RAYALASEEMA UNIVERSITY

DEPARTMENT OF BIOTECHNOLOGY

(A State University Established by Govt. of A.P)
(UGC 2 (f) & 12B, Accredited by NAAC with 'B" Grade)

M.Sc. BIOTECHNOLOGY

(SELF FINANCE COURSE)

SCHOOL OF LIFE SCIENCES
RAYALASEEMA UNIVERSITY
KURNOOL – 518007
ANDHRA PRADESH, INDIA

CURRICULUM

(EFFECTIVE FROM THE ACADEMIC YEAR 2022-23 onwards)

REGULATIONS FOR

M.Sc. BIOTECHNOLOGY (2 YEARS)

Name of the Course: M.Sc. Biotechnology

A brief description of the course: This is full time course to impart knowledge and training in different areas of Biotechnology so as to equip the candidates for higher studies in research and also to take up jobs in the industry.

School offering the course: The School of Life Sciences offer two years full time M. Sc. program in Biotechnology for the academic year 2022-23.

Board of Studies: Board of Studies in Biotechnology approved the course structure and CBCS syllabus of M. Sc. Biotechnology 1st, 2nd, 3rd, and 4th semesters for 2022-23.

Prerequisites: B.Sc. Chemistry with the combination any two Life/biological science subjects.

Credits (Theory, Practicals, Seminar and Viva-voce): 98 credits

Distribution of courses:	1st Semester:	24 credits	– 600 Max Marks
	2nd Semester:	25 credits	– 650 Max Marks
	3rd Semester:	24 credits	– 600 Max Marks
	4th Semester:	25 credits	– 650 Max Marks
		……	…….
		98 Credits	**2500 Max. Marks**

Duration:

The minimum duration for completion of a two year master program in Biotechnology is 4 semesters. The maximum period for completion is ten semesters counting from first semester.

- A department shall offer a minimum of four theories and two practical's in a semester.
- One credit shall mean one hour of teaching for theory or two hours for laboratory per week in a semester for 90 working days (15 weeks).

Course Fees:

- Each student admitted in to the M.Sc. Biotechnology degree course shall have to pay Tuition, Lab, Special, Stationery, Chemical, Computer and other fees as decided by the University from time to time

Syllabus:

From the academic year (2022-23) semester based Choice Based Credit System (CBCS) is introduced in all departments of the University. According to this system the M.Sc. Biotechnology Course requires a student to earn 98 credits in four semesters. The basic course structure and the scheme of examinations are given in tables that follow.

RAYALASEEMA UNIVERSITY::KURNOOL
M.Sc BIOTECHNOLOGY (CBCS)
(Syllabus w.e.f. academic year 2022-23 onwards)

I SEMESTER

Sl No	Course Components	Course Code	Course Title	No. of Credits	SEE Duration hr.	Total Marks	
						IAE	SEE
			I SEMESTER THEORY				
1	Mandatory Core	BT-101	Biomolecules & Metabolism	4	3	20	80
2	Mandatory Core	BT-102	General Microbiology	4	3	20	80
3	Compulsory foundation	BT -103	Analytical Techniques	4	3	20	80
4	Internal Elective	BT -104	**Internal Elective: (Elective)** a. Cell and Molecular Biology b. Medicinal Biotechnology c. Pharmaceutical Biotechnology	4	3	20	80
5.	Audit course	BT-AC-1	Ethics in biological research	-	-	-	-
			PRACTICAL				
1	LAB-I	BT-101P & BT-102P	Biomolecules & Metabolism, General Microbiology	4	8	30	70
2	LAB-II	BT-103P & BT-104P	Compulsory Foundation & IE	4	8	30	70
			Total Credits 24 **Total Marks= 600**	24	-	140	460

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M.Sc BIOTECHNOLOGY (CBCS)

(Syllabus w.e.f. academic year 2022-23 onwards)

II SEMESTER

Sl No	ourse Components	Course Code	Course Title	No. of Credits	SEE Duration hr.	Total Marks	
						IAE	SEE
II SEMESTER THEORY							
1	Mandatory Core	BT-201	Genetics & Evolution	4	3	20	80
2	Compulsory Foundation	BT-202	Enzymology	4	3	20	80
3	Internal Elective	BT -203	**Internal Elective** a. Genetic Engineering b. Bioprocessing & Engineering technology c. Genomics & Proteomics	4	3	20	80
4	Open Elective	BT -204	**Open Elective** a. Foundation of Biology b. Basics of Infection biology c. Vaccinology	4	3	20	80
5.	Audit course	BT-AC-2	Intellectual Property Rights	-	-	-	-
PRACTICAL							
1	LAB-I	BT-201P & BT-202P	Genetics & Evolution & Enzymology	4	8	30	70
2	LAB-II	BT-203P & BT-204P	IE & OE	4	8	30	70
3.	Comprehensive viva	BT-Viva-1	Viva-voce	1	-	-	50
			No. of credits: 25 **Total marks = 650**	25	-	140	510

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(Syllabus w.e.f. academic year 2022-23 batch)

III SEMESTER

Sl No	Course Components	Course Code	Course Title	No. of Credits	SEE Duration hr.	Total Marks	
						IAE	SEE
III SEMESTER THEORY							
1	Mandatory Core	BT-301	Plant & Animal Biotechnology	4	3	20	80
2	Mandatory Core	BT-302	Environmental, Food & Industrial Biotechnology	4	3	20	80
3	Internal Elective skill oriented courses	BT -303	**Internal Elective (IE) (skill oriented courses)** a. Tissue culture b. Nanobiotechnology c. Molecular diagnosis	4	3	20	80
4	Open Elective	BT -304	**Open Elective (OE)** a. Model organisms in biology & biotechnology b. Drug discovery c. Computational biology	4	3	20	80
PRACTICAL							
1	LAB-I	BT-301P & BT-302P	Plant & Animal Biotechnology, & Environmental, Food and Industrial Biotechnology	4	8	30	70
2	LAB-II	BT-303P & BT-304P	IE & OE	4	8	30	70
			No. of Credits: 24 **Total Marks = 600**	24	-	140	460

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M.Sc BIOTECHNOLOGY (CBCS)

(Syllabus w.e.f. academic year 2022-23batch)

IV SEMESTER

Sl No	Course Components	Course Code	Course Title	No. of Credits	SEE Duration hr.	Total Marks	
						IAE	SEE
IV SEMESTER THEORY							
1	Mandatory Core	BT-401	Immunology	4	3	20	80
2	Mandatory Core	BT-402	Biostatistics & Bioinformatics	4	3	20	80
3	Internal Elective	BT - 403	**Internal Elective (IE)** a. Research methodology & communication b. Bioenterprenuership & Biosafety skills c. MOOCS/SWAYAM/NPTEL	4	3	20	80
4.	Open Elective	BT- 404	**Open Elective (OE)** a) Ecology &Evolution b) Recombinant technology c) Agricultural biotechnology	4	3	20	80
PRACTICAL							
1	LAB-I	BT-401P & BT-402P	Immunology & Biostatistics & Bioinformatics	4	8	30	70
2	Compulsory Project	BT-PW405	Project work and dissertation	4	--	-	100
3	Comprehensive viva	BT-Viva-2	Comprehensive Viva-voce	1	-	-	50
			No. of credits: 25 **Total marks = 650**	25	-	110	540

Total Credits: 24+25+24+25=**98;** **Total Marks:** 600+650+600+650=**2500**

IAE: Internal Assessment Examination - 20 marks; **SEE:** Semester End Examination (both theory and Practicals)

(Syllabus w.e.f. academic year 2022-23 onwards)
SEMESTER I
BT 101 (M.C): BIOMOLECULES & METABOLISM

Theory: 5 untis **Mid Marks Theory: 20**
Ext. Marks Theory: 80
Exam: 3Hrs. **Credits: Theory - 4**
Practicals -2

Course Objectives:

1. To explore the knowledge and awareness of the basic principles and concepts of Biomolecules.
2. To understand the structure, functions and metabolisms of Biomolecules – Carbohydrates, proteins, lipids and nucleic acids.

Unit – I:

Carbohydrates: Classification, structure, functions and reactions of biologically important carbohydrates; Monosaccharides; Disaccharides; structural and storage polysaccharides;

Unit – II:

Amino acid, peptide and proteins: Amino acids: Classification, Properties, reactions, rare amino acids; Biologically important peptides; Protein classification: Reactions, functions, properties; Structural levels of proteins: (a). Primary Structure (b). Secondary structure: alpha-helix, β - structure, β-helix, (c). Tertiary Structure (d). Quaternary structure; sequencing and peptide synthesis, Ramachandran plot and its significance.

Unit – III:

Lipids and Fatty acids: Nomenclature, Fatty acids and their types, structure and biological functions of various classes of lipids; Lipoproteins; Lipids of physiological significance; Lipid transport and storage; Polyamines, Prostaglandins, Types and functions of Porphyrins, pigments and growth regulators.

Unit – IV:

Nucleic acids: Building blocks of nucleic acids – purines and pyrimidines, nucleosides, nucleotides; Types of DNA (A, B and Z); Double stranded linear DNA; Circular DNA and Extra chromosomal DNA; Watson and Crick DNA double helix model; Chargaff's rule; DNA organization, Stability and formation of phosphodiester linkages; denaturation of nucleic acids and melting temperature; Different types of RNA and their biological functions; De& novo! Synthesis of purine and pyrimidines, salvage pathways.

Unit – V:

Metabolisms - Carbohydrate metabolism: Starch and sucrose biosynthesis, Glycolysis, TCA cycle, glycogenesis, gluconeogenesis, pentose phosphate shunt pathway.

Amino Acid metabolism: Transamination reaction, oxidative deamination, urea cycle, Anabolic Reactions, and amino acid synthesis from metabolic intermediates.

Lipids and Fatty acids metabolism: Oxidation of fatty acids, biosynthesis of fatty acids and cholesterol, oxygenation of PUFAs O COX and LOX pathways.

List of Practicals:

1. Determination of reducing sugars arabinose, xylose, fructose, galactose, sucrose, maltose & lactose by spectrophotometer
2. Isolation of Protein
3. Preparation of casein from milk
4. Estimation of proteins by Biuret, Folin-Lowry, UV and Bradford dye binding methods
5. Estimation of amino acids by Ninhydrin method
6. Estimation of tyrosine by Millon's reaction
7. Estimation of fructose in fruit juice
8. Isolation of lipids

Suggested Readings:

1. Lehninger- Principles of Biochemistry by Nelson D. Cox Michael M – 6th Edition
2. Biochemistry by L. Stryer – 4th Edition
3. Biochemistry by V.Voet and J.G.Voet - 4th Edition
4. Harpers Illustrated Biochemistry by Victor W. Rodwell, David Bender, Kathleen M. Botham – 30th Edition
5. Modern Experimental Biochemistry by Rodney F. Boyer – 3rd Edition

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.
5. Understand the metabolisms of carbohydrates, amino acids, lipids and fattyacids.

M.Sc. BIOTECHNOLOGY (CBCS)
(Syllabus w.e.f. academic year 2022-23)
SEMESTER I
BT102 (M.C): GENERAL MICROBIOLOGY

Mid Marks Theory: 20
Theory: 5 units **Ext. Marks Theory: 80**
Exam: 3Hrs. **Credits: Theory – 4**
Practicals -2

Course objectives:

1. To impart the knowledge on discovery and classification of microorganisms
2. To develop understanding on microbial nutrition, growth pattern and physiology of microorganisms
3. To know about viral, bacterial, fungal and protozoan diseases in plants and animals. Its influence on earth's environment.
4. To understand Pathogen-host interactions.
5. To understand the role of microbes in nutrient cycle.

Unit I: Microbial diversity and Systematics: Classical and modern methods and concepts; domain and kingdom concepts in classification of microorganism; criteria for classification; classification of Bacteria according to Bergy's manual; genetic and molecular classification systems; Ultra structure of Archaea, Eubacteria, Unicellular Eukaryotes (Yeast) and Structure and classification of viruses, viroid and prions; Modern concepts in virology: Replication, Assembly, Mode of infection, Transduction.

Unit II: Microbial Growth, nutrition & physiology: Microbial nutrition - common nutrient requirements, Nutritional types of microorganisms, Microbial growth; Batch, fed-batch, continuous kinetics, synchronous growth, methods of growth estimation, Control of Microorganisms by Physical and Chemical Agents; Microbial physiology; physiological adoption and life style of prokaryotes

Unit III: Microbes, infection and environment: Microbial interactions and infection; Host-pathogen interactions; microbes infecting humans, veterinary animals and plants; pathogenicity islands and their role in bacterial virulence. Microbes and environment; influence of microbes on the Earth's environment, ecological impacts of microbes.

Unit IV: General characters of Actinomycetes, Archaebacteria, Mycoplasmas and Cyanobacteria; Economic importance. Microbes and nutrient cycles; microbial communication system; quorum sensing; microbial fuel cells; prebiotics and probiotics.

Unit V: Ecto and endo mycorrhizal associations; Edible and poisonous mushrooms, Mushroom cultivation; Importance of Fungi in Agriculture and industry. Mycotoxins.

List of Practicals

1. Isolation of Pure Cultures : Serial Dilution, pourplate, spread plate and streak plate methods
2. Antibiotic sensitivity test
3. Growth measurement by using spectrophotometer (growth rate and generation time in bacteria)
4. Starch hydrolysis assay for identification of amylase producing microorganisms

5. Gram staining
6. Yeast Fermentation process
7. Water analysis for bacteria & determination of BOD and COD of water.
8. Isolation of phages from sewage and quantification by plaque assay
9. Observation of Rhizobium from root nodules of groundnut plant

Suggested Readings:

1. MJ. Peleczar, Jr & E.C.S Chan International students - Elements of Microbiology, McGraw Hill International Book Company, New Delhi.
2. C.B. Powar & H.F. Daginawala - General Microbiology, Himalaya Publishing House, Bombay.
3. R Aananthnarayan & C.K. Jayaram Panikar - Text Book of Microbiology, Orient Longmen, Hyderabad.
4. A. Mani, A. M. Selvaraj, L.M. Narayanan and N. Arumugam – Microbiology, Saras Publications.
5. Bauman Robertt et al. – Microbiology with diseases: Taxanomy, Benjamin Cummings Publishers.

Course outcomes:

The student will be able to

1. Acquire knowledge on classification and structure of different microorganisms.
2. Acquire knowledge on microbial techniques for isolation, cultivation and maintenance of pure cultures.
3. Develop understanding on cause, spread and control of diseases caused by different microorganisms.
4. Acquire knowledge on general characters and economic importance of microbes.
5. Acquire knowledge on plant – fungi associations.

RAYALASEEMA UNIVERSITY::KURNOOL
M.Sc. BIOTECHNOLOGY (CBCS)
(Syllabus w.e.f. academic year 2022-23)
SEMESTER I
BT103 (C.F): ANALYTICAL TECHNIQUES

Mid Marks Theory: 20
Theory: 5 units **Ext. Marks Theory: 80**
Exam: 3Hrs. **Credits: Theory – 4**
Practicals -2

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 bio molecules.
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: Microscopy and Centrifugation: Principles and application of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Microtomy and double staining of plant sections. Centrifugation: Basic principles of sedimentation, types of centrifuges and rotors. Centrifugation methods: differential, density-gradient, analytical, and ultracentrifugation and their applications.

Unit-II: Chromatography: Separation methods - General principles and applications. Affinity, Gel filtration, Ion exchange, Partition and adsorption chromatography. Techniques of paper chromatography, Thin layer chromatography, Gas and High performance liquid chromatography.

Unit –III: Electrophoresis: General principles and applications. PAGE: Native -PAGE, SDS-PAGE, Isoelectricfocusing, 2D electrophoresis, identification of proteins in 2D gels, capillary electrophoresis. Agarose gel electrophoresis – Elution of DNA from agarose gels. Hybridization, Electrophoretic mobility shift assay [EMSA].

Unit-IV: Spectroscopy: Principles, laws of light absorption, Instrumentation and applications of UV- visible spectrophotometer, fluorescence spectroscopy, Mass spectroscopy – Matrix Assisted Laser Desorption Ionization Mass Spectrometry (MALDI – TOF).

Unit-V: Radioisotope Techniques: Types of isotopes, radioactive decay. Detection and measurement of radioactivity. GM counter, scintillation counter, autoradiography. Isotopes used in biology, safety methods in handling radioisotopes.

List of Practicals:

1. Effect of solvent system on R_f value of two solutes using Thin Layer Chromatography (TLC).
2. Analysis of amino acids by Thin Layer Chromatography (TLC).
3. Separation of purines and pyrimidines by paper chromatography.

4. Preparation of Buffers and measurement of pH.
5. Isolation and spectrophotometric characterization of plant pigments.
6. Measurement of pH of a biological fluid using pH meter.

Suggested Readings:

1. Ed.John. R.W.Masters - Animal Cell culture: A Practical approach, IRL Press.
2. Ronert Braun - Introduction TO Instrumental Analysis, McGraw Hill International.
3. K. Wilson & K.W. Goulding - A Biologists Guide to Principles and Techniques of Practical BIOTECHNOLOGY, ELBS Edn.
4. K.T. Brown and D.G. Flamming IBRO - Advanced Micropipette Techniques for cell physiology Hand Book Series, A Wiley Interscience publications, John Wiley and Sons, New York.
5. N.J. Stransfed and T.A. Miller - Neuro anatomical Techniques, Springer Verlag, New York Heidelberg, Berlin.
6. Robert S. Feldman, Jerrold S. Meyer and Unida quenzer - Principles of Neuropsychopharmacology, Sinancer Associates Inc. Publishers. Sunderland, Massachusetts.
7. F.M. Weesner - General Zoological Microtechnique

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 bio molecules 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.

RAYALASEEMA UNIVERSITY::KURNOOL
M.Sc. BIOTECHNOLOGY (CBCS)
(Syllabus w.e.f. academic year 2022-23)
SEMESTER I
BT104 (I.E-A): CELL AND MOLECULAR BIOLOGY

Mid Marks Theory: 20
Theory: 5units **Ext. Marks Theory: 80**
Exam: 3Hrs. **Credits: Theory – 4**
Practicals -2

Course objectives:

1. To know the structure and functions of prokaryotic and eukaryotic cells and cell organells.
2. To understand cell membrane composition and its functions.
3. To impart knowledge on organization of genetic material and its replication.
4. To develop understanding on mechanism of transcription and translation process of genome.
5. To gain awareness on prokaryotic and eukaryotic gene structure, its organization and regulation.

Unit–I: Cellular organization and cell cycle: Prokaryotes and Eukaryotes, ultra structure of Plasma membrane, cytoskeletal elements, Chloroplasts; Mitochondria; Golgi complex; Endoplasmic reticulum; Vacuole; peroxisomes, glyoxysomes, Nucleus and Nucleolus; Micro bodies; Lysosomes; plant cell wall, C-value paradox; Organization of Eukaryotic chromosome.

Unit – II: Cell cycle - G1, S, G2 and M phases, Check points in cell cycle - Role of Cyclins; Cyclin dependent kinases; Cell division; significance of meiosis. Apoptosis –mechanism and significance, oncogene and tumour suppressor genes. Genomes of mitochondria and chloroplasts. Endosymbiotic theory; Karyotype study in relation to taxonomy.

Unit – III: **Genetic material, genome organization and replication**: classical experimental-Evidence of DNA as genetic materials, RNA viruses-RNA as genetic material, Organization of DNA in prokaryotes and Eukaryotes. DNA Replication and Repair, Semi Conservative mode of Replication – Messelson - Stahl and Cairns experiments; Replication fork, Continuous and Discontinuous DNA synthesis; Enzymes and Proteins in Replication - Single Strand DNA binding Proteins (SSB), Helicases, Topoisomerases, DNA Ligases; Priming by RNA Polymerase and Primase; DNA Polymerases - *E.coli* DNA Polymerase I, II and III and Eukaryotic DNA Polymerases. DNA Damage and repair mechanisms.

Unit – IV: **Transcription and translation**: Polynucleotide phosphorylase, RNA polymerases - Structure of *E.coli* RNA polymerase; sigma factor, sigma cycle, Promoter-polymerase interaction. Nature of Eukaryotic RNA polymerases; Enhancers, Initiation, Elongation and Termination of RNA Synthesis. Processing of RNA (Capping, Splicing, Tailing). Translation (Protein synthesis) - Mechanism of Initiation, Elongation and Termination of Protein synthesis; Inhibitors of Protein synthesis; Post-Translational Modifications; Protein sorting and Targeting.

Unit – V: **Regulation of Gene Expression**: Fine structure of gene, differences between prokaryotic and eukaryotic gene organization; spilt genes in eukaryotes House Keeping genes, Constitutive and Regulatory genes; Inducers and Repressors; Regulation of Gene expression in Prokaryotic Operons - Negative regulation and Positive regulation; Fine structure of *lac* operon - Repressor and the Catabolite activator proteins in gene regulation of *lac* operon; Dual functions of the Repressor in *ara* operon; Antisense RNA; Hormones and Environmental factors affecting Gene expression; Homeotic genes and their Regulation. siRNA and miRNA- RNA interference.

List of Practical:

1. Preparation of Cytological slides for Mitosis using Root tips.
2. Preparation of Cytological slides for Meiosis-I using Flower buds.
3. Observation of different types of chromosomes
4. Estimation of DNA by Diphenylamine methods
5. Estimation of RNA by Orcinol method.
6. Determination of purity and quantity of DNA by UV absorption method.
7. Determination of GC content of DNA and estimation by Tm
8. Assessment of DNA Meltine Point

Suggested Readings:

1. Cooper Geoffrey, M. - The Cell-A Molecular Approach, ASM Press, Washington.
2. Albert's, A. et al. - Molecular Biology of the Cell, Garland Publishing House, New York.
3. De Robertis, E.D.P. & E.M.F. DeRobertis. - Cell and Molecular Biology, Lippincott Williams & Wilkins, Bombay.
4. B. Alberts, D. Bray, J.Lewis, M.Raff, K. Roberts and J.D.Watson - Molecular Biology of the Cell, Garald Publishing, New York & London.
5. D. Freifelder - Molecular Biology – A Comprehensive Introduction to Prokaryotes and Eukaryotes, Jones and Bartlett, USA.
6. Maniatis, E.F.Fritsch and J.Sambrook - Molecular Cloning: Laboratory Manual, Cold Spring Harber Laboratory, NewYork.
7. Benjamin Lewin – Genes, Oxford University Press.

Course outcomes:

The student will be able to

1. Differentiate prokaryotic and eukaryotic cell
2. Understand the organization of genetic material in lower and higher organisms
3. Appreciate the mechanism of mitotic and meiotic process and identify the abnormalities
4. Learn about the mechanism of tissue specific transcription and role of RNA polymerases.
5. Gain insights of mechanism of gene expression and regulations

RAYALASEEMA UNIVERSITY::KURNOOL
M.Sc. BIOTECHNOLOGY (CBCS)
(Syllabus w.e.f. academic year 2022-23)
SEMESTER I
BT104 (I.E-B): MEDICINAL BIOTECHNOLOGY

Mid Marks Theory: 20
Theory: 5 units **Ext. Marks Theory: 80**
Exam: 3Hrs. **Credits: Theory – 4**
Practicals -2

Course Objectives:

1. To gain knowledge on applications and uses of recombinant DNA technology
2. To gain knowledge on Disease Diagnosis
3. To gain knowledge on Factors affecting Microbial Pathogenicity
4. To gain knowledge on Biochemical and molecular basis of metabolic disorders
5. To gain knowledge on clinical diagnostics

UNIT-I: Medical biotechnology- History, Definition, applications and uses of recombinant DNA technology Products like "Insulin, growth factor, factor- VIII, tissue plasminogen activator, interferons, B-cell, Blood products-Erythropoietin"

UNIT – II: Disease Diagnosis - Gene therapy- vector engineering and gene delivery methods, gene replacement, gene agumentation, gene silencing. Current strategies for development of vaccines against HBV, Malaria, Tuberculosis. Role of PCR and RFLP in disease prognosis U

UNIT – III: Introduction to Medical Microbiology, Factors affecting Microbial Pathogenicity – Adhesion – Invasiveness – Toxigenicity. Bacterial Toxins, Virulence Factors, Normal Flora; Epidemiology - Route of Transmission, Carriers, etc

UNIT-IV: Biochemical and molecular basis of metabolic disorders and life style disorders - Diabetes, Atherosclerosis, PCOD, Obesity, Parkinson Disease, and Alzheimer's disease, OCD, Depression.

UNIT-V: Introduction to clinical diagnostics, Normal and reference values, Biological sample collection and preservation, Selection of analytical methods. Diagnostics - Biochemical, Immunological and Molecular Diagnostics in relation to Organ function tests, prenatal diagnosis.

List of Practicals:

1.Total protein isolation, SDS PAGE / Native PAGE and Western Blotting
2.Sterilization By Autoclaving And Test For Sterility.
3. Sterilization By Dry Heat And Test For Sterility
4.Sterilization By Heating With Bactericide And Test For Sterility
5.Test For Presence Of Fungi In Tap Water
6.Immobilization Of Microbial Cells By Entrapment In Sodium Alginate
7. Bioinformatic software-

Hex 8.Bioinformatic software - Rasmol 9. Drug Receptor interactions (Molecular docking) 10. DNA Finger printing for disease diagnosis

Suggested Readings

1. Biotechnology by B.D.Singh (Kalyani).
2. Molecular Biology and Biotechnology by Meyers, RA, A comprehensive Desk reference (VCH Publishers).
3. Biotechnology by U. Satyanarayana (Books & Allied (P) Ltd).
4. Tietz Textbook of Clinical Chemistry, Third Edition. Carl A. Burtis and Edward R. Ashwood, eds.
5. Clinical chemistry By William J. Marshall, William J. Marshall (Ph. D.), S. K. Bangert
6. Clinical Chemistry: Principles, Procedures, Correlations, 5th ed. Michael L. Bishop, Edward P. Fody, and Larry Schoeff. Baltimore, MD: Lippincott Williams & Wilkins, 2005.
7. Medical Microbiology: with STUDENT CONSULT Online Access (Murray, Medical Microbiology) by Patrick R. Murray PhD, Ken S. Rosenthal PhD, and Michael A. Pfaller MD (Paperback - Dec 10, 2008)
8. Medical Microbiology, 24th edition (Jawetz, Melnick, & Adelberg's Medical Microbiology) by Geo. Brooks, Karen C. Carroll, Janet Butel, and Stephen Morse (Paperback - April 20, 2007)
9. Jawetz, Melnick, & Adelberg's Medical Microbiology, 25th Edition (LANGE Basic Science) by Geo. Brooks, Karen C. Carroll, Janet Butel, and Stephen Morse (Paperback - May 14, 2010)

Course outcomes:

The student will be able to

1. Understand uses of r-DNA technology in medicine
2. Gain knowledge on Current strategies for development of vaccines
3. Gain knowledge on Epidemiology
4. Gain knowledge on metabolic disorders and life style disorders
5. Gain knowledge on Diagnostics in relation to Organ function tests.

RAYALASEEMA UNIVERSITY::KURNOOL
M.Sc. BIOTECHNOLOGY (CBCS)
(Syllabus w.e.f. academic year 2022-23)
SEMESTER I
BT104 (I.E-C): PHARMASEUTICAL BIOTECHNOLOGY

Mid Marks Theory: 20
Theory: 5 units **Ext. Marks Theory: 80**
Exam: 3Hrs. **Credits: Theory – 4**
Practicals -2

Course Objectives:

1. It is designed to equip students with a basic knowledge of concepts directly relevant to working in the biopharmaceutical industry.

2. The main areas of employment for biotechnologists/ pharmacists within this sector are; Research and development, production, quality assurance and regulatory affairs.

3. To impart an understanding of the terms 'traditional pharmaceutical product', 'biologic' and ‘biotechnological’ products

4. To study the clinical trials

5. To know about the importance of transgenic plants in health care.

UNIT -I : Chemotherapy Antimicrobial Drug. Mechanism of action of antimicrobial agents. Microbial Resistance to antibiotics and antimicrobial agents (Types and Mechanism). Types of Antibiotics: Classification of antibiotics with example. General characteristics of an Secondary Metabolites: Types and Medicinal Applications.

UNIT-II: Chemotherapeutics Agents Structure, Mechanism of Action and Applications of Antibacterial drug: Sulfonamides, Quinolones. Antiviral drug: Amantadine, Azidothymidine. Antifungal drug: Nystatin, Griseofulvin.Mechanism of action of Anticancer drugs, Drugs acting on CNS, Insulin, Blood factor VIII.

UNIT - III: Discovery and Development History, drug targeting, Molecular Biology and Combinatorial drug discovery, Rational Drug designing. Stability of Drug, Pharmacokinetics, Pharmacodynamics. Drug delivery systems, Liposomes.

Unit - IV : Clinical Trials Phases of Clinical trials of drugs, Preclinical drug evaluation of its biological activity, potency and toxicity-Toxicity test in animals including acute, sub-acute and chronic toxicity, ED50 and LD50 determination, special toxicity test like teratogenecity and mutagenecity. Biosimilar Technology, Introduction to Indian, International Pharmacopoeia and global regulatory guidelines.

UNIT – V: Transgenic plant and animal and their applications in healthcare. c- DNA and intragenic arrays, Differential gene expression and protein array. Role of gene therapy in management of communicable, lifestyle and metabolic diseases/disorders. Guidelines for gene therapy.

List of Practicals:

1. Estimation of penicillin/streptomycin by biological assay.

2. Estimation of penicillin/streptomycin by chemical assay.

3. Assay of antimicrobial activity of Penicillin, Chloramphenicol, Streptomycin

4. Determination of Minimum Inhibitory Concentration (MIC) of Antibiotic

5. Determination of shelf life of antibiotics (Expired drugs)

6. Sterility testing of commercial pharmaceuticals.

7. Study of microbial spoilage of pharmaceuticals.

8. Effect of chemical disinfectant on growth of bacteria

9. Study of Pharmacopeia and global regulatory guidelines in pharma industry

10. Visit to Pharmaceutical industry

Suggested Readings

1. Hugo W. B. and Russell A. D. - Pharmaceutical Microbiology -Wiley India

2. Ashutosh Kar-Pharmacology and Pharmacobiotechnology-New Age

3. FSK Barar- Pharmaceutical- Essentials of Pharmaceuticals- S.Chand

4. B.Glick and J Pasernak -Molecular Biotechnology –ASM Press.

5. Doble- Drug Designing-McGraw Hill

6. S.P. Vyas, Dixit- Pharmaceutical Biotechnology-CBS 22

7. B.Razdan-Medicinal Chemistry-CBS

8. Satoskar, Bhandarkar- Pharmacology and Pharmacotherapeutics- Popular

9. Purohit, Saluja- Pharmaceutical Biotechnology-Student Edition

10. Ramawat K.G; Merillon J.M - Biotechnology: Secondary Metabolites-Oxford

11. Ed. R.H. Thomson-Chemistry of Natural Products-Springer 12. Jogdand S.N - Biopharmaceuticals, Himalaya Publishing

Course outcomes:

1. Get awareness with antibiotics
2. Get awareness about the applications of antimicrobial drugs.
3. Get awareness about drug designing
4. Get awareness about toxicity of drugs.
5. Get awareness about role of gene therapy.

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M.Sc. BIOTECHNOLOGY (CBCS)
(Syllabus w.e.f. academic year 2022-23)
SEMESTER I
BT105 (A.C): ETHICS IN BIOLOGICAL RESEARCH

Theory: 5 units
Course Objectives:

Student shall be able to:

1. Identify and analyze ethical issues in biology,
2. Understand that science is filled with ethical judgments,
3. Learn and apply formal ethical principles,
4. Learn the professional standards that govern the practice of biology and decision making,

UNIT –I: **Introduction:** ethical norms in research, Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT –II: Scientific Ethics - Importance of Scientific Ethics, Structure and Practice of Ethics Committees & Govt. Regulations, Scientific Ethics in Research Planning and Execution, Research Misconduct (Bias in research design, Unethical practices in data acquisition and data Management, Data Fabrication), Research Publishing: plagiarism, credit, responsibility and funding, Research ethics and misconduct: Case studies.

UNIT –III: Ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

UNIT –IV: **National and International Regulations*:*** International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology. Regulatory authority of India - containments – biosafety levels and category of rDNA experiments;

UNIT –V: Ethical implications of biotechnological products and techniques, Social and ethical implications of biological weapons.

Course Outcomes:
1. Recognize differing priorities and to balance them when designing solutions to complex ethical problems,
2. Identify impacts of current and historical cultural and societal norms on bioethical issues and their resolution, and

3. Demonstrate understanding and critical evaluation of ethical issues in biology through writing and discussion.

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SEMESTER II

BT 201 (M.C): GENETICS AND EVOULTION

Theory : 5 units | **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. | **Credits: Theory - 4**

Practicals -2

Course Objectives:

1. To gain awareness on Mendelian genetics and recombination.
2. To develop understanding on chromosomal abnormalities and their role in evolution
3. To develop understanding on Human chromosomes and deficiency syndromes.
4. To understand evolution and speciation of organisms.
5. To understand about the fundamental processes of evolution.

UNIT I: Mendelian Laws of Inheritance: An Overview: Genetic conventions, Notations and Terminology. Genetic Recombination: Types (Homologous - Reciprocal and Non-reciprocal, Site specific and Illegitimate). Different models of Homologous Recombination. Molecular Mechanisms of Recombination. Non-Mendelian inheritance.

UNIT II: Chromosome as a Linkage unit: Coefficient of Coincidence of Double Crosses, Chiasma Interference. Chromosomal Mapping: Mapping by Recombinational Frequencies, Transformation and Interrupted Mating. Chromosomal Aberrations: Types (Numerical and Structural) and their significance in Evolution. Sex Chromosomes: Determination of Sex; Genic balance theory; Gynandromorphs; Sex- linked inheritance; Criss - cross inheritance.

UNIT III: Numerical (aneuploidy: trisomy, monosomy, nullisomy; euploidy) and Structural abnormalities (deletion, duplication, inversion and translocation) of Human chromosomes and Syndromes: Turner's; Down's and Klinifelter.Human karyotype and Human genome. Inborn errors of Metabolism.Pedigree analysis. Concepts of Eugenics: Artificial Insemination, sperm banks, Amniocentesis, Consanguinity, prenatal diagnosis. Inborn diseases and genetic counselling.

UNIT IV: Emphasis on Darwinism and Lamarckism. Neo-Darwinism.An account on destabilizing forces: (i) Natural selection (ii) Mutation (iii) Genetic drift. Hardy and Weinberg equilibrium and its significance in understanding Evolution. Modes of Speciation: (Allopatric, Sympatric and Parapatric). Phylogenetic Gradualism and Punctuated Equilibrium. Micro and Macro Evolution.

UNIT V: Fundamental evolutionary processes in natural populations and their influence on biological diversity by using molecular methods. -Variation within and between populations, sequencing

techniques and data bases useful for ecological applications and environmental protection. detection of natural selection and measurement of adaptive processes (Fitness landscapes; adaptive landscape) and how adaptation may be constrained (breeders equation; heritability; evolutionary constraints).

List of Practicals:

1. Mendelian Laws using Colour Marbles or Beads.
2. Evaluation of Segregation and Random assessment using Chi-Square test or Test of fitness.
3. Demonstration of Barr bodies.
4. Construction of Genetic Maps based on problems in two and three factor crosses.
5. Demonstration of Neo-Darwinism and Lamarckism.
6. Charts – Micro and Macro Evolution.
7. Sex determination of Drosophila
8. Variance of eye and wings studies in drosophila

Suggested Readings:

1. B. D. Singh, P.B. KaviKishor, PratibhaNallari, P. H. Rao. Cell Biology and Genetics; Genetics : Fundamentals.Kalyani Publishers, Hyderabad, New Delhi. Published in the year2009.
2. Monrve W. Strickberger – Genetics.
3. K.B. Ahluwallia - Genetics.
4. E.J. Gardner. M.J. Simmons and D.P. Snustad- Principles of Genetics.
5. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner - Molecular Biology of Genes, Benjamin Cummings Publishing Company. Inc. Tokyo.
6. E.J. Mange, Arthur P. Mange - Basic Human Genetics, Indian Print.
7. M.R. Goodman - Genetic disorders of Man.

Course outcomes:

The student will be able to

1. Understand Genetic Recombination and its significance in evolution.
2. Learned the preparation of Chromosomal mapping.
3. Understand the molecular mechanisms of mutations and its importance in evolution.
4. Understand Micro and Macro evolution.
5. Useful for ecological applications.

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SEMESTER II

BT 202(C.F): ENZYMOLOGY

Theory : 5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives:

1.To provide knowledge on classification, nomenclature, isolation, and purification of enzymes.
2.To provide knowledge on kinetics of enzymes.
3.To provide knowledge on catalysis of enzymes.
4.To provide knowledge on regulation mechanisms of enzymes.
5.To apply the knowledge in Biotechnology & in Medicine

UNIT – I: Nomenclature and classification of enzymes: EC, Vitamin cofactors: TPP, FMN/FAD, NAD/NADP, Pantothenic acid; Factors affecting catalysis (pH, temperature, pressure, enzyme and substrate concentration); Chemicals to identify active site residues: Arg, Cys, Lys, His.

UNIT – II: Kinetics of catalysed reaction: Single substrate reactions, bisubstrate reactions (ordered, random, sequential, Ping-Pong), Michaelis-Menton kinetics (derive equation and transformations); Transformation of Michaelis-Menton equation, Determination and significance of kinetic constants, Activation energy and Arrhenius concept. Enzymes activation by ligand binding and dimerization (protein tyrosine kinase receptors). Reversible and irreversible activation of enzymes (pro-enzymes, phosphorylation). Inhibitors (competitive, uncompetitive, noncompetitive, suicide). Enzyme inhibitors as drugs: RT and Protease inhibitors as anti-HIV drugs

UNIT – III: Enzyme catalysis: enzyme specificity and the concept of active site, determination of active site. Stereospecificity of enzymes. Mechanism of catalysis: Proximity and orientation effects, general acid-base catalysis, concerted acid - base catalysis, nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis. Catalytic mechanism of RNase, Chymotrypsin, Trypsin, Lysozyme, Carboxypeptidase and Subtilisin.

UNIT – IV: Enzyme regulation: General mechanisms of enzyme regulation. Regulation of Glutamine Synthetase. Allosteric regulation of Aspartate Transcarbamylase. Sigmoidal kinetics and their physiological significance, Symmetric and sequential modes for action of allosteric enzymes. Multi-enzyme Complex: fatty acid synthase. Cooperativity in binding (oxygen binding to hemoglobin). Cooperativity: MWC model, KNF model. Immobilised enzymes and their industrial applications. Isoenzymes and their significance.

UNIT- V: Biotechnological applications of enzymes- Food and Drink Industry, Recombinant DNA Technology, Immobilised Enzymes. Inborn errors of metabolism-Phenylketonuria, Alkaptonuria, Sickle Cell Anaemia,

Fructosaemia. Application of enzymology, enzymes as analytical reagents, instrumental techniques available for using enzymatic analysis in Medicine and Industry,

List of Practicals:

1. Assay of Amylase from saliva
2. Assay of Acid phosphatase from potato
3. Assay of Trypsin
4. Assay of urease from Horse gram
5. Assay of Succinate dehydrogenase from the liver
6. Effect of temperature on enzyme activity and calculation of energy of activation.
7. Enzyme kinetics-Vmax,Km, Ki
8. Effect of PH on enzyme activity and determination of optimum PH
9. Effect of substrate concentration on enzyme activity and determination of Michealis constant.

Suggested Readings

1. Lehninger Principles of BIOTECHNOLOGY, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman.
2. Molecular Biology of the Cell, 3rd edition. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D Watson. Publisher New York: Garland Science.
3. The Cell: A Molecular Approach, Fifth Edition, by Geoffrey M. Cooper and Robert E. Hausman, published by ASM Press.

Course outcomes:

Students will be able to

1. Gain knowledge on different enzymes and their significance.
2. Gain knowledge on enzyme kinetics, their activation and inhibitory mechanisms.
3. Gain knowledge on Mechanism of catalysis of enzymes.
4. Gain knowledge on general mechanisms of enzyme regulations.
5. Gain knowledge on its applications.

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SEMESTER II

BT 203 (I.E-A): GENETIC ENGINEERING

Theory -5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives:

1. To impart knowledge about major events in the development of rDNA technology
2. To acquire skills on techniques of construction ofrecombinant 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).
5. To know about gene silencing techniques.

UNIT – I: Enzymes used in Recombinant DNA Technology - Restriction Endonucleases – Types, Nomenclature and Properties, DNA Ligases, Topoisomerases, Methylases, Nucleases, Polymerases, Reverse Transcriptase and their Properties and Functions. Salient features of Cloning Vectors – Salient features, Types –M 13 vectors and SV40 based vectors, Baculo virus, PBR and its derivatives, Cosmids, Shuttle vectors, PBR322 and its derivatives. Artificial Chromosomes – BACs, YACs and PACs used in cloning. Ligation of foreign DNA to vectors - cohesive and blunt end ligation, homopolymer tailing and adaptors. Preparation of gene libraries and c-DNA libraries.

UNIT – II: Introduction of Recombinant DNA molecules into Appropriate Hosts – Preparation of Competent cells, Electroporation, Microinjection and Particle Bombardment method and Selection of Transformants. Cloning and Selection strategies and Screening analysis of Recombinants (Single Colony Hybridization technique, Fluorescence, In situ Hybridization), Immunologic test.

UNIT – III: Expression of Cloned Genes – Construction of Expression Vectors. Vectors having Inducible lac, taq promoters. Expression of proteins with His tag and its significance in simultaneous expression. DNA Finger Printing – RAPD, RFLD and AFLP Analysis, Restriction mapping, DNA sequencing by chemical and enzymatic methods. Nucleic acid blotting – southern and northern blotting.

UNIT – IV: Polymerase Chain Reaction and its applications. DNA micro array technology. Applications of genetic engineering in agriculture, animal husbandry, medicine and in industry. Genomics –genome sequencing by shot gun and hierarchical method. Genome annotation – identification of genes, promoters and exons – intron boundaries, NGS technologies CRISPR-Cas 9 technology for genome editing.

UNIT – V: Gene silencing techniques - Introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic

manipulation in different model systems e.g. fruit flies (drosophila), worms (*C. elegans*), frogs (xenopus), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.

List of Practicals

1. Cloning Vectors – Properties and Functions.
2. Electro – elution of DNA.
3. Restriction digestion of DNA.
4. Separation of RE –digested fragments by Gel Electrophoresis.
5. Restriction Mapping of a Plasmid.
6. Cloning of foreign DNA insert into a Plasmid followed by Transformation.
7. Polymerase Chain Reaction.
8. Southern and Western blotting.

Suggested Readings

1. Recombinant DNA technology by Watson et. al., (Scientific American Books).
2. Genes-VIII by Benjamin Lewin.(Oxford).
3. Principles of Gene Manipulation by Old and Primrose. (Blackwell).
4. DNA Science by Carolina Publishing Company.
5. From genes to clones by Winneker.
6. From genes to genomes concepts and applications of DNA technology by Jeremy W
7. dale and Malcolm von Scrantz, Weil publications
8. Molecular Biotechnology by Glick.
9. Genetic Engineering by Sandhya Mitra.
10. Genes and Genomes by T.A. Brown.
11. Gene cloning by T.A. Brown.

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. Known the techniques for transfer and expression of cloned gene and applications of genetic engineering in biological research.
5. Known about transgenic plants.

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SEMESTER II

BT 203 (I.E-B): BIOPROCESS & ENGINEERING TECHNOLOGY

Theory -5 units | **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. | **Credits: Theory - 4**

Practicals -2

Course Objectives:

1. To make the student to learn about fermentation technology.
2. To impart knowledge about Isolation, screening and maintenance of industrially important microbes.
3. To educate the student to gain knowledge in cell disruption
4. To familiarize with the concepts and the techniques of bio separation
5. To familiarize with the applications of enzymes in food processing.

UNIT – I: Fermentation Technology – The component parts of a fermentation process, range of fermentation processes, chronological development of fermentation industry; Isolation, Preservation and strain improvement of industrially important microorganisms; Fermentation media for industrial fermentation; Design of different types of Fermenters – Basic functions of a fermenters for microbial culture, aseptic operation and containment, aeration and agitation, valves and steam traps.

UNIT – II: Bioprocess principles, Types of Fermentation process, Microbial culture, mass production of enzymes, metabolites and recombinant products; Batch culture, continuous culture, fed batch culture; Fermentation Economics – Market potential, recovery costs, water usage and recycling, effluent treatment. Production of Penicillin, Vitamin C, Amylase, Acetone, Butanol, Beer making.

UNIT – III: Cell disruption (physical, chemical and mechanical methods). Downstream processing - Removal of insolubles, centrifugation, sedimentation, flocculation, electro-precipitation, gravity settling (grinding, homogenization, leaching if required); Recovery of microbial cells, precipitation, filtration.

UNIT – IV: Product purification - chromatography, (fractional), crystallization, recrystallization, dessication, spray drying, product formulation; Precipitation (Ammonium Sulfate, solvent fractionation); Electrophoresis (capillary); Extraction(solvent, aqueous two phase, super critical), Drying.

UNIT – V: Applications of enzyme technology in food processing - Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions e.g. starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

List of Practicals:

1. Production of alcohol by *S. cerevisiae*
2. Production of citric acid by *A. niger*.
3. Production of streptomycin by fermentation
4. Production of wine from grapes
5. Production of glutamic acid
6. Production of protease/glucose isomearase by batch fermentation
7. Preparation of toxoid from a toxin
8. Immobilization of an enzyme by gel-entrapment
9. Immobilization of whole cells for enzyme/antibiotic production by gel entrapment

Suggested Readings:

1. Bioseparations: Downstream Processing for Biotechnology by Paul A. Belter (Author), E. L. Cussler , Wei-Shou Hu
2. Principles of Fermentation Technology by P F Stanbury, A Whitaker, S Hall
3. Fermentation and Enzyme Technology by Wang W
4. Fermentation Microbiology and Biotechnology, Second Edition by E. M. T. El-Mansi, C. F. A. Bryce, Arnold L. Demain, A.R. Allman

Course outcomes:

The student will be able to

1. Handle the cultures of industrially important microbes and gain knowledge on design, operations and types of fermentation systems.
2. Gain knowledge on bioprocessing of fermented substances.
3. Able to handle the downstream processing.
4. Apply knowledge on separation and purification of end products of fermentation
5. Apply knowledge of enzyme technology in food processing.

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SEMESTER II

BT 203 (I.E-C): GENOMICS & PROTEOMICS

Theory =5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives:

1. To understand structure of genomes different organisms.
2. To understand the function of genes.
3. To understand structure and function of proteomics.
4. To understand the Technology for protein expression analysis.
5. To understand Protein expression analysis.

UNIT- I: Introduction to genomics, types of genomics and its databases, genome, genome sizes, organization and structure of genomes of viruses, prokaryotes and eukaryotes, organization of organelle genomes. Genome projects – Aims of project, model organisms, Human genome project and its applications. Computational genomics – concepts. **Structural Genomics** - Concept, genome mapping, genome sequencing, sequence assembly, genome annotation, whole genome sequencing by shotgun approach and sequencing; Analysis of sequence data – ORF, exon/intron boundaries, promoters, expression signals, etc. Gene ontology, phylogenetics. Centers of Genomics -JCSG, BSGC, MCSG, NYSG, TBSG. Comparative genomics – introduction, comparative genomics of prokaryotes, eukaryotes and organelles.

UNIT - II: Functional genomics– concepts and applications. Analysis of gene function - gene knockouts, complementation, gene function through protein interactions. Forward genetics, reverse genetics – knock-ins, knock-outs, RNAi technology Mutagenesis as functional genomics tool – T- DNA, T- DNA Insertional mutagenesis, transposan (*Ac*/*Ds* and *En*/*Spm*). Genome wide mutation screening - TILLING (Targeted Induced Local Lesion IN Genome) - principle and mechanism. DeALING (Detecting Adducts Local Lesions IN Genome) – principle and experimental approach to identify deletions.

UNIT - III: Introduction to Proteomics - The concept of proteomics, Types of proteomics: Expression proteomics, structural proteomics, functional proteomics, applications of proteomics. Structural overview of proteins structures and functions, Protein localization and compartmentalization, Protein structure visualization, protein structure databases, visualization databases and tools, Prediction of secondary, tertiary structures of proteins, protein function prediction and modelling.

UNIT - IV: Tools of proteomics – Technology for protein expression analysis - Protein separation of proteins by 2D electrophoresis – principles, detections, and softwares to handle electrophoretogram, Alternatives of Electrophoresis separation and isolation of protein, Protein digestion techniques. Protein characterization - Mass spectrometry, ESIMS, Tandem MS, MALDI-TOF, QTOF, SELDI, and SALSA. DIGE, SILAC. Mass Spectrometry Protein Identification, Protein Identification through Database Searching, Protein structure analysis - X-ray Crystallography, NMR. CryoEM. Post translational modifications and their predictions through bioinformatics tools. Protein identification through database searching.

Unit V:

Functional Proteomics - Protein expression analysis - Protein biochips, Protein microarrays (Ab array, Ag array). Protein - protein Interactions – Phage display, Yeast two hybrid; Protein expression profiling; Protein folding - Chaperones and their role in protein folding. Proteomics approach to protein phosphorylation; protein mining. Making of proteins through rDNA technology - Native and fusion proteins, Yeast expression systems, The baculovirus expression system, Mammalian cell lines.

List of Practicals:

1.Reporter gene assay (Gus/CAT/b-GAL)
2. Demonstration of blotting methods – Sourthern, northern.
3. Bioinformatics for genome sequence
4. Finding genes in prokaryotic and eukaryotic genomes ORF, contents, signals 5. Searching DNA databases with FASTA and BLAST
6. Multiple sequence alignment
7. Isolation and purification of protein
8. SDS - PAGE
9. Mass spectroscopy MOLDI TOF
10. protein structure prediction by bioinformatics
11. Protein structure prediction and classification
12. Protein structure prediction. Structure visualization, Secondary structure prediction, Structural prediction through homology modeling.

Suggested Readings:

1. DNA replication, 2nd ed. 1991. A. Kornberg and T.A. baker. W.H. Freeman and Company, New York. Ny. PP 931.
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. Methods in Enzymology. Vol.152. Guide to molecular cloning techniques. 1987. S.L. Berger and A.R. Kimmel. Eds. Academic Press.
7. Recombinant DNA Laboratory manual. 1989. J.W. Zyskind and S.I. Bernstein. Academic Press.
8. Methods in Molecular Genetics. Vol. 7, Viral Gene Techniques. Ed. By Kenneth W. Adoph, Academic Press, 1995.
9. Gene transfer and expression protocols : Methods in Molecular Biology, Vol.7. 1991. E.J. Murray Ed. Humana Press. Clifton, NJ. PP 439.
10. Bioinformatics and Functional Genomics, Pevsner (3rd edition)
11. Practical Computing for Biologists, Haddock and Dunn
12. Primrose SB, Twyman RM (2006). Principles of gene manipulation and genomics. Blackwell Publishing
13. Simpson R (2002). Proteins and proteomics: A laboratory manual. Cold Spring Harbor Laboratory Press.

COURSE OUTCOMES:

At the formal end of the course student will be able to

1: It will give knowledge on the various model organisms that can be used to ask some of the biological questions as well the latest sequencing technologies available in area of Life Sciences

2: It will give the thorough knowledge on the basic to advanced molecular markers that have a tremendous applications in the Biological systems.

3: It will give enlighten the students thirst, how the technological developments can solve the ever ending problems of studying thousands of genes at a given point of time in any Biological Systems. As well the wonder in biological genome / systems editing for desired traits.

4: It will provide the knowledge on the application of the knowledge what they got in the entire course of their two year journey from most primitive cell types to unknown cell types that we may not be able to culture / see with our naked eye even we apply any microscopes available.

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SEMESTER II

BT 204 (O.E-a): FOUNDATION OF BIOLOGY

Theory =5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Course Objectives:

1. To create awareness about classification, cell structure, general characters and reproduction of microorganisms.
2. To create awareness about plant growth, development, physiology and economic importance of plants.
3. To create awareness about tissue organization, physiology, neuromuscular system and Sensory system of animals.
4. To create awareness about genetic material, its replication.
5. To know the importance of various bio products.

UNIT I: INTRODUCTION TO MICROORGANISMS

Diversity in biological systems, Cell biology and cell structure, Difference between Prokaryotes & Eukaryotes. Kingdom systems. Five-kingdom classification, General characters, Brief account on Ecology, Morphology, Nutrition, Locomotion and Reproduction, useful and harmful effects of Bacteria, Viruses, Algae, Fungi and Protozoans.

UNIT II: PLANT BIOLOGY

Plant Biology: Concepts of Growth, Meristems. Development of different plant organs; Plant growth regulators; Photosynthesis : Plant & Bacterial photosynthesis; oxygenic and anoxygenic photosynthesis; chlorophyll as trapper of solar energy, photosynthetic reaction centres, Hill reaction, PS I & PS II, Photophosphorylation - cyclic & noncyclic; Dark reaction & CO_2 fixation. Economic Importance of Plants.

UNIT III: ANIMAL BIOLOGY

Introduction of body as a whole, Cells and Tissue Organization, Electrolytes and Body fluids. Physiology: Digestive system, Circulatory systems & Blood, Respiratory system and Endocrine system, Neuromuscular system, Sensory systems - hearing, taste, smell and visual receptors.

UNIT IV: BASIC MOLECULAR BIOLOGY

Genetics: DNA as genetic material, Structure of DNA, DNA replication, Transcription, Translation, Genes to proteins to protein function, Gene expression and regulation, Recombinant DNA technology.

UNIT V:APPLICATIONS OF BIOTECHNOLOGY

Drugs and Chemicals from Plants & Animals, Definition and importance (in general) of Biofuels, Biofertilizers, Biopesticides, Bioindicators and Biosensors, Microbial Enzymes, Single Cell Protein (SCP), Monoclonal Antibodies, Introduction to Transgenic Plants & Animals.

List of Practicals:

1. Cell biology experiments (Slides of various organisms, and types of cells)

2. Estimation Chlorophyll pigments by Arnon method.
3. Staining of blood smear and identification of different leukocytes.
4. Determination of A,B, O and Rh blood groups in humans
5. Rules and regulations of Microbiology Laboratory
6.Sterilization
7.Preparations of Media
8.Simple staining
9.Gram staining
10.pH determination
11.Buffer preparation
12.Colorimetric estimations of biomolecules (proteins, sugars)

Suggested Readings:

1. Introduction to biology and biotechnology, second edition, K.Vaitaidyanath, K. Pratap Reddy, and K.Satya Prasad, BS Publications.
2. H.G. Rehen and G.Reed, biotechnology Volume I & 2
3. Basic Biotechnology, Second Edition, by Colin Ratledge and Bjorm Kristiansen, Cambridge University Press.
4. Anatomy and Physiology In Health and Disease,K. J.W. Wilison and A. Waugh, Churchill & Livingston.
5. Plant Physiology F.B Salisbury & C.W. Ross 4th edition Thomson Wadsworth
6. Dr. C.C. Chatterjee, Human Physiology (11th Edition) Vol I and II, Medical Allied Agency, Kolkata, 1987.

Course outcomes:

1. To know about differences between Prokaryotes & Eukaryotes
2. To know about plant growth, development, physiology and economic importance of plants.
3. To know about tissue organization, physiology, neuromuscular system and Sensory system of animals.
4. To know about basics in molecular biology.
5. To know about applications of Biotechnology.

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SEMESTER II

BT 204 (O.E-b): BASICS IN INFECTION BIOLOGY

Theory =5 **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Course Objectives:

1. To create awareness about COVID-19, HIV viruses and to know about viral outbreaks such as Ebolla, H1N1, and Zika virus.
2. To create awareness about epidemiology and treatment for tuberculosis.
3. To create awareness about general information on fungal pathogenesis.
4. To create awareness about Parasite infection leishmaniasis and malaria.
5. To create awareness about plant diseases, zoonotic infections and recent research on infections.

UNIT-I : Viral infection: Corona virus structure, life cycle, COVID-19 infection to humans, Development of HIV virus, HIV infection to humans, Structure of HIV virus, mechanism of HIV infection, role of T cells in infection development, development of therapy against HIV, anti-retroviral therapy, HAART, economic loss by COVID-19 and HIV at national & international level. Hepatitis virus, types of hepatitis infection, viral outbreaks such as Ebolla, H1N1, and Zika virus.

UNIT-II : Bacterial infection: Development of tuberculosis infection, diagnosis of tuberculosis, epidemiology and geography of tuberculosis, treatment of tuberculosis, identification of drug targets, vaccine development for tuberculosis, mechanism of anti-tuberculosis drug action, development of resistant, multidrug resistant, economic loss by tuberculosis at national and international level, HIV-tuberculosis co-infection.

UNIT-III : Fungal infection: general characteristics, classification, medical importance of major fungal groups, fungal cell structure, fungal morphology, fungal replication, general information on fungal pathogenesis. **Superficial, Cutaneous & Subcutaneous Mycoses:** mechanisms of fungal pathogenesis, superficial mycoses (pityriasis versicolor, tinea nigra, black piedra, etc.), cutaneous mycoses (etiology, ecology & epidemiology, clinical manifestations),subcutaneous mycoses (lymphocutaneous sporotrichosis, chromoblastomycosis, phaeohyphomycosis, etc.). coccidioidomycosis, cryptococcosis, candidiasis (skin and nail diseases, disseminated infections, etc.), aspergillosis, zygomycosis, Pneumocystis carinii pneumonia.

UNIT-IV: Parasite infection: Parasitic infectious diseases, leishmaniasis, epidemiology and geography of leishmaniasis, vector and transmission of leishmaniasis, host-pathogen interaction, diagnosis and treatment for leishmaniasis, genetics of leishmaniasis, mechanism of drug resistance and drug susceptibility for promastigotes and amastigotes, history of malaria, life cycle of *plasmodium*, factors affecting transmission of parasite, vectors and epidemics, parasite metabolisms, secondary endosymbiosis, drug resistant parasites, identification of drug targets, amoebiasis.

UNIT-V: Recent trends in infection biology research and techniques. Antibiotic action and resistance mechanisms, Drug resistance - origin (genetic and non-genetic), mechanisms. Anti-viral chemotherapy and viral vaccines. Plant diseases. Zoonotic infections.

List of Practicals:

1. Instrumental training
2. ELISA
3. Complete blood picture: TLC.
4. WBC differential count.
5. Determination of Haemoglobin (Hb).
6. Mean cell Haemoglobin and Mean cell RBC volume.
7. Determination of SGOT activity
8. Determination of SGPT activity
9. Tests for abnormal constituents in urine.
10. Detection of HCG by latex agglutination inhibition test.

Suggested Readings :

1. Irwin W. Sherman, Malaria Parasite Biology, Pathogenesis, andProtection, American Society for Microbiology. 1998.
2. WHO technical series-949; Control of the leishmaniasis (ISBN 978 92 4 120949 6).
3. Virology: Principles and Applications John Carter, Venetia Saunders.

Course outcomes:

1. To know about economic loss by COVID-19 and HIV at national & international level.
2. To know about diagnosis of tuberculosis, HIV-tuberculosis co-infection.
3. To know general information on fungal pathogenesis.
4. To know about diagnosis and treatment for leishmaniasis and malaria.
5. To know about Antibiotic action and resistance mechanisms, Drug resistance.

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SEMESTER II

BT204 (O.E-c): VACCINOLOGY

Theory =5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives:

1. To create awareness about the importance of vaccines for human health.
2. To know about Immunization strategies.
3. To know about immunotherapy.
4. To know about new approaches for vaccine delivery.
5. To know about the evaluation of vaccine toxicity.

UNIT - I: Historical background of vaccination, vaccine preventable infectious diseases, human vaccine manufacturers and licensed vaccines. Over view of bacterial and viral vaccines and their importance to public health. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, Tetanus and Pertussis

UNIT- II: Conventional and modern methodologies to bacterial seed strain characterization. Overviewof the immune system and basic aspects of immune response(s) to vaccines. Adjuvants: history, types, mechanisms and current achievements. Immunization strategies for disease control and eradication. New vaccines under development and prominent vaccine delivery systems. Production life cycle of inactivated bacterial vaccine: DTwP, Adsorbed.

UNIT - III: Conventional vaccines; Bacterial vaccines; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine. Immunotherapy; Monoclonal antibodies; Vaccines: types, recombinant vaccines and clinical applications

UNIT- IV: New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine.

UNIT -V: Toxicity and potency evaluation of bacterial and viral vaccines: overview of currently approved methods and alternative methods under development. Consistency approach for vaccine quality improvement.

List of Practicals:

1. Storage of antigens and adjuvants.
2. Preparation of laboratory for production of therapeutic antisera.
3. Environmental monitoring of production and testing area.
4. Dose preparation and immunization of rats/ mice
5. Manufacturing bleeding, collection, separation of plasma, and reinfusion of RBC's in Rats/ mice for production of therapeutic antisera.

6. Processing of plasma: Pepsin treatment, Precipitation with ammonium sulphate, Dialysis of antisera, Preparation of sub lots, 0.45µ filtration of sub lots.
7. Preparation of final bulk of antisera and its filtration.
8. Testing of venoms and toxoid (in vivo & in vitro).
9. Testing of antigen and product (pH, Sterility, Abnormal toxicity and Potency testing).

Suggested Readings:

1. Edited by Stefan H.E. Kaufmann, Novel Vaccination Strategies, Wiley-VCH Verlag GmbH & Co. KgaA, 2004 or later edition.
2 Topley & Wilson's, Microbiology and Microbial Infections Immunology Edited by Stefan H.E. Kaufmann and Michael W Steward Holder Arnold, ASM Press, 2005 or later edition.
3 Edition Charles A Janeway. Jr, Paul Travers, Mark Walport and Mark J Shlomchik, Immuno Biology, The Immune system in health and Disease, 6th Edition, Garland Science, New York, 2005 or later edition.
4 Annual Review of Immunology: Relevant issues
5 Annual Review of Microbiology: Relevant issues

Course outcomes:

1. To know about Epidemiology of bacterial and viral diseases.
2. To know about storage of antigens and adjuvants.
3. To know about clinical applications of vaccines.
4. To know about New Vaccine Technologies.
5. To know about the quality improvement approaches of vaccines.

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SEMESTER II

BT205 (AC-2): INTELLECTUAL PROPERTY RIGHTS

Theory =5 units
Exam: 3Hrs. **Credits: Theory - 4**

Course Objectives:

1. The course is designed to provide comprehensive knowledge to the students regarding the general principles of IPR, Concept and Theories.
2. The course is designed to provide comprehensive knowledge to the students regarding Indian position of the Patent Law (1970), Historical development, Procedure for granting a patent, Infringement. 3.
The course is designed to provide comprehensive knowledge to the students regarding Indian position of the Copyright Law, 1957, Historical background and Development of Copyright Law, Infringement.

4. The course is designed to provide comprehensive knowledge to the students regarding Indian position of the Trademark Act, 1999, Historical development of the concept of trademark and trademark law, Registration of trademark, Infringement of trademark.

5. The course is designed to provide comprehensive knowledge to the students regarding the effect of IPR especially of patents on emerging issues like public health, climate, Domain Name Disputes and Cyber squatting, Bio piracy etc. and the ways to tackle this problem. The course is designed to provide comprehensive knowledge to the students regarding the effect of IPR especially of patents on emerging issues like public health, climate, Domain Name Disputes and Cyber squatting, Bio piracy etc. and the ways to tackle this problem.

UNIT - I: PRINCIPLES OF IPR: Introduction to Intellectual Property Rights, Concept and Theories, Kinds of Intellectual Property Rights, Economic analysis of Intellectual Property Rights. Advantages and Disadvantages of IPR. IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS,

UNIT- II: PATENT LAW AND PRACTICES: Research exemption Introduction to Patents, Overview Historical development Concepts, Novelty, Utility Inventiveness/Non-obviousness, Patent Act 1970 – amendments of 1999, 2000, 2002 and 2005, Patentable subject matter, Patentability criteria, non-patentable inventions, Pharmaceutical products and process and patent protection, Software Patents, Patenting of Micro-organism, Rights of patentee, Procedure for granting a patent and obtaining patents, Grounds for opposition, Working of Patents, Compulsory License Acquisition, Surrender, Revocation, restoration, Transfer of patent rights, Infringement . What Is Infringement? Direct, Contributory, and Induced, How Is Infringement Determined? Who Is an Infringer? Official Machinery, Controller, Powers and Functions, Defenses to Infringement.

UNIT- III: COPYRIGHT LAW AND PRACTICES: Copyright and Neighbouring, Rights Concept and Principles, Historical background and Development of Copyright Law, Leading International Instruments, Berne Convention, Universal Copyright Convention, International Copyright under Copyright Act ,WIPO Phonograms and Performances treaty, Copyright Act 1957, Terms of Copyright, conditions for grant of copyright, Infringement-Criteria of Infringement, Infringement of Copyright-Films, Literary and Dramatic works, Importation and Infringement.

UNIT - IV: TRADEMARK LAW AND PRACTICES: Historical development of the concept of trademark and trademark law-National and International Introduction to Trademarks , Need for Protection. Kinds of trademarks Concept of Well known trademark, Registration of trademark, Grounds of refusal of registration - Absolute ground, Relative ground; Procedure of registration of trademark, opposition and its grounds, Infringement of trademark, Passing off Deceptive similarity, Defences, Remedies for infringement and passing off Civil remedies, Criminal remedies.

UNIT- V: EMERGING ISSUES AND CHALLENGES: Public health and Intellectual Property Rights, Case study—Novartis Pharmaceuticals , Bayer Pharmaceuticals, TRIPS Flexibilities and access to medicine , IPR and Climate change, Patents and Biotechnology , Traditional knowledge and IPR.

Suggested Readings:

1. B.L. Wadera, Patents, trademarks, copyright, Designs and Geographical Judications.
2. P. Narayanan (Eastern Law House), Intellectual Property Law
3. N.S. Gopalakrishnan &T.G. Agitha, Principles of Intellectual Property (2009), Eastern Book Company, Lucknowacy, Domain Name Disputes and Cyber squatting, Future aspects of IPR.
4. Sookman, Computer Law, 1996
5. W. Cornish (Universal Publication), Intellectual Property Law
6. R.K. Nagarjan, Intellectual Property Law
7. Ganguli (Tata Megraw), Intellectual Property Rights
8. Merges, Patent Law and Policy: Cases and Materials, 1996
9. Brian C. Reid, A Practical Guide to Patent Law, 2nd Edition, 1993
10. Brinkhof (Edited), Patent Cases, Wolters Kluwer
11.Prof. Willem Hoyng& Frank Eijsvogels, Global Patent Litigation, Strategy Hilarry Pearson and Clifford Miller, Commercial Exploitation of Intellectual Property
12.Avtar Singh, Competition Law, Eastern Book Company
13. Dr. H. K. Saharay, Textbook on Competition Law, Universal Publications
14. Brinkhof (Edited), Patent Cases, Wolters Kluwer
15. Bio pir D.P. Mittal (Taxman Publication), Indian Patents Law and Procedure

Course Outcomes:

1. Ability to manage Intellectual Property portfolio to enhance the value of the firm.
2. Ability to protect innovations.
3. Ability to get a copyright.
4. Ability to get a trademark to the goods.
5. Known about the emerging issues related to IPR.

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(Syllabus w.e.f. academic year 2022- 23)
SEMESTER III
BT 301(M.C.): PLANT AND ANIMAL BIOTECHNOLOGY

Theory : 5 units **Mid Marks Theory: 20**
Ext. Marks Theory: 80
Exam: 3Hrs. **Credits: Theory - 4**
Practicals -2

Course Objectives:

Plant Biotechnology

1. To impart knowledge on analysis of differential gene expression in plants
2. Train in identification of plant pathogens using immunological and molecular techniques

Animal Biotechnology

1. Make them learn the principle and methods of animal cell culture.
2. Provide knowledge on gene cloning and production of transgenic animals

UNIT I : Components of plant genetic engineering, Methods for analysis of differential gene expression in plants, Enhancer trap, Promoter tagging, gene tapping, gene tagging, Insertion mutagenesis, Activation tagging, Tissue specific promoters, characterization of plant promoters, Agrobacterium and Ti Plasmid based and physical DNA delivery methods. Analysis of transgenic plants, Approaches to marker-free transgenics

UNIT II : Developing herbicide resistance in crops: Target of herbicide action and Detoxification of herbicides. Engineering male sterility in crop plants. Genetic engineering of plants for Insect resistance: Bt toxins and use of protease inhibitors, Transgenic plants for disease resistance engineering plants for abiotic stress tolerance. Biopolymer Production through transgenic plants. Gene silencing, RNai, Antisense echnology and Applications. Biosafety, Bioethics and plant biotechnology.

UNIT III: Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Methods of sterilization, types of culture media, composition, preparation and metabolic functions. Role of CO_2, Serum, supplements, growth factors (EGF, PDGF, NGF, Gap-43). Serum and protein free defined media.

UNIT IV: Culture and maintenance of primary and established cell lines. Biology of cultured cells and culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis. Expression of culture efficiency. Stem cells and applications.

UNIT V: Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Animal cloning: methods of cloning and their importance with reference to domestic animals. IVF- technology for livestock and humans. recombinant vaccines for poultry, Cell culture based vaccines. Pharmaceutical products produced by mammalian cells –

plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons.

List of Practicals – Plant Biotechnology

1. Preparation of media.
2. Surface sterilization.
3. Micropropagation of tree species or elite plants.
4. Organ culture.
5. Callus propagation.
6. Induction of shoots or roots (organogenesis).
7. Induction of somatic embryogenesis.
8. Synthetic seed preparation.
9. Protoplast isolation and culture.
10. Anther culture, production of haploids.
11. Induction of cell suspension cultures.
12. Production of secondary metabolites in cell suspension culture.
13. Cytological examination of regenerated plants.
14. Agro bacterium culture, selection of transformation.
15. Reporter gene (GUS) assays.
16. Isolation of DNA from plant material and quantitative analysis.
17. Molecular weight determination of DNA extracted from different plant sample

Animal Biotechnology :

1. Preparation of tissue culture medium and membrane filtration.
2. Preparation of single cell suspension from lymphoid organs.
3. Cell counting using Hemocytometer
4. Cell viability testing.
5. Cold and warm Trypsinization.
6. Monolayer culture
7. Cryopreservation using liquid nitrogen and thawing.
8. Measurement of cell doubling time.
9. Preparation of metaphase chromosomes from animal cells.
10. Cell fusion with PEG
11. Pregnancy diagnosis.
12. Extraction of DNA from animal cells
13. Establishment of primary cultures from chick embryonic liver
14. Establishment of primary cultures from chick embryonic heart
15. Establishment of primary cultures from spleen cells
16. Culturing of lymphocytes
17. Culturing of HeLa cell
18. Sub-culturing of primary cultures

Suggested Readings:

Plant Biotechnology

1. Methods in Plant Molecular Biology and Biotechnology by B.R.Glick, 2014
2. Plant Biotechnology-The genetic manipulation of plants, Second Edition by Adrian Slater, Nigel Scott, and Mark Fowler, 2008
3. International Society for Acquisition of Agribiotech Applications- an open resource for Agricultural Biotechnology related applications, world status of Agricultural Biotechnology

Animal Biotechnology

1. Ballinic C.A., Philips J.P and Moo Young M. Animal Biotechnology. Pergamon press, New York. 1989.
2. Watson J.D.et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings.2007.
3. Berger S. L. and A.R. Kimmel. Methods in enzymology guide to molecular cloning techniques (Vol 152). Academic Press Inc. San Diego.1996
4. Glick, B.R. and Pasternak J.J. Molecular Biotechnology.ASM Press, Washington DC.2003.
5. Watson J.D et al. Molecular Biology of the Gene(6th Ed), The Benjamin Cummings Pub.Co.Inc.USA.2008
6. Shantharam, D., Jane F Montgomery. Biotechnology, Biosafety & Biodiversity: Scientific &Ethical issues for Sustainable development. 1999
7. Ian Freshney. R .Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6th Ed.) Wiley & Sons. 2010
8. John Davis., Animal Cell Culture: Essential Methods (1st Ed.) Wiley-Blackwell and Sons publisher. 2011

Course outcomes:

Plant Biotechnology

The student will be able to

1. Develop skill in production of resistant transgenic plants
2. Apply knowledge for industrial production of plant metabolites

Animal Biotechnology

1. Learn the techniques of In Vitro Fertilization and artificial insemination
2. Apply knowledge on molecular farming for production of vaccines and hormones

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M.Sc BIOTECHNOLOGY (CBCS)

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SEMESTER III

BT 302 (M.C.): ENVIRONMENTAL, FOOD AND INDUSTRIAL BIOTECHNOLOGY

Theory: 5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives:

1. Impart knowledge on the process of biodegradation and bioremediation
2. Equip with the knowledge on biological control and scope of bio fertilizers in agriculture
3. To impart knowledge about the application of biotechnology in food industries
4. To give insight on role of microorganisms in environment and their applications in food and dairy Industry

UNIT – I: Environmental Pollution & Bioremediation: Air pollution and its control through Biotechnology- biofilters, bioscrubbers, biotrickling filters. Waste water treatment - Physical, chemical and biological treatment processes - Aerobic Process: trickling filter, rotating discs, oxidation ponds, Anaerobic Processes: Anaerobic digestion, anaerobic filters.
Concepts and principles of bioremediation, in-situ & ex situ bioremediation. Bioremediation of heavy metal ions - biosorption & bioaccumulation principles. Role of genetically modified and genetically engineered microbes in Bioremediation. Applications of microbes in mining industry.

UNIT – II: Biofuels, Biofertilizers and Biopesticides: Biogas - Hydrogen and methane. Microbial groups involved in biogas production and interactions among them. Factors affecting biogas production, Design of digestors, feed stock. Bio fertilizers - Rhizobium, Azospirillum, Azotobacter, Vermiculture. Biopesticides.

UNIT – III: Food Biotechnology: Definition, Scope, and Application of Biotechnology - Application in Food Industries, Pharmaceuticals, Agriculture, and Waste Utilisation. Genetically Modified Organisms (GMOs) in Industrial Fermentation Processes (Induction, Manipulation And Recombination). Therapeutic Proteins produced by Biotechnological Processes. Role of Plants For Production of Nutraceuticals and Bioremediation. Manufacture of Vinegar, Cheese, and Mould-Modified Foods.

UNIT-IV: Scope of biotechnology in the food and drink industry, Traditional fermented foods – Curd, yoghurt, cheese, butter milk, dosa. Modern fermented products – Wine, beer, baker's yeast, sauerkrauts, sausages, , Fruit juices preparation, ice-cream and frozen desserts, Cereal products. milk products; khoa, chhana, paneer

UNIT-V: Industrial Biotechnology: Selection of Microorganisms: Isolation, screening, preservation and maintenance of industrially important microorganisms. Microbial Production of Alcohols & beverages: ethanol, wine and beer. Immobilized/ Industrial enzymes. Instruments and equipment validation: Validation of autoclaves, dry heat sterilizers, incubators, fermentors, and analytical instruments. Process validation: Clean area operations, production protocols, standard operating procedures and validation protocols and in-house standards. Quality control concepts.

List of Practicals:

1. Isolation of microorganisms from air
2. Determination of biochemical oxygen demand (BOD) of water
3. Determination of chemical oxygen demand (COD) of water
4. Metal tolerance in bacteria isolated from polluted and non polluted water
5. Estimation of chlorides from polluted and non polluted water
6. Estimation of carbonates from polluted and non polluted water
7. Isolation of industrially important microorganisms.
8. Screening techniques - crowded plate technique.
9. Fermentative production of ethanol by yeast
10. Estimation of ethanol by colorimetric method.
11. Production of wine from grapes.

Suggested Readings:

1. Michael T. Madigan, John M. Martinko & Jock Parker, Brock Biology of Micro organisms, Pearson Education, International Prentice Hall, 2003.
2. Michael J. Pelczar, JR, E.C.S. Chan & Noel R. Krieg, Microbiology, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2005.
3. K. Vijaya Ramesh, Environmental Microbiology, MJP Publishers, Chennai, 2004.
4. Power un seen: How microbes rule the world. Freeman/ Spectrum, Oxford. 1994.
5. Mitchell. R., Environmental Microbiology. Wiley, New York. 1992.
6. Y. Anjaneyulu, Introduction to Environmental Sciences, - BS Publications, 2004.
7. L. E. Casida Jr. Industrial Microbiology. 1997.
8. P .F. Stanbury, A. Whitaker, and S. J. Hall. Principles of Fermentation Technology, Pergamon Press, Oxford. 1997.
9. W ulf Crueger and Anneliese Crueger. Biotechnology- A Text book of Industrial Microbiology. 2nd edition. Panima Publishing Co. 2004.
10. E. M. T. EL- Mansi and C. F. A. Bryce. Fermentation Microbiology and Biotechnology. 1999.
11. M. Moo-Young. Comprehensive biotechnology-Volume 2, 3 and 4. Pergamon Press, 2004.
12. D.G. Rao. Introduction to Biochemical Engineering. Tata McGraw-Hill Publishing Company limited, New Delhi. 2002.
13. Gerald Reed. Prescott and Dunn's. Industrial Microbiology. 4th edition. CBS Publishers ft Distributors. 2004.
14. Joshi VK and Singh RS. 2013. Food Biotechnology: Principles and Practices. I.K. International Publishing House Pvt. Ltd. Knorr D. 1982. Food Biotechnology. Marcel Dekker
15. Anal AK. 2017. Food Processing By-Products and their Utilization (IFST Advances in Food Science). Wiley Blackwell.m

Course outcomes:

The student will be able to

1. Appreciate the role of microorganisms in biodegradation and pollution detection
2. Develop skill on large scale production and applications of bio pesticides and bio fertilizers for agriculture
3. Acquire knowledge on use of genetically modified organisms in food industry.
4. Appreciate the industrial role of microorganisms in production of bio molecules

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SEMESTER III

BT 303 (I.E-a) : TISSUE CULTURE

Theory: 5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives

1. To train the students on practical and theoretical aspects of plant tissue culture.
2. To expose the students to basic concept of regeneration and about the role of Plant growth regulators governing *in vitro* response of cultures.
3. To enlighten students about micropropagation, somatic embryogenesis, artificial seeds, somaclonal variations, somatic hybrids, cybrids, embryo and another culture.
4. To make students to learn about secondary metabolite production through tissue culture, cryopreservation and gene banks.

UNIT-I: Plant tissue culture laboratory organization and requirements.Various explant and nonexplant sterilization techniques.Tissue culture media: Composition and preparation of different types of media.

UNIT – II: Basic concept of regeneration: Concept of Cellular Totipotency and Differentiation.Fundamental aspects of Morphogenesis. Organogenesis- direct & indirect. Role of plan growth regulators and factors governing *in vitro* behavior of cultures.

UNIT-III: Propagation and variation: stages and applications of micropropagation. Photoautotrophic micropropagation and acclimatization of tissue culture plants. Production of pathogen free plants and their application. Somatic embryogenesis, role of physical and chemical factors in the induction of synthetic seed-production and their uses. Somaclonal variations and their applications.

UNIT-IV: Somatic hybridization: Protoplast isolation, fusion and culture, selection and characterization of hybrids. Symmetric, asymmetric hybrids and cybrids, significant achievements and limitations of Protoplast research, production of test tube plants. Callus and embryo culture, production of seedless fruits.

UNIT-V: Applications of plant tissue culture: production of haploids and its significance in crop improvement. Secondary metabolite production through cell and organ culture (Hairyroots). Cryopreservation and conservation of Germplasm. Gene Banks.

List of Practicals:

1. Preparation of Stock solutions and Media
2. Production of Aseptic seedlings
3. Isolation and culture of embryos of Maize, *Crotalaria, Cyamopsis* etc.
4. Induction of callus and histological/cytological studies of callus
5. Direct organogenesis and somatic embryogenesis from Tobacco explants
6. Androgenesis and production of haploids from *Datura* flower buds
7. Establishment of Cell cultures and determination of plating efficiency

8. Enzymatic isolation and culture of protoplasts
9. Fusion of protoplasts using PEG
10. Preparation of synthetic seeds using sodium alginate

REFERENCE BOOKS

1. Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice (a revised edition). Elsevier Science Publishers, New York, USA.
2. Bojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations, Elsevier Science Publisher, New York, USA.
3. Vasil, I.K. and Thorp e, T.A. 1994. Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands.
4. Razdan, M.K. 1994. An Introduction to Plant Tissue Culture: Oxford & IBH Publishing Company Private Limited, New Delhi.
5. Chawla, H.S. 2003. Introduction to Plant Biotechnology.Oxford & IBH, New Delhi.
6. George, E.F., Vol-I (1986) and Vol II (1993) Plant propagation by Tissue culture.
7. Kartha, K.K. 1985. Cryopreservation of plant cells and organs. CRC Press, Boac Raton, Florida, USA.
8. Reinert, J. Bajaj, YPS (Eds.). 1977. Applied and fundamental aspects of plant cell, tissue, and organ culture. Springer-Verlag, New York.

Course Outcomes:

1. Students will learn about laboratory organization and needs of plant tissue culture lab.
2. Students will learn about preparation and sterilization of various plant tissue culture media, basic concepts of totipotency, differentiation and morphogenesis.
3. Students will learn about working principles and applications of micropropagation, somatic embryogenesis, synthetic seeds, and somaclonal variations in terms of theory and practical experience.
4. Students will gain hands on experience on production of somatic hybrids, cybrids, callus and embryo culture.
5. Students will be in a position to produce haploids by anther and microspore culture, secondary metabolite by cell cultures, cryopreservation and gene banks.

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SEMESTER III

BT 303 (I.E-b): NANOBIOTECHNOLOGY

Theory: 5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives

1. To understand the application of nanotechnology in the field of research, industry and developmental domains.
2. To study basics in Nano- biotechnology and Nanoparticular carrier system
3. To provide the professional services to industry, research organization, institutes.
4. To Study professional consultancy and research support for the relevant organization in the domain of super specialization.
5. To provide, value based and ethical leadership in the professional and social life

UNIT-I: Introduction to Nanotechnology - Nanomaterials - Self-assembly to artificial assembly for creation of useful nanostructures – Bottoms up and Top down approach (Nano rods, nanocages, nanotubes, quantum dots, nanowires, metal / polymer-based nanostructures) – Preparation and Characterization of nanoparticles (particle size analyzer, microscopy viz., electron microscopy, atomic force microscopy etc).

UNIT-II: Cell structure – Bio macromolecules: Types, Structure, Dynamics and interaction with water –Cellular nano machines – cellular transducers, membrane channels, membrane transporters, Membrane motors – Creation of bio-nanostructures (Nano liposomes, Nano micelles, Nanomotorsetc).

UNIT-III: Chemical, physical and biological properties of biomaterials and bio response: biomineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and structural proteins); Aerosol properties, application and dynamics; Statistical Mechanics in Biological Systems,

UNIT-IV: Nanoparticular carrier systems; Micro- and Nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nano- imaging, Metabolic engineering and Gene therapy.

UNIT-V: Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment

List of Practicals:

1. Synthesis of Ag, Au nanoparticles through chemical reduction method
2. Synthesis of CdS quantum dots through microemulsion method
3. Synthesis of GO (Graphene Oxide) using Hummers method
5. Synthesis of any two metal oxide nanomaterials through co-precipitation, hydrolysis and hydrothermal methods.
6.Preaparation of nanocrystals
7.Liposome targeted directed drug delivery using nanotechnology
8.Synthesis of nanopolymers
9.Optical and electronic measurement of charge transport in biomolecules
10.Detection methods of drug delivery
11.Biomarker generation using nanoparticles
12.Polymer nanoparticles in cancer therapy

Suggested Readings:

1. Nalwa, H. S. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publications.
2. NiemeyerCM&Mirkin CA. Eds (2005). Nanobiotechnology: ConceptsApplications and Perspectives, Wiley Inter science publications.
3. Cao, G., and Wang, Y., (2004) Nanostructures and Nanomaterials: Synthesis, propertiesand applications, Imperial College Press
4. GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA
5. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss
6. . Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press
7. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier
8. Recent review papers in the area of Nanomedici

Course Outcomes:

At the formal end of the course student will be able to get

1. Basic knowledge on the Nanotechnology - Nanomaterials and Characterization.
2. Knowledge on various cell components in Nano sizes.
3. Knowledge on the Chemical, physical and biological properties of biomaterials.
4. Knowledge on Drug and gene delivery system
5. Knowledge on Nanotoxicity assessment

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SEMESTER III

BT 303 (I.E.-c): MOLECULAR DIAGNOSIS

Theory: 5units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives

1. The main objective of the course in "Molecular Diagnostic Techniques" is to make the student familiar to the procedures used in a Laboratory of Molecular Diagnostics.
2. The course will describe the techniques commonly used in diagnostics and molecular pathology laboratories and the underlying principles and applications, advantages and limitations of each technique.
3. The course will also deal with the requirements to set up a molecular diagnostics laboratory and obtain certification and accreditation and to choose the test menu to offer.

Unit-l: lntroduction and History of diagnostics: Biochemical tests for detection and quantification of sugar, albumin, urea, protein, globulin, and vitamins. lmportance of molecular biology in diagnostics. Various types of storage and shippingl transport procedures for clinical samples. Collection procedure for clinical samples.

Unit-lI: Cells culture, induction of metaphase, cell cycle arrest, chromosome staining and visualization of chromosome. Chromosome karyotyping, chromosome banding {G-banding, C-banding, R-banding etc), chromosome labeling, in situ hybridization (Fluorescence in situ hybridization), chromosome painting, comparative genome hybridization (CGH).

Unit-lII: Gene cloning, Iabelling of nucleic acids, and hybridization. lntroduction of restriction enzymes, palindromic sequence, isoschizomers. TA cloning, blunt-end cloning, staggered end cloning. Types of labels for nucleic acid probes: radioactive and fluorescent labels. Body and end labelling of nuclei acid probes. Northern blotting: experimental set-up, reagents used and its application. Southern blotting: experimental set-up, reagents used and iis application. Western blotting: primary and secondary antibody, detection methods and its application.

Unit-lV: lmmunodiagnostics- lntroduction, antigen-antibody interaction, polyclonal and monoclonal antibodies. lmmunoassays - types [Radioimmunoassay (RlA), ELISA (enzyme-linked immunosorbent assay). Chemiluminescent lmmunoassays, Fluorescent Immunoassays {FlA)l and specific applications. lmmunohistochemistry - Principle and techniques. Good Laboratory Practices.

Unit-V: Next-Generation Sequencing platform. NGS based methods (ChlP-seq, Metagenomics. Epigenomics & Exome Sequencing). NGS Sequencing Depth and Coverage. Genome Mapping & Annotation. Genome Databases (UCSC, ENCODE, etc.). NGS Data analysis pipelines (Galaxyi.**:**

List of Practicals:

1. Handling of cells in Laminar flow with negative and positive pressure.
2. How to perform Genomic DNA isolation from eukaryotic cells.
3. Quantitation of genomic DNA using Nanodrop method.
4. How to perform total cell RNA isolation from eukaryotic cells.
5. Quantitation of total RNA using Nanodrop method.
6. Eukaryotic cell total and gene specific cDNA synthesis.
7. Gel electrophoresis of DNA and RNA.
8. Protein transfer from gelto nitrocellulose membrane followed by blocking in BSA or milk.
9. Primary antibody incubation followed by secondary antibody incubation.
10. Desired protein detection and analysis.

REFERENCE BOOKS:

1. Fundamentals of Molecular Diagnostics (2007). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group. lstsN-13: 978-1-4160-3737-8.
2. Bailey & Scott s Diagnostic Microbiology {2002). Betty A. Forbes, Daniel F. Sahm, Alice S. Weissfeld, Ernest A. Trevino, Published by C.V. Mosby. ISBN: 9780323075022.
3. Medical Genetics (2009). Lynn B. Jorde, John C. Carey, and Michael J. Bamshad, Mosby. 4th Edition. ISBN: 9780323053730.
4. Molecular Microbiology: Diagnostic Principles and Practice (2003). David H. Persing, Fred C. Tenover, James Versalovic, Yi-Wei Tang, Elizabeth R. Unger, David A.; L Relman, and Thomas J. White, (Eds.) ASM Press. ISBN: 155581221X.
5. Principles of lmmunology and lmmunodiagnostics (1988). Ralph Michael Aloisi. Lippincott Williams and Wilkins. ISBN-10: 4U211 1 338; ISBN-13: 978-08121 1 1 330.
6. Next Generation Sequencing, Methods and Protocols (2018). Steven R. Ordoukhanian, Phillip, Salomon, Daniel R. (Eds.). Springer,4th Edition. ISBN 978-1493S-7514-3.
7. Integration of Omics Approaches and Systems Biology for Clinical Applications (2018). Antonia Vlahou, Harald Mischak, Jerome Zoidakis, Fulvio Magni (Eds). Willy Online Library. ISBN:9781 1'l 91 81 1 49.

Course Outcomes:

At the formal end of the course student will be able to get 1.Knowledge of up to date methods in Molecular Biology and Molecular Genetics, including their theoretical bases.

2.Ability to evaluate papers dealing with methods or clinical applications and to interpret the correct execution and interpretation of a molecular test

3. Ability to acquire independence in searching data, information, methodologies in order to set up and validate new diagnostic protocolsAbility to apply the knowledge acquired in the field of Molecular Diagnostics to make decisions on clinical tests to be applied to particular diagnostic queries.

4. Ability to apply an analytical, problem-solving, approach.

RAYALASEEMA UNIVERSITY::KURNOOL

M.Sc BIOTECHNOLOGY (CBCS)

(Syllabus w.e.f. academic year 2022- 23)

SEMESTER III

BT 304 (O.E-a): MODEL ORGANISMS IN BIOLOGY AND BIOTECHNOLOGY

Theory: 5units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives

1. **To** understand how human diseases work in different model organisms
2. To know about the biology and physiology of model organisms
3. To know how to apply emerging technology to model organisms

Unit-l: History; Selection of model organisms; what is model organism in biology; Characteristic features of different model organisms.

Unit II

Introduction to Different Model Systems—

*E.*coli (bacterial systems), Saccharomyces cerevisiae (yeast), Caenorhabditis elegans (nematode worm), Drosophila melanogaster (fruit fly), Xenopus leavis (frog), Danio rerio (zebrafish), Mus musculus (mouse), and Arabidopsis thaliana (plant system). Genetic resources and bioinformatics databases of these model systems.

Unit-III

Developmental genetics of the popular invertebrate and vertebrate model organisms – converging concepts and comparative analysis of all the model systems mentioned in the Unit-1

Unit-IV

Emerging technologies for genetic manipulations in model systems. Technologies used for micromanipulating, imaging, and phenotyping small invertebrate and vertebrate model organisms. Improving and humanizing the animal models by microbiomic techniques.

Unit-IV

Genome-wide screens in small model organisms–strategies to identify new genes and pathways. Using animal models to study genes and behavior, physiology and disease mechanisms.

List of Practicals:

1. Exhibit the model organisms in Physiology
2. Exhibit the model organisms in Development & Evolution
3. Exhibit the model organisms in Genetics
4. Charts of model organisms

Course References:

The Biological Resources of Model Organisms : Collection, Characterization and Applications - by Robert L. Jarret and Kevin McCluskey

- The Cricket as a Model Organism: Development, Regeneration, and Behavior - by Hadley Wilson Horch, Taro Mito, et al.

- X is for Xenopus: A Model Organism ABC Book - by Marisa Claire Yadon | Jun 19, 2019

- Mouse as a Model Organism: From Animals to Cells - by Cord Brakebusch and Taina Pihlajaniemi

Research papers:

1. Leonelli, S., & Ankeny, R. A. (2013). What makes a model organism?. *Endeavour*, *37*(4), 209-212.

2. Davis, R. H. (2004). The age of model organisms. *Nature Reviews Genetics*, *5*(1), 69-76.

3. Rédei, G. P. (1975). Arabidopsis as a genetic tool. *Annual review of genetics*, *9*(1), 111-127.

4. Spitsbergen, J. M., & Kent, M. L. (2003). The state of the art of the zebrafish model for toxicology and toxicologic pathology research—advantages and current limitations. *Toxicologic pathology*, *31*(1_suppl), 62-87.

5. Fields, S., & Johnston, M. (2005). Whither model organism research?. *Science*, *307*(5717), 1885-1886.

Learning outcomes:

This course gives a comprehensive insight into various popular model organisms used both in basic and applied scientific research.

Helps the students to develop an idea of which model is good for the research questions they are interested in, and how to create such model systems.

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(Syllabus w.e.f. academic year 2022- 23)

SEMESTER III

BT 304(O.E-b): DRUG DISCOVERY

Theory: 5units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives

1. Complete knowledge of the theoretical chapters (structural design, rational and combinatorial methods, drug target selection, etc.)
2. Knowledge and training of practical drug designing tools
3. Application and technicalities of drug development process
4. Guidance by field experts during the programme and drug patenting
5. Knowledge of global scenarios, scope and opportunities.
6. Knowledge about the clinical trials, ethics and regulatory processes involved.

UNITI: Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs - Lipinski's rule; How drugs work - Drug targets, drug-target interaction and dose-response relationships. Classification of drugs- Based on the structure or a pharmacological basis with examples. Anti-bacterials, antivirals, antifungal, anticancer agents, statins, antidiabetic drugs, cardiovascular drugs

UNIT II: New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches - Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD).

UNIT III: Drug Designing: Fundamentals of drug designing, The Pharmacophore, The Drug Discovery: Combinatorial Chemistry, Structure based design, QSAR and drug design, Computational Drug design, Example of drug design, Limitation of De Novo design, Example of different Rational Drug Design Software, Future perspectives.

UNIT IV: Drug Regulatory Agencies: US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application & New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

UNIT V: Herbal Drug Development: Introduction to natural products, definition and types of principle bioactive components, Antioxidant Redox Signalling and Cellular Longevity. Benefits of herbal drugs over other therapeutic approaches. Current Research on herbal drug development.

List of Practicals:

1. Genetic and biochemical analysis of novel molecules
2. Molecular modeling; synthesis of a complex drug and analysis of intermediate and final products using various analytical methods;
3. Drug docking; structure based de novo ligand design.
4. Effect of drugs on rats; genotoxic effect of unknown drug; demonstration of nerve conduction velocity in rats; effect of antidepressant on tail suspension test, antinflammatory activity of unknown compounds; measurement of cholesterol and TGs in rats, effect of cyclophosphamide on neutrophil counts; blood cell counting and

REFERENCES:

1. Drugs: From discovery to approval 2nd Ed by Rick NG. Wiley Blackwell (2009)

2. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Drug Discovery and development.6th Edition. Ed Donald J Abraham Wiley- Interscience.

3. Essentials of Medical Pharmacology, 6the Edition (Hardcover) by Tripathi Kd. Publisher: Jaypee Brothers (2008)

Course Outcomes:

1. The topics are framed to enhance the student's knowledge in various areas of drug action in biological system.

2. In Pharmacokinetics, Molecular Docking, Drug Design Techniques, Molecular modelling.

3. Understanding how the dosage form can be tailored to the needs of the patient and disease to be treated.

4. Learn about the physicochemical and physiological principles that are forming the basis of a rational development of modern dosage forms.

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M.Sc BIOTECHNOLOGY (CBCS)

(Syllabus w.e.f. academic year 2022- 23)

SEMESTER III

BT 304(O.E-c): COMPUTATIONAL BIOLOGY

Theory: 5units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives

1. The course explains the applications of computer in biotechnology and statistical analysis of experimental data.
2. To basic computational analysis and its applications
3. To make them aware the application of various computational tools in Bioinformatics and related subjects.
4. To introduce to the world of various databases and its importance in biological research.
5. It gives an outline on the various bioinformatics and computational tools used in analyzing protein, gene and genome data bases.

UNIT I: Bioinformatics basics: Bioinformatics basics: Computers in biology and medicine; Introduction to operating systems ; windows and Open Source systems ; Data Structure and Data bases; Database management system; Database browsing and Data retrieval, Protein and Nucleic acid databases;Structuraldatabases; Database introduction ;NCBI; publicly available tools; resources at EBI;Sequence database and genome database, Databases such as Gen Bank; EMBL; DDBJ; Swiss-prot ; PIR MIPS;TIGR; Hovergen; Tair; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm. Resources on web; database mining tools.

UNIT II: DNA sequence analysis: Algorithmbasics;databases and search tools:biologicalbackground for sequence analysis; Handling BiologicalSequences such as searching of databases similar sequence;DNA sequence analysis:genebank sequence database;submitting DNA sequences to databases and database searching; sequence alignment; pair wise alignment techniques; BLAST; Types of BLAST; Importance of BLAST

UNIT III: Multiple sequence analysis: Multiple sequence analysis;multiple sequence alignment; flexible sequence similarity searching with the FAST Aprogram package; use of CLUSTAL Wand CLUSTALX for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centers; submitting aligned sets of sequences, updating submitted Page 26 of 60 sequences, Basic methods in phylogenetic analysis.

UNIT IV: Protein modeling&Protein structure prediction: Protein structure prediction; Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and

conserved regions; evaluation of models; structure prediction on a mystery sequence; PDB (Protein Data Bank) and Swissprot; Uniprot.

UNIT V: *in silico* drug design &Virtual library: File formats for storage and dissemination of molecular structure. Elements of in silico drug design; Virtual library: Molecular Interaction Studies: Types of Docking; Docking Softwares; Ligand Preparations; Target Preparations; Searching Drug Databases; Searching PubMed, current content, science citation index and current awareness services, electronic journals, grants and funding information; Activity predictions.

List of Practicals:

1. Operating systems - components and selection techniques, file and disk management. Word processing - font, paragraph, page formatting, tables and columns, printing, tables, text boxes, graphics. Spread sheet - spread sheet layout, formatting and customizing data, formulas, functions and named ranges, charts, printing worksheets and charts. Internet browsing and using e-mail.
2. Sequence analysis by BLAST-FASTA-ClustalW-primer designing prediction of 3D structure of proteins.
3. Molecular visualization using Molmol, Rasmol, 3D structure. Docking, homology modeling.
4. Introduction and use of various genome databases.
5. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.
6. Multiple sequence alignment using ClustalW.
7. Use of various primer designing and restriction site prediction tools.
8. Phylogenetic analysis of protein and nucleotide sequences.

Reference Books:

1.Arthur M. Lesk. 2002. Introduction to Bioinformatics. Oxford University Press, USA
2. Mount, D., 2004. Bioinformatics: Sequence and Genome Analysis. (2nd Ed.) Cold Spring Harbor Laboratory Press.
3. Bioinformatics. A practical guide to analysis of genes and proteins. 1998. Baxevanis and Quellette. 4. Bioinformatics: A biologist's guide to biocomputing and the internet. 2000. Stuart M.Brown. 5. Bioinformatics: Sequence and genome analysis. 2001. David W. Mount.
6. S.R. Pennington, M.J. Dunn ; Proteomics. Viva Books Pvt. Ltd., New Delhi
7.Dan Gusfield; Aloagarithms on strings, trees, and sequences- Computer Science and Computational Biology; Cambridge University Press
8. G.P. Quinn, M.J. Keough; Experimental Design and Data Analysis for Biologist. Cambridge University Press

Course outcomes:

At the end of the course,

1. The student will be aware with a basic knowledge of modern molecular biology and genomics.
2. The student will understand how theoretical approaches can be used to model and analyze complex biological systems.
3. Develop an understanding of basic theory of these computational tools
4.Gain working knowledge of these computational tools and methods
5.Appreciate their relevance for investigating specific contemporary biological questions • critically analyse and interpret results of their study.

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M.Sc BIOTECHNOLOGY (CBCS)

(Syllabus w.e.f. academic year 2022- 23)

SEMESTER IV

BT 401(M.C.): IMMUNOLOGY

Theory : 5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Practicals -2

Course Objectives:

1. To provide knowledge on the types of immunity and immunoglobulin genes.
2. To provide knowledge on immune system and organs.
3. To demonstrate the structure of antibody types and their interaction with antigen. To acquaint them with the hybridoma technique and its clinical applications
4. Explain the concept of hypersensitivity, Immuno hematology and Immunodeficiency

UNIT– I: Introduction: Origin of immune system - History of immunology - Types of immunity, characteristics of innate and acquired immunity; Antigens: Types of Antigens - general properties; adjuvants; antigenic determinants or epitopes; generation of B-cell and T-cell receptors; Antibodies (Immunoglobulins): Basic structure, properties, isotypes, allotypes and idiotypes; Classes of immunoglobulins - functions in relation to their structure; Organization and expression of immunoglobulin genes.

UNIT– II: Cells of immune system: Types and structure of lymphocytes - T and B lymphocytes, Null cells, NK cells, lymphocytic traffic; T and B cell generation, activation and differentiation; Lymphoid organs: Organs of immune system - primary and secondary lymphoid tissues; Immune response: Cell mediated and Humoral immunity - Factors influencing antibody formation, Immunological memory, Differences between primary and secondary immune responses.

UNIT– III: Antigen and antibody interactions: Forces involved in antigen antibody binding - antigen antibody binding sites, antibody avidity, cross reaction, bonus effect; Antigen – antibody interactions – precipitation, agglutination, opsonization, flocculation reactions; Complements and Major Histocompatibility Complex : Salient features of complements, biosynthesis of complements, pathways of complement activation; Types and structure of MHC molecules and antigen presentation; Hybridoma Technology, Monoclonal and Polyclonal antibody production. Introduction of Autoimmune disorders and immune response to infectious diseases.

UNIT– IV: Hypersensitivity: Factors causing hypersensitivity - Types and their characteristic reaction with specific examples; Immuno hematology: ABO blood group system - Distribution and

transfusion - Rh blood group system - application of blood groups; Immunodeficiency and AIDS; Vaccines and its types.

UNIT– V: Cytokines; Basic biology of Interleukins, complement components and pathways of activation; Tumor immnunology - Tumor associated antigens, immune response to tumor antigens. Basis and types of autoimmunity and hypersensitivity. Vaccines, routes of administration, immunoprophylaxis, designing and production of vaccines, viral and recombinant vaccines

List of Practicals:

1. Antigen – Antibody interaction in vitro (Blood grouping)
2. RBC and WBC count, WBC differential count
3. Separation of serum protein
4. Immunological tests: Immunodiffusion and Immunoelectrophoresis.
5. Detection of viral fever by slide agglutination tests.
6. Estimation of hemoglobin.

Suggested Readings:

1. Kuby, J. (1998) Immunology, W.H. Freeman and Company, New York.
2. Essentials of Immunology by Ivan M.Roitt.
3. An introduction of Immunology by C.V. Rao
4. Immunology by Dulsy Fatima and Armugam
5. General Immunology by E.L. Cooper

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.

RAYALASEEMA UNIVERSITY::KURNOOL
M.Sc BIOTECHNOLOGY (CBCS)
(Syllabus w.e.f. academic year 2022- 23)
SEMESTER IV
BT 402(M.C.): BIOSTATISTICS & BIOINFORMATICS

Theory : 5 units **Mid Marks Theory: 20**
Ext. Marks Theory: 80
Exam: 3Hrs. **Credits: Theory - 4**
Practicals -2

Course Objectives:

1. To get introduced the concepts of Biostatistics and its significance in biological data analysis.
2. To know the use of computer applications in Biostatistics.
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 : Introduction and scope of biostatistics – variables and attribution, diagrammatic representation of biological data. Measures of location and dispersion and skewness, arithmetic mean, median and mode, standard deviation and co-efficient of variation. Curve fitting – fitting straight line, parabola exponential curve and power curve.

UNIT – II : Probability: Various definitions of probability, addition theorem (without proof), conditional probability, multiplication theorem (without proof), Random variables (discrete and continuous), distribution function of a random variable and its properties, probability density function and frequency function, Binomial and normal distributions (their properties).

UNIT – III: Correlation and regression – Scatter diagram, positive and negative correlation. Sample, sampling distribution, student's t, F and Chisquare distributions and their properties and uses. The concept of 'Statistical Hypothesis (simple and composite), Type-I and Type-II errors level of signification, power of the test. Analysis of variance (ANOVA), elements of probit analysis. Applications of Computers in statistics. Elements of statistical quality control.

UNIT – IV : Introduction of computers: Definition, various sub units of computer such as CPU, ROM, RAM etc, Classification of computers based on technology, usage and working principle, various peripheral devices such as input, output, storage – capabilities and limitations – communication with computers ; hard ware, system software and applications.
Programmed development cycle: Various stages such as recognition of problem, algorithm, flowchart development. Selection of a language, compilation, execution and debugging. MS-Windows, MS-Office, Adobe Photoshop. Networking of computers, need and advantages, overview of Indian networks such as NICNET and INFLIBNET.

UNIT – V : Sequence Data Bases: Gene Bank, European Molecular Biology Laboratory (EMBL), National Center for Biotechnology Information (NCBI), DNA Data Bank of Japan (DDBJ), SWISS-PORT, BLAST, FASTA, Data Mining, Vector NT. Protein Data Bank (PDB), PIR, Protein visualization (RASMOL), Goals of Human Genome Project, Application of Bioinformatics in Drug Designing. **Genomics:** Nucleotide Sequence Databases its analyses and identification.

List of Practicals:

1. Downloading genes and EST sequences from databases.
2. Sequence alignment - pair wise and multiple sequences.
3. Primer designing.
4. Phylogenetic analysis at the nucleotide and amino acid sequence levels. Construction of phylogenetic trees using software tools.
5. Identification of coding gene sequences.
6. Identification of promoter sequences in the genome sequences.
7. Chi-test
8. ANOVA

Suggested Readings:

1.Statistical concepts and applications in Medicine Monographs on statistics and Applied Probability series. 1994. J. Aitchison.
2.Statistical methods sin Agriculture and Experimental biology. 2nd ed. 1993. R. Mead, R.N. Curnow, A.H. Hasted, Panima Publications, pp 415.
3.Introduction to Biostatistics. 1995. R.N. Forthafter and E.S. Lee. Academic Press.
4.Biometrical interpretation, making sense of statistics in Biology. 1989. 2nd ed. Neil Gilbert. Oxford Science Publication.
5.Statistics with applications to the biological and health sciences. 1985. R.D. Remington and M.A. Schork. Prentice-Hall.
6.Zar, Jerrold. H., Biostatistical Analysis, Engel Wood Cliffs Prentice Hall, 1974.
7.Lewis, Alvin, E, Biostatistics, Affiliated East West Press (P) Ltd., New Delhi, 1971.
8.Daniel, Waynew, Biostatistics a foundation for analysis in the health sciences, John Wiley and Sons, New Delhi, 1983.
9.Goldstein, Avrom, Biostatistics an introductory text, New York, The Mac Millian Company, 1971.
10.Ingelfinger, Joseph A and Others : Biostatistics in Clinical Medicine, 1983.
11.Stephen Misener & S.A. Krawez 2000. Bioinformatics, Methods and Protocol.
12.R. Durbin, S. Eddy, A. Krogh & G Mitchson.Biological sequence analysis. Cambridege Univesity Press, 1998.

Course outcomes:

3. To develop a skill for using of Biostatistics & Bioinformatics in data analyses.
4. To develop a skill for preparation of scatter diagram.
5. To develop a skill for computer programming.
6. To develop a skill for application of Bioinformatics in Drug Designing.

M.Sc BIOTECHNOLOGY (CBCS)
(Syllabus w.e.f. academic year 2022- 23)
SEMESTER IV
BT 403(I.E-a): RESEARCH METHODOLOGY AND COMMUNICATION SKILLS

Theory : 5 units **Mid Marks Theory: 20**
Ext. Marks Theory: 80
Exam: 3Hrs. **Credits: Theory - 4**

Course Objectives:

1. To choose the appropriate research design and develop appropriate research hypothesis for a research project
2. To choose the appropriate sampling and sample size.
3. To describe the appropriate statistical methods required for a particular research design
4. To effective use of tools / techniques for Research: methods to search required information.

UNIT- I: Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process.
Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance
Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

UNIT- II: Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. **Measurement:** Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. **Sampling:** Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

UNIT- III: Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. Mean, ANOVA, SPSS, t-test, correlation and regression,
Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism (urkund, Turnitin) and Self-Plagiarism.

UNIT- IV: Use of Encyclopedias, Research Guides, Handbook etc., Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office.

UNIT-V: Professional Written Communication: Students prepare E-mails, Letters, memos,

proposals, formal and informal reports.
Oral Communication: Impromptu and Extemporaneous methods of delivery.
Oral Presentations using usual aids such as handouts, overhead transparencies and presentation software such as PowerPoint.

Suggested Readings:
a) Best and Kahn, Research Methodology, PHI Limited.
b) Kothari, C.R. Research Methodology (Methods and Techniques), NewAge Publisher.
c) Kerlinger, Foundation of Research.
d) Fundamentals of modern statistical methods by Rand R.wilcox.
e) Power Analysis for Experimental research A Practical Guide for the Biological, Medical and social Sciences by R. Barker Bausell, Yi-Fang Li Cambridge University Press.
f) Design of Experience: Statistical Principles of Research Designand Analysis, by Robert O. Kuehl Brooks/cole.

Course outcomes:

1. To develop a skill for identification and formulation of a research topic.
2. To develop a skill for selection of good sample.
3. To develop a skill for statistical analysis of data and its interpretation.
4. To develop a skill for oral presentation.

(Syllabus w.e.f. academic year 2022- 23)
SEMESTER IV
BT 403(I.E-b): BIOENTERPRUNUERSHIP AND BIOSAFETY

Theory : 5 untis **Mid Marks Theory: 20**
Ext. Marks Theory: 80
Exam: 3Hrs. **Credits: Theory - 4**

Course Objectives:

1. To learn about Bioentreprenuership and scope of Biotechnology in bioentrepreneurship.
2. To learn about business plan proposal for virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices.
3. To learn about entry and exit strategy and marketing.
4. To learn about managing technology transfer and regulations for transfer.

UNIT- I : Basics of Bioentreprenuership - Importance of entrepreneurship; advantages of being entrepreneur - freedom to operate; introduction to bioentrepreneurship – biotechnology in a global scale; Scope in bioentrepreneurship; types of bio-industries – biopharma, bioagri, bioservices and bioindustrial; innovation – types, out of box thinking; skills for successful entrepreneur – creativity, leadership, managerial, team building, decision making; opportunities for bioentrepreneurship-entreprenuership development programs of public and private agencies (MSME, DBT, BIRAC, Startup & Make in India); patent landscape, IP protection & commercialization strategies.

UNIT- II : Accounting and Finance- Business plan preparation; business feasibility analysis by SWOT, socio-economic costs benefit analysis; funds/support from Government agencies like MSME/banks and private agencies like venture capitalists:/angel investors for bioentrepreneurship; business plan proposal for „virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices: concepts of balance sheet, profit and loss statement, double entry book keeping; collaborations & partnerships; information technology for business administration and expansion.

UNIT – III: Business Strategy - Entry and exit strategy; pricing strategy; negotiations with financiers, bankers, government and law enforcement authorities; dispute resolution skills; external environment/ changes; avoiding/managing crisis; broader vision–global thinking; mergers & acquisitions.

Marketing - Market conditions, segments, prediction of market changes; identifying needs of customers; Market linkages, branding issues; developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for virtual startup company.

UNIT – IV : Knowledge Centre and R&D - Knowledge centres e.g., in universities, innovation centres, research institutions (public & private) and business incubators; R&D for technology development and upgradation; assessment of technology development; managing technology transfer; industry visits to successful bio-enterprises, regulations for transfer of foreign technologies; quality control; technology transfer agencies; Understanding of regulatory compliances and procedures (CDSCO, NBA, GLP, GCP, GMP)

UNIT – V : Biosafety -Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture;

Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

Suggested Readings:

1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for life scientists: Developinginnovation and entrepreneurship in the biosciences*. Bloxham: Scion.
2. Shimasaki, C. D. (2014). *Biotechnology entrepreneurship: Starting, managing, andleading biotech companies*. Amsterdam: Elsevier. Academic Press is an imprint ofElsevier.
3. Onetti, A., &Zucchella, A. (n.d.). *Business modeling for life science and biotechcompanies: Creating value and competitive advantage with the milestone bridge*.Routledge.
4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences*. London: CRC Press.
5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management*. New Delhi: Himalaya Pub. House.

Course outcomes:

1. To develop skills for successful entrepreneur.
2. To develop skills in information technology for business administration and expansion.
3. To develop skills for developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for virtual startup company.
4. To know about technology transfer agencies and to understand regulatory compliances and procedures.

(Syllabus w.e.f. academic year 2022- 23)
SEMESTER IV

BT 403(I.E-c): MOOCS/SWAYAM COURSE

Theory: 5 **Mid Marks Theory: 20**
Ext. Marks Theory: 80
Exam: 3Hrs. **Credits: Theory - 4**

Students will select the Moocs/ Swayam course.

Faculty will help the students to select the course

BT 404 (O.E-a): ECOLOGY & EVOLUTION

Theory : 5 units **Mid Marks Theory: 20**
Ext. Marks Theory: 80
Exam: 3Hrs. **Credits: Theory - 4**

Course Objectives:

1. Students acquire fundamental knowledge about the structure and function of ecosystem, types of ecosystems, ecotone and edge effect.
2. Learn about the waste water treatment processes;Composting.
3. Learn how the organisms degrades the pollutants.
4. Students will understand the Theories of organic evolution, modern synthetic theory, mutations, Hardy-Weinberg law of equilibrium and genetic drift.
5. Students will learn the Isolation, pattern, mechanisms and models of speciation,

UNIT – I: Ecology: Nature and scope of ecology; ecosystem structure and function. Composition: Abiotic and biotic components; classification of ecosystem with examples; Major terrestrial biomes; ecotone, edge effect and advantages and disadvantages.Biological magnification.

UNIT – II: Issues and scopes of environmental biotechnology. Waste water characterization and its significance: COD, BOD, Inorganic constituents, solids, biological components; Principles and aims of biological wastewater treatment processes. Composting: Factors influencing composting and composting systems. Compost quality and uses. Vermicomposting.

UNIT – III: Biodegradation of organic pollutants: Mechanisms and factors affecting biodegradation. Bioremediation: Intrinsic bioremediation, Biostimulation and Bioaugmentation. In situ and ex situ bioremediation technologies Phytoremediation.

UNIT – IV: History of evolution of life on earth: Chemical basis of evolution, Evolution of DNA, RNA and proteins, origin of the genetic code. Hardy-Weinberg equilibrium; Evolutionary changes by mutation al impact gene flow, genetic drift. The concept of homology in molecular evolution. Role of transitions and transversions; chromosomal deletions and insertions in evolution. Role of pseudogenes, repetitive DNA, transposable elements and junk DNA in evolution.

UNIT – V: Speciation: Isolation pattern and mechanisms of reproductive isolation; Mechanism of speciation, Modes of speciation: sympatric, peripatric, parapatric and allopatric. phylogenetic and biological concepts of species.

Suggested Readings:

1. Chapman JL and Reiss MJ. 1995. *Ecology Principles and Application.* Cambridge Univ.Press.

2. Kormondy EJ. *Concepts of Ecology*. Eastern Economy Edition.
3. Odum EP. 1983. *Basic Ecology.* Saunders Publishing.
4. Sharma PD. 1991. *Ecology and Environment.*
5. Rastogi VB. 1991. Organic Evolution. Kedar Nath Ram Nath Publications, Meerut,Uttar Pradesh, India.

6. P.A. Moody – An Introduction to Evolution, II Edn, Kalyani publishers, New Delhi
7. An Introduction to Molecular Evolution and Phylogenetics by Lindell Bromham, 2016, Oxford University Press.
8. Molecular Evolution by Wen Hsiung-Li, 1997, Sinauer Associates, Sunderland, MA

Course outcomes:

1. Understood his environment.
2. Knows to treat waste water for recycling.
3. Knows about composting of the waste.
4. Knows about the evolution of organisms.
5. Knows about the origin of species

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SEMESTER IV

BT 404(O.E-b): RECOMBINANT TECHNOLOGY

Theory : 5 units **Mid Marks Theory: 20**

Ext. Marks Theory: 80

Exam: 3Hrs. **Credits: Theory - 4**

Course Objectives:

1. Students acquire fundamental knowledge about RNA & DNA, the genetic materials and how to label them in experimental laboratories.
2. Learn about the enzymes that uses in slicing of nucleic acids.
3. Learn about the storage processes of nucleic acids.
4. Learn about the isolation techniques of nucleic acids.
5. Learn about the vector engineering of organisms.

UNIT-I: Isolation of DNA and RNA. Quantification of nucleic acids. Radiolabeling of nucleic acids: End labeling, nick translation, labeling by primer extension, DNA sequencing: Maxam-Gilbert (Chemical) and Sanger- Nicolson (dideoxy/ enzymatic) sequencing method, Pyrosequencing.

UNIT-II: Restriction endonucleases: Types of restriction endonucleases, classification and uses. Restriction mapping. DNA modifying enzymes: Nucleases, Polymerases, Phosphatases and DNA ligases.

UNIT –III: Prokaryotic host. Plasmid vectors, Bacteriophage, other vectors, expression vectors, Construction of genomic and c-DNA libraries, Joining of DNA Fragments to vectors,Homo polymer tailing, cohesive and blunt end ligation, adaptors, linkers.

UNIT-IV: Selection, screening and analysis of recombinants. Principle of hybridization. Northern blotting, Southern blotting, Western blotting. Polymerase chain reaction, Restriction fragments length polymorphism, RAPD, AFLP, MAP.

UNIT –V: Vector Engineering and codon optimization, host engineering. Strategies of gene delivery, *in vitro* translation, expression in bacteria and yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants. Chromosome engineering, Targeted gene replacement, gene editing, gene regulation and silencing.

Suggested Readings:

1. Principles of Gene manipulation(1994) Old R.N. and Primrose S.B.
2. From Genes to Clones (1987) Winnaeker E.L.
3. Recombinant DNA (1992) Watson J.D., Witreowski J., Gilman M. and Zooller M.
4. An Introduction to GeNETIC Engineering: Nicholl, D.S.T.
5. Molecular Biotechnology (1996) Pasternak
6. The Biochemistry of Nucleic acid(1996)Adam et al
7. Genetic Engineering (1998)Janke k. swtlow

Course outcomes:

1. Students learnt about RNA & DNA, the genetic materials and how to label them in experimental laboratories.
2. Learn about the enzymes that uses in slicing of nucleic acids.

3. Learn about the storage processes of nucleic acids.
4. Learn about the isolation techniques of nucleic acids.
5. Learn about the vector engineering of organisms.

This knowledge is useful in laboratories.

Theory: 5 units **Mid Marks Theory: 20**
Ext. Marks Theory: 80
Exam: 3Hrs. **Credits: Theory - 4**

Course Objectives:

1. Students acquire fundamental knowledge about the agriculture – backbone of our economy.
2. To know plant genetics
3. To know about plant breeding techniques.
4. To know the role of biotechnology in agriculture.
5. To know about the tramsgenic crops that are developed by transmitting the genes

UNIT – I: General Principles of Agriculture - Agriculture in India; World agriculture in relation to trade in commodity, biodiversity and agricultural process outsourcing; Global warming and challenges of agriculture – global warming, factor (soil, water and crop) productivity; Cropping systems; Varieties and cultivars; Agronomic practices and Good Agricultural Practices; Crop diseases and pests, their control; Abiotic stress, their amelioration; Pollution in and by agriculture. Origin and expansion of biotechnology; Non-rDNA and rDNA biotechnology; Application of biotechnology in agriculture; Scope of agricultural biotechnology.

UNIT- II :Agricultural Genetics - Eukaryotic chromatin structure; Chromosome replication; Structure, organisation and manipulation of eukaryotic genes; rRNA gene; Histone gene; Molecular genetics of photosynthesis; Molecular genetics of nitrogen fixation; Molecular genetics of stress (abiotic and biotic).

UNIT - III: Plant Breeding Principles and practice of plant breeding of major crops (rice, wheat and one vegetable crop); Morphological and molecular markers; Agricultural Biodiversity and its dynamics; Sources of variation; Seeds and production of seeds; Biofertilisers; Mycorrhizae; Biopesticides; Pharming; Use of agriculture of mass scale production of energy, secondary metabolites and fortified consumables.

UNIT - IV: Techniques in agricultural biotechnology -Cell fractionation: Genomic, Mitochondrial and Chloroplast DNA, and Protein isolation and characterization; Plant tissue culture technique for one selected crop: Collection of material, Sterilization; Media preparation; Media manipulation; Culture maintenance; Culture characterization; Biochemical and cytological characterization; Hardening; Field transfer of plantlets. Transformation/transgenesis; Selection of desired transgenics in vitro and their establishment in the field condition; Laws relating to rDNA safety protocols.

UNIT – V: Transgenic crops - Traditionally bred and transgenic crops; Details of one selected transgenic crop; Trends in transgenesis of crops; Laws relating to transgenics; Controversies and remedies; Business and international trade in agricultural biotechnologies. International protocols and instruments relating to agricultural biotechnology; Indian laws relating to agriculture, biotechnology and biodiversity; IPR consideration in planning of agricultural biotechnology experiments; Confined and field trials.

Suggested Readings:

1. Introduction to plant Biotechnology (2018) 3rd ed., Chawla HS, CRC Press, ASIN: B07LH5S4P3.

2. Applied Biotechnology in Genetic Engineering, Pharmaceuticals and Agriculture (2016) Adam J, Syrawood Publishing House, ISBN: 978-1682862766.
3. Molecular Markers in Plants (2012), Henry RJ, Wiley-Blackwell. ISBN: 978-0-470-95951-0.
4. Genetic Transformation of Plants-Series: Molecular Methods of Plant Analysis (2013) Vol. 23, Jackson JF and Linskens HF, Springer, ASIN: B000PY3TJ0.
5. Plant Biotechnology – The genetic manipulation of plants (2017) 3rd ed., Slater A, Scott N and Fowler M, Oxford University Press. ISBN: 1138407674.
6. Plant Transformation Technologies (2011), 1st ed., Stewart CN and Touraev, A Wiley-Blackwell. ISBN: 9780813821955

Course outcomes:

1. Awareness creates about the agriculture,
2. Develop the knowledge to create transgenic plants
3. Develop plant breeding techniques to improve the yield.

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SEMESTER IV

BT 405: RESEARCH PROJECT

Faculty will help the students to select the course

Exam: 4Hrs. **Research project Marks - 100**

Credits: 4

COMPREHENSIVE VIVA – VOCE AT THE END OF I YEAR & II YEAR

END OF I YEAR - 100 Marks

END OF II YEAR - 100 Marks

BT ----------

Time: 3 hrs **Max Marks 80**

MODEL QUESTION PAPER

PART – A 20Marks

Answer to all questions:

I. Multiple choice questions - 5 X 1 = 5
1.
2.
3.
4.
5.

II. Fill up the blanks - 5 X 1 = 5
1.
2.
3.
4.
5.

III. Very short answer questions – Answer 2 questions 5 X 2 = 10
1.
2.
3.
4.
5.

PART – B 60Marks

Answer to all questions **5 X 12 = 60**

IV. Question from UNIT - I
OR
Question from UNIT - I

V. Question from UNIT - II
OR
Question from UNIT - II

VI. Question from UNIT - III
OR
Question from UNIT - III

VII. Question from UNIT - IV
OR
Question from UNIT - IV

VIII. Question from UNIT - V
OR
Question from UNIT - V