M.Sc. BIOTECHNOLOGY PROGRAMME

Vision

To nurture world-class bioengineers with a potential to innovate, invent and disseminate knowledge for the benefit of society and environment.

Mission

- Regular updation of the course curriculum to cater to the needs of academia and industry.
- Initiate academia-industry interface with special emphasis on implementation of bioprocess design and scale-up.
- Emphasis on recent trends in biotechnology through organization of conferences, symposia, workshops.
- To be an excellent quality, comprehensive, multidisciplinary department that supports, coordinates, disseminates the advances in biotechnology in the areas of social welfare and entrepreneurship.

Programme Education Objectives

- Aims to provide an advanced understanding of the core principles and topics of Modern day Biotechnology, and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of a lecture series and a research project.
- To equip the students to apply knowledge of molecular mechanisms of cellular processes in living systems including microbes, plants, and higher order organisms to applied aspects.
- The laboratory training in addition to theory is included to prepare them for careers in the industry, agriculture, and applied research where biological system is increasingly employed.
- Basics and current updates in the areas of Industrial Microbiology, Fermentation Technology, Medical, Agriculture & Environmental Biotechnology are included to train the students and also sensitize them to scope for research.
- Will address the increasing need for skilled scientific manpower with an understanding of research ethics involving animals and humans to contribute to application, advancement, and impartment of knowledge in the field of biotechnology globally.
- Will enable the students to pursue higher education and research in reputed institute at national and international level.

Programme Outcomes

- Will gain and apply knowledge to solve problems related to field of Biotechnology.
- Will be able to design and develop solution to Biotechnology problems by applying appropriate tools while keeping in mind safety factor for environment and society.
- Will be able design, perform experiments, analyze and interpret data for investigating complex problems in biotechnology and related fields.
- Will be able to justify societal, health, safety and legal issues and understand his responsibilities in biotechnological practices
- Will be able to understand the need and impact of biotechnological solutions on environment and societal context keeping in view need for sustainable solution.
- Will have knowledge and understanding of related norms and ethics in Biotechnology product/technique development.
- Will be able to undertake any responsibility as an individual and as a team in a multidisciplinary environment.
- Acknowledges health, safety and environment (HSE) issues in handling chemicals and biological materials; understands the environmental impacts associated with the activity; performs risk assessments and is familiar with safety instructions in his/her subject area.
- Is able to work both independently or in groups on complex projects that require collaboration across disciplines.
- Can communicate scientific results to the general public and experts by writing wellstructured reports and contributions for scientific publications and posters, and by oral presentations

SWOC Analysis of the Department of Biotechnology

Strengths

1) Interdisciplinary nature of subject and faculty,
2) Applied nature of the Programme
3) Basic infrastructure facility like labs
4) Faculty qualification and experience
5) Relavant and updated syllabus
6) Department have sufficient teaching aids like LCD's.
7) Separate department level library
8) MoU with Administrative Staff College of India for three student Internships
9) R&D ongoing Research Projects
10) Student placements
11) Student pass percentage of more than 80%
12) Encourage students to participate in extra-curricular and extension activities

Weakness

1) R&D Projects and Research Admissions
2) Lack of training for technical staff undertaken
3) Excesss administrative work load of the faculty,
4) Need for filling Vacant faculty position has to be filled in need
5) Inter departmental and inter university, University-Industry interaction need to be strengthened

Opportunities

1) Collaborative research projects with other institute,
2) Starting new relavant PG courses in allied area.
3) MoU's with industries.
4) Job placements with national & international core sector companies
5) Alumni network to be taped for industry MoU's and student placements
6) Financial self sustainability.

Challenges:

1) Attrition of faculty in high-demand areas to industry/ other institutes/foreign universities
2) Competition from other Foreign, Deemed and Private Universities that are coming up in India
3) Decreasing students enrolment at PG level
4) Fast changing technology
5) Motivating female students to enter Job market
6) Inhibition in Students to relocate to distant places for Internship and Employment
7) Under employment and low remuneration of PG students in industry
8) Lack of student geographical diversity due to localised enrolment measures
9) Decreasing external funding

Strategic Plan for the Department of Biotechnology

1. Strengthening of PG program

2. Development of R&D activities

3. Establishment of centre of excellence in new emerging areas

4. Starting new courses in collaboration with industries and national laboratories

5. Increase in networking with Indian and Foreign universities

6. Enhancing of faculty & staff skills through continuing training programmes

7. Encouragement of industrial training/internship among students

8. Enhancing the existing laboratory facilities/resources to meet the industry requirements

9. Creating awareness about the availability of Resources

Short Term Goals

1. Strengthen the Infrastructure,
2. faculty position
3. Improvement in R&D activities
4. Guest lectures by eminent Academecians from University/Industry

Long Term Goals

1. Live Projects from Industry
2. Building Centers of Excellence in Biotechnology and Allied areas
3. To upgrade lab facilities to be a world class University.
4. University exchange programme.
5. Tie-up with International Universities

Dr. B. R. AMBEDKAR UNIVERSITY, SRIKAKULAM
General Regulations relating to

POST GRAUDATE AND PROFESSIONAL COURSES
Syllabus under Outcome Based Education System

(with effect from 2020-2021)

1. Candidates seeking admission for the Masters/Professional Degree Courses shall be required to have passed the qualifying examination prescribed for the course of any University recognized by Dr. B.R. Ambedkar University, Srikakulam as equivalent there to

2. The course and scope shall be as defined in the Scheme of Instruction and syllabus prescribed.

3. The course consists of 2/4/6 semesters, @ two semesters/year, unless otherwise specified.

4. The candidates shall be required to take an examination at the end of each semester of the study as detailed in the Scheme of Examination. Each semester theory paper carries a maximum of 100 marks, of which 75 marks shall be for semester-end theory examination of the paper of three hours duration and 25 marks shall be for internal assessment

4. (a) Internal Assessment for 25 Marks: Three mid-term exams, two conventional (descriptive) for 15 marks and the third – 'on-line' with multiple choice questions for 5 marks for each theory paper shall be conducted. The other 5 marks are awarded for the assignments in the respective subject. The average of these first two mid-term and the marks in the online mid exams shall be taken as marks obtained for the paper under internal assessment. If any candidate appears for only one mid-term exam, the average mark, dividing by two shall be awarded. If any candidate fails to appear for all the midterm exams of a paper, only marks obtained in the theory paper shall be taken into consideration for declaring the result. Each mid-term exam shall be conducted only once.

4. (b) Candidates shall be declared to have passed each theory paper if he/she obtains not less than E Grade ie., an aggregate of 40 % of the total marks inclusive of semester-end and internal assessment marks in each paper.

5. A candidate appearing for the whole examination shall be declared to have passed the examination if he/she obtains a Semester Grade Point (SGP) of 5.0 and a CGPA of 5.0 to be declared to have passed the Course.

6. Notwithstanding anything contained in the regulations, in the case of Project Report/Dissertation/ Practical/Field Work/Viva-voce etc., candidates shall obtain not less than D grade, i.e., 50% of marks to be declared to have passed the examination.
7. ATTENDANCE: Candidates shall put in attendance of not less than 75% of attendance, out of the total number of working periods in each semester. Only such candidates shall be allowed to appear for the semester-end examination.

7. (a) A candidate with attendance between 74.99% and 66.66% shall be allowed to appear for the semester-end examination and continue the next semester only on medical and other valid grounds, after paying the required condonation fee.

7. (b) In case of candidates who are continuously absent for 10 days without prior permission on valid grounds, his/her name shall automatically be removed from the rolls.

7 (c) If a candidate represents the University at games, sports or other officially organized extra-curricular activities, it will be deemed that he/she has attended the college on the days/periods

8 Candidates who put in a minimum of 50% attendance shall also be permitted to continue for the next semester. However, such candidates have to re-study the semester course only after completion of the course period for which they are admitted. The candidate shall have to meet the course fees and other expenditure.

9 Candidates who have completed a semester course and have fulfilled the necessary attendance requirement shall be permitted to continue the next semester course irrespective of whether they have appeared or not at the semester-end examination, at their own cost.

Such candidates may be permitted to appear for the particular semester-end examination only in the following academic year; they should reregister/ reapply for the Semester examination.

The above procedure shall be followed for all the semesters

10. Candidates who appear and pass the examination in all the papers of each and every semester at first appearance only are eligible for the award of Medals/Prizes/Rank Certificates

11. BETTERMENT: Candidates declared to have passed the whole examination may reappear for the same examination to improve their SGPA, with the existing regulations without further attendance, paying examination and other fees. Such reappearance shall be permitted only with in 3 consecutive years from the date of first passing the final examination. Candidates who wish to appear thereafter should take the whole examination under the regulations then in vogue.

12. The semester-end examination shall be based on the question paper set by an external paper-setter and there shall be double valuation for post-Graduate courses. The concerned Department has to submit a panel of paper-setters and examiners approved by the BOS and the Vice-chancellor nominates the paper-setters and examiners from the panel.

13. In order to be eligible to be appointed as an internal examiner for the semester-end examination, a teacher shall have to put in at least three years of service. Relaxation of service can be exempted by the Vice-Chancellor in specific cases.

14. If the disparity between the marks awarded in the semester-end examination by internal and external examiners is 25% or less, the average marks shall be taken as the mark obtained in the paper. If the disparity happens to be more, the paper shall be referred to another examiner for third valuation. In cases of third valuation, of the marks obtained either in the first or second valuation marks, whichever is nearest to the third valuation marks are added for arriving at the average marks.

15. Candidates can seek revaluation of the scripts of the theory papers by paying the prescribed fee as per the rules and regulations in vogue.

16. The Project Report/Dissertation/ Practical/Field Work/Viva-voce etc shall have double valuation by internal and external examiners.

17. A Committee comprising of the HOD, one internal teacher by nomination on rotation and one external member, shall conduct viva-voce examination. The department has to submit the panel, and the Vice-chancellor nominates viva-voce Committee.

18. Grades and Grade Point Details (with effect from 2009-10 admitted batches)

S.No.	Range of Marks %	Grade	Grade Points	
01	>90 ≤100	O	10	Out Standing
02	>80 ≤90	A+	9	Excellent
03	>70 ≤80	A	8	Very Good
04	>60 ≤70	B+	7	Good
05	>55 ≤60	B	6	Above Average
06	≥50 ≤55	C	5	Average
07	≥40 < 50	D	4	Pass
08	<40	F	0	Fail
09			0	AB (Absent)

Termsusedandtheirexplanation:

Credit Point: It is the product of grade point and number of credits for a course.

Credit: Aunitbywhichthecourseworkismeasured.Itdeterminesthenumberofhoursofinstructions requiredperweek.Onecreditisequivalenttoonehourofteaching(lectureortutorial)ortwohoursof Practical work/ field work perweek.

Grade Point: It is a numerical weight allotted to each letter grade on a 10- point scale.

LetterGrade: Itisanindexoftheperformanceofstudentsinasaidcourse.Gradesaredenotedbyletters O,A+,A,B+,B,C,DandF.

19. Calculation of SGPA (Semester Grade Point Average) & CGPA (Cumulative Grade Point Average):

For example, if a student gets the grades in one semester A+,A+,A,A,A,B in six subjects having credits 2(S1), 4(S2), 4(S3), 4(S4), 4(S5), 2(S6), respectively. The SGPA is calculated as follows:

$$SGPA = \frac{\{9(A+)x2(S1)+9(A+)x4(S2)+8(A)x4(S3)+8(A)x4(S4)+8(A)x4(S5)+6(B)x2(S6)\}}{\{2(S1)+4(S2)+4(S3)+4(S4)+4(S5)+2(S6)\}} = \frac{162}{20} = 8.10$$

i. A student securing 'F' grade thereby securing 0.0 grade points has to appear and secure at least 'E' grade at the subsequent examination(s) in that subject.

ii. If a student gets the grades in another semester B, A+, A, B+, A+, C, A+, in seven subjects having credits 4(S1),2(S2), 4(S3), 2(S4), 4(S5), 4(S6), 2(S7) respectively,

$$\mathbf{SGPA = \frac{\{6(B)x4(S1)+9(A+)x2(S2)+8(A)x4(S3)+7(B+)x2(S4)+9(A+)x4(S5)+5(C)x4(S6)+9(A+)x2(S7)\}}{\{4(S1)+2(S2)+4(S3)+2(S4)+4(S5)+4(S6)+2(S7)\}} = \frac{162}{22} = 7.36}$$

$$\mathbf{CGPA = \frac{(9x2+9x4+8x4+8x4+6x2+6x4+9x2+8x4+7x2+9x4+5x4+9x2)}{(20+22)} = \frac{324}{42} = 7.71}$$

a) A candidate has to secure a minimum of 5.0 SGPA for a pass in each semester in case of all PG and Professional Courses. Further, a candidate will be permitted to choose any paper(s) to appear for improvement in case the candidate fails to secure the minimum prescribed SGPA/CGPA to enable the candidate to pass at the end of any semester examination.

b) There will be no indication of pass/fail in the marks statement against each individual paper.

c) A candidate will be declared to have passed if a candidate secures 5.0 CGPA for all PG and Professional Courses.

d) The Classification of successful candidates is based on CGPA as follows:
   i) Distinction –CGPA 7.0 or more;
   ii) First Class –CGPA 6.0 or more but less than 7.0
   iii) Second Class –CGPA 5.0 or more but less than 6.0
   iv) Pass –CGPA 4.0 or more but less than 5.0

e) Improving CGPA for betterment of class will be continued as per the rules in vogue.

f) CGPA will be calculated from II Semester onwards up to the final semester. CGPA multiplied by gives"10" aggregate percentage of marks obtained by a candidate.

Dr. B. R. AMBEDKAR UNIVERSITY, SRIKAKULAM

ANNEXURE – I

Eligibility

Course	Qualifying Examination for Admission
M.Sc Biotechnology	B.Sc/B.Sc. (Vocational with any two of the following subjects: Biotechnology, Biochemistry, Botany, Zoology, Chemistry Microbiology, Env. Science, Human Genetics,Fisheries, Aquaculture, B.Sc (Vocational) with food Science & Quality Control

ANNEXURE – II

M.Sc. BIOTECHNOLOGY
SCHEME OF INSTRUCTION

First Semester:

Course name	Title of the Paper	Compulsory/ Elective	No.of Periods of instruction per week
101	Cell Biology	Core/Compulsory	4
102	Biomolecules	Core/Compulsory	4
103	Microbial Physiology & Genetics	Core/Compulsory	4
104	Analytical Tools and Techniques in Biotechnology	Core/Compulsory	4
105	Fundamentals Of English Grammar, Vocabulary & Phonetics	Non-Core/Elective	3
106	Lab-I: Cell Biology and Microbiology	Core/Compulsory	6
107	Lab-II: Biochemical Analysis and Techniques	Core/Compulsory	6

Second Semester:

Course	Title of the Paper	Compulsory/ Elective	No.of Periods of instruction per week
201	Enzymology and Metabolism	Core/Compulsory	4
202	Molecular Biology	Core/Compulsory	4
203	Genetic Engineering	Core/Compulsory	4
204	Biology of Immune System	Core/Compulsory	4
205	Communication Skills	Non-Core/Elective	3
206	Lab-III: Molecular Biology & Genetic Engineering	Core/Compulsory	6
207	Lab-IV: Enzymology and Immunology	Core/Compulsory	6

Third Semester:

Course No.	Title of the Paper	Compulsory/Elective	No. of Periods of instruction per Week
301	Animal Biotechnology	Core/Compulsory	4
302	Plant Biotechnology	Core/Compulsory	4
303A	Cell Culture Technology and Tissue Engineering	Core/Elective	4
303B	Intellectual Property Rights, Bio safety and Bioethics	Core/Elective	4
303C	Vaccines	Core/Elective	4
303D	Molecular Diagnostics	Core/Elective	4
304A	Medical and Environmental Biotechnology	Core/Elective	4
304B	Critical analysis of classical papers	Core/Elective	4
304C	Bio-nanotechnology	Core/Elective	4
304D	Bioentrepreneurship	Core/Elective	4
305	Mental Ability,Reasoning And Quantitative Aptitude	Core/Elective	3
306	Lab-V: Plant Tissue Culture Techniques	Core/Compulsory	6
307	Lab-VI: Animal Cell Culture and Environmental	Core/Compulsory	6

Fourth Semester:

Course No.	Title of the Paper	Compulsory/Elective	No. of Periods of instruction per Week
401	Heterologous Expression and Downstream Processing	Core/Compulsory	4
402	Bioinformatics and Biostatistics	Core/Compulsory	4
403	Soft Skills For Employability Enhancement	Non-Core/Elective	3
404	Lab-IV: Industrial Biotechnology and Bioinformatics	Core/Compulsory	6
404	Project work*	Core/Compulsory	
405	Seminar@		

In each of the semesters each candidate has to present a paper on Biotechnology and related topics, according to the schedule given by the Department for 20 Minutes in the SEMINAR conducted by the Department.

*Project Work: Candidates shall have to do a project work in the field of Biotechnology and related fields in reputed Organizations/ Companies/ Laboratories etc. for a period of two months at the end of IV Semester. The candidate shall submit the project work dissertation under the supervision of a faculty member.

@Seminar: Each student shall give seminar on project work dissertation.

During all the four semesters the medium of instruction and writing examination is ENGLISH only.

Annexure - III
Scheme of Examination as per Credit System

First Semester:

Course No.	Title of the Paper	No. of Credits	Maximum Marks	Double valuation (Internal + External)	Internal Assessment
101	Cell Biology	4	100	75	25
102	Biomolecules	4	100	75	25
103	Microbial Physiology and Genetics	4	100	75	25
104	Analytical Tools and Techniques in Biotechnology	4	100	75	25
105	Fundamentals Of English Grammar, Vocabulary & Phonetics	2	100	75	25
106	Lab 1: Cell Biology and Microbiology	2	50	45	5
107	Lab 2: Biochemical Analysis and Techniques	2	50	45	5
108	Field Visits/ Societal Engagement Programs	2	25		
109	Physical education / Yoga/ Extracurricular activities/Swachh Bharat/ Internship etc	1			
	TOTAL	**25**	**625**		

Second Semester:

Course No.	Title of the Paper	No. of Credits	Maximum Marks	Double valuation (Internal + External)	Internal Assessment
201	Enzymology and Metabolism	4	100	75	25
202	Molecular Biology	4	100	75	25
203	Genetic Engineering	4	100	75	25
204	Biology of Immune System	4	100	75	25
205	Communication Skills	2	75	25	
206	Lab III: Molecular Biology and Genetic Engineering	2	50	45	5
207	Lab IV: Enzymology and Immunology	2	50	45	5
208	Field Visits/ Societal	2	25		

	Engagement Programs				
209	MOOCs Courses	2			
210	Physical education / Yoga/ Extracurricular activities/Swachh Bharat/ Internship etc	1			
	TOTAL	**27**	**625**		

Third Semester:

Course No.	Title of the Paper	No. of Credits	Maximum Marks	Double valuation (Internal + External)	Internal Assessment
301	Animal Biotechnology	4	100	75	25
302	Plant Biotechnology	4	100	75	25
303A Elective	Cell Culture Technology and Tissue Engineering	4	100	75	25
303B Elective	Intellectual Property Rights, Bio safety and Bioethics				
303C Elective	Vaccines				
303D Elective	Molecular Diagnostics				
304A Elective	Medical and Environmental Biotechnology	4	100	75	25
304B Elective	Critical analysis of classical papers				
304C Elective	Bio-nanotechnology				
304D Elective	Bioentrepreneurship				
305	Mental Ability,Reasoning And Quantitative Aptitude	2	100	75	25
306	Lab V: Plant Tissue Culture and Techniques	2	50	45	5
307	Lab VI: Animal Cell Culture and Environmental Biotechnology	2	50	45	5
308	Field Visits/ Societal Engagement Programs	2	25		
309	MOOCs Courses	2			
310	Physical education / Yoga/ Extracurricular activities/Swachh Bharat/ Internship etc	1			
	TOTAL	**27**	**625**		

Fourth Semester:

Course No.	Title of the Paper	No. of Credits	Maximum Marks	Double valuation (Internal + External)	Internal Assessment
401	Heterologous Expression and Downstream Processing	4	100	75	25
402	Bioinformatics and Biostatistics	4	100	75	25
403	Soft Skills For Employability Enhancement	2	100	75	25
404	Lab VII: Industrial Biotechnology and Biostatistics	2	50	45	5
404	Project work and Dissertation	6	150	150	
405	Seminar	2	50	50	
406	Comprehensive Viva-Voce	2	50	50*	
407	Field Visits/ Societal Engagement Programs	2	25		
408	MOOCs Courses	2			
409	Physical education / Yoga/ Extracurricular activities/Swachh Bharat/ Internship etc	1			
	TOTAL	**27**	**625**		

* Single Valuation by Viva-Voce committee

Total Marks :- First, Second, Third &Fourth Semesters put together: 625+625+625+625 = 2500

Total Credits :- First, Second, Third & Fourth Semesters put together: 25+27+27+27 = 104

Additional credits will be given to the students for Extension Work(2 credits), MOOCs (2 credits) and Physical education / Yoga/ Extracurricular activities/Swachh Bharat/ Internship etc(1 credit). The student can also select Open/Free Elective as add on Course (Not mandatory & it is optional) (2 credits)

I SEMESTER

101: CELL BIOLOGY

Course Objectives

- To understand basic and advanced Cell biology theories & concepts.
- Know about the cellular organelles and their functions in detail.
- Learn how to present Cell biology data and concepts to an audience.
- Understand current experimentation research in the field of Cell Biology.

UNIT-I

Cell cycle – Molecular events including cell cycle check points and Cdk – cyclin complexes and their role in cell cycle regulation. Mechanism of cell division: Mitosis, Meiosis and Cytokinesis. Cell Differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues.

Learning Outcomes:

- At the end of the unit the student should be able to understand Cell Cycle and Check point including regulation at the check points.
- Should learn different mechanisms and stages during cell division.

UNIT-II

Interactions between cells and their Environment: Extracellular matrix, Interaction of cells with other cells, Tight Junctions, Gap Junctions and Plasmadesmata, Cell wall. Ultra structure of plasmamembrane: Chemical composition of the membranes: Membrane lipids, Carbohydrates and Proteins, Membrane asymmetry, Dynamic nature of the plasma membrane. Movement of substances across cell membranes: Diffusion, Facilitated Diffusion & active transport.

Learning Outcomes:

- At the end of the unit the student should get familiarized with cellular membranes composition and functions of it.
- Should understand the dynamic nature of the plasma membrane.

UNIT-III

Ionophores and ion channels. Exo and endocytosis. Phago and pinocytosis. Endoplasmic reticulum: The Smooth Endoplasmic Reticulum, Functions of the Rough Endoplasmic Reticulum, Vesicular Transport from ER to Golgi complex. Signal hypothesis. Golgi Complex: Role of Golgi in protein secretion, Glycosylation in the Golgi Complex, Trans Golgi Network (TGN). Lysosomes and peroxisomes. Ribosomes: Eukaryotic and prokaryotic, Ribosomal proteins.

Learning Outcomes:

- At the end of the unit the student should know different mechanisms through which the cell exchange materials across the membrane.
- Should inference the inter relationship between Golgi and ER in secretion of proteins and post translational modifications and targeting.

UNIT-IV

The Cytoskeleton: Microtubules, Intermediate Filaments, Microfilaments, Muscle Contractility. Mitochondria: Structure and Function, biogenesis and enzymatic compartmentation, mechanism of oxidative phosphorylation (TCA Cycle), Organization of mitochondrial respiratory chain, Structure of ATP Synthase, Formation of ATP.

Learning Outcomes:

- At the end of the unit the student should be able to understand the cytoskeleton and its components including its importance
- Should do a detailed study about different pathways and mechanisms that play in Mitochondria

UNIT-V

Chloroplast: Structure and Function, the absorption of light, Photosynthetic units and Reaction centers, photophosphorylation. Carbon dioxide fixation and synthesis of Carbohydrates in C-3, C-4 and CAM plants. Photorespiration.

Learning Outcomes:

- At the end of the unit the student should be able to know the structure and functions of chloroplast and different pathways that occur in the chloroplast
- Should differentiate the mechanisms that occur in C-3, C-4 and CAM plants

Course Outcomes: upon successful completion of this course, participants will be able to

- Will have an insight on the structure and function of various organelles and macromolecular components of cells and their functions.
- Get familiarize with Cell Cycle and its regulatory check points and understand how cell grow, divide and die.
- Know the structure and function of Biological membrane and mechanism of exchange of compounds across the plasma membrane.
- Will be able to explain the morphology and physiological functions of ER, Ribosomes and protein targeting on ER.
- Understand Trans Golgi Network and protein secretion.
- Able to explain basic pathways and mechanisms in biological energy transduction from oxidation of metabolites to synthesis of ATP.

BOOKS RECOMMENDED:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science.
2. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman

REFERENCE BOOKS:

1. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning.
2. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland.
3. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell.
   Boston (8th Ed.). Benjamin Cummings.

I SEMESTER

102: BIOMOLECULES

Course Objectives:

- The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways.
- The course shall make the students aware about the four major complex biomolecules found in living cells and the basis for grouping of biomolecules into those four groups within the context of each topic.
- To learn the chemical foundation of Biology, classification, structure and properties of carbohydrates & lipids, Amino acids, nucleosides & vitamins.

UNIT-I

Basic aspects of the chemistry of life: bonding properties of carbon, asymmetry of carbon compounds, basic concept of pH, pKa, buffers, various bonds stabilizing biomolecules (peptide, glycosidic, ester, phosphodiester, disulfide, ionic, hydrogen, hydrophobic, Vander wall's force), Properties of water as a solvent of life.

Learning Outcomes

- To understand the bonding properties of carbon, asymmetry of carbon compounds.
- Learn the elements present in biomolecules, the difference monomers and polymers, pH, pKa, buffers.
- Explain the Properties of water as a solvent of life and various bonds.

UNIT-II

Classification, structure, properties and biological significance of carbohydrates. Monosaccharides, Disaccharides, and Polysaccharides. Biological role of peptidoglycans, glycosaminoglycans and Lectins. Lipids - classification, structure and properties of fatty acids, triglycerides, phospholipids, sphingolipids and cholesterol.

Learning Outcomes

- At the end of the unit the student should be able to understand the structure and function of the following carbohydrates and where they are found: glucose, glycogen, starch, cellulose and chitin.
- Will learn the three groups of lipids, saturated, mono-unsaturated, and poly-unsaturated fatty acids, Phospholipids, glycolipids, cholesterol, prostaglandins.
- To understand the biological role of peptidoglycans, glycosaminoglycans and Lectins.

UNIT-III

Amino acids - Classification, structure and physico-chemical properties. Chemical synthesis of peptides – solid phase peptide synthesis. Proteins - classification, purification and criteria of homogeneity. Structural organization, sequence determination and characterization of proteins. Conformation of proteins – Ramachandran plots. Denaturation of proteins. Hetero cyclic compounds – Heme and Chlorophylls.

Learning Outcomes

- At the end of the unit the student should be able to understand the structure of an amino acid and the peptide bond that connects di-, tri, and polypeptides. Recognize the presence of 20 amino acids and that not all are essential amino acids.
- Should learn the function of proteins and recognize the importance of the three dimensional shape of a protein on its function and the role of non-covalent bonds in maintaining the shape of a protein.
- To gain the knowledge about the structure and function of Heme and Chlorophylls.

UNIT-IV

Nucleic acid as genetic material, building blocks of nucleic acids- purines and pyramidines, nucleosides, nucleotides, DNA- double helix structure, properties and function, chromosomal organization; DNA super coiling. Types of RNA and covalent structure of t-RNA. Classification, structure and physiological roles of Vitamins.

Learning Outcomes

- At the end of the unit the student should be able to understand the structures of nitrogenous bases (adenine, guanine, thymine, cytosine and uracil), nucleotides and nucleosides.
- To learn the 2 types of nucleic acids: DNA and RNA.
- Should learn about the classification, structure and physiological roles of Vitamins.

UNIT-V

Hormones- classification and mechanism of action of steroid and protein hormones. Signal transduction cascade by cyclic AMP, Phosphoinositate and calcium (Ca^{+}), G-proteins, growth factors and membrane receptor tyrosine kinases. Phytohormones and their physiological roles.

Learning Outcomes

- At the end of the unit the student should be able to understand the chemical nature of hormones and neurotransmitters and their function in cell communication.
- Gain fundamental knowledge about the modes of action of hormones and neurotransmitters and describe how drugs can be used to alter their action.
- Should learn the phytohormones and their physiological roles.

Course Outcomes: On completion of this course, students should be able to:

- Gain fundamental knowledge in biochemistry;
- Understand the molecular basis of various pathological conditions from the perspective of Biochemical reactions.
- Learn the saponification number, acid number and iodine number of fats.
- Learn the structure and classification of amino acids, proteins with functions.
- Understand the structure of DNA, RAN and its functions, and the structure of Hormones, Chlorophyll and its functions

BOOKS RECOMMENDED:

1. Chemistry of Biomolecules,R.J.Simond, Royal Society of Chemistry.
2. Biomolecules: Chemistry of Living System, V.K.Ahluwalia.
3. Biochemistry. Basic classes of biomolecules: (Principles of biochemistry)", Tom N Corles.
4. Chemistry of Biomolecules"; 5th revised edition. Chapman and Hall.

REFERENCE BOOKS:

1. Principles of Biochemistry by A.L.Lehninger, 2 Ed. (worth).
2. Biochemistry by L. Stryer 4 Ed. (Freeman-Toppan).
3. Text Book of Biochemistry by West et. al., (Mac Millan).
4. Principles of Biochemistry by Smith et. al., (McGraw Hill).
5. Harper's Biochemistry (Langeman).
6. Biochemistry by D.Voet and J.G.Voet (John weily).
7. Biochemistry by U.Satyanarayana (Books &alied (p) Ltd.

I SEMESTER

103: MICROBIAL PHYSIOLOGY & GENETICS

Course Objectives:

- To study the process of sterilization and classification, cultivation of bacteria
- To understand the economic importance of micro organisms.
- To study the genetics in prokaryotic gene and eukaryotic genetics.

UNIT-I

Discovery, Evolution and development of Microbiology. Contributions of Van Leuwenhoek, Joseph Lister, Pasteur, Koch, Jenner, Winogradsky, Beijerinck. Recent trends and development in modern microbiology.Methods of sterilization, pasteurization and disinfection. Microbes as pathological agents in plant and animals. *Microbes and Environment:* Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing.

Learning Outcomes

- Define microbiology and Describe how scientific methodologies are used to do the experiments,
- Define and apply biohazards and safety precautions.

UNIT-II

Classification and cultivation of bacteria. Bacterial reproduction and growth curve. Preparation of bacteriological media. Staining techniques. Differences between gram positive and gram negative bacteria. Actinomycetes, spirochetes, rickettsiae, mycoplasma, Chlamydiae – TRIC agents and LGV Archaebacteria.Clinically important bacteria.Microbialfuel cellsPrebiotics and Probiotics;General characteristics, Classification, structure, reproduction and economic importance of fungi, algae. Bluegreen algae and Protozoa.

Learning Outcomes

- Identify the major categories of microbe classification and cultivation.
- Analyze bacteriological media and preparations.
- Identify and demonstrate the staining techniques.

UNIT-III

Chemical nature and classification of bacteriophages. Parasitic and temperate phages. Plant and animal viruses – multiplication of viruses. General characteristics of T Phage, φx174, SV40, TMV. Clinically important viruses, retroviruses, HIV, Hepatitis B Virus and viral infections.

Learning Outcomes

- Describe viral structure and its significance in microbiology,
- Discuss the different types of viral organisms
- Distinguish between the cellular organization of prokaryotic and eukaryotic cells.

UNIT – IV

Microbial genetics: Recombination in prokaryotes, Transformation - natural and artificial transformation, conjugation - F, F', Hfr; F transfer; Hfr-mediated chromosome transfer, transduction and sexduction. Mapping of prokaryotic gene. Transposons, retrotransposons and mechanism of transposition. Viral genetics. Biology of plasmids. Extra chromosomal inheritance.

Learning Outcomes

- Give examples of genetic recombination prokaryotes,
- Identify the steps in a microbial reproduction,
- Describe the role of transposons in microbial genetics and development.

UNIT-V

Genetics of Eukaryotes: Gene & Environment, Genotype and phenotype, Mendel's experiments, Dominance relationships. Multiple alleles, Gene Interaction, Gene mutations-base pair changes; frame shift; insertions; deletions; tandem duplication; Reversion vs. suppression, Sex determination, Sex linkage, Linkage and recombination in diploids. Tetrad analysis. Elements of gene mapping, Pedigree analysis.

Learning Outcomes

- Describe different types Mendel experiments,
- Give the examples of mutations and mechanisms of mutations,
- Apply the knowledge in pedigree analysis.

Course Outcomes:

- Define microbiology and describe how scientific methodologies are used to do the experiments, Define and apply biohazards and safety precautions.
- Identify the major categories of microbe classification and cultivation. Analyze bacteriological media and preparations. Identify and demonstrate the staining techniques.
- Describe viral structure and its significance in microbiology, Discuss the different types of viral organisms.
  Distinguish between the cellular organization of prokaryotic and eukaryotic cells.
- Give examples of genetic recombination prokaryotes, identify the steps in a microbial reproduction, Describe the role of transposons in microbial genetics and development.
- Describe different types Mendel experiments, Give the examples of mutations and mechanisms of mutations, Apply the knowledge in pedigree analysis.

BOOKS RECOMMENDED:

1. Text book of Microbiology by Pelczar and Reid (Mc Graw Hill).
2. Microbiology by Tortora, Funk & Case.
3. Microbiology by Prescott.

REFERENCE BOOKS:

1. Principles of Genetics by Sinnet et.al,., (Mc Graw Hill).
2. Principles of Heridity by Robert Tumarin.
3. Genetics by M.W.Strick Berger (Mac Millan).
4. Cell and Molecular Biology by E.D.P.De Roberties (International edition).

I SEMESTER

104 ANALYTICAL TOOLS AND TECHNIQUES

Course Objectives

- To impart the knowledge of various microscopes and their applications.
- To impart the knowledge of electronic, rotation, vibration. NMR, FTIR, ESR, spectroscopy and their applications.
- To learn the separation techniques by means of chromatography and centrifugation
- To study the principles and applications of electrophoresis
- To gain knowledge on blotting techniques and DNA Fingerprinting
- To understand use of radio isotopes in biology
- To gain knowledge on electrochemical techniques and electrodes

UNIT-I

Microscopy- Light microscopy- Phase contrast Microscopy, Fluorescent microscopy,Modern Developments in Microscopy-Electron Microscopy- Transmission and Scanning Electron Microscopy- Principle and applications, Resolution of a Microscope; Flow cytometry

Learning Outcomes

- Will have an insight on the basic principle and working of microscopy
- Will learn about the various types of microscopes
- Will have a basic knowledge on the latest developments in microscopy

UNIT-II

Electromagnetic radiation- electromagnetic spectrum, photoreceptors- types of radiations-visible spectrum, absorption spectrum.Spectroscopy- various types of spectroscopic techniques, spectrophotometer- UVVisiblespectroscopy- Beer Lambert Law, IR spectroscopy, NMR spectroscopy-principle andapplication, Fluorescent spectroscopy-principle and application; ORD and CD, Xraydiffraction technique-principle and application; Mass Spectrometry

LearningOutcomes

- Will learn about the basics of EMR
- Will have a basic knowledge on different types of spectropy
- Will get expertise on characterizations of biomolecules using spectroscopic techniques and methods.

UNIT-III

Chromatography- Principle and application, Classification of Chromatography, Paper Chromatography, TLC, LiquidChromatography - ion exchange chromatography, Gel permeation chromatography,affinity chromatography, HPLC and GLC.

Centrifugation -Basic principles of sedimentation- sedimentationcoefficient, Svedberg unit.Applications of preparative and analytical ultra centrifuges; Dialysis, Principles and applications of lyophilization.

Learning Outcomes

- Will learn the basic principle and types of chromatographic techniques
- Will be able to understand the concept of centrifugation
- Gain knowledge on the specific technique to be applied for separation of compounds based on their physico-chemical properties.

UNIT-IV

Electrophoresis- principle and application, PAGE- Native and SDS-PAGE, Isoelectric focusing, 2D -gel Electrophoresis, immuno electrophoresis; Agarose gel electrophoresis of DNA and RNA.

Molecular hybridization Techniques- Southern blotting, Northern blotting and Western blotting;DNA fingerprinting.

Learning Outcomes

- Will attain basics of electrophoretic techniques
- Will have a basic understanding of the separation process of proteins and nucleic acids
- Will gain knowledge on techniques used for separation of nucleic acids

UNIT-V

Principle and applications of tracer technique in biology: Radioactive Isotopesand half life of isotopes; Effect of radiation on biological system; autoradiography;radiation dosimetry; scintillation counting, safety aspects; Non-isotopic tracer techniques.

Electrochemical instruments - Principles and range of electrochemical techniques. Operation of pH electrodes. Principles and applications of Ion-selective and gas sensing electrodes, Oxygen electraodes.

Learning Outcomes

- Will attain basics of radioactivity
- Will gain knowledge on electrochemical techniques
- Will understand the range and applications of various types of electrodes

Course Outcomes:

- Will gain knowledge in the use of different microscope for structural analysis
- Will have a theoretical basis and basic understanding of some of the technologies used in the area of biotechnology like spectroscopy, chromatography, electrophoresis, electrochemical techniques
- To get introduced to the tools and techniques available for studying biochemical and biophysical nature of life
- To be able to learn about principles and working of these technologies
- Enable the students to get sufficient knowledge on applications of bio-instruments

BOOKS RECOMMENDED:

1. Biophysical chemistry principles and techniques by Upadyay, Upadyay and Nath(Himalaya publishing).
2. Principles and techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, Cambridge University Press
3. Instrumental methods of chemical analysis by Dr. G.R. Chatwal and Sham Anand, Himalaya Publishing House

REFERENCE BOOKS:

1. Analytical Biochemistry by David J.Holme (Long man).
2. A Biologists guide to Principles and techniques of practical Biochemistry. Ed.by.B.D. Williams (Edward Arnold).
3. Instrumental methods of chemical analysis by G.K.Sharma (Goel).
4. Modern experimental Biochemistry by Rodney Boyer (Pearson Education)
5. Physical Biochemistry by Frefielder (Freeman & Co).

I SEMESTER

105:FUNDAMENTALS OF ENGLISH GRAMMAR, VOCABULARY & PHONETICS

UNIT-1

GRAMMAR & USAGE:

Parts of speech, articles, determines, main verbs, strong verbs, weak verbs, auxiliary verbs, modals, transitive verbs & Intransitive verbs, tenses and appropriate use of tenses.

Learning outcomes:

1. The Student will be able to understand the nature and functions of various parts of speech in English sentences.
2. They acquire the skill of using of grammatically correct verb forms in sentences depending upon the tense.
3. formation and appropriate use of tenses will be understood and used accordingly.

UNIT-II

TRANSFORMATION OF SENTENCES & SENTENCE STRUCTURE:

Inter change of sentences, Assertive, Interrogative, Imperative and Exclamatory sentences, Degrees of comparison, change of Active voice and positive voice, simple, compound and complex sentences Direct & Indirect Speech, sentence structures – sub + transitive verb + obj + obj complement, sub + verb + noun / prounoun + conjunctive + to infinitive, sub + verb + obj + present participle, sentences with If clauses, conversational structures, question tags and short answers.

Learning outcomes:

1. The Student Learn about different types of sentences and their transformation from one type to another.
2. They get the drilling of different sentence structures and syntax
3. They understand the rules for writing question tags for different types of sentences at advanced stage.

UNIT-III

VOCABULARY (MEANING, FUNCTION & USGAGE by David Green)

Word formation: Prefixes and Suffixes, simple and Compound words. Synonyms & Antonyms, Homophones, Homonyms, One-word substitutes, Words often confused, Words always used as singular, Words always used as plurals.

Learning out comes:

1. The Student understand how different words are formed from root words.
2. Acquire knowledge about synonyms and Antonyms at advanced stage and their contextual usage.
3. The distinctive use of "words often confused " in English language will be learnt and used appropriately.

UNIT –IV

PHONETICS:(basics)

Vowel sounds, consonant sounds, phonetic transcription, syllables, accentuation, word stress, sentence stress, intonation, falling tone, rising tone, falling rising and rising falling tones .

Learning out comes:

1. The student will be able to acquire the skill of correct pronunciation of English words and sentences with proper stress and intonation as per the IPA (International Phonetic Alphabet)
2. They learn about syllable - division of words and their accentuation
3. The understand various types of intonation and communicate with others duly following appropriate intonation.

UNIT –V

ENGLISH FOR COMPETITIVES(David Green):

Reading comprehension, Spot the error, jumbled sentences , Phrasal verbs, use of correct phrases, Idioms and phrases, better sentences / improvement in the part underlined, use of appropriate words in the blanks from the given alternatives.

Learning Out comes:

1. They enable to acquire the skill of answering the questions correctly, in various competitive exams under General English part and improve the overall score.
2. They acquire the skill of locating grammatical errors in sentences.
3. The special meaning conveyed through English "Idioms and Phrases" will be understood and they can be used in English oral or written communication by the student to ensure beauty and decoration to the language.

Course objectives:

1. To make the students understand the various theoretical concepts of English Traditional Grammar and to make them speak the language correctly, and fluently with proper accent and also to enable them to write grammatically error - free language.
2. To enable the students to enhance their pronunciation skills as per the IPA (International Phonetic Alphabet)
3. To enable the students establish themselves in good positions in career by hitting good score in English proficiency test in various competitive exams.

Course out comes:

1. The student learn various components of English traditional grammar and its correct usage in spoken and written forms.
2. They acquire the skill in transformation of sentence, from one type toanother.
3. They understand different sentences structures of English language and their correct usage.
4. They acquire mastery over various components of English Vocabulary and their appropriate usage .
5. They Understand the elements of English phonetics and speak English language correctly and fluently with proper stress and intonation as per the IPA rules.

Reference Books:

1. Contemporary English Grammar, structures and composition - David Green

2. English Grammar & composition by Wren & Martin

3. Cambridge English Pronouncing Dictionary -Daniel Jones

4. Better English Pronunciation - JDO conuor (Cambridge)

5. Oxford writing & speaking English - Sealy (OUP)

6. Communicative English by, Mohapatra, Dash, Kalyani.

I SEMESTER

106: LAB - I: CELL BIOLOGY AND MICROBIOLOGY

Course Objectives:

- Become proficient at laboratory skills and safety procedures.
- Learn to follow experimental procedures.
- Develop skills to formulate answerable questions/hypotheses, predict expected results.
- Learn how to make careful observations, collect and analyze data, and draw appropriate conclusions.
- Utilize active learning opportunity in the laboratories.
- Demonstrate good lab citizenry and the ability to work with others.

1. **Mitosis in onion root tip cells: All phases (Squash method).**
2. **Meiosis in onion flower buds: All phases including zygotene, diplotene and diakinesis of prophase I (Smear method).**
3. **Preparation of liquid and solid media for growth of microorganisms.**
4. **Slants and Stab cultures, Isolation and maintenance of microorganisms by plating, streaking and serial dilution methods.**
5. **Biochemical characterization of selected microbes.**
6. **Simple staining and Grams staining.**
7. **Acid fast and spore staining.**
8. **Microscopic examination of bacteria, yeast and molds.**
9. **Growth of a microorganism and growth curve.**
10. **Analysis of water for portability and determination of MPN.**
11. **Microbiological examination of milk.**
12. **Oligodynamic action of heavy metals.**
13. **Evaluation of disinfectants by phenol coefficient method.**
14. **Isolation of viruses.**
15. **Examination of thallus structure and reproductive bodies of algae.**
16. **Examination of external features and reproductive organs of fungi.**

17. Representative species of protozoa.

Learning Outcomes:

- Demonstrate practical skills in microscopy and their handling techniques in staining procedures
- Know various Culture media preparations and their applications
- Understand various physical and chemical means of sterilization
- Know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and algae
- Master aseptic techniques and be able to perform routine culture handling tasks safely and effectively
- Comprehend the various methods of disinfection
- Apply the potability of water and water testing methods
- Know the various Physical and Chemical growth requirements of bacteria and get equipped withvarious methods of bacterial growth measurement.

BOOKS RECOMMENDED:

1. Handbook of Microbiological Media by Atlas R.L.
2. Manual of Clinical Microbiology by Lennettee E.H.
3. Manual of Clinical Microbiology by Murray PR.
4. A Laboratory manual of Microbiology: Microbes in Action.

I SEMESTER

107: LAB-II: BIOCHEMICAL ANALYSIS AND TECHNIQUES

Course Objectives:

- The objective of this laboratory course is to introduce students to experiments in biochemistry.
- The course is designed to teach students the utility of set of experimental methods in biochemistry in a problem oriented manner.
- Will try to develop the skills required to design and interpret the data from scientific experiments.
- The importance of good experimental design, including the use of appropriate controls, will be highlighted in all experiments.
- Also, as an introductory lab course, the lab work will emphasize the learning of basic lab skills (including dilutions, good pipetting technique) and good lab practices (such as good notebook keeping).

1. **Separation of amino acids by paper chromatography.**
2. **Separation of amino acids/ sugars/ lipids by Thin Layer Chromatography.**
3. **Ultra violet absorption spectra of nucleic acids and proteins.**
4. **Determination of molar extinction coefficient of tryptophane / tyrosine.**
5. **Gel filtration of proteins.**
6. **Ion exchange chromatography of amino acids.**
7. **Purification of enzyme by affinity chromatography.**
8. **Subcellular fractionation by differential centrifugation.**
9. **Polyacrylamide gel electrophoresis of proteins.**
10. **Determination of isoelectric point of glycine.**
11. **Estimation of glycine by formal titration.**
12. **Estimation of reducing sugars by Benedict's titrimetric method.**
13. **Estimation of total carbohydrates by anthrone method.**
14. **Estimation of proteins by Lowry and Bradford methods.**
15. **Estimation of ascorbic acid.**

16. Determination of Iodine value of oils.

17. Estimation of cholesterol.

Course Outcomes:

Students should be able to

- To elaborate concepts of biochemistry with easy to run experiments.
- To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.

BOOKS RECOMMENDED:

1. Hawk's physiological chemistry Ed. by Oser (McGraw Hill).
2. Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3. An introduction to practical biochemistry by D.T.Plummer (McGraw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).

II SEMESTER

201: ENZYMOLOGY & METABOLISM

Course Objectives:

- To understand the classification & nomenclature of enzymes and the factors effecting enzymatic reaction.
- Learn about the mechanism of Enzyme action.
- Familiar about the chemical nature of enzymes and their function in biochemical reactions.
- Study the effects of the inborn errors of metabolism.
- Understand the synthesis & degradation process of carbohydrates, lipids, amino acids & nucleic acids.

UNIT – I

Classification and Nomenclature of Enzymes. Assay of Enzyme Activity- units of enzyme activity. Coenzymes, metalloenzymes, and isoenzymes with examples. Ribozymes and catalytic antibodies.Chemical Nature of Enzymes and their Function in Biochemical Reactions.

Learning Outcomes:

- At the end of the unit the student should be able to understand the classification of Enzymes and Assay of Enzyme Activity- units of enzyme activity.
- Should able to get on overall idea about the coenzymes, metalloenzymes and isoenzymes with examples.
- Should learn about the chemical nature of Enzymes and their function.

UNIT-II

Enzymekinetics: Factors affecting the rates of enzyme catalysed reactions. Enzyme – substrate (protein ligand) binding. Michaelis- Menten equation. Methods of Measurement of k_m. Enzyme inhibition – Competitive, non-competitive and uncompetitive. Allosteric enzymes and their properties with examples-Multisubstrate reactions.

Learning Outcomes:

- At the end of the unit the student should be able to understand the mechanisms of enzyme action, Michaelis Menten equation and its transformation.
- Should gain the knowledge about the enzyme inhibition – Competitive, non-competitive and uncompetitive and metabolic regulation.
- To understand the covalently modulated enzyme and role of covalent modification in enzymatic activity.

UNIT – III

Allosteric Regulation, Zymogen activation- Covalent modification- Active site determination. Mechanism of enzyme action of chymotrypsin,Trypsin (serine proteases), carboxy peptidase-A and ribonuclease A. Multienzyme systems.

Learning Outcomes:

- At the end of the unit the student should be able to understand the enzyme specificity and Feedback Regulation, Allosteric Regulation.
- Should learn the enzymes in the cell, localization and zymogens.
- To understand the Mechanism of enzyme action and Active site determination.

UNIT – IV

Glycolysis, Glycogenolysis, glycogenesis, gluconeogenesis, HMP shunt path way and their regulation. Tricarboxylic acid (TCA) cycle, Glyoxylate cycle and its significance. Biosynthesis and oxidation of fatty acids- The concept of free energy- Energy rich compounds. Metabolism of cholesterol. Ketone bodies. Biosynthesis of Heme and chlorophylls.

Learning Outcomes:

- At the end of the unit the student should be able to understand the structure of ATP and identify the major class of macromolecules to which ATP belongs.
- To understand the HMP shunt path way, tricarboxylic acid (TCA) cycle and Glyoxylate cycle and its significance.
- Should learn the metabolism of cholesterol and biosynthesis of Heme.

UNIT – V

Amino Acids– General reactions of amino acid metabolism, degradation of individual amino acids, regulation of amino acid metabolism. Ammonia formation. Urea cycle. Nitrogen fixation. Inborn errors of amino acid metabolism. Biosynthesis of purine and pyrimidine nucleotides and their regulation. Catabolism of purines and pyrimidine.

Learning Outcomes:

- At the end of the unit the student should be able to understand the metabolic pathways and regulation of amino acids. Catabolism of purines and pyrimidine and their regulation.
- Will have an insight on the Urea cycle and Nitrogen fixation.
- To understand the inborn errors of amino acid metabolism

Course Outcomes:

On successful completion of this course, the student will be able to

- Describe the chemical nature of enzymes and their function in biochemicalreactions.
- Explain how enzyme activity is (a) regulated, and (b) affected by temperature, pH, and concentration.
- Predict the products of chemical reactions of carbohydrates and fatty acids
- Describe what happens during carbohydrate digestion, glycolysis, glycogenesis, and glycogenolysis.
- List the essential and non-essential amino acids and describe the general strategies for amino acid and nucleic acid synthesis.
- Explain what happens during digestion of proteins, catabolism of amino acids and the urea cycle.

BOOKS RECOMMENDED:

1.Principles of Biochemistry by A.L.Lehninger, 2 Ed. (worth).

2.Lehninger Principles of Biochemistry by Nelson, D and Cox, D. Macmillon Pub.

3.Biochemistry by L.Stryer 5 Ed. (Freeman-Toppan).

REFERENCE BOOKS:

1.Text Book of Biochemistry by West et. al., (Mac Millan).

2.Principles of Biochemistry by Smith et. al., (McGraw Hill).

3 Harper's Biochemistry (Langeman).

4.Biochemistry by D.Voet and J.G.Voet (John wiley).

5.Enzoyms by Trevor PalmerTheHorwood publishing colophon Chichester.

II SEMESTER

202: MOLECULAR BIOLOGY

Course Objectives

- To understand basic and advanced molecular biology theories & concepts.
- Know the concepts of gene relgulation at transcriptional and post transcriptional level.
- Learn how to present molecular biology data and concepts to an audience.
- Understand current experimentation and research in the field of Molecular Biology.

UNIT – I

Organization of genetic material - Packing of DNA into chromatin - protein components of chromatin, histones, nucleosome organization. Solenoids loops, domains & scaffolds. Fine structure of the eukaryotic gene. Different kinds of genes: overlapping, Split genes, polyprotein & nested genes. Nuclear genome & C - value paradox. Mitochondrial & plastid genomes.

Learning Outcomes:

- After completion of the unit the student should be able to understand how the genetic material is organized in the nucleus.
- Know different types of genes and gene arrangement in the genetic material.

UNIT – II

DNA replication – Semi conservative nature of Replication. Apparatus, enzymes involved in replication and replication mechanism. Accuracy of Replication. Replication at telomeres. DNA damage and repair mechanism (Mismatch repair, Base Excision repair, Nucleotide Excision repair, Direct repair, Photoreactivation, Error prone Translesion DNA synthesis). DNA Recombination. Transposans.

Learning Outcomes:

- After completion of the unit the student should be able to know the replication of DNA in the nucleus.
- Learn different types of DNA damage and various DNA repair mechanisms

UNIT – III

Mechanism of transcription in prokaryotes and eukaryotes: RNA Polymerases and other transcription factors, enzymes involved and mechanism of transcription. Footprinting. Selective Inhibition of RNA polymerase by antibiotics. Maturation and processing of m-RNA: Splicing (Splicing of Type I, Type II & Type III introns), 5' end capping & 3' end tailing. Processing of tRNA's & Ribosomal RNA's. RNA editing and transport. RNA Dependent Synthesis of DNA. RNA interference by small non coding RNA's (mi RNA's and si RNA's)

Learning Outcomes:

- After completion of the unit the student should be able to know the replication of DNA in the nucleus.
- Learn different types of DNA damage and various DNA repair mechanisms.

UNIT – IV

Genetic code - deciphering of the genetic code, properties of the genetic code. Wobble hypothesis. Translation in prokaryotes and eukaryotes. Ribosome as a translation factory. t - RNA as an adaptor, its mode of function. Post translational modifications. Inhibition of protein synthesis by Antibiotics. Leader sequences & protein targeting. Protein turnover and Degradation.

Learning Outcomes:

- After completion of the unit the student should be able to understand the concept of Genetic code and the process of translation in prokaryotes and eukaryotes.
- Know different post translational processes and protein degradation.

UNIT – V

Regulation of gene expression in prokaryotes - Operon concept, lac & tryp operons. Transcriptional control. Post translational control. Regulatory proteins DNA binding Motifs: zinc finger, Helix turn Helix, Homeodomain. Protein – Protein interacting domains: leucine zipper & Basic Helix loop Helix. Regulation in eukaryotes - Control by

promoter, enhancer and silencers. Cis-trans elements. Environmental & developmental regulation. DNA methylation & gene expression. Chromatin structure & gene expression.

Learning Outcomes:

- After completion of the unit the student should be able to learn various regulatory mechanism observed in prokaryotes and eukaryotes at transcription and post transcriptional level.
- Should appreciate the mechanisms of environmental and developmental regulation on gene expression.

Course Outcomes: upon successful completion of this course, participants will be able to

- Describe general principles of genome organization and replication in prokaryotes and eukaryotes.
- Familiarize with gene expression in prokaryotes and eukaryotic organisms.
- Learn the principles of protein synthesis and protein degradation.
- Understand various levels of gene regulation in prokaryotes and eukaryotes.
- Interpret the outcome of experiments that involve the use of recombinant DNA technology and other common gene analysis techniques.

BOOKS RECOMMENDED:

1. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.

2. Molecular Biology by David Friefielder. Narosa publications.

REFERENCE BOOKS:

1. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning.

2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science.

II SEMESTER

203: GENETIC ENGINEERING

Course Objectives:

- In-depth understanding of various techniques involved in gene amplification, labelling and detection of nucleic acid sequences.
- Learn about various enzymes, sources and their roles in genetic engineering.
- Understand the concept of vectors, their types, sources and their roles in genetic engineering.
- Will provide plethora of information to students regarding the different types of PCR
- Gain knowledge on various techniques involved in detection of nucleic acid sequences
- Learn about the various techniques used in gene transfer
- Focus on screening which would be the next stage of gene manipulation.
- Knowledge on applications of genetic engineering
- Knowledge on advances in rDNA technology

UNIT-I

Introduction and tools for genetic engineering: General requirements for performing a genetic engineering experiment; restriction endonucleases -types, nomenclature and properties; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; terminal nucleotide transferase, S_1 nuclease; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, and colony hybridization, fluorescence in situ hybridization.

Learning Outcomes

- Understand and think about the basics of recombinant DNA technology
- To understand the role, use and types of different DNA modifying enzymes viz. Polymerases, Nucleases, restriction endonuclease, ligases etc.
- Fundamental understanding of the techniques of gene amplification

UNIT-II

Different types of vectors: Salient features of cloning vectors, types of cloning vectors - plasmids, cosmids, phages (lambda, M13 phages, pBluescript), Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Expression vectors – Elements of expression vectors, pET-based vectors, Baculovirus vectors system, Shuttle vectors

Learning Outcomes

- Will attain knowledge on the types of vectors
- To understand the role and use of vectors in genetic engineering
- Students will able to understand the strategies to increase the expression of inserted gene

UNIT –III

Different types of PCR techniques: Principles of PCR, types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, hot start PCR, touchdown PCR, colony PCR, cloning of PCR products; T-vectors; PCR based site directed mutagenesis;Sequencing methods - enzymatic DNA sequencing, chemical sequencing of DNA, automated DNA sequencing, RNA sequencing

Learning Outcomes

- Students will able to understand the strategies and steps involved in invitro synthesis of desired gene
- Will gain knowledge on the different methods of sequencing
- Will have an insight in the sequencing technology theory and types.

UNIT – IV

Gene manipulation: Insertion of foreign DNA into host cells; transformation, electroporation, transfection,micro injection, lipofection; construction of libraries: isolation of DNA and RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; Microarrays. Protein-DNA interactions using chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system.

Learning Outcomes

- Will learn essential tools for rDNA transfer
- to understand the strategies and steps involved in construction of genomic and cDNA library
- Will attain knowledge on protein –DNA interactions

UNIT – V

Screening of recombinant clones: Chromogenic substrate, Insertional inactivation, Colony hybridization, Immunological tests and FISH. Transgenics - Applications in agriculture, animal husbandry, medicine and in industry.Gene therapy- Types and Approaches of gene therapy,Transgenic and knockout mice; Introduction to genome editing by CRISPR-CAS method

Learning Outcomes

- Will learn essential tools for rDNA screening
- Learn the application of gene manipulation

Course Outcomes:

- Understand and think about the basics of recombinant DNA technology
- To understand the role, use and types of different DNA modifying enzymes viz. Polymerases, Nucleases, restriction endonuclease, ligases etc.
- Acquire basic knowledge of DNA sequencing methods from conventional (Sanger sequencing) to High throughput Next generation sequencing technology
- Students will able to understand the strategies and steps involved in construction of genomic and cDNA library, essential tools and role of each and every constituents.
- Syllabus will also provide plethora of information to students regarding basic molecular biology techniques like blotting and its different types, DNA footprinting as well as description of application of rDNA Technology,
- The students should be endowed with strong theoretical knowledge of this technology

BOOKS RECOMMENDED:

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. **B**rown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Genetic Engineering by Sandhya Mitra.

REFERENCE BOOKS:

1. Recombinant DNA technology by Watson et. al., (Scientific American Books).
2. *Genes XI, Lewin, Benjamin; Krebs, Jocelyn E.; Goldstein, Elliott S.; Kilpatrick, Stephen T. (2014), Jones & Bartlett Learning*
3. **DNA Science: A First Course David Micklos and Greg A. Freyer** Cold Spring Harbor Laboratory Press,U.S.; 2nd ed. edition.

204: BIOLOGY OF THE IMMUNE SYSTEM

Course Objectives

- The objectives of this course are to make students learn about the structural features of the components of the immune system as well as their function.
- The major emphasis of this course will be on the development of the immune system and mechanisms by which our body elicit the immune response.
- To know the mechanism of Major Histocompatability Complex
- To understand the diagnostic process of diseases by immunological techniques
- To learn the production of chimeric and monoclonal Antibodies production using Hybridoma technology and their applications
- To learn the process of vaccination and development of vaccine
- This will be imperative for the students as it will help them to think like an immunologist and predict about the nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments

UNIT-I

Types of immunity – innate, acquired, passive and active; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens;Organisation and structure of lymphoid organs – bone marrow, thymus, spleen and lymphnodes.

Learning Outcomes:

1. To impart the knowledge on the types of immunity
2. To understand the concept of organs of immune system
3. To apprehend the structure and organization of lymphoid organs

UNIT-II

Immune response generated by B lymphocytes: Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell

signaling; basis of self & non-self discrimination; kinetics of immune response, memory;B cell maturation, activation and differentiation; generation of antibody diversity

Learning Outcomes:

1. To gain knowledge on the structure and function of Immunoglobulin
2. To understand the concept of cell signalling
3. To gain insight on antibody diversity

UNIT-III

Immune response generated by T lymphocytes: T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines-properties, receptors and therapeutic uses; Major Histocomaptibility complex; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Hapten-carrier system.

Learning Outcomes:

1. To understand the knowledge of T-cell maturation
2. To comprehend the knowledge of MHC
3. To get an insight on antigen processing and presentation

UNIT-IV

Immunological techniques - ELISA, RIA, Western Blot, Immunoblot and Immuno fluorescent techniques ELISPOT assay, immunoelectron microscopy, FACS. Hybridoma technology - production and applications of monoclonal antibodies. Antibody engineering, chimeric antibodies.

Learning Outcomes:

1. To impart the knowledge of immunological technique
2. To apply the knowledge of monoclonal anti bodies
3. To apprehend the concept of antibody engineering

UNIT-V

Hypersensitivity - types of hypersensitivity - immediate and delayed hypersensitivity, autoimmune diseases, transplantation and immunity, immunity to infectious agents.

Vaccines and Vaccination, types of vaccines including new generation vaccine, General strategies for design of vaccines; Tumor immunology- Immune system recognition of cancer, tumour evasion from immune system.

Learning Outcomes:

1. To understand the concept and mechanism of hypersensitivity
2. To gain knowledge about the mechanism of vaccination
3. To know the concept of cancer and tumor evasion from immune system

Course Outcomes:

- Evaluate usefulness of immunology in different pharmaceutical companies
- Identify proper research lab working in area of their own interests
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).
- Get a deep foundation in the immunological processes.
- Students will gain knowledge on how the immune system works and also on the immune system network and interactions during a disease or pathogen invasion.

Recommended Text Books and References

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology.* New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology.* London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology*. New York: Garland Science.
4. Paul, W. E. (1993). *Fundamental Immunology*. New York: Raven Press.

5. Goding, J. W. (1986). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology*. London: Academic Press.
6. Parham, P. (2005). *The Immune System.* New York: Garland Science.

II SEMESTER

205: COMMUNICATION SKILLS

Course objectives:

- The main objective of this course is to develop instructional strategies to develop the written, verbal, non-verbal, and communication skills of post graduate students.
- To improve communication skills in English among the student in both oral and written form as per the needs of the job market and to enable the students face the job interviews confidently
- To make the students present a paper in seminar to understand nature and scope of presentation skills to have and overall about various papers presentation
- To familiarize the student with process of writing resumes to different companies and organizations.
- To crack and awareness among the students on how to write job applications to different organizations effectively and impressively.
- To make the students to understand value of time and utilize in proper way .

Course Outcomes:

- The student will able to face interview successes fully through communication situations and participate in such presentations with confidence.
- Gain learning by themselves to improve writing skills and effectively presents wherever they need.
- Be self-confident and change to adapt to job culture by being learned interview skills and improve professionally life .
- Successfully and smoothly running organization by conducts meetings effectively in real life situations.
- Analyse to enhance professional exposure through various referencing and bibliography
- By gathering and Synthesis data and making oral and written presentations on the same.

UNIT –I

FEATURES OF COMMUNICATION :

Meaning, Objectives and Functions; process of communication, modes of Communication - Various Types Communication-Verbal and non-verbal Communication.

UNIT-II

INTERVIEW SKILLS:

Nature and scope of interview, kinds of interview-one to one interview, panel interview, Skype interview, telephone interview group interview, walk in interview, interview preparation techniques, Mock interview practice and group discussion.

UNIT –III

COMMUNICATION THROUGH WRITING:

Punctuation, paragraph writing, note taking, note making , précis writing ,expansion, report writing ,essay writing, message writing, writing Emails, Resume writing,

UNIT-IV

EFFECTIVE MEETINGS :

a. Notice Writing: Introduction, Notice Format, Topics, Examples and Samples.
b. Agenda: Professional Agenda, Template, Example.
c. Minutes and Different Steps to write Minutes.
d. Reviewing: Tips and Tricks of review.
e. Editing: Importance of Editing, Types of Editing, Guidelines of Editing.
f. Proof Reading and Copy- Editing,
g. Referencing and Bibliography.

UNIT –V

ORAL COMMUNICATION:

Role-play, describing a process, Telephone conversation, storytelling incident narration, describing oneself, presentation skills and stages of presentation skills.

Suggested Reading:

- Madhavi Apte , “A Course in English communication”, Prentice-Hall of India, 2007
- Leena Sen , “Communication Skills”, Prentice-Hall of India, 2005
- Dr. Shalini Verma, “Body Language- Your Success Mantra”, S Chand, 2006
- English for Foundation Books by M. A. Yadugiri and GeethaBhaskar.
- Developing Communication Skills by Krishna Mohan and Meera Benerji. (2nd Edition,Macmillan2010).
- Language Use in Industries by Kamlesh Sadanand – Bahri Publications,1993.
- English and Soft Skills by S. P. Dhanavel (OrientBlackswan).
- Communication Skills for Technical students by T. M. Farhatullah (Orient Longman).
- The Basics of Communication by SteveDuck.

II SEMESTER

206 LAB III: MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Course Objectives:

- To understand basic and advanced molecular biology concepts and techniques
- Learn how to understand and present molecular biology data and concepts to an audience
- Understand current experimentation in the field of Molecular Biology

1. **Isolation of RNA from yeast.**
2. **Estimation of RNA using orcinol reagent and by UV spectrophotometry.**
3. **Isolation of DNA from microbial, plant and animal sources.**
4. **Estimation of DNA using diphenylamine reagent and by UV spectrophotometry.**
5. **Enzyme induction in E.Coli.**
6. **Isolation of plasmid DNA.**
7. **Digestion of plasmid DNA with restriction endonucleases.**
8. **Separation of DNA fragments by Agarose gel electrophoresis.**
9. **Elution of DNA from agarose gels.**
10. **Ligation of DNA fragments.**
11. **Bacterial transformation and identification of transformants.**
12. **Cloning of green fluorescent protein.**
13. **Gene expression in bacteria.**
14. **Amplification of DNA by PCR.**
15. **Southern blotting technique.**
16. **RFLP and RAPD mapping.**

Learning Outcomes: upon successful completion of this course, participants will be able to

- Do simple Molecular biology and Genetic Engineering experiments
- Familiarize with advance techniques in the field of Genetic Engineering

- Interpret the outcome of experiments that involve the use of recombinant DNA technology and other common gene analysis techniques.
- Present Molecular Biology experimental date to a scientific audience
- Design simple research experiment involving Molecular Biology and Genetic engineering techniques

BOOKS RECOMMENDED:

1. Biotechnology: A laboratory course by Becker J.M.
2. Molecular Cloning : A laboratory manual Vols. 1-3, Sambrook, J.
3. Lab manual in Biochemistry by J.Jayaraman (Wiley Eastern Limited).
4. Biochemistry – A lab course by J.M.Becker (Academic Press).

II SEMESTER

207: ENZYMOLOGY AND IMMUNOLOGY LAB

Course Objectives:

- To provide in practicum training to students in enzymology and Immunology aspects.
- See how enzymes operate and how factors such as temperature and pH affect the function of the enzyme.
- Developing a working knowledge of the principles and procedures of Immunology and enzymology.

1. **Assay of amylase from Saliva.**
2. **Assay of trypsin.**
3. **Assay of acid-phosphatase from potato.**
4. **Assay of Lipase from serum.**
5. **Assay of Catalase from liver.**
6. **Time course of enzyme activity**
7. **Effect of pH and determination of optimum pH.**
8. **Effect of temperature on enzyme activity and calculation of energy of activation.**
9. **Effect of substrate concentration on enzyme activity and determination of Km.**
10. **Effect of metal ions on enzyme activity.**
11. **Purification of an enzyme.**
12. **Determination of A, B, O and Rh blood groups in human beings.**
13. **Handling of mice and rats, techniques of immunization and bleeding.**
14. **Dissection and identification of thymus, spleen and lymph nodes.**
15. **Ouchterloney double diffusion.**
16. **Radial immunodiffusion.**
17. **Quantitative precipitin assay.**
18. **Immunoelectrophoresis.**
19. **Latex agglutination test.**
20. **Enzyme Linked Immunosorbent Assay (ELISA).**
21. **Western blotting.**

22. Diagnostic test for typhoid fever by Widal test.

23. VDRL test for syphilis.

24. Pregnancy tests.

Learning Outcomes:

- Will acquire hands on knowledge on different enzyme assay procedures
- State the principle of the routine Immunology procedures performed in the clinical laboratory.
- Evaluate laboratory test outcomes and determine the validity of the test results obtained for blood grouping, VDRL, Widal Test etc

BOOKS RECOMMENDED:

1. Hawk's physiological chemistry Ed. by Oser (Mc Graw Hill).
2. Biochemical methods By Sadasivam and Manikam (Wiley Eastern limited).
3. An introduction to practical biochemistry by D.T.Plummer (Mc Graw Hill).
4. Laboratory manual in Biochemistry by J.Jayaraman (Wilety Eastern limited).
5. Biochemistry - a laboratory courses by J.M.Beckar (Academic Press).
6. Immunology methods manual - The comprehensive source book by Lefkovits. I.
7. Manual of clinical laboratory immunology by Rose NR.
8. The experimental foundations of modern immunology by Clark W.R.
9. Laboratory Immunology by Bradshaw LJ.

III SEMESTER

301: ANIMAL BIOTECHNOLOGY

Course Objectives:

- The objectives of this course are to introduce students to the principles, practices and application of animal biotechnology, animal genomics, genetic transformation and molecular breeding of animals.
- The course is designed to give students a perspective on recent advances in Animal Biotechnology. Students will get familiarized with the different approaches to generate transgenic animals for various applications.
- To know the causes of infertility in humans and the process of in-vitro fertilization.
  To understand the importance of aquaculture and to learn the induced breading techniques in fishes.

UNIT-I

Structure and function of male and female reproductive system. Infertilities in humans-Types and causes of male and female infertility, sperm collection, Cryopreservation, artificial insemination, Oocyte recovery, superovulation.

Learning Outcomes:

- Understand the History, scope, principle, merits and demerits of animal Biotechnology and Infertilities in humans
- Understand the structure and function of male reproductive system.
- Understand the structure and function of female reproductive system-

UNIT-II

In vitro fertilization in humans and cattle, Artificial insemination (AI) techniques and their development: Oocyte maturation in vitro, Embryo culture, embryo transfer in farm animals. Somatic cell nuclear transfer in humans – Legal aspects. Immunocontraception - hormonal methods.

Learning Outcomes:

- Understanding the concept of IVF in humans and cattle.
- Developing embryo - transfer technology.
- Understanding structural, functional and comparative genomics of farm animals and its application for livestock improvement.

UNIT-III

An overview of transgenic technology, Development of transgenic mice, sheep and fish. Molecular pharming and animal cloning. Potential applications of transgenic animals. Biotechnological approaches for the management of pests, mosquitoes and nematodes.

Learning Outcomes:

- Understanding transgenic animals.
- Understand the Generation of chimeric, transgenic and knockout mice and other animals and their characterization.

UNIT-IV

Transgenic poultry and transgenic insects as bioreactors. Animal models for various diseases/disorders, production of peptides and proteins of biopharmaceutical interest. Transgenic animals in live-stock improvement; transgenic in industry; Risks and ethical issues in animal biotechnology

Learning Outcomes:

- Understanding the principles of transgenic animal and its application.
- Understanding the Production of peptides and proteins of biopharmaceutical interest (molecular farming).
- Understanding the live-stock improvement; transgenics in industry; Ethical issues in animal biotechnology

UNIT-V

Aquaculture - Fresh water fish culture practices and types. Bioactive compounds from corals. Fish bio products. Pearl culture technology – principles and applications. Breeding: Hypophysation and induced breeding techniques. Eyestalk oblation. Post-harvest technology. Diagnosis of shrimp & fish diseases caused by bacterial, fungal and viral pathogens using molecular methods.

Learning Outcomes:

- Understand the fresh water fish culture practices and types.
- Understand the bioactive compounds from corals and Pearl culture technology – principles and applications.
- Understand the breeding: Hypophysation and induced breeding techniques.
- Understand the diagnosis of shrimp & fish diseases caused by bacterial, fungal and viral pathogens using molecular methods.

Course Outcomes: at the end of the course, students will be able to

- Describe the basics of Animal Biotechnology. Comprehend the fundamental concepts of animal cell culture, and its importance.
- Discuss the significance of transgenesis with reference to animal models. Explain the principles and applications of animal cloning and gene therapy along with ethical concerns.
- To identify and comprehend experimental knowhow of various techniques involved in cell separation and quantitation using latest technology.
- To relate and evaluate the applications of animal biotechnology, animal breeding, vaccine production and other biotechnological products of industrial and medical benefits.
- To relate to the social, cultural, economical, legal issues associated and comprehend the need Bioethics and patent rights in biotechnological research.
- To describe gene transfer technologies for animals and animal cell lines.

BOOKS RECOMMENDED:

1. Text Book of Animal Biotechnology, P R Yadav .

REFERENCE BOOKS:

1. Elements of Biotechnology by PK Gupta (Rastogi& Co).
2. Biotechnology by Kashav. T (Wiley Eastern Ltd).
3. Concepts in Biotechnology by Balasubrahmanianet. al.,(University press)
4. Principles and practices of aquaculture by TVR Pillay.
5. Coastal aquaculture by Santhanam.
6. Fisheries of India by CBL Srivatsava.
7. Molecular Biotechnology by Glick.

III SEMESTER

302: PLANT BIOTECHNOLOGY

Course Objectives:

- To understand basic and advanced Plant Biotechnology techniques & concepts.
- The students should able to know the applications of Plant Biotechnology.
- Learn how to present Plant molecular biology data and concepts to an audience.
- Understand current experimentation and research in the field of Plant Biotechnology.

UNIT-I

Plant Genetic engineering: Cloning Vectors, Screenable and Selectable markers. Gene cloning techniques. Agrobacterium and its importance in Plant transformation, The process of T-DNA transfer and integration, T_I plasmid. Vectors for plant transformation: Features of Binary vectors. Techniques for gene transfer into plants: Agrobacterium mediated transformation, Direct Gene transfer by Particle bombardment. Identification of transgenic plants. Reporter genes. Transient gene assays. Clean gene technology.

Learning Outcomes:

- At the end of the unit the student should be able to understand how cloning is done.
- The student should understand different techniques used in Plant transformation.

UNIT-II

Molecular markers and their significance: Hybridization and PCR based markers - RFLP, SSR, SNP's, AFLP & RAPD. Biodiversity utilization and conservation. Introduction to molecular mapping in plants. Marker Assisted Selection (MAS). QTL mapping in plants.

Learning Outcomes:

- At the end of the unit the student should be able to conceptualize polymorphism and different molecular markers types.
- The student should able to understand how molecular markers are utilized in molecular breeding for crop improvement.

UNIT-III

Agricultural Biotechnology: Engineering of herbicide tolerance in plants (Case study: Glyphosate & Phosphinothricin tolerance), Environmental impact of herbicide tolerant crops: The development of super weeds. Development of insect resistant plants (Case study: Resistance of Bt Cotton). Biopesticides & Biofertilizers. Genetic engineering to improve plant disease resistance: PR proteins and antimicrobial proteins. Biotechnological strategies for engineering stress tolerance: Nature of abiotic stresses (Case studies: Glycine betaine production for water deficit stress, Na^+/H^+ antiporter for improving salt tolerance).

Learning Outcomes:

- At the end of the unit the student should learn the applications of Plant Biotechnology in generating tolerance/resistance to herbicides, pests, plant diseases and abiotic stesses.
- Should understand experimental procedure followed in Engineering tolerance/resistance to biotic and abiotic stresses.

UNIT-IV

Genetic modifications for reducing the effects of viral diseases: Antisense RNA, ribozymes and Post transcriptional gene silencing approaches. Genetic modifications for improving crop yield and quality: (Case studies: Manipulation of fruit ripening, Golden rice, Oil quality improvement). Chloroplast transformation – advantages in tobacco and potato. Molecular pharming. Edible vaccines and plantibodies.

Learning Outcome:

- At the end of the unit the student should plants are being used as a medium for productionof Pharmaceutically important compounds.

UNIT-V

Plant tissue culture technology: Plasticity and totipotency, The culture environment, Plant cell culture media, Plant growth regulators. Culture types: Callus, Cell suspension cultures, Protoplasts, root cultures, shoot tip and meristem culture, embryo culture, microspore

culture. Factors governing in vitro behaviour. Plant regeneration: Somatic embryogenesis, organogenesis and plant regeneration. Micro propagation. Somatic hybridization.

Learning Outcomes:

- At the end of the unit the students should be able to know the composition of different media used in tissue culture and importance of the components.
- Should understand invitro manipulation of tissues.

Course Outcomes: upon successful completion of this course, participants will be able to

- Understand how techniques of biotechnology are helping in unravelling the knowledge of complex plant processes.
- Analyze and understand the advantages of Molecular markers and QTLs provide over traditional breeding technologies.
- Explain how biotechnology is used for crop plant improvement with regards to Herbicide. tolerance, tolerance to pests and pathogens, yield improvement, stress tolerance and the ethical implications of that use.
- Familiarize with the processes involved in the planning, conduct and execution of plant biotechnology experiments.
- Cooperate and work effectively as a member of a team to solve complex problems.

BOOKS RECOMMENDED:

1. Plant Biotechnology by A. Slater, N.W.Scott and M.R. Fowler (Oxford University Press)
2. Plant Biotechnology by Chawla M.S. (Oxford)

REFERENCE BOOKS:

1. Biotechnology in Agriculture by Swaminathan, M.S. (Mc. Millan India Ltd).
2. Biotechnology and its applications to Agriculture by Copping LG and P. Rodgers (British Crop Projection).
3. Plant Biotechnology by Kung, S. And C.J. Arntzen (Butterworths).

III SEMESTER
ELECTIVE I

303A: CELL CULTURE TECHNOLOGY AND TISSUE ENGINEERING

Course Objectives:

This course aims that the students

- To obtain deeper knowledge and understanding about the techniques of animal cell culture subject tissue engineering and tissue engineering.
- To obtain knowledge on fundamental concepts and different types of stem cells
- To learn about key technologies used in tissue engineering and transplantation
- To understand the concept of regenerative medicine and application of stem cells in regenerative medicine.
- To impart theoretical knowledge on various techniques of cell culture and tissue engineering and their applications

UNIT-I

Introduction to Animal cell culture: Background,Advantages, Limitations, Application; Culture environment, Cell adhesion, Cell proliferation, Differentiation; Essential equipments, Aseptic techniques, Sterile handling, Biohazards; Culture Media: Role of Physicochemical properties CO_2 and bicarbonates; Buffering; Oxygen; Osmolality; Temperature; Surface tension and foaming, Balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media.

Learning Outcomes:

- At the end of the unit the student should have the basic knowledge on Animal cell culture
- The student should understand physical requirements of of cell culture

UNIT-II

Primary Culture: Isolation of tissue, Steps involved in primary cell culture, Subculture and propagation, Cell lines, Nomenclature, Cell line designations, Routine maintenance, Immortalization of cell lines, Cell transformation. Cell cloning and Cell separation, Cell synchronization, Measurement of viability and cytotoxicity: MTT assays, Trypan Blue, PI, FDA assays, Survival Assays, Applications of cytotoxicity assays

Learning Outcomes:

- At the end of the unit the student should have the basic knowledge on Animal cell culture
- The student should understand different types cell cultures and culture methods

UNIT-III

Fundamentals of Stem cells: Stem cells, Totipotency, Pluripotency, Embryonic stem cells, Germinal stem cells, Adult stem cells, Tumor stem cells,Properties and Potency of embryonic and adult stem cells. Differences and similarities in adult and embryonic stem cells. Stem cell markers. Stem-cell plasticity and differentiation.Mechanisms of self renewal.

Learning Outcomes:

- At the end of the unit the student should have insights into the basics of stem cells and their properties
- The student should understand different types of stem cells

UNIT-III

Isolation and characterization of stem cells: Isolation of stem cells;Epigenetics in stem cells development. Genetic programming in stem cells. Cell cycle regulation in stem cells. Tissue derivation from different germ layers. Differentiation of stem cells. Significance of pluripotency. Induced pluripotency of stem cells, Markers and factors involved in induced pluripotency. Production of induced pluripotent stem cells, Applications and challenges in the production of IPSCs.

Learning Outcomes:

- At the end of the unit the student should have an insight on stem cell differentiation and renewal
- The student should understand the Isolation of embryonic stem cells
- The student should know the basics Pluripotent stem cell production

UNIT – IV

Tissue engineering:: Introduction, structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing, Scaffold and transplant ; Bone marrow Transplantation- Autologous and Allogenic Stem Cell Transplantation,HLA Typing.

Learning Outcomes:

- At the end of the unit the student will gain knowledge on structural and organization of tissue
- The student should have an insight stem cell transplantaion

UNIT – V

Stem cells in therapy: Stem Cells in gene therapy; Applications of stem cells in regenerative medicine-neurodegenerative diseases, stroke, diabetes, cancer and Anti-aging.Cryopreservation and maintenance of stem cells. Stem cell banking. Status of clinical trials in stem cell research. Challenges and promises of stem cell applications in medicine and research. Ethical and regulatory issues involving stem cell research.

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Learning Outcomes:

- At the end of the unit the student will gain knowledge on clinical applications of stem cell therapy
- The student should have an insight on ethical and regulatory issues in stem cell research

Course Outcomes:

- Students will be able to Explain the fundamental scientific principles that underlie cell culture.
- Exhibit appropriate safety procedures in the cell culture laboratory including personal protective equipment, aseptic technique.
- Acquire comprehensive knowledge about transplantation techchnologies and its application.
- Learn the pathophysiologic basis for acute and chronic graft versus host disease.
- Develop an understanding of significance of stem cells role in the neurogenerative field.
- Student should gain strong understanding of animal based cell cultures system. This should help them to take up plant and animal biological research as well as placement in relevant biotech industry.

BOOKS RECOMMENDED& REFERENCES:

1. R. Ian Freshney Culture of Animal Cells: A Manual of Basic Technique, (2000).
2. Marshak L, Stem Cell Biology, Cold Spring Harbor Publication, (2001).
3. Masters, J. R.W., Animal Cell Culture, Oxford (2000). 2. Ranga, M.M., Animal Biotechnology, Agrobios (2007).
4. Essentials of Stem Cell Biology by Robert Lanza and Anthony Atala, 3rd ed, Academic Press.
5. Stem Cells: Basics and Applications by Koushik k Deb, Satish M Totey Tata McGraw- Hill Education, 2009.
6. Stem Cells: From Mechanisms to Technologies edited by Michal K. Stachowiak, Emmanuel Tzanakaki, Publishers: World Scientific.
7. Principles of Tissue Engineering by Robert Lanza, Robert Langer, Joseph P. Vacanti, Elsevier Academic Press.
8. Stem Cell Anthology: From Stem Cell Biology, Tissue Engineering, Cloning by Bruce M Carlson.
9. Stem Cells: From Basic Research to Therapy, Volume 1 by Federico Calegari, Claudia Waskow, CRC Press

III SEMESTER
ELECTIVE I

303B: INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY AND BIOETHICS

Course Objectives

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development;
- To become familiar with India'sIPR Policy;
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products;
- To become familiar with ethical issues in biological research.

UNIT I

Introduction to IPR: Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

Learning Outcomes:

- The student will be introduced on the basics on Intellectual property
- To gain a considerable insights on international framework for IP protection

UNIT II

Patenting: Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application-forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames

Learning Outcomes:

- Students should be able to understand the basics of patent types.
- Learn about the Indian patent acts and its role in patenting
- Will have knowledge on the process of filing a patent application

UNIT III

Types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting- introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

Learning Outcomes:

- The student will understand the international patent procedures.
- The student will apply the patent knowledge in new discoveries.

UNIT IV

National and international regulations: International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

Learning Outcomes:

- The student should have a detailed knowledge on regulatory framework of patenting
- They will focus on patent regulation frame works in rDNA experiments

UNIT V

Bioethics: Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy

Learning Outcomes:

- To have an insight on the bio ethical conflicts in biological sciences.
- Will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications, DNA testing
- To focus on the various areas of research that require the concept of bioethics

Student Learning Outcomes

- Understand the rationale for and against IPR and especially patents
- Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations;
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents;
- Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations;
- Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

III SEMESTER

ELECTIVE I

303C: VACCINES

Course Objectives

- The objectives of this course are to make students learn about the structural features of the vaccines and their function.
- The major emphasis of this course will be on the development of the immune system and mechanisms by which our body elicit the immune response.
- To know the mechanism of immune response in our immune system.
- To understand the role of vaccination for pathogenic microorganisms
- To learn the production mechanism of vaccines to stop the diseases

UNIT I

Fundamentals of immune system: Overview of Immune system; Human Immune system: Effectors of immune system; Innate & Adaptive Immunity; Activation of the Innate Immunity; Adaptive Immunity; T and B cells in adaptive immunity; Immune response in infection; Correlates of protection.

Learning outcomes:

- To recall the fundamentals of the immune system
- To understand the types of immune systems in our body
- To summarize the lymphoid organs of the immunity

UNIT II

Immune response to infection: Protective immune response in bacterial; viral and parasitic infections; Primary and Secondary immune responses during infection; Antigen presentation and Role of Antigen presenting cells: Dendritic cells in immune response; Innate immune response; Humoral (antibody mediated) responses; Cell mediated responses: role of CD4+ and CD8+ T cells; Memory responses: Memory and effector T and B cells, Generation and Maintenance of memory T and B cells.

Learning outcomes:

- To classify the immune response types in our body
- To compare the humoral and cell mediated immune responses
- Tosummarize the immune response to infection

UNIT III

Immune response to vaccination: Vaccination and immune response; Adjuvants in Vaccination; Modulation of immune responses: Induction of Th1 and Th2 responses by using appropriate adjuvants and antigen delivery systems - Microbial adjuvants, Liposomal and Microparticles as delivery systems; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity.

Learning outcomes:

- To understand the vaccination and immune response
- To apply the immunization methods to develop immunity
- To implement the delivery systems of vaccination

UNIT IV

Vaccine types & design: **History of vaccines, Conventional vaccines; Bacterial vaccines; Viral Vaccines; Vaccines based on routes of administration: parenteral, oral, mucosal; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine.**

Learning outcomes:

- To understand the vaccines andvaccine developing methods
- To apply the immunization administration methods to develop immunity
- To classify the different vaccine types

UNIT V

Vaccine technologies: New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for targeted delivery (Vaccine Delivery systems); Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (Ebola, Zika).

Learning outcomes:

- To generate the new technologies for new vaccines
- To plan for the specific vaccines design
- To plan for the future vaccines for new diseases

Student Learning Outcomes

By the end of this course, students should be able to:

• Understand fundamental concepts of human immune system and basic immunology;

• Differentiate and understand immune responses in relation to infection and vaccination;

• Understand requirement and designing of different types of vaccines;

• Comprehend importance of conventional and new emerging vaccine technologies.

Recommended Textbooks and References:

1. Janeway, C. A., Travers, P., Walport, M., & Shlomchik, M. J. (2005). *Immuno Biology: the Immune System in Health and Disease*. USA: Garland Science Pub.

2. Kindt, T. J., Osborne, B. A., Goldsby, R. A., & Kuby, J. (2013). *Kuby Immunology*. New York: W.H. Freeman.

3. Kaufmann, S. H. (2004). *Novel Vaccination Strategies*. Weinheim: Wiley-VCH.

4. Journal Articles (relevant issues) from: Annual Review of Immunology, Annual Review of Microbiology, Current Opinion in Immunology, Nature Immunology, Expert review of vaccines.

III SEMESTER

ELECTIVE I

303D: MOLECULAR DIAGNOSTICS

Course Objectives:

- The objectives of this course are to build upon knowledge about recent advances in molecular biology and various facets of molecular medicine which has potential to profoundly alter many aspects of modern medicine including pre- or post-natal analysis of genetic diseases and identification of individuals predisposed to disease ranging from common cold to cancer.\
- The course shall make the students aware about Genome biology in health and disease.
- To known the chromosomal, structure & mutations, DNA polymorphism: human identity, clinical variability and genetically determined adverse reactions to drugs.
- To learn the Direct detection and identification of pathogenic-organisms, inherited diseases and Detection of recognized genetic aberrations in clinical samples from cancer patients

UNIT I

Genome biology in health and disease: DNA, RNA, Protein: An overview; chromosomal structure & mutations; DNA polymorphism: human identity; clinical variability and genetically determined adverse reactions to drugs.

Learning outcomes

- To understand the structure of DNA, RNA and protein.
- Learn about the chromosomal structure and mutations and DNA polymorphism.
- Unfold the human identity, clinical variability and genetically determined adverse reactions to drugs.

UNIT II

Genome: resolution, detection & analysis: PCR: Real-time; ARMS; Multiplex; ISH; FISH; ISA; RFLP; DHPLC; DGGE; CSCE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization &analysis; molecular markers: 16S rRNA typing; Diagnostic proteomics: SELDI-TOF-MS; Bioinformatics data acquisition & analysis.

Learning outcomes:

- To comprehend about the resolution techniques of Genome analysis
- To have an in-depth knowledge on sequencing techniques
- Have an outline on the advanced techniques like SELDI-TOF-MS

UNIT III

Detection and identity of microbial diseases: Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of *in vitro* cultivation as well as genotypic markers of microbial resistance to specific antibiotics.

Learning outcomes:

- To understand how to detect and identification of microbial diseases.
- To identify pathogens based on genotypic markers

UNIT IV

Detection of inherited diseases: Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes.

Learning outcomes:

- How to Apply of molecular markers in medical care
- To acquire knowledge on current molecular diagnostics available for inherited diseases

UNIT V

Molecular oncology: **Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma; Quality oversight; regulations and approved testing.**

Learning outcomes:

- Apply the knowledge of NGS in cancer detection
- To gain insight on the biomarkers used for onco-therapy
- The basics of regulations and quality testing of molecular biomarkers

COURSE OUTCOMES:

- Gain fundamental knowledge in Genome biology;
- Comprehend the molecular basis of various pathological conditions from the perspective of biochemical reactions.
- Gain the insights on Genome resolution, detection & analysis.
- Understand the Direct detection and identification of pathogenic-organisms that are slow growing or currently lacking a system of *in vitro* cultivation.
- Apply the various facets of molecular procedures and basics of genomics, proteomics and metabolomics in early diagnosis and prognosis of human diseases.

Recommended Textbooks and References:

1. Campbell, A. M., & Heyer, L. J. (2006). *Discovering Genomics, Proteomics, and Bioinformatics.* San Francisco: Benjamin Cummings.

2. Brooker, R. J. (2009). *Genetics: Analysis & Principles*. New York, NY: McGraw-Hill.

3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, DC: ASM Press.

4. Coleman, W. B., & Tsongalis, G. J. (2010). *Molecular Diagnostics: for the Clinical Laboratorian*. Totowa, NJ: Humana Press

III SEMESTER

ELECTIVE II

304A: MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY

Course Objectives:

- to learn the types of enzyme and DNA probes& its importance in diagnosis
- to know the strategies for vaccine development and production methods of health care products through rDNA Technology
- to understand the importance of environment and its conservations
- to know the importance ofwaste management
- to know the importance of alternative resources to understand the process of bio hazards management

UNIT – I

Revolution in diagnosis - Use of Enzymes in the diagnosis and treatment of diseases;Enzyme probes - glucose oxidase, lactate oxidase, monoamine oxidase;Enzyme based Biosensors;Nucleic acid probes – Use of nucleic acid probes in disease diagnosis; PCR amplification and disease diagnosis - Applications in forensic medicine.

Learning Outcomes

- Gain basic knowledge on the various application of enzymes in the field of medicine
- Will obtain an insight on the use of nucleic acid probes in the field of medicine

UNIT – II

Changing approaches of therapy - Genetic diseases and gene therapy; Current strategies for development of vaccines against HIV, Malaria, Tuberculosis and Hepatitis B. Clinical trails – norms and ICMR guidelines for design and conducting clinical trails.Health care products from recombinant DNA Technology - insulin, growth hormone, factor VIII, tissue plasminogen activator, interferons, lymphokines;

Learning Outcomes

- Will be introduced to the concept of gene therapy
- Will get indepth information on the current trends of vaccine development
- Will learn the application of rDNA products in the field of medicine

UNIT – III

Environmental pollution - types, sources and control of aerial and aquatic pollution. Environmental monitoring and biomonitoring. Bioremediation - solid and liquid waste treatment,Microbiology of waste water treatment,Industrial effluents and their management, oil spills, chemical herbicides;Bioleaching.

Learning Outcomes

- Will gain a comprehensive knowledge on different types of pollution and their remedial measures
- Will get an insight on the remedial measures of the environmental pollutants
- Will get a basic idea on bioleaching process

UNIT IV

Feacal Sludge and Septage Management (FSSM): Introduction, Government Initiatives, characteristics of feacal sludge, sampling and laboratory methods for waste characterization, health implication of unsafe practices, FSSM Value Chain and treatment options of feacal sludge for safe disposal, natural biological methods of waste treatment, reuse and recycling options of water and bio solids, safety, health and environmental protection measures.

Learning Outcomes

- Apprehend the process of FSSM
- Will gain an insight into the various methods of treatment for FSSM
- Will grasp the various resuse and recycling options of treated waste waters

UNIT-V

Environment and energy: Biomass, waste materials, energy crops, cellulose; Renewable sources of energy - Biogas, Biodiesel, Bioethanol, Biobutanolenergy and fuel using microorganisms. Global environmental problems: Ozone depletion, Green house effect, Climate Change. Biodiversity-benefit to mankind-conservation; Sustainable development; Environment Impact Assessment. Biosafety and environmental issues.

Learning Outcomes

- Will be aware of the various biofuels and their production methods
- Will apprehend the global environmental problems and their impact
- Will get an insight on the biosafety regulations of GMOs

Course Outcomes:

- Comprehensive information and insights in medical biotechnology and the development of biopharmaceuticals in pharmaceutical industry
- Address environmental issues including pollution, mineral resource, renewable energy
- Will have a specific focus on bioremediation and treatment of polluted effluent.
- Will also provide conceptual knowledge and significance of genetically modified microbes.
- Obtain knowledge on basic principles and technologies of decontamination of mainly by means of the biological approaches i.e. using bioremediation etc.
- Acquire the knowledge of biofuel production technologies, and their applications.

BOOKS RECOMMENDED:

1. Biotechnology by B.D.Singh (Kalyani).
2. Ecology and Environment by PD Sharma.
3. Environmental Biotechnology by Forster, C.F. and Wase D.A.J. (Ellis Horwood).
4. Biotechnology by U.Satyanarayana (Books & Allied (p) Ltd.

REFERENCE BOOKS:

1. Biotechnological innovations in environmental management by Leach, CK and Van Dam-Mieras, MCE (Butterworth-Herinemann, Oxford (Biotol Series).
2. Fundamentals of Ecology, by Odum, EP (Mc Graw Hill)
3. Molecular Biology and Biotechnology by Meyers, RA, A Comprehensive Desk Reference (VCH Publishers).

ELECTIVE II

304B:CRITICAL ANALYSIS OF CLASSICAL PAPERS

Course Objectives

The objectives of this course are to familiarize students with classic literature to make them appreciate how ground-breaking discoveries were made without, necessarily, use of high-end technologies.

How does the Course Module work? Students may be divided in groups and each group may be responsible for one classical paper. Each week there may be a 1.5 hour presentation cum discussion for each of the papers. At the end of the semester each student will be asked to write a mini-review (4-5 pages long) on any one classical paper, other than the one he/she presented/discussed.

(Student Evaluation: Mini-review – 30 Marks; Presentation – 25 Marks; Continuous Evaluation – 20 Marks; Assignments – 25 Marks)

UNIT I

Molecular Biology I:

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a deoxyribonucleic acid fraction isolated from *Pneumococcus* type III. Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1; 79(2):137-58.

2. Independent functions of viral protein and nucleic acid in growth of bacteriophage. Hershey AD and Chase M.; J Gen Physiol. 1952 May; 36(1):39-56.

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Learning outcomes:

- First paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.
- Second paper demonstrates that DNA, and not protein, component of phages enter bacterial cells

UNIT II

Molecular Biology II:

1. Studies on the chemical nature of the substance inducing transformation of Pneumococcal types: Induction of transformation by a deoxyribonucleic acid fraction isolated from *Pneumococcus* type III.
Avery OT, Macleod CM, McCarty M.; J Exp Med. 1944 Feb 1; 79(2):137-58.

2. Molecular structure of nucleic acids; a structure for deoxyribose nucleic acid Watson JD and Crick FH; Nature. 1953 Apr 25; 171(4356):737-8

Note:

Study help - Watson_Crick_Nature_1953_annotated

Learning outcomes:

- This paper demonstrates that DNA is the transforming Principle originally described by Fredrick Griffith.
- In this one page paper Watson and Crick first described the structure of DNA double helix

UNIT III

Cell Biology I

1. A protein-conducting channel in the endoplasmic reticulum Simon SM AND Blobel G.; Cell. 1991 May 3; 65(3):371-80

2. Identification of 23 complementation groups required for post-translational events in the yeast secretory pathway
Novick P, Field C, Schekman R.; Cell. 1980 Aug; 21(1):205-15

3. A yeast mutant defective at an early stage in import of secretory protein precursors into the endoplasmic reticulum Deshaies RJ and Schekman R.; J Cell Biol. 1987 Aug;105(2):633-45

Learning Outcomes:

- First paper demonstrates the existence of a protein conducting channel Study help - A brief history of Signal Hypothesis
- In the secondgroundbreaking paper Randy Schekman's group used a mutagenesis screen for fast sedimenting yeast mutants to identify genes involved in cell secretion
- In the third paper using another yeast mutation screen Schekman lab identifies Sec61, a component of ER protein Conducting Channel (PCC) Suggested reference paper - A biochemical assay for identification of PCC.

UNIT IV

Cell Biology II

1. Reconstitution of the Transport of Protein between Successive Compartments of the Golgi Balch WE, Dunphy WG, Braell WA, Rothman JE.; Cell. 1984 Dec; 39(2 Pt 1):405-16

2. A complete immunoglobulin gene is created by somatic recombination Brack C, Hirama M, Lenhard-Schuller R, Tonegawa S.; Cell. 1978 Sep; 15(1):1-14

3.Kinesin walks hand-over-hand Yildiz A, Tomishige M, Vale RD, Selvin PR.; Science. 2004 Jan 30; 303(5658):676-8

Learning Outcomes:

- First paper describes setting up of an *in vitro* reconstituted system for transport between golgi stacks which eventually paved the way for identification of most of the molecular players involved in these steps including NSF, SNAP *etc.*
- Second study demonstrates DNA level molecular details of somatic rearrangement of immunoglobulin gene sequences leading to the generation of functionally competent antibody generating gene following recombination.
- Third paper shows that kinesin motor works as a two-headed dimeric motor walking hand-over-hand rather than like an inchworm on microtubule tract using the energy of ATP hydrolysis.

UNIT V

Developmental Biology/ Genetics:

1. Mutations affecting segment number and polarity in *Drosophila* Christiane Nusslein-Volhard and Eric Weischaus; Nature 287, 795-801, 1980

2. Information for the dorsal--ventral pattern of the *Drosophila* embryo is stored as maternal mRNA. Anderson KV and Nüsslein-Volhard C; Nature. 1984 Sep 20-26; 311(5983):223-7

Learning outcomes:

- This single mutagenesis screen identified majority of the developmentally important genes not only in flies but in other metazoans as well.
- The second landmark paper demonstrated that early dorsal-ventral pattern information is stored as maternal mRNA in flies and devised the method of identifying genes encoding such genes

Course Outcomes

Students should be able to train in the exercise of hypothesis building and methods of addressing the hypothesis with readily available technology.

ELECTIVE II

304C: NANO-BIOTECHNOLOGY

Course Objectives

- To provide a general and broad introduction to multi-disciplinary field of nanotechnology
- To familiarize students with the top-down approach of microelectronics and micromechanics
- To familiarize students with the bottom-up approach of chemistry/biochemistry; a development that is creating new and exciting cross-disciplinary research fields and technologies.
- To throw light on the nano-toxicity and safety precautions
- To give an insight into complete systems where nanotechnology can be used to improve our everyday life.

Unit I

Introduction to nanobiotechnology: Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

Learning Outcomes

- Gain basic knowledge on nanobiotechnology
- Will obtain an insight on the different formats of nanomaterials
- Will be introduced to the concept of synthesis of nanomaterials

Unit II

Nano – films: Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterisation.
Nano – materials: Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in sythesis, applications of nanobiocatalysis in the production of drugs and drug intermediates.

Learning Outcomes

- Will be introduced to the concept of nano-films
- Will gain basic information on nano-materials
- Will learn the application of nanobiocatalysts in drug development

Unit III

Nano – particles: Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

Learning Outcomes

- Will gain a comprehensive knowledge on nanoparticles
- Will get an insight on various strategies for effective use of nanoparticles

Unit IV

Nano – toxicity: Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment.

Learning Outcomes

- Will gain an insight into the various methods of assay of nanotoxicity
- Will be aware on the effect of nanomaterials on environment
- Will have an insight on the various options for containment of nanotoxicity

Unit V

Applications of nano – particles: Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.

Learning Outcomes

- Will learn the applications of nanoparticles in diagnostics
- Will have an insight on nanoparticles in cancer therapy
- Will be introduced to the concept of nanodevices

Course Outcomes

- Will describe basic science behind the properties of materials at nanometre scale,
- Comprehensive information and insights on nanobiotechnology and the synthesis of nanomaterials
- Acquire the knowledge of nano-films, nano-materials and nano-particles
- Address toxicity issues including assessment and containment
- Will also provide conceptual knowledge and significance of nano-particles in the diagnostics

Recommended Textbooks and References:

1. GeroDecher, Joseph B. Schlenoff, (2003); *Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials*, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); *Bionanotechnology: Lessons from Nature*; Wiley-Liss
3. Neelina H. Malsch (2005), *Biomedical Nanotechnology*, CRC Press
4. Greg T. Hermanson, (2013); *Bioconjugate Techniques*, (3rd Edition); Elsevier
5. Recent review papers in the area of Nanomedicine.

ELECTIVE II

304D:BIOENTREPRENEURSHIP

Course Objectives

- To study the process of entrepreneurship and types of bio entrepreneurship
- To understand the private and public agencies for developmental programmes
- To apply the methods and principles for a bio entrepreneurship
- To make judgment of ideas of bio entrepreneurship
- To apply the make in India, BIRAC, DBT like programmes in the field of bio entrepreneurship.

UNIT I

Innovation and entrepreneurship in bio-business: Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech).

Learning outcomes:

- To understand the bio entrepreneurship and bio business.
- To classify the types of bio industries and their role
- To compare the different industries in biosector

UNIT II

Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

Learning outcomes:

- To apply abstractions, general principles, or methods to specific concrete situations.
- To analyze the implications of business in bio sectors
- To give the examples of public and private agencies to develop

UNIT III

Bio markets - business strategy and marketing: Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

Learning outcomes:

- To understand the business strategy and marketing methods
- To apply the basic contract principles, different types of agreement and contract terms
- To explore the dispute resolution skills

UNIT IV

Finance and accounting: Business plan preparation including statutory and legal requirements, Business feasibility study, and financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

Learning outcomes:

- To apply the legal requirements for a business
- To analyze the business feasibilityand financial management issues immunization
- To implement the collaborations and partnerships.

UNIT V

Technology management: Technology – assessment, development & up gradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Learning outcomes:

- To understand the technology assessment and development
- To comparing the foreign technologies with local technologies
- To understand the regulatory compliances and procedures

Course Outcomes

- Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation,
- Identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies.
- The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.

Recommended Textbooks and References:

1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences.* Bloxham: Scion.

2. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.

3.Onetti, A., & Zucchella, A. *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge*. Routledge.

4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences*. London: CRC Press.

5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management.* New Delhi: Himalaya Pub. House.

III SEMESTER

305: MENTAL ABILITY, REASONING AND QUANTITATIVE APTITUDE

UNIT-I

Learning Objectives:
To enable the student to solve problems based on reasoning ability including Mathematical and Logical Reasoning.

Reasoning Ability:
Alphabet Test, Classification Test, Analogy Test, Coding and De-coding Test and Number and Alphabetical test

Learning Outcomes:
1. The student will be able to make answers in analogy test, classification test and Alphabet test.
2. The Student will be able to give correct solutions in coding and De-coding test.
3 The student will be able to attempt any competitive test with confidence and get through the said test.

UNIT-II

Relations and Series:

Learning Objectives: To understand blood relations, number related and missing number appeared in all sorts of competencies.
Blood Relations, Number related test, Chart type test, missing number, Series completion test, Diagram test, different positions of dice, figure analogy test and Data interpretation test.

Learning Out comes:
1 The students will able to choose answers regarding blood relations, number related and missing number appeared in all sorts of competencies.
2 The students will be able to find answers regarding Series completion test, Diagram test, different positions of dice, figure analogy test and Data interpretation test.

UNIT-III

Logical reasoning

Learning Objectives: To enable the student to perform different competencies incorporated with mathematical and logical reasoning.

Cloze test, clerical aptitude test, clock problem, calendar

Learning Out comes:
1 The students will able to perform Cloze test and clerical aptitude test.
2 The students will able to analyze all sorts of clock problem and calendar

UNIT-IV

Learning objective:

1 To enable the student mentally for achieving all kind of competencies.
Mental ability
Verbal and non-verbal reasoning, bodmas rules, binary operation system, time and distance problems work done problems, stream problem: down word and up word problem.

Learning Out comes:
1 The students will able to understand verbal and non verbal reasoning
2 The students will able to calculate numeric problems
3 The students will able to choose find correct answers in all competitive exams .

UNIT-V

Learning objective:
1 To enable the students to inculcate quantitative aptitude to prepare themselves competitive exams.
2 to understand and use simple arithmetic calculations
Lea

Quantitative aptitude

Number system, simplification, percentage, profit and losses, time and work, time and distance, and average

Learning outcomes:

1 The students acquire knowledge and practice on number system, simplification and percentage.
2 The students understand about the mathematical concepts imbibed in profit and losses, time and distance, work and time and average and apply the same knowledge in real time situations. *MLED*

III SEMESTER

306: LAB - V: PLANT TISSUE CULTURE TECHNIQUES

Course Objectives:

- To understand basic and advanced Plant Biotechnology techniques & concepts.
- Learn how to understand and present Plant molecular biology data and concepts to an audience.
- Understand current experimentation and research in the field of Plant Biotechnology.

Experiments

1. **Preparation of media for plant tissue culture (MS and B5).**
2. **Establishment of callus cultures from carrot cambial tissue.**
3. **Establishment of cell cultures and plating.**
4. **Embryo culture of maize/ crotalaria.**
5. **Organogenesis and regeneration of plants from tobacco explants.**
6. **Anther culture and production of haploids.**
7. **Micropropagation using suitable system: Potato/solanum's**
8. **Enzymatic isolation of protoplast and culture.**
9. **Polyethylene glycol (PEG) mediated fusion of protoplasts.**
10. **Agrobacterium culture and transformation.**
11. **Reporter gene assay (GUS).**

Learning Outcomes: upon successful completion of this course, participants will be able to

- Familiarize with the processes involved in the planning, conduct and execution of plant biotechnology experiments
- Do simple Plant Biotechnology experiments based on the knowledge gained in Molecular biology and Plant biotechnology practical experiments

- Analyze and understand the research papers in the field of Molecular markers and QTLs and appreciate the advantages of these techniques provide over traditional breeding techniques.
- Familiarize with advance techniques in the field of Plant Biotechnology
- Interpret the outcome of experiments that involve the use of recombinant DNA technology and other common gene analysis techniques.
- Present Plant Biotechnology experimental and Research date to a scientific audience
- Cooperate and work effectively as a member of a team to solve complex problems

BOOKS RECOMMENDED:

1. Plant cell culture – A practical approach by Dixion RA.
2. Plant tissue culture – theory and practice by Bhojwani, S.S.
3. Biotechnology: A laboratory Course by Becker, J.M.

III SEMESTER

307 LAB-VI: ANIMAL CELL CULTURE AND ENVIRONMENTAL BIOTECHNOLOGY

Course Objectives:

- Learn to grow animal cells in favourable environment
- To obtain a working knowledge of the principles, techniques and current applications of biotechnology to environmental quality evaluation, monitoring
- Focuses on the utilization of microbial processes in water treatment, and bioremediation.

1. **Preparation of animal cell culture media and membrane filtration.**
2. **Preparation of single cell suspension from spleen and thymus.**
3. **MTT assay for cell viability and growth.**
4. **Demonstration of sections of human ovary, testis and aborted human embryos.**
5. **Estimation of dissolved oxygen and salinity in water samples.**
6. **Estimation of Chemical Oxygen Demand (COD).**
7. **Estimation of Biochemical Oxygen Demand (BOD).**
8. **Determination of suspended solids in industrial effluents.**
9. **Removal of color of the industrial effluents by biological methods.**
10. **Reduction of pollution load in effluents by biological methods (laboratory models).**

Learning Outcomes:

- Learn the basics of handling animal cells
- Gain knowledge on utilization of microbial processes in water and waste water treatment
- Evaluate the potential for biodegradation of organic pollutants, taking microbial and physical/chemical environments,

BOOKS RECOMMENDED:

1. Animal cell culture – A practical approach Ed. By John R.W. Masters (IRL Press).
2. Animal cell culture techniques, Ed. Martin clyenes (Springer).
3. Comprehensive Biotechnology. Vol. 4. M.Moo-Young (Ed-in-chief), Pergamon Press, Oxford.
4. Environmental Chemistry. A.K.De, Wiley Eastern Ltd, New Delhi.
5. Introduction to Biodeterioration, D.Allsopp and K.J.Seal, ELBS/Edward Arnold.

IV SEMESTER

401: HETEROLOGOUS EXPRESSION AND DOWN STREAM PROCESSING

Course Objectives:

- To learn the production of recombinant proteins
- To learn the process of fermentation
- To know the applications of Enzymes in various industries
- To learn the process of immobilization of Enzymes

UNIT-I

Basic principles of biochemical engineering - Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.

Learning Outcomes

- Appreciate relevance of microorganisms from industrial context.
- Carry out calculations and specify models of their growth.
- Explain the strain improvement for increased yield of design and operations of various fermenters.

UNIT-II

Bioreactor design and analysis– fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess. Batch fermentation, fed-batch fermentation and continuous fermentation. Fermentation v/s biotransformation.

Learning Outcomes

- Give an account of design and operations of various fermenters.
- Use basic methods in productiontechnique for bio-based products.
- Present unit operations together with the fundamental principles for basic methods.

UNIT-III

Downstream processing and product recovery - Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.

Learning Outcomes

- Discriminate among the types of enzymes purification methods.
- Summarize downstream processing methods for product recovery.
- Identify the steps in separation of soluble products.

UNIT-IV

Processing technology: Microbial metabolites - Organic solvents (Alcohol, Acetone, Butanol), Organic acids (Citric acid, lactic acid), Beverages-distilled and non-distilled beverages. Antibiotics (penicillin, streptomycin, tetracycline, semi synthetic penicillins), Vitamins (Vitamin B_{12} and Riboflavin), Amino acids (lysine, glutamic acid).

Learning Outcomes

- Discuss the important microbial metabolites and its role in human welfare.
- Summarize the metabolite production for secondary metabolites.
- Appreciate the role of microbes and bioreactors.

UNIT-V

Enzyme technology: Sources production, isolation and purification of enzymes for the industrial use. Application of enzymes in pharmaceutical, food processing and other industries. Different techniques of immobilization of enzymes, applications and kinetics of immobilized enzymes. Design and operation of immobilized enzyme systems and bioreactors. Whole cell immobilization. Biosensors - principle and types.

Learning Outcomes

- Utilize scientific methods to enzyme immobilization.

- Able to explain the use of enzymes industrially.
- Develop an understanding the basic theory biosensors.

Course Outcomes:

- Demonstrate the methods of cell culture under various conditions, strain improvement methods
- Design and develop medium for cell cultivation for fermentation process
- Understand needs of various parts of fermenter and their operation
- Will provide fundamental insights to exploit enzymes and microbes for the manufacturing of products which have a huge industrial significance.
- Students will be able to explain the steps involved in the production of bioproducts
- Develop an understanding the basic theory biosensors

BOOKS RECOMMENDED:

1. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
2. Industrial Microbiology by Presscot and Dunn.

REFERENCE BOOKS:

1. Biotechnology – Volumes 1 to 5 by Rehem.
2. Industrial Microbiology by LE Casida Jr.

IV SEMESTER

402: BIOINFORMATICS AND BIOSTATISTICS

Course Objectives:

- To learn the fundamentals of computer languages and programming
- To learn the fundamentals of bio informatics
- To learn the CADD in dry discovery
- To present facts in definite form and simplify the mass of figures
- To facilitate comparison of data
- To help in formulating and testing hypothesis
- To analyze public health problems and to further Bio-medical research

UNIT-I

Bioinformatics basics: Computers in biology and medicine; Database - Protein and nucleic acid and Structural databases; Search tools: Identification of protein sequence from DNA sequence; searching of databases for similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools.

Learning Outcomes:

- Describe the contents and properties of the bioinformatics databases.
- Explain the biological databases and its role in bioinformatics
- Able to explain genomics and proteomics

UNIT-II

DNA sequence analysis: sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; Multiple sequence analysis; multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; methods of phylogenetic analysis. Genome annotation – Tools. Physicalmap of genomes.

Learning Outcomes

- Explain the pairwise and multiple sequence alignment
- Describe the Genome annotation and tools
- Able to construct physical map of genomes

UNIT-III

Protein structure prediction: Protein secondary structure prediction and 3D structure prediction. Protein docking.Homology modeling, Computer Aided Drug Design (CADD) in drug discovery. Virtual library: Searching PubMed, current content, science citation index and current awareness services, electronic journals, grants and funding information.

Learning Outcomes

- The students will predict the protein structure and properties
- Understand the protein docking
- Able to create a drug using the online tool
- Develop an understanding of the basic theory of the CADD

UNIT-IV

Bio-Statistics: Brief description and Tabulation of data and its Graphical representation, Measures of Central tendency and Dispersion - Mean, Median, Mode, Range, Standard Deviation, Variance, Coefficient of Variation -Applications- Properties of a good Average and Dispersion; Simple correlation and Regression - Meaning and types - Applications of Simple Correlation and Regression.

Learning Outcomes

- Acquire the knowledge and understanding of the fundamentals of biostatistics
- Describe the contents and properties of measures of central tendency
- Explain the pairwise and multiple sequence alignment
- Critically analyze and interpret the results of correlation and regression.

UNIT-V

Sampling: Random Sampling (Simple, stratified, systematic, cluster and Multistage Sampling) - Non- Random Sampling (Judgment, Quota, Convenience and Deliberate Sampling); Formulation of Statistical Hypothesis - Null and Alternative - Errors: Type - I and Type - II - Tests of Significance: F, t, and Chi – Squaretests – ANOVA

Learning Outcomes

- Develop an understanding of the sampling and types
- Appreciate their relevance for investigating specific contemporary biological questions.
- Critically analyze and interpret the results of their study.

Course Outcomes:

- Describe the contents and properties of the bioinformatics databases.
- Explain the biological databases and its role in bioinformatics
- Able to explain genomics and proteomics
- Explain the pairwise and multiple sequence alignment
- Describe the Genome annotation and tools
- Explain the pairwise and multiple sequence alignment
- Able to construct physical map of genomes
- The students will predict the protein structure and properties
- Understand the protein docking
- Able to create a drug using the online tool
- Develop an understanding of the basic theory of the CADD
- Acquire the knowledge and understanding of the fundamentals of biostatistics
- Describe the contents and properties of measures of central tendency
- Explain the pairwise and multiple sequence alignment
- Critically analyze and interpret the results of correlation and regression.
- Develop an understanding of the sampling and types
- Appreciate their relevance for investigating specific contemporary biological questions.
- Critically analyze and interpret the results of their study.

BOOKS RECOMMENDED:

1. Bioinformatics – B.Mount.
2. BASIC Programming by Balaguru Swamy.
3. Introduction to Bioinformatics by Arthur M.Lesk, Oxford.
4. Biostatistics – Daniel. (Willey).
5. Statistics by S.C.Gupta.
6. Statistical Methods by G.W.Snedecor & W.G.Cochran.
7. Fundamentals of Biostatistics – Khan & Khanum.
8. Fundamentals of Biostatistics by V.B.Rastogi (Ane Books in India)

IV SEMESTER

403: SOFT SKILLS FOR EMPLOYABILITY ENHANCEMENT

Course Objectives: To help the students

- Realize their personal and professional resourcefulness so as to augment the same to lead a successful life.
- Work in teams to become good at people skills, persuasion through effective communication and inter-personal skills.
- Understand confidence building strategies and thereby to make effective presentations.
- Learn to build resume on their own thereby prepare to face mock-interviews and job interviews successfully.
- Imbibe an impressive personality, etiquette, professional ethics & values, effective time management & goal setting.
- Understand the elements of professional update & upgrade through industry exposure in a mini-live project.

Course Outcomes: By the end of the course students will be able to

- Win in professional communication situations and participate in such presentations with confidence.
- Appreciate learning by themselves to improve thinking and effective time management skills through soft skills.
- Be assertive and change to adapt to corporate culture by being sensitive - personally and sensible - professionally.
- Make the transition smoothly from campus to corporate. Also use YouTube for understanding from virtual world.
- To analyse good professional exposure through the mini-live project,
- By collecting and Synthesis data and making oral and written presentations on the same.

Unit-I

Introduction of Soft Skills: Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development, Beliefs, Moral Values, Attitude, Virtue.

Unit-II

Well thinking and Effective Time Management: Attendance, Discipline, Punctuality, Act in time on commitment setting realistic goals, selfconfidence and assertiveness, stress management, moral values, Thinking skills - positive attitude, improving perceptions and Driving out Negativity.

Unit-III

Self-discovery skills: Self-Evaluation, Self-Discipline, Self-Criticism, Recognition of one's own limits and deficiencies, Independency etc. Thoughtful & Responsible, Self-Awareness, adaptability, grooming and etiquette, communication media, etiquette, academic ethics and integrity, empathy and sympathy.

Unit-IV

Coordinating skills: Team-building skills, Problem Solving Skills, Conflict Management Skills, Persuasion skills, Negotiation Skills, Analytical Skills, Feedback Skills, Counseling Skills, Mentoring and adjust to the Environment.

Unit- V

Interpersonal skills:

1. Leadership and Assertiveness Skills: A Good Leader; Leaders and Managers; Leadership Theories; Types of Leaders; Leadership Behaviors; Assertiveness Skills.

2. Emotional Intelligence: Meaning, History, Features, Components, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence

Suggested Reading:

1. Madhavi Apte , "A Course in English communication", Prentice-Hall of India, 2007
2. Leena Sen , "Communication Skills", Prentice-Hall of India, 2005
3. Dr. Shalini Verma, "Body Language- Your Success Mantra", S Chand, 2006
4. Edgar Thorpe and Showick Thorpe , "Objective English", 2nd edition, Pearson Education, 2007
5. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010 6. Gulati and Sarvesh, " Corporate Soft Skills", New Delhi: Rupa and Co. , 2006

6. Van Emden, Joan, and Lucinda Becker, “Presentation Skills for Students”, New York: Palgrave Macmillan, 2004,
7. Covey and Stephen R, “The Habits of Highly Effective People”, New York: Free Press, 1989
8. .McAdams, D. P. The Person: A New Introduction to Personality Psychology (4th edition). John Wiley and Sons,2006.
9. Klinger. E., & Cox, W. M. _Motivation and the Theory of Current Concerns in Handbook of Motivation Counseling. Ed.,E. Klinger& W. M. Cox.
10. Markus.H.,&Kitayama.S._CultureandSelf:ImplicationsforCognition,Emotion, and Motivation‘ in Psychological Review, 1998 (pp.224-253)
11. McCullough, M. E., Emmons. R. A & Tsang. ‘The Grateful Disposition:A conceptual and Empirical Topography‘ in Journal of Personality and Social Psychology, 1992 (pp.112-127).
12. Nitin Bhatnagar and Mamta Bhatnagar. Effective Communication and Soft Skills: Strategies for Success. Pearson Pub.2012.

IV SEMESTER

404: LAB:VII : INDUSTRIAL BIOTECHNOLOGY AND BIOINFORMATICS

Course Objectives:

- The objectives of this laboratory course are to provide in practicum training to students in upstream and downstream unit operations.
- Skills and knowledge gained will be useful in solving problems typical of bio industries and research.

1. **Production of protease/amylase by batch fermentation.**
2. **Immobilization of an enzyme (invertase/lipase/amylase) by gel entrapment.**
3. **Immobilization of whole cells for enzyme/antibiotic production by gel entrapment.**
4. **Screening of soil samples for isolation of bacteria, fungi and actinomycetes.**
5. **Selective isolation of actinomycetes from soil samples.**
6. **Microbiological assay of an antibiotic including the construction of standard curve.**
7. **UV survival curve.**
8. **Production of alcohol by S.cerevisiae and its estimation.**
9. **Production of streptomycin by fermentation.**
10. **Production of citric acid by A.niger.**
11. **Production of red wine from grapes.**
12. **Production of Glutamic acid by M. glutamicus.**

Course Learning Outcomes:

Students should be able to

- Gain ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve bioprocess problems.
- To give the student a basic knowledge aboutmicrobiological assay of an antibiotic
- Will understand the theoretical and practical aspects of immobilized enzyme systems and bioreactors

- Will provide the importance and utility of industrial enzymes towards research.

BOOKS RECOMMENDED:

1. A manual of Industrial Microbiology and Biotechnology by Demain A.L.
2. Immobilization of enzymes and cells: Methods in Biotechnology vol.1 by Bickerstaff G.F.

REFERENCE BOOKS:

1. Principle of fermentation technology by Stanbury.
2. Biotechnology: A laboratory course by Becker J.M.

Dr.B.R.Ambedkar University, Srikakulam, Etcherla – 532410, A.P.

QUESTION PAPER FORMAT FOR PG EXAMINATIONS (ARTS, COMMERCES, LAW, EDUCATION & SCIENCE PROGRAMMES)

DEGREE : PG BRANCH: Biotechnology
PROGRAMME : MSc SEMESTER :
SUBJECT Code and Name :
(Codes/Tables/Charts to be permitted, if any may be indicated _____)

To be downloaded from www.brau.edu.in Examinations folder

Time: 3 Hours **Answer All Questions** **Max. Marks 75**

PART – A (10 x 2 = 20 Marks) - Scope should be Maximum Five lines

Note to question paper setter * Five questions should be of lower order (LO) cognitive type i.e. remembrance type questions. * Five questions should be of intermediate order (IO) cognitive type i.e. understanding type questions.		Std. of questions (please tick)
1	UNIT 1	LO / IO
2	UNIT 1	LO / IO
3	UNIT 2	LO / IO
4	UNIT 2	LO / IO
5	UNIT 3	LO / IO
6	UNIT 3	LO / IO
7	UNIT 4	LO / IO
8	UNIT 4	LO / IO
9	UNIT 5	LO / IO
10	UNIT 5	LO / IO

PART – B (5 x 8 = 40 Marks) - Scope should be Maximum Two to Three Pages for each part
For each parts of (a) & (b), Marks distribution allotted as follows:- (3&5), (4&4), (5&3)

Note to question paper setter * Two or Three questions (both subdivisions) should be of lower order (LO) cognitive type i.e. remembrance type questions. * Two or Three questions (both subdivisions) should be of intermediate order (IO) cognitive type i.e. understanding type questions.			Std. of questions (please tick)
11	a	UNIT 1	LO / IO
	b	UNIT 1	LO / IO
(OR)			
12	a	UNIT 1	LO / IO
	b	UNIT 1	LO / IO
13	a	UNIT 2	LO / IO
	b	UNIT 2	LO / IO
(OR)			
14	a	UNIT 2	LO / IO
	b	UNIT 2	LO / IO
15	a	UNIT 3	LO / IO
	b	UNIT 3	LO / IO
(OR)			
16	a	UNIT 3	LO / IO
	b	UNIT 3	LO / IO
17	a	UNIT 4	LO / IO
	b	UNIT 4	LO / IO
(OR)			
18	a	UNIT 4	LO / IO
	b	UNIT 4	LO / IO
19	a	UNIT 5	LO / IO
	b	UNIT 5	LO / IO
(OR)			
20	a	UNIT 5	LO / IO
	b	UNIT 5	LO / IO

PART – C (1 x 15 = 15 Marks) Scope should be Maximum Six Pages either of the single question (or) Two each parts (a)& (b) is allowed. For each Parts 21(a & b) & 22(a & b), Marks distribution allotted as follows :(5&10), (6&9),(8&7),(9&6), (10&5) (Application / Design / Analysis /Evaluation / Creativity / Essay / Case study questions)

Part C should be a higher order cognitive type questions			
21	a		HO
	b		HO
22	a		HO
	b		HO

Dean I/C (Confidential - Paper Setting)