DEPARTMENT OF BIOTECHNOLOGY

S.V.U. COLLEGE OF SCIENCES

SRI VENKATESWARA UNIVERSITY: TIRUPATI

RESTRUCTURED CURRICULUM

TO BE IMPLEMENTED WITH EFFECT FROM THE ACADEMIC

YEAR 2019-2020

SYLLABUS

Choice Based Credit System (CBCS)

SRI VENKATESWARA UNIVERSITY
SVU COLLEGE OF SCIENCES, TIRUPATI
DEPARTMENT OF BIOTECHNOLOGY
M.Sc. Biotechnology Programme CBCS pattern (with effect from 2019-20)

Vision:

The vision is to become a leader and centre of excellence in technology based training and innovative research in the fields of Plant, Agriculture, Animal and Medical Biotechnology.

Mission:

The Department's academic and research programmes will provide the students and research scholars value based, technology oriented education in a trusting and caring environment. The faculty strive to equip the students with technical expertise and knowledge to keep pace with the changes in technology and meet the new challenges in Life Sciences.

Programme Objectives

1. Students will gain necessary knowledge and develop specialized skills in the different areas of Biotechnology.
2. Students will think critically and creatively about the use of biotechnology to address local and global problems.
3. Students will be able to implement the scientific skills for development of industrial applications and entrepreneurship

Programme Outcomes, Programme Specific Outcomes and Course Outcomes

Programme Outcomes

Upon completion of the M.Sc. Biotechnology programme, the candidate should be able to:

No.	Programme Outcomes
PO1	Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies & Academia.
PO2	Develop an ability to solve, analyze and interpret data generated from experiments done in project work or practical courses in reaching conclusions.
PO3	Apply the knowledge based on research and other related methods to investigate the problem and provide valid conclusions
PO4	Design and develop methods to measure experimental data by following ethical principles
PO5	Demonstrate skills to use modern analytical tools/ software/ equipments to design & develop experiments and analyze and solve problems in various courses of biotechnology.

PO6	Appreciate and execute their professional roles in society as biotechnology professionals, employers and employees in various industries, regulators, researchers, educators and managers.
PO7	Augment and demonstrate the knowledge acquired to address environmental issues and evolve methods for sustainable development
PO8	Adopt code of ethics in professional and social context and demonstrate exemplary professional, ethical and legal behaviours in decision making.
PO9	Execute responsibilities efficiently in solving different issues as an individual/ member of team/ team leader
PO10	Apply written and oral communication skills to communicate effectively in healthcare, industry, academia and research
PO11	Acquire basic and advance skills in in various fields of biotechnology for self-employment and entrepreneurship
PO12	Develop skills, attitude and values required for self-directed, lifelong learning and professional development.

Programme Specific Outcomes (PSOs):

- Students will be able to demonstrate and apply their knowledge of cell biology, biochemistry,microbiology and molecular biology to solve the problems related to the field of biotechnology.
- Postgraduate students will be able to demonstrate and apply the principles of bioprocess engineering in the design, analysis, optimization and simulation of bioprocess operations.
- Students will be able to gain fundamental knowledge in animal and plant biotechnology and their applications.
- Students will be equipped to understand three fundamental aspects in biological phenomenon: a) what to seek; b)how to seek; c) why to seek?
- Student will be able to (a) Describe fundamental molecular principles of genetics; (b) Understand relationship between phenotype and genotype in human genetic traits; (c) Describe the basics of genetic mapping; (d) Understand how gene expression is regulated.
- Students will be able to (a) To elaborate concepts of biochemistry with easy to run experiments; (b) To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry.
- Students will be able to understand various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.
- Students will be able to gain hands on experience in gene cloning, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research

SRI VENKATESWARA UNIVERSITY

M.Sc programme in Biotechnology CBCS pattern (with effect from 2019-20)

SEMESTER-I								
S. No.	**Code**	**Components of Study**	**Title of the Paper**	**Instruction hours per week**	**Credits**	**Internal Assessment Marks**	**End Semester Exam Marks**	**Total Marks**
1.	**BTH 101**	**Core 1**	Structure and Functions of Biomolecules	6	4	20	80	100
2.	**BTH 102**	**Core 2**	Advanced Tools and Techniques	6	4	20	80	100
3.	**BTH 103P**	**Core 3**	Practicals related to Biochemical Preparations and Analysis & Analytical Methods	6	4	-	-	100
4.	**BTH 104P**	**Core 4**	Practicals related to Microbiology and Immunology	6	4	-	-	100
5.	**BTH 105**	**Compulsory Foundation**	Microbiology and Immunology	6	4	20	80	100
6.	**BTH 106**	**Elective foundation**	Human Values and Professional Ethics-I	6	4	20	80	100
		Total		36	24	-	-	**600**

SEMESTER-II								
S. No.	**Code**	**Components of Study**	**Title of the Paper**	**Instruction hours per week**	**Credits**	**Internal Assessment Marks**	**End Semester Exam Marks**	**Total Marks**
1.	**BTH 201**	**Core 1**	Enzymes and Intermediary Metabolism	6	4	20	80	100
2.	**BTH 202**	**Core 2**	Molecular Biology	6	4	20	80	100
3.	**BTH 203P**	**Core 3**	Practicals related to Enzymology & Molecular Biology	6	4	-	-	100
4.	**BTH 204P**	**Core 4**	Practicals related to Biostatistics and Bioinformatics	6	4	-	-	100
5.	**BTH 205**	**Compulsory Foundation**	Research methodology, Biostatistics and Bioinformatics	6	4	20	80	100
6.	**BTH 206**	**Elective foundation**	Human Values and Professional Ethics-II	6	4	20	80	100
		Total		36	24	-	-	**600**

SEMESTER -III								
S. No.	**Code**	**Components of Study**	**Title of the Paper**	**Instruction hours per week**	**Credits**	**Internal Assessment Marks**	**End Semester Exam Marks**	**Total Marks**
1.	**BTH 301**	**Core 1**	Genetic Engineering	6	4	20	80	100
2.	**BTH 302**	**Core 2**	Cell and Tissue Culture	6	4	20	80	100
3.	**BTH 303P**	**Core 3**	Practicals related to Genetic Engineering, Cell and Tissue culture & Food and Industrial Biotechnology	6	4	-	-	100
4.	**BTH 304 (Two papers out of three)**	**Generic**	a) Bioprocess Engineering and Technology b) Legal, Ethical and Implications of Biotechnology c) Food and Industrial Biotechnology	6 6	4 4	20 20	80 80	100 100
5.	**BTH 305 (For other department students)**	**Open Elective to others (For other department students)**	a) Plant Tissue Culture b) Bioethics c) Bioinformatics	6	4	20	80	100
		Total		**36**	**24**	**-**	**-**	**600**

SEMESTER-IV								
S. No.	**Code**	**Components of Study**	**Title of the Paper**	**Instruction hours per week**	**Credits**	**Internal Assessment Marks**	**End Semester Exam Marks**	**Total Marks**
1	**BTH 401**	**Core 1**	Environmental Biotechnology	6	4	20	80	100
2	**BTH 402**	**Core 2**	Plant Biotechnology	6	4	20	80	100
3	**BTH 403**	**Core 3**	Project work	6	4	-	-	100
4	**BTH 404 Generic Elective (Two papers out of three)**	**Generic Elective (Two papers out of three)**	a) Pharmaceutical Biotechnology b) Animal Biotechnology c) Applications of Biotechnology D) Practicals Related to Environmental Biotechnology & Plant Biotechnology	6 6	4 4	20 20	80 80	100 100
5	**BTH 405 Open Elective to others (For other department students)**	**Open Elective to others (For other department students)**	a) Tools in Biotechnology b) Immunology c) Applications of Biotechnology	6	4	20	80	100
		Total		**36**	**24**	**-**	**-**	**600**

Core 1: STRUCTURE AND FUNCTIONS OF BIOMOLECULES

Course Objectives:

1. To explore the knowledge and awareness of the basic principles and concepts of Biomolecules.
2. To acquaint the classification of carbohydrates, proteins, lipids and nucleic acids
3. To know the characteristic features of biomolecules
4. To understand the structure and functions of biomolecules

UNIT – I

Chemistry of carbohydrates - Definition and classification of carbohydrates. Outlines of structures and properties of important mono- (Glucose & Fructose), di- (Lactose, Sucrose, Maltose) and polysaccharides (Glycogen, Cellulose, Chitin). Physical and Chemical reactions of carbohydrates. Analysis of carbohydrates- Qualitative and Quantitative.

UNIT – II

Chemistry of amino acids and proteins - Classification of amino acids, Structures of amino acids, Chemical reactions of amino acids. Peptide bond - Nature of peptide bond, pi/φ rotation. Ramachandran plot, Secondary structure predictions, helices and beta-sheets, Determination of primary structure. Proteins and their classification, properties of proteins, determination of amino acid sequences (N and C terminus) Tertiary/quaternary structure of proteins (myoglobin/ hemoglobin model). Structural organization of proteins - Outline structures and biological functions. Protein folding and significance.

UNIT – III

Chemistry of lipids - Classification of lipids, Properties of lipids, Outline structures of saturated and unsaturated fatty acids, fats and waxes, phospholipids, glycolipids, cholesterol, prostaglandins, leukotrienes. Lipids as signaling molecules. Structure and functions of, heterocyclic molecules, porphyrins and vitamins.

UNIT – IV

Chemistry of nucleic acids - Structure of purines and pyrimidines, modified bases nucleosides and nucleotides; Properties of nitrogen bases and nucleotides, Structure, variation and properties of DNA and RNA. DNA denaturation and renaturation kinetics, Determination of DNA complexity, Hyperchromacity, Tm, cot curves and their significance.

Recommended Textbooks and References

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Rodwell, V., Bender, D., Botham, K. M., Kennelly, P. J., & Weil, P. A. (2015). Harpers illustrated biochemistry (30th ed.). McGraw Hill Professional.

Course outcomes:

The student will be able to

1. Understand the classification of carbohydrates and their biochemical functions.
2. Correlate the reactions of amino acids that are basis for identification tests and

biochemical pathways.

3. Know the structure of different classes of lipids and their roles in biological systems.
4. Comprehend the structure and functions of nucleic acids

	PO 1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	3	2	1	-	-	1	-	1	1	1	-
CO_2	3	3	2	1	2	-	1	-	1	1	1	-
CO_3	2	2	2	1	-	-	1	-	1	1	1	-
CO_4	3	2	3	2	-	-	1	-	1	1	1	1

Core 2: ADVANCED TOOLS AND TECHNIQUES

Course Objectives:

1. To impart knowledge about the various analytical and biophysical techniques.
2. To make the student to be able to carry out purification and characterization of various biomolecules.
3. To educate the student to characterize the separated biomolecules by electrophoresis and spectroscopic techniques.
4. To familiarize with the concepts and the techniques of Radioactivity

UNIT – I

Isolation techniques - Cell disruption techniques - sonication, french press, enzymatic, non-enzymatic techniques. Isolation of proteins - salting in/out, ammonium sulphate fractionation. Nucleic acids - polar solvents precipitation. Lipids - extraction by differential solubility. Concentration of macromolecules flash evaporation, lyophilization, pressure dialysis, reverse dialysis, hollow fiber membrane filters and reverse osmosis. Microscopic studies (principles and applications): Light, compound, phase contrast, confocal and SEM and TEM.

UNIT –II

Adsorption chromatography - principles, counter current distribution and its significance, Adsorption materials - paper, silica gel, cellulose acetate, affinity chromatography, merits and demerits – Instrumentation -TLC, GLC, HPLC.

Size- Filtration, Dialysis, principles and applications-molecular sieve chromatography - principle. Determination of void volume, extension co-efficient and molecular mass of native molecules. Density- Centrifugation technique - density gradient - sucrose, cesium chloride, Determination of sedimentation co-efficient, Molecular mass.

Charge- Ion exchange chromatography – Matrices - Principles of separation of charged molecules. Chromatography separations. Electrophoresis - principles governing the movement of charged molecules in the electric field. Relationship of voltage, current and the mobility of biomolecules. Matrices used in electrophoresis - starch, cellulose acetate, agarose, polyacrylamide. Use of PAGE for separation of proteins, molecular mass determination. Immunoelctrophoresis, Separation of nucleic acids using agarose gel electrophoresis. Blotting techniques - western, southern and northern blotting techniques.

UNIT – III

Characterization of biomolecules by Spectroscopy - Electromagnetic spectrum of light, simple theory of absorption of light by molecules, Beer-Lambert law, Types of detectors. UV-visible spectrophotometry, infrared Spectroscopy, Raman Spectroscopy, fluorescence Spectroscopy, flame photometry, atomic absorption, plasma emission, mass, ESR and NMR spectrophotometry. Optical rotatory dispersion (ORD) and Circular Dichroism (CD). X-ray diffraction and X-ray crystallography.

UNIT – IV

Radioisotope tracer techniques - Nature and types of radioactivity, half life, decay units, Preparation of labeled biological compounds. Detection and measurement of radioactivity (GM counter, scintillation counter), quench correction, Autoradiography. Labeling of carbohydrates (C^{14} acetate), proteins (S^{35} methionine, I^{125} aminoacid) and nucleic acids (P^{32} dATP). Biological uses of radioisotopes, Isotope dilution techniques, Safety measures in handling radio-isotopes.

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).
6. Biophysical chemistry principles and techniques by Upadyay, Upadyay and Nath (Himalaya Publishing).
7. Instrumental methods of chemical analysis by Chatwal & Anand.
8. Biochemical techniques: Theory and Practical. 1987. J.F. Robft and B.J. White, Waveland Press, Inc. Prospect Heights, IL, PP407.
9. Principles and Techniques of Practical Biochemistry, 1994. 4th ed, Eds. K. Wilson and J. Walker.
10. Physical Biochemistry: Applications to Biochemistry and Molecular Biology. 2nd ed. David Freifelder. W.H. Freeman and Company, New York.
11. Affinity Chromatography: Bio selective adsorption on insert matrices. 1992. W.H. Scouten, John Wiley & Sons, New York, PP 348.
12. Applications of HPLC in Biochemistry ; Laboratory Techniques in Biochemistry and Molecular Biology. 1987. A. Fallen, R.F.G. Booth and L.D. Bell, eds. Elsevier Science Publishers, Amsterdam, the Netherlands. PP 338.
13. Electron microscopy; Principles and Techniques for biologists. 1992. J,J. Bozola and L.D. Rusel, Jones and Bartlett Publishers, Boston, M.A. PP 542.
14. Electrophoresis : Theory, techniques and biochemical applications. 2nd ed. 1986. A.T. Andrews, Oxford University Press, Oxford. PP 452.
15. Enzymatic analysis : A practical guide. 1993. Janet. V. Passonneau and Oliver. H. Lowry, Humana Press, Totowa, N.J. PP400.
16. Enzyme assay : A Practical Approach. 1992. R. Eisenthal and M. J. Danson, Eds. IRL Press. PP. 351.
17. Flow Cytometry: A practical approach. 1990. M.G.Ormerod. Ed. IRL Press. PP 279.
18. Introduction to Biophysical methods for protein andNucleic acid research. (1995). J.A, Glasel; and Murray P. Deutscher. Academic Press. PP 505.
19. Special Analytical techniques in Nutritional Biochemistry. 1991. Gopalakrishna and S.K. Ranjhan. Kalyani Publishers,

20. Methods in Non-radioactive deteraction, 1993. Gary C Howard. Ed. Appleton & Lange Earwalk. CT PP. 342.
21. Preparative centrifugation: A Practical approach. 1992. D. Rickwood. Ed.IRL Press, PP400.
22. Principles of Laboratory Instruments. 1993. L.E. Schoeff, R.H. Williams, Mosby Year-book Inc. Pp 473.
23. Radioisotopes in Biology; a Practical approach. 1990. R.J. Slater, Ed., IRL Press, PP307.
24. Physical Chemistry. 1986. P.W. Atkins, W.H. Freeman. Sanfrancisco Pub.
25. Principles and techniques of Practical biochemistry, 1994 (4th ed.) by K. Wilson and J. Walker (eds).

Course outcomes:

The student will be able to

1. Learn about various techniques for isolation and concentration of macromolecules. They will also understand the principles and applications of different Microscopes
2. Understand the techniques of chromatography, centrifugation and electrophoresis
3. Achieve a basic understanding of characterization of biomolecules by different Spectroscopic techniques
4. Familiarize with the various radioisotope tracer techniques and their role in biology. Eventually they learn safety measures in handling radio-isotopes.

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	3	3	3	3	1	3	1	3	3	3	3
CO_2	3	3	3	3	3	1	3	1	3	3	3	3
CO_3	3	3	3	3	3	1	2	1	3	3	3	3
CO_4	3	3	3	3	3	1	2	2	3	3	2	3

Core 3P: BIOCHEMICAL PREPARATION AND ANALYSIS & ANALYTICAL TECHNIQUES

1. Separation of chlorophyll pigments 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. Polyacrylamide gel electrophoresis of proteins.
5. Determination of isoelectric point of glycine.
6. Estimation of reducing sugars by benedict's titrimetric method.
7. Estimation of total carbohydrates by anthrone method.
8. Estimation of proteins by lowry and bradford methods.
9. Estimation of cholesterol.

Reference Books

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).

Core 4P - PRACTICAL RELATED TO MICROBILOGY & IMMUNOLOGY

MICROBILOGY

1. Sterilization techniques: Autoclaving (Moistened-heat), Oven sterilization (dry-heat), Filtration, UV irradiation and Chemical.
2. Preparation of media: For Bacteria and Fungi.
3. Isolation and cultivation of pure cultures: Serial dilution, Pour plate method, Spread plate method and streak plate method.
4. Methods for the estimation of Growth (Growth rate and generation time in bacteria).
5. Staining techniques for bacteria and yeast: Gram Staining and Spore staining for bacteria; Methylene blue staining for Yeast.
6. Antibiotic sensitivity test.
7. Induction of mutation in bacteria using physical and chemical mutagens.

Reference Books

1. Microbiology laboratory Manual 4th Edit. By Cappuccino
2. Microbiology laboratory Manual (2001) by Aneja, K.M
3. Laboratory Manual in Microbiology by P.Gunasekaran (1996), New Age Publ.

IMMUNOLOGY

1. Determination of A, B, O and Rh blood groups in human beings.
2. Dissection and identification of thymus, spleen and lymph nodes.
3. Ouchterloney double diffusion.
4. Radial immunodiffusion.
5. Quantitative precipitin assay.
6. Immunoelectrophoresis.
7. Enzyme Linked Immunosorbent Assay (ELISA).
8. Western blotting.
9. Diagnostic test for typhoid fever by Widal test.
10. Pregnancy tests.

Reference Books

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.

COMPULSORY FOUNDATION: MICROBIOLOGY AND IMMUNOLOGY

Course objectives:

1. To impart the knowledge on discovery and classification of microorganisms
2. To develop understanding on microbial nutrition, cultivation and growth pattern of microorganisms
3. To provide knowledge on the types of immunity and the immune organs
4. To demonstrate the structure of antibody types and their interaction with antigen

Unit-I

Discovering the microbial world. Classification of micro organisms up to order level - bacteria, algae, fungi, protozoa. Structure of prokaryotic and eukaryotic microorganisms. General and distinctive characteristics of the major groups of microorganism bacteria, mycoplasma, chalmidae, rickettsias, actinomycetes, fungi, algae, protozoa Prions and viruses. Isolation, cultivation and enumeration of microorganisms - direct and indirect methods, Maintenance of culture. Outlines of characterization and identification of common bacteria, fungi, algae and protozoa.

Unit-II

Nutritional requirements to microorganisms - Mode of nutrition - phototrophy, chemotrophy - methylotrophy organotrophy, mixotrophy, saprophytic, symbiotic and parasitic, Interaction of microbes. Growth of microorganism (bacteria) - normal and biphasic growth curve, batch and continuous cultures, chemostats, shift up and shift down. Growth determination, Microbial metabolism - energy yielding and energy requiring processes. Control of microorganisms - principles, physical and chemical agents, Assay of antimicrobial action. Batch and continuous sterilization .of media and air. Viruses - nature, cultivation and assay methods, structure, physico-chemical properties, classification, pathogenicity, Replication of viruses. Microbes of biotechnological importance - examples of bacteria, yeast, algae and viruses.

Unit-III

Immunity- innate and acquired, innate immune mechanisms, acute phase reactants, properties of acquired immunity, Toll-like receptors. Immunogens and antigens – Properties, factors governing immunogenicity, haptens, epitopes-size and identification. Adjuvants-properties and mechanism of action. Cells involved in the immune response- T cells, B cells, CD antigens, neutrophils, eosinophils and natural killer cells. Macrophages, dendrites, Phagocytosis. Lymphoid tissues- Primary and secondary lymphoid organs, structure and cellular organization. Lymphocyte traffic.

Unit-IV

Functions of antibody in relation to structure. Antigen-antibody interactions- affinity of antibody, avidity, bonus effect, classical precipitin reaction, antigen-binding site of antibody, forces involved in antigen-antibody complex formation. Generation of antibodies, Theories of antibody formation. Monoclonal and polyclonal antibodies. Complement - nature, physicochemical properties, complement cascade pathway, complement fixation. Antibody response-primary and secondary

antibody response, antibody response to haptens, enumeration of antibody-forming cells, T-dependent and T-independent antigens, MHC, Interleukins, cytokines

REFERENCES:

1. Microbiology: concepts and Applications. Michael J. Pelczar, Jr., E.C.S., Chan, Noel R. Krieg, 1993. Me. Graw Hill, Inc.
2. Introductory Microbiology. 1995, by Trevor Gross.
3. Fundamentals of Microbiology. 4ltled. 1994. I.E.AIcamo. Scientific Publication,
4. Microbiology, 1990. 4th Ed.B.D. Davis, R. Dulbeco, H.N. Eisen and H.S. Ginsberg and J.B. Lippincott Company.
5. Fundamental Principles of Bacteriology. 1994. A.J. Sake. Tata McGraw Hill.
6. Laboratory Experiments in Microbiology. 3rd ed. Brief Version. 1992. T.R. Johnson and C.L. Case. Addision Wesley International Publications. PP 350.
7. Essentials of Immunology by Roit (ELBS).
8. Immunology by Roit et.al (Harper Row).
9. Text book of Immunology by S.T,Barrot (Mosby).
10. Immunology by Kubay.

Course outcomes:

The student will be able to

1. Acquire the knowledge on classification and structure of different microorganisms
2. Understand the microbial techniques for isolation, cultivation and maintenance of pure cultures
3. Out line, compare and contrast the key mechanism of innate and adaptive immunity
4. Apply knowledge in disease diagnosis through serological tests

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	2	1	3	2	1	1	2	2
CO_2	3	2	3	3	3	2	3	1	2	3	3	3
CO_3	3	3	3	3	2	-	-	-	2	1	2	3
CO_4	3	3	3	3	2	-	-	-	2	1	2	3

ELECTIVE FOUNDATION 4: HUMAN VALUES AND PROFESSIONAL ETHICS-I

Unit-I

Definition and Nature of Ethics- Its relation to Religion, Politics, Business, Law, Medicine and Environment. Need and Importance of Professional Ethics- Goals- Ethical Values in various Professions.

Unit-II

Nature of Values – Good and Bad, Ends and Means , Actual and potential Values, Objective and

S. No.	Components of Study	Title of the Paper	Instruction hours per week	Credits	Internal Assessment Marks	End Semester Exam Marks	Total Marks

Subjective Values, Analysis of basic moral concepts- right , ought, duty, obligation, justice, responsibity and freedom , Good behavior and respect for elders, Character and Conduct.

Unit-III

Individual and Society: Ahimsa (Non- Violence), Satya (Truth), Brahmacharya (Celibacy), Asteya (Non possession) and Aparigraha (Non- stealing). Purusharthas (Cardinal virtues) – Dharma (Righteousness), Artha (Wealth), Kama (Fulfillment Bodily Desires), Moksha (Liberation).

Unit-IV

Bhagavad Gita- (a) Niskama Karma (b) Buddhism- The Four Noble Truths- Arya astanga marga, (c) Jainism- mahavratas and anuvratas. Values Embeded in various Religions, Religious Tolerance, Gandhian Ethics.

Unit-V

Crime and Theories of punishment (a) Reformative, Retributive and Deterrent. (b) Views on manu and Yajnavalkya.

Reference Books

1. John S Mackenjie: A manual of ethics.
2. The Ethics of Management" by Larue Tone Hosmer, Richard .D. Irwin Inc.
3. Management Ethics-integrity at work" by Joseph A. Petrick and John F. Quinn, Response Books: New Delhi.
4. Ethics in management" by S.A.Sherlekar, Himalaya Publishing House.
5. Harold H. Titus:Ethics for Today.
6. Maitra,S.K: Hindu Ethics.
7. William Lilly : Introduction to Ethics
8. Sinha : A Manual of Ethics
9. Manu : Manu Dharma Sastra or the Institute of Manu : Comprising the Indian System of Duties: Religious and Civil (ed.) G.C. Haughton.
10. Susruta Samhita : Tr. Kaviraj Kunjalal ,Kunjalal Brishagratha, Chowkamba Sanskrit series, Vol I,II and III, Varanasi, Vol 1 OO, 16-20, 21-32 and 74- 77 only.
11. Caraka Samhita : Tr. Dr. Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series Office , Varanasi Vol 100, 16-20,21-32 and 74-77 only.
12. Ethics:Theory and Contemporary Issues, Barbara Mackinnon Wadsworth/Thomson Learning , 2001.
13. Analysing Moral Issues, Judith A. Boss, Mayfield Publishing Company ,1999.
14. An Introduction to Applied ethics (Ed.) John H.Piet and Ayodhya Prasad, Cosmo Publications.
15. Text Book for Intermediate logic, Ethics and Human Values .Telugu Academic Hyderabad.
16. I.C.Sharma Ethical Philosophy of India, Nagin & Co Julundhar.

SEMESTER-II

1.	**Core 1**	Enzymes and Intermediary metabolism	6	4	20	80	100
2.	**Core 2**	Molecular Biology	6	4	20	80	100
3.	**Core 3**	Practical related to Enzymology & Molecular Biology	6	4	-	-	100
4.	**Core 4**	Practical related to Biostatistics and Bioinformatics	6	4	-	-	100
5.	**Compulsory Foundation**	Research methodology, Biostatistics and Bioinformatics	6	4	20	80	100
6.	**Elective foundation**	Human values and Professional ethics-II	6	4	20	80	100
	Total		36	24	-	-	600

Core 1: ENZYMES AND INTERMEDIARY METABOLISM

Course Objectives:

1. To provide knowledge on classification, nomenclature, isolation, and purification of enzymes

2. To educate them to understand the importance of energy relationships and its transformation in living organisms

3. To explain the metabolic pathways involved in biosynthesis of macromolecules

4. To impart awareness on the types and symptoms of metabolic diseases and their inheritance

UNIT - I: Classification of enzymes and their significance - Isolation and purification of enzymes - assay of enzyme activity. Determination of K_M, Vmax and K cat. Enzyme inhibition - competitive, non-competitive, uncompetitive allosteric regulation and irreversible enzyme inhibition. Enzyme action, Active site determination. Isoenzymes - detection, characterization and significance. Ribozymes, Abzymes, multicomplex and multifunctional enzymes,

Unit-II: Bioenergetics - Free energy change in biological transformations, thermodynamic principles in biology, Redox potential, high energy compounds. Glycolysis - Biochemical steps involved in glycolytic pathway, TCA cycle and their Regulatory mechanisms. Glyoxalatye cycle, gluconeogenesis, HMP shunt, interconversion of hexoses and pentoses, amylogenesis, glycogen metabolism. Brief account of enzymes and co-enzymes involved in biological oxidations, Organization of respiratory electron transport system. Mechanism of oxidative phosphorylation. Biological energy transducers, Chemiosmotic regeneration of ATP.

Unit III: Biosynthesis, degradation and regulation of saturated fatty acids. Degradation of lipids from membranes, Oxidation of unsaturated fatty acids and synthesis of UFA by enzymatic (synthesis of prostaglandin and leukotrines) and non-enzymatic (free radicals and lipid peroxidations) mechanisms.

Cholesterol and ketone bodies. Metabolism and regulation. Metabolism of triglycerides, phospholipids, glycolipids.

UNIT - IV: Metabolism of amino acids and proteins - Hydrolysis of proteins, proteases, Biosnynthesis of essential amino acids and their catabolism (deamination, decarboxylation, and transamination), Coordinated control of metabolism, Formation of ammonia and urea. Nitrogen fixation by bacteria. Metabolism of purines and pyrimidines, Biosynthesis and catabolism of Nucleosides and nucleotides, role of DNases and RNases on nucleic acids. Outlines of biosynthesis of porphyrins (Chlorophyll and Haeme). Inborn errors in metabolism - Phenylketonuria, Alkaptonuria, Sickle cell anaemia, Fructosaemia, galactosuria, Gaucher's and Krabbe's disease.

Reference Books:

1. Principles of Biochemistry: White. A, Handler, P., and Smith.
2. Biochemsitry, Lehninger A.L.
3. Biochemistry, David E. Metzler.
4. Biochemistry, Lubert Stryer.
5. Review of Physiological Chemistry: Harold A. Harper.
6. Outlines of Biochemistry, Conn and Stummf.
7. Text of Biochemsitry, West and Todd.
8. Metabolic Pathways - Greenberg,
9. Biochemistry, 2na Edition, G. Zubay (1988). Practical Course
10. Practical Biochemistry - H. Varley.
11. Methods in Enzymology S.P. Colowick & N.O. Kapalan, Academic Press.
12. Methods in Biochemical analysis.

Course outcomes:

Students will be able to

1. Gain knowledge on different enzymes and their significance
2. Correlate how the living organisms exchange energy and matter with the surroundings for their survival, and store free energy in the form of energy-rich compounds
3. Recognize how the catabolic breakdown of the substances is associated with release of free energy; whereas, free energy is utilized during synthesis of biomolecules i.e., anabolic pathways
4. Apply the knowledge of metabolic pathways to biotechnological and biochemical research.

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	3	2	3	-	1	3	-	-
CO_2	3	3	3	2	2	2	2	-	1	2	-	-
CO_3	3	3	3	2	2	2	2	-	1	2	-	2
CO_4	3	3	3	3	3	2	3	-	1	3	3	3

Core 2: MOLECULAR BIOLOGY

Course Objectives:

1. To provide comprehensive background of Salient features of Nucleic acids, DNA models and its replication to the course learners.
2. To impart detailed understanding of key events of transcription and post transcriptional modifications
3. To develop understanding of translational process in protein biosynthesis in prokaryotic and eukaryotic organisms
4. To make them understand the regulation of catabolic and anabolic gene expression

UNIT - I: DNA replication - Enzymes involved in DNA replication. Accessory proteins. Structures of oriC. Replisome – oriC - accessory protein interactions - Mechanism of formation of oriC open complex. Replication initiation – elongation - okazaki fragments synthesis and processing - Direction of replication fork movement. Termination - Nature of termination sequences - Interactions between polymerase III and *ter* sequences. Mode of DNA replication Messelson and Stahl experiments. Replication of single stranded DNA -ØX174. Replication of bacteriophage lambda DNA (rolling circle). Replication of closed covalent circular DNA (θ model of DNA replication). Problems associated with replication of linear DNA molecules - Structure and synthesis of telomere sequences. Cell cycle and its regulation - Interphasing of cell cycle and DNA replication.

UNIT - II: Prokaryotic RNA polymerase - σ factors: -σ^{70}, σ^{32}, σ^{54} , σ^{28} promoter elements-Structural differences between E σ^{70}, σ^{54} dependent promoters - Promotor polymerase interaction - Foot printing assays - Mapping of transcription start point (TSP). Gene structure, Upstream activating sequences and their role in regulation of transcription. Transcription elongation and termination. Eukaryotic RNA polymerases - Transcription factors – transcription. Structure and functions of RNA pol I, II and III dependent promoters. Enhancer sequences. Post transcriptional modification of RNA and its regulation, Mechanism of tissue specific transcription.

UNIT - III: Translation - Central dogma theory and flow of genetic information, Genetic code and its elucidation, Wobble hypothesis, Structure and composition of prokaryotic and eukaryotic ribosomes, Structures of mRNA and tRNA. Events of protein synthesis (amino acid activation, initiation, elongation and termination) in prokaryotes and eukaryotes. Post-translational modification of proteins, Inhibitors of translation. Protein trafficking - Concept of signal peptide - transport and membrane targeting of proteins - Sec pathway - Alternative protein transport mechanisms.

Unit IV: Regulation of gene expression. Constitutive and inducible gene expression, Use of mutants in gene expression. P and O site determination. Regulation of catabolic gene expression Eg: lac operon, ara operon and gal operon. Regulation of anabolic gene expression Eg: Trp and His operons. Hormonal regulation of genes.

Reference Books

1. Molecular Biology. 2"^{13} ed. 1994. D. Freifelder. Springer.
2. Molecular Biology by G. Padmanabhan, K. Sivaram Sastry, C. Subramanyam, 1995, Mac Millan.
3. Molecular Biology and Biotechnology 2na ed. J.M. Walker and E.B. Gingold. Panima Publications. PP 434.
4. Dictionary of microbiology and molecular biology. 2nd ed. 1994. Sigleton. P. and Sainsbury, D. Sciential Publication.

5. Molecular Biology of the Gene, 1S87. 4th Ed. J.D. Watson, N.H.Hopkins, J.W. Roberts, J.A. SteitzandA.M. Weiner, 2 Vol. Benjmin/Cummings.
6. Biochemistry of the Nucleic acids. 1992. 11th ed. R.L.P. Adams, J.T. Knowler, D.P. Leader, Chapman and Hall.

Course outcomes:

1. Understand the biochemical composition and genome organization in living cells
2. Learn about the mechanism of tissue specific transcription and role of RNA polymerases
3. Appreciate the correlation of genetic code with protein synthesis in prokaryotic and eukaryotic cells.
4. Gain insights of mechanism of gene expression and regulations

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	3	2	3	-	1	3	-	-
CO_2	3	3	3	2	2	2	2	-	1	2	-	-
CO_3	3	3	3	2	2	2	2	-	1	2	-	2
CO_4	3	3	3	3	3	2	3	-	1	3	3	3

Core 3P: PRACTICALS RELATED TO ENZYMOLOGY & MOLECULAR BIOLOGY

ENZYMOLOGY

1. Assay of amylase from Saliva.
2. Assay of urease from Horse-gram.
3. Assay of acid phosphatase from Potato.
4. Determination of optimal conditions for SDH activity
5. Determination of effect of substrate concentration on SDH activity
6. Determination of effect of enzyme concentration on SDH activity
7. Determination of effect of temperature on SDH activity
8. Determination of effect of PH on SDH activity
9. Estimation of activity of SGOT
10. Estimation of activity of SGPT

Recommended Books:

1. Hawk's Physiological chemistry
2. Practical Biochemistry by T Plummer
3. Practical Biochemistry by J Jayaraman
4. Klemir and others: practical Biological chemistry.
5. Practical Biochemistry – Koch and Hank Dunn and Drell
6. Practical Biochemistry-Sawhney (2000)

7. Varley's Practical clinical Biochemistry – Ed. Alan W.Gowenlock (Heinemann Medical Books, London).

MOLECULAR BIOLOGY

1. Isolation of DNA from bacterial, plant and animal cells.
2. Estimation of DNA by Diphenylamine method.
3. Isolation RNA from yeast cells.
4. Estimation of RNA BY Orcinol method.
5. Estimation of DNA and purity determination by UV absorption method.
6. Determination of melting temperature (Tm).
7. Isolation of plasmid DNA from E.coli.
8. Transformation of E.coli with ampicillin resistant plasmid.

Reference Books

1. Techniques in molecular biology. Vol.2. 1987. ed. J.M. Walker and Wim Gaestra. Panima Publications. PP 332.
2. Methods in Plant Molecular Biology. 1989. M.A. Schuler and R.E. Zielinski. Academic Press.
3. Methods for cloning and Analysis of eukaryotic genes. 1990. ABothwell, G.D. yancoponlos and F.W.Alt: Jones and Bartlett Publishers. PP 1990.
4. PCR; A Practical approach. 1991. M.J. McPherson. P. Quirke and GR. Taylor. Eds. IRL Press, PP 253.
5. Short Protocols in Molecular Biology. 1992. P.M. Ansubel et al., Academic Press, PP 800.
6. Essential molecular biology: A Practical approach, Vol. I, II. 1991. T.A. Brown. Ed. IRL Press, PP 318-. PP 320.

Core 4P: PRACTICALS RELATED TO BIOSTATISTICS AND BIOINFORMATICS

BIOSTATISTICS

1. Measures of Location.
2. Measures of Dispersion.
3. Correlation Analysis.
4. Regression Analysis.
5. Student Paired t-Test.
6. X^2- Test of Independence of Attributes.

BIOINFORMATICS

1. Introduction and use of various genome databases.
2. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.
3. Similarity searches using tools like BLAST and interpretation of results.
4. Multiple sequence alignment using ClustalW.
5. Use of various primer designing and restriction site prediction tools.
6. Phylogenetic analysis of protein and nucleotide sequences.

7. Sequence alignments.
8. Sequence and structure visualization.

COMPULSORY FOUNDATION 5 : RESEARCH METHODOLOGY , BIOSTATISTICS AND BIOINFORMATICS

Course Objectives:

1. To choose the appropriate research design and develop appropriate research hypothesis for a research project
2. To describe the appropriate statistical methods required for a particular research design
3. To get introduced to the basic concepts of Bioinformatics and its significance in Biological data analysis
4. To provide knowledge about the basics of sequence alignment and analysis.

UNIT-I: Preparation of informal proposal, modified proposal and formal proposal. Experimental design and Collection of results, submission of progress report (year wise) and submission of technical report (Format: Title page, Introduction, Aims of the proposal/research, methodology, results, references, acknowledgments, budgetary preparation). Submission of final technical Report. Patenting and intellectual property rights.

UNIT-II: Data - Data types, collection of data, classification and tabulation. Measures of central tendencies. Mean, median and mode. Measures of variation - Range, quartile deviation, mean deviation and standard deviation. Coefficient of variation. Probability, addition and multiplication theories, conditional probability and probability distributors. Binomial, poission and normal distribution. Correlation and linear regression. Regression: Regression coefficients and properties. Small sample tests- t, F and chi square tests. ANOVA - one way and two way classifications.

UNIT-III: Origin of bioinformatics biological data (genome projects), Disciplines of bioinformatics, transcriptomics, functional genomics, structural genomics, metabolomics, pharmaco-genomics, structure prediction, drug design and Microarrays.

Genome projects - General introduction to genome projects (rice and Mycobacterium tuberculosis genome project). Special emphasis on Human Genome Project (HGP). Science behind HGP, benefits of HGP, ELSI of HGP in use of genetic information, genetic testing standard, quality and commercialization.

Biological database - Introduction of database (DB), need, organization, search of DB. An over view of biological databases - NCBI, EMBL, DDBJ, SWISS-PROT, PDB, KEGG. Decoding of the genome (Nathan blow study), Ribosomal bar codes, Molecular signatures.

UNIT-IV: Database querying with NCBI using key words, sequences (proteins and genes), finding similarities, identifying genes and proteins from different organisms. Sequence alignment - Introduction, significance of sequence alignments and use of dot matices. Pair wise and multiple sequence alignment (MSA) using Clustal programs. Sequence analysis - concepts of sequence

analysis and their importance. BLAST. blastn, blastp, blastx, tblastx, output analysis matrix BLOSSUM, PAM, e-value. Proteomics - Introduction, principle, technique, 2-D data base. Gel analysis, post gel analysis, MALDI-TOF. Significance and applications of proteomics in modern biology.

Reference Books:

1. Statistical methods. S.P. Gupta
2. Fundamentals of mathematical statistics. S.C Gupta & Kapoor
3. Statistical methods in biological and Health Science. J. S. Milton & J.O. Tsokan.
4. Primrose SB. Principles of Genome Analysis: a guide to mapping and sequencing DNA from different organisms. 2nd Ed. 1998. Blackwell Science: Oxford. ISBN 0-632-04983-9.
5. Genome Mapping: A practical approach. Dear P (Editor). 1st Ed. 2000. Oxford University Press: Oxford.
6. Developing Bioinformatics Skills. Alfonso Valencia and Blaschke. L (2005) Oreille.s Publication.
7. Bioinformatics sequence, structure and data banks ed. By Des Higgins Willie Taylor. (2006).
8. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins" (Andreas D. Baxevanis, B. F. Ouellette), Paperback, 2nd ed., 470 pp., ISBN: 0471383910, Publisher: Wiley, John & Sons, Inc., Pub.
9. David W. Mount, Bioinformatics: Sequence and Genome Analysis, 2nd edition, Cold Spring Harbor Laboratory, 2004, ISBN 0-87969-687-7.
10. Introduction to Bioinformatics by T.K.Altwood and D.J Parry-Smith (Pearson Education Asia 1999).
11. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
12. Discovering Genomics, Proteomics and Bioinformatics, 2nd edition-A. Malcolm Campbell and Laurie J. Heyer (ISBN 0-8053-4722-4)-Cold Spring Harbor Laboratory press and Benjamin Cummings, 28 Feb 2006.
13. Campbell AM & Heyer LJ, Discovering Genomics and Proteomics.

Course outcomes:

The student will be able to

1. Discuss the various steps involved in conducting research
2. Learn to apply hypothesis testing via some of the statistical distributions
3. Develop understanding about Biological data and database search tools
4. Acquire hands on training on various computational tools and techniques employed in Biological sequence analysis

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	3	3	3	3	2	3	-	1	3	-	-
CO_2	3	3	3	2	2	2	2	-	1	2	-	-
CO_3	3	3	3	2	2	2	2	-	1	2	-	2
CO_4	3	3	3	3	3	2	3	-	1	3	3	3

ELECTIVE FOUNDATION 4: HUMAN VALUES AND PROFESSIONAL ETHICS-II

Unit –I: Value Educattion- Defination- relevance to present day- Concept of Human Values- self introspection- Self esteem- Family Values – Components, Structure and responsibilities of family- Neutralization of anger- Adjustability- Treats of famiy life – Status Of women in family and society- Caring for needy and elderly – Time allotment for sharing ideas and concerns.

Unit –II: Medical ethics- Views of Charaka, Sushruta and Hippocratus on moral responsibility of medical practitioners. Code of ethics for medical and Health care professionals. Euthanasia, Ethical obligation to animals, Ethics issues in relation to health care professionals and patients. Social justice in health care. Human cloning, Problems of abortion. Ethical issues in genetic engineering and Ethical issues raised by new biological technology or knowledge.

Unit –III: Business ethics- Ethical standards of business- Immoral and illegal practices and their solutions. Characteristics of ethical problems in management, ethical theories, causes of unethical behavior, ethical abuses and work ethics.

Unit –IV: Environment ethics- Ethical theory, man and nature- Ecological crisis, Pest control, Pollution and waste, Climate change, Energy and population, Justie and Environmental health.

Unit –V: Social ethics- Organ trade, Human trafficking, Human rights violation and social disparities, Feminist ethics, Surrogacy/ pregnancy. Ethics of media- Impact of Newspaper, Television, Movies and Internet.

Reference Books

1. John S Mackenjie: A manual of ethics.
2. The Ethics of Management" by Larue Tone Hosmer, Richard .D. Irwin Inc.
3. Management Ethics-integrity at work" by Joseph A. Petrick and John F. Quinn, Response Books: New Delhi.
4. Ethics in management" by S.A.Sherlekar, Himalaya Publishing House.
5. Harold H. Titus: Ethics for Today.
6. Maitra, S.K: Hindu Ethics.
7. William Lilly: Introduction to Ethics
8. Sinha: A Manual of Ethics
9. Manu: Manu Dharma Sastra or the Institute of Manu : Comprising the Indian System of Duties: Religious and Civil (ed.) G.C. Haughton.
10. Susruta Samhita: Tr. Kaviraj Kunjalal ,Kunjalal Brishagratha, Chowkamba Sanskrit series, Vol I,II and III, Varanasi, Vol 1 OO, 16-20, 21-32 and 74- 77 only.
11. Caraka Samhita: Tr. Dr. Ram Karan Sarma and Vaidya Bhagavan Dash, Chowkambha Sanskrit Series Office , Varanasi Vol 100, 16-20,21-32 and 74-77 only.
12. Ethics: Theory and Contemporary Issues., Barbara Mackinnon Wadsworth/ Thomson Learning , 2001.
13. Analysing Moral Issues, Judith A. Boss, Mayfield Publishing Company ,1999.
14. An Introduction to Applied ethics (Ed.) John H.Piet and Ayodhya Prasad, Cosmo Publications.
15. Text Book for Intermediate logic, Ethics and Human Values , board of intermediate Education & Telugu Academic Hyderabad.
16. I.C.Sharma Ethical Philosophy of India, Nagin & Co

SEMESTER-III

S. No	Components of Study	Title of the Paper	Instruction hours per week	Credits	Internal Assessment Marks	End Semester Exam Marks	Total
1	**Core 1**	Genetic Engineering	6	4	20	80	100
2	**Core 2**	Cell and Tissue culture	6	4	20	80	100
3	**Core 3**	Practical related to Genetic Engineering, Cell and Tissue culture & Food and Industrial Biotechnology	6	4	-	-	100
5	**Generic Elective (Two papers out of three)**	a) Bioprocess Engineering and Technology b) Legal, ethical and implications of Biotechnology c) Food and Industrial Biotechnology	6 6	4 4	20 20	80 80	100 100
6	**Open Elective to others (For other department students)**	a) Plant tissue culture b) Bioethics c) Bioinformatics	6	4	20	80	100
	Total		36	24	-	-	600

Core 1: GENETIC ENGINEERING

Course Objectives:

1. To impart knowledge about major events in the development of rDNA technology
2. To acquire skills on techniques of construction of recombinant DNA - Cloning vectors and isolation of gene of interest.
3. To familiarize with the concepts of constructing genomic DNA library and cDNA library
4. To understand the principles and applications of Polymerase Chain Reaction (PCR).

UNIT - I: Requirements and steps involved in gene cloning, Isolation of gene/DNA fragments. Purification of genes, Mechanical shearing, restriction digetion, cDNA synthesis, and chemical synthesis of gene. Enzymes involved in gene cloning: polymerases, kinases, ligases, nucleases.

Restriction enzymes - Outlines of bacterial restriction and modification systems – Classification of restriction enzymes - Type II restriction enzyme: Nomenclature, Production of DNA fragments with cohesive ends and blunt ends and their significance, vectors and hosts.

UNIT – II: Vectors for construction of genomic libraries - cosmids, bacterial artificial chromosomes (BACs), yeast artificial chromosomes (YACs) - vectors for construction of cDNA libraries - lamda ZAP. Multipurpose vectors - pUC 18/19, Blue script vectors - multiple cloning site - Strategies for unidirectional deletion of cloned DNA fragments - Generation of sequence of cloned DNA fragments. Site directed mutagenesis.

Expression vectors – structure - promoters used in expression vectors - *lac, tac, λpL*, T7 promoters and their significance in constructing expression vectors. Promoter-probe vectors – Structure promoter probe vector - Reporter genes (*lacZ*, *gf*p, gus, luciferase) and strategies used to assay promoter activity. Vectors used for cloning in to mammalian cells - SV40. Vectors - Cloning in plants by Ti and Ri vectors.

UNIT - III: cDNA synthesis - Mechanism of cDNA synthesis, Strategies used to obtain full length cDNA. 5' and 3' RACE. Chemical synthesis - solid phase synthesis of oligonulceotides - Designing of gene from amino acid sequences, *In vitro* synthesis of gene. Ligation between cohesive and blunt end DNA fragments - T4 DNA ligase - Conversion of blunt end DNA fragment into cohesive ended DNA - linkers, adapters, homopolymer tailing.

UNIT - IV: Cloning strategies: Introduction of cloned genes into host - Transformation, transduction, conjugation, transfection, electroporation, particle bombardment, microinjection, liposome mediated DNA delivery. Identification and characterization of cloned genes - Screening of genomic/cDNA libraries - genetic, molecular hybridization - immunochemical techniques. PCR - Concept and technology- Properties of primers -Taq DNA polymerase and its significance Inverse, multiplex PCR, RAPD, RFLP, AFLP and its significance. Real time PCR. Applications of genetic engineering

REFERENCES

1. DNA replication, 2nd ed. 1991. A. Kornberg and T.A. baker. W.H. Fre.eman and Company, New York. Ny. PP931.
2. Gene transfer and expression protocols: Methods in Molecular Biology, Vol.7,1991. E.J. Murray Ed. Human Press, Clifton, NJ. PP 439.
3. Genes IV, 1990. B. Lewin. Oxford University Press. PP 857.
4. Microbial genetics. 1994. Freifelder, D. Springer.
5. Glossary of Genetics. 5 ed. Classical and molecular, 1994, Reiger. R. et aL, Springer.
6. Gene regulation, 2nd ed. 1994. D, latchman. Sciential Publication.
7. Bacterial and Bacteriophage genetics. 1994. E.A. Birge. Springerscan Publication.
8. Genetics : A molecular approach. 2nd ed. 1992. T.B. Brown. Panima Publications. PP 496.
9. Principles of Gene Manipulation. 1991. R.W. Old and S.B. Prim-Rose. 2nd ed. Blackwell Scientific.

Course outcomes:

The student will be able to

1. Familiar with the tools and techniques for isolation and purification of genes
2. Acquire knowledge on vectors for construction of genomic libraries and cDNA libraries
3. Understand the mechanism of cDNA synthesis

4. Know the techniques for transfer and expression of cloned gene and applications of genetic engineering in biological research.

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	3	3	3	3	2	3	-	1	3	-	-
CO_2	3	3	3	2	2	2	2	-	1	2	-	-
CO_3	3	3	3	2	2	2	2	-	1	2	-	2
CO_4	3	3	3	3	3	2	3	-	1	3	3	3

Core 2: CELL AND TISSUE CULTURE

Course Objectives:

1. To impart knowledge about the organization of Plant Tissue Culture Lab and to give insight of nutrient requirements and factors influencing plant tissue culture.
2. To develop skill on micropropagation of forest trees, medicinal plants and endangered plants and to educate the student to learn methods to in vitro germplasm conservation and production of secondary metabolites through cell culture.
3. To gain knowledge on the biology of stem cells
4. To acquaint with Nuclear transfer technology, stem cell therapies and animal cloning

UNIT - I: Introduction to plant tissue culture: Preparatory techniques - cleaning, sterilization, sterile handling tissue culture lab requirements. Media - Composition, preparation and sterilization. Genetic manipulation through tissue culture techniques - Concepts of differentiation and dedifferentiation. Callus - growth pattern/characteristics, Organogenesis and plant regeneration. Somatic embryogenesis. Anther, endosperm and pollen cultures, Significance and advantages of haploid plants. Production of virus-free plants by meristem tip and other tissue culture techniques.

UNIT - II: Micropropagation of elite plants - Food and fruit crops, forest trees, fibre crops, ornamental plants, medicinal plants and endangered plants. Cell culture techniques for production of useful compounds - Hairy root cultures - transformed roots using Agro bacterium rhizogenesis - Production of secondary metabolites of commercial importance - Elicitors - factors affecting their yield, immobilized cell systems, bioreactors.

Selection of clones for nutritional, disease resistance, salt and drought resistance. Germplasm preservation by tissue technology, Artificial synthetic seeds. Protoplast culture -isolation of protoplasts, culture and fusion methods, Somatic hybrids and cybrids.

UNIT - III: Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures.

The biology of stem cells – Different types of stem cells – embryonic stem cells, fetal tissue stem cells, adult stem cells; stem cell differentiation, stem cell plasticity – Differentiation versus stem cell

renewal. Isolation and propagation of embryonic stem cells; chimeras; generation of knockout mice and knock-in technology.

UNIT - IV: Application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Stem cell therapies: Clinical applications of stem cell therapy; Neurodegenerative diseases- Parkinson's disease, Alzeimer's, spinal cord injury, other brain syndromes; tissue systems failures - diabetes, cardiomyopathy, kidney failure, liver failure - hemophilia, lymphoma and leukemic malignancies requiring stem cell therapy.

REFERENCE BOOKS

1. Plant tissue culture – theory and practice by Bhojwani S.S.
2. Plant cell culture – A practical approach by Dixion R.A.
3. Plant Cell, Tissue and Organ Culture, By Reinert, J. and YPS Bajaj (Springer – Verlag).
4. Plant tissue and cell culture, by Street, HE (Blackwell).
5. Introduction to Plant Biotechnology, Chawla, H. S. (2000), Enfield, NH: Science.
6. Introduction to Plant Tissue Culture, Razdan, M. K. (2003), Enfield, NH: Science.
7. Plant Biotechnology: an Introduction to Genetic Engineering, Slater, A., Scott, N. W., & Fowler, M. R. (2008), Oxford: Oxford University Press.
8. Biochemistry & Molecular Biology of Plants, Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015), Chichester, West Sussex: John Wiley & Sons.
9. Animal Cell Biotechnology: Methods and Protocols, Pörtner, R. (2007),Totowa, NJ: Humana Press.
10. Culture of Animal Cells by R.I. Freshney. Wiley – Liss.
11. Animal Cell Culture – A Practical approach Ed. by John R.W. Masters (IRL Press).
12. Animal cell culture techniques, Ed. Martin Clynes, Springer.
13. Stem cells in regenerative medicine by Audet (Springer).
14. Cell and tissue reaction engineering by Eibl (Springer).

Course outcomes:

The student will be able to

1. Learn important milestones in the plant tissue culture and understand the concepts and principles of Plant tissue culture.
2. Learn different pathways of plant regeneration under in vitro conditions – organogenesis, somatic embryogenesis, synthetic seeds and applications, techniques of virus elimination by meristem and shoot tip culture.
3. Acquire knowledge on the biology of stem cells
4. Acquaint with Nuclear transfer technology, stem cell therapies and animal cloning

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	3	3	3	3	2	3	-	1	3	-	-
CO_2	3	3	3	2	2	2	2	-	1	2	-	-
CO_3	3	3	3	2	2	2	2	-	1	2	-	2

CO_4	3	3	3	3	3	2	3	-	1	3	3	3

Core 3P: PRACTICALS RELATED TO GENETIC ENGINEERING, PLANT CELL AND TISSUE CULTURE & FOOD AND INDUSTRIAL BIOTECHNOLOGY

PLANT CELL AND TISSUE CULTURE

1. Organizing Plant tissue culture Laboratory
2. Preparation of Tissue Culture Media
3. Callus Induction
4. Shoot tip culture
5. Embryo / Endosperm Culture
6. Organogenesis
7. Somatic Embryogenesis
8. Cell suspension culture
9. Anther and Pollen cultures

GENETIC ENGINEERING

1. Polymerase chain reaction (PCR) teaching kit
2. RFLP teaching kit
3. RAPD teaching kit
4. Southern blotting teaching kit
5. Elution of DNA from Agarose gel
6. Isolation of RNA from yeast
7. Isolation of plasmid DNA

FOOD AND INDUSTRIAL BIOTECHNOLOGY

1. Isolation of surface flora of vegetables
2. Determination of quality of milk sample
3. Production of pectinase enzyme from a pathogen
4. Estimation of amylase activity produced by bacillus subtilis
5. Production of catalase by bacteria
6. Cellulase production test [Degradation of cellulose]
7. Estimation of protein content in spirullina

References:

1. Atlas Ronald M. (2004)
Handbook of Microbiological Media (Third Edition) CRC Press London, New York, Washington DC
2. De Kalyan Kumar- An Introduction to Plant tissue culture (1995)
3. Narayanaswamy S. (1998), Plant cell and Tissue culture
4. Smith Roberta H. (2005), Plant Tissue Culture
Techniques and Experiments Second Edition
Academic Press An Imprint of Elsevier New Delhi India

GENERIC ELECTIVE 4 a: BIOPROCESS ENGINEERING AND TECHNOLOGY

Course Objectives:

1. To impart knowledge about Isolation, screening and maintenance of industrially important microbes
2. To make the student to learn about fermentation technology
3. To educate the student to gain knowledge in reaction kinetics, kinetics of enzyme catalyzed reactions
4. To familiarize with the concepts and the techniques of bio separation

UNIT -1: 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.

UNIT - II: Bioreactor designs; types of fermentation and fermenters; Concepts of basic modes of fermentation – batch, fed batch and continuous; conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design - mechanically agitated; pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization: Upstream processing; media formulation; sterilization; aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

UNIT - III: Kinetics of Enzyme catalyzed reactions - immobilization - Kinetics of immobilized enzyme catalyzed reactions - Kinetics of balanced growth - Transient growth kinetics. Gas-liquid mass transfer in cellular systems - Aeration – Agitation - Estimation of oxygen transfer rates.

UNIT - IV: Bioseparation - filtration, centrifugation, sedimentation, flocculation; cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; reverse osmosis and ultra filtration; drying; crystallization; Storage and packaging; Treatment of effluent and its disposal. Large scale production and purification of recombinant therapeutics (streptokinase, epidermal growth factor, insulin)

REFERENCES:

1. Bio processing Engineering principles. 1995. P.M.Doran. Har court Brace. PP 464
2. Biochemical engineering . 1992. James .M.Lee Prentice -Hall.
3. Biochemical engineering Fundamentals, 2ed 1986 J.E.Bailey and D.F.Oilis. Me Graw-Hill Publication.
4. Chemical Process Control: An Introducation to theory and practice. 1984.G.Stephanopoulos, Prentice-hall.
5. Modelling and controlling of fermentation Process. Ed. J.R.Leigh
6. Biochemical Engineering by S.Aiba, AE Humphery, NF Millis, University, of Tokyo Press.
7. Chemical Engineering by JM Coulson and JF Richarson ,Pergamen Press.
8. Fundamentals of Biotechnology by P.Prave , U.Faust W.Sitting and DASukatsch, VCH.
9. A Text Book on Biotechnology by HD Kumar, Affliated East West Press Private ltd.

Course outcomes:

The student will be able to

1. Handle the axenic cultures of industrially important microbes and appreciate the relevance of microorganisms from industrial context.
2. Gain an overview on design, operations and types of fermentation systems
3. Calculate yield and production rates in a biological production process, and also interpret data
4. Apply knowledge on separation and purification of end products of fermentation

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	3	3	3	3	-	-	-	1	1	-	-
CO_2	3	3	3	3	2	-	-	-	1	1	-	-
CO_3	3	3	3	3	2	-	-	-	1	1	-	-
CO_4	3	3	3	3	3	-	-	-	1	1	-	-

GENERIC ELECTIVE b: LEGAL, ETHICAL & MORAL IMPLICATIONS OF BIOTECHNOLOGY

Course Objectives:

1. To make them understand the concept of intellectual property rights and its importance in biotechnology
2. To acquaint them to identify legal and ethical issues raised in Biotechnology
3. To make them know the social and moral implications in biotechnology research.
4. To impart knowledge on pros and cons of genetically modified foods and microbes

UNIT - I: Intellectual property rights - Definition - types -patents - copy rights-trade marks: essential requirements for IPR, procedures of filing patents-provisional and complete specifications-Pan-Co-operation treaty (PCT)-application: GATT and IPR: WTO Act - Global and Indian Biodiversity Act-Indian Patnt Act and their revised versions.

UNIT - II: Legal and Ethical aspects of Biotechnology -Prenatal diagnosis - Genetic screening - Surrogate mothers and exploitation of women - designing of plants and animals- gene therapy - cloning - Manipulation of human genome -Technology transfer.

UNIT - III: Social and Moral aspects of Biotechnology -Biotechnology and International trade - Privatisation and patenting of Biotechnology products - Role of Government, Industries and society in promoting, accepting and regulating the rDNA research.

UNIT – IV: Environmental and Health aspects of Biotechnology - Generally engineered organisms - Introduction of novel species and natural equilibrium - Environmental security and safety - Precautionary measures - Genetically modified foods - health safety.

REFERENCES:

1. Gene cloning - Brown
2. Concepts in Biotechnology- Balasubramanyam.D
3. Basic Biotechnolgy - Colin Rotledge and Kristainsen

4. Gene Biotechnology - Jogdand
5. From Genes to Clones, Introduction to Gene Technology-Winnacker, Ernst.L
6. Safety, Moral, Social and Ethical issues related to geneticalls modified foods - Smith J.E.
7. Molecular Biology and Biotechnology - Meyer R A
8. Environmental Biotechnology- Forster and wase
9. Biotechnological Innovations in Environmental Management - Leach and Van Dam-mieras
10. Industrial Microbiology and Biotechnology- Demain and Solomon

Course outcomes:

The student will be able to

1. Develop awareness on types IPR and patenting process
2. Understand legal and ethical controversies in biotechnological innovations
3. Apply knowledge in providing safety of food, water and environment
4. Gain overview of GM crops and microbes and their impact on environment

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2	3	1	2	-	-	-	1	1	-	-
CO_2	2	2	3	1	2	-	-	-	1	1	-	-
CO_3	2	2	3	1	2	-	-	-	1	1	-	-
CO_4	2	2	3	2	2	-	-	-	1	1	-	-

GENERIC ELECTIVE c: FOOD AND INDUSTRIAL BIOTECHNOLOGY

Course Objectives:

1. To impart knowledge about the principles of food preservation and processing
2. To make the student to be learn about various aspects of the Nitrogen fixation and mass production of bio fertilizers
3. To educate the student about bioenergy and its production.
4. To give insight on role of microorganisms in environment and their applications in food and dairy Industry

UNIT - I: Scope of biotechnology in the food and drink industry: Contamination of foods by pesticides, fertilizers, industrial waste and chemical contaminants. Principles under lying food spoilage - chemical, physical and physiological changes caused by microorganisms. Control measures for food poisoning. Principles of food preservation, foods produced by microorganisms. Milk and Dairy products, Cereal products, Brewing, Protein products, Food additives and ingredients, Fruits and vegetables, large scale cultivation of edible mushrooms, meat and sausage products.

UNIT - II: Nitrogen fixation and mass production of biofertilizers - diazotrophic microorganisms, Biochemical aspects of diazotrophy. Genetics of free living and symbiotic diazotrophs. Blue Green

Algae and Azolla, Micorrhizae, Vermiculture, Mass cultivation of commercially valuable macro and micro algae for agar agar, alginates, single cell protein and other products.

UNIT - III: Energy and Biotechnology : Biomass, solar energy technology, Agriculture and forestry, conversion to fuel, bio fuel cells and other devices. Biogas production – design and types of biogas digesters. Production of biohydrogen. Microbial leaching, Metal transformation, accumulation and immobilization by microbes. Application of microbes in mining and petroleum industry. Microbial enhanced oil recovery. Biodegradation of xenobiotic compounds, Hazards from xenobiotics.

UNIT - IV: Materials and Biotechnology : Biomolecules production - microbial polysacchrides, organic acids, amino acids, vitamins, antibiotics, enzymes, alcohols, food flavours, significance of Agrobacterium in enhancing food quality and yield Microbial toxins. Pharmaceuiticals - vaccines, hormones, diagnostics. Applications of enzymes in industry and medicine; immobilized enzymes - their preparation and applications. Use of microbes in biodegradation of organic wastes. Industrial production of fungal, bacterial and viral biopesticides.

REFERENCES:

1. Fermentation : A Practical approach. 1990. B. Me Neil and L.M. Harvey. IRL Press. PP 226.
2. Biofertilizers in Agriculture and Agroforestry. 3ed. 1994. Subbarao. Oxford & IBH Publications.
3. Manual of Industrial Microbiology and Biotechnology. 1986. Edited by Arnold L. Demain and Nadine. A. Solomon. PP 466,
4. Bioreactors in Biotechnology-A Practical Approach. AR. Seregg.
5. Downstream Process : Equipment and Techniques. Advances in Biotechnological Process. Vol. 8,1988. Ed. A. Mizrahi, Alan R. Liss. Ince.
6. Biotechnology and the Food Industry. 1989. Ed.P.L.Rogers and G.H. Plat, Gordon & Breach. Sci. Publication.
7. Principles of fermentation technology. 1984. P.F. Stanbury and A. Witaker. Perman Press.
8. Biochemsitry and genetic regulation of commercially important antibiotics. 1983. L.C. Ving,
9. Enzymes in industry and Medicine. 1987. G.F. Bickerstaff. Edward Arnold Publishers.
10. Biotechnology: Principles and Applications, 1994, by J. Hrggins, D.J. Best and J. Jones.
11. Fundamentals of Biotechnology, 1987. P. Prave, V. Paust, W. Sitting and D.A. Sukatsch (eds). VCH.
12. Crueger, W., and Crueger: Biotechnology; A Textbook of Industrial Microbiology, 2nd ed. Sinauer Associates. Inc. Sunderiand Mass/1990.
13. Demain, A.L., and N.A. Solomon, eds., Manual of Industrial Microbiology and Biotechnology, American Society for Microbiology. Washington. D.C., 1986.
14. Frazier, W.C.,.and D.C. Esthoff: Food Microbiology, 4lh ed., Me Graw-Hill, New York, 1988.
15. U.S. Congress, Office of Technology Assessment: "Biotechnology in a Global Economy" OTA-BA-494, Government Printing Office, Washington, D.C., 1991.
16. Industrial microbiology, Prescott and Dunn. 1997. Ed. Gerald Reed.

Practical Course

1. Manual of Industrial microbiology and biotechnology. 1986. Edited by Arnold L. Demain and Nadine. A. Solomon. PP466.
2. Vanderzant, C., and D. Splittstoesser.: Compendium of Methods for the Microbiological Examination of Foods, American Public Health Association, Washington, D.C. 1992.

Course outcomes:

The student will be able to

1. Acquire knowledge on food preservation, processing and control measures for food poisoning
2. Establish indoor and outdoor cultivation units for algal cultivation
3. Learn effective management of solid waste for energy production.
4. Appreciate the industrial role of microorganisms in production of biomolecules

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2	3	3	2	-	-	-	1	1	1	-
CO_2	3	2	3	3	2	-	-	-	1	1	1	-
CO_3	3	2	3	3	2	-	-	-	1	1	2	-
CO_4	3	2	3	3	2	-	-	-	1	1	2	-

OPEN ELECTIVE a: PLANT TISSUE CULTURE

Course Objectives:

1. To impart knowledge about the organization of Plant Tissue Culture Lab.
2. To give insight of nutrient requirements and factors influencing plant tissue culture.
3. To develop skill on micropropagation of forest trees, medicinal plants and endangered plants.
4. To educate the student to learn methods to in vitro germplasm conservation and production of secondary metabolites through cell culture.

UNIT - I: Introduction to plant tissue culture: Preparatory techniques - cleaning, sterilization, sterile handling tissue culture lab requirements. Media - Composition, preparation and sterilization.

Genetic manipulation through tissue culture techniques - Concepts of differentiation and dedifferentiation. Callus - growth pattern/characteristics, Organogenesis and plant regeneration.

UNIT-II:

Somatic embryogenesis. Anther, endosperm and pollen cultures, Significance and advantages of haploid plants. Production of virus-free plants by meristem tip and other tissue culture techniques.

UNIT - III: Micropropagation

Cell culture techniques for micropropagation of elite plants - Food and fruit crops, forest trees, fibre crops, ornamental plants, medicinal plants and endangered plants.

Cell culture techniques for production of useful compounds - Hairy root cultures - transformed roots using Agro bacterium rhizogenesis - Production of secondary metabolites of commercial importance - Elicitors - factors affecting their yield, immobilized cell systems, bioreactors.

UNIT-IV:

Selection of clones for nutritional, disease resistance, salt and drought resistance. Germplasm preservation by tissue technology, Artificial synthetic seeds. Protoplast culture -isolation of protoplasts, culture and fusion methods, Somatic hybrids and cybrids

Course outcomes:

The student will be able to

1. Learn important milestones in the plant tissue culture and understand the concepts and principles of Plant tissue culture.
2. Learn different pathways of plant regeneration under in vitro conditions – organogenesis, somatic embryogenesis, synthetic seeds and applications.
3. Understand techniques of establishing cell suspension culture, techniques of virus elimination by meristem and shoot tip culture.
4. Acquire skill of propagation of elite medicinal and economically important plants and establish micropropagation unit for commercialization.

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2	3	3	2	-	-	-	1	1	1	-
CO_2	3	2	3	3	2	-	-	-	1	1	1	-
CO_3	3	2	3	3	2	-	-	-	1	1	2	-
CO_4	3	2	3	3	2	-	-	-	1	1	2	-

OPEN ELECTIVE b: BIOETHICS

Course Objectives:

1. To impart knowledge about intellectual property rights
2. To make the student to learn about legal and ethical aspects of Biotechnology
3. To educate the student about Social and Moral aspects of Biotechnology
4. To train students on Environmental risk assessment and food and feed safety assessment.

UNIT - I: IPR

Intellectual property rights - Definition - types -patents - copy rights-trade marks: essential requirements for IPR, procedures of filing patents-provisional and complete specifications-Pan-Co-operation treaty (PCT)-application: GATT and IPR: WTO Act - Global and Indian Biodiversity Act-Indian Patnt Act and their revised versions.

UNIT - II: Ethics

Legal and Ethical aspects of Biotechnology -Prenatal diagnosis - Genetic screening - Surrogate mothers and exploitation of women - designing of plants and animals- gene therapy - cloning - Manipulation of human genome -Technology transfer.

UNIT - III: Society and Government roles

Social and Moral aspects of Biotechnology -Biotechnology and International trade - Privatisation and patenting of Biotechnology products - Role of Government, Industries and society in promoting, accepting and regulating the rDNA research.

UNIT – IV: Health Measures

Environmental and Health aspects of Biotechnology - Generally engineered organisms - Introduction of novel species and natural equilibrium - Environmental security and safety -Precautionary measures - Genetically modified foods - health safety.

REFERENCES:

1. Gene cloning - Brown
2. Concepts in Biotechnology- Balasubramanyam.D
3. Basic Biotechnolgy - Colin Rotledge and Kristainsen
4. Gene Biotechnology - Jogdand
5. From Genes to Clones, Introduction to Gene Technology-Winnacker, Ernst.L
6. Safety, Moral, Social and Ethical issues related to geneticalls modified foods - Smith J.E.
7. Molecular Biology and Biotechnology - Meyer R A
8. Environmental Biotechnology- Forster and wase
9. Biotechnological Innovations in Environmental Management - Leach and Van Dam-mieras
10. Industrial Microbiology and Biotechnology- Demain and Solomon

Course outcomes:

The student will be able to

1. Acquire the knowledge on IPR and procedures for patent filing
2. Understand the Legal and Ethical aspects of gene therapy - cloning - Manipulation of human genome -Technology transfer.
3. Learn role of Government, Industries and society in promoting, accepting and regulating the rDNA research
4. Develop understanding on Environmental and Health aspects of Biotechnology

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	2	3	3	2	-	-	-	1	1	1	-
CO_2	3	2	3	3	2	-	-	-	1	1	1	-
CO_3	3	2	3	3	2	-	-	-	1	1	2	-
CO_4	3	2	3	3	2	-	-	-	1	1	2	-

OPEN ELECTIVE c: BIOINFORMATICS

Course Objectives:

1. To gain working knowledge on computational tools and methods
2. To gain knowledge about various Biological databases that provide information about nucleic acids and protein
3. To get exposed to computational methods, tools and algorithms employed for Biological Data Interpretation
4. To provide knowledge about the basics of sequence alignment and analysis.

UNIT I: Basics of Personal computer and its components

Concept of programming languages, hardware and software. The basics of operating system. Windows operating systems commands to create and handle directory and files, creation of biological data bases and MS access.
MS office: introduction and facilities available, shortcut bar, customizing tool bars, starting an office file, MS word, Excel, Power point

UNIT II:
Introduction to internet and biologists: Basics on internet, getting into the internet, email, file transfer protocols, gopher, www, browsing and downloading from the sites
Networking of computers and overview of networks: Virtual library I, II, III and information networks: www, http, html, URLs, EMB net, NCBI net, Virtual tourism.

UNIT III: Databases and predictive tools
Sequence Analysis: Homology, Gap Penalty, Scoring matrices (PAM, BLOSUM), Dot matrix method, Dynamic programming using Needleman-Wunsch algorithm, Scoring methods of MSA (Sum of Pair), BLAST and FASTA.
Molecular Modeling and Molecular Docking: Structure alignment: superimposition and RMSD calculations, DALI, Classification of 3-D structures of proteins, SCOP, CATH, Structure Prediction of Protein Structure (Chou-Fasman), Homology modelling.

UNIT IV:
Phylogenetic analysis: phylogenetic models, multiple alignment procedures, (CLUSTAL, ALIGN, PHYLIP), tree building methods, trees evaluation, rooting trees, phylogenetic software.
Predictive methods: Detecting regulatory elements in the DNA, Physical properties of proteins based on proteins based on sequences, differential protein structural motifs, RNA binding domains and folding classes, transcription factors and their DNA binding, protein structure predictions.
Applications of Bioinformatics: Cheminformatics, Big data analysis, Microarray - Data analysis, Theory and Algorithms, motif analysis and presentation.

Reference

1. Robert B Northrop, Anne N Connor: Introduction to Molecular Biology, Genomics and Proteomics for Biomedical Engineers, CRC Press.
2. Brown TA, Genomes, 3rd Edition, Garland Science, 2006.
3. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
4. Discovering Genomics, Proteomics and Bioinformatics, 2nd edition-A. Malcolm Campbell and Laurie J. Heyer (ISBN 0-8053-4722-4)-Cold Spring Harbor Laboratory press and Benjamin Cummings, 28 Feb 2006.
5. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and
6. Bioinformatics, 2nd Edition, Benjamin Cummings, 2007.
7. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.

Course outcomes:

The student will be able to

1. Develop understanding about Biological data and database search tools
2. Acquire hands on training on various computational tools and techniques employed in Biological sequence analysis
3. Learn about pathway and enzyme databases, Sequence submission tools
4. Develop understanding on protein folding and its significance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
S. No	**Components of Study**	**Title of the Paper**				**Instruction hours per week**		**Credits**	**Internal Assessment Marks**		**End Semester Exam Marks**		**Total**
CO1	3	2	3	3	2	-	-	-	1	1	1	-	
CO2	3	2	3	3	2	-	-	-	1	1	1	-	
1	**Core 1**	Environmental Biotechnology				6		4		20		80	100
CO3	3	2	3	3	2	-	-	-	1	1	2	-	
CO4	3	2	3	3	2	6	-	4	1	20	2	80	100
2	**Core 2**	Plant Biotechnology				6		4		20		80	100
3	**Core 3**	Project work				6		4		-		-	100
PO Attainment													
5	**Generic**	a) Pharmaceutical				6		4		20		80	100

Semester-IV

	Elective (Two papers out of three)	Biotechnology b) Animal Biotechnology c) Applications of Biotechnology D) Practical related to Environmental Biotechnology & Plant Biotechnology	6	4	20	80	100
6	**Open Elective to others (For other department students)**	a) Tools in Biotechnology b) Immunology c) Applications of Biotechnology	6	4	20	80	100
	Total		36	24	-	-	600

Core 1: ENVIRONMENTAL BIOTECHNOLOGY

Course Objectives:

1. Make them understand the concept, organization and energy flow in an ecosystem
2. Impart knowledge on the process of biodegradation and bioremediation
3. Equip with the knowledge on biological control and scope of bio fertilizers in agriculture
4. Educate about different types of wastes and their ecofriendly management

UNIT -1: Ecosystem and energy flow

Structure of model ecosystem - terrestrial, aquatic ecosystems - Energy flow - Degradation of ecosystem. Consequences - Ecosystem managements - Energy conservation - Alternative energy sources - Biofuels: Production of bioethanol, boibutanol from agriculture waste - Problems and perspectives - Biodiesels: mass cultivation of *Jatropa* and use of *Jatropa*, marine algae for producton of biodiesel.

UNIT-II: Biodegradation and remediation

Nature of recalcitrant compounds - Anthropogenic activities generating recalcitrant chemical waste - BHC, DDT, nitrophenols, polycyclic aromatic carbons. Biodegradation - microbial conversion of recalcitrant toxic compounds into TCA cycle intermediates eg: *Pseudomonas putida*. Bioremediation, Degradation pathways - napthaline, BHC, and nitrophenols. Use of microbes for reconstruction of ecosystems - Genetics of biodegradation. Microbes as biosensors for detecting pollution. Superbug – cleaning of oil spills.

UNIT - III: Biopest and Biofertilizers regulation

Biological methods of pest management - Role of Juvenile hormones, pheromones and its analogues for pest management, Chromosomal manipulation and androgenesis of pest , sterile male technology, Biological control of weeds. Bacterial (BT), viral, fungal insecticides - Technology for mass production and formulation of biopesticides - Problems and prospects.

Biofertilizers - Important diazotropic, microbes - mechanism of symbiotic and asymbiotic biological nitrogen fixation - Regulation of nitrogen fixing genes (Nif genes). Manipulation of Nif genes for constitutive expression of nitrogenase - Ammonia transport and its significance. Mass production of biofertilizers - *Ribozium, Azolla.*

UNIT - IV: Waste disposal

Waste management - Nature and classification of agriculture, domestic and industrial waste - Recycling methods. Solid waste treatment. Biological and non-biological methods of waste water treatment. Reclamation of treated waste water.

REFERENCES:

1. Biotechnology from A to Z. 1993. William Bains, IRL Press, Oxford, England PP 358.
2. DNA Science : A first course in Recombinant DMA technology. 1990. D.A. Micklos and G.A. Freyer. Carolina Biological Supply Co., Burlington, NC, PP 477.
3. DNA finger printing: An Introduction. 1990. L.T. Kirby, Stockton Press, New York, NY PP 365.
4. Molecular biotechnology principles and applications of recombinant DNA. 1994. B.R. Glick and J.J. Pasternak. Panima book distributors. PP 500.
5. Fundamentals of biotechnology. 1987. P. Prave, V. Faust, W. Sitting and D.A. Sukatsch. Ed. WCH. Weinhein.
6. Principals of Genetics. 8th ed. 1991. E.J.G. Gardner, M.J. Simmons and D.P. Snustad. John Wiley and Sons. PP713.
7. Biotechnology. 1988. J.E. Smith. Edward Arnold. London.
8. Molecular Cloning : A Laboratory manual. 1989. 2nd ed. J. Sambrook, E.F. Fritsch and T. maniatis. Cold Spring Harbor Laboratory Press. 3 Volumes.
9. Principles of Gene Manipulation. 1991. R. W. Old and S.B. Prim-Roses. 2nd ed. Blackwell Scientific Publications.
10. Methods in Enzymology. Vol. 152. Guide to molecular cloning techniques. 1987. S.L. Berger and A.R. Kimmel, eds. Academic Press.

Course outcomes:

The student will be able to

1. Learn the relation between biotic and abiotic factors in different ecosystem models and predict how changes in free energy availability affect ecosystems.
2. Appreciate the role of microorganisms in biodegradation and pollution detection
3. Develop skill on large scale production and applications of bio pesticides and bio fertilizers fin agriculture
4. Apply knowledge on solid waste management and reclamation of waste water

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	2	3	3	2	-	-	-	1	1	1	-
CO_2	3	2	3	3	2	-	-	-	1	1	1	-
CO_3	3	2	3	3	2	-	-	-	1	1	2	-

CO_4	3	2	3	3	2	-	-	-	1	1	2	-

Core 2: PLANT BIOTECHNOLOGY

Course Objectives:

1. To impart knowledge about transgenic plants: herbicide, pest and disease resistant, abiotic stress resistant, nutritional enhancement and traits for improved quality
2. Impart knowledge on biosynthesis of plant compounds
3. Improve understanding on the role of algae as food, feed and medicine
4. Train in identification of plant pathogens using immunological and molecular techniques

UNIT - I: Introduction to Plant Biotechnology

Concepts and scope of plant biotechnology -Application of genetic engineering technology for crop improvement - production of transgenic plants resistant to herbicides, pathogens, pests and abiotic stresses (drought, salt, frosts); production of transgenic plants with improved yields and nutritional quality; transgenic plants for production of viral antigens.

UNIT - II: Role of Industry on Plant Biotechnology

Industry and Plant Biotechnology: Biosynthesis of plant compounds – Selection of cell lines for high yields of secondary metabolites – Enzymes from palnts – Food and food additives from plants – Breeding strategies for enhancing the active principles in plants.

UNIT - III: Algal Biotechnology

Algae as a source of food, feed, single cell proteins, biofertilizers, industrial uses of algae.
Mass cultivation of commercially valuable marine microalgae for agar agar, alginates and other products of commerce and their uses. Mass cultivation f macroalgae as a source of protein and feed. Indoor and out door cultivation of economic important alage – Use of alage in waste water treatment.

UNIT - IV: Plant pathology

Nutrient film culture techniques - plant diseases – Physiology of infection in plants – disease resistance in plants - phytodiagnostics based on immunological and molecular techniques. Biological control of pests and diseases of crop plants and weeds - biopesticides - predators, parasites, insect viruses, antagonistic fungi and bacteria, antifeedants, and insecticidal activities of the compounds of Botanicals.

REFERENCES:

1. Molecular approaches to crop improvement. 1991. Dennnis andLiwellyeds. PP. 164.
2. Plant cell and Tissue culture. A Laboratory Manual. 1994. Reinert. J. and Yeoman, M.M. Spring.
3. Plant biotechnology, 1994. Prakash and Pierik. Oxford & IBH Publishing Co.
4. Gene transfer to plants. 1995. Potrykus-l and Spangenberg, G. Des. Springer Scan.
5. Methods in Plant Molecular Biology and biotechnology, 1993. R. Bernard Click and Joh. E. ;Thompson, CRC, Press, PP. 384.

6. Genetic engineering with plant viruses. 1992. T. Michale. A. Wilson and J.W. Davies. CRC Press Inc, PP 384.
7. Plant cell Biotechnology. 1988. Borocoitzka M.A. and Borocoitzka L.J. Cambridge University Press.
8. Microaigal Biotechnology. 1988. Borocotizka M.A. and Borocoitzka L.J. Cambridge University Press.
9. Algal and Cyanobacterial biotechnology, 1989. Cresswell. R.C, Rees, T.A.V. and Shah, N.Eds. Longman Scientific and Technical, Essex, London.

Course outcomes:

The student will be able to

Students will be able to

1. Develop skill in production of transgenic plants resistant to biotic and abiotic stress
2. Apply knowledge for industrial production of plant metabolites
3. Cultivate the micro and macro algae of commercial importance on large scale
4. Identify different plant pathogens and apply biological control methods

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	2	3	3	2	-	-	-	1	1	1	-
CO_2	3	2	3	3	2	-	-	-	1	1	1	-
CO_3	3	2	3	3	2	-	-	-	1	1	2	-
CO_4	3	2	3	3	2	-	-	-	1	1	2	-

Core 3: PROJECT WORK (100 marks):

Marks allotted to thesis preparation-80 (40 marks for the progress performed by the student in laboratory will be awarded by project research supervisor and another 40 marks for content of the thesis)

Marks allotted to viva presentation-20

GENERIC ELECTIVE a: PHARMACEUTICAL BIOTECHNOLOGY

Course Objectives:

1. To impart knowledge on production of pharmaceutical products by biotechnological applications
2. Provide training in clinical testing of pharmaceutical products
3. Give insight on the drug designing and development
4. Explain the comprehensive overview on the conventional and recombinant vaccines and bioethical issues

UNIT -I

Definition - History of development of Pharmaceutical Products by biotechnological methods like genetic recombinant vaccines, microbial and non-microbial products - scope of biotech products and biochemical in pharmaceutical industry. Need to design a drug, drug receptor interactions, antagonisms, biological activity, efficacy and stimulus, recepors and ion channels, ion gating co-operatively effect of solvent on drug - receptor interactions, drug docking.

UNIT- II

Methods of testing products for abti-microbial potentials, pharmacological activities and biopesticidal properties -conventional and rapid enzyme inhibitor techniques; in vivo methods - use of animals models for confirmation of in vitro properties - transgenic systems - preclinical, toxicological studies, Acute, subacute, chronic studies. Clinical trials -definition - design - specific objectives - types of clinical trials -phase I, II & II - randomised controlled clinical trails - multicentric double nlind clinical trials - pharmaceutical/drug regulations for commercialising new biotech products for human use - PDA and Indian regulations.

UNIT – III

Biotech products as medicines and pharmaceutical products: Biochemicals - enzymes like proteases - chemical like ethanol, vinegar, citric acid and glutamic acid; vitamins like B12; drugs for infection and metabolic, immunomodulatory -insulin - interferons, B-cell growth factors, Tissue plasminagen activator. r-DNA based production of regulatory protins, blood products, hormones, vaccines, Application of RELP in forensic, disease prognosis, genetic counselling, pedigree, variation.

UNIT - IV

Vaccines - cell culture based vaccines - genetic recombinant vaccines - recombinant vector based vaccines -live and subunit - their production model - fermentation technology - expression systems - guideline for the production of genetic recombinant vaccines - Eg. Hepatitis B vaccine, HIV vaccine and other vaccines in pipeline. Application of biotechnology to Animal health and disease diagnosis, Development of kits and their application in disease diagnosis. Gene theraphy, vector engineering, strategies of gene deliver, gene replacement, augmentation, gene correction, gene regulation and silencing safety and bioethical issues in biotechnology.

REFERENCES

1. Biopharmaceuticals- Walsh , John Willey and Sons, New York 1998
2. Pharmaceutical Biotechnology- Daan J.A.Crommelin, RobestD. Sindelar, Daan JACrommelinAmazon.
3. Physical Methods to charecterize Pharmaceutical Protines- James. N.Herron, Wim Jiskoor and Daan J.A.Crommelin Amazon. Wm From clone to clinic (Developments in Biotherapy)-Daan J.A.Crommelin and H.Schellekom Amazon.Wm.
4. Hand Book of Pharmaceutical Biotechnology- Jay P.Rho, Star4lonie The Haworth press.
5. Alice Sr. Bringhamtpn, NY13904JUS Drug discovery, Tamas bartifai, Harold L.Dorn's The Scientific world Ltd., Newburry, U.K.

Course outcomes:

The student will be able to

1. Gain knowledge on preparation and formulations of different drugs
2. Develop skill on commercial production of pharmaceutical products for human welfare
3. Learn the techniques of drug validation and vaccine production

4. Understand the bioethical principle, values, concepts and social and judicial implications of pharmaceutical biotechnology

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	3	2	3	3	2	-	-	-	1	1	1	-
CO_2	3	2	3	3	2	-	-	-	1	1	1	-
CO_3	3	2	3	3	2	-	-	-	1	1	2	-
CO_4	3	2	3	3	2	-	-	-	1	1	2	-

GENERIC ELECTIVE b: ANIMAL BIOTECHNOLOGY

Course Objectives:

1. Develop understanding on the structure and functions of male reproductive system and methods of contraception
2. Make them learn the principle and methods of animal cloning
3. Provide knowledge on gene cloning and production of transgenic animals
4. Impart the knowledge on role of biotechnology in health care system

UNIT - I

Structure and function of male reproductive system - Hormonal regulation of spermatogenesis and spermeiogenesis; Inhibin and androgen binding proteins; Capacitation of spermatozoa. Structure and function of female reproductive system - influence of hormones on development of ovarian follicles and oogenesis; Reproductive cylces; estrus and menstrual cycle; Ovulation, atresia and corpus luteum formation; Pregnancy and lactation; Implantation and placentation. Contraception in males and females; Hormonal and chemical; Recent advances in contraception research.

UNIT - II

Introduction - Sex determination; Principles of animal breeding; Structure of the live stock breeding industry: dairy cattle, beef cattle, swine, sheep and poultry. Selection for qualitatively inherited characters - Gene frequency and selecting against recessive genes; detecting heterozygotes for recessive; parental determination and verification; the use of markers and/ or molecular probes, selction criteria: multiple records, pedigree selection, family selection; progeny testing: breeding value, transmitting ability and heritability; correlated characters; selection for maternal ability; factors affecting selection response; genotypes - environment interactions. Artificial insemination (AI) techniques and their development; Estrus synchronization; Semen collection, evaluation, storage, *in vitro* fertilization, Embryo transfer - ICSI and preservation of endangered species.

UNIT-III

Animal cloning and application in wild life and life stock: Overview; Challenges in human therapeutic cloning; Somatic cell nuclear transfer in humans; Pronuclear early embryonic development. Nuclear transfer technology: Transfer of nuclei into eggs; development potential of

transplanted nuclei; reprogramming a nucleus. Development of transgenic mice and other animal models: by injection of foreign DNA/gene into zygote; optimization of construct for *in vivo* expression. Generation of chimeric, transgenic and knockout mice and other animals and their characterization. Potential application of transgenic animals: Models for various diseases/disorders, Production of peptides and proteins of biopharmaceutical interest (molecular pharming), Transgenic fishes, Transgenic poultry and Transgenic insects as bioreactors.

UNIT - IV

Applications of biotechnology to animal health - Production of vaccines, diagnostics, hormones and other products. Animal nutrition and biotechnology - Microbial supplements, non-genetic and genetic manipulation of rumen microbes, Utilization of animal waste as live stock feed.

REFERENCES

1. Culture of animal cell: A Manual of Basic techniques. 3rd ed. 1994. R.I. Reshnery, Alan R. liss. Inc. New York, NY, 397.
2. Recombinant and synthetic vaccines 1994. G.P. 1 Taiwan K.V.S. Rao, V.S. Chauhan, Eds. PP. 528. Springerscan Publication,
3. Animal Cell Biotechnology, Vol.6, 1994, R.E. Spier, J.B. Griffiths, Eds. Harcourt Brace. PP

Course outcomes:

The student will be able to

1. Understand the organization of reproductive organs and advances in contraception research
2. Learn the techniques of In Vitro Fertilization and artificial insemination
3. Develop skill in molecular techniques for production of transgenic animals
4. Apply knowledge on molecular farming for production of vaccines and hormones

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	3	2	3	3	2	-	-	-	1	1	1	-
CO_2	3	2	3	3	2	-	-	-	1	1	1	-
CO_3	3	2	3	3	2	-	-	-	1	1	2	-
CO_4	3	2	3	3	2	-	-	-	1	1	2	-

GENERIC ELECTIVE c: APPLICATIONS OF BIOTECHNOLOGY

Course Objectives:

1. To provide understandng on different areas of biotechnology
2. Impart knowledge on the role of biotechnology in agriculture
3. Develop skill on the cell & tissue culture system for vaccine production

4. Give insight on the xenobiotic environmental pollution and methods of degradation of toxic compounds

UNIT – I

History and scope of Biotechnology, Definition of Biotechnology, Old & Modern Biotechnology, Different areas of Biotechnology.

UNIT- II

Biotechnology and Agricultural, Micro propagation, (Cell and Tissue culture) Transgenic plants, Biofertilization, organic farming, Biopesticides.

UNIT - III

Application of Biotechnology in Animal sciences, Animal cell and tissue culture, production of transgenic animals, cloning of animals (IVF & ET) cryopreservation somatic production of animals, application of human vaccines in improving productivity.

UNIT - IV

Biotechnology and Environment: Microbial agents and Biochemical methods of xenobiotic degradation, OEMs, Waste water and solid waste management.

REFERENCES

1. Gene cloning - Brown
2. Concepts in Biotechnology- Balasubramanyam.D
3. Basic Biotechnolgy - Colin Rotledge and Kristainsen
4. Gene Biotechnology - Jogdan
5. From Genes to Clones , Introduction to Gene
6. Technology- Winnacker, Ernst.L
7. Safety .Moral, Social and Ethical issues related to
8. geneticalls modified foods - Smith J.E.
9. Molecular Biology and Biotechnology - Meyer R A
10. Environmental Biotechnology- Forster and wase
11. Biotechnological Innovations in Environmental
12. Management - Leach and Van Dam-mieras
13. Industrial Microbiology and Biotechnology- Demain and Solomon

Course outcomes:

The student will be able to

1. Acquire the knowledge on applications of plant, animal and environmental biotechnology
2. Develop skill on organic farming and preparation of bio pesticides and bio fertilizers
3. Establish and maintain cell lines for vaccine production
4. Apply knowledge on waste management and recycling for environmental protection

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	3	1	-	-	-	-	1	-	-	-
CO_2	2	2	3	1	-	-	-	-	1	-	-	-

CO_3	2	2	1	1	-	-	-	-	1	-	-	-
CO_4	2	2	3	2	-	-	1	-	1	-	-	-

GENERIC ELECTIVE d: PRACTICAL RELATED TO ENVIRONMENTAL BIOTECHNOLOGY & PLANT BIOTECHNOLOGY

ENVIRONMENTAL BIOTECHNOLOGY

1. Determination of total dissolved solids of water.
2. Determination of dissolved oxygen (DO) of water.
3. Determination of biological oxygen demand (BOD) of water.
4. Determination of chemical oxygen demand (COD) of water.
5. Determination of total bacterial population by standard plate count technique.

PLANT BIOTECHNOLOGY

1. Preparation of competent cells of E. coli for harvesting plant transformation vector.
2. Transformation of competent cells of E. coli with plant transformation vectors.
3. Mobilization of recombinant Ti plasmid from common laboratory host (E. coli) to an *Agrobacterium tumefaciens* strain.
4. Agrobacterium tumefaciens-mediated plant transformation.

REFERENCES

1. Biotechnology from A to Z. 1993. William Bains, IRL Press, Oxford, England PP 358.
2. DNA Science : A first course in Recombinant DMA technology. 1990. D.A. Micklos and G.A. Freyer. Carolina Biological Supply Co., Burlington, NC, PP 477.
3. DNA finger printing: An Introduction. 1990. L.T. Kirby, Stockton Press, New York, NY PP 365.
4. Molecular biotechnology principles and applications of recombinant DNA. 1994. B.R. Glick and J.J. Pasternak. Panima book distributors. PP 500.
5. Fundamentals of biotechnology. 1987. P. Prave, V. Faust, W. Sitting and D.A. Sukatsch. Ed. WCH. Weinhein.
6. Plant cell and Tissue culture. A Laboratory Manual. 1994. Reinert. J. and Yeoman, M.M. Spring.
7. Plant biotechnology, 1994. Prakash and Pierik. Oxford & IBH Publishing Co.
8. Gene transfer to plants. 1995. Potrykus-l and Spangenberg, G. Des. Springer Scan.

OPEN ELECTIVE a: TOOLS IN BIOTECHNOLOGY

Course Objectives:

1. To improve understanding on replication initiation point mapping.
2. To gain knowledge on use of DNA microarrays to analyze origin activation patterns
3. To build knowledge on Electron microscopic methods for identifying DNA replication intermediates.
4. To give insight on replication dynamics of gene

Unit I: Methods of Analysis of Replication of Single locus

Replication initiation point mapping: Approach and implications, purification of restriction fragments containing replication intermediates, Topological analysis of plasmid DNA replication intermediates, Analysis of telomeric DNA replication using neutral alkaline 2D gel electrophoresis, chromatin immunoprecipitation of replication factors moving with replication fork, density transfer as a method to analyze the progression of DNA replication fork, High resolution mapping of points of site specific replication, DNA replication in nucleus

Unit II Genome wise analysis methods

Chip-chip to analyze the binding of replication proteins to chromatin using oligonucleotides DNA microarrays, analyzing origin activation patterns by changing experiments. Detection of replication origins using comparative genomics and recombination ARS assay. Isolation of restriction fragments containing origin of replication from complex genomes. Application of alkaline sucrose degradation and analysis of DNA replication after DNA damage.

Unit III Biochemistry and Biophysics Methods

Isolation of recombinant DNA elongation proteins Invitro assays for studying helicase activities, the use of two amino fluorescence to study DNA polymerase function, Single molecule observation of prokaryotic DNA replication, The FAST-HALO assay for the assessment of DNA damage for the single cell level. Electron microscopic methods for studying In vivo DNA replication intermediates.

Unit IV Cell biology and Genetics methods

Visualization of DNA replication sites in mammalian nuclei, measuring of DNA content by Floucytometry in Fission Yeast. Assays used to study replication check point in Fission Yeast. Use of DNA combining to study SNA replication in genus and in human cell free systems. Determining the replication dynamics of specific gene loci by single molecule analysis of replicated DNA.

References

1. DNA replication methods and protocols in Methods in Molecular Biology Edited by John N walker co edited by Soniya and Jacob Gelgard 2009. Humana press, New York.
2. General biochemistry and biophysics methods books.

Course outcomes:

The student will be able to

1. Acquire the knowledge on analysis of DNA replication to map site specific points of replication
2. Learn to apply DNA microarrays to detect replication origins
3. Understand the functions of helicase and polymerase in DNA replication
4. Acquire knowledge on sophisticated programmed of genome replication

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2	3	1	-	-	-	-	1	-	-	-
CO_2	2	2	3	1	-	-	-	-	1	-	-	-
CO_3	2	2	1	1	-	-	-	-	1	-	-	-
CO_4	2	2	3	2	-	-	1	-	1	-	-	-

OPEN ELECTIVE b: IMMUNOLOGY

Course Objectives:

1. To provide knowledge on the types of immunity and the immune organs
2. To demonstrate the structure of antibody types and their interaction with antigen
3. To acquaint them with the hybridoma technique and its clinical applications
4. Explain the concept of hypersensitivity, auto immunity and tumer immunology

UNIT - I: Architecture and types of immune system:

Immunity- innate and acquired, innate immune mechanisms, acute phase reactants, properties of acquired immunity, Toll-like receptors.

Immunogens and antigens – Properties, factors governing immunogenicity, haptens, epitopes-size and identification. Adjuvants-properties and mechanism of action.

Cells involved in the immune response- T cells, B cells, CD antigens, neutrophils, eosinophils and natural killer cells. Macrophages, dendrites, Phagocytosis

Lymphoid tissues- Primary and secondary lymphoid organs, structure and cellular organization. Lymphocyte traffic.

Unit II Humoral Immunity

Functions of antibody in relation to structure. Antigen-antibody interactions- affinity of antibody, avidity, bonus effect, classical precipitin reaction, antigen-binding site of antibody, forces involved in antigen-antibody complex formation

Generation of antibodies, Theories of antibody formation. Monoclonal and polyclonal antibodies. Complement - nature, physicochemical properties, complement cascade pathway, complement fixation.

Antibody response-primary and secondary antibody response, antibody response to haptens, enumeration of antibody-forming cells, T-dependent and T-independent antigens, MHC, Interleukins, cytokines

UNIT - III: *In vitro* serological tests

Principles and applications of serological tests used in identification of pathogenic agents and initial sources of inoculum-precipitation tests in liquid media, single and double diffusion tests using agar gel media,

Immunoelectrophoresis, rocket immunoelectrophoresis, hemagglutination, bentonite and later flocculation tests, complement fixation test, labeled antibody techniques (tests with fluorescent antibody, test with radioisotope-labeled antibody and enzyme-labeled immunoassays ELISA) Immunosorbent electron-microscopy, infectivity neutralization test, and western blotting and immunodetection of viral antigens, relative merits and demerits of the above tests.
Blood groups and isohaemagglution.

UNIT - IV:

Antigen Presentation- pathways of antigen processing and presentation of intracellular and extracellular antigens. Cell mediated immunity (CMI): Induction and mechanism
Hypersensitivity reactions – Classification, Type I – IV reactions. Immunity to bacterial, fungal, viral and parasitic diseases. Allergy: classification and details.
Immune tolerance, immune suppression. Transplantation and G.V.H. reactions.
Immunopathology -Autoimmune diseases; immune complex diseases; immunodeficiency diseases; immunity to infection. Production of vaccines and sera - conventional and biotechnological.

REFERENCES:

1. Advanced immunochemistry. 2nd ed. 1990. E.D. Day, Wiley Liss, Inc. New York. PP 633.
2. Basic and clinical immunology, 7lh ed. 1991. D.P. Stites and A.I. Terr Eds, Appleton and Lange, Norwalk, CT, pp. 870.
3. Clinical immunology : A practical approach. 1990. H.C. Goo, and H. Chapel. Eds. IRL Press, Oxford, PP 263.
4. Immunology: A short course, 2nd. 1991. B. Benjamin and S. Leskowitz, Wiley-Liss, NY. PP459.
5. Immunochemical protocols : Methods in Molecular biology. Vol. 10, 1992, M.M, Manson. Ed. Humanma Press. Totowa, NJ, PP 480.
6. Immunology, 1995, R.B. Gallagher, J. Gilder, G.J.VNossalandG Salvatore. Ed. Academic Press. PP 300.
7. Cellular and Molecular Immunology. 1991. A.K. Abbas, A.K. Lichtman, J.S. Pober, Harcourt Brace. PP480.
8. Hybridoma techniques : A Laboratory Course. 1986. Muthukkar Uppan, U.R. Bhaskar, S. and F. Singaglia. Macmillan India Ltd.,
9. Immunology, 1989.1. Riott, J. BroStoft and Dauid Male. 2nd ed. Churchill Livingston
10. Essential immunology, 1988. 6ltl ed. I.M. Roitt. ELBS.
11. Fundamental immunology. 1992. 2nd ed. R.M. Coleman.
    M.F. Lombard and R.E. Sicard. Wm. C. Brown. Puhlir.atinn
12. Immunology. 1990. R.M. Hyde and R.A. Patnode. 2nd ed. John Wiley and Sons.
13. Immunology -An illustrated outline. 1986. David Male. Churchill Livingstone.
14. Serological methods for detection and identification of viral and bacterial plant pathogens. 1990. R. Mampton, E. Ball and S.De. Boer (eds). American Phytopathological Society.
15. Monoclonal antibodies. 1992. J.H. Peters and H. Baumgarten. Eds. Springer-Verlag. New York. PP488,

Course outcomes:

The student will be able to

1. Out line, compare and contrast the key mechanism of innate and adaptive immunity
2. Apply knowledge in disease diagnosis through serological tests
3. Develop skill in production of monoclonal antibodies

4. Gain knowledge on undesirable immunological reactions and their complications in health management

	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7	PO_8	PO_9	PO_{10}	PO_{11}	PO_{12}
CO_1	2	2	3	1	-	-	-	-	1	-	-	-
CO_2	2	2	3	1	-	-	-	-	1	-	-	-
CO_3	2	2	1	1	-	-	-	-	1	-	-	-
CO_4	2	2	3	2	-	-	1	-	1	-	-	-

OPEN ELECTIVE c :APPLICATIONS OF BIOTECHNOLOGY

Course Objectives:

1. To provide understandng on different areas of biotechnology
2. Impart knowledge on the role of biotechnology in agriculture
3. Develop skill on the cell & tissue culture system for vaccine production
4. Give insight on the xenobiotic environmental pollution and methods of degradation of toxic compounds

UNIT - I: Introduction

History and scope of Biotechnology, Definition of Biotechnology, Old & Modern Biotechnology, Different areas of Biotechnology.

UNIT- II: Plant Biotechnology

Biotechnology and Agricultural - Callus culture, Organogenesis and plant regeneration. Somatic embryogenesis. Anther, endosperm and pollen cultures, meristem tip culture. Micropropagation of elite plants - Food and fruit crops, forest trees, fibre crops, ornamental plants, medicinal plants and endangered plants. Production of transgenic plants resistant to herbicides, pathogens, pests and abiotic stresses, Biofertilization, organic farming, Biopesticides.

UNIT - III: Animal Biotechnology

Application of Biotechnology in Animal sciences, Animal cell and tissue culture, production of transgenic animals, cloning of animals (IVF & ET) cryopreservation somatic production of animals, application of human vaccines in improving productivity.

UNIT - IV: Environmental Biotechnology

Biotechnology and Environment: Microbial agents and Biochemical methods of xenobiotic degradation, OEMs, Waste water and solid waste management.

REFERENCES:

1. Gene cloning - Brown
2. Concepts in Biotechnology- Balasubramanyam.D
3. Basic Biotechnolgy - Colin Rotledge and Kristainsen
4. Gene Biotechnology - Jogdan
5. From Genes to Clones , Introduction to Gene
6. Technology- Winnacker, Ernst.L

7. Safety .Moral, Social and Ethical issues related to
8. geneticalls modified foods - Smith J.E.
9. Molecular Biology and Biotechnology - Meyer R A
10. Environmental Biotechnology- Forster and wase
11. Biotechnological Innovations in Environmental
12. Management - Leach and Van Dam-mieras
13. Industrial Microbiology and Biotechnology- Demain and Solomon

Course outcomes:

The student will be able to

1. Acquire the knowledge on applications of plant, animal and environmental biotechnology
2. Develop skill on organic farming and preparation of bio pesticides and bio fertilizers
3. Establish and maintain cell lines for vaccine production
4. Apply knowledge on waste management and recycling for environmental protection

	PO_1	**PO_2**	**PO_3**	**PO_4**	**PO_5**	**PO_6**	**PO_7**	**PO_8**	**PO_9**	**PO_{10}**	**PO_{11}**	**PO_{12}**
CO_1	2	2	3	1	-	-	-	-	1	-	-	-
CO_2	2	2	3	1	-	-	-	-	1	-	-	-
CO_3	2	2	1	1	-	-	-	-	1	-	-	-
CO_4	2	2	3	2	-	-	1	-	1	-	-	-

MSc Biotechnology :: Model Question paper

Semester I/II/III/IV

Paper BTH: 101 etc

Time 3 Hrs **Max marks 80**

Attempt any five from part A (5 x 4=20 marks) and all from part B (4 x 15=60 marks)

PART A (5 x 4=20 marks)

1. Unit 1

2. Unit 1

3. Unit 2

4. Unit 2

5. Unit 3

6. Unit 3

7. Unit 4

8. Unit 4

PART A (4 x 15=60 marks)

9. Unit 1 A or B

10. Unit 2 A or B

11. Unit 3 A or B

12. Unit 4 A or B