GOVERNMENT DEGREE COLLEGE FOR WOMEN (AUTONOMOUS)

BEGUMPET, HYDERABAD-16

Affiliated To Osmania University, Re-Accredited With 'B^{+}' Grade by NAAC

DEPARTMENT OF BIOTECHNOLOGY

SYLLABUS (2020-21)

SEMESTER-I CELL BIOLOGY AND GENETICS

Course objectives:

- The objective of this course is to have a firm foundation in the fundamentals of Cell Biology, deep understanding of cell biology and advanced knowledge for growth and control microorganisms.
- This course will aid students to acquire skills and competency in cell biology laboratory practices applicable to biological research or clinical methods, including accurately reporting observations and analysis.

B.Sc. Biotechnology I YEAR
COURSE CODE: BT101

SEMESTER- I DSC-Paper- I: CELL BIOLOGY AND GENETICS

Unit 1: Cell structure and Functions

1. Cell as basic unit of living organisms-bacterial, fungal, plant and animal cells
2. Ultrastructure of prokaryotic cell (cell membrane and plasmids, Nucleoid)
3. Ultrastructure of eukaryotic cell (cell wall, cell membrane, nucleus, mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, vacuoles)
4. Fluid mosaic model, Sandwich model, Cell membrane permeability
5. Structure of chromosome-morphology, components of chromosomes (histones and nonhistones),
6. Specialized chromosomes (Polytene, Lampbrush) Structural and Numerical Aberrations

Unit 2: Cell cycle

1. Bacterial cell division
2. Eukaryotic cell cycle –phases
3. Mitosis - Stages -significance
4. Meiosis- Stages -significance
5. Senescence and necrosis
6. Apoptosis

Unit 3: Principles and mechanism of inheritance

1. Mendelian laws of inheritance- Monohybrid cross, Dihybrid Ratio, Trihybrid Ratio
2. Deviation from Mendel's laws- partial or incomplete dominance (eg: Flower Color in *Mirabilis jalapa*), Co-dominance (eg: Coat colour in cattle),
3. Gene interaction – Modified dihybrid ratios (12:3:1; 9:7; !5:1; 9:3:4:, 9:7; 13:3),
4. Multiple alleleism (eg: Coat color in Rabbits and ABO Blood groups, drosophila eye colour)
5. Penetrance and Expressivity (Polydactyly and Waardenburg syndrome, Pleiotropism – microcephaly and cleft lip
6. X-Y chromosomes - Sex determination in Drosophila, Birds, Man, Bonellia; X-linked inheritance– Hemophilia and Color blindness; X-inactivation; Y-linked inheritance- Holandric genes

Unit 4: Linkage, Recombination and Extension to Mendel's Laws

1. Linkage and recombination- Stern's Cytological proof of crossing over in Drosophila, Mcclintock-Creighton experiment in maize Phases of linkage, recombination frequency. Gene mapping and map distance
2. Non-Mendelian Inheritance – Maternal effect (Shell coiling in snail), variegation in leaves of *Mirabilis jalapa*
3. Cytoplasmic Male sterility in Maize
4. Chloroplast inheritance in Chlamydomonas,
5. Mitochondrial inheritance in human
6. Hardy-Weinberg Equilibrium, allelic and genotypic distribution

Course outcomes:

· Students develop an understanding of the Cytoskeleton and Cell Membrane & discuss the structure of Microtubules, microfilaments & can differentiate the organisms by its cell structure

· Students can explain various process in cell division

• To understand the basic unit of the organism.

• To differentiate the organisms by its cell structure.

• To know Components of the Cell and their division.

• To explain the arrangement of Genes and their interaction.

• To describe the influence of environment on gene expression.

• To understand extra nuclear inheritance, linkage & crossing over

SEMESTER-II

COURSE CODE: BT201

Biochemistry and Microbiology

Course Objectives :

- To acquaint students with the concept of bioenergetics and various metabolic processes taking place inside the human body.
- understanding of advantages and hazards of microbial world and advanced knowledge for growth and control microorganisms.
- This course will aid students to acquire skills and competency in microbiological laboratory practices applicable to microbiological research or clinical methods, including accurately reporting observations and analysis.

SEMESTER- II Paper- II: BIOLOGICAL CHEMISTRY AND MICROBIOLOGY

Unit 1: Biomolecules

1.1 Carbohydrates- importance, classification; structure and functions of monosaccharides (glucose & fructose), disaccharides (sucrose, lactose & maltose) and polysachharides (starch, glycogen & inulin)

1.2 Amino acids- importance, classification, structure, physical and chemical properties of amino acids; peptide bond formation

1.3 Proteins- importance, structure of proteins- primary, secondary, tertiary and quaternary

1.4 Lipids- importance, classification- simple lipids (triacylglycerides & waxes), complex lipids (phospholipids & glycolipids), derived lipids (steroids, terpenes & carotenoids)

1.5 Nucleic acids :structure and chemistry of DNA (Watson and crick) and RNA(TMV) Structure and forms of DNA (A, B and Z)

1.6 Enzymes- importance, classification and nomenclature; Michaelis-Menton Equation, factors influencing the enzyme reactions; enzyme inhibition (competitive, uncompetitive & mixed), co-enzymes

Unit 2: Bioenergetics

2.1 Glycolysis, Tricarboxylic Acid (TCA) Cycle,

2.2 Electron Transport, Oxidative Phosphorylation

2.3 Gluconeogenesis and its significance

2.4 Transamination and Oxidative deamination reactions of amino acids

2.5 B-Oxidation of Fatty acids

2.6 Glyoxalate cycle

3. Unit: Fundamentals of Microbiology

3.1 Historical development of microbiology and contributors of microbiology

3.2 Microscopy: Bright field microscopy, Dark field microscopy, Phase contrast microscopy, Fluorescent microscopy, Scanning and Transmission electron microscopy

3.3 Outlines of classification of microorganisms

3.4 Structure and general characteristics of bacteria and virus
3.5 Disease causing pathogens and symptoms (Eg: Mycobacterium, Hepatitis)
3.6 Structure and general characteristics of micro-algae and fungi

4. Unit : Culture and identification of microorganisms
4.1 Methods of sterilization- physical and chemical methods
4.2 Bacterial nutrition nutritional types of bacteria, essential macro& micro nutrients and growth
4.3 Bacterial growth curve-batch and continuous cultures, synchronous cultures measurement of bacterial growth-measurement of cell number and cell mass.
4.4 Factors affecting bacterial growth
4.5 Culturing of anaerobic bacteria and viruses
4.6 Pure cultures and its characteristics

Course outcomes

- After completion of Biochemistry program students will able to get exposed
- To strong theoretical and practical background in fundamental concepts.
- To get insights of multiple important technical areas of Biochemistry.
- To apply contextual knowledge and modern tools of biochemical research for solving problems.
- To give students a generalized idea about microbiology its basic aspects
- Course will provide practical knowledge about different types of bacteria, virus and fungi found in environment
- principles and applications of various types of Microscopy
- Students would know about the contribution of microbiologists, the principle and application of various types of microscopic techniques, and different staining protocols
- Study the morphology of bacteria and detailed account of bacterial cell structure
- Classify microorganisms through Bergey's manual and apply basic knowledge of nutrients required by different microorganisms for their growth
- Students would be able to understand characteristics of viruses, classification and life cycles of viruses
- Description of the structure and Classification, staining, culturing, physiology, of microorganisms

SEMESTER-III -

COURSE CODE: BT301

MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY

Course Objectives

- To acquaint the students with basic and advanced knowledge of molecular biology.
- Students will be able to understand molecular Biological processes like DNA replication, transcription and repair systems
- Know how different genes are expressed and regulated in a cell by using operon model.
- Understand use the DNA replication mutants in the study of replication

Molecular Biology and Recombinant DNA Technology

Unit 1: Nucleic Acids and Genome organization

1.1 DNA as the genetic material- Griffith's experiments on transformation, Avery McCleod and McCarty experiment, Hershey-Chase experiment, RNA as Genetic Material

1. Genome organization in prokaryotes and Eukaryotes
1. Genome organization in Mitochondria and Chloroplast genome
1. DNA replication- Semi conservative DNA replication-Messelson and Stahl experiment
1. Replication in Prokaryotic Genome and Nuclear Genome of Eukaryotes
1. Mutation-Spontaneous and Induced , Physical and chemical Mutagens\

1. Gene expression in prokaryotes and Eukaryotes

1. Structure of prokaryotic and Eukaryotic gene ,Structure and functions of prokaryotic RNA polymerase
2. Transcriptional machinery of eukaryotes - Structure and functions of eukaryotic RNA polymerase
3. Genetic Code-Properties ,deciphering genetic code, wobble hypothesis
4. Prokaryotic Transcription- initiation, elongation , proof reading and termination (rho dependent and independent),
5. Eukaryotic Transcription- initiation, elongation and termination
6. Prokaryotic and eukaryotic- Translation- initiation, elongation and termination.

3. Unit: Gene regulation in Prokaryotes and Eukaryotes

3.1 Prokaryotic transcriptional regulation (inducible System)-Operon concept, Lac operon, glucose effect.

3.2 Prokaryotic transcriptional regulation (repressible system)- Tryptophan operon

3.3 Post transcriptional modifications – Capping and Poly adenylation

3.4 Splicing and alternate splicing

3.5 Post translational modification- glycosylation and adenylation and ubiquitination

3.6 Gal regulation in yeast-mating type gene switching

Unit 4: Recombinant DNA Technology

4.1 Enzymes useful in molecular cloning: Restriction endonuclease, DNA ligases, Polynucleotide kinase, DNA Polymerase, klenow enzyme, reverse transcriptase, Alkaline phosphatase, terminal nucleotidyltransferase

4.2 Cloning Vectors: pBR322, Bacteriophage, Cosmid, Phagemid, Shuttle vectors

4.3 Vectors for library preparation (lambda phage vector, Cosmid, BAC and YAC)

4.4 Gene transfer techniques: Physical, Chemical and Biological methods

4.5 Se;lection of recombinant clones-colony hybridization and library screening

4.6 Polymerase Chain Reaction and Applications of recombinant DNA technologies-Agriculture, Medicine

Course Outcomes

- Learning structural levels of nucleic acids- DNA and RNA and genome organization in prokaryotes and eukaryotes.
- Understanding the concept of Gene and the gene architecture.
- Overview of the central dogma of life and various molecular events
- Overview of the central dogma of life and various molecular events
- Understanding the principles and applications of Polymerase Chain Reaction(PCR).
- Molecular Events of Transcription and processing of transcripts, RNA editing.
- Described the knowledge of recombinant DNA technology
- Understood the tools of gene manipulation and gene transfer
- Knowledge of construction and labeling of molecular probe, construction of genomic library and protein engineering.
- Understood the techniques of recombinant DNA technology and its applications
- Came to know about the techniques and applications of human genome projects
- Molecular Events of Translation leading to protein synthesis and Post translational modification.
- Understanding the regulation of gene expression in prokaryotes using operon concept and Eukaryotes.
- Learn the methods of DNA sequencing and various tools and techniques of molecular biology.

SEMESTER IV-

COURSE CODE: BT401

Bioinformatics and Biostatistics

Course objectives

- knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics
- existing software effectively to extract information from large databases and to use this information in computer modeling
- problem-solving skills, including the ability to develop new algorithms and analysis methods
- an understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries

Bioinformatics and Biostatistics

Unit 1: Introduction to Bioinformatics and Biological Databases

1.1 Bioinformatics – a history, Scope and applications

1.2 Bioinformatics tools and resources, internet basics, role of internet, free online tools, downloadable tools

1.3 Bioinformatics web portals-NCBI, EBI,ExPASy

1.4 Biological databases: classification of Databases primary (Genbank), Secondary (PIR),Tertiary and composite (KEGG)databases

1.5 Sequence Databases – DNA sequence databases

1.6 Protein data sequence databases-(swissprot and PROSITE)

Unit 2: Sequence Alignment

2.1 Basics of sequence alignment – match, mismatch , gaps, gap penalties, Scoring alignment

2.2 Types of sequence alignment- pairwise and multiple alignment, local and Global alignment

2.3 Dot matrix comparison of sequences

2.4 Scoring matrices – PAM and BLOSUM

2.5 Pair wise sequence similarity search by BLAST and FASTA

2.6 Concepts of phylogeny- distance based (NJ Method) and Character based (ML method) ,Tree construction methods

Unit 3: Descriptive Biostatistics and Probability

3.1 Introduction to Biostatistics, kinds of data and variables, based on nature (numerical, discrete and continuous, categorical –ordinal and nominal), based on source (primary and secondary data) sample size, sampling methods and sampling errors

3.2 Data tabulation and representation methods, graphical methods (stem and leaf plot, line diagram, bar graphs, histogram, frequency polygon & frequency curve)diagrammatic method(pie diagram)

3.3 Measures of central tendency- arithmetic mean, median, mode (merits and demerits)

3.4 Measures of dispersion- range, mean deviation, variance and standard deviation, Standard error and Co efficient of Variation -merits and demerits
3.5 Concepts of probability-random experiment, events and Probability of an event, probability rules (addition and multiplication), uses of permutation and combinations, random variables(discrete and continuous)
3.6 Probability distributions-Binomial, Poisson for discrete variables and Normal distribution for continuous varialbles

Unit 4: Applications of Biostatistics

4.1 Hypothesis testing- steps in testing for statistical hypothesis, null and alternative hypothesis level of significance- type 1 and type 2 errors
4.2 Test of significance- for small samples- student's t- test(one sample amd two samples)
4.3 Test of significance- for large samples – Z test for means and proportions
4.4 Chi-square test- and their applications –goodness of fit, test of independence
4.5 Analysis of Varience (ANOVA)- one way analysis

Course Outcomes

- Bioinformatics is the science of storing, extracting, organizing, analyzing, interpreting and using information.
- The approaches to the discipline of bioinformatics incorporate expertise from the biological sciences, computer science and mathematics.
- The major in bioinformatics is designed for students interested in molecular biology and genetics, information technologies and computer science.

- Bioinformaticists are involved in the analysis of the human genome, identification of targets for drug discovery, development of new algorithms and analysis methods, the study of structural and functional relationships, and molecular evolution.
- Store and Retrieve drug related information using online tools
- Comprehend the utility of tools & databases available in genomic & proteomics
- Understand simple calculations
- Statistics helps to analyze data, interpret, and present information
- Publishing research data
- Calculate; analyse and compare observed data; perform simple sums in proportions and algebraic functions

SEMESTER V

COURSE CODE: BT501
Plant Biotechnology

Course objectives:

- To make students aware of various tissue culture techniques and their application in biotechnology for commercial purpose and to acquaint students with applications of genetic engineering like transgenic plants
- The course will provide complete exposure as how plant and animal cells are isolated, cultured and genetically manipulated in laboratory. Also the course will provide information how cell suspension cultures can be utilized for molecular farming for commercially synthesizing products such as vaccines, hormones, proteins, enzymes, etc

SEMESTER V PLANT BIOTECHNOLOGY

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Unit 1: Basics of Plant Biotechnology
1.1 Introduction to plant tissue culture, totipotency of plant cells (Dedifferentiation, redifferentiation, regeneration of whole plant) Initiation of callus cultures
1.2 Nutritional requirements for plant tissue culture: Plant growth regulators (cytokinins, auxins, gibberellins).
1.3 Preparation of media, selection and surface sterilization of explants, inoculation, incubation (temperature and light regime), regeneration of plants.
1.4 Regeneration of Plants (Organogenesis & Embryogenesis)

Unit 2: Methods in Plant Tissue Culture
2.1 Meristem culture and production of disease free plants
2.2 Micropropagation: Factors affecting and applications
2.3Cell suspension culture- Batch and Continous Culture for production of secondary metabolites.
2.4 Virus resistant plants: Transgenic plants with viral coat protein and viral nucleoprotein

Unit 3: Applications of Plant Tissue Culture
3.1 Encapsulation and production of synthetics seeds
3.2 ; Protoplast culture and fusion, Development of somatic hybrids
3.3, production of haploids, Anther and pollen culture
3.4 Methods of cryopreservation for conservation of plant germplasm

Unit 4: Transgenic plants and applications
4.1 Gene Transfer techniques for production of transgenic Plants

4.2 Engineering Biotic and Abiotic Resistance in plants: Bt cotton, Stress tolerant, Heat Tolerance, Fungal resistance in plants
4.3 Transgenic plants with enhanced nutritive values: Vitamin A, Vitamin E
4.4 Transgenic plants as Bioreactor: Antibody production in plants, Biodegradable plastics

Course outcomes

- Learning important milestones in the plant tissue culture.
- Understanding the concepts and principles of Plant tissue culture.
- Learning the techniques of sterilization and monitoring method of sterilization.
- Learning different pathways of plant regeneration under in vitro conditions - organogenesis and somatic embryogenesis.
- Techniques of establishing cell suspension culture. Synthetic seeds and applications.
- Understanding the techniques of virus elimination – methods of virus indexing. Meristem and Shoot tip culture and Applications.
- Performing procedures for Micropropagation techniques in rose and banana.
- Culturing of reproductive structures - anther, microspores, embryos, endosperm, Ovule and ovary cultures and methods to produce haploids.
- Protoplast isolation, culture and protoplast fusion - applications -. Somaclonal variation - applications.
- Learning methods to conserve germplasm under In vitro. Production of Secondary metabolites production through cell culture.

SEMESTER VI

COURSE CODE: BT601

Animal Biotechnology

Course objectives :

- The application of biotechnology to animals will be learned in detail.
- Challenges facing the intensive and extensive livestock industries, as well as wildlife management and conservation, will be discussed
- Problems specific farm animals will be also considered.
- The contribution of biotechnology to laboratory animal models for human and animal disease will be addressed.
- In addition, the use of biotechnology for animal related issues such as food safety, disease control and biosecurity will be considered.
- Different reproductive technologies will be introduced
- The integration of these technologies to improve animal production, health and welfare will be explored.

Unit 1: **Animal tissue culture: principles and applications**

1.1 Cell culture technique: cell culture media, sterilization techniques
1.2 Cell lines, characteristic feature of cell lines and maintenance
1.3 Methods of separation of various cell types (physical and enzymatic methods)
1.4 Stem cell: Features, culture, embryonic stem cells and adult stem culture

Unit 2: **Animal improvement for desired traits by biotechnology interventions**

2.1 Scope for biotechnological interventions (Buffalo as multipurpose livestock)
2.2 Model organisms and their significance (Cattle, Fish)
2.3 DNA micromanipulation
2.4 Somatic cell nuclear transfer, Embryo sexing

Unit 3: **Developments in Molecular markers in Livestock and Transgenic Animals**

3.1 Gene mapping and identification of genes of economic importance in farm animals
3.2 Developments in Livestock Genomics (Estimated Breeding Value -EBV)
3.3 Molecular markers (RFLP, RAPD and SNP) and applications
3.4 Applications of cell culture: Cell based manufacturing (vaccines), toxicity testing and tissue engineering

Unit 4: **Applications in Animal Biotechnology**

4.1 Animal transgenesis- methods and applications
4.2 Animal cloning – Case study-Dolly
4.3 Applications of animal biotechnology: Gene therapy, milk production, meat production, Aquaculture production
4.4 Ethical consideration of Transgenic animals

Course outcomes

- Outline the history and structure of animal cell
- To illustrate the techniques, procedure and growth patterns of animal cell culture.
- To describe in vitro applications of animal cell culture
- To distinguish the structure of gametes and its application in animal cell culture.
- To use the assisted reproductive technology practised in livestock and its applications
- To construct the techniques in production of cloned animal and its applications.
- To predict the ethical, social and moral issues related to cloning
- To Construct techniques involved in transgenic animal technology and its applications
- To apply the applications of Gene therapy for the treatment of various diseases.