THIRUVALLUVAR UNIVERSITY
MASTER OF SCIENCE
M.Sc. Biotechnology
(With effect from 2020 – 2021)

The Course of Study and the Scheme of Examination

Sl. No.	Study Components: Course Title		ins. hrs / week	Credit	Title of the Paper	Maximum Marks: CIA	Uni. Exam	Total
SEMESTER I								
1	Core Practical	Paper 1	5	4	Cell & Developmental Biology	25	75	100
2		Paper 2	5	4	Biochemistry	25	75	100
3		Paper 3	5	4	Genetics & Molecular Biology	25	75	100
		Paper 1	3	0	Lab in Cell & Developmental Biology	0	0	0
		Paper 2	3	0	Lab in Biochemistry	0	0	0
		Paper 3	3	0	Lab in Genetics & Molecular Biology	0	0	0
Internal Elective for same major students (Choose any one)								
4	**Core Elective**	**Paper-1**	3	3	A. Bioinstrumentation B. Bioprospecting C. Aqua Culture Biotechnology	25	75	100
External Elective for other major students (Inter/multidisciplinary papers)								
5	**Open Elective**	**Paper-1**	3	3	A. Tools in Biotechnology B. Medical Biotechnology C. Food Biotechnology	25	75	100
			30	**18**		**125**	**375**	**500**
SEMESTER II						***CIA***	***Uni. Exam***	***Total***
6	Core	Paper 4	4	4	Microbial Technology	25	75	100
7		Paper 5	4	4	Immuno Technology	25	75	100
8		Paper 6	4	3	Genetic Engineering	25	75	100
9	Core Practical	Paper 1	3	3	Lab in Cell & Developmental Biology and Microbial Technology	25	75	100
10		Paper 2	3	3	Lab in Biochemistry and ImmunoTechnology	25	75	100
11		Paper 3	3	3	Lab in Genetics & Molecular Biology and Genetic Engineering	25	75	100
Internal Elective for same major students (Choose any one)								
12	**Core Elective**	**Paper-2**	4	3	A. Omics Technology B.Pharmaceutical Biotechnology C. Nanotechnology	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
13	**Open Elective**	**Paper-2**	3	3	A. Medicinal Plants	25	75	100

					B. Tissue Culture C. Molecular Diagnostics			
14	***Field Study**		-	2		100	-	100
15	**Compulsory Paper**		2	2	**Human Rights**	25	75	100
			30	**30**		**325**	**675**	**1000**

*** Field Study**

There will be field study which is compulsory in the first semester of all PG courses with 2 credits. This field study should be related to the subject concerned with social impact. Field and Topic should be registered by the students in the first semester of their study along with the name of a mentor before the end of the month of August. The report with problem identification and proposed solution should be written in not less than 25 pages in a standard format and it should be submitted at the end of second semester. The period for undergoing the field study is 30 hours beyond the instructional hours of the respective programme. Students shall consult their mentors within campus and experts outside the campus for selecting the field and topic of the field study. The following members may be nominated for confirming the topic and evaluating the field study report.

(i). Head of the respective department
(ii). Mentor
(iii). One faculty from other department

THIRUVALLUVAR UNIVERSITY

MASTER OF SCIENCE

M.Sc. BIOTECHNOLOGY

DEGREE COURSE

UNDER CBCS

(With effect from 2020-2021)

SEMESTER I

CORE PAPER 1

Cell and Developmental Biology

Course Objectives

1. To understand better the cell and intracellular organelles.
2. Cells vital functions and biological developments of cells.
3. To get a knowledge in DNA replication and protein synthesis
4. To understand briefly about Developmental biology

Unit-1

Structural organization and function of intracellular organelles - Cell wall, Nucleus, Mitochondria, Golgi bodies, lysosomes, Endoplasmic reticulum, Peroxisomes, Plastids, Vacuoles, Chloroplast, structure &function of cytoskeleton and its role in motility.

Unit-2

Cell signalling: Hormones and their receptors, Cell surface receptors, signaling through G – Protein, Coupled receptors, Signal transduction pathways, Second messengers, regulation of signaling pathways, Light signaling in plants. Ion Channel – Leaked receptors, Enzyme linked receptors, Cytoplasmic and Nuclear receptors.

Unit-3

DNA Replication: Prokaryotic & Eukaryotic replication. DNA damage and repair mechanisms.

RNA synthesis and processing – Transcription mechanism - Factors - Formation of initiation complex, Transcription activator and repressor, RNA polymerases, Capping, Elongation. RNA processing - RNA editing, Splicing and polyadenylation

Protein synthesis and processing – Genetic code, Ribosome, Formation of initiation complex, Initiation factors and their regulation complex, Elongation and elongation factors, Termination. Post-translational modification of proteins.

Unit-4

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Unit-5

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

References / Textbooks

1. Cell and Molecular Biology - P.K. Gupta
2. Cell and Molecular Biology - De Roberties and DeRoberties
3. Molecular Biology – Labfax, T.A. Brown, Bioscientific publishers Ltd, Oxford.
4. Molecular Biology of the Cell – Alberts, B *et al*
5. Developmental Biology by Scott F. Gilbert
6. Principles of Development by Lewis Wolpert, Cheryll Tickle
7. Molecular Biology - Channarayappa University Press India (P) Limited.
8. Molecular Biology and Biotechnology - J.M. Walker and R. Rapley, 2005 7.
9. Genomes – T.S. Brown
10. Frontiers in Celland Developmental Biology
11. Cell & Developmental Biology-Longdom publishing
12. https://ghr.nlm.nih.gov/primer/basics/cell
13. https://www.britannica.com/science/cell-biology
14. https://www.cellsignal.com/contents/science/cst-pathways/science-pathways
15. https://www.khanacademy.org/science/biology/cell-signaling/mechanisms-of-cell-signaling/a/introduction-to-cell-signaling
16. https://www.yourgenome.org/facts/what-is-DNA-replication
17. https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-rna-and-protein-synthesis/a/hs-rna-and-protein-synthesis-review
18. https://www.nature.com/scitable/topicpage/ribosomes-transcription-and-translation-14120660/
19. https://opentextbc.ca/biology/chapter/24-6-fertilization-and-early-embryonic-development/
20. https://courses.lumenlearning.com/boundless-biology/chapter/fertilization-and-early-embryonic-development/
21. https://www.eolss.net/Sample-Chapters/C03/E6-183-06-00.pdf
22. http://bio1520.biology.gatech.edu/growth-and-reproduction/animal-development-i/
23. https://opentextbc.ca/biology/chapter/13-2-development-and-organogenesis/

Course Outcomes

1. The students will be able to understand the cell and its basic functions
2. The students will be able to learn about the cell signaling and different pathways of cell signaling and types of receptors
3. The students will be able to learn the concept of DNA replication and central dogma of molecular biology
4. The students will be able to understand the gametes and its production, fertilization and formation of zygote and embryo
5. The students will be able to understand the morphogenesis and organogenesis in animals

SEMESTER I

CORE PAPER 2

Biochemistry

Course Objectives

1. To understand about metabolism of carbohydrates
2. To learn about the metabolism of lipids
3. To study about basic metabolism of in proteins
4. To learn about nucleic acid, vitamins and their types
5. To learn about biocatalyst
6. To know about functions of biomolecules

Unit-1

Carbohydrates – Introduction,Classification Significance - Carbohydrates - Structure and function. Metabolism of carbohydrates - Glycolysis, Citric acid cycle, Gluconeogenesis and Glycogenolysis. Electron Transport chain - oxidative and substrate level phosphorylation, Electron carriers of ETC.

Unit-2

Lipids – Classification- Structure and functions. Significance of PUFA, Cholesterol and its derivatives. Metabolism of fatty acids - β-oxidation. Fatty acid biosynthesis. Energetics of lipid metabolism.

Unit-3

Proteins - Classification – Structure and functions of essential and nonessential aminoacids, Properties of amino acids. General degradation of amino acids. Structure of protein - primary secondary, tertiary and quaternary. Conformation of protein (Ramachandran plot, secondary structure, domains, motif and folds).

Unit-4

Nucleic acids - Structure and function of DNA and RNA. Inborn errors of nucleotide metabolism. Vitamins - Structure, functions. Deficiency syndrome of vitamins (A, D, E, K, B12 & C).

Unit-5

Biocatalyst - Enzymes classification, Mechanism of action - allosteric enzymes, isoenzymes, coenzymes and cofactors. Michaelis – Menton equation. Bioenergetics - Concept of free energy, Entropy, Enthalpy & Redox Potential. High energy phosphate compounds - ATP, Phosphenol pyruvate, Creatine phosphate, phosphate potential. ATP-ADP Cycle.

References / Textbooks

1. Lehninger AL, Nelson DL and Cox MM (2002), Principles of Biochemistry. Mac Millan Worth Publishers Inc. (CBS Pub. & Distributors, New Delhi)
2. Martin DW, Jr., Mayer, PA and Rodwell, VW (2002). Harper's Review of Biochemistry 25th Edition, Maruzen Asian Ed: Lange Med. Pub.
3. Sunjay Jain, J L Jain & Nitin Jain, Fundamentals of Biochemistry, Chand Publications, New Delhi.
4. Stryer L (2002). Biochemistry, Freeman & Co.
5. Zubay, G. Biochemistry. Mac Millan Publication co. New York
6. Corn and Stump. Outline of Biochemistry.
7. Deb, A.C. Fundamentals of Biochemistry, New Central Book Agency-Kolkata
8. https://courses.lumenlearning.com/suny-ap2/chapter/carbohydrate-metabolism-no-content/

9. https://accesspharmacy.mhmedical.com/content.aspx?bookid=2492&sectionid=204926092
10. https://www.amboss.com/us/knowledge/Lipids_and_fat_metabolism
11. https://www.britannica.com/science/protein
12. https://www.toppr.com/guides/biology/biomolecules/proteins/
13. https://www.creative-enzymes.com/resource/enzyme-definition-and-classification_18.html

Course Outcomes

1. The students will be able to understand carbohydrates and their functions.
2. The students will be able to know metabolism of lipids.
3. The students will be able to understand important of proteins.
4. The students will be able to know nucleic acids and their functions.
5. The students will be able to understand enzymes and their functions.

SEMESTER I

CORE PAPER 3

Genetics and Molecular Biology

Course Objectives

1. To make the students familiar with the activity Genetics, mutation at the molecular level.
2. To Understand the Students about the mutation at the molecular level and Gene Expression.

Unit-1

Central dogma: Structure of DNA and RNA

DNA as the Genetic Material: Griffith's experiment, Hershey-Chase Experiment, Experimental Proof by Avery, McLeod and McCarty. RNA as genetic material. Basic Concept - Gene, Chromosome,DNA and RNA

Mendelian Principles: Introduction – Birth of Genetics, Mendelian principles –Mendel's experimental organism

DNA as the genetic material: Griffith's experiment, Hershey-Chase experiment, Experimental proof by Avery, McLeod and McCarty.

Unit-2

DNA Replication: Conservative, Semi conservative, Rolling circle. Mechanism of replication

Genetics of Bacteria and viruses: Transformation, Conjugation, F+, Hfr, Transduction- generalized and specialized.

Regulation of gene expression: Operon concept - lac and trp operons

Unit-3

Mutation: Spontaneous, Induced mutation, Radiation induced Mutation – (Ionizing and UV radiation),Molecular basis of Mutation. Point mutation. Chromosomal Abnormalities. Genetic basis of cancer – benign, malignant and metastatic cancer, Oncogenes and tumor suppressor genes.

Unit-4

Allelic variation and gene function–Completed Dominance, Incomplete Dominance, Pleotrophy, Penetrance and expressivity. Sex-linkage, sex limited and sex influenced characters.

Unit-5

Human genetics - Pedigree analysis, Twin studies–Mono zygotic, Di zygotic. Genetic testing–Prenatal genetic testing, Postnatal genetic testing. Transposable genetic elements – IS elements, composite transposons, Tn3, Tn5. Eukaryotes – Ac and Ds elements in maize, elements in drosophila. Retro transposons.

References / Textbooks

1. Textbook of population genetics by tomar
2. Textbook of Genetics by R.P. Meyyan (Saras Publication)
3. Text book of Genetics from Genes to Genomes–A joy Paul
4. Genetics–P.S. Verma,V.K. Agarwal
5. Essential of human genetics (5th Edn)–Manu L Kothari, Opa A Metha and Sadhana S Roy chodhury, Universities Press, Hyderabad.
6. Molecular Biology of Genes. 4th edition by Watson, Hopkins, Roberts, Steitz, Weiner.
7. The Cell – A molecular approach. 3rd edition by Geoffrey M. Cooper, Robert E. Hausman.
8. iGenetics (A Molecular Approach)- 2nd edition by Peter J. Russell

9. Genetics– A Conceptual Approach (2nd Edition)–Benjamin A. Pierce.W.H. Freeman Company
10. https://www.khanacademy.org/science/biology/bacteria-archaea/prokaryote-structure/a/genetic-variation-in-prokaryotes
11. https://www.ndsu.edu/pubweb/~mcclean/plsc431/mendel/mendel9.htm

Course Outcomes

1. The students will be able to explain DNA as a genetic material and mendelian principle
2. The students will be able to understand replication, genetics of bacteria and virus and gene regulation
3. The students will be able to know mutation, cancer and oncogene, tumour supression
4. The students will be able to know allelic variation and gene function
5. The students will be able to explain the human genetics and transposable elements

CORE ELECTIVE

PAPER-1

(to Choose either A or B)

Bioinstrumentation

Course Objectives

1. The overall objective of this paper is to enrich the student intelligentsia in all the biological observations which are explainable in terms of physical principles as biophysical phenomena.
2. Understand the canonical structure of biomedical instrumentation systems.
3. Through this course, students are introduced to basic biomedical engineering technology and introduce different biological signals, their acquisition, measurements and related constraints.
4. Students will have complete insight in these important techniques for the possible applications in various research areas of biological sciences.
5. On the successful completion of this course, the students would understand the analytical techniques and the principles of equipment used in biological and medical field.

Unit-1

Physical techniques in separation of biomolecules: Centrifugation, Density Gradient Centrifugation and ultra-centrifugation. Chromatography Techniques: Theory and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GC/GC-MS, HPLC, LC-MS, MALDI.

Unit-2

Theory and Application of PAGE, SDS PAGE, Agarose Gel Electrophoresis 2DE, Iso-electric Focusing, pulse field gel electrophoresis, Immuno diffusion, Immuno Electrophoresis, ELISA and RIA. Cell analysis: Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Confocal Microscopy.

Unit-3

Structural analysis of Biomolecules: Concepts, principle and applications of UV, IR, NMR, LASER Raman Spectroscopy, Mass Spectroscopy, Fluorescence Spectroscopy. X ray crystallography, X ray computer tomography and patch clamping

Unit-4

Principles of PCR, semi quantitative RT-PCR, Real Time PCR, Touch down PCR, Flow Cytometry, FACS, MACS and Microarray. Circular dichroism and optical rotatory dispersion, Polarography and Manometry – theory and application, Introduction Biosensors- Applications of Biosensors.

Unit-5

Tracer and other techniques – Radioactive decay, units of radioactivity, detection – Geiger Muller counter, Scintillation counter, Autoradiography. Applications and use of radio isotopes in biomedical sciences.

References / Textbooks

1. Anna Pratima G. Nikalje (2017). A Handbook of Chromatography. Scholar's Press Verlag Omniscriptam, Deutschland, Germany.
2. Wilson. K and Walker. J (2000). Practical Biochemistry – Principles and techniques. Cambridge University Press.
3. Reiner Westermeier (2004). Electrophoresis in Practice: A Guide to Methods and Applications of DNA and Protein Separations, Fourth Edition. Wiley Publishers.
4. Michael Hoppert (2003). Microscopic Techniques in Biotechnology. Wiley Publishers.
5. Gordon G. Hammes (2005). Spectroscopy for the Biological Sciences. Wiley Publishers.
6. Carmona, P., Navarro, R., Hernanz, A (1997). Spectroscopy of Biological Molecules: Modern Trends. Springer Publishers.
7. L Veerakumari (2015). Bioinstrumentation. MJP Publishers
8. Sarah Maddocks Rowena Jenkins (2016). Understanding PCR- A practical bench top guide. Elsevier Publishers.
9. Slater, Robert J (2005). Radioisotopes in biology (2nd ed.): Biochemistry and Molecular Biology Education. IUBMB Journals
10. Bell Z.W. (2012) Scintillation Counters. In: Grupen C., Buvat I. (eds) Handbook of Particle Detection and Imaging. Springer, Berlin, Heidelberg
11. P.K. Sharma (2014). Instrumental methods of chemical analysis. Krishna Prakashan Media Pvt Ltd.
12. Upadhyay., Upadhyay and Nath (2010). Biophysical chemistry. Himalaya Publishing House
13. Keith Wilson and Kenneth H. Goulding. A Biologist‟s guide to principle and techniques of practical biochemistry. Cambridge University Press.
14. Khandpur RS (2014). Handbook of Biomedical Instrumentation – R.S. Khandpur, McGraw Hill Education; Third edition
15. Wilson. K and Walker. J (2000). Practical Biochemistry – Principles and techniques. Cambridge University Press.
16. DonaldL.Pavia Gary M.Lipman, George S Kriz and Vyvyan JA (2015). Introduction to Spectroscopy- Cengage Learning India Private Limited; 5 edition
17. https://www.sciencedirect.com/topics/engineering/bioinstrumentation
18. https://cw.fel.cvut.cz/b172/_media/courses/a6m33zsl/microscopic_techniques.pdf

Course Outcomes

1. The students will be able to acquire knowledge about importance of various chromatographic techniques.
2. The students will be able to understand working principles and application of microscopes.
3. The students will be able to get insight into application of spectroscopy techniques.
4. The student will get knowledge about advanced instruments like qPCR, FACS etc.
5. The students will be able to learn about application of radio isotopes in biomedical sciences.

Bioprospecting

Semester: I **Credits: 3**

Hours of teaching: 3 **Paper type: Core Elective 1**

Course Objectives

1. To understand the bioreactors design and different types of bioreactors then its application in different field.
2. To depict the information in fermentation techniques and about the sterilization of bioreactors.
3. The course objectives are framed to give an adequate knowledge about fermentation process and types of fermentation process.
4. To learn about the physical, chemical and enzymatic methods used in the downstream processing.
5. To provide adequate knowledge in primary and secondary screening methods in drug designs.

Unit-1

Bioreactors Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases.

Unit-2

Gas- liquid exchange and mass transfer, oxygen transfer, critical oxygen concentration, determination of Kla, heat transfer, aeration/agitation, its importance. Sterilization of Bioreactors, nutrients, air supply, products and effluents, process variables and control, scale-up of bioreactors.

Unit-3

Fermentation Process Growth of cultures in the fermenter, Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process form shake flask to industrial fermentation.

Unit-4

Downstream Processing Biomass separation by centrifugation, filtration, flocculation and other recent developments. Cell disintegration: Physical, chemical and enzymatic methods. Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purificationby different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

Unit-5

Chemically creative fungi; screening for industrially useful fungal metabolites; drugs and pharmaceuticals from fungi; Ecotaxonomic approach in chemical screening; primary and secondary products of metabolism; classification of secondary metabolites; primary and secondary screening of antibiotic producers; auxanography; enrichment culture, techniques for strain improvement and Strain development; Industrial fungal strains preliminary and high throughput screening (HST); leads and lead optimization, IPR issues and patents.

References / Textbooks

1. Bioreactor design fundamentals (2013). Norton G. McDuffie. Butterworth- Heinemann.
2. Bioreactors analysis and design. Tapobrata Panda.
3. Practical manual on fermentation technology. S. Kuladaivelu and S. Janarthanan.
4. Bioreactors design, operation and novel applications edited by Carl-Fredrik Mandenius.
5. Fermentation, Biocatalysis and Bioseperation, Encyclopedia of Bioprocess Technology by Chisti, Y., Vol. 5, John Wiley and Sons, N,Y.
6. Fermentation biotechnology: Industrial perspectives by chand.
7. Downstream processing techniques in biotechnology (2018). Anuj Kumar Rana.
8. Reverse osmosis design, processes and applications 2nd edition (2015). Jane Kucera.
9. Antibiotic basics for clinicians choosing the right antibacterial agent second edition (2012). Alan R. Hauser.
10. Strain development in concrete under cyclic loading: theoretical and experimental investigations (2010). Marek Foglar.
11. Jagritisingh *et al*.,(2014) Bioreactors- Technology and design analysis. The Scitech Journal Vol. 01.
12. Jian-Jiang Zhong (2010) Recent advances in bioreactor engineering. Korean journal of chemical engineering.
13. Marcel Gutierrez-Correa and gritty K. Villena (2010) Characteristics and techniques of fermentation systems.
14. 4.Jungmin Kim *et al*., (2013) Methods of downstream processing for the production of biodiesel from microalgae. Biotechnology advances journal.
15. Gamal Osman Elhassa and Khalid Omer Alfarouk (2015) Drug development: stages of drug development. Journal of pharmacovigilance.
16. https://www.sciencedirect.com/topics/neuroscience/bioreactors
17. https://www.britannica.com/science/fermentation

Course Outcomes

1. The students will be able to gain knowledge of bioreactor.
2. The students will be able to understand the application and functioning of bioreactors.
3. The students will be able to understand the fermentation process growth of cultures in the fermentor.
4. The students will be able to understand the downstream procedure and fermenter waste treatment.
5. The students will be able to know the role of fungi in food and feed industries viz. Edible mushrooms, different cultivation and nutritional aspects of mushrooms.

Aquaculture Biotechnology

Semester: I **Credits: 3**

Hours of teaching: 3 **Paper type: Core Elective1**

Course Objectives

1. To understand the application of biotechnology in different aspects of aquaculture Feed, environmental management, diagnostic and pharmaceuticals.
2. To understand the use of biotechnology tools in application of tissue culturing etc.,

Unit-1

Introduction - Scope of biotechnology in fisheries and aquaculture research. Transgenics - Principles of transgenic technology and its application in fisheries, Synthetic hormones for induced breeding.

Unit-2

Feed biotechnology: Probiotics, single cell proteins, nutraceuticals. Commercial Recombinant protein - enzymes, hormones, bioactive compounds, therapeutic proteins. Antimicrobial peptides and their applications. Marine toxins.

Unit-3

Biotechnological approaches in environmental management: Bioremediation, biosensors, biofouling, treatment of waste water. Vaccination in fishes- DNA vaccines, sub UNIT vaccines and Biofilm Vaccines.

Unit-4

Applications of biotechnological tools - Recombinant DNA, Monoclonal antibodies, Cell lines, Stem cell culture, DNA markers and MAS. Application of tissue culture in sea weed and pearl production.

Unit-5

Molecular diagnostic technology in aquaculture: PCR protocol for white spot syndrome virus WSSV, Infectious hypodermal and hematopoietic necrosis virus IHHNV, Yellowhead disease YHD, Taura syndrome virus TSV. Electron microscopy in advanced fisheries research. Cryomicroscopy in aquaculture research.

References / Textbooks

1. Ramesh RC. (Ed.). 2007. Microbial Biotechnology in Agriculture and Aquaculture. Vol.II. Science Publ.
2. Nagabhushanam R, Diwan AD, Zahurnec BJ & Sarojini R. 2004.Biotechnology of Aquatic Animals. Science Publ.
3. Felix S 2007. Molecular diagnostic technology in aquaculture, Narendra Publishing House, Delhi, India
4. Pandian TJ, Strüssmann CA & Marian MP. 2005. Fish Genetics and Aquaculture Biotechnology. Science Publ. Primrose SB. 1989. Modern Biotechnology. Blackwell.
5. Glick BR & Pasternak JJ. 1999. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology. ASM Press.
6. Felix S. 2007. Molecular Diagnostic Biotechnology in Aquaculture. Daya Publ. House.
7. Fingerman M, Nagabhushanam R & Thompson MF. 1997. Recent Advances in Marine Biotechnology. Vols. I-III. Oxford & IBH.
8. Nair PR. 2008. Biotechnology and Genetics in Fisheries and Aquaculture. Dominant Publ.
9. Reddy PVGK, Ayyappan S, Thampy DM & Gopalakrishna. 2005. Text Book of Fish Genetics and Biotechnology. ICAR.

10. Singh B. 2006. Marine Biotechnology and Aquculture Development. Daya Publ. House.
11. Zhanjiang JL. 2007. Aquaculture Genome Technologies. Blackwell.
12. http://aquafind.com/articles/Aquaculture_Biotechnology.php
13. https://www.dfo-mpo.gc.ca/science/biotech-genom/publications/strategy-strategie/index-eng.htm
14. https://www.dfo-mpo.gc.ca/science/biotech-genom/publications/strategy-strategie/index-eng.htm
15. http://www.fao.org/3/i1140e/i1140e01.pdf

Course Outcomes

1. The students will be able to understand the scope of aquatic biotechnology as an emerging field
2. The students will be able to learn feed biotechnology, scp, active compounds and proteins
3. The students will be able to use of technology in environment management
4. The students will be able to understand and biotechnology in aquatic applications
5. The students will be able to molecular diagnostic technologies in aquatic biotechnology

Tools in Biotechnology

Semester: I **Credits: 3**

Hours of teaching: 3 **Paper type: Open Elective 1**

Course Objectives

1. Introduction to prokaryotic and eukaryotic genomes
2. Basic knowledge about cloning strategies
3. Technical knowledge of gene manipulation
4. Introduction to screening techniques
5. Application of biotechnology

Unit-1

Gene and Genomes: Prokaryotic and Eukaryotic Genomes - Structure of Gene - DNA as the genetic material; Extra chromosomal DNA: Plasmid, mitochondrial DNA and chloroplast DNA.

Unit-2

Cloning Vectors: Plasmid, phagemid, cosmid, Artificial Chromosomes (BAC) - Transformation techniques: Electroporation, CaCl2 method.

Unit-3

Tools for Gene Manipulation: Gel Electrophoresis: AGE and PAGE; Restriction Enzymes, Ligases, Modifying Enzymes - Markers for Selection: selectable and scorable - Examples.

Unit-4

Selection Strategy and Screening for Transformants: Selection of rDNA Clones: Blue-White Selection, Colony Hybridization, PCR, Molecular analysis: Western blotting, Southern Blotting and Northern Blotting.

Unit-5

Application of Cloning: Over expression of Biomolecules (Insulin) - Gene therapy– GMO – Application and Biosafety issues.

References / Textbooks

1. Primrose. S.B., Twyman R.M., Old. R.W. (2001) Principles of Gene Manipulation. 1. Blackwell Science Limited.

2. Molecular Biotechnology. S.B Primrose, Blackwell Scientific Publishers,Oxford, 1994.

3. Principles of Gene Manipulation. T.A.Brown

4. DNA Science – A first course in rDNA technology, D.A. MicklossndG.A.Freyar, Cold Spring Harbor laboratory Press, New York, 1990.

5. Molecular Cloning. Maniatis, Fritsch and Sambrook.

Course Outcomes:

1. The students will be able to obtain a comprehensive knowledge about concepts of gene and genomics.
2. The students will be able to gain an in-depth knowledge about vectors used in gene cloning.
3. The students will be able to apprehend about the principle tools that are used for gene manipulation.

4. The students will be able to know about the importance of selection and screening of transformants.
5. The students will be aware with the principal applications of gene cloning.

Medical Biotechnology

Semester: I **Credits: 3**

Hours of teaching: 3 **Paper type: Open Elective 1**

Course Objectives

1. To understand about medical microbiology
2. To Learn about the bacterial infection
3. To Study about basics of viral infection
4. To Learn about parasitology
5. To Learn about clinical symptoms of various infections
6. To know about different characteristics of infectious agent

Unit-1

Medical Microbiology - Introduction and historical developments – Developments in medical bacteriology, developments in medical virology. Normal microbiota of human body – Host, microbe interactions. Classification of diseases.

Unit-2

Bacterial infection - Introduction, causative agents, characteristic features, virulence, pathogenesis, diagnosis, treatment and prevention of pneumonia, diphtheria, meningitis, whooping cough, Tb, leprosy, diarrhoea, cholera, typhoid, gonorrhea, syphilis, tetanus and gastroenteristis.

Unit-3

Viral infection - Introduction, causative agents, characteristic features, virulence, pathogenesis, diagnosis, treatment and prevention of small pox, common cold, influenza, measles, mumps, tubella, hepatitis, AIDS and polio.

Unit-4

Parasitology - General characteristics of parasites – Habitat, structure, life cycle, clinical manifestation, diagnosis, treatment and control of amoebiosis, malaria, ascariasis, enterobiasis, giardiasis, sleeping sickness.

Unit-5

Clinical symptoms - zoonotic infection, nosocomial infection, mycoplasma. Factors in Diseases - Environmental factor - physical injury, chemical injury, thermal injury, electrical injury. Developmental and genetic factors in diseases - gene defects. Abnormal fetal development – agenesis, dysgenesis, hypoplasia, aplasia, hypoplasia of mandibles, cleft palate.

References / Textbooks

1. Immunology by Roitt- (2006)
2. Immunology by Kuby-(2003)
3. Medical Physiology Guyton and Hall-(1996)
4. Medical Microbiology by Green
5. Fundamentals of Biochemistry- J. L. Jain-(2006)
3. Medical microbiology Mims Play fair Roitt, wekelin Williams.-(2009)
4. Biopharmaceuticals: Biochemistry and biotechnology, Harvard Academic publishers-(1998)
5. Human Genetics- Gangane –(2000)
6. Fundamentals of Biochemistry- J. L. Jain-(2006)
7. Text book of Biotechnology by R. C. Dubey - (2008)
8. Biotechnology by Satyanarayana- (2010)

6. https://jamanetwork.com/journals/jama/article-abstract/377575
7. https://www.verywellhealth.com/what-is-a-bacterial-infection-770565
8. https://www.healthline.com/health/signs-of-infection
9. https://www.betterhealth.vic.gov.au/health/ConditionsAndTreatments/infections-bacterial-and-viral
10. https://www.webmd.com/a-to-z-guides/bacterial-and-viral-infections
11. https://www.healthline.com/health/bacterial-vs-viral-infection

Course Outcomes

1. The students will be able to know medical microbiology
2. The students will be able to know bacterial infection
3. The students will be able to know viral infection
4. The students will be able to know parasitology
5. The students will be able to know clinical symptoms of various infections

Food Biotechnology

Semester: I **Credits: 3**

Hours of teaching: 3 **Paper type: Open Elective 1**

Course Objectives

1. To understand the basic concepts of food biotechnology in day to day life.
2. Students will get an idea about the process of quality control parameters related to different production process.
3. Thus the course objectives is framed- to impart adequate information regulatory guidelines related to genetically modified food.
4. To understand recent developments related to use and production of nutraceuticals.
5. Thorough knowledge gained after completing this course will help students to take up a career in fermentation and food processing. This course will also help students who are willing to take up the research in areas like food technology.

Unit-1

Important Industrial microorganism. Media for industrial fermentations, media composition – energy, carbon, nitrogen and other growth factors. Production of mass culture, maintenance and inoculum preparation. Single Cell Protein (SCP): Production and Process. Microbes as direct of nutritional food (chlorella, spirulina, mushrooms and Baker's yeast). Basics of Generally Recognized as Safe (GRAS).

Unit-2

Food Fermentation– Batch and continuous fermentation process for production of different food products or additives. Production process for alcoholic beverages: Beer, wine: Non -alcoholic beverages: tea, coffee, cocoa, Dairy products including cheese, yoghurt, acidophilus milk. Therapeutic value of fermented foods. Quality control process and parameters for fermented foods. Safety concerns.

Unit-3

Food additives: Introduction and basic concepts of food additives. Production of different additives - organic acids (lactic acid, acetic acid, succinic acid), amino acids, production of L- Glutamate, L-Lysine and other essential amino acids. Basic concepts pf food flavourants and pigments. Importance of nutraceuticals in daily life. Nutraceuticals from plants and bacteria.

Unit-4

Food spoilage and public health: Harmful effects of food borne bacterial and fungal toxins; Deterioration of foods. Food preservation: Principles and methods of preservation: Physical, irradiation, drying, heat processing, chilling and freezing, high pressure and modification of atmosphere); Chemical (Sodium benzoate Class I & II); Biological: Probiotics and bacteriocins.

Unit-5

Introduction to Genetically Modified (GM) foods. Ethical, legal and social issues concerning GM foods. current guidelines for the production, release and movement of GM foods; labeling and traceability; trade related aspects; biosafety and regulatory concerns related to GM food. Risk assessment and risk management. Public perception of GM foods. GMO Act.

References / Textbooks

1. E. M. T. El-Mansi, Jens Nielsen, David Mousdale, Ross P. Carlson (2019). Fermentation Microbiology and Biotechnology. Fourth Edition. CRC Press.

2. Single Cell Protein: Production and Evaluation for Food use. Bacha U and Nasir M (2011). LAP LAMBERT Academic Publishing.
3. Frazier And West Hoff (1995), Food Microbiology, Tata Mcgraw Hill Publishing Company Ltd, New Delhi.
4. Prescot (1987), Industrial Food Preservation, John Willey and Sons
5. Farshad Darvishi Harzevili, Hongzhang Chen (2015). Microbial Biotechnology - Progress and Trends. CRC press, Taylor and Francis Group.
6. Neelam Khetarpaul (2005). Food Processing and Preservation. Daya Publishing Group.
7. Neelam Khetarpaul (2007). Food Microbiology. Daya Publishing Group.
8. Tuteylan V (2013). Genetically Modified Food Sources. Safety Assessment and Control. Academic Press.
9. Safety Assessment of Genetically Modified Foods (2017). Huang K. Springer Publishers.
10. Bhunia A (2018). Foodborne Microbial Pathogens. Springer Publishers.
11. Doyle MP (2020). Food Microbiology and Food Safety. Springer Publishers.
12. https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/---coop/documents/instructionalmaterial/wcms_628571.pdf
13. https://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732/

Course Outcomes

1. The students will be able to acquire knowledge about importance of microbes in food production.
2. The students will be able to understand QC and other safety guidelines related to production of fermented food.
3. The students will be able to get insight into process involved in production of organic acids, amino acids and nutraceuticals.
4. the student will be understanding the important role played by food preservatives in preventing spoilage.
5. The students will be able to learn about recent developments in GM food and related regulatory aspects.

Microbial Technology

Semester: II **Credits: 4**

Hours of teaching: 4 **Paper type: Core Theory**

Course Objectives:

1. To study about industrial products obtained from microbial fermentations.
2. To understand the fundamentals of the fermentation process, strain improvement and culture.
3. To understand the use of different microorganisms for manufacture of a variety of industrial products.

Unit-1

Introduction to DNA technology - Principles and tools of genetic engineering - Restriction enzymes, Cloning Vectors, gene library, DNA probe. Molecular techniques: Electrophoresis, Southern, Northern, Western & Slot blots. Polymerase Chain Reaction. Transgenic microbes.

Unit-2

Fermentation - Introduction – general information on microbial-based industries – substrates for industrial fermentation – strain improvement - an outline on fermentation and product recovery.

Unit-3

Pharmaceutical and related industries - Antibiotics- sources and types- production of Penicillin, Production of insulin and Hep B vaccine. Vitamins- Production of vitamin B12

Unit-4

Enzymes, Amino acids and Organic acids - Microbial sources, steps involved in production and product recovery and applications of amylase L- glutamic acid and Citric acid.

Unit-5

Food dairy, beverages and Agricultural industries - Single cell proteins (SCP) - SCP as food and feed – mass cultivation of Spirulina.cheese production. Alcoholic beverages – Beer and wine fermentation. Mushroom cultivation. Biofertilizers- mass production of Rhizobium. Biopesticides- Principles, production and application.

References / Textbooks:

1. Crueger,F. and Anneliese Crueger, 2000. Biotechnology: Industrial Microbiology Panima publishing Coporation New Delhi
2. Adams, M.R. and Moss, M.O. 1995. Food Microbiology New Age International Publishers New Delhi
3. Casida, L.E. Jr. 1996. Industrial Microbiology New Age International Publishers New Delhi
4. Alexander N. Glazer and Hiroshi Nikaido, 1994. Microbial Biotechnology: Fundamentals of Applied microbiology. W.H. Freeman and Co., New York.

Course Outcomes:

1. The students will able to Explain the principles and fundamentals of microbial technology.
2. The students will able to Elucidate the structure of fermentor.
3. The students will able to Understand the formulation of culture media.
4. The students will able to Describe the microbial processing in food and pharmaceutical industries.

5. The students will able to Summarize the methods used in industrial products such as microbial enzymes, organic acids etc.,

Immunotechnology

Semester: II **Credits: 4**

Hours of teaching: 4 **Paper type: Core Theory**

Course Objectives

1. To give an overview the basic concepts and principles of immune system and the techniques for developing diagnostics
2. To give an overview on Antigens and Antibodies
3. To give an overview on Immunoglobulins
4. To give an overview on cytokines
5. To give an overview on hypersensitivity

Unit-1

History and scope of immunology; Types of immunity - Innate and adaptive; Haematopoiesis and the cells of immune system; Organs of immune system. Structure and function of Primary and secondary lymphoid organs.

Unit-2

Antigens: properties and classes, haptens, mitogens, adjuvants and epitopes. T cell receptors - its organization and role in antigen recognition; MHC-general organization, antigen processing and presentation. T-cell: maturation, activation and differentiation; B-cell: maturation, activation, proliferation and differentiation; Clonal selection and immunological memory.

Unit-3

Immunoglobulin: Structure, classes, properties and functions; Organization and expression of immunoglobulin genes; Antigen- antibody interactions: Principles and applications of Precipitation and agglutination reaction, RIA, ELISA, Immunofluorescent microscopy; FACS. Hybridoma technology: monoclonal antibody production. Antibody engineering.

Unit-4

Cytokines: properties, structure and functions; Cytokine receptors; Therapeutic uses of cytokines and their receptors. Complement system: properties, activation pathways-classical, alternative and lectin. Transplantation: immunological basis of graft rejection and immunosuppressive therapy, immunological tolerance, clinical transplantations, molecular aspects of HLA typing.

Unit-5

Hypersensitivity reactions-Type I, II, III and IV. Autoimmune disorders- types, mechanism and treatment. Immune response to infectious diseases. Tumor immunology and cancer immunotherapy; Vaccines: Immunization schedule, traditional and novel strategies in designing vaccines.

References / Textbooks

1. Goldsby RA, Kindt TJ, Osborne BA, Kuby J. (2003). Immunology, 6th Edition, W.H. Freeman & Co. New York.
2. Kuby J. (2000). Immunology, 4 th Edition, W.H. Freeman & Co. New York.
3. Benjamini E, Coico R and Sunshine G. (2000). Immunology, 4th Edition, John Wiley & Sons, Inc.
4. Tizard IR. (1995). Immunology, 4th Edition. Saunders College Publishing Harcourt Brace College Publishers.
5. Ivan Riot and Peter I Delvis. (2004). Essentials of Immunology, 10th Edition, Blackwell Scientific Publications, Oxford

6. Abul K Abbas, Andrew H Litchman. (2004). Basic Immunology: Functions and disorders of the immune system, 2nd Edition, Elsevier Publications
7. Gerd Rudiger Burmester and Antonio Pezzuto. (2003). Color Atlas of Immunology, Thieme Stuttgart, New York
8. 2. Gabriel Virella. (1998). Introduction to Medical Immunology, 4th Edition, Marcel Dekker. Inc. New York
9. William E and Md. Paul. (2003). Fundamentals of Immunology, 5th Edition, Lippincott William and Wilkins Publishers.
10. 2. Myron M. Levine, James B Kaper, Rino Rappuoli, Margret A Liu, Michael F Good. (2004). New Generation Vaccines, 3rd Edition, Marcel Dekker, Inc. New York.
11. Rajasekara Pandian M and Senthilkumar B. (2007). Immunology and Immunotechnology. Panima Publishing Corporation, New Delhi. n L. nology: concepts, applications and perspectives, Wiley VCH publishers
12. Journal of immunology vol 204 issue 5
13. https://www.roswellpark.org/sites/default/files/thanavala_9-4-14_innate_immunity_part_1.pdf
14. https://www.slideshare.net/zamrankhan1/bth-203-immunology-and-immunotechnology

Course Outcomes

1. The students will be able to know the detailed description of the immune response made in humans to foreign antigens including microbial pathogens.
2. The students will be able to know about the cells involved in the immune response either innate or acquired and how the immune system recognizes self from non-self.
3. The students will be able to know about the b and t cell maturation and specific responses. Other topics covered will include the genetic basis of diversity of immune responses in mammals.
4. The students will be able to describe the cause and treatment for immune system pathologies and dysfunctions.
5. The students will be able to learn the importance techniques of immunodiagnosis.

Genetic Engineering

Semester: II **Credits: 3**

Hours of teaching: 3 **Paper type: Core Theory**

Course Objectives

1. To understand about gene cloning
2. To learn about the cloning vectors
3. To study about basics of cloning strategies
4. To learn about cloned genes
5. To learn about recombinant DNA technologies
6. To know about functions recombinant DNA technologies

Unit-1

Gene Cloning – Introduction, Basic tools - restriction enzymes, modifying enzymes, linker, Adaptor, Homopolymor tailing, DNA ligase, Polymerase enzyme – types, functions, applications. Core techniques in gene manipulation - Cutting and joining of DNA, Itroduction of DNA into cells

Unit-2

Cloning vectors - Bacteriophage vectors - pBr 322, PUC 18, M13. Bacterial vector - Cosmids, Phagemids, Phasmids, Bacterial Artificial Vector (BAC). Animal viral vectors - SV40. Plant vectors – CaMV, Ti-plasmid. Yeast vector - Yeast Artificial Chromosome. Gene transfer method - Transformation, Transduction, Particle bombardment, Electroporation, Liposome mediated gene transfer, Microinjection. Agrobacterium mediated gene transfer.

Unit-3

Cloning strategies - Construction – Genomic, rDNA libraries, Probe construction, methods of labeling gene probes - recombinant selection and screening, Molecular cloning. Strategies for identifying recombinant clones – gene mapping technique

Unit-4

Analysis of cloned genes - Restriction enzyme analyses, Southern blotting, Northern blotting, Western blotting, colony & plague hybridization. Factors affecting expression of cloned genes, Reporter genes, Fusion proteins. Cloning and expression of commercially useful proteins.

Unit-5

Application of r-DNA technology - production of recombinant proteins - insulin, Human growth hormone HGH, DNA vaccines. Transgenic plants - insect resistance, disease resistance. Transgenic animals – molecular pharming.

References / Textbooks

1. Principles of gene manipulation by RN old & S.B. Primrose (1996) Blackwell Scientific Publications
2. DNA cloning, I & II by DM Glover & BD. Hames (1995) IRL, Press
3. PCR strategies by MA. Innis, DH, Gelfand & JJ Sninskey (%), Academic press
4. Recombinant DNA by Watson JD, Gilman M. Witkowski, Zoller M. (1992), Scientific American Books
5. Diagnostic Molecular Microbiology by D.H. Persing, K T.F. Smith, F.c. Teower and T.J. While. ASM Press 1993
6. Recombinant DNA by Watson JD, Gilman M. Witkowski, Zoller M. (1992), Scientific American Books

7. Recombinant gene expression protocols by Tvan RS (1997) Humana Press.
8. https://www.khanacademy.org/science/biology/biotech-DNA-technology/DNA-cloning-tutorial/a/overview-DNA-cloning
9. https://studiousguy.com/cloning-vectors-types-characteristics/
10. https://plasmid.med.harvard.edu/PLASMID/cloningstrategies.jsp
11. https://www.thermofisher.com/in/en/home/life-science/cloning/cloning-learning-center/invitrogen-school-of-molecular-biology/molecular-cloning/cloning/common-applications-strategies.html
12. https://www.genscript.com/molecular-cloning-strategy.html
13. https://www.ncbi.nlm.nih.gov/books/NBK21505/
14. https://www.ncbi.nlm.nih.gov/books/NBK21450/
15. https://www.bio-rad.com/en-us/applications-technologies/introduction-gene-cloning-analysis?ID=LUSNKO4EH
16. https://www.hindawi.com/journals/ijg/2016/2405954/
17. https://medcraveonline.com/JABB/application-of-recombinant-DNA-technology-genetically-modified-organisms-to-the-advancement-of-agriculture-medicine-bioremediation-and-biotechnology-industries.html

Course Outcomes

1. The students will be able to know gene cloning.
2. The students will be able to understand cloning vectors.
3. The students will be able to know cloning strategies.
4. The students will be able to understand cloned genes.
5. The students will be able to know recombinant DNA technologies.

Omics Technology

Semester: II **Credits: 3**

Hours of teaching: 3 **Paper type: Core Elective 2**

Course Objectives

1. To make the students familiar with the eukaryotic and prokaryotic genomes and central dogma of molecular biology.
2. Students will get an idea about the new sequencing technologies and also to the development of database and their uses.
3. Thus the Course Objectives is framed to impact adequate knowledge about PCR and the types of PCR techniques.
4. To understand recent developments related to genomics and the genomics used in different field like plant and animal breeding and in recombinant protein.
5. To expose the students to understand the protein sequencing methods and proteomics tools.

Unit-1

RNA world hypothesis, Genetics to Genomics, Forward and revers genetics. Eukaryotic and prokaryotic genomes, Chromosome structure and function, Chromatin re-modeling/organization, DNA as genetic material, Central dogma of molecular biology.

Unit-2

Overview of conventional and new sequencing technologies, Strategies used in whole genome sequencing, NGS technologies, RNAseq, Genome annotation, Candidate gene discover and data mining, Transcription factor, Development of databases and their uses, Genome mapping by genetic and physical technique, Comparative genomics and SNP analysis.

Unit-3

Restriction and modifying enzymes, Various blotting techniques, PCR techniques, RT-PCR, qPCR, Digital PCR, Site directed mutagenesis, Genomic and cDNA libraries, Screening of libraries, DNA microarray, Antisense RNA, RNA interference, TALEN, CRISPR-Cas9.

Unit-4

Genomics in gene function analysis, Genomics in plant and animal breeding and improvement, Genomics in drug discovery, Genomics in valued added crops, Genomics in recombinant protein etc.

Unit-5

Proteomics basics, Forces that determine protein structure and physicochemical properties, Mechanisms of protein folding, Molten globule structure.Protein sequencing using various methods, Protein identification by mass spectrometry, Determination of post translation modification, Proteomics tools and databases.

References / Textbooks

1. Genome and Genomics: From Archaea to Eukaryotes 1sted 2019 Edition (2019), K. V. Chaitanya.
2. Molecular biology, Dr. P.S. Verma and Dr. V.K. Agarwal (2010) S Chand publisher.
3. Genome sequencing technology and algorithms 1st edition (2007) sun kim *et al*., Artech house publisher.
4. An introduction to database systems (8th edition) 2003, C. J. Date pearson publisher.
5. PCR Protocols third edition (2010), edited by Daniel J. Park.

6. Principles and technical aspects of PCR amplification, Alex van belkum *et al*.,
7. Bioinformatics methods and applications genomics, proteomics and drug discovery fourth edition, S.C. Rastogi *et al*.,
8. Genomics and proteomics principles, technologies and applications. DevarajanThangadurai, Ph.D, JeyabalanSangeetha, Ph.D (2015).
9. Principles of Proteomics, Twyman Richard.
10. Fundamentals of database system seventh edition, RamezElmasri, Shamkant B. Navathe.
11. Thomas Shafee and Rohan Lowe (2017). Eukaryotic and Prokaryotic gene structure. A Review. Wikijounal of medicine.
12. Chandra ShekharPareek *et al*., (2011). Sequencing technologies and genome sequencing. A Review. Journal of applied genetics.
13. Polymerase chain reaction: Theory, practice and application: A review. Sahel Medical Journal.
14. Sharma Neha and Harikumar S.L. (2013). Use of genomics and proteomics in pharmaceutical drug discovery and development: A Review. International journal of pharmacy and pharmaceutical sciences.
15. MohleddinJafari and All Masoudi- Nejad (2012). Proteomics databases and websites. Journal of Paramedical Sciences(JPS).
16. https://www.yourgenome.org/facts/what-is-the-central-dogma
17. https://microbiologyinfo.com/polymerase-chain-reaction-PCR-principle-procedure-types-applications-and-animation/

Course Outcomes

1. The students will be able to get the detailed characteristics of prokaryotes and eukaryotes genome as well as application of forward and reverse genetics.
2. The students will be able to get knowledge and design the experiments using various techniques of genome sequencing as well proper organization of generated biological data.
3. The students will be able to apply structural and functional genomics approaches on newly sequenced genome for functional characterization of genes.
4. The students will be able to develop capacity to pin point the strategies used for crop improvement and development of drug, recombinant proteins or value added crop.
5. The students will be able to handle a proteins and its characterization and demonstrate how various types of mass spectrometers can be used for proteome quantification, structure determination of proteins by various methods.

Pharmaceutical biotechnology

Semester: II **Credits: 3**

Hours of teaching: 3 **Paper type: Core Elective 2**

Course Objectives

1. Biotechnology has a long promise to revolutionize the biological sciences and technology.
2. Scientific application of biotechnology in the field of genetic engineering, medicine and fermentation technology makes the subject interesting.
3. Biotechnology is leading to new biological revolutions in diagnosis, prevention and cure of diseases, new and cheaper pharmaceutical drugs.

Unit-1

Introduction: Brief introduction to Biotechnology with reference to Pharmaceutical Sciences and pharmacology. History & principle of pharmacology. Drug names & classification systems. Routes of Drug administration, Absorption, Distribution and Metabolism. General principle of drug action – Pharmacokinetics, Pharmacodynamics. Measurement of drug action

Unit-2

Chemotherapeutic drugs – Protein Synthesis Inhibitors, Anti-Inflammatory, Antibacterial, Antifungal, Antiviral, Antihelminthic, Anticancer Drugs. Genetic recombination and drugs-Development of hybridoma for monoclonal antibodies. Human insulin, HGH, Erythropoietins, IFN, TNF, IL, Clotting factor VIII

Unit-3

Enzyme immobilization: Techniqes of immobilization, factors affecting enzyme kinetics. Study of enzymes such as hyaluronidase, penicillinase, streptokinase and streptodornase, amylases and proteases etc. Immobilization of bacteria and plant cells.

Unit-4

Micro-encapsulation: Types of microcapsules, importance of microencapsulation in pharmacy, microencapsulation by phase separation, coacervation, multi orifice, spray drying and other techniques, evaluation of micro capsules. Macro capsules: Advantages and disadvantages of capsule dosage form, material for production of hard and soft gelatin capsules.

Unit-5

Design and Development of Drugs: Drug discovery process: Principles, Techniques and Strategies used in new drug discovery. Regulations for laboratory animal care and ethical requirements. Bioassays: Basic principles of bioassays, official bioassays and experimental models. Pre-clinical and clinical models employed in the screening of new drugs

References / Textbooks

1. R.S. Satoskar, S.D. Bhandarkar, Nirmala N. Rege, R.R. Satoskar. Pharmacology and Pharmacotherapeutics 20th Revised Edition, Popular Prakashan (P) Ltd (2014)
2. S.S. Purohit, Kaknani, Saleja Pharmaceutical Biotechnology.
3. Torchilin, V. P. (2012). Immobilized enzymes in medicine (Vol. 11). Springer Science & Business Media.
4. Handbook of Encapsulation and Controlled Release by Munmaya Mishra first edition CRC Press
5. Pharmaceutical manufacturing handbook production and processes by Shayne Cox Gad, A John Wiley & Sons, Inc., Publication
6. Drugs: From Discovery to Approval by Rick NG, 3rd Edition, Wiley-Blackwell

7. The Journal of Pharmacology and Experimental Therapeutics by American Society of Pharmacology and Experimental Therapeutics
8. The Journal of Pharmacology & Pharmacotherapeutics (JPP), a publication of Phcog.Net, published by Medknow Publications and Media Pvt. Ltd.
9. H.P. Rang, M.M. Pale, J.M. Moore, Churchill Livingston. Pharmacology.
10. N.Murugesh, A concise Text Book of Pharmacology. Sixth edition. Sathya Publishers, Madurai.
11. R.C. Dubey, A Text Book of Biotechnology. S.Chand& Co Ltd, New Delhi.
12. Lynn Wecker, Lynn Crespo, George Dunaway, Carl Faingold and Stephanie Watts. Brody's Human Pharmacology, Elsevier 5th Edition 2010.
13. https://www.healthline.com/health/administration-of-medication#takeaway
14. http://howmed.net/pharmacology/routes-drug-administration/
15. https://www.nature.com/scitable/topicpage/genetic-recombination-514/
16. https://www.fda.gov/patients/drug-development-process/step-1-discovery-and-development
17. https://ebrary.net/18050/environment/application_immobilized_enzymes_pharmaceutical
18. https://wis-wander.weizmann.ac.il/space-physics/immobilized-enzymes-used-pharmaceutical-industry

Course Outcomes

1. The students will be able to learn about drugs and their action in our body
2. The students will be able to learn about chemotherapeutic drugs, genetic recombination and drugss
3. The students will be able to learn about enzyme immobilization and its application in pharmaceutical industry
4. The students will be able to learn about current trending microencapsulation technique
5. The students will be able to learn about designing and development of drugs

Nanotechnology

Semester: II **Credits: 3**

Hours of teaching: 3 **Paper type: Core Elective 2**

Course Objectives

1. The syllabus is designed in accordance with the latest industry trends and demands
2. The objective of this course is to train the students to have a strong of theoretical knowledge in the subject.
3. Covers the whole spectrum of nanomaterials ranging from overview, synthesis, properties, and characterization of nanophase materials to application including some new developments in various aspects.
4. Imparting the state of art of Nanotechnology to the society and to the environmental implication.
5. After completing this paper, student will be able to apply gained knowledge for various industrial applications of nanotechnology.

Unit-1

Introduction to Nanotechnology: Basic concepts of nanotechnology. definition & prospects. Importance of nanotechnology in biology. Classification of Nanostructures Bionanoparticles & nanocomposites. Types of biomaterials & biodegradable polymers.

Unit-2

Applications of nanomaterials – Importance of nanomaterials in chemical catalysis in dye & heavy metal removal, cosmetics, batteries, biosensor, food. Use of nanomaterials in agriculture. Application of nanoparticles in energy, tissue engineering (wound healing). Importance of nanobiotechnology in medicine and drug delivery.

Unit-3

Introduction to Nano-structured materials. Fullerenes - Properties and Characteristics. Carbon Nanotubes Characteristics and Applications. Basic concepts of Quantum Dots and Wires. Introduction to Gold and Silver Nanoparticles. Nanopores. Preparation and synthesis of gold and silver nanoparticles. Small Molecule-Protein Interactions. Micro-array and Genome Chips.

Unit-4

Microbial based synthesis of nanoparticles and its advantages. Synthesis of nanomaterials- Sol-Gel method for synthesis of nanoparticles, hydrothermal, Physical vapor deposition, chemical vapor deposition, ball milling, microfabrication, lithography-iron beam lithography. Concerns and Challenges of Nanotechnology.

Unit-5

Nanomedicine - Bio-Pharmaceuticals, Implantable Materials, Implantable Devices, Surgical Aids, Diagnostic Tools, Genetic Testing, Imaging, Nanoparticles Probe. Nanotechnology for Cancer Research and Therapy. Nanotechnology for Imaging and Detection. Environmental Nano Remediation Technology - Thermal, Physico-Chemical, and Biological Methods. Nano Filtration for the Treatment of Wastes, Removal of Organics, Inorganics and Pathogens. Nanotechnology for Water Purification.

References / Textbooks

1. Horst–Günter Rubahn (2008) Basics of Nanotechnology (3rd edition). Wiley Publishers.

2. Sengupta and Sarkar (2015). Introduction to Nano. Basics to Nanoscience and Nanotechnology. Springer Publishers.
3. Murty, B.S., Shankar P., Raj B., Rath B.B. and Murday, J (2013). Textbook of Nanoscience and Nanotechnology. Springer Publishers
4. K Raja and M Kannan Subramanian, K S (2018). Textbook on Fundamentals and Applications of Nanotechnology. Daya Publishing House.
5. Tuan Vo-Dinh (2019). Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, Second Edition. CRC Press.
6. L Karthik, A. Vishnu Kirthi, Shivendu Ranjan, V. Mohana Srinivasan (2019). Biological Synthesis of Nanoparticles and Their Applications. CRC Press.
7. Joachim Schummer and Davis Baird (2006). Nanotechnology Challenges Implications for Philosophy, Ethics and Society. World Scientific Press
8. Demetzos, Costas (2016). Pharmaceutical Nanotechnology Fundamentals and Practical Applications. Springer Publishers.
9. Anming Hu and Allen Apblett (2014). Nanotechnology for Water Treatment and Purification. Springer Publishers.
10. Nanobiotechnology Concepts, Applications and Properties by Christef M. Niemeyer, C.A.Mirkin. Wiley – VCH Publishers
11. Mark Ratner and Daniel Ratner (2005). Nanotechnology a Gentle Introduction to the Next big idea. Pearson education. Inc.
12. Ramachandra Rao MS, Shubra Singh. (2014). Nanoscience and Nanotechnology: Fundamentals of Frontiers. Wiley India Pvt. Ltd., 370pp.
13. Pradeep T. (2012). A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education Pvt. Ltd.,ISBN: 9781259007323.
14. Hari Singh Nalwa. (2002). Nanostructured Materials and Nanotechnology, Academic Press.
15. http://genesdev.cshlp.org/content/27/22/2397.full
16. https://onlinelibrary.wiley.com/doi/pdf/10.1002/adma.200703183

Course Outcomes

1. The students will be able to acquire knowledge about importance of nanotechnology and nanomaterials.
2. The students will be able to understand application of nanomaterials in day to day life.
3. The students will be able to get insight into process involved in production of metal nanoparticles and its application.
4. The student will be understanding critical factors in synthesis of nanoparticles.
5. The students will be able to learn about recent developments and application of nanoparticles.

Medicinal Plants

Semester: II **Credits: 3**

Hours of teaching:3 **Paper type: Open Elective 2**

Course Objectives

Elementary treatment of various morphological uses in the identification and utilization of medicinal plants in general.

Unit-1

Introduction: Herbal Medicine–History of Traditional Medicine – History of Islamic Medicine, Siddha, Ayurveda, Homeopathy, Allopathy and Unani medicine.

Unit-2

Ethano botany:*Withania somnifera* (Amukkara) *Glycyrrhizaglabra* (Athimathuram), *Myristica fragrans* (Jathikkai), *Gymnemasylvestre* (Cakkaraikkolli), *Pongamiapinnata* (Punkam)-PropertiesandMedicinaluses.

Unit-3

Common medicinal plants: Family, Local Name, Common name, Medicinal uses–*Ocimumsanctum, Solanumtrilobatum, Cardiospermumhalicacabum, Adhatodavasica, Catharanthusroseus, Ecliptaalba*.

Unit-4

Parts of Medicinal plants: Fruit –Amla, Bulb – Garlic, Rhizome – Ginger, Seed –Castor, Bark – Cinchona, Leaves –Neem and Flower – Clove.

Unit-5

Cultivation methods– crop protection – Harvesting– Storage and Protection–Marketing utilization– Export of medicinally important plant (General aspects).

Course Outcomes

1. The student will be able to gain knowledge on traditional medicine
2. The student will be able to study some important medicinal plants
3. The student will be able to know the common herbal plants
4. The student will be able to know the preservation of herbal medicine
5. The student will be able to learn cultivation methods of herbal plants

References / Textbooks

1. Gokhale, S.S,C.K.Kokate and A.P.Purohit (1994). Pharmacognosy. Niraliprakashan, Pune.
2. Faroogi, A.A. and B.S.Sreeramu (2004), Cultivation of Medicinal and Aromatic crops. University Press (India) P. Ltd., Hyderabad.
3. Pal. D.C and S.K. Jain (1998), Tribal medicine, Naya Prakash, 206, Bidhan Sarani, Calcutta.
4. Thirugnanam, Akbarsha and Krishnamurthy (2010), Indian Medicinal plants and Home Remedies, Selvi Pathipagam, Trichy.

Tissue Culture

Semester: II **Credits: 3**

Hours of teaching: 3 **Paper type: Open Elective 2**

Course Objectives

1. To understand the techniques for tissue culture environment
2. To understand the laboratory rules.
3. To know that propagation techniques and plant nutritional perspectives.
4. To develop the knowledge of commercial applications and techniques.

Unit-1

The Tissue Culture Environment- Media Types -Filter Bridge, Agar, Liquid - Nutrient Media Composition – Cleanliness - Light and Temperature – Hormones - Artificial Light - Water Quality - Water Treatments - Carbon Dioxide Effects – Greenhouses.

Unit-2

Plant Nutrients - Major Elements - Minor (Trace) Elements -Total Salts - How Plants Grow - Factors Affecting Nutrient Uptake - Nutrient Solution Preparation - Hydroponic Nutrients – Chelates - Growing Media for Tissue Culture - Water in Tissue Culture - Chemical Analysis

Unit-3

The Laboratory - The Tissue Culture Laboratory - Preparation Area - Transfer Chamber - Culture Growing Area - Siting a New Lab - Equipment Requirements for a Lab – Chemicals

Unit-4

Micropropagation Techniques - Stock Plants -selection, planting, management - Uses for Tissue Culture - Problems with Tissue Culture – Procedures – Explants – Sterilization - Nutrient Media - Shoot Induction and Proliferation - Rooting and Planting Out - Stages in Plant Development - Treating Plant Tissue with Sterility

Unit-5

Commercial Applications - Understanding Genetics and Plant Breeding – Biotechnology - Cell Fusions - Overcoming Pollination Incompatibility - Pollination Biology - Taking Plants out of Culture - Hardening off Plants - Growing Rooms or Chambers.

References / Textbooks

1. An introduction to Plant Tissue culture by MK Razdan. M.K. 2003. Oxford & IBH Publishing Co, New Delhi, 2003.
2. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.
3. Plant tissue culture by Bhojwani. S.S and Razdan. M.K 2004.
4. Plant Propagation by Tissue Culture: Volume 1 & 2. EF George. Exegetics Limited, 1999.
5. Plant cell culture, A Practical approach, 2nd Edition, Edited by R.A. Dixon and R.A. Gonzales.

Course Outcomes

1. The students will gain knowledge on tissue culture environment
2. The students will be able to learn about the nutritional properties and requirements for tissue culture.

3. The students will learn about the design of a tissue culture laboratory and its requirements
4. The students will be able to grow plants at controlled conditions in laboratory
5. The students will be able to understand plant breeding techniques and transfer lab-grown plants to environmental conditions in hardening facility

Molecular Diagnostics

Semester: II **Credits: 3**

Hours of teaching: 3 **Paper type: Open Elective 2**

Course Objectives

1. To provide an advanced understanding for students about the molecular basis of the pathogenesis, diagnosis and treatment of human diseases.
2. To describe and discuss topics related to infectious diseases, chronic diseases, genetic diseases, and diseases arising from abnormal immune responses.
3. To have precise diagnosis of diseases are of paramount importance to overcome false diagnosis based on symptoms
4. The main objectives of this paper is to introduce students to different techniques that are commercially used in molecular diagnosis of diseases and give an account of different diseases that are routinely diagnosed using molecular testing.
5. At the end of the course work, students should have idea about molecular diagnosis and the methods to implement the challenges that health care field faces very often.

Unit-1

Introduction to molecular diagnostics Definition - History – Diseases- infectious, physiological and metabolic errors, and inherited diseases. Biomarkers- types, potential uses and limitations. Diagnostics – types and importance in clinical decision making. Benefits of molecular diagnostics over conventional diagnostics. Ethical issues related to molecular diagnostics. Personal safety and laboratory safety. GLP for handling highly infectious disease samples and documentation.

Unit-2

DNA based molecular techniques for diagnosis DNA based molecular techniques: SNP chromosomal microarrays, relative-quantitative PCR, methylation analysis, MLPA, mutation screening panels (xTAG, Luminex), and SNP testing. PCR-based SNP detection: single-stranded conformational polymorphism analysis, heteroduplex analysis, allele-specific and multiplex PCR.

Unit-3

Proteomic assays for diagnostics Proteomics- introduction to clinical proteomics. Gel based techniques: 1D and 2D PAGE. High throughput multidimensional protein identification technology: Protein microarray, Immunoassays –Immunohistochemistry.

Unit-4

Applications of molecular diagnostics Major Histocompatibility Complex (MHC), HLA typing. Role of Molecular diagnostics in bone marrow transplantation and organ transplantation. Diagnosis of genetic diseases- Thalassemia, Cystic Fibrosis. Neonatal and Prenatal disease diagnostics- Prenatal and pre-implantation diagnosis. Molecular diagnosis for early detection of cerebral palsy, Down's syndrome

Unit-5

Molecular diagnosis of degenerative diseases and infectious disorders Muscular Dystrophy, Cardiovascular diseases. Pharmacogenomic testing for cardiovascular diseases. Malignant diseases: Molecular oncology testing in malignant disease- Acute and Chronic leukemias. Circulating tumour cell testing (CTC). Molecular diagnostic of various viral diseases: Dengue, Chickgungunya, Ebola and Influenza(H1N1), Corona, SARS.

References / Textbooks

1. George Patrinos Wilhelm Ansorge Phillip B. Danielson (2016). Molecular Diagnostics (3rd Edition) Academic Press.
2. Nader Rifai A. Rita Horvath Carl T. Wittwer Jason Park (2018). Principles and Applications of Molecular Diagnostics. Elsevier Publishing Group.
3. Wayne W. Grody and Frederick L. Kiechle (2010). Molecular Diagnostics Techniques and Applications for the Clinical Laboratory. Elsevier Publishing Group.
4. Jim Huggett and Justin O'Grady (2014). Molecular Diagnostics – Current Research and Application. Academic Press.
5. William B. Coleman and Gregory J. Tsongalis (2005). Molecular Diagnostics for the Clinical Laboratorian. Humana Press.
6. Jonathan L. Haines Margaret A. Pericak Genetic Analysis of Complex Disease (2005). John Willey
7. Lela Buckingham (2011). Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications. FA Davis Publishers.
8. Carl Burtis, Edward Tietz (2011). Textbook of clinical chemistry and molecular diagnostics. Ashwood, David Bruns, Elsevier Publishing Co
9. Juluri R Rao, Colin Craig John E Moore (2006). Molecular Diagnostics: Current Technology and Applications. Taylor and Francis.
10. https://researchadvocacy.org/system/files/MolecularDiagnosticsTutorialFinal_0.pdf?file=1&type=node&id=152&force=0
11. https://academic.oup.com/clinchem/article/49/2/348/5639602

Course Outcomes

1. The students will be able to acquire knowledge about importance of molecular diagnostic methods over conventional methods.
2. The students will be able to understand application of DNA based detection methods.
3. The students will be able to get insight into application of proteomic diagnostic methods.
4. The student will be understanding critical factors diagnosis of various genetic and immune disorders.
5. The students will be able to learn about recent developments and application of molecular diagnosis in cancer therapy and viral disease.

Lab in Cell and Developmental biology

Semester: I& II **Credits: -**

Hours of teaching: 3 **Paper type: Core Practical**

1. Observation of prokaryotic and eukaryotic cells and cell types - Living Cells / Temporary / Permanent Preparations.
2. Squash preparation of onion root tip, testis and anther lobes.
3. Preparation of buccal smear.
4. Isolation, determination, purification and separation of protein, carbohydrates, lipids, DNA and RNA.

Lab in Biochemistry

Semester: I& II **Credits: -**

Hours of teaching: 3 **Paper type: Core Practical**

1. Estimation of protein by – Lowry method, Bradford method
2. Estimation of glucose by Ortho-toluidine method,
3. Total sugars by Anthrone method
4. Determination of glycine (Sorensen formal titration),
5. Separation of Amino acids by TLC method
6. Determination of physical factors (temperature and pH) affecting enzyme activity
7. Immobilization of enzyme

Lab in Genetics and Molecular Biology

Semester: I & II **Credits: -**

Hours of teaching: 3 **Paper type: Core Practical**

1. Isolation of plant DNA by CTAB method
2. Isolation of DNA from the buccal cells / animal tissue
3. Estimation of DNA by diphenylamine method
4. Observation of Mendelian traits in student population
5. Bacterial conjugation/ Transformation

Lab in Microbial Technology

Semester: II **Credits: 3**

Hours of teaching: 3 **Paper type: Core Practical**

1. Sterilization, media preparation.
2. Isolation of Industrially important microorganisms.
3. Product recovery – Paper chromatography.
4. Demonstration of Fermenter operation.
5. Batch culture Technique a) Still culture & b) Shake culture.
6. Cultivation of yeast – biomass production.
7. Mushroom cultivation – demonstration.
8. Ethanol production.

9. Wine fermentation.
10. Citric acid production.
11. Glutamic acid production.
12. Biofertilizers
    a) Bacterial: Rhizobium.
13. Visit to Biotech Industries.

Lab in Immunotechnology

Semester: II **Credits: 3**

Hours of teaching: 3 **Paper type: Core Practical**

1. Study on Blood Cells Identification of blood cells Differential count of white blood cells and red blood cells.
2. Agglutination test a) ABO Blood grouping b) Widal test for typhoid fever
3. Agglutination inhibition test - Pregnancy test for detection of HCG
4. Precipitation test
    a) Ouchterlony's Double Immunodiffusion Technique (ODD)
    b) Radial Immuno Diffusion (RID)
    c) Rocket Immuno Electrophoresis (RIE)

Lab in Genetic Engineering

Semester: II **Credits: 3**

Hours of teaching: 3 **Paper type: Core Practical**

1. Plasmid DNA extraction from E. coli
2. Isolation of plasmid DNA
3. Restriction digestion

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