M.Sc. BIOTECHNOLOGY

CURRICULUM

FOR

SEMESTER CHOICE BASED CREDIT SYSTEM

UTKAL UNIVERSITY

Vani Vihar, Bhubaneswar,

ODISHA

Academic Session 2017-18

M.Sc. Course in Biotechnology (Semester system)

Regulation

Eligibility Criteria:

Bachelor's degree under 10+2+3 pattern of education in Physical and Biological Sciences with at least 55% Marks in aggregate or as decided by the Department of Biotechnology, Govt. of India, New Delhi from time to time.

1. The course M.Sc. in Biotechnology under choice based credit system comprises of four semesters for two academic sessions. The Semester System of examination will have Internal and External system of valuation for theory paper only and external system for practical papers as suggested by the Board of Studies. Internal and External Examiners for both theory and practical papers will be appointed by the Board of Studies.

2. In all semesters there will be two Examinations (Total: 100 marks per paper) comprising of one mid semester (30 marks) & End semester (70 marks) respectively. However practical paper in each semester is of 90 marks and 10 marks are allotted for Seminar/Journal club/Summer training report. For each Semester, examination for each paper will be held at the end of the semester. Examination and evaluation of theory papers for each semester will be conducted by the Teacher(s) / Research Scientist(s) of Govt. Institutes engaged in teaching at the University for that paper or as suggested by the Board of Studies.

3. If due to any reason(s), Semester examinations could not be conducted, both semester examinations (Theory & Practical) of the session will be conducted at the end of the Academic Session of that year.

4. The external examiners of practical examination of different examination centres under Utkal University will be from a panel of examiners for each centre. The answer scripts of practical examination of all centres may be re-examined by a Chief Examiner, appointed by Board of Studies.

5. The Institution offering M.Sc. Biotechnology Course under the University is designed on semester pattern choice based credit system.

6. If the University desires, the examination of theory papers of all the centres can be conducted at the Utkal University campus.

7. For passing an examination a candidate must secure a minimum of 40% marks in dissertation / project / practical and 33% marks in aggregate of theory papers at the end of semester. However, minimum pass mark for each theory paper is 30%, securing below 25% in any theory paper will be considered as scratched and he / she will be allowed to repeat the same as per the University Rule.

8. If a candidate passes all the four Semester Examinations, he/ she will be declared to have passed the M.Sc. Examination in Biotechnology.
   (i) In First class securing 60% marks or, more.
   (ii) In Second class securing 48% marks or, more but less than 60%marks.
   (iii) In Third class securing 33% marks or, more but less than 48%marks in aggregate of all the semester examinations taken together.

9. Attendance in each semester shall be strictly adhered to University Rules.

10. A candidate may repeat only once in one or more papers of any semester examination within a period of one year of the said semester examinations. However, if the candidate does not clear the 1^{st} and 2^{nd} semesters, his/ her result will not be published even after successfull completion of the 3^{rd} and 4^{th} semester. In case a candidate is unsuccessful in 3^{rd} and/or 4^{th} semester, he/she will appear in the immediate next examination of the next batch for the same. A candidate failing on any semester examination will be allowed to appear once only in the examination for that semester conducted for the next batch of students and also be allowed to continue to the next semester.

11. Merit list of candidates will be provided as per University rules from among the students those who have cleared all semester examinations in time without repeat of any paper.

12. For Seminar presentation there will be a maximum of 10 marks. Seminar Presentation will be evaluated by Teacher(s) of the Department. The mark obtained in the Seminar will be kept confidentially with the Head of the Department and will be added to the practical paper examination of that semester.

13. As per the the Choice Base Credit System implemented form the Academic Session 2013-2014, the P.G. curriculum in Biotechnology comprises a total of 120 credits with total marks 2000 over a span of four semesters. All the theory, practicals and elective papers in 1st, 2nd and 3rd Semester are compulsory. A student in 3rd semester shall take Core Elective (CE-I). and Allied Elective courses, however during the 4th Semester, besides the project work student has to take Paper-401 (CE-II).

14. Project work in form of a dissertation, duly certified by the supervisor of the work done and Head of the Department in the Institutional letter-head in Original should be submitted on or before 10 days ahead of the examination of the paper through the in-charge of the Examinations of the respective centre.

M.Sc. BIOTECHNOLOGY

COURSE STRUCTURE

1ST SEMESTER: **(500 Marks, 30 Credits)**

Paper-101 Biochemistry (40 Lectures / 6 Credits)
Paper-102 Cell Biology and Genetics (40 Lectures / 6 Credits)
Paper-103 Instrumentation & Analytical techniques (40 Lectures / 6 Credits)
Paper-104 Biostatistics and Computational Biology (40 Lectures / 6 Credits)
Paper-105 PRACTICAL-I (60 Practical Classes / 5 Credits)
Seminar/Journal club/Assignment (1 Credit)

2ND SEMESTER: **(500 Marks, 30 Credits)**

Paper-201 Microbiology (40 Lectures / 6 Credits)
Paper-202 Immunobiology and Immunotechnology (40 Lectures / 6 Credits)
Paper-203 Molecular Biology (40 Lectures / 6 Credits)
Paper-204 Plant Biotechnology (40 Lectures / 6 Credits)
Paper-205 PRACTICAL-II (60 Practical Classes / 5 Credits)
Seminar/Journal club/Summer training report (1 Credit)

3RD SEMESTER: **(500 Marks, 30 Credits)**

Paper-301 Genetic Engineering (40 Lectures / 6 Credits)
Paper-302 Bioprocess Engineering and Industrial Biotechnology (40 Lectures / 6 Credits)
Paper-303 **Core Elective courses (CE-i)**
: Animal Biotechnology (40 Lectures / 6 Credits)
Paper-304 **Allied Elective courses (AE)** (40 Lectures / 6 Credits)
AE-1 Animal Physiology and Developmental Biology (for M.Sc. Biotechnology)
AE-2 Biotechniques ` (for Allied subjects)
Paper-305 PRACTICAL-III (60 Practical Classes / 5 Credits)
Seminar/Journal club (1 Credit)

4TH SEMESTER: **(500 Marks, 30 Credits)**

Paper-401 **(CE-II):** Evolution and Environmental Biotechnology (40 Lectures / 6 Credits)
Paper-402 Project Work (400 Marks, 24 Credits)

- **Dissertation** **[300 marks]**
- **Seminar presentation and Viva Voce** **[50+50 marks]**

<u>Free Electives (Non-Credit course for Students from other disciplines)</u>:

Fundamentals of life science: Origin of life, Living systems and living processes

` **Total Marks: 2000**

Total Credits: 120

1st SEMESTER

M.Sc. BIOTECHNOLOGY SYLLABUS

1st SEMESTER

Paper: 101 (Theory) **Full Marks: 100**

Subject: BIOCHEMISTRY

UNIT-I

1. Chemical basis of life: Chemical composition and bonding, three dimensional structure (configuration and conformation, Isomerism and steriospecificity), Chemical Reactivity: Oxidation-reduction reactions, Nucleophilic substitution, internal rearrangements, Group transfer reactions, Condensation.
2. Water: Structure of water, water as a solvent, ionization of water, Weak Interactions in aqueous solution (Dipole movement, van der Waal's, ionic and hydrophobic interactions. Hydrogen bonding). Weak acids, bases, pH and buffers, Blood buffering system.
3. Bioenergetics: Laws of Thermodynamics, entropy, enthalpy and free energy, standard free energy, free energy change, chemical equilibrium. Phosphoryl group transfer and ATP.

UNIT-II

1. Amino acids: Classification and properties, Acid–base properties, Non-standard amino acids, amino acid derivatives in proteins, D-amino acids.
2. Peptides: Peptide bond, ionization behavior of peptides, biologically active peptides. Levels of protein structure. Determination of primary structure of protein. Three dimensional structures of proteins (Secondary, tertiary and quaternary structures, structural patterns: motifs and domains).
3. Protein denaturation and Protein folding
4. Biosynthesis of Amino acids, Amino acid catabolism (transamination, oxidative deamination and urea cycle), Protein degradation (proteosomal pathway) and Solid phase synthesis of peptides.

UNIT-III

1. Enzymes: Nomenclature, classification and properties, Extraction, assay and purification of enzymes.

2. Enzyme kinetics: Chemical kinetics, enzyme kinetics (Michaelis-Menten equation, Briggs-Halden Modification, determination of V_{max} and K_m).
3. Mechanism of enzyme action: General principles of enzyme reactions catalysed by Chymotrypsin, RNase, Carbonic anhydrase, Restriction Endonucleases, NMP kinase.
4. Enzyme inhibition: types of inhibitors, determination of K_i
5. Regulation of enzyme action: Allosteric control, stimulation and inhibition by control proteins, covalent modification, proteolytic activation.

UNIT-IV

1. Carbohydrates: Classification, configuration and conformation of monosaccharides, sugar derivatives, important disaccharides. Structural and storage polysaccharides, glucosaminoglycans, proteoglycans, glycoproteins and glycolipids.
2. Carbohydrate metabolism: Glycolysis, TCA cycle, glyoxalate cycle, pentose-phosphate pathway.
3. Gluconeogenesis, glycogen metabolism, biosynthesis of starch and sucrose, regulation of carbohydrate metabolism.
4. Oxidative phosphorylation, electron transport and ATP synthesis.
5. Photosynthesis- Electon transfer by chlorophyll, Molecular mechanism of Photosystem I & II, Transport across the thylakoid membrane, Light Harvesting complex, antennary complex.

UNIT-V

1. Lipids: Classification, storage lipids, structural lipids (glycerophospholipids and sphingolipids), signaling lipids, cofactors, terpenes, and pigments.
2. Biosynthesis and oxidation of fatty acids.
3. Nucleotides and Nucleic acids.
4. Biosynthesis and degradation of Nucleotides.
5. Coenzymes and vitamins.
6. Hormones.
7. Inborn errors in metabolism.

Books:

1. Lehninger Principle of Biochemistry by D.L. Nelson & M.M. Cox.
2. Biochemistry by D. Voet and J Voet.
3. Biochemistry by J.M. Berg, J.L. Tymoczko & Lubert Stryer.

Paper: 102 (Theory) **Full Marks: 100**

Subject: CELL BIOLOGY AND GENETICS

UNIT- I

1. General organization of Prokaryotic and Eukaryotic cells.
2. Cell Wall and Cell Membranes: Cell wall of Eubacteria, lipopolysachharides, Peptidoglycans and related molecules. Prokaryotic cell inclusions: Endospores and gas vesicles, Eukaryotic cell wall and plasma membrane (composition and dynamics, membrane carobohydrates and their role in cell recognition).
3. Social context of cells: Cell junction, cell adhesion and extra-cellular matrix.
4. Cell motility: Cilia and flagella of prokaryotes and eukaryotes.
5. Cytoskeleton: Microtubules, intermediate filaments and microfilaments.

UNIT – II

1. Nucleus: Structure and function of nuclear envelope, nucleolus, Chromatin organization and its packaging, role of nuclear matrix in chromosome organization and function, matrix binding proteins.
2. Global structure of chromosome: Lampbrush chromosome, Polytene chromosome, Interphase chromatin, Euchromatin and Heterochromatin.
3. Cell cycle: Molecular models and events. Regulators and checkpoints in cell cycle (Cyclin and CDKs).
4. Molecular mechanisms of cell division, Mitosis (Behaviour of chromosomes, formation of mitotic spindle, Sister chromatid separation) Cytokinesis (Role of mitotic spindle in determining cytoplasmic cleavage site).
5. Cellular basis of differentiation and development: Benefits of sexual reproduction, Meiosis, Gametogenesis and fertilization.

UNIT-III

1. Mitochondria: Structure, function, mitochondrial DNA, origin and evolution of mitochondria
2. Chloroplast: Structure and function, chloroplast DNA and its significance, chloroplast biogenesis, origin and evolution

3. Intracellular compartments-I: Golgi apparatus and endoplasmic reticulum (structure & function).
4. Intracellular compartments-II: Lysosomes, peroxisomes (structure and function).

UNIT – IV

1. Transport across cell membrane: Major types of membrane transport, Active transport, Co-transport, Symports, Antiports, Ion channels, Osmosis.
2. Macromolecular trafficking into and out of nucleus
3. Protein sorting: Transport of proteins into mitochondria, chloroplast and lysosomes.
4. Vesicular traffic: Coated and un-coated vesicles, Transport of secretory materials,
5. Endocytosis.

UNIT- V

1. Mendel's laws of inheritance and chromosomal theory of heredity.
2. Gene linkage and crossing over, Chromosomal mapping, Tetrad analysis
3. Pedigree analysis. Lod score for linkage testing, Karyotypes, Genetic disorders, Polygenic Inheritance, Heritability and its measurements, QTL mapping.
4. The origin of genetic variability through mutation (Spontaneous and chemical mutation, Frame-shift mutation, point mutations and chromosomal abberations).
5. Human chromosomes, Genetic diseases and syndromes.

Books:

1. Molecular biology of the cell. By Alberts. *et al*.
2. Molecular cell biology. By Lodish *et al*
3. Cell, a molecular approach. By Cooper.
4. Cell Biology. By De Robertes and De Robertes.
5. Genetics by Sinnot, Don, Dobjanasky.
6. Genetics by Strickberger.
7. Genetics by Gardner.

Paper: 103 (Theory) **Full Marks: 100**

Subject: INSTRUMENTATION & ANALYTICAL TECHNIQUES

UNIT - I

1. Microscopy: Principle of operation and Instrumentation of Light microscopy (Bright field, Phase-contrast, Fluorescence), Confocal microscopy and Electron Microscopy (Scanning and transmission).
2. Microtomy and histological techniques.
3. Immuno-cytochemistry: Principles, techniques and application.

UNIT – II

1. Principles of electrochemical techniques: Electrochemical cells and reactions, potentiometry and voltametry.
2. The pH electrode, ion-selective and gas-sensing electrodes, Clark type oxygen electrode.
3. Biosensors.
4. Flow cytometry.

UNIT – III

1. Ultraviolet-visible absorption spectroscopy: Principle, Instrumentation and application.
2. Fluorescence spectrophotometry: Principle, Instrumentation and application.
3. Other types (IR, NMR, ESR and MASS) of spectrophotometry: Basic principle and application.
4. Elimentary idea about X-ray crystallography, API- Electrospray and MALDI TOF.

UNIT - IV

1. Centrifugation techniques: Basic principles of sedimentation, Types of centrifuges, Types of rotors, Methods in preparatory ultacentrifugation (differential and density gradient centrifugation, centrifugal elutriation).
2. Chromatographic techniques: Principles of chromatography (Adsorption and Partition chromatography), Planar chromatography (Paper and Thin-layer chromatography), Column chromatography (Gas chromatography, Gel exclusion/permeation

chromatography and FPLC, Ion-exchange chromatography, Affinity chromatography, HPLC).

UNIT – V

1. Electrophoretic techniques: General principles, support media, electrophoresis of proteins (SDS-PAGE, native gels, gradient gels, isoelectric focusing gels and two dimensional gels), electrophoresis of nucleic acids (Agarose, pulse-field and sequencing gels).
2. Radioisotope techniques: Nature of radioactivity, isotopes in biochemistry, measurement of radioactivity (carbon dating, Geiger-Muller counting and liquid scintillation counting), autoradiography.

BOOKS:

1. Physical Biochemistry by David Freifelder.
2. Practical Biochemistry by Keith Wilson and John Walker.
3. Modern Experimental Biochemistry by Rodney Boyer.

Paper: 104(Theory) **Full Marks: 100**

Subject: BIOSTATISTICS AND COMPUTATIONAL BIOLOGY

UNIT - I

1. Statistics: Definition, functions and limitations.
2. Treatment of data: frequency distribution, Graph of Frequency Distribution
3. Descriptive Measures: Averages and Dispersions (Grouped and ungrouped).
4. Probability: Concepts, definition and elementary problems based on definition.

UNIT - II

1. Inference: Definition-parameter, Statistic sampling distributors, standard error,
2. Test of Hypothesis, type I and Type II errors.
3. Large sample tests**:** Z tests, small sample tests**:** t and F tests.
4. Chi-square test: Goodness of fit and Test of independence.

UNIT - III

1. Curve Fitting: First, Second degree and exponential curve.
2. Simple correlation and Regression.
3. Concept of multiple correction and Regression.
4. Analysis of variance: one way and two way classification.

UNIT – IV

1. Fundamentals of Computer: CPU, memory, I/O unit, storage, multimedia. Introduction to Operating Systems: DOS, Windows and Linux Operating Systems. Ideas about Computer Viruses. Use of online resources and the internet communication technology.
2. Idea on working with MS-Word, Excel and Power point.
3. Programming with C++ and PERL: Introduction, Control Flow: Statement and Block, if, if-else, Nested if-else statements, For, while, do-while loops, break, switch continue, Statements, go to statement. Functions and Arrays.
4. Computation of simple mathematical and statistical formulae using the Programming C++ and PERL.

UNIT - V

1. Introduction to Bioinformatics
2. Elementary idea about Database management system, e.g. Genebank, EMBL, Swiss-Prot, Sequence database like FASTA, BLAST algorithm and Bioinformatics tools.
3. Pairwise sequence alignment, Multiple sequence alignment, Gene prediction and Protein structure prediction.

PRACTICAL

Paper: 105 (Not less than 6 hours) **Full Marks: 90**

1. Microscopy, Microtomy and Histological techniques.
2. Measurement of pH, Preparation of buffer, determination of pK value.
3. Determination of absorption maxima of given chemicals.
4. Validation of Beers and Lambert Law
5. Calibration curve of starch.
6. Estimation of Lipid and Cholesterol.
7. Estimation of Nucleic Acids.
8. Estimation of Proteins.
9. Estimation of Sugars.
10. Paper Chromatography of amino acids.
11. Gel exclusion chromatography.
12. TLC of lipids
13. SDS-PAGE
14. Enzyme assay (effect of substrate concentration, time and temperature)
15. Study of mitosis and meiosis
16. Computer and bioinformatics practical: Working with MS-Word, Power Point and Excel (Data entry and editing, use of inbuilt statistical function for computation and graph plotting), Implementation of programs. Introduction to NCBI databases

Seminar/Journal club/Assignment **Full Marks: 10**

Each student has to deliver a lecture on a topic assigned to him/her linked to the subject for a minimum of thirty minutes duration and submit the write-up of the report for evaluation during the Seminar presentation.

2nd SEMESTER

2nd SEMESTER

Paper: 201 (Theory) **Full Marks: 100**

Subject: MICROBIOLOGY

UNIT –I

1. Beginning of Microbiology, milestones in the development of microbiology, spontaneous generation, Microbial Ecosystem, Microbial world, Branches of Microbiology, Application of microbiology.
2. Methods in Microbiology: Sterilization, Culture Media, Pure culture technique, enrichment culture technique, Microbial staining methods, Maintenance and preservation of Microorganisms, Culture collection centers.
3. Microbial growth: Growth curve, measurement of growth, growth yields, synchronous growth, continuous culture, growth as affected by environmental factors such as temperature, acidity, alkalinity, water availability and oxygen.
4. Microbial evolution, systematics and taxonomy: Evolution of earth's earliest life forms, primitive organisms, their metabolic strategies and their molecular coding, New approaches to bacterial taxonomy, nomenclature, Bergey's manual, Ribotyping.

UNIT – II

1. Elementary idea about Cynobacteria, Mycobacteria, Rickettsia, Chlamidias, Mycoplasma, Actinomycetes, Bacteria: Cell structure, genetic recombination in bacteria (Homologous and non-homologous recombination including transposition)
2. Microbial Physiology (Growth yield and characteristics, strategies of cell division, stress response)
3. Metabolic diversity among micro-organisms: Photosynthesis in micro-organisms (role of chlorophylls, carotenoids and phycobilins), anoxygenic photosynthesis, oxygenic photosynthesis.
4. Microbial nutrition, Chemoautotrophy, Chemoheterotrophy, Chemoorganotrophy, chemolithotrophy, syntrophy, nitrogen metabolism, nitrogen fixation and biofertilizers, Industrial production of biofertilizers.

UNIT – III

1. Archea: Halophyles, Methanogens, Thermophyles
2. Eukarya: Algae, fungi, slime moulds and protozoa (overview).

3. Viruses: Discovery, classification and structure of viruses, Bacterial, plant, animal and tumor viruses, replication of DNA- and RNA- viruses, Examples of Herpes, pox, adenoviruses, retroviruses, viroids and prions.

UNIT- IV

1. Normal microflora of skin, oral cavity, gastrointestinal tract, entry of pathogens into the host, Colonization and factors predisposing to infections.
2. Microbial diseases: Disease reservoirs, epidemiological technology, infectious disease transmission, respiratory infections caused by microbes, sexually transmitted diseases, diseases transmitted by animals, insects, ticks. Food and water born diseases, public health and water quality.
3. Microbial toxins: Exo-, Endo- and Entero-toxins, mode of action of toxins, virulence and pathogenesis.

UNIT - V

1. Chemotherapeutic agents: Growth factor analogues, Sulfa drugs, Quinolones
2. Antibiotics: Penicillins and Cephalosporins, broad-spectrum antibiotics, antibiotics from prokaryotes, antifungal antibiotics, mode of action of different antibiotics, resistance to antibiotics, Multiple Drug Registance.
3. Antiviral chemotherapeutic agents.

Books:

1. Brock Biology of Microorganisms, Maidgan,Martinko and Parker, Prentice Hall Inc., New York.
2. Microbiology, Prescott., Harley and Klein, William C Brown Press.
3. General Microbiology, S.B.Sullia and V. Santharam, Oxford & IBH, New Delhi.
4. Text book of Microbiology, R.C. Dubey and D.K.Maheswari, S.Cahnd and Company.
5. Modern concepts of Microbiology, H.D.Kumar and S.Kumar, Vikas Publications.
6. Microbiology: Fundamentals and applications, S.S.Purohit, Agro Botanical Publications, Jaipur.
7. Microbiology, Pelczar, Chan and Creig, Tata Mc Graw Hill Publ.
8. Textbook of Microbiology by Ananthanarayan and Paniker, Paperback
9. Brock Biology of Microorganisms by Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel Buckley, David Stahl, Pearson

Paper: 202(Theory) **Full Marks: 100**

Subject: IMMUNOBIOLOGY AND IMMUNOTECHNOLOGY

UNIT- I

1. Introduction, Phylogeny of Immune system, Innate and acquired Immunity, Clonal nature of Immune response.
2. Cells of the Immune system: Haematopoiesis and differentiation, Lymphocytes trafficking, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, Natural Killer cells, Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells.
3. Organization and Structure of Lymphoid Organs
4. Activation and regulation of B and T lymphocytes.

UNIT-II

1. Nature and Biology of antigens and super antigens.
2. Structure and function of antibody molecule, Antigen – Antibody interaction,
3. Major histocompatibility complex and MHC restriction
4. Transplantation

UNIT-III

1. Antigen Processing and Presentation, Generation of humoral and cell mediated immune response.
2. BCR and TCR, generation of diversity
3. Complement system
4. Cytokine and their role in immune regulation

UNIT-IV

1. Cell-mediated cytotoxicity, Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity.
2. Immunological tolerance, Hypersensitivity and Autoimmunity.
3. Immunity to infectious agents (intracellular parasites, helminthes and Viruses), Tumor Immunology
4. AIDS and other immunodeficiency diseases.

UNIT-V

1. Vaccine technology: Rationale of vaccine designing based on clinical requirements, Subunit vaccines, Attenuated vaccines, Vector vaccines, peptide vaccines and conjugate vaccines, cell based vaccines.
2. Catalytic antibodies
3. Western blot and ELISPOT assay
4. Immunofluorescence

BOOKS

1. Kuby Immunology, 5th edition, By R. A. Goldsby et al.
2. Immunology By Roitt
3. Immunology by Khan
4. Fundamentals of immunology By William Paul.
5. Principles of Immunology by N.V. Shastri, Himalaya Publishing House.

Paper: 203 (Theory) **Full Marks: 100**

Subject: MOLECULAR BIOLOGY

UNIT – I

1. Introduction to molecular biology.
2. Chemistry of nucleic acids, Structure and types of nucleic acids.
3. Prokaryotic and eukaryotic Genome organization, organelles genomes (mitochondrial and chloroplast genome).
4. DNA Replication: prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, Enzymes and accessory proteins involved in DNA replication.
5. Mutability and DNA repair.
6. Homologous and Site-specific Recombination, Transposition.

UNIT – II

1. Prokaryotic transcription: Principle and mechanism of gene regulation, The Operon concept, (lac-, trp-, ara-and his-operon). Transcript processing of tRNA and rRNA
2. Transcriptional control in lamda phage.
3. Eukaryotic transcription and regulation: RNA polymerases structure and assembly, Eukaryotic promoters and enhancers, General and specific transcription factors, transcriptional repressors, mechanism of transcription regulation, Transcriptional and post-transcriptional gene silencing.
4. Post transcriptional modifications (processing, capping and polyadenylation, splicing).

UNIT - III

1. The universal genetic code and genetic code in mitochondria.
2. Prokaryotic and eukaryotic translation: The translation machinery, mechanism of initiation, elongation and termination.
3. Regulation of translation, co- and post-translational modifications of proteins.

UNIT – IV

1. Signaling at the cell surface: Signaling molecules and cell-surface receptors, second messengers, G protein coupled receptor, activation of gene transcription by G protein coupled receptors.

2. Signaling pathways that control gene activity: TGFβ receptors and Smads, Cytokine Receptors and JAK-STAT pathway, Receptor Tyrosine kinases and Ras, MAP kinase pathways.
3. Phosphoinositides as signal transducers.
4. Pathways that involve signal-induced protein cleavage.
5. Down-modulation of receptor signaling.

UNIT – V

1. Gene regulation during development: General strategies of spatial and temporal gene expression, molecular mechanism of *Drosophilla* embryogenesis (Dorsal-Ventral patterning and segmentation).
2. Embryogenesis and early pattern formation in plants.
3. Cancer: Biology of cancer cell, viral and cellular oncogenes, tumor suppressor genes from humans: structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.

BOOKS

1. Molecular Biology by T.A. Brown
2. Genomes by T.A. Brown.
3. Genes and genome by M. Singer and P. Berg.
4. Gene – VIII by B. Lewin.
5. Molecular biology of the gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine and R. Losick.
6. Molecular Clonning: A laboratory manual by J. Sambrook and E.F. Fritsch.
7. Molecular biology LabFax, by T.A. Brown.

Paper: 204 (Theory) **Full Marks: 100**

Subject: PLANT BIOTECHNOLOGY

UNIT-I

1. Conventional plant breeding, Introduction to cell and tissue culture, tissue as technique to produce novel plants and hybrids.
2. Tissue culture media (composition and media), Initiation and maintenance of callus and suspension culture; single cell clones.
3. Morphogenesis and Organogenesis in plants; Organization of shoot and root apical meristem, shoot and root development, Leaf development and Phyllotaxy, Transition to flowering, Floral meristem and Floral development in *Arabidopsis* and *Antirrhinum*.

UNIT-II

1. Shoot tip culture: Rapid clonal propagation and production of virus- free plants, Anther, pollen and ovary culture for production of haploid plants and homozygous lines, Embryo culture and embryo rescue.
2. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.
3. Cryopreservation, slow growth and DNA banking for germplasm conservation.

UNIT-III

1. Plant transformation technology: Basis of tumor formation, hairy root , features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors.
2. Use of 35S and other promoters, genetic markers, use of reporter genes, reporter gene with introns, use of scaffold attachment regions.
3. Methods of nuclear transformation, viral vectors and their applications, multiple gene transfers, vector-less or direct DNA transfer,
4. Particle bombardment, electroporation, microinjection, transformation of monocots, transgene stability and gene silencing.

UNIT-IV

1. Application of plant transformation for productivity and performance: Herbicide resistance, atrazine, Insect resistance, Bt-genes, non-Bt like protease inhibitors, disease resistance.
2. Virus resistance, chitinase, 1-3 beta glucanase, antifungal proteins, thionins, PR proteins, nematode resistance.

3. Abiotic stress, use of ACC synthease, ACC oxidase, male sterile lines, carbohydrate composition and storage, ADP glucose pyrophosphatase.

UNIT-V

1. Chloroplast transformation: advantages, vectors, success with tobacco and potato.
2. Metabolic Engineering and industrial products: Plant secondary metabolites, Biosynthesis of Alkaloids, terpenes, phenols and nitrogenous compounds, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway.
3. Biodegradable plastics, edible vaccines, oleosin partioning technology.

BOOKS

1. Plant Biotechnology by J. Hammod, P. McGarvey, V. Yusibov.
2. Plant cell and Tissue Culture for the production of Food Ingradients by Fu, Singh and Curtis.
3. Biotechnology in crop improvement. H.S.Chawla.
4. Biotechnology and Genomics, P.K.Gupta, Rastogi publications.
5. Handbook of plant tissue culture, ICAR, publications & information division, New Delhi.
6. Biotechnology, B.D. Singh & R.P. Singh, Kalyani publishers.

PRACTICAL

Paper: 205 (Not less than 6 hours) **Full Marks: 90**

1. Growth curve, measurements of bacterial population and generation time by turbidometry and cell counting.
2. Preparation of liquid and solid media for growth of microorganisms.
3. Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and slab cultures.
4. Isolation of pure cultures from soil/ water.
5. Microscopic examination of Bacteria, Cyanobacteria, Molds and study of organisms by Gram stain and staining of spores.
6. Assay of antibiotics and determination of antibiotic resistance.
7. Isolation of genomic DNA (Plant & Animal).
8. Southern Blotting.
9. Isolation of RNA/mRNA.
10. Northern Blotting.
11. Blood film preparation and identification of cells.
12. Lymphoid organs and their microscopic organization.
13. Immunization and collection of serum, Immunodiffusion.
14. Purification IgG from serums.
15. Western Blotting.
16. Serological test: Hemagglutination test (HA), Hemagglutination Inhibition test (HI), ELISA etc.
17. Preparation of plant tissue culture medium.
18. Organ culture, Callus propagation.
19. Isolation of bacteria on the basis of biochemical test: Oxidase test, Indole test, Methylene Red test, Urease test, Oxydation-Fermentation test, Catalase test, Coagulase test.

Seminar/Journal club/Summer training report **Full Marks: 10**

Each student has to deliver a lecture on a topic assigned to him/her linked to the subject for a minimum of thirty minutes duration and submit the write-up of the report for evaluation during the Seminar presentation.

3rd SEMESTER

3rd SEMESTER

Paper: 301(Theory) **Full Marks: 100**

Subject: GENETIC ENGINEERING

UNIT-I

1. Scope of Genetic engineering, Milestones in genetic engineering
2. Molecular tools: Enzymes (Nucleases, Restriction endonucleases, Phosphomonoesterase, Alkaline phosphatase, Polynucleotide kinase, DNA ligase, DNA polymerases, Reverse transcriptase, terminal deoxynucleotidyl transferase, Poly A polymerase), Hosts (E. coli, yeast, animal cells and Plant cells) and Vectors (Plasmids, Bacteriophages, Cosmids, Phagemids and Artificial Chromosomes).
3. Means: Inserts (Genomic DNA, synthetic DNA, DNA from RNA or cDNA, PCR products, Nucleic acid purification, yield analysis, labeling nucleic acid probes (isotopic and non-isotopic labeling) Infection and transfection, Screening (Phenotypic, antibiotic and through hybridization).
4. Nucleic acid sequencing (Maxum-Gilbert sequencing, Sanger's dideoxy sequencing, pyrosequencing, automated DNA sequencing).
5. Nucleic acid amplification (PCR): General protocol, Primer designing, fidelity of thermostable DNA polymerases, Types of PCR (multiplex, nested, reverse transcriptase, real time, touch down, hot start and colony PCR), PCR in gene recombination (deletion, addition, overlap extension).

UNIT-II

1. Mapping of genome: Genetic and physical maps, physical mapping (restriction mapping, fluorescence in situ hybridization, sequence tagged site mapping), map based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, molecular markers in genome analysis (RFLP, RAPD, AFLP, SSLPs, STRs and SNPs).
2. Molecular markers linked to disease resistant genes, application of molecular markers in forensics, disease prognosis, genetic counseling, pedigree analysis, animal trafficking and poaching, germplasm maintenance, taxonomy and biodiversity**.**
3. Genome sequencing: Construction of libraries (genomic and cDNA), strategies for sequencing genomes, packaging, transections and recovery of clones, application of

sequence information for identification of defective genes. Expression cloning, Jumping or hopping libraries, Southwestern and Farwestern cloning.

UNIT-III

1. DNA transfection: Physical methods (microinjection, electroporation, biolistics, somatic cell fusion, Gene transfer by pronuclear microinjection), Chemical method (liposomes), Virus mediated transfection.
2. Expression Strategies for Heterologous genes: *Saccharomyces cerevisiae* expression systems (*S. cerevisiae* vectors, intracellular cellular production of heterologous proteins, secretion of heterologous proteins by *S. cerevisiae*), *Pichia pastoris* and other yeast expression systems, Baculovirus-insect cell expression systems, mammalian cell expression systems.

UNIT-IV

1. Mapping and quantifying transcripts: Northern blot, S_1 mapping, RNase protection assay and Primer extension, Run-off Transcription and G-less cassette transcription, Nuclear Run-on transcription and Reporter gene assays.
2. DNA-protein interactions: EMSA, DNase foot printing, Methyl interference assay, CHIP.
3. Protein-protein interaction cloning and yeast two hybrid system.
4. Phage display.

UNIT-V

1. Site-directed Mutagenesis and protein engineering.
2. Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.
3. Role of gene tagging in gene analysis, T-DNA and transposon tagging, identification and isolation of gene through T-DNA transposon.
4. Gene therapy: Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation.
5. Knockout and transgenic technologies.
6. Gene silencing (ribozyme, antisense and RNAi technologies).

BOOKS

1. Molecular Cloning: A laboratory manual by J. Sambrook and E.F. Fritsch.
2. Genome by T.A. Brown.
3. DNA Science. A First Course in Recombinant Technology by Mickloss and Freyer
4. Molecular Biotechnology by S.B. Primrose
5. Molecular Biotechnology by Glick.
6. Molecular Biology by Weaver
7. Genes and Genomes by Singer and Berg

Paper: 302(Theory) **Full Marks: 100**

Subject: BIOPROCESS ENGINEERING AND INDUSTRIAL BIOTECHNOLOGY

UNIT – I

1. Industrial application of enzymes: Enzymes used in detergents, uses of proteases in food, leather and wool industries.
2. Application of enzymes in food processing: Production of glucose syrup from starch using starch hydrolyzing enzymes, production of syrup containing maltose, enzymes in sucrose industry, glucose from cellulose, lactase in dairy industry, glucose oxidase and catalase in food industry, Cheese making by protease.
3. Medical applications of enzymes: Use of enzymes in medical diagnostics and clinical treatment.

UNIT –II

1. Problems with the use of enzymes in solution and objectives of immobilization
2. Methods of enzyme immobilization: Adsorption, entrapment, Direct covalent linking, cross-linking. Applications of immobilized enzymes.
3. Kinetics of immobilized enzymes, effect of solute partition & diffusion on the kinetics of immobilized enzymes.
4. Enzyme electro-catalysis (Biosensors): General approach to immobilization of enzymes into electrodes.
5. Measurement of enzyme activity, Regeneration of cofactors.
6. Abzymes and its application.

UNIT III

1. Introduction to bioprocess engineering,
2. Principle of bioreactor design, Bioreactors: batch, fed batch and continuous, Specialized bioreactors: pulsed, fluidized and photo-bioreactors, bioreactors using immobilized enzymes.
3. Ideal and non-ideal multiphase bioreactors, mass and heat transfer; Rheology of fermentation fluids, Aeration and agitation,
4. Media for industrial fermentation, air and media sterilization, Sources of microbes for industrial use, kinetics of microbial growth and death, substrate utilization and product formation, measurement and control of bioprocess parameters.
5. Downstream processing, removal microbial cells from bioreactors, foam preparation, filtration, drying and crystallization.

UNIT – IV

1. Industrial production of chemicals: alcohols (ethanol), Beer, citric acid, solvents (glycerol, acetone), Antibiotics (penicillin, streptomycin, tetracycline), Amino acid (lysine and glutamic acid), Enzymes (protease, Asparaginase).
2. Whole cell immobilization and their industrial application.
3. Microbes in mineral beneficiation, and oil recovery.
4. Large scale production methods of biofertilizers (Cyanobacteria, *Rhizobium, Azotobacter, Azospirilum*, *Azolla*, PSB, Mycorrhiza) and protocols for their use.

UNIT – V

1. Food technology: Elementary idea of canning and packing, Sterilization and pasteurization of food products, Food preservation,
2. Single cell proteins (*Spirulina*, Yeast).
3. Micro-algal technology (*Dunaliella, Haematococcous*).
4. Bioplastics, Production and purification of recombinant proteins

BOOKS

1. Enzymes in industry: Production and application by W. Gerhartz, VCH Publishers, New York.
2. Principles of enzymology for technological applications, Butterworth Heinemann Ltd.
3. Enzyme technology by M.F. Chaplin and C. Bucke. Cambridge University Press.
4. Concepts in Biotechnology by D. Balsubramanian *et al*., Universities Press.
5. Biochemical Engineering by Aiba, Humphery and Mills.
6. Biochemical Engineering Fundamentals by Baily and Oilis.
7. Principle of Fermentation Technology by Stanbury and Whitaker.
8. Process Engineering in Biotechnology by Jackson.
9. Microalgal biotechnology by Borowitzka.
10. Principle of Bioprocess engineering by P.Doran

Paper- 303- Core Elective (CE-i)): (Theory) **Full Marks: 100**

Subject: ANIMAL BIOTECHNOLOGY

UNIT-I

1. Equipments and materials for animal cell culture: Design and layout of culture room, Sterilization and aseptic techniques.
2. Culture media: General considerations in media design, Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture.
3. Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer and suspension cultures.
4. Growth curve, Establishment of cell line, cell counting.

UNIT-II

1. Various methods of cell separation.
2. Cell cloning: Dilution cloning and suspension cloning, isolation of clones
3. Characterization of cultured cell: Morphology of cells, Species identification; identification of tissue of origin, identification of specific cell lines.
4. Scaling up of cultured cells: Anchorage dependent cell culture: Substrate for cell growth (conventional methods and new trends), Suspension culture: Modes (Batch, Fed-batch, continuous and perfusion culture modes), Fermentation technology for the growth of animal cells and their products (Bioreactors, Hollow fibre reactors, Air-lift fermentors, chemostats and microcarriers).
5. Transformation of cells: Characteristics of transformed cells and the process of Immortalization (by suppression of senescence genes, induction by viral genes, by induction of telomerase and by chemical carcinogens).

UNIT-III

1. Organ culture.
2. In vitro fertilization, Embryo culture, embryo sexing of farm animals.
3. Three dimensional culture: Multicellular tumour spheroids (mono- & co-culture)
4. Tissue engineering: Design stages for tissue engineering, cell substrates and support materials, cell sources, orientation and protocol.

UNIT-IV

1. Cytotoxicity studies.
2. Necrosis and apoptosis (mechanism and assay)
3. Cryopreservation.

UNIT-V

1. Scope of animal cell culture.
2. Genetic engineering of animal cells: Transfection, microcell-mediated chromosome transfer, irradiation fusion gene transfer.
3. Hybridoma technology and production of monoclonal antibodies.
4. Stem cell culture and its application.

BOOKS

1. Culture of animal cells by R.I. Freshney.
2. Tissue Culture – Methods and Applications by Paul F. Kruse Jr. and M. K. Patterson, Jr.
3. Cell Culture Lab Fax by Butler and Dawson.
4. Cell and Tissue culture: Laboratory procedures by Doyle and Griffiths.

Paper-304-Allied Elective (AE-1) **Full Marks: 100**

Subject: ANIMAL PHYSIOLOGY AND DEVELOPMENTAL BIOLOGY

UNIT I

1. Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissues.
2. ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.
3. Respiratory system: Respiratory organs in animals, anatomical considerations, transport of gases, exchange of gases.
4. Neural and chemical regulation of respiration.

UNIT II

1. Excretory system: Excretory organs in animals, kidney, urine formation, urine concentration, waste elimination & micturition,
2. Regulation of water balance, blood volume, blood pressure, electrolyte balance, acid base balance.
3. Thermoregulation: Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

UNIT III

1. Nervous system: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Physiology of impulse transmission through nerves and synapse
2. Endocrinology and reproduction: Hormonal control of reproductive processes.

UNIT-IV

1. Basis concepts of Development: Cell commitment and differentiation (Specification, determination, induction, competence, differentiation)
2. Morphogen gradients, cell fate, cell potancy and morphogenesis

3. Gametogenesis: Origin and migration of primordial germ cells; Production of male gametes (Spermatogenesis), Gene expression during spermatogenesis and sperm maturation
4. Production of female gametes (oogenesis, Previtellogenesis of amphiabian egg); Gene expression during amphibian oogenesis; Ovulation and ovum transport in mammals, structure of gametes, Externan fertilization in *Sea urchins*, Internal fertilization in mammals.

UNIT-V

1. Morphogenesis: Cell aggregation and differentiation in Dictyostelium; axes formation in Drosophila and amphibia (*Xenopus laevis*)
2. Organogenesis – vulva formation in *Caenorhabditis elegans*, cleavage and axis formation in *C. elegans*, eye lens induction, limb development and regeneration in vertebrates;
3. Post embryonic development- larval formation, metamorphosis, environmental regulation of normal development.

Paper-304- Allied Elective (AE-2) **Full Marks: 100**

Subject: BIOTECHNIQUES

UNIT-I (Microbial Techniques)

1. Methods in microbiology: Criteria for microbial classification and approaches to taxonomy, sterilization, culture media, pure culture 6technique, microbial staining methods, maintenance and preservation of microorganisms.
2. Microbial growth: Growth curve, measurement of growth, growth yields, synchronous growth, continuous culture, environmental factors affecting growth.
3. Microbes for industrial use: Primary and Secondary metabolites, Fermentation and Fermented products, Biofertilizers, Microbes in mineral beneficaion and bioremediation, Microbial toxin-BET, Test for sterility.

UNIT-II (Cell Culture Techniques)

1. Equipments, materials and Culture media for plant and animal cell culture: Design and layout of culture room, Sterilization and aseptic techniques; Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture.
2. Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer and suspension cultures; Establishment of cell line; Characterization of cultured cell
3. Initiation and maintenance of callus and suspension culture; single cell clones, Shoot tip culture: Rapid clonal propagation and production of virus- free plants, Anther, pollen and ovary culture for production of haploid plants and homozygous lines, Embryo culture and embryo rescue.

UNIT-III (Purification and Bio-separation techniques)

1. Isolation and purification of Bimolecules like, protein, DNA and RNA.
2. Principles and applications of electrophoresis; Separation of Biomolecules (protein/nucleic acids) by electrophoresis, SDS-PAGE, Agarose and 2D Gel Electrophoresis.
3. Principles and applications of chromatography, types and application of chromatography (Gel exclusion, Gas, Liquid and HPLC)

UNIT-IV (Spectroscopy)

1. Principles and Applications of Spectrophotometer, Ultraviolet-visible absorption Spectroscopy: Principle, Instrumentation and Application.
2. Fluorescence spectrophotometry: Principle, Instrumentation and Application.
3. NMR, and MASS Spectrophotometry: Basic principle and application.

UNIT-V (Immuno-technology)

1. Antigen- antibody interaction and their applications in Immuno-diagnostics; Detection of antigen/protein by Western Blotting.
2. ELISA and CHIP
3. FACS and its applications.

PRACTICAL

Paper: 305 (Practical) **Full Marks: 100**

1.Sterilization techniques.

2.Bacterial culture and storage techniques.

(i) Isolation of individual colonies.

(ii) Plate sterilization techniques.

(iii) Storage of bacterial culture.

3. Growth pattern of bacterial cells.
4. Isolation and purification of plasmid.
5. Restriction digestion and mapping of plasmid.
6. Preparation of competent cells.
7. Bacterial transformation.
8. Restriction digestion of λ – DNA.
9. Demonstration of apoptosis.
10. PCR/ RFLP/ RAPD.
11. Primary culture of animal cell**:** Aseptic techniques, selection and isolation of organ, disaggregation (mechanical/enzymatic), seeding, Cell counting and cell viability, Primary culture.
12. Preparation of metaphase chromosome from cultured cells.
13. Preparation of plant tissue culture medium.
14. Organ culture, Callus propagation.
15. Immobilization of enzyme and whole cell.
16. Isolation and characterization of microbes from contaminated food.
17. Batch culture of microbes in a Fermentor.
18. Production of alcohol using a suitable substrate.

4th SEMESTER

4th SEMESTER

Core Elective (CE-iI)-401 **Full Marks-100**

Subject: EVOLUTION AND ENVIRONMENTAL BIOTECHNOLOGY

UNIT-I

1. Origin of basic biological molecules: Abiotic synthesis of organic monomers and polymers, Concepts of Oparin and Haldane, Experiments of Miller, The first cell; Origin and Evolution of Prokaryotes and Eukaryotes
2. Concepts of Neutral Evoluion, Molecular divergence and Molecular clocks, Molecular tools in Phylogeny; Classification and Identification.
3. Protein and Nucleotide sequence analysis, Origin of new Genes and proteins, Gene duplication and Divergence.

UNIT-II

1. Environment: Basic concepts and issues, Environmetal modeling, Systems ecology, Ecosystem, Global Environmental Problems; Ozonwe depletion, Ingfluence on Biodiversity of aquatic and terrestrial environment, Biodiversity of oceans, Estuaries and Lagoons.
2. Acid rain, Arid and semi-arid plant bioecdhnology, Green house technology, Environmental pollution and measures; Air, Water, Soil, Radioactive pollutions.

UNIT-III

1. Wastewater Treatment, Oxidation pond, Anaerobic process of treatment, Solid waste management(Composting, Vermicultre and Biogas production), Biopesticides, Biofuels.
2. Bioremediation- Aerobic and anaerobic processes for stabilization of solid / liquid wastes, Degradation of Xenobiotoc compoubnds, Bioprospecting of Marine Organisms, Sea weeds as food, Phycocolloids and source of Pharmaceuticals compounds.

UNIT-IV

1. Concept of Habitat and Niche; Niche width and Overlap, Resource partitioning, Character displacement, Characteristics of a population, Population growth curves,

Population regulation, Life history strategies (R and K selection), Concept of Metapopulation, Interdemic extinctions, Age structured populations.

2. Species interaction: Types of interactions, Inter-specific competition, Herbivory, Carnivory, Pollination, Symbiosis, Community ecology, Nature of communities, Community structure and attributes, Levels of species diversity and measurement.
3. Ecological succession; Types, Mechanism, Changes involved in succession, Ecosystem Ecology; Ecosystem structure, Ecosystem function, Energy flow and Mineral cycling(C, N, P) Structure and function of terrestrial (Forest, Grassland) and aquatic (Fresh water, Marine, Eustrine) ecosystem, Biogeography; Major terrestrial Biomes, Biogeographical zones of India.

UNIT-V

1. Introduction to intellectual property: Types of IP (Trademarks, Copyright & Related rights, Industrial design, Traditional knowledge, Geographical indications, Protection of GMOs).
2. Agreements and Treaties (GATT & TRIPS agreement, Madrid agreement, Hague Agreement, WIPO treaties, Budapest treaty, PCT, Indian Patent Act 1970 & recent amendments.
3. Basics of patents (Types of patent application and Specifications), concept of Prior Art and patent filing procedures.

4th SEMESTER

Paper: 402 (Project work) **Full Marks: 400**

Each student has to carryout a project work during his/her tenure in 4th Semester and submits a dissertation towards partial fulfillment of M.Sc. degree in Biotechnology. The student has to defend his/her project work in a seminar which will be evaluated by a minimum of two external experts appointed by the University. The project work comprises of dissertation (300 marks) followed by seminar presentation and viva-voce examination (100 marks)

FREE ELECTIVE (F.E-403)

FUNDAMENTALS OF LIFE SCIENCE: ORIGIN OF LIFE, LIVING SYSTEMS, AND LIVING PROCESSES

Unit -I

1. What is life?
2. What is the unit of life?
3. Cellular basis of life and chemical composition of cells
4. How cells obey physical and chemical laws?
5. How cells diversify to perform various activities in our body?

Unit -II

1. What do you understand by terms gene, genome and genetics?
2. Genetics Vs Epigenetics
3. How I inherited my qualities from my parents?
4. Where my characters are located and how they are expressed?
5. How do I develop from a single cell to multi-cellular organism?

Unit -III

1. How plants trap solar energy and make food for animals?
2. How body digests and gets energy from food?
3. How transport occurs in body?
4. How body functions are regulated?
5. How life continues and why I age?

Unit -IV

1. How life is evolved on our planet?
2. Biodiversity and diverse forms of life
3. How human being is evolved?
4. How human activities affect our environment?
5. What is global warming, Acid rain, Green house effect?

Unit -V

1. Another world of living organisms: microbes.
2. Are all microbes harmful to us?
3. How I fight against microbes and defend my body?
4. Common health ailments like Diabetes, Cancer, AIDS, Cardiac dysfunction
5. Adolescents: health risks and solutions