION OF SUCCESSFUL STUDENTS

8.1 PART I TAMIL / OTHER LANGUAGES; PART II ENGLISH AND PART III CORE SUBJECTS, ALLIED, ELECTIVES COURSES AND PROJECT: Successful Students passing the Examinations for the Part I, Part II and Part III courses and securing the marks (a) 60 percent and above and (b) 50 percent and above but below 60 percent in the aggregate shall be declared to have passed the examination in the **FIRST and SECOND** class respectively; all other successful candidates shall be declared to have passed the examination in the **THIRD Class.**

9. MARKS AND GRADES: The following table shows the marks, grade points, letter grades and classification to indicate the performance of the Student:

RANGE OF MARKS	GRADE POINTS	LETTER GRADE	DESCRIPTION
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
40-49	4.0-4.9	C	Satisfactory
00-39	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

9.1 Computation of Grade Point Average (GPA) in a Semester, Cumulative Grade Point Average (CGPA) and Classification

GPA for a Semester: = ∑iCiGi ÷ ∑iCi

That is, GPA is the sum of the multiplication of grade pointsby the credits of the coursesdivided by the **s**um of the credits of the courses in a semester.

CGPA for the entire programme: = ∑n∑iCniGni ÷∑n∑iCni

That is, CGPA is the sum of the multiplication of gradepoints by the credits of the entire programme divided bythesum of the credits of the courses of the entireprogramme

Where,

Ci= Credits earned for course i in any semester,

Gi = Grade Points obtained for course i in any semestern = Semester in which such courses were credited.

9.2 Letter Grade and Class

CGPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.5-10.0	O +	First Class - Exemplary *
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D + +	First Class withDistinction *
8.0 and above but below 8.5	D +	

7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A + +	First Class
6.5 and above but below 7.0	A +	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B +	Second Class
5.0 and above but below 5.5	B	
4.5 and above but below 5.0	C +	Third Class
4.0 and above but below 4.5	C	
0.0 and above but below 4.0	U	Re-appear

*****The Students who have passed in the first appearance and within the prescribed semester of the UG Programme (Major, Allied and Elective courses only) are eligible.

10. RANKING

Students who pass all the examinations prescribed for the Program in the **FIRST APPEARANCE ITSELF ALONE** are eligible for Ranking / Distinction, provided in the case of Students who pass all the examinations prescribed for the Program with a break in the First Appearance due to the reasons as furnished in the Regulations **6** supra are only eligible for Classification.

11. CONCESSIONS FOR DIFFERENTLY-ABLED STUDENTS

11.1 Dyslexia students: For students who are mentally disabled, learning disability and mental retardation,who are slow learners, who are mentally impaired having learning disorder and seizure disorder and students who are spastic and cerebral Palsy, the following concessions shall be granted:

i) Part I Foundation course Tamil or any other Language can be exempted.

ii) One-third of the time of paper may be given as extra time in the examination.

iii) Leniency in overlooking spelling mistakes, and

iv) Amanuensis for all courses provided the request is duly certified by the Medical Board of the Government Hospital/ General Hospital/ District headquarters Hospitals and they shall be declaredqualified for the degree if they pass the otherexaminations prescribed for the degree.

11.2 Hearing, Speaking Impaired & Mentally retarded: For students who are hearing and speakingimpaired and who are mentally challenged, thefollowing concessions shall be granted:

i) One Language paper either Part I Foundation course Tamil or any other Language or Part II English or its equivalent can be exempted

ii) Part IV Non-Major Elective (NME) or Basic Tamil or Advanced Tamil can be exempted.

11.3 Visually Challenged students:

i) Exempted from paying examination fees.

ii) A scribe shall be arranged by the College and the scribe be paid as per the College decision.

12. MAXIMUM PERIOD FOR COMPLETION OF THE PROGRAMS TO QUALIFY FOR A DEGREE

12.1 A Student who for whatever reasons is not able to complete the **program** within the normal period (N)or the Minimum duration prescribed for the programme, may be allowed two years period beyond the normal period to clear the backlog tobe qualified for the degree. (Time Span = N + 2 years for the completion of programme.)

12.2 In exceptional cases like major accidents and child birth an extension of one year be considered beyond maximum span of time (Time Span = N + 2n+1 years for the completion of programme).

12.3 Students qualifying during the extended period shall not be eligible for **RANKING.**

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SYLLABUS

FIRST SEMESTER

S. No	Course component	Name of course	Inst. hours	Credits	Theory/ Practical (External : Internal)	Max. marks
1	Part I	Language/ Tamil Paper 1	4	3	75 : 25	100
2	Part II	English Paper 1	4	3	75 : 25	100
3	Part III	**Core**: Paper1: Cell biology	6	4	75 : 25	100
4	Part III	**Core**: Paper 2: Practical 1*	6	4	60 : 40	100
5	Part III	**Allied** :Paper1: Microbiology	6	5	75 : 25	100
6	Part IV	**1.a.** Those who have not studied Tamil up to XII std and taken a non-Tamil language	2	2	75 : 25	100

		under Part – I shall take Tamil comprising of two courses (level will be at 6th std). **b.** Those that have studied Tamil up to XII std and taken a non-Tamil language under Part- I shall take Advanced Tamil comprising of two courses. **c.** Others that do not come under a+b can choose non- major elective comprising of two courses.				

7		**2.Skill based subject (Elective):** Soft skill -1	2	3	50 : 50	100
Total Credits						**24**

* Practical examination will be conducted at the end of second semester.

SECOND SEMESTER

S. No	Course component	Name of course	Inst. Hours	Credits	Theory/ Practical External : Internal	Max. marks
1	Part I	Language/ Tamil Paper 2	4	3	75 : 25	100
2	Part II	English Paper 2	4	3	75 : 25	100
3	Part III	**Core**: Paper3: Developmental Biology and Genetics	6	4	75 : 25	100
4	Part III	**Core**: Paper 4: Practical 2*	6	4	60 : 40	100
5	Part III	**Allied** :Paper2: Chemistry	6	5	75 : 25	100
6	Part IV	**1. A.** Those who have not studied Tamil up to XII std and taken a non- Tamil language under Part – I shall take Tamil comprising of two courses (level will be at 6^{th} std).	2	2	75 : 25	100

		b. Those that have studied Tamil up to XII std and taken a non-Tamil language under Part- I shall take Advanced Tamil comprising of two courses. **c.** Others that do not come under a+b can choose non-major elective comprising of two courses.				
7		**2. Skill based subject (Elective) :** Soft skill-II	2	3	50 : 50	100
Total Credits						**24**

* Practical examination will be conducted at the end of second semester.

THIRD SEMESTER

Course components	Subject	Inst Hrs.	Credits	Exam Hrs.	Max. Marks		
					Ext. Marks	Int. Marks	Total
Part-I	Language Paper- III	5	3	3	75	25	100
Part-II	English Paper- III	5	3	3	75	25	100
Part III - Core Courses	Paper-V – Immunology	6	4	3	75	25	100
Practical*	Paper- VI Immunology and Biochemistry (Practical)	6	4	3	60	40	100
Allied Subject-II	Paper – I Biochemistry	6	5	3	75	25	100
Part-IV	2. Soft Skill-III	2	3	3	50	50	100
Total Credits							**22**

* Practical examination will be conducted at the end of fourth semester.

FOURTH SEMESTER

Course Components	Subject	Inst Hrs.	Credits	Exam Hrs.	Max. Marks		
					Ext. Marks	Int. Marks	Total
Part-I	Language Paper- IV	6	3	3	75	25	100
Part-II	English Paper-IV	6	3	3	75	25	100
Part III Core Courses	Paper-VII - Animal and Medical Biotechnology	6	4	3	75	25	100
	Paper-VIII – Animal and Medical Biotechnology (Practical)	3	4	3	60	40	100
Allied Subject-II	Paper-II - Biophysics and Biostatistics	5	5	3	75	25	100

Part-IV	2. Soft Skill-IV	2	3	3	50	50	100
3. Environmental Studies		2	2	3	75	25	100
Total Credits							**24**

FIFTH SEMESTER

Course components	**Subject**	**Inst Hrs**	**Credits**	**Exam Hrs.**	**Max. Marks**		
					Ext. Marks	**Int. Marks**	**Total**
Part-III Core Courses	Paper- IX – Plant Biotechnology	6	4	3	75	25	100
	Paper- X - Environmental Biotechnology	6	4	3	75	25	100
	Paper-XI - Bioinformatics	5	4	3	75	25	100
Practical*	Paper- XII - Plant Biotechnology and Environmental Biotechnology	6	4	3	60	40	100
Project (at VI Semester) or Three Electives	Project/Elective –I Methods in Biology	5	5	3	75	25	100
Part-IV 4. Value Education		2	2				
Total Credits						**18/23**	

* Practical examination will be conducted at the end of sixth semester.

SIXTH SEMESTER

Course components	*Subject*	Inst Hrs.	Credits	Exam Hrs.	Max. Marks		
					Ext. Marks	Int. Marks	Total
Part-III Core Courses	Paper- XIII - Genetic Engineering.	5	4	3	75	25	100
	Paper- XIV – Industrial Biotechnology	5	4	3	75	25	100
Practical	Paper-XV - Genetic Engineering and Industrial Biotechnology (Practical).	6	4	3	60	40	100
Project or Three Electives	Project/Elective –II Microbial Biotechnology	6	5	3	75	25	100
	Project/Elective –III Pharmaceutical Biotechnology	6	5	3	75	25	100
	Student project	12	15		240 (40-work book, 150-Dissertation + 50- Viva)	60	300
Part-V - Extension Activities		2	1				
Total Credits						**13/23**	

Title of the paper	**Cell Biology**	
Category : **Part III Core**	Year & Semester	Credits
	First year, Sem I	4
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to various biological activities occurring at cellular level	
Course focusing on: Employability		
Course Outcome		
CO-1.	A student will be able Students will understand the basic structural organization of prokaryotic and eukaryotic cells	
CO-2.	Will have complete knowledge about Specific organelles and its function.	
CO-3.	Student can learn the Molecular mechanism of DNA replication	
CO-4.	Students can learn the Molecular mechanism of transcription.	
CO-5.	Students can learn the Molecular mechanism of translation.	

Syllabus

Unit	**Content**	**Hours**	**Cos**	**Cognitive level**
I	Introduction to the cell: Cell theory, Prokaryotic and Eukaryotic cell, Differences between animal cell and plant cell. Structure and Functions of Cell wall, Plasma membrane (fluid mosaic model) Cell division: mitosis and meiosis cell cycle. Programmed cell death.	**12**	**CO-1**	**K1, K2, K4**
II	Endoplasmic Reticulum Rough and Smooth- ultra structure. Structure and Functions of Ribosome, Mitochondria, Chloroplast, Nucleus, Chromosomes, Golgi apparatus, Lysosomes and peroxisomes.	**12**	**CO-1 CO-2**	**K1, K2**
III	Introduction to molecular biology: Central dogma, Nucleic acids, DNA Structure (Watson and Crick model). DNA replication, methods of DNA replication, Enzymes and accessory proteins involved in DNA replication, DNA repair mechanism.	**12**	**CO-3**	**K1, K2, K4, K5**
IV	Prokaryotic transcription-Eukaryotic transcription-RNA polymerase-General and specific transcription factors, post transcriptional modifications, Gene expression (Lac operon concept).	**12**	**CO-4**	**K1, K2, K3, K6**

V	Genetic code; characteristics of genetic code, Translation: Prokaryotic translation-Eukaryotic translation-Mechanism of initiation-elongation and termination, Post translational modifications of proteins.	**12**	**CO-5**	**K1, K2, K3, K4, K5**

Text Books:

1. Gupta, P. K. 2015 .Cell and Molecular Biology, 4th edition, Rastogi Publications.
2. Cooper, G.M. 2000. The Cell- A molecular approach, 2nd edition. A.S.M. Press, Washington DC.

Reference Books:

1. David Baltimore.2002.Molecular cell biology4 th edition. W H Freeman & Co publisher
2. Brown, T.A. 2001. Gene Cloning & DNA analysis. Blackwell Science, London.
3. Lodish, H., Berk, A., Zipursky, S.L., Matusudaria, P., Baltimore, D. and Darnell, J., 2000. Molecular Cell Biology, Media Connected, W.H. Freeman and Company, New York.
4. Benjamin Lewis, 2001. Genes VII. Oxford University Press, London.

Title of the paper	**Practical - 1 Cell Biology and Microbiology**	
Category : **Part III Core**	Year & Semester	Credits
	First year, Sem I	4
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to various laboratory exercises pertaining to cell biology and microbiology.	
Course focusing on: Skill Development		
Practical - 1 Course Outcome		
CO-1.	This course enables the students to differentiate the various prokaryotes and eukaryotic division of cells.	
CO-2.	They will be able to stain and observe cell types using different microscopic techniques.	

Content

Cell Biology: Microscopy- RBC and WBC counting- Enumeration of WBC- Differential leukocyte Count- Salivary gland preparation from Chironomous larva- Mitosis preparation from onion root tip and meiosis preparation from grasshopper testis- Enumeration of prokaryotic cell- Buccal smear preparation- Cell fractionation (nucleus, mitochondria- Demonstration).

Microbiology: Sterilization techniques: Preparation of media, inoculation techniques – Pour plate, spread plate and dilution techniques. Demonstration of microbial contamination on culture plates. Micrometry- Wet preparation: Hay infusion broth, Hanging drop- Simple staining, Differential staining- Capsule staining- Spore staining- Inoculation techniques: Pour plate- spread plate- Dilution techniques. Biochemical tests for identification of bacteria: - Catalase test- Oxidase test- Urease test- IMVIC test- LAO test- Gelatin liquefaction- Starch Degradation- Carbohydrate fermentation- Viable Bacteria; - morphological identification of Fungi.

Title of the paper	**Allied 1- Microbiology**	
Category : **Part III Allied**	Year & Semester	Credits
	First year, Sem I	5
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to various aspects of basic microbiology.	
Course focusing on: Employability		
Course Outcome		
CO-1.	A student will be able Students will understand the History and scope of microbiology	
CO-2.	Will have complete knowledge about microbial classification	
CO-3.	Student can learn the role of microbes in environment	
CO-4.	Students can gain knowledge on basics in Medical microbiology.	
CO-5.	Students can learn use of microbes in industry.	

Syllabus

Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	History and Scope of Microbiology- Anatomy of Prokaryotes and Eukaryotes- Bacteria, Fungi, Algae, Protozoa and Viruses- structure and functions of the cellular comaponents- Growth and nutrition- media and culture.	**12**	**CO-1**	**K1, K2, K4**
II	Classification of microbes- DNA analysis, Ribosomal RNA analysis- Numerical taxonomy- Molecular taxonomy- methods of microbial identification.	**12**	**CO-2**	**K1, K2**
III	Environmental Microbiology- role of microorganisms in the productivity of ecosystems- Role of microorganisms in food production; dairy and non-dairy products- fermented foods and alcoholic beverages- production of food (single cell protein), Fuel (ethanol).	**12**	**CO-3**	**K1, K2, K4, K5**
IV	Medical Microbiology- Pathogenic microbes- Bacterial, Viral, Fungal and Protozoan diseases. Cure, control and prevention- Pharmaceuticals (antibiotics, vaccines etc.), production of vitamins, organic acids Biofertilizers (BGA), Biopesticides, biopolymers, biosurfactants.	**12**	**CO-4**	**K1, K2, K3, K6**

V	Industrial use of microbes- fermentation products- bioconversions- products of industrial microbiology- Streptomyces, yeasts (Saccharomyces, Hansenula), Spirulina and Penicillium.	**12**	**CO-5**	**K1, K2, K3, K4, K5**

Text Books:

1. Lucy Phillip, 2016. Microbiology: Concepts and Applications. Syrawood Publishing House, USA.
2. Ananthanarayan, R. and Paniker, C.K.J. 2016 A text book of Microbiology. 8th edition. Orient Longman Ltd., Hyderabad.
3. Pelzar, 2000. Microbiology. 5th edition. Tata McGraw Hill., New Delhi.

Reference books:

1. Puvanakrishnan, R, Sivasubramanian, S and Hemalatha, T. 2015. Microbes and enzymes basics and applied, 1st edition MJP Publishers, India
2. Kathleen Park Talaro and Talaro, A. 2012. Foundation in Microbiology, 3rd edition, McGraw-Hill, New York.
3. Daniel Lim, 2002. Microbiology, 2nd edition. McGraw-Hill, New York.

	Plant Physiology	
Category : **Part IV NME**	Year & Semester	Credits
	First year, Sem 1	2
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	This course is designed to survey contemporary aspects of plant physiology with emphasis on recent research progress in related fields. Topics covered plant water relations, water transport, mineral nutrition, carbon and nitrogen metabolism (photosynthesis, respiration, and N assimilation), plant growth and development.	
Course focusing on: Employability		

Course Outcome

CO-1.	A student will acquire the knowledge about photosynthesis and its molecular level pathway.
CO-2.	Will have basic knowledge about the biological pathways.
CO-3.	Student will get appropriate knowledge about nitrogen fixation.
CO-4.	Student will learn the basics about biosynthesis of its metabolites and its actions
CO-5.	This unit clearly give the knowledge about the stresses that will affect the plants.

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	Light harvesting complexes; mechanisms of electron transport; photo protective mechanisms; CO-2 fixation-C3, C4 and CAM pathways.	**12**	**CO-1**	**K1, K2, K5**

II	Glycolysis**,** Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photo respiratory pathway. stomatal movement; photoperiodism and biological clocks.	**12**	**CO-1 CO-2**	**K1, K2, K5**
III	Nitrate and ammonium assimilation; nif genes, amino acid biosynthesis.	**12**	**CO-3**	**K1, K2, K3, K5**
IV	Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. Biosynthesis of secondary metabolites – phenols, nitrogenous base and their role.	**12**	**CO-3 CO-4**	**K2, K4, K5**
V	Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress.	**12**	**CO-5**	**K1, K2, K3, K4, K5**

Text Books:

1. V.K.Jain. 2015.Fundamentals of Plant physiology 8 th edition, S Chand Publisher.
2. S. N. Pandey, B. K. Sinha, 2009.Plant Physiology, 4th Edition, Vikas publishing company, Noida.
3. N.K. Gupta, S. Gupta, 2005. Plant Physiology Oxford & IBH Publishing Company Pvt Ltd, New Delhi.
4. Rajiv Kumar Sinha, 2004. Modern Plant Physiology, Alpha Science International Ltd, England.
5. Janat Shah, 2003.Plant Physiology., New Age International Pvt Ltd, New Delhi.

Reference books:

1. Lincoln Taiz, Eduardo Zeiger. 2014. Plant Physiology and Development.6th edition. Sinauer Associates.
2. William G. Hopkins, Norman P. A. Huner .2008. Introduction to plant physiology, 5th Edition. Wiley publishers

Title of the paper	**Animal Physiology**	
Category : **Part IV NME**	Year & Semester	Credits
	First year, Sem 1	2
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To provide students with a comprehensive overview of animal physiology from molecular, cellular and whole animal systems approaches.	
Course focusing on: Employability		
Course Outcome		
CO-1.	Students can learn a topic on blood and circulation.	
CO-2.	This course enables students to know about cardiovascular System.	
CO-3.	Will able to gain complete knowledge on respiratory system	
CO-4.	Students can understand nervous system.	

CO-5.	This course gives an idea about excretory system

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity, haemostasis.	**12**	**CO-1**	**K1, K2, K5**
II	Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.	**12**	**CO-2**	**K1, K2, K5**
III	Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.	**12**	**CO-3**	**K1, K2, K5**
IV	Neurons, action potential, gross neuro anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.	**12**	**CO-4**	**K1, K2, K5**
V	Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.	**12**	**CO-5**	**K1, K2, K5**

Text Books:

1. Surendra Nath Paipuru, 2013. Essentials of Animal Physiology. Lap Lambert Academic Publishing GmbH KG.
2. S. C. Rastogi, 2005. Essentials of Animal Physiology, 3rd Edition, New Age International Pvt Ltd, New Delhi.

Reference books:

1. Lincoln Taiz, Eduardo Zeiger. 2014. Plant Physiology and Development.6th edition. Sinauer Associates.
2. William G. Hopkins, Norman P. A. Huner .2008. Introduction to plant physiology, 5th Edition. Wiley publishers

Title of the paper	**Herbal Medicine**	
Category : **Part IV NME**	Year & Semester	Credits
	First year, Sem I	2
Pre- requisites	Knowledge of biology at Higher Secondary level	

Objectives of the course	This course is designed to impart a basic knowledge on Herbal Medicine
Course focusing on: Employability	
Course Outcome	
CO-1.	Students can learn topics on relevance of herbal medicine and its scope.
CO-2.	Students will be introduced to medicinal plant cultivation and poisonous plants.
CO-3.	Will able to gain knowledge on herbal drugs, its adulteration and export potentials.
CO-4.	Students can learn about the medicinal uses of rhizomes and roots.
CO-5.	This course will introduce the medicinal uses of different plant parts.

Syllabus

Unit	Content	Hours	Cos	Cognitive level
I	Importance and Relevance of Herbal drugs in Indian System of Medicine, Pharmacognosy – Aim and scope.	**12**	**CO-1**	**K1, K2, K5**
II	Medicinal gardening – Gardens in the Hills and plains; House gardens; plants for gardening – Poisonous plants – Types of plant poison; action of poisons; treatment for poisons, some poisonous plants; their toxicity and action.	**12**	**CO-2**	**K1, K2, K3**
III	Adulteration of crude drugs and its detection – methods of adulteration; types of adulteration. Medicinal plants of export values; rejuvenating herbs; Medicinal uses of Non-flowering plants.	**12**	**CO-3**	**K1, K2, K3, K4, K5**
IV	Botanical description and active principles of Root drugs; Rhizomes woods and bark drugs (Two examples for each plant organs).	**12**	**CO-4**	**K1, K2, K3, K4, K5**
V	Botanical description and active principles of leaves; Flowers; Fruits seed and entire plants as drugs. Taxonomic study of some selected herbals (Two examples for each plant organs).	**12**	**CO-5**	**K1, K2, K3, K4, K5**

References:

1. Srivastava, A.K. 2006, Medicinal Plants, International Book Distributors, Dehradun.
2. Agarwal, P., Shashi, Alok., Fatima, A and Verma, A. 2013. Current scenario of Herbal Technology worldwide: An overview. Int J Pharm Sci Res: 4(11): 4105-17.
3. Miller, L and Miller, B. 2017. Ayurveda & Aromatherapy: The Earth Essential Guide to Ancient Wisdom and Modern Healing. Motilal Banarsidass, Fourth edition.
4. Patri, F and Silano, V. 2002. Plants in cosmetics: Plants and plant preparations used as ingredients for cosmetic products - Volume 1. ISBN 978-92-871-8474-0, pp 218.

Title of the paper	Developmental Biology and Genetics	
Category : **Part III Core**	Year & Semester	Credits
	First year, Sem II	4
Pre- requisites	Knowledge of biology at Higher secondary level and cell biology at Bachelors level.	
Objectives of the course	To introduce the student to various molecular aspects of developmental biology and genetics	
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**	
AGR/Q4804 Animal Health Worker	AGR/N4821	Gain knowledge about the infertility problems
LFS/Q3905 Bioinformatics Scientist	LFS/N03912	Apply the coding and non-coding in gene regulatory pathways as appropriate for delivering project outcome. Explain the concepts of human genetics, disease and human genomics

Course focusing on: Employability

Course Outcome

CO-1.	It provides an introduction about the fundamental molecular mechanisms of organism development
CO-2.	Will have complete knowledge about embryogenesis
CO-3.	Student can learn the mechanism of Drosophila development
CO-4.	Students can learn the Mendelian laws.
CO-5.	Students can learn the mechanism of genetic recombination

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	Gamete cells: Spermatogenesis, Oogenesis, Sperm and oocyte maturation, Cellular regulation – cell cycle control, important signalling pathways in vertebrate development.	**12**	**CO-1**	**K1, K2**

II	Fertilization: Types of fertilization, Molecular recognition of egg and sperm, fusion and prevention of Polyspermy, rearrangement of egg cytoplasm and activation of egg. Blastulation, Gastrulation, Types of cleavage, Fate Maps, Nieuwkoop center, molecular role of organizer.	**12**	**CO-2**	**K1, K2, K4**
III	Myogenesis in mammals- growth factors: Mitogens and Oncogenes. Neurogenesis in Drosophila and chick - Regional specification in Drosophila. Embryogenesis- Mammalian homologs in Drosophila ANT-C and BC-X.	**12**	**CO-3**	**K1, K2, K4, K5**
IV	Mendelian laws of Inheritance - Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Allele, multiple alleles, pseudo allele, complementation tests. Pedigree analysis, karyotypes, genetic disorders.	**12**	**CO-4**	**K1, K2, K3, K4, K5, K6**
V	Identification of the DNA as the genetic material. Genetic recombination in bacteria: Conjugation, transduction, and transformation. Transcription, expression and regulation.	**12**	**CO-5**	**K1, K2, K4, K5**

Text Books:

1. Monroe Strickberger, W. 2015.Genetics,3rd edition Pearson education ,India
2. Verma, P.S. and Agarwal, V.K. 2010. Genetics, 9th edition, S. Chand Publishers
3. Karvita, B. Ahluwalia, 2010. Genetics. 2nd edition. New Age International Pvt Ltd, New Delhi.
4. Gardener, E.J, Simmons, M.J and Peter Snustad, D.2006.Principles of Genetics, 8th edition. Wiley Publishers.
5. Gilbert, S. 2000. Developmental Biology, 7th edition. Sinaver Associates Inc. Publishers, USA.

Reference Books:

1. Peter Snustand,D and Simmons,M.J. 2011.Genetics, 6th edition John Wiley and sons publication
2. Lewis, R.2001. Human genetics- concepts and application, 4th edition. McGraw Hill.
3. Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P., Baltimore, D and Darnell, J. 2000. Molecular Cell Biology. Media Connected. W.H. Freeman and Company, New York.
4. Winter, P.C., Hickey, G.J. and Fletcher, H.L.2000. Instant notes in Genetics. Viva books, Ltd.

Title of the paper	**Practical - 2 Developmental Biology and Genetics & Chemistry**	
Category : **Part III Core**	Year & Semester	Credits
	First year, Sem II	4
Pre- requisites	Knowledge of biology at Higher Secondary level	

Objectives of the course	To introduce the student to various laboratory exercises in molecular developmental biology and genetics
Course focusing on: Skill Development	
Practical - 2 Course Outcome	
CO-1.	This course enables the students to study the development of organisms.
CO-2.	To learn the principle and estimation of volumetric analysis and to understand the experiment of organic compound and identification of organic compounds.
Content	

Molecular developmental biology and Genetics

1. Observation of sperm from Frog
2. Observation of egg from Frog
3. Observation of living gametes from Grasshopper
4. Observation of living chick embryos 12 hrs development
5. Observation of living chick embryos 24 hrs development
6. Observation of living chick embryos 48 hrs development
7. Observation of living chick embryos 72 hrs development
8. Preparations of culture medium for drosophila.
9. Identification of mutants in Drosophila population
10. Blood grouping
11. Meiosis from grass hopper testis
12. Giant chromosomes from Chironomous larvae

Chemistry

VOLUMETRIC ANALYSIS

1. Estimation of Sodium hydroxide using HCl – standard Sodium Carbonate.
2. Estimation of Ferrous sulphate by using KMnO4 – standard Mohr's salt.
3. Estimation of Potassium permanganate using by oxalic acid – standard Sodium hydroxide.
4. Estimation of hardness of water using EDTA

ORGANIC ANALYSIS

DETECTION OF ELEMENTS (N, S, HALOGENS)

To distinguish between aliphatic and aromatic, saturated and unsaturated compounds. Functional group tests for phenol, acids, amide & Carbohydrate. Systematic analysis of organic compounds containing one functional group and characterization by confirmatory test. (Phenol, benzoic acid, phthalic acid, urea, glucose).

Reference:

Basic Principles of practical Chemistry: Venkateswaran, Veerasamy & Kulandaivel, S. Chand & Co.

Title of the paper	**Allied 2 Chemistry**	
Category : **Part III Allied**	Year & Semester	Credits
	First year, Sem II	5
Pre- requisites	Knowledge of chemistry at Higher Secondary level	

Objectives of the course	To understand the fundamental of acids, bases and solutions, thermodynamics and chemical kinetics. To understand the basic concepts of organic chemistry and industrial chemistry.
Course focusing on: Employability	
COURSE OUTCOMES	
CO-1	To learn about the periodic classification of elements and formation of different types of bonds.
CO-2	To study the concepts of acids, bases, pH and buffers.
CO-3	To enable the students to learn about the kinetics of the reaction and basic concepts of thermodynamics.
CO-4	To explain the basic concepts of classification of organic compounds, hybridization, polar effect, tautomerism, optical activity and polymer chemistry.
CO-5	To learn about hardness of water, purification methods, TDS, TSS, BOD COD, fuels and fertilizers.

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	**STRUCTURE OF ATOMS AND CHEMICAL BONDING:** Dalton's Atomic theory- Subatomic particles– concepts of atoms and molecules– General electronic configuration of s, p and d block elements – isotopes, isobars and isotones– shapes of atomic orbitals – periodic table– periodic classification– periodicity, valency. Types of bonds – ionic, covalent, coordinate and hydrogen bonding.	**12**	**CO-1**	**K1, K2, K4**
II	**ACIDS-BASES AND SOLUTIONS:** Arrhenius concept of acid and bases, proton transfer theory of acid and bases, Lewis concept of acids and bases, concentration of solution, ways of expressing concentrations of solutions – per cent by weight, normality, molarity, molality, mole fraction, pH of solution, pH scale, measurement of pH, buffer solutions, mechanism of buffer action of acid buffer and basic buffer.	**12**	**CO-2**	**K1, K2**

III	**CHEMICAL KINETICS AND THERMODYNAMICS:** Rate – factors influencing rate of reactions – order and molecularity – integrated rate expression for first and zero order reactions – Half life period – Pseudo first order reaction, methods to determine order of the reaction– Effect of temperature on rate – concept of activation energy – Arrhenius equation. Catalysis – Enzyme catalysis (derivation of Michaelis Menton equation) Terminology of thermodynamics – Types of systems, Reversible, irreversible, isothermal, adiabatic processes, exothermic and endothermic reactions – Spontaneous processes –First law of thermodynamics –Need for the second law – different statements of second law –	**12**	**CO-3**	**K1, K2, K4, K5**
IV	**FUNDAMENTALS OF ORGANIC CHEMISTRY** Classification of organic compounds – Hybridization in methane, ethylene, acetylene, and benzene. Definition with examples– electrophiles, nucleophiles, carbenes, and free radicals. Types of reactions: substitution, addition, elimination and condensation. (one example each) Electrophilic substitution reaction in benzene (nitration and sulphonation) Optical isomerism - symmetry, elements of symmetry – Cause of optical activity, Optical isomers of tartaric acid, Racemisation, Resolution by salt formation method – Geometric isomerism of maleic and fumaric acids. – Keto-enol tautomerism in acetoacetic ester. Polymers – Natural and synthetic polymers, Thermosetting and Thermo plastic polymers - Degradable and Non-degradable polymers. Poly alkenes preparation and uses (PET, PVC and PTFE Only).	**12**	**CO-4**	**K1, K2, K3, K6**

V	**INDUSTRIAL CHEMISTRY:** Hardness of water: temporary and permanent hardness, disadvantages of hard water – Softening of hard water – demineralization process – Zeolite process, and reverse osmosis – Purification of water – for domestic use – use of chlorine, Ozone and UV light. Definitions of pH, TDS, TSS, BOD and COD Fuels – Characteristics and Calorific value, Classification, gaseous fuels like water gas, producer gas, liquefied petroleum gas (LPG), gobar gas, compressed natural gas. Fertilizers– Role of NPK fertilizers – manufacture and uses of Urea, Ammonium sulphate, Superphosphate, Triple super phosphate, Potassium nitrate.	**12**	**CO-5**	**K1, K2, K3, K4, K5**

Text Books:

1. Veeraiyan, V. Text book of Ancillary Chemistry, Highmount Publishing house, Chennai-14. Edition-2006.
2. Vaithyanathan, S. and Others, Textbook of Ancillary Chemistry, Priya Publications, Karur-2. Edition-2006.
3. Jain, P. C. and others, Engineering chemistry, Dhanpat Rai publishing company, New Delhi, Edition 2009.

Reference Books:

1. Soni, P. L. and Others, Textbook of Organic chemistry, Sultan Chand and Company, New Delhi, Edition-2006.
2. Soni, P. L. and Others, Text book of Inorganic Chemistry, Sultan Chand and Company, New Delhi, Edition-2006.
3. Lee, J. D. Concise Inorganic chemistry. UK, Black well science 2006.
4. Puri, B. R, Sharma, L. R, Pathania, M. S., Principles of physical chemistry, Vishal Publishing Co. 2006.
5. Negi, A.S., and Anand, S.C., A text book of physical chemistry. Taj Press., New Delhi. 2001

Title of the paper	**Basics of Ecology**	
Category : **Part IV NME**	Year & Semester	Credits
	First year, Sem II	2
Pre- requisites	Knowledge of biology at Higher Secondary level	

Objectives of the course	To introduce the student to basics of ecology
Course focusing on: Employability	
Course Outcome	
CO-1.	Students can learn a topic on biotic and abiotic environmental factors and their interactions, symbiosis and concept of habitat and niche.
CO-2.	This course enables students to know about characteristics of population and its growth curve, population regulation, life history strategies and finally concept of metapopulation.
CO-3.	Will able to gain complete knowledge on community ecology
CO-4.	Students can understand mechanism of ecological succession and concept of climax.
CO-5.	This course gives an idea about terrestrial and aquatic ecosystem.

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	**The Environment:** Physical environment; biotic environment; biotic and abiotic. Concept of habitat and niche.	**12**	**CO-1**	**K1, K2, K3**
II	**Population ecology:** Characteristics of a population; population growth curves; population regulation concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.	**12**	**CO-2**	**K1, K2, K3, K4, K5**
III	**Community ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.	**12**	**CO-1 CO-3**	**K1, K2, K3, K4, K5**
IV	**Ecosystem and Ecological succession:**; Ecosystem Structures, ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; Types of ecological succession	**12**	**CO-1 CO-4**	**K1, K2, K3, K4, K5**
V	**Applied Ecology and conservation biology:** Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. **Conservation Biology:** Principles of conservation	**12**	**CO-3 CO-4 CO-5**	**K1, K2, K3, K4, K5, K6**

Text Books:

1. Manuel Molles and Anna Sher , 2019. Ecology: Concepts and Applications 8th Edition, McGraw Hill Publication.
2. S. S. Purohit, Ashok Agrawal, 2011. Ecology and Environmental Biology. Agrotech Publishing House, New Delhi.

3. Dash. 2009, Fundamentals of Ecology 3rd Edition Tata Mac Graw Hill Education Pvt Ltd, New Delhi.
4. P. S. Verma, V. K. Agarwal, 2000. Environmental Biology: Principles of Ecology .S. Chand Limited, New Delhi.

Reference Book:

1. J. L. Chapman, M. J. Reiss, 2009. Ecology Principles and Applications 2nd Edition Cambridge Publishing
2. Eugene Pleasants Odum, 2005 Fundamentals of Ecology. Cengage Publishing Company.

Title of the paper	**Evolution**	
Category : **Part IV NME**	Year & Semester	Credits
	First year, Sem II	2
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to the concepts of evolution	

Course focusing on: Employability

Course Outcome

CO-1.	The students can learn about the concepts of evolution
CO-2.	This course enables students to understand the origin of biological molecules
CO-3.	Will be able to learn the origin and evolution of living cells
CO-4.	Students can learn the evolutionary history
CO-5.	This course give an account of human evolution.

Syllabus

Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	**Emergence of evolutionary thoughts:** Lamarck; Darwin–concepts of variation, adaptation, fitness and natural selection.	**12**	**CO-1**	**K1, K2**
II	**Origin of molecules:** Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers.	**12**	**CO-2**	**K1, K2, K4, K5**
III	**Origin of cells and unicellular evolution:** Evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes.	**12**	**CO-2 CO-3**	**K1, K2, K4, K5**
IV	**Evolutionary history:** The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale.	**12**	**CO-4**	**K1, K2**
V	**Human evolution:** Stages in primate evolution including human.	**12**	**CO-4 CO-5**	**K1, K2**

Text Books:

1. Veer Bala Rastogi. 2014. Organic Evolution. Meddec, Publishing, New Delhi.

<table>
<tr><td colspan="4">2. R. Rajagopalan, 2009, Environment & Ecology, Oxford University Press-New Delhi.
3. P.S.Verma, 2004, Cell Biology, Genetics, Evolution & Ecology (M.E.), 14th Edition. S.Chand Publishing.</td></tr>
<tr><td colspan="4">Reference Book:
1. Brian K. Hall, Benedikt Hallgrimsson. 2013. Strickberger Evolution Fifth Edition, Jones and Bartlett publishers. New Delhi.
2. Carl Zimmer. 2011 Evolution: The Triumph of an Idea. Arrow books London.</td></tr>
<tr><td>Title of the paper</td><td colspan="3">Immunology</td></tr>
<tr><td rowspan="2">Category : Part III Core</td><td colspan="2">Year & Semester</td><td>Credits</td></tr>
<tr><td colspan="2">Second year, Sem III</td><td>4</td></tr>
<tr><td>Pre- requisites</td><td colspan="3">Knowledge of biology at Higher Secondary level</td></tr>
<tr><td>Objectives of the course</td><td colspan="3">To introduce the student to basic understandings of our immune system.</td></tr>
<tr><td colspan="4">Course focusing on: Employability</td></tr>
<tr><td>QUALIFICATION PACK</td><td colspan="3">NATIONAL OCCUPATIONAL STANDARDS</td></tr>
<tr><td>LFS/Q0308 Quality Control Chemist – Microbiology</td><td>HSS/N0301</td><td colspan="2">Correctly collect, transport, receive, accept or reject and store blood samples; Have a fair knowledge of blood cell biology</td></tr>
<tr><td rowspan="2">HSS/Q0301 Medical Laboratory Technician</td><td>HSS/N0302</td><td colspan="2">Conduct analysis of body fluids/ samples.</td></tr>
<tr><td>HSS/N0304</td><td colspan="2">The cells and their development, identification and functions and the microscopic examination of blood films.
The basic concepts of transfusion science, including the application of genetics and immunology to transfusion practice
Identify characteristics of major blood group systems, detect and identify antibodies.
Major blood group systems, antibody detection and identification procedures</td></tr>
<tr><td colspan="4">Course focusing on: Employability</td></tr>
<tr><td colspan="4">Course Outcome</td></tr>
<tr><td>CO-1.</td><td colspan="3">A student will gain overall knowledge about immune system and its components.</td></tr>
<tr><td>CO-2.</td><td colspan="3">Will have complete knowledge about primary and secondary lymphoid organs.</td></tr>
</table>

CO-3.	Students study about the detailed theory portion on antibody.
CO-4.	Students can complement with the cytokines and its activation
CO-5.	Students will know about the detail on hypersensitivity types and reactions

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	Introduction to the immune system: Innate immune response – protective barriers, inflammation. Adaptive immune response- Soluble components of the immune system, lymphocytes, antigen presenting cells. Major histocompatibility complex, Human leukocyte antigens, HLA typing.	**12**	**CO-1**	**K1, K2, K4**
II	Cells and organs of the immune system: Hematopoiesis, Cells involved in the immune response, lymphocytes, mononuclear phagocytes, granulocytes. Primary lymphoid organs, secondary lymphoid organs and tissues, Serum and lymph, Clonal selection of lymphocytes	**12**	**CO-2**	**K1, K2**
III	Antigen and antibody: Properties of antigen, Haptens, Adjuvants, epitopes. Antigen-antibody interaction. Structure of immunoglobulin, antibody classes and biological activities. Theories of antibody formation. Production and application of monoclonal antibody.	**12**	**CO-1 CO-3**	**K1, K2, K3, K4**
IV	Cytokines and complement: Properties and biological functions of cytokines. Cytokine related diseases. Complement components; complement activation-classical, alternative and lectin pathway. Membrane attack complex (MAC).	**12**	**CO-1 CO-4**	**K1, K2, K3, K4**
V	Hypersensitivity and autoimmunity: Hypersensitivity Type I, Type II, Type III, and Type IV. Vaccines- Types of vaccines, DNA vaccines. Autoimmune diseases-organ specific and systemic. Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, Immunological basis of AIDS and cancer.	**12**	**CO-5**	**K1, K2, K3, K4, K6**

Text Books:

1. Abul K. Abbas & Andrew H. H. Lichtman & amp; Shiv Pillai. 2019. Basic Immunology, 6th Edition, Elsevier Publications.
2. Sunil Kumar, M, K. Sai, K. C. Nathsarma, 2013. Textbook of Immunology. 2 edition, Jaypee Brothers Medical Publisher, New Delhi.

<table>
<tr><td colspan="4">3. B. Annadurai. 2010. A Textbook of Immunology & Immunotechnology, S. Chand Publisher, New Delhi.
4. Nandini Shetty. 2007. Immunology: Introductory Textbook. Revised 2nd edition. New Age International publishers, Chennai.</td></tr>
<tr><td colspan="4">Reference Books:
1. Delves P, Martin S, Burton D, and Roitt IM. 2017. Roitt’s Essential Immunology. 13th edition, Wiley-Blackwell Scientific Publication, Oxford.
2. Judith A. Owen, Jenni Punt , Sharon A. Stranford. 2013, Kubey Immunology 7th edition W H Freeman & Co (Sd) Publisher.
3. Abbas AK, Lichtman AH, Pillai S. 2007. Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.</td></tr>
<tr><td>Title of the paper</td><td colspan="3">Practical - 3 Immunology and Biochemistry</td></tr>
<tr><td rowspan="2">Category : Part III Core</td><td>Year & Semester</td><td colspan="2">Credits</td></tr>
<tr><td>Second year, Sem III</td><td colspan="2">4</td></tr>
<tr><td>Pre- requisites</td><td colspan="3">Knowledge of biology at Higher Secondary level</td></tr>
<tr><td>Objectives of the course</td><td colspan="3">To introduce the student to basic techniques related to immunology</td></tr>
<tr><td>QUALIFICATION PACK</td><td colspan="3">NATIONAL OCCUPATIONAL STANDARDS</td></tr>
<tr><td rowspan="2">HSS/Q0301 Medical Laboratory Technician</td><td>HSS/N0302</td><td colspan="2">Conduct analysis of body fluids/ samples.</td></tr>
<tr><td>HSS/N0304</td><td colspan="2">The cells and their development, identification and functions and the microscopic examination of blood films</td></tr>
<tr><td colspan="4">Course focusing on: Skill Development</td></tr>
<tr><td colspan="4">Practical - 3 Course Outcome</td></tr>
<tr><td>CO-1.</td><td colspan="3">A student will perform a practical session on various immunodiagnostic techniques along with the identification of various immune cells from human blood.</td></tr>
<tr><td>CO-2.</td><td colspan="3">Will come to know practical work on the volumetric, qualitative and quantitative analysis</td></tr>
<tr><td colspan="4">Immunology Practical:
1. Identification of human blood groups.
2. Separation of serum from blood sample.
3. Identification of various immune cells from peripheral blood smear.
4. Total Leukocyte Count of the given blood sample.
5. Differential Leukocyte Count of the given blood sample.
6. Immunodiagnostic - WIDAL Test
7. Immunodiagnostic - ASO Test
8. Immunodiagnostic - Rheumatoid arthritis Test
9. Immunodiagnostic - Pregnancy Test (HCG)
10. Double Immunodiffusion Test</td></tr>
</table>

11. Immuno electrophoresis.
12. Rocket electrophoresis
13. Counter current electrophoresis
14. ELISA (Demo)

Biochemistry Practical:

1. Volumetric analysis

a. Estimation of ascorbic acid using 2,6 – dichlorophenol indophenol as link solution.
b. Estimation of HCl using Na2CO-3 as link solution.
c. Estimation of Glycine by formal titration.
d. Estimation of Glucose by Benedict's method.

2. Qualitative analysis

Qualitative analysis of carbohydrates- glucose, fructose, galactose, lactose, maltose and sucrose.

3. Qualitative analysis

Qualitative analysis of amino acids – arginine, cysteine, tryptophan and tyrosine.

Reference Books:

1. Laboratory Handbook of Biochemistry, S.Shanmugam and T. Sathish Kumar, 1st Edition, 2010, PHI Learning Pvt Ltd.
2. Laboratory manual in Bio chemistry, J. Jayaraman, 1st Edition, 2000, New Age International Publisher.

Title of the paper	**Allied 3 -Biochemistry**	
Category : **Part III Allied**	Year & Semester	Credits
	Second year, Sem III	5
Pre- requisites	Knowledge of biology and chemistry at Higher Secondary level	
Objectives of the course	To introduce the student to basics of biochemistry	

Course focusing on: Employability

Course Outcome

CO-1.	A student will be able Students will understand the basic Structure of atoms
CO-2.	Will have complete knowledge about Classification of porphyrins
CO-3.	Student can learn metabolism of Biochemicals
CO-4.	Students can learn about enzymes
CO-5.	Students can learn about metabolic disorders

Syllabus

Unit	**Content**	**Hours**	**COs**	**Cognitive level**
I	Structure of atoms, molecules and chemical bonds. Van der Waals, hydrogen bonding. pH, buffer. Structure, Chemistry and properties of Carbohydrates, Lipids, Proteins.	**12**	**CO-1**	**K1, K2, K4**

II	Classification of prophyrins, their structure and properties. Structure of metalloprophyrins – haeme and chlorophyll. Vitamins and Hormones.	**12**	**CO-2**	**K1, K2**
III	Principles of Bioenergetics, Metabolism of Carbohydrates, fat, proteins, purines, pyrimidines – their biosynthesis and degradation, mechanism of oxidative phosphorylation and its inhibitors, photo phosphorylation.	**12**	**CO-3**	**K1, K2, K4, K5**
IV	Enzymes – Nomenclature, Classification, Properties of enzymes, Enzyme Kinetics - Effect of substrate concentration, Effect of pH, Effect of temperature. Isoelectric point, Enzyme Regulation - Feedback Regulation, Allosteric enzymes, Isoenzymes.	**12**	**CO-4**	**K1, K2, K3, K6**
V	Diabetes mellitus, Atherosclerosis, In bone errors of metabolism - Glycogen storage disease, phenylketonuria, acute intermittent porphyria, Lipoid congenital adrenal hyperplasia, Gaucher's disease, Lesch-Nyhan syndrome. Serum lipids in diseases with special reference to cholesterol, lipidosis, triglyceridemia, hypo and hypercholesterolemia, Fatty Liver.	**12**	**CO-5**	**K1, K2, K3, K4, K5**

Text Books:

1. Nagini S. 2015. Textbook of Biochemistry. 2nd Edition. Scitech Publications Pvt Ltd. India.
2. Victor Rodwell, P. Anthony Weil, Kathleen M. Botham – 2015. Illustrated Biochemistry. 30th Edition. McGraw-Hill. Europe.
3. Charlotte W. Pratt, Donald Voet, and Judith G. Voet. 2012. Principles of Biochemistry, 4th Edition. Hoboken, N.J. Wiley; Chichester: John Wiley. New York, United States.
4. Sathyanarayana. U. 2007. Biochemistry. Books and allied Pvt. Ltd. India

Reference Books:

1. Lehninger, A.L., Nelson, D.L and Cox, M.M. 2017. Principles of Biochemistry, 7nd edition. WH Freeman Publishers. New York, United States.
2. Charlotte W. Pratt, Donald Voet, and Judith G. Voet. 2012. Principles of Biochemistry, 4th Edition. Hoboken, N.J. Wiley; Chichester: John Wiley. New York, United States.

Title of the paper	**Animal and Medical Biotechnology**	
Category : **Part III Core**	Year & Semester	Credits
	Second year, Sem IV	4
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to basics of animal biotechnology	

QUALIFICATION PACK	NATIONAL OCCUPATIONAL STANDARDS	
HSS/Q0301 Medical Laboratory Technician	HSS/N0301	Correctly collect, transport, receive, accept or reject and store blood and tissue samples.
	HSS/N0303, HSS/N9610 F	Maintain, operate and clean laboratory equipment, follow infection control policies and procedures
	KB4 KB5	How to clean and sterile techniques The path of disease transmission: paths of transmission including direct contact and penetrating injuries - risk of acquisition
AGR/Q4804 Animal Health Worker	AGR/N4821	Conduct artificial insemination • Gain knowledge about the infertility problems and handling • Practice appropriate method for feeding and breeding of animals • Understand the common animal birth related problems.

Course focusing on: Employability

Course Outcome

CO-1.	A student will have knowledge on animal cell culture, primary and secondary cell culture as well as its maintenance and applications of cell culture.
CO-2.	This course enables students to know techniques like artificial insemination, in vitro fertilization, embryo culturing and its maintenance.
CO-3.	Student can learn about diagnosis of pathogenic microbes using modern techniques and its preventive measures. They will have complete knowledge on monoclonal antibody production and vaccination.
CO-4.	Students can understand gene therapy methods and gene editing technology
CO-5.	Will able to gain theoretical knowledge on nucleic acid analysis methods like PCR, blotting techniques, DNA finger printing, AFLP, RFLP. This course also enables students to apply nanotechnology methods to animal biotechnology.

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	Basic principles - Animal cell, tissues and organs culture, medium composition, primary culture and maintenance, secondary and continuous cell lines and suspension cultures. Applications cell culture technology in production of animal.	12	**CO-1**	K1, K2, K3

II	Structure of sperms and ovum, cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, in vitro fertilization, culture of embryos, cryopreservation of embryos, embryo transfer, embryo-splitting, embryo sexing, transgenic manipulation of animal embryos.	12	**CO-2**	K1, K2, K4
III	Historical aspects – Medical Biotechnology – Pathogenic microbes – Bacterial, Viral, Fungal and Protozoan disease – diagnosis using modern techniques – probes – Cure, control and prevention. Probes -disease diagnosis - existing and emerging in animal-Monoclonal antibody-Development of MAB as therapeutics. Vaccines: Conventional vaccines, Modern vaccine technologies, genetically improved subunit vaccines, DNA vaccines.	12	**CO-3**	K1, K2, K3, K4
IV	Gene transfer methods in Animals – Microinjection, Embryonic Stem cell gene transfer, Retrovirus, Gene transfer & Antibody engineering- Knockout mice- Gene-editing technology-TALEN	12	**CO-4**	K1, K2, K3, K4, K5
V	Tools in medical biotechnology- Methods of nucleic acid analysis- Polymerase chain reaction, DNA finger printing, Southern blot and Western blot analysis, RAPD, AFLP, RFLP. Nanotechnology and Its Applications to Animal Biotechnology- Genetic engineered fish for human consumption. Ethical and social considerations surrounding animal biotechnology.	12	**CO-5**	K1, K2, K3, K4, K5

Text Books:

1. Satyanarayana U .2016. Biotechnology, Tenth printing, Books and Allied (P) Ltd.
2. Ashish Verma, Anchal Singh. 2013. Animal Biotechnology, Models in Discovery and Translation, 1st Edition, Elsevier press.
3. Portner R. 2007. Animal Cell Biotechnology. Humana Press.
4. Ralf Portner, 2007. Animal cell biotechnology: Methods and protocols. 2nd edition, Humana Press, New Jersey
5. Gordon I. 2004. Reproductive Technologies in Farm Animals. 1st Edition, CABI press.

Reference Books:

1. Ian Freshney, 2010. Culture of animal cells. 6th edition. Wiley-Blackwell publishers.
2. Leda R. Castilho, Angela Maria Moraes, Elisabeth F.P. Augusto and Michael Butler, 2008.Animal Cell Technology: From Biopharmaceuticals to Gene Therapy, Taylor & Francis Group.
3. Twyman RM, 2003. Advanced Molecular Biology. 3rd Edition, Bios Scientific publishers.

<table>
<tr><td>Title of the paper</td><td colspan="3">Practical - 4 Animal and Medical Biotechnology</td></tr>
<tr><td rowspan="2">Category : Part III Core Practical</td><td colspan="2">Year & Semester</td><td>Credits</td></tr>
<tr><td colspan="2">Second year, Sem IV</td><td>4</td></tr>
<tr><td>Pre- requisites</td><td colspan="3">Knowledge of biology at Higher Secondary level</td></tr>
<tr><td>Objectives of the course</td><td colspan="3">To introduce the student to basic techniques related to animal biotechnology</td></tr>
<tr><td>QUALIFICATION PACK</td><td colspan="3">NATIONAL OCCUPATIONAL STANDARDS</td></tr>
<tr><td rowspan="2">HSS/Q0301 Medical Laboratory Technician</td><td>HSS/N0303</td><td colspan="2">Maintain, operate and clean laboratory equipment</td></tr>
<tr><td>KB4</td><td colspan="2">How to clean and sterile techniques</td></tr>
<tr><td colspan="4">Course focusing on: Employability</td></tr>
<tr><td colspan="4">Course Outcome</td></tr>
<tr><td>CO-1</td><td colspan="3">A student will perform a practical basic technique related to animal cell culture</td></tr>
<tr><td>CO-2</td><td colspan="3">Will come to know practical work on DNA isolation and identification</td></tr>
<tr><td colspan="4">Content</td></tr>
<tr><td colspan="4">1. Preparation of tissue culture medium and membrane filtration
2. Preparation of single cell suspension from spleen and thymus
3. Primary cell culture
4. Introduction to Animal Cell culture: Procedure for handling cells and medium.
5. Cleaning and sterilization of glassware and plastic tissue culture flasks
6. Preparation of sera for animal cell culture
7. Cell counting
8. Acridine orange/Ethidium bromide staining
9. Macrophage monolayer from PEC and measurement of phagocytic activity
10. Cryopreservation and thawing
11. Measurement of doubling time
12. MTT assay for cell viability and growth
13. Isolation of genomic DNA</td></tr>
<tr><td>Title of the paper</td><td colspan="3">Allied 4- Biophysics and Biostatistics</td></tr>
<tr><td rowspan="2">Category : Part III Allied</td><td colspan="2">Year & Semester</td><td>Credits</td></tr>
<tr><td colspan="2">Second year, Sem IV</td><td>5</td></tr>
<tr><td>Pre- requisites</td><td colspan="3">Knowledge of biology at Higher Secondary level</td></tr>
</table>

Objectives of the course	To introduce the student to basics of Biophysics and Biostatistics	
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**	
LFS/Q0501 Drug Regulatory Affairs Chemist	LFS/N0503	Application of statistics to analyse trends and data

Course focusing on: Employability

Course Outcome

CO-1.	A student will be able Students will understand Scope and methods of biophysics
CO-2.	Will have complete knowledge Biological macromolecules
CO-3.	Student can learn scope of biostatistics
CO-4.	Students can learn about Measures of central tendency
CO-5.	Students can learn about Probability distributions

Syllabus

Unit	Content	Hours	Cos	Cognitive level
I	Scope and methods of biophysics – levels of molecular organization – detailed structure of protein molecules at primary, secondary, tertiary and quaternary levels.	**12**	**CO-1**	**K1, K2, K3**
II	Biological macromolecules - physical properties of proteins, three dimensional structure and confirmation using physical methods (principles and applications of electrophoresis, chromatography, viscosity, spectrophotometry, ORD, CD, NMR, ESR to study biomolecules). Analysis of protein, protein interaction and protein – nucleic acid interaction. Structure and chemical nature of polysaccharides.	**12**	**CO-2**	**K1, K2, K3, K4, K5**
III	Definition- scope of biostatistics - Population and Sample collection, classification, and tabulation of data - graphical and diagrammatic representation - scale diagram - histograms - pie diagrams - frequency polygon - frequency curves.	**12**	**CO-3**	**K1, K2, K3, K4, K5, K6**
IV	Measures of central tendency - arithmetic mean, median, and mode - calculation of mean, median and mode in series of individual observation, discrete series continuous open - end classes. Measure of dispersion - standard deviation and standard curves.	**12**	**CO-4**	**K1, K2, K3, K4, K5, K6**

V	Probability distributions – Binomial and negative binomial, compound and multinomial distributions – Tests of significance – t tests – F tests – Analysis of variance – Spread sheets Data entry – Graphics display – word processes.	**12**	**CO-5**	**K1, K2, K3, K4, K5, K6**

Text Books:

1. A.K. Sharma. 2005. Text Book of Biostatistics. House. New Delhi
2. Mahajan. 2006. Methods in Biostatistics. 6th edition. Jaypee brother's publishers, New Delhi.

Reference Books:

1. J. Richard and Sundar P. S. S. Rao, 2006. Introduction to Biostatistics and Research Methods 4th Revised edition edition Prentice-Hall of India Pvt.Ltd.
2. Protein structure and molecular properties. Creighton, T.E.2002. W.H. Freeman and Company.
3. DNA Science. Micklos, D.A. and Freyes, G.A. 2002. Cold Spring harbour Laboratory Press.

Title of the paper	**Plant Biotechnology**	
Category : **Part III Core**	Year & Semester	Credits
	Third year, Sem V	4
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to basics of plant biotechnology	
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**	
AGR/Q8101 Plant Tissue Culture Technician	AGR/N8102	Prepare culture medium such as MS, B5, N6, Nitsch and Whites using the recommended quantity of sucrose, agar, water and stock solution with the help of hot plate and magnetic stirrer. Different types of plant growth regulators and their correct use.
	AGR/N8103	Prepare the mother plant and explants. Prepare for transferring the explant to culture medium. Transfer the explant to culture medium. Acclimatize the tissue cultured plants. Harden off the plants

Course focusing on: Entrepreneurship

Course Outcome

CO-1.	A student will gain knowledge in detail about the plant genome organization

CO-2.	Will come to study about the plant growth regulators
CO-3.	Students study about the detail's theory portion on plant tissue culture
CO-4.	Students will know about the regulation of gene expression
CO-5.	Students will study about the details on transgenic plants

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	Plant genome organization: Nuclear genome-structure of plant genes, chloroplast and its genome, mitochondria and its genome, cytoplasmic male sterility, Transposable elements.	**12**	**CO-1**	**K1, K2, K4**
II	Plant growth regulators: Growth Hormones-Biosynthesis and physiological effects of auxin, gibberellins, cytokinin, abscisic acid and ethylene.	**12**	**CO-1 CO-2**	**K1, K2**
III	Plant tissue culture: culture media (White's, MS, B5, N6, Nitsch's), Plant growth regulators, preparation and sterilization of explants. Callus and suspension cultures, protoplast isolation, fusion and regeneration. Micropropagation, Morphogenesis and organogenesis, transformation-Direct and *Agrobacterium* mediated transformation. Ti plasmid.	**12**	**CO-2 CO-3**	**K1, K2, K4, K5**
IV	Regulation of gene expression: Inducible control of gene expression-class I Promoters, hormone inducible gene expression, Class II promoters. Phytochrome.	**12**	**CO-4**	**K1, K2, K3, K6**
V	Transgenic plants: Guidelines for introduction of transgenic plants in the field. Herbicide resistance, pest resistance, disease resistance and stress tolerant plants. Molecular pharming.	**12**	**CO-5**	**K1, K2, K3, K4, K5**

Text Books:

1. Krishna G.K.A.Elangovan S.Devika. 2016. Plant Biotechnology, New Visal Publications
2. C.B. Nirmala, G. Rajalakshmi and Chandra Karthick, 2009. 1st Edition. MJP Publishers.
3. B.D. Singh, 2007. Plant Biotechnology. 1st Edition. Kalyani Publishers
4. M. Sudhir, 2000. Applied Biotechnology and plant Genetics. 1st Edition. Dominant Publishers and Distributors.

Reference Books:

1. Adrian Slater, 2011. Plant Biotechnology: The Genetic Manipulation of Plants. 2nd Edition. Oxford University Press.
2. Sant Saran Bhojwani and Prem Kumar Dantu 2013 Plant Tissue culture: An Introductory Text, Springer publisher.
3. H.S Chawla, 2010. Introduction to Plant Biotechnology. 3rd Edition. Oxford and IBH Publishing Co. Pvt. Ltd.

4. C. Neal Stewart Jr, 2016. Plant biotechnology and genetics: principles, techniques, and applications. 2nd Edition. John Wiley & Sons Inc.			
Title of the paper	**Environmental Biotechnology**		
Category : **Part III Core**	Year & Semester		Credits
	Third year, Sem V		4
Pre- requisites	Knowledge of biology at Higher Secondary level		
Objectives of the course	To introduce the student to basics of Environmental Biotechnology		
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**		
LFS/Q0214 Environment, Health and Safety Manager	LFS/N0230	Pollution control, pollution prevention and recycling programs and supervise Effluent Treatment Plant (ETP) operations	
LFS/Q0220 Effluent Treatment Plant Operator	SGJ/N6601	overall operations and different processes of wastewater treatment plan	
LFS/Q0308 Quality Control Chemist - Microbiology	LFS/N0321	Perform inspection of incoming materials	
LFS/Q2301 Quality Control Biologist	LFS/N0338	Application of microbiological techniques such as air monitoring, water testing	
	LFS/N0338	TOC Analyzer	
Course focusing on: Employability			

Course Outcome	
CO-1.	A student will acquire the knowledge about our ecosystem and the energy flow.
CO-2.	Will have basic knowledge about type of pollution and its effects.
CO-3.	Student will get appropriate knowledge about to control pollution and remediation process
CO-4.	Student will learn the basics about biofertilizers, biopesticides and crop production
CO-5.	This unit clearly give the knowledge about the genetically modified organisms

Syllabus

Unit	**Content**	**Hours**	**COs**	**Cognitive level**

I	Basic Concepts: Ecosystem dynamics and management: Stability and complexity of ecosystems; Energy flow, food chain, food web and tropic levels; Ecological pyramids and recycling, biotic community-concept, structure, dominance, fluctuation and succession; N.P.C and S cycles in nature.	**12**	**CO-1**	**K1, K2, K3, K4, K6**
II	Environmental Pollution: Methods for Monitoring Environmental Pollution, Water Pollution: sources of pollution and pollutants. Industrial effluents, pollution control, prevention and recycling programs and Effluent Treatment Plant (ETP) operations; waste management, environmental health and risk assessment. Methods for Monitoring Environmental Pollution. Domestic wastes, Agrochemical, Heavy metals. Effects of Water Pollution, Prevention and Control of water pollution. Water pollution analysis and monitoring; wastewater screening, sedimentation, neutralization, absorption, adsorption, oxidation /reduction, ion exchange process, chlorination, aeration tank, sludge digesters, handling and drying. Soil pollution- sources, effects and its control. Air pollution- sources, air pollutants, effects, control measures. Ozone depletion, Global environmental change and Global warming. Biodiversity change; biodiversity management approaches.	**12**	**CO-2**	**K1, K2, K3, K4, K5**
III	Bioremediation, Phytoremediation and Bio-leaching: Environmental impact of pollution and measurement methods, microbial bioremediation of oil spills. Concepts of bioremediation (in-situ and ex-situ), Bioleaching.	**12**	**CO-2 CO-3**	**K1, K2, K3, K4, K6**
IV	Biofertilizers and Biopesticides: Biofertilizers and their importance in crop productivity; Algal and fungal (Mycorrhizae) biofertilizers Bacterial biofertilizers (Rhizobial, free living N2 fixers and phosphate solubilizing bacteria), their significance and practice; Biopesticides: Bacterial (BT pesticides), fungal (*Trichoderma*).	**12**	**CO-3 CO-4**	**K1, K2, K3, K4, K5, K6**

V	Genetic Engineering in Environmental Biotechnology: Genetically engineered microorganisms in environmental health-Genetically engineered plants and microorganisms in agriculture and productivity-Genetically engineered bacteria in bioremediation of organic pesticides, insecticides oil spills-Hazards of genetically engineered microorganisms.	**12**	**CO-5**	**K2, K3, K4, K5, K6**

Text Books:

1. Indu Shekar Thakur, 2013.Environmental Biotechnology Basic concepts and applications.2nd edition I.K.International Publishing House Pvt.Ltd
2. R.C.Dubey.2004. Text Book of Biotechnology. Schand Publishers, New Delhi.
3. Sathyanarayana. U, 2002. Biochemistry. Books and allied Pvt. Ltd.
4. Gothandam K..M, Shivendu Ranjan, Nandita Dasgupta. Eric Lichtfouse. 2021. Environmental Biotechnology. Vol. 3. Springer Nature Switzerland AG.
5. Bruce E. Rittmann, Perry L. McCarty.2001.Environmental Biotechnology: Principles and Applications. McGraw-Hill Education.

Reference Books:

1. Bruce E. Rittmann, Perry. L. McCarty. 2012. Environmental biotechnology. Tata Mcgrew Hill Publisher.
2. Technoglous, G., Burton, F.L. and Stensel, H.D. 2004. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata Mc Graw Hill, New Delhi.
3. Ian Graham, 2010. Global Warming, A Very Peculiar History.1st edition. Brighton [England], Publishing Book House.
4. Mitra, A.P. and Sharma, C, 2010.Global Environmental Changes in South Asia - A Regional Perspective, 1st edition. Dordrecht: Springer Netherlands: Springer Publisher
5. Liu, Jingling,Zhang, Lulu, Liu, Zhijie. 2017. Environmental pollution control, Berlin, [Germany]; Boston, [Massachusetts]: De Gruyter: China Environmental Publishing Group.

Title of the paper	**Bioinformatics**	
Category : **Part III Core**	Year & Semester	Credits
	Third year, Sem V	4
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to various biological activities occurring at cellular level	
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**	
LFS/Q3904 Bioinformatics Associate/ Analyst	LFS/N3909	Basics of object-oriented programming languages including C++ and PERL for bioinformatics and Linux operating systems
	LFS/N3910	Analyze data from databases or datasets using computational tools to drive biological or medical

		knowledge and insight from them. Implement bioinformatics tools to predict the structure and function of genes, proteins, drug ingredients and metabolic pathways
LFS/Q0605 Coordination Manager - Life Sciences	LFS/N0607	Maintain proper and concise records as per given format good report writing skills Ability to communicate, solve conflicts, negotiate on behalf of the team and company Maintain confidentiality of information and data

Course focusing on: Employability

Course Outcome

CO-1.	The Student are able to get biological database and gene prediction rules and software
CO-2.	Will have complete knowledge about sequence alignments and Drug design.
CO-3.	Student can understanding the Proteomics and Oncogenes.
CO-4.	Students can appreciate the sequence alignment tools and phylogenetic relationship.
CO-5.	Students are apply the bioinformatics approaches to Drug Designing.

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	Biological Databases**:** Sequence databases – Nucleic Acid sequence Databases: GenBank; Protein Sequence Databases: Swiss Prot, gene prediction rules and software – Human Genome Project-KEGG metabolic pathway database.	**12**	**CO-1**	**K1, K2, K3**
II	Sequence alignment methods: Pair wise alignment Alignment Algorithms: Needleman – Wunsch Global Alignment Algorithm; Smith – Waterman Local Alignment Algorithm. Drug design / discovery synthesis.	**12**	**CO-2**	**K2, K3, K4, K5**
III	Genes: Oncogenes – Basics of object-oriented programming languages including C++ and PERL for bioinformatics and Linux operating system-DNA microarrays – Structural genomics - Functional Genomics – Proteomics Comparative Genomics – Phylogeny.	**12**	**CO-3**	**K1, K2, K3, K4, K5, K6**

IV	Pair wise Sequence Analysis Tools: BLAST– Steps involved in using BLAST – Interpreting BLAST results; FASTA – Alignment Scores - Multiple Alignment — ClustalW – Phylogenetic Tree- basics of technical writing and report writing –communicative skills for reports according to SOPs and regulations.	**12**	**CO-1 CO-4**	**K1, K2, K3, K4, K5, K6**
V	Sequence analysis: (Proteins and Nucleic acids) Proteomics: Proteins analysis – structural comparisons – 2D gel, Mass spec. Genome application – Drug design, Management of diverse chemical libraries.	**12**	**CO-2 CO-5**	**K1, K2, K3, K4, K5, K6**

Text books:

1. Dassanayake S.Ranil, Silva Gunawardene, Y.I.N., 2011, Genomic and Proteomic Techniques. 1st edition, Narosa Publishing House Pvt. Ltd., New Delhi.
2. Thiagarajan, B., Rajalakshmi, .P.A., 2009, Computational Biology. 1st edition, MJP Publishers, Chennai.
3. Lohar S. Prakash, 2009, Bioinformatics. 1st edition, MJP Publishers, Chennai.
4. Bosu Orpita, Simminder Kaur Thukral, 2007, Bioinformatics Databases, Tools and Algorithms. 1st edition, Oxford University Press, New Delhi.
5. Rastogi, S.C., Mendiratta, N., Rastogi, P., 2004, Bioinformatics Methods and Protocols. 1st edition, Prentice-Hall of India Pvt. Ltd. New Delhi.

Reference Books:

1. Mairan Walhout, Marc Vidal, Job Dekker, 2012, Handbook of Systems Biology-Concepts and Insights. 1st Edition, Elsevier publications.
2. Chris Eaton, 2012, Understanding Big Data. 1st edition, Mc-Graw Hill.
3. James A. Marcum, 2009, The conceptual foundations of systems biology- An introduction. 1st edition, Nova Science publishers.
4. David Posada, 2009, Bioinformatics for DNA Sequence Analysis (Methods in Molecular Biology). 1st edition, Humana Press.
5. Lakshminarayanan, R.2010.English for technical communication. Scitech Publications, India.

Title of the paper	**Practical 5 -Plant Biotechnology and Environmental Biotechnology**		
Category : **Part III Core Practical**	Year & Semester		Credits
	Third year, Sem V		4
Pre- requisites	Knowledge of biology at Higher Secondary level		
Objectives of the course	To introduce the student to basics of plant biotechnology and industrial biotechnology		
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**		
	AGR/N8102	Prepare culture medium such as MS, B5, N6, Nitsch and Whites using the	

HSS/Q0301 Medical Laboratory Technician		recommended quantity of sucrose, agar, water and stock solution with the help of hot plate and magnetic stirrer Different types of plant growth regulators and their correct use
	AGR/N8103	Prepare the mother plant and explant Prepare for transferring the explant to culture medium. Transfer the explant to culture medium Acclimatize the tissue cultured plants Harden off the plants
LFS/Q0308 Quality Control Chemist - Microbiology	LFS/N0322	Methods of using laboratory equipment like autoclave, laminar airflow, etc.
LFS/Q2301 Quality Control Biologist	LFS/N0338	Application of microbiological techniques such as air monitoring, water testing

Course focusing on: Employability

Course Outcome	
CO-1	This course enables them to culture plant cells
CO-2	They can able to analyze B.O.D and C.O.D

Content

PLANT BIOTECHNOLOGY - Practical

1 Organizing Plant tissue culture Laboratory
2 Preparations of Tissue Culture Media (White's, MS, B5, N6, Nitsch's)
3 Callus Inductions
4 Shoot tip culture
5 Embryos / Endosperm Culture
6 Somatic Embryogenesis
7 Hardening and Planting in field
8 Isolation of protoplasts
9 Cell suspension culture
10. Micropropagation of Tobacco plant by leaf disc culture
11. Agarose Electrophoresis
12. Agrobacterium tumefaciens-mediated plant transformation
13. Direct DNA delivery to plant by Particle Bombardment Demo
14. Isolation of plant genomic DNA

ENVIRONMENTAL BIOTECHNOLOGY - Practical

1. Detection of coliforms for determination of purity of fresh water.
2. Determination of total dissolved solids of water
3. Determination of total organic carbon (TOC) using analyzers
4. Determination of BOD of sewage samples.
5. Determination of COD of sewage samples
6. Vermicomposting making

7. Screening of Microorganisms form polluted environment /Water resources.
8. Screening of Microorganisms form polluted environment /Air
9. Estimation of Dissolved Oxygen by Winkler's method
10. Identification of zooplankton and phytoplankton in water sample.
11. Removal of Microplastics in drinking water

Title of the paper	**Elective I - Methods in Biology**	
Category : Part III Elective I	Year & Semester	Credits
	Third year, Sem V	5
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to basic methods applied in the field of biology	
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**	
LFS/Q0203 Production Supervisor/In Charge LFS/Q0509 Lab Technician/ Assistant	LFS/N010 LFS/N0560	Handling and working on the instruments in the industry and research fields

Course focusing on: Employability

Course Outcome

CO-1.	A student will acquire the knowledge about the separation of bio micro and macro molecules.
CO-2.	Will have basic knowledge about histochemical and immunotechniques.
CO-3.	Student will get appropriate knowledge about to instruments and techniques used for the analysis of biomolecules.
CO-4.	Student will learn the basics about microscopic techniques.
CO-5.	This unit clearly give the knowledge about the research and thesis writing.

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	**Separation of Biomolecules**: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods for proteins; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels.	**12**	**CO-1**	**K1, K2**

II	**Histochemical and immunotechniques:** Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy.	**12**	**CO-2**	**K2, K3, K4**
III	**Biophysical methods:** Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy.	**12**	**CO-3**	**K2, K3, K4**
IV	**Microscopic techniques:** Light microscopy, resolving powers of different microscopes, Phase contrast, inverted microscopy, scanning and transmission microscopes. Different fixation and staining techniques for light microscopy and electron microscopy, freeze-etch and freeze-fracture methods for EM. Radiolabelling and detection.	**12**	**CO-3, CO-4**	**K2, K3, K4**
V	**Research Design** -Basic principles, Meaning, Need and features of good design, important concepts. Types of research designs. Development of a research plan -Exploration, Description, Diagnosis, Experimentation. Hypothesis -Null and alternate hypothesis and testing of hypothesis. Writing Skills; Selection of topic, thesis statement, developing the thesis.	**12**	**CO-5**	**K5, K6**

Text Books:

1. Ekwal Imam. 2015. Basics of Research Methodology. New India Publishing Agency, New Delhi.
2. K. Wilson, J. Walker. 2010. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press, London.
3. R. K. Sharma, S.P.S. Sangha. 2008. Basic Techniques in Biochemistry and Molecular Biology. I K International Publishing House Pvt. Ltd, New Delhi.

Reference Books:

1. Lehninger, A.L., Nelson, D.L and Cox, M.M. 2017. Principles of Biochemistry, 7th edition. WH Freeman Publishers.
2. Webster. G. J. 2004. Bioinsrumentaion . John Wiley & Sons, Hoboken, NJ.

Title of the paper	**Genetic Engineering**	
Category : **Part III Core**	Year & Semester	Credits
	Third year, Sem VI	4
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to basics of genetic engineering	

QUALIFICATION PACK	NATIONAL OCCUPATIONAL STANDARDS	
LFS/Q0507 Scientist Clinical Research and Development	LFS/N0516	Knowledge of purification and analytical techniques
LFS/Q3905 Bioinformatics Scientist	LFS/N3912	Apply the coding and non-coding in gene regulatory pathways as appropriate for delivering project outcome
	LFS/N3912	Make use of the concepts of genetic studies/lab diagnostics. Explain the concepts of human genetics, disease and human genomics
LFS/Q3904 Bioinformatics Associate/ Analyst	LFS/N3909	Principles of Microarray, basic molecular techniques (PCR, extractions etc…)
LFS/Q0308 Quality Control Chemist - Microbiology	LFS/N0501	Recombinant and DNA Vaccine
LFS/Q0511 Research Associate-Technology Transfer/ Process Development	LFS/N0517	Standardized protocols and support in technology transfer
LFS/Q2301 Quality Control Biologist	LFS/N0338	Biological assays reporter gene

Course focusing on: Employability

Course Outcome	
CO-1.	Students can learn a topic on introduction of genetic engineering, cloning vector and its type.
CO-2.	This course enables students to know about technology such as Recombinant DNA technology, gene cloning, DNA sequencing.
CO-3.	Will able to gain complete knowledge on nucleic acid analysis technique such as PCR, Antisense technology, Whole genome sequencing, Chromosome walking, jumping. Human genetic disease, Ligase chain reaction, Site directed mutagenesis, Principles of Electrophoresis and blotting techniques.
CO-4.	Students can understand prokaryotic and eukaryotic expression system and its application.

CO-5.	This course give an idea about gene transfer methods and gene cloning and its manipulations.

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	Introduction to Genetic Engineering, Restriction enzymes. Cloning vector, Plasmids & Phage Vectors, Cosmids, Phasmids, advanced vectors, artificial chromosomes BACs, YACs and PACs.	**12**	**CO-1**	**K1, K2, K6**
II	Recombinant technology: gene cloning – Selection and screening for recombinants RFLP, AFLP, RAPD, DNA finger printing, Microarray and DNA sequencing.	**12**	**CO-2**	**K1, K2, K3**
III	DNA sequencing, Methods for screening based on detecting a DNA sequence, Colony hybridization and Plaque hybridization. PCR, Antisense technology, Whole genome sequencing, Chromosome walking, jumping. Human genetic disease, Ligase chain reaction, Site directed mutagenesis, Principles of Electrophoresis and blotting techniques.	**12**	**CO-3**	**K1, K2, K3 K5**
IV	Gene expression, Reporter gene, expression systems: Inducible expression system, Prokaryotic expression systems, Eukaryotic expression systems - applications: Production of protein from cloned genes.	**12**	**CO-4**	**K1, K2, K6**
V	Gene transfer in bacteria, plant and animal cells, Electroporation, particle bombardment and Lipofection, Gene cloning and manipulations, Recombinant and DNA Vaccine.	**12**	**CO-5**	**K1, K2, K3, K6**

Text Books:

1. T.A. Brown, 2010. Gene cloning and DNA analysis: An introduction, 6th edition, Wiley-Blackwell.
2. Sandy B. Primrose and Richard Twyman, 2006. Principles of Gene Manipulation and genomics, 7th edition, Wiley-Blackwell.
3. Bernard R. Glick and Jack J. 2003. Molecular Biotechnology: Principles and Applications of recombinant DNA, PesternaK3rd Edition, American Society for Microbiology.
4. Brown, T.A, 2002. Genomes, 2nd Edition, Wiley-Liss.
5. Old RW and Primrose SB, 2001. Principles of gene manipulation, 6th Edition, Blackwell Scientific Publications.
6. Kreuzee and Massey, 2001. Recombinant DNA & Biotechnology, A, 1st Edition, ASM Press.

Reference Books:

1. Thiel, 2002. Biotechnology DNA to Protein: A laboratory Project, 1st Edition, and Tata McGraw-Hill.
2. Ring, C.J.A. and Blair, E.D, 2001. Genetically Engineered viruses: Development and

<table>
<tr><td colspan="4">application, 1st Edition, and Bios Scientific publishers.
3. Davidson, E.H, 2001. Genomic regulatory systems: Development and evaluation, 1st Edition, 2001 and Academic press.
4. Jognand, S.N, 2000. Gene Biotechnology, Edition1 Himalaya publishers.
5. Lewin, 2009. Genes X, 10th edition, Jones & Barlett Publishers.
6. Dr.P.S.Verma and Dr.V.K.Agarwal, 37th edition 2020.Genetics, New Delhi vikas publishers.</td></tr>
<tr><td>Title of the paper</td><td colspan="3">Industrial Biotechnology</td></tr>
<tr><td rowspan="2">Category : Part III Core</td><td colspan="2">Year & Semester</td><td>Credits</td></tr>
<tr><td colspan="2">Third year, Sem VI</td><td>4</td></tr>
<tr><td>Pre- requisites</td><td colspan="3">Knowledge of biology at Higher Secondary level</td></tr>
<tr><td>Objectives of the course</td><td colspan="3">To introduce the student to basics of fermentation technology</td></tr>
<tr><td>QUALIFICATION PACK</td><td colspan="3">NATIONAL OCCUPATIONAL STANDARDS</td></tr>
<tr><td>LFS/Q0308
Quality Control Chemist - Microbiology</td><td>LFS/N0322</td><td colspan="2">Grow strains of bacteria in various conditions to understand their reactions.
Methods of using laboratory equipment like autoclave, laminar airflow, etc.</td></tr>
<tr><td>LFS/Q2301
Quality Control Biologist
Bioinformatics Scientist</td><td>LFS/N0338</td><td colspan="2">Explain different types of medias for bioanalytical quality test
Describe culture and sub-cultures, its handling and maintenance</td></tr>
<tr><td>LFS/Q0308
Quality Control Chemist - Microbiology</td><td>LFS/N0321</td><td colspan="2">Fulfil requirements of sterility testing like aseptic conditions</td></tr>
<tr><td>LFS/Q3904
Bioinformatics Associate/ Analyst</td><td>LFS/N0203</td><td colspan="2">Follow-up on Reaction set up/ Distillation/ Separation/ Dispensing/ Mixing /Granulation/ Compression/ Coating/ Filling/ Encapsulation/ Visual Inspection/any other production activity as per Good Manufacturing Practices (GMP)</td></tr>
<tr><td>LFS/Q1201
Production/ Manufacturing Chemist</td><td>LFS/N0501</td><td colspan="2">Recombinant and DNA Vaccine</td></tr>
</table>

LFS/Q0219 Bio Process Engineer	LFS/N0247	Standardized protocols and support in technology transfer
LFS/Q2301 Quality Control Biologist	LFS/N0338	Provide day-to-day bioprocess engineering support to upstream / downstream manufacturing operations Operate fermenters, centrifuges, other harvest systems and protein purifications units

Course focusing on: Entrepreneurship

Course Outcome

CO-1.	Students can learn a topic on introduction of genetic engineering, cloning vector and its type.
CO-2.	The student will able to get media for industrial fermentation process.
CO-3.	Student can understand the Industrial Production like., Alcohol.
CO-4.	Also, comprehension about product recovery process.
CO-5.	Students can learn the product extraction and formulation techniques.

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	**Media for Industrial Fermentation:** Types of media, composition of media – carbon sources, nitrogen sources, vitamins and growth factors, mineral, inducers, precursors and inhibitors. Aerobic and anaerobic fermentation processes and their application in the field of biotechnology industry.	**12**	**CO-1**	**K1, K2**
II	**Bioreactors:** Introduction to bioreactors, Batch and Fed-batch bioreactors, Continuous bioreactors; solid state and submerged; photo bioreactors Sterilization of bioreactors; Design of Bioreactors.	**12**	**CO-1 CO-2**	**K2, K3**
III	**Industrial Production**: Alcohol (Ethanol, Beer, Wine) Acids (citric), Solvents-(glycerol) Antibiotics (penicillin, tetracycline), Aminoacids (lysine, glutamic acid), Single Cell Protein (algae/fungi). Use of microbes in mineral beneficiation and oil recovery.	**12**	**CO-3**	**K2, K3**
IV	**Introduction to Bioseparation:** Primary recovery process: Cell disruption methods. Cell lysis and Flocculation: Osmotic and mechanical methods of lysis. Filtration and sedimentation.	**12**	**CO-4**	**K4, K5**

V	**Extraction Principles**: Liquid-liquid extraction, aqueous two-phase extraction, drying. Principles and operation of vacuum dryer, shelf dryer, rotary dryer, freezer and spray dryer, formulation methods.	**12**	**CO-5**	**K2, K5, K6**

Text Book:

1. Puvanakrishnan, R, Sivasubramanian, S and Hemalatha, T. 2015. Microbes and enzymes basics and applied: 1st edition MJP Publishers, India.
2. Mathuriya S. Abhilasha. 2009. Industrial Biotechnology, 1st edition ANE Books publisher.
3. Nuzhat Ahmed, Fouad M. Qureshi, and Obaid Y. Khan. 2001. Industrial and Environmental Biotechnology. Horizon Scientific Press

Reference Books:

1. Min-tze Liong, 2011.Bioprocess Sciences and Technology. Nova Science Pub Inc.
2. L.Shuler, Fikret Kargi. 2003. Bioprocess Engineering: Michael and PHI publishers.
3. R.G. Harrison,P.Todd, SR.Rudge and D.P. Petrides.2003. Bioseparation science and engineering: John Wiley and sons.
4. Amold, L., Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology, 2nd Edn. ASM Press, Washington DC.

Title of the paper	**Practical 5 - Genetic Engineering and Industrial Biotechnology**	
Category : **Part III Core Practical**	Year & Semester	Credits
	Third year, Sem VI	4
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to basics of fermentation technology and genetic engineering	
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**	
LFS/Q0507 Scientist Clinical Research and Development	LFS/N0516	knowledge of purification and analytical techniques
LFS/Q0308 Quality Control Chemist – Microbiology	LFS/N0322	Grow strains of bacteria in various conditions to understand their reaction methods of using laboratory equipment like autoclave, laminar airflow, etc.

Course focusing on: Employability

Course outcome	
CO-1	To introduce the student to basics of genetic engineering techniques such as genomic and plasmid DNA isolation, extraction and estimation of DNA, RNA and proteins, Agarose gel electrophoresis.
CO-2	Students gain practical knowledge on Isolation and screening of organisms and production process

Content

GENETIC ENGINEERING:

Extraction and estimation of intracellular proteins from *E. Coli* – Lowry's Method – Production of competent cells for transformation – Bacterial transformation – Isolation of genomic DNA – Extraction and estimation of RNA – Restriction Digestion of DNA – Absorption spectra of Nucleic acid – Estimation of DNA by Diphenyl amine method – Melting temperature of DNA, Agarose gel electrophoresis – SDS – PAGE – *Agrobacterium* mediated gene transfer – Isolation of plasmid DNA – Screening of Recombinants- Southern hybridization (DEMO) – Western Blotting (DEMO) – DNA amplification – PCR (DEMO).

INDUSTRIAL BIOTECHNOLOGY:

1. Production, recovery and assay of citric acid by *Aspergillus niger*.
2. Biological assay of antibiotic.
3. Screening of Antibiotic producing microorganisms from soil by crowded plate Technique.
4. Production, recovery of Amylase.
5. Assay of amylase.
6. Production of Bio insecticides by using *B.thuringenesis*.
7. Estimation of milk sugar by Benedict's method.
8. Qualitative analysis of milk sample by Methylene Blue Reduction Time Test.
9. Enumeration of bacteria in milk by Standard Plate Count.
10. Determination of efficiency of pasteurization of milk by alkaline phosphatase test.
11. Isolation of lactic acid bacteria from the curd sample.
12. Isolation of lipolytic microorganisms from butter.
13. Isolation of spoilage microorganisms from spoiled vegetables/fruits.

Title of the paper	**Elective II- Microbial Biotechnology**	
Category : **Part III Elective - II**	Year & Semester	Credits
	Third year, Sem VI	5
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to basic methods in microbial biotechnology	
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**	

LFS/Q0308 Quality Control Chemist - Microbiology	LFS/N0322	Grow strains of bacteria in various conditions to understand their reaction methods of using laboratory equipment like autoclave, laminar airflow, etc.
LFS/Q1201 Production/ Manufacturing Chemist	LFS/N0501	Recombinant and DNA Vaccine
LFS/Q0219 Bio Process Engineer	LFS/N0247	Standardized protocols and support in technology transfer

Course focusing on: Entrepreneurship

Course Outcome

CO-1.	A student will gain knowledge in detail about the history and scope of microbial biotechnology
CO-2.	Will come to study about the microbial enzymes and applications
CO-3.	Students study about the detail procedure about production of beverages
CO-4.	Students will know about the biofertilizer and biopesticides
CO-5.	Students will study about the details on bioremediation

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	History and scope of microbial biotechnology, microbial diversity and its use, cultivation and preservation of microorganisms in small scale in Fermentor, bioreactors, immobilized cells and microbial polysaccharides- Microbial Biomass.	**12**	**CO-1**	**K1, K2**
II	Production of microbial enzymes and applications, production of organic solvents-single cell proteins.	**12**	**CO-2**	**K1, K2, K4**
III	Production of beverages, beer, wine, microbes in baking- production of baker yeast and milk products.	**12**	**CO-3**	**K1, K2, K4**
IV	Biofertilizers and Biopesticides: Biomass from carbohydrates, higher alkanes, methanol. Biofertilizers – manufacture, formulation and utilization. Biopesticides – Bacteria, virus and fungi.	**12**	**CO-4**	**K1, K2, K4**

V	Bioremediation: Microbes in mining, ore leaching, oil recovery, waste water treatment, biodegradation of non cellulose and cellulosic wastes for environmental conservation.	**12**	**CO-5**	**K1, K2, K4**

Text Books:

1. L.E.J.R.Casida.2016.Industrial Microbiology. New age international publishers.
2. Puvanakrishnan.R, Sivasubramanium.S and Hemalatha.T.2015. Microbes and enzymes basics and applied, 1st edition MJP Publishers, India.
3. A.H.Patel.2005Industrial Microbiology. Mac Millan India Ltd New Delhi.

Reference Books:

1. W.Clarke.2016.Biotechnology: Industrial Microbiology A text book.CBS Publisher.
2. Principles of Fermentation technology by P.F. Stanbury, and A.Whitakor (2013). Pergamum Press Elsevier science Ltd.
3. M.S.Abhilasha.2009.Industrial Biotechnology. ANE books publisher.
4. Arnold, L., Demain, A.L., Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology, 2nd Edn. ASM Press, Washington DC.

Title of the paper	**Elective III- Pharmaceutical Biotechnology**	
Category : **Part III Elective - III**	Year & Semester	Credits
	Third year, Sem VI	5
Pre- requisites	Knowledge of biology at Higher Secondary level	
Objectives of the course	To introduce the student to basic methods applied in the field of pharmaceutical biotechnology	
QUALIFICATION PACK	**NATIONAL OCCUPATIONAL STANDARDS**	
LFS/Q0403 Business Development Executive	LFS/NO409	Understanding and skills required of Market Research Specialist to work with cross-functional teams to enhance research outputs
LFS/Q1201 Production/ Manufacturing Chemist	LFS/N0203	Follow-up on Reaction set up/ Visual Inspection/any other production activity as per Good Manufacturing Practices (GMP)

Course focusing on: Entrepreneurship

Course Outcome	
CO-1.	A student will acquire the knowledge about concepts and applications.
CO-2.	Will have basic knowledge about production process.
CO-3.	Student will get appropriate knowledge about recombinant proteins.
CO-4.	Student will learn the basics about pharmacodynamics.

CO-5.	This unit clearly gives the knowledge about concepts of gene therapy.

Syllabus

Unit	Content	Hours	COs	Cognitive level
I	Introduction to concepts and technologies in pharmaceutical biotechnology and industrial applications. Biopharmaceuticals expressed in plants.	**12**	**CO-1**	**K1, K2, K3**
II	Industrial development and production process. Scientific, technical and economic aspects of vaccine research and development. DNA vaccines: from research tools in mice to vaccines for humans. Biotransformation of drugs; Enzymes responsible for bio transformations; Microsomal and non microsomal mechanisms.	**12**	**CO-1 CO-2**	**K1, K2, K3, K4, K5**
III	Characterization and Bioanalytical aspects of recombinant proteins as pharmaceutical drugs-Biogeneric drugs. Therapeutic proteins – special pharmaceutical aspects. Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes	**12**	**CO-3**	**K1, K2, K3, K4**
IV	Pharmaceutical and pharmacodynamics of biotech drugs- Formulation of biotech products-Rituximab: clinical development of the first therapeutic antibody for cancer. Models to study drug metabolism; Dose effect relationships; Adverse drug reactions and drug interactions; Toxic reactions; Allergic reactions; Idiosyncrasy.	**12**	**CO-4**	**K1, K2, K3, K4, K5**
V	Somatic gene therapy – advanced biotechnology products in clinical development-Nonviral gene transfer systems in somatic gene therapy-Xenotransplantation in pharmaceutical biotechnology, Pharmaceutical enzymes	**12**	**CO-1 CO-5**	**K1, K2, K3, K5**

Text Books:

1. Kayser, O and Muller R. H, 2004. Pharmaceutical Biotechnology Drug Discovery and Clinical Applications. 2nd edition. Wiley.
2. Carlos A. Guzmán and Giora Z. Feuerstein, 2009. Pharmaceutical Biotechnology, 1st edition. Springer.
3. Harbans lal, 2011. Pharmaceuticals Biochemistry. 2nd edition. CBS Publishers and distributors Pvt. Ltd, Chennai.

<table>
<tr><td colspan="3">Reference Books:
1. Leon Shargel, Andrew B. C. Yu, Susanna Wu-Pong, and Yu Andrew B. C, 2004. Applied Biopharmaceutics & Pharmacokinetics. 5th edition. McGraw-Hill Companies.
2. Daniel Figeys, 2005. Industrial Proteomics: Applications for Biotechnology and Pharmaceuticals. 1st edition. Wiley, John & Sons.</td></tr>
<tr><td>Title of the paper</td><td colspan="2">Project (Instead of Elective 1-3 in V and VI semesters)</td></tr>
<tr><td rowspan="2">Category : Part III Project</td><td>Year & Semester</td><td>Credits</td></tr>
<tr><td>Third year, Sem VI</td><td>15</td></tr>
<tr><td>Pre- requisites</td><td colspan="2">Knowledge of biology at UG level</td></tr>
<tr><td>Objectives of the course</td><td colspan="2">To introduce research concepts and execute their ideas through project.</td></tr>
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PSO –CO MATRIX

Course	Course outcome	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
Cell Biology	CO-1	✓	✓	✓	✓	
	CO-2	✓		✓	✓	
	CO-3	✓		✓	✓	✓
	CO-4	✓		✓	✓	✓
	CO-5	✓		✓	✓	✓
Allied Microbiology	CO-1	✓		✓		
	CO-2	✓		✓		
	CO-3	✓		✓		
	CO-4	✓		✓		
	CO-5	✓		✓		✓
Plant Physiology	CO-1	✓		✓	✓	
	CO-2	✓		✓	✓	
	CO-3	✓			✓	
	CO-4	✓			✓	
	CO-5	✓		✓	✓	✓
Animal Physiology	CO-1	✓			✓	
	CO-2	✓		✓	✓	
	CO-3	✓			✓	
	CO-4	✓			✓	
	CO-5	✓		✓	✓	✓
Practical 1	CO-1		✓	✓		✓
	CO-2		✓	✓		✓
Developmental Biology and Genetics	CO-1	✓	✓	✓	✓	
	CO-2	✓		✓	✓	
	CO-3	✓			✓	
	CO-4	✓			✓	
	CO-5	✓			✓	✓
Allied Chemistry	CO-1	✓				
	CO-2	✓				
	CO-3	✓				
	CO-4	✓				
	CO-5	✓				✓
Basics of Ecology	CO-1	✓		✓	✓	
	CO-2	✓		✓	✓	
	CO-3	✓			✓	
	CO-4	✓			✓	
	CO-5	✓		✓	✓	✓

Course	Course outcome	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
Evolution	CO-1	✓			✓	
	CO-2	✓		✓	✓	
	CO-3	✓			✓	
	CO-4	✓			✓	
	CO-5	✓		✓	✓	✓
Practical 2	CO-1		✓	✓		✓
	CO-2		✓	✓		✓
Immunology	CO-1	✓		✓	✓	
	CO-2	✓	✓	✓	✓	
	CO-3	✓		✓	✓	
	CO-4	✓			✓	
	CO-5	✓			✓	✓
Allied Biochemistry	CO-1	✓		✓	✓	
	CO-2	✓		✓	✓	
	CO-3	✓		✓	✓	
	CO-4	✓		✓	✓	
	CO-5	✓		✓	✓	✓
Practical 3	CO-1		✓			
	CO-2		✓			
Animal and Medical Biotechnology	CO-1	✓	✓	✓	✓	✓
	CO-2	✓		✓	✓	✓
	CO-3	✓	✓	✓	✓	✓
	CO-4	✓		✓	✓	
	CO-5	✓	✓	✓	✓	✓
Biophysics and Biostatistics	CO-1	✓				
	CO-2	✓				
	CO-3	✓		✓		
	CO-4	✓		✓		
	CO-5	✓		✓		
Practical 4	CO-1		✓			✓
	CO-2		✓			✓

Course Subject Code	Course outcome	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
Plant Biotechnology	CO-1	✓				
	CO-2	✓		✓		✓
	CO-3	✓	✓	✓		✓
	CO-4	✓		✓		✓
	CO-5	✓	✓	✓		✓
Environmental Biotechnology	CO-1	✓		✓		
	CO-2	✓		✓		
	CO-3	✓				
	CO-4	✓				
	CO-5	✓		✓		✓
Bioinformatics	CO-1	✓			✓	
	CO-2	✓		✓	✓	
	CO-3	✓				
	CO-4	✓	✓			
	CO-5	✓		✓	✓	✓
Methods in Biology	CO-1	✓	✓	✓	✓	✓
	CO-2	✓	✓	✓	✓	✓
	CO-3	✓	✓	✓	✓	✓
	CO-4	✓	✓	✓	✓	✓
	CO-5	✓	✓	✓	✓	✓
Practical 5	CO-1		✓			✓
	CO-2		✓			✓
Genetic engineering	CO-1	✓	✓	✓	✓	✓
	CO-2	✓		✓	✓	✓
	CO-3	✓	✓	✓	✓	
	CO-4	✓		✓	✓	✓
	CO-5	✓	✓	✓	✓	✓
Industrial Biotechnology	CO-1	✓	✓	✓	✓	
	CO-2	✓	✓	✓	✓	✓
	CO-3	✓	✓	✓	✓	✓
	CO-4	✓	✓	✓	✓	
	CO-5	✓	✓	✓	✓	✓
Microbial Biotechnology	CO-1	✓				
	CO-2	✓		✓		✓
	CO-3	✓				
	CO-4	✓		✓		✓
	CO-5	✓		✓		✓

Course	Course outcome	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
Pharmaceutical Biotechnology	CO-1	✓				
	CO-2	✓	✓			
	CO-3			✓		
	CO-4				✓	
	CO-5	✓				✓
Practical 6	CO-1		✓			✓
	CO-2		✓			✓

Teaching - learning process

The Learning Outcomes-Based Approach to curriculum planning and transaction requires that the teaching-learning processes are oriented towards enabling students to attain the defined learning outcomes relating to the courses within a programme. The outcome- based approach, particularly in the context of undergraduate studies, requires a significant shift from teacher-centric to learner-centric pedagogies, and from passive to active/participatory pedagogies. Planning for teaching therein becomes critical. Every programme of study lends itself to well-structured and sequenced acquisition of knowledge and skills. Practical skills, including an appreciation of the link between theory and experiment, will constitute an important aspect of the teaching learning process. Teaching methods, guided by such a framework, may include:

- ✓ **Classroom Teaching** for topics which are intensely information-based. This a very regular feature of all the courses in Biotechnology
- ✓ **Power Point slides** for topics which involve information, use of Power Point presentations are also made whenever the lectures are to be summarized in a crisp and pointwise manner to highlight salient / important conclusions from the topics.
- ✓ **Classroom Discussions** are a regular feature while teaching. The students are drawn into impromptu discussions by the teacher during the process of teaching.
- ✓ **Video Displaying**, both real-time and animations, are used for topics which require 3D dimensional viewing of the biological mechanisms to drive the point home. These have proved to be very helpful while teaching concepts of molecular biology like DNA replication, transcription and translation.
- ✓ **Model Making** is also used especially for understanding and building a perception of the students.
- ✓ **Laboratory Practical** are an integral part of every course included in UG programme in Biotechnology. The is also a daily affair for UG students of Biotechnology.
- ✓ **Problem Solving** is encouraged during the laboratory work.

- ✓ **Group Activity** as well as discussions with the laboratory supervisor/ among the students themselves/ Mentor is also encouraged during laboratory work.
- ✓ **Project Work** is included in the programme where students work individually or in groups to design experiments to solve/answer a problem suggested by the Mentor or identified by the students in consultation with the Mentor. The students are mentored regularly during the duration the project is in progress.
- ✓ **Presentations by the Students** are regularly done. The students are mentored in presentation of data, interpretation of data and articulation with the students/teachers/Research Scholars during their presentation.
- ✓ **Presentation by Experts** in different specialties of Biotechnology are arranged to broaden the horizons of the students.
- ✓ **Interaction with Experts** is also encouraged during/after presentations to satisfy/ignite curiosities of the students related to developments in the different areas of Biotechnology.
- ✓ **Visit to Industries/Laboratories** related to Biotechnology like fermentation, food, Pharmaceutical, diagnostics etc. are organized to acquaint the students with real-life working environments of the professional biotechnologist with a view to broaden their perspective of the subject of Biotechnology.

Assessment methods

It is important that the students of UG Biotechnology program achieve the desired results in terms of the learning outcomes to be professionally sound and competitive in a global society. Achieving the desired learning outcomes is also imperative in terms of job employment leading to a happy and prosperous individual further leading to a happy and prosperous family and thereby a happy and prosperous society or nation. The assessments tasks are pivotal to get an authentic feedback for the teaching learning process and for mid-course corrections and further improvements in future. The assessment tasks are carried out at various stages of the duration of the UG Biotechnology programme like Mid-term assessments, End-term assessments, Semester examinations, Regular assessments, viva-voce etc. The assessment tasks are listed below:-

- ✓ **Short-Answer Questions** during term and semester examinations are used to assess the ability of the student to convey his thoughts in a coherent way where prioritization of the information in terms of their significance is tested.

- ✓ **Surprise Quizzes** are regularly used during continuous assessment while the teaching learning process is continuing which prepares the student to quickly recall information or quickly analyze a problem and come up with proper solutions.
- ✓ **Impromptu Opinions** on biotechnological problems are sought from student during regular teaching learning which help them to think quickly in a given context. This help build their ability to come up with solutions to problems which the students might not have confronted previously.
- ✓ **Problem Solving** question are generally given during the laboratory work.
- ✓ **Data Interpretation** is also another assessment task which is used to develop analytical skills of the students. This assessment is used during laboratory work as well as during conduction of project work.
- ✓ **Analytical Skills** are assessed during work related to several experiments like enzyme kinetics, growth of bacteria and bacteriophages, mutation frequencies.
- ✓ **Paper/ Project** presentations are used to assess the articulation skills of the student. These are carried out both during the duration of the teaching learning processes as well as during end-Semester examinations.
- ✓ **Report Writing** is used to assess the keenness of the students for details related to Biotechnology while visiting laboratories / industries as students invariably are required to submit a report after such visits.
- ✓ **Assignment Writing** are used to assess the writing abilities of the students during midterm vacations.
- ✓ **Viva-voce** during the laboratory working hours and during laboratory examination are used to assess the over-all knowledge and intelligence of the students.

Key Words:

Biotechnology, Teaching, Learning outcomes, Curriculum, Curriculum Framework, Programme outcomes, Course outcomes, UG Programme, Undergraduate programme, Teaching learning processes, Assessment Tasks, Evaluation Tasks, Online Courses, MOOCS, NPTEL, SWAYAM, UGC, India, Higher Education Institutions, HEI