Mahajana Education Society (R)

Education to Excel

Pooja Bhagavat Memorial Mahajana Education Center
Post Graduate Wing of SBRR Mahajana First Grade College (Autonomous)
K.R.S. Road, Metagalli, Mysuru

M.Sc. BIOTECHNOLOGY PROGRAM

Choice Based Credit System (CBCS)

I Semester

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Molecular Cell Biology	FCHC	3	1	0	4
2		Fundamentals of Biochemistry	FCHC	3	1	0	4
3		Techniques in Biology	FCHC	3	1	0	4
4		**Practical IA** (Techniques in biology& Fundamentals of Biochemistry)	FCHC	0	0	2	2
5		**Practical IB** (Molecular Cell Biology/Genetics /Microbiology)	FCHC	0	0	2	2
Soft Core (Any ONE)							
1		Genetics	FCSC	3	0	0	3
2		Microbiology	FCSC	3	0	0	3
TOTAL CREDITS 5 Hard Core (3 theory + 2 practicals) :16 credits ,1 Softcore: 03 credits							**19 CREDITS**

- **NOTE ADD ON COURSE:** Interested students can opt for more than "ONESOFT CORE(THEORY)".

II Semester

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Molecular Biology	FCHC	4	0	0	4
2		Genetic Engineering	FCHC	4	0	0	4
3		**Practical IIA**: (Molecular Biology and Genetic Engineering)	FCHC	0	0	2	2
4		**Practical IIB:** (Molecular Diagnostics /Food and Environmental Biotechnology/ Bioprocess technology)	FCHC	0	0	2	2
	Soft Core (Any TWO)						
1		Molecular Diagnostics	FCSC	3	0	0	3
2		Food and Environmental Biotechnology	SC	3	0	0	3
3		Bioprocess technology	SC	3	0	0	3
Biotechnology and its applications (For other discipline students)			OE	4	0	0	4
TOTAL CREDITS 4 Hard Core (2 theory + 2 practicals) :12credits 2 Softcore: 06 credits 1 Open elective :04 credits							**22 CREDITS**

III **Semester**

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Plant Biotechnology	HC	3	1	0	4
2		Animal Biotechnology	HC	3	1	0	4
3		Immunology	FCHC	3	1	0	4
4		**Practical-III:** Plant Biotechnology. Animal Biotechnology &Immunology	HC	0	0	4	4
Soft Core (Any TWO)							
1		Natural products & Drug discovery	SC	3	0	0	3
2		Biostatistics & Bioinformatics	SC	3	0	0	3
3		Genomics& Proteomics	SC	3	0	0	3
TOTAL CREDITS 4 Hard Core (3 theory + 1 practical's) :16 credits ,2Softcore: 06 credits							**22 CREDITS**

IV **Semester**

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Project Work	HC	0	0	10	10
Soft Core (Any One)							
1		Molecular plant pathology	SC	3	0	0	3
2		Stem cell & regenerative medicine	SC	3	0	0	3
3		Research Methodology	SC	3	0	0	3
TOTAL CREDITS **1 Hard Core :10 credits ,1 Softcore: 03 credits**							**13 CREDITS**

MOLECULAR CELL BIOLOGY(FCHC)

Total Credit: 04 Total Marks-Theory 70+30 (100 M) Total Hours: 48 hours

Learning Objectives: Students should study this paper to know –

a. The structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
b. Cell cycle and cellular processes.
c. Concept of cancer biology and signal transduction.

Module- I

Organization of the cell 12 hours

Universal features of cells, Ultra-structure of prokaryotic and eukaryotic cells (Plants and animals), Structure of plant cell wall, Structure of cell membrane and models, functions of cell membrane, Intracellular organelles: Structure and functions of Ribosomes, Golgi apparatus; Mitochondria, Chloroplast, Lysosomes, Centrosome, Endoplasmicreticulum, Nucleus-Internal organization, Chromatin- structure and function, cellular cytoskeleton.

Module - II

Cellular processes 12 hours

Cell cycle and its regulation, Cell cycle check points, Molecular dynamics of cell division, interphase, Mitosis and meiosis, Cyclins and CDKs, Cell differentiation: Stem cells, Differentiation of stem cells into different cell types and organization into specialized tissues, apoptosis, necrosis & autophagyMolecular mechanisms of membrane transport active, passive and facilitated, Receptor mediated endocytosis.

Module - III

Cancer Biology 12 hours

Introduction,Historical account, classification, Characteristics of cancer cells, hallmark features of cancer cells,Carcinogenesis, Exogenous and endogenous carcinogens, cancer initiation, promotion and progression, Cancer cell cycle, Viruses and cancer, Oncogenes, Tumor suppressor genes with examples, cancer therapy present and future, Role of p53 in cancer. Role of phytochemicals in cancer treatment, cancer stem cells.

Module - IV

Basics of Signal Transduction 12 hours

Extra-cellular matrix components, Cell junctions, Cell adhesion molecules, Hormones and their receptors, Cell surface receptors as reception of extra-cellular signals, Types of cell signalling, Growth factors- EGFR, VEGF, PDGF and theirSignalling, signalling through G-protein coupled

receptors; Second messengers in signal transduction pathways: cAMP and calcium ions (Ca2+), signalling through Receptor tyrosine kinases ,MAP kinase pathway,P13K -Akt pathway.

Learning Outcomes: After studying this paper the students will know –

a. Role of cell cycle and its regulation.

b. Phytochemicals in cancer treatment and stems cells.

c. Receptors of signalling pathways.

PRACTICAL IB:

Total Credit: 02

Total hours: 32

1) Microscopic examination of prokaryotic and eukaryotic cells using staining techniques.
2) Isolation of mitochondria by differential centrifugation.
3) Measurement of cell dimension by micrometery.
4) Cell Counting and viability by tryphan blue exclusion method.
5) Bacterial growth curve.
6) Study of mitosis in onion root tips.
7) Study of meiosis in onion flower buds.
8) Polytene chromosomes.
9) Study of chromosomes by air-dry technique.

REFERENCES:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. 2008. Molecular Biology of the Cell. (5^{th} Ed.) New York: Garland Science.
2. Cooper, G. M., andHausman, R. E. 2013. The Cell: a Molecular Approach (6^{th} Ed.). Washington: ASM, Sunderland.
3. Hardin, J., Bertoni, G., Kleinsmith, L. J., and Becker, W. M. 2012. Becker's World of the Cell. Boston (8^{th} Ed.). Benjamin Cummings.
4. Kleinsmith, L.J.,and Kish, V. M. 1995. Principles of Cell and Molecular Biology (2^{nd}Ed.) Harper Collins College Publishers, New York, USA.
5. LodishH., and Berk A. 2016. Molecular Cell Biology (8^{th} Ed.). New York. W H Freeman.
6. E-books
    - https://cdn.preterhuman.net/texts/science_and_technology/nature_and_biology/Cell_and_Molecular_Biology/Molecular%20Cell%20Biology%205th%20ed%20-%20Lodish%20et%20al.pdf
    - http://standring.weebly.com/uploads/2/3/3/5/23356120/8_-_unit_30c.pdf

- file:///C:/Users/Dr.%20Divya/Downloads/Cancer%20Biology%204th%20ed%20-%20R.%20Ruddon%20(%20PDFDrive%20).pdf

Web links:

- https://www.slideshare.net/musselburghgrammar/cell-molecular-biology
- https://www.slideshare.net/TapeshwarYadav1/basics-of-molecular-biology-56429099
- https://slideplayer.com/slide/12568274/

FUNDAMENTALSOF BIOCHEMISTRY(FCHC)

Total Credit: 04 Total Marks-Theory 70+30 (100 M) Total Hours: 48 hours

Learning Objectives: Students should study this paper to know –

a. The basics of biomolecules.

b. Functions of biomolecules in the biological system.

c. Interactions among the biomolecules in the nature.

Module 1: Basics of Chemical Bonding and Carbohydrates 18 hours

Bonding: Covalent bond; coordinate bond; coordinate bond formation in transition metals. Bonding of iron in hemologlobin and cytochromes, cobalt in Vit B_{12}, magnesium in chlorophyll.Special properties of water; Structure and bonding, non-covalent interactions, reactions of carbohydrates.

Carbohydrates: Structure and classification of carbohydrates, monosaccharides (pentoses, hexoses), disaccharides (lactose, sucrose, maltose) and polysaccharides (starch, cellulose, glycogen and bacterial cell wall polysaccharides) explanations.

Module 2: Basics of Amino Acids and Proteins 10 hours

Aminoacids: Nomenclature, classification and buffering properties, zwitterionic structure,reactions of Aminoacids.

Proteins: Primary, secondary, tertiary and quaternary structures, protein sequencing.

Factors responsible for protein folding: Anfinsen's experiment. Non-covalent interactions and S-S bridges in stabilizing the proteins, Denaturation and renaturation of proteins, molten globule, chaperones.

Module 3: Basics of Lipids& Enzymology 08 hours

Lipids: Classification & reaction of lipids; oils, fats, and waxes. Occurrence and properties of fatty acids, esters of fatty acids, cholesterol, phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides. Role in cell membrane.

Enzymology:Classification, enzyme activity, Michaelis-Menten kinetics, LB plot, inhibition - competitive, uncompetitive, non-competitive, determination of Ki, active site, allosterism - ATCase, isoenzymes- LDH, catalytic strategies, co-enzymes and cofactors, multienzyme complexes-PDC.

Module 4: Basics of Nucleic Acids 12 hours

Nucleic Acids: DNA as genetic material ,Griffith ,Avery & Macleod experiments , isolation of DNA & RNA from biological sources, secondary structure of DNA, Watson and Crick model, Chargaff's rule; B and Z DNA. Features of mitochondrial, chloroplast DNA and plasmids.Secondary structure of tRNA and clover leaf model. Physiochemical properties of

nucleic acids, melting of DNA, T_m; factors affecting T_m, C_ot curve, classification of DNA based on C_ot curve.

Learning Outcomes: After studying this paper the students will know –

a. Chemistry of biomolecules.

b. The fundamental principles in sequencing of DNA.

c. Importance of biomolecules in the biological system.

REFERENCES:

1. Bahl, A. 2010. Advanced organic chemistry. S Chand & Company Limited.
2. Berg, J. M., Tymoczko, J. L., andStryer, L. 2006. Biochemistry: International edition. W H Freeman & Company Limited.
3. Berg, J. M.,Tymoczko, J. L, andStryer, L. 2002. Biochemistry (5th Ed.). W H Freeman.
4. Mathews, P. 2002. Advanced chemistry. Cambridge low price editions. Cambridge University Press, UK.
5. Morrison, R., and Boyd, R. 1992. Organic Chemistry (6th Ed.). Englewood Cliffs, NJ: Prentice Hall.
6. Nelson, D. L., Lehninger, A. L., and Cox, M. M. 2008. Lehninger principles of biochemistry. New York : W.H. Freeman.
7. Voet, D., andVoet, J. G.2010. Biochemistry,(4thEd.) New York: J. Wiley & Sons.
8. Videos for the concept:
   - www.khanacademy.org – Chemical Bonding, Chemistry of Biomolecules
   - www.yourgenome.org – Structure of DNA

Weblink:

- https://www.slideshare.net/AshfaqAhmad52/introduction-to-biochemistry-67924875
- https://slideplayer.com/slide/252874/

PRACTICAL JA:

Total Credit: 02

Total hours: 32

1. Preparation buffers and solutions&Measurement ofpH.
2. Determination of pKa of aminoacids.
3. Estimation of reducing sugar by DNSmethod.
4. Estimation of proteins by Lowry'method.
5. Estimation of proteins by Bradford'method.
6. Estimation of proteins by Bicinchonicacid method.

7. Estimation of amino acids by Ninhydrin method.
8. Estimation of cholesterol by Zak's method.
9. Estimation of saponification and iodine value of lipids.
10. Estimation of total carbohydrates by phenosulfuric acid method.

TECHNIQUES IN BIOLOGY (FCHC)

Total Credit: 04 Total Marks-Theory 70+30 (100 M) Total Hours: 48 hours

Learning Objectives: Students should study this paper to know –

a. This paper is designed to give a brief introduction to most of the techniques used in the field of biological analyses.
b. Nevertheless, the topics in this paper are to be taught compendiously.

Module I: Biological samples: Types and preparation 12 hours

Study Models: *In vivo* and *in vitro* models; Microbial, Animal, Plants; choice of models;types of studies, auxotrophs. Routes of exposure of test chemicals in animals. Culture: microbes, animal and plant cells in laboratory.

Cell fractionation techniques: Tissue homogenization, Cell lysis techniques, extraction of cellcellularcontents. Protein purification techniques: salting in, salting out, dialysis and ultrafiltration.

Centrifugation: Svedberg's constant, sedimentation velocity and sedimentation equilibrium.

Ultra centrifugation: Differential and density gradient centrifugation, centrifugal elutriation, isolation of cell organelles (e.g. Mitochondria) from biological tissue samples.

Module II:Spectroscopicanalysis 12 hours

Principles and applications of colorimeter, spectrophotometer, fluorimeter, multiwell plate reader. Beer-Lambert's Law and its limitations. Extinction coefficient, chromogenic and fluorescent probes, their applications.Principle of flame photometry, and X-ray crystallography, IR, ESR, NMR& Raman's spectroscopy.

Module III: Chromatographic and electrophoretic techniques: 12 hours

Chromatography: Principles, working and applications of paper chromatography (radial, ascending, descending and 2-D), Thin layer chromatography,Brief introduction, application of Adsorption, Ion exchange, Gel filtration, Affinity, Gas chromatography. Chromatofocusing, HPLC, UPLC and FPLC.

Protein electrophoresis: Polyacrylamide gel electrophoresis, SDS-PAGE, IEF & 2DEF.Visualizing proteins using CBB, silver stain;glycoproteinsand lipoproteins staining,Brief introduction to Zymogram and reverse zymogram;

Nucleic acid electrophoresis: Agarose gel electrophoresis, Visualizing nucleic acids in using Ethidium bromide and UV. Fluorescence probes: SYBR green and Eeva green, Taq man, PFGE and capillary electrophoresis.

Module IV: Radiochemistry and Mass spectroscopy 12 hours

Isotopes: Heavy isotopes and radio isotopes, half-life, decay constant, detection and quantitation; Principle and working of GM counter and scintillation counter (solid/liquid).

Mass spectroscopy Principle and construction of mass spectrometer.m/e, tof, MALDI and ESI. LC-MS, LC-MS-MS.

Applications of radioactivity: Radio isotopes in biology 3H, 14C, 32P, 131I, 35S; Labeling of proteins and nucleic acids, autoradiography, pulse chase method, carbon dating.

Learning Outcomes: After studying this paper the students will know –

a. Techniques in Biology.

b. The fundamental principles in cell homogenization.

c. Importance of bioanalytical techniques.

REFERENCES:

1. Bryce, C., and Balasubramanian, D.2004. Concepts in Biotechnology: Hyderabad Universities Press.
2. Crueger, W., andCrueger, A. 2017. Biotechnology: a textbook of industrial microbiology. Medtech.
3. Marshall, A. G.1978. Biophysical chemistry: principles, techniques, and applications: Wiley New York.
4. Micklos, D. A., andFreyer, G. A. 1990. DNA science; a first course in recombinant DNA technology: Cold Spring Harbor Laboratory Press.
5. Purohit, S., andMathur, S.1999. Drugs in Biotechnology fundamentals and applications. PurohitSS.,Ed.,Maximum Publishers, India.
6. Slater,A.., Scott, N., and Fowler, M. 2003. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press, Oxford, New York,
7. Walker, M., andRapley, R. 2009. Route maps in gene technology. John Wiley & Sons.
8. Wilson, K., andWalker, J. 2010. Principles and techniques of biochemistry and molecular biology. Cambridge University Press.

Weblink:

- https://www.slideshare.net/mprasadnaidu/molecular-biology-tecniques
- https://www.slideshare.net/MeenalAggarwal2/chromatographic-techniques
- https://www.slideshare.net/JayashreeShanmugam14/cell-fractionation-115544348

PRACTICAL IA:

Total Credit: 02

Total hours: 32

1. Ascending, descending and circular paper chromatography for separation of amino acids.
2. TLC of amino acids (1D and2D).
3. Column chromatography- gelfiltration.
4. Gel electrophoresis- native and SDS-PAGE and estimation of molecular weight of proteins.
5. Demonstration of HPLC, LC-MS, XRD, NMR, Confocal and Electronmicroscopy.
6. Wavelength scans of proteins and nucleic acids.
7. Preparation of homogenates and mitochondria from plant and animal tissues.
8. Estimation of molar extinction coefficient of methylene blue (Beer Lambert's Law).
9. Isolation of esterase from green peas using ammonium sulphate precipitation.
10. Estimation of esterase activity using colorimetric method.
11. Separation of WBC, RBC and platelets using gradient centrifugation.

GENETICS(FCSC)

Total Credit: 03 Total Marks-Theory 70+30 (100 M) Total Hours: 48 hours

Learning Objectives: Students should study this paper to know –

a. The development of Genetics and the principles of Mendel.
b. The concepts of Viral, Bacterial, Fungal & Algal genetics.
c. Mutation and Mutagenesis.

Module- I **14 hours**

History and developments of genetics. Principle of Genetic Transmission: Mendel's' Experiments, Symbols and terminology, Principle of dominance and segregation, Principle of independent assortment, Mendelian inheritance and probability (Multiplication and Addition rites). Extensions of Mendelian Principles:co-dominance, incomplete dominance, gene interactions, multiple alleles, lethal alleles, pleiotropy, penetrance and expressivity, polygenic inheritance, linkage and crossing over, sex linked inheritance, sex limited and influenced traits, genome imprinting, extra nuclear inheritance.

Module- II **12 Hours**

Viral Genetics: Lytic and Lysogenic cycles, Phage Phenotypes, Phenotypic Mixing, Recombination and Mapping. **Bacterial Genetics:** Bacterial Transformation- Types of transformation mechanisms found in prokaryotes, Bacterial Conjugation- properties of the F plasmid, F^+ x F^- mating, F' x F^- conjugation, Hfr conjugation. **Fungal Genetics:***Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses, chromatid and chiasma interference, Mitotic recombination in *Neurospora*. **Algal Genetics:** *Chlamydomonas*- unordered tetrad analysis - Recombination and Mapping.Floral meristems and floral development in *Arabidopsis,* ABC model.

Module- III **12 Hours**

Mutation and mutagenesis: Nature, type and effects of mutations. Mutagenesis – physical and chemical mutagens, base and nucleoside analog, alkylating agents, interrelating agents, ionizing radiation. Induction and detection of mutation in microorganisms and *Drosophila*. Site directed mutagenesis and its applications.

Recombination: Homologous and non-homologous recombination, Holliday model, site-specific recombination.

DNA Repair: Mechanism of genetic repair- direct repair, photoreactivation, excision repair, mismatch repair, post-replicative recombination repair, Repair of double-strand breaks, SOS repair.

Module- IV **10 Hours**

Sex Determination-Sex chromosomes, Chromosomal and genetic basis of sex determination. Sex determination in *C.elegans,Drosophila*, human and Plant(*Melandrium*). Dosage compensation-Genic balance, Gene dose, Molecular basis of dosage compensation in Drosophila and man.

Transposable elements- discovery in maize and bacteria, transposal elements in bacteria and bacteriophage, types and functions; Transposable elements in eukaryotes- Plants, *Drosophila* and Humans, mechanisms of transpositions.

Learning Outcomes: After studying this paper the students will know –

a. Model organisms available to study genetics.
b. Types of DNA recombination and DNA repair.
c. Detailed account on transposable elements and transpositions.

PRACTICALS IB :

Total Credit: 02

Total hours: 32

1. Replica plating technique for transfer of bacterial colonies.
2. Ultra-violet killing curve and determination of mutant types in *Saccharomyces cerevisiae.*
3. Induction of mutation
4. Isolation of streptomycin resistant strain of *E .coli* by gradient plate method.
5. Ames test
6. Study of special chromosomes- B chromosomes, and sex chromosomes.
7. Determination of chiasma frequency in onion.
8. To solve genetic problems on linkage, ordered and unordered tetrads
9. Study of Mutations in *Drosophila*
10. Study of Autosomal and sexlinked gene inheritance in *Drosophila*

REFERENCES:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Robert, K.., and Watson, J. D.1999. Molecular biology of the cell. Garland Pub. Inc. New York.
2. Alberts, B., Johnson, A., Lewis, J., Rafi, M., Roberts, K., and Walter, P. 2008. Molecular biology of the cell (5th Ed.), Garland science. Taylor & Francis Group, NewYork, USA.
3. Atherly, A.G.,Girton, J. R., and Donald, J.R. 1999. The Science of Genetics. Saunders College Publishing, Fort Worth. Texas.

4. Brooker, R.J. 2005. Genetics –analysis and principles. Addison Wesley Longman Inc., California.
5. Brown, T.A. 2000. Genetics: a molecular approach. Van NostrandReinhold (intn) Co., Ltd., London.
6. Buchanan, B.B., Gruissem, W., and Jones, R.L. 2010. Biochemistry and Molecular Biology of Plants. Ed. ASPP Press.USA.
7. Fairbanks, D.J., and Anderson, W.R. 1999. Genetics the continuity of Life. Brooks's/Cole Pub. California.
8. Griffith, A.J.F.,Gelbart, W.M., Muller, J. H., and Lewintin, R. C. 1999. Modern Genetic Analysis. W.H. Freeman and Co. New York.
9. Hartl, D. 1991. Basic Genetics (2nd Ed.). Jones and Barlett Publisher Inc. Boston.
10. Kleinsmith, L.J., and Kish, V.M. 1995. Principles of Cell and Molecular Biology (2nd Ed.). Harper Collins College Publisher, New York, USA.
11. Lodish, H., Berk, A., Zipurasky, S. L., Matsudaira, P., Baltimore, D., and Darnell, J.2000. Molecular Cell Biology (4th Ed.). W.H. Freeman and Co. New York, USA.
12. Randhawa, S. S. 2017. Textbook of Genetics (Ist Ed.).S Vikas and Company, Jalandhar.
13. Snustad, D.P., Simmons, M. J., and Jenkins, J. R. 1997. Principles of Genetics.Hohn Wiley &son'sInc, New York.
14. Strickberger andMonroe W. 2000. Evolution (3rd Ed.). Jones & Bartlett Publisher, Inc. USA.
15. Tamarin, R. H. 2009. Principles of Genetics (7th Ed.) Tata-McGraw Hill, New Delhi.
16. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine M., andLosick, R. 2004. Molecular Biology of the Gene (5th Ed.). Pearson Education Pt. Ltd., New Delhi, India.

Web links

- https://www.youtube.com/watch?v=L42IwtPC7eM
- https://www.youtube.com/watch?v=3VrGkCm4sT4
- https://www.youtube.com/watch?v=l-9iUpFGbxE
- https://www.youtube.com/watch?v=pdEgBMXJdeg
- https://www.youtube.com/watch?v=VIS_4G3Ysyk
- https://www.youtube.com/watch?v=TfBnfxm0Xyc
- https://www.youtube.com/watch?v=he260FUU5_M
- https://www.youtube.com/watch?v=BlnUNmfGn7I
- https://www.youtube.com/watch?v=o4yJF90OR9M
- https://www.youtube.com/watch?v=_cJfsWYR42M

MICROBIOLOGY (FCSC)

Total Credit: 03 Total Marks-Theory 70+30 (100 M) Total Hours: 48 hours

Learning Objectives: Students should study this paper to know –

a. The characteristics of microbes, their taxonomy and diversity.
b. The growth of microbes and their control.
c. The relationship between microbes and environment.

Module I **12 hours**

The beginning of microbiology and Microbial Characteristics

Introduction to Microbiology and Microbes; History and scope of Microbiology – Hook,Antony van Leeuwenhoek and Cohn; Contribution of Pasteur and Koch. Prokaryotic cell structure, pure culture techniques; bacterial genetics: transformation, transduction and conjugation; antimicrobial resistance.Culture collection and Maintenance of cultures.

Module II **12 hours**

Microbial Taxonomy and Microbial diversity

Criteria for classification of bacteria; Bergy's manual, Cyanobacteria, acetic acid bacteria,lacticnacid bacteria and Mycobacteria.Archaea: Halophiles, Methanogens and thermophiles. Viruses: general properties of virus, viral structure, sub-viral particles – viroids and prions.Eukarya: algae and fungi, general characteristics and outline classification.

Module III **12 hours**

Microbial Growth and Control

Microbial growth: Growth curve, batch and continuous culture systemculture, factors affecting growth like temperature, acidity, alkalinity. Sterilization, disinfection and antisepsis: physical and chemical methods for controlof microorganisms, antibiotics,

Microbes and environment: Nutrient cycles (carbon and nitrogen cycle); microbial communication system; quorumsensing, prebiotics and probiotics.

Module IV **12 hours**

Beneficial and Harmful effects of Microorganism

Beneficial aspects of microbes and their metabolites in food industry, Bioremediation.Important microbial diseases of Plants caused by fungi, bacteria and viruses.Important infectious diseases of humans, caused by bacteria, protozoaand viruses - tuberculosis, malaria and AIDS.Emerging andresurgent infectiousdiseases,SARS-COV 2 structure and virulence of virus.

Host-Microbe interaction (pathogen interaction, microbiome analysis method.)

Learning Outcomes: After studying this paper the students will know –

a. Identification of bacteria through Bergy's manual.

b. The fundamentals of antibiotics.

c. The beneficial and harmful effects of microorganisms.

REFERENCES:

1. Matthai, W., Berg, C. Y., and Black, J. G. 2005. Microbiology, Principles and Explorations. Boston, MA: John Wiley & Sons.
2. Parker, N, Schneegurt, M., ThiTu, A. H, Forster B. M., Lister P. 2017. Microbiology. Openstrax.
3. Pelczar, M. J., et al., 2001. Microbiology (5^{th} Ed.). New York: McGraw-Hill.
4. Rekadwad, B, 2020. Microbial Systematics, Taxonomy, Microbial Ecology, Diversity. CRC Press.
5. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., and Willey, J. M. 2011. Prescott's Microbiology. WilleyNew York, McGraw-Hill.

Weblink:

- https://www.slideshare.net/sarah_jumali/1-introduction-to-microbiology
- https://www.austincc.edu/cbeaman/micro%20ppt/chp%201%20combined.ppt

PRACTICALS IB:

Total Credit: 02

Total hours: 32

1. Preparation of liquid and solid media for growth of microorganisms
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and stab cultures, storage of microorganisms
3. Isolation of pure cultures from soil and water
4. Microbial growth curve
5. Measurement of bacterial population by turbidometry and serial dilution methods.
6. Effect of temperature, pH, carbon and nitrogen sources on growth.
7. Microscopic examination of bacteria, yeast and molds& study of organisms by gram stain, acid fast stain and staining for spores.
8. Assay of antibiotics and demonstration of antibiotic resistance.
9. Biochemical characterization of selected microbes

II Semester

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Molecular Biology	FCHC	4	0	0	4
2		Genetic Engineering	FCHC	4	0	0	4
3		**Practical IIA**: (Molecular Biology and Genetic Engineering)	FCHC	0	0	2	2
4		**Practical IIB:** (Molecular Diagnostics /Food and Environmental Biotechnology/ Bioprocess technology)	FCHC	0	0	2	2
	Soft Core (Any TWO)						
1		Molecular Diagnostics	FCSC	3	0	0	3
2		Food and Environmental Biotechnology	SC	3	0	0	3
3		Bioprocess technology	SC	3	0	0	3
Biotechnology and its applications (For other discipline students)			OE	4	0	0	4
TOTAL CREDITS 4 Hard Core (2 theory + 2 practicals) :12credits 2 Softcore: 06 credits 1 Open elective :04 credits							**22 CREDITS**

MOLECULAR BIOLOGY(FCHC)

Total Credit: 04 Total Marks-Theory 70+30 (100 M) Total Hours: 48 hours

Learning Objective: After studying this paper the students will know –

a. To understand biological activities and metabolism at DNA and protein level
b. The course gives an in-depth insight into the molecular aspects of life - the central dogma.
c. It explains molecular aspects of genes and its regulation- genome- gene expressions heredity- recombination- protein synthesis- molecular basis of diseases- mutations genetic analysis etc.

Module 1: 08 Hours

1. **Genome organization:** Prokaryotic and eukaryotic genome organization, central dogma, structural organization of chromosome, structure and functions of DNA & RNA, Biochemical evidences for DNA as genetic material.
2. **DNA**: Chemistry of DNA, Forces stabilizing DNA structure, Physical Properties of Ds DNA (UV absorption spectra Denaturation and renaturation), chemical that react with DNA, Interaction with small ions, DNA binding motifs: Zinc finger, leucine zipper, helix-turn- helix others motifs, DNA binding and kinks.

Module 2: **12 Hours**

1. **DNA topology:**Supercoiled form of DNA, Biology of supercoiled DNA, DNA topoisomerases, effect of supercoiling on structure of DNA and role of supercoiling in gene expression and DNA replication.
2. **DNA Replication:** Characteristics and functions of bacterial DNA polymerases I, Mechanism of prokaryotic DNA replication, models of replications in prokaryotes. Fidelity of replication,Eukaryotic DNA polymerases and mechanism of replication. Replication of viral DNA, DNA replication in telomeric regions,Telomerases,mechanisms of action of topoisomerase I and II ,Models of DNA replication, Inhibitors of replication.

Module 3: **14 Hours**

1. **Transcription:** Characteristics and function of bacterial RNA polymerases Eukaryotic RNA polymerases, mechanism of transcription and regulation. transcription factors, Stringent response. Post transcriptional modifications of mRNA mechanism of splicing,Processing of tRNA and rRNA. Inhibitors of transcription. Mechanism of action of ribozymes ,

2. **Translation:** Structure and role of tRNA in protein synthesis, ribosome structure, basic feature of genetic code and its deciphering, translation (initiation, elongation and termination in detail in prokaryotes as well as eukaryotes), Post translational processing,Control of translation in eukaryotes (Antisense RNA, Heme and interferon).

Module 4: **14 Hours**

1. **Regulation of Gene expression in prokaryotes and eukaryotes:** Positive and negative regulation. lac-, ara-, his- and trp- operon regulation; antitermination,global regulatory responses; Regulation of gene expression in eukaryotes: Transcriptional, translational and processing level control mechanisms.

2. **Protein localization&Gene Silencing**: Export of secretory proteins- signal hypothesis, transport and targeting of proteins to mitochondria, chloroplast, peroxisomes, Gene Silencing: Definition, types, RNAipathway, shRNA & CRISPR-CAS.

3. **Non coding RNA**: coding and non coding RNA,types of ncRNA : Short ncRNA(mi RNA,Sn RNA,Pi RNA,t-RNA &it's fragments,SnoRNA)long ncRNA ,functional significance of ncRNA

Learning Outcomes: After studying this paper the students will know –

1. The idea about the principles behind molecular biology.
2. Understand the molecular tools and its application in basic research and applied research in various fields of life sciences.

REFERENCES:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D.1994. Molecular Biology of the Cell. Garland Science, New York.
2. Cooper, G.M. 1997.The Cell: A molecular approach, ASM Press, USA.
3. Darnell, J. Lodish, H. and Baltimore, D. 1990. Molecular Cell Biology. Scientific American Books Inc. NY.
4. Elliott, W. H., and Elliott, D. C. 2006. Biochemistry and Molecular Biology (3rd Indian Ed.). Oxford University Press, Oxford.
5. Garrett, R.H. and Gresham, C.M.1995. Molecular aspects of Cell Biology, International edition, Saunders College Publishing.

6. Karp, G. 1996.Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
7. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., and Darnell, J. 2004. Molecular Cell Biology, Scientific American Books Inc. NY.
8. Mathews, C. K, Van Holde, K. E., Ahern, K. G. 2000. Biochemistry (3rd Ed.) Pearson education.
9. Nelson, D. L., Cox, M. M. 2005. Lehninger. Principles of Biochemistry (4th Ed.). W H Freeman Co.
10. Old, R.W., Primrose, S.B. 1993.Principles of gene manipulation - An introduction to genetic engineering (7th Ed.). Blackwell Scientific Publications.
11. Weblinks :
    i. https://www.slideshare.net/ShobhaSurbhaiyya/gene-silencing-69645867.
    ii. https://www.slideshare.net/lalvarezmex/dna-topology.
12. Research/Review articles:
    i. Anderson, P. and Ivanov, P., 2014. tRNA fragments in human health and disease. FEBS letters, 588(23), pp.4297-4304
    ii. Basto, A. P., et al., 2021. Micro RNAs in Tfh regulation: Small molecules with a big impact. European Journal of Immunology, 51(2), 292-295
    iii. Crick, F. H. 1958. On protein synthesis. In SympSocExpBiol (Vol. 12, No. 138-63, p. 8).
    iv. Karakar, D., *et al*., 2021.The Role of Lnc RNAs in translation. Non coding RNA 7 (1):16. .
    v. Langston, L. D., et al., 2006. DNA replication: keep moving and don't mind the gap. Molecular cell, *23*(2), 155-160.
    vi. Mleczko, A. M., et al. 2014. Ex-translational function of tRNAs and their fragments in cancer. ActaBiochimicaPolonica, *61*(2).

PRACTICALS IIA:

Total Credit: 02

Total hours: 32

1. Estimation of DNA by diphenyl amine method.
2. Estimation of RNA by orcinol method.
3. Isolation of Genomic DNA from yeast cell,
4. Determination of purity and concentration of isolated DNA using spectrophotometer and agarose gel electrophoresis.
5. Determination of RNAse&DNAseactivity

6. Isolation of RNA & analysis using Bleach Gel electrophoresis
7. Restriction digestion of plasmid and analysis
8. DNA ligation

GENETIC ENGINEERING (FCHC)

Total Credit: 04 Total Marks-Theory 70+30 (100 M) Total Hours: 48 hours

Learning Objectives: Students should study this paper to know –

a. To understand cloning and expression vectors.
b. Methods involved in gene manipulation and techniques of gene analysis.
c. The vast knowledge of gene editing.

Module-I **12 hours**

Cloning and Expression vectors: Plasmids, lambda vectors, M13 Phage, cosmids,phagemids, Artificial chromosome vectors-YACs, PACs and BACs, plant and animal viruses as vectors, Transposons, Expression vectors- prokaryotic (pRSET, pET), eukaryotic (pcDNA3, pCEP), Baculovirus and Pichia vector system, plant based vectors- Ti and Ri, binary and shuttle vectors,Gene cloning: genomic cloning, c-DNAcloning,

Module- II **12 hours**

Gene manipulation Restriction enzymes, restriction mapping, cloning in plasmid, Phage and cosmid vectors, insertion of foreign DNA into host cells-transformation, electroporation, transfection transient and stable, screening methods for transformants, downstream processing of recombinant proteins, affinity tags- His-tag, GST-tag, MBP-tag, Fc-tag. Construction and screening of genomic and cDNA libraries, chromosome walking, Chromosome Jumping, BAC libraries and assembly of BACs into contigs.

Module- III **14 hours**

Gene analysis techniques

Hybridization techniques- Southern, Northern, South-western, Far-western, Colony hybridization, fluorescence *in situ* hybridization, molecular probes-preparation, labelling, amplification, applications, Polymerase chain reaction-Principle, primer designing, Types- RT-PCR, Realtime PCR, colony PCR, Multiplex PCR, Hot-start PCR, asymmetric PCR, Sequencing methods-chemical sequencing of DNA (Maxam and Gilberts methods andSangers dideoxy method), automated DNA sequencing, sequencing by DE-MALDI- TOFMS,microarray. ChIP and Chip-on-chip techniques Chromogenic *in situ* hybridization, qPCR, next generation sequencing.

Module- IV **10 hours**

Gene therapy, transgenics and Genome editing

Ex vivo and *in vivo* gene therapy, Vectors and other delivery systems for gene therapy, Invitro gene therapy, gene therapy of genetic diseases: eg.Neurologocal, metabolic disorders and cystic fibrosis, viruses for gene therapy- lentivirus, adenovirus. Gene targeting, knockout

mice, genome editing by CRISPR-CAS

Learning Outcomes: After studying this paper the students will know –

a. Theuse of plant and animal viruses as vectors.
b. The in-depth knowledge of techniques used in genetic engineering.
c. The knowledge about the Ex vivo and in vivo gene therapy.

PRACTICAL IA:

Total Credit: 02
Total hours: 32

1. Salt fractionation of Yeast protein and quantification.
2. Isolation of plasmids from bacteria by agarose gel electrophoresis.
3. Preparation of competent *E. coli* cells for Bacterial transformation.
4. Induction of gene expression and purification of the induced protein from the host.
5. Amplification, Purification and separation of PCR product.
6. Determination of Proteinase activity on proteins.
7. Production of recombinant protein.

REFERENCES:

1. Brown, T.A. 2010. Gene Cloning and DNA Analysis-An Introduction (6th Ed.). Blackwell Science.
2. Brown, T.A., 2011. Introduction to Genetics: A Molecular Approach (1st Ed.). Garland Science.
3. Desmond, S. T., and Nicholl, 2002. An Introduction to Genetic Engineering. (1st Ed.) Cambridge University Press. Cambridge.
4. Glazer, A. N., and Nikaido, H. 2007. Microbial Biotechnology Fundamentals of Applied Microbiology (2nd Ed.). Cambridge University Press.
5. Gupta, P. K. 2008. Molecular Biology and Genetic Engineering. Deep and Deep Publications, India.
6. Gupta, V. K., Schmoll, M., Maki, M., Tuohy, M., Mazutti, M. A. 2013. Applications of Microbial Engineering. CRC Press.
7. Jane, K. S. 2004 .Genetic Engineering: Principles and Methods (1st Ed.). Springer.
8. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M. 2007 .Molecular Cell Biology (6th Ed.). WH Freeman and Company, New York.
9. Maheshwari, D.K., Dubey, R.C. and Kang, S.C. 2006. Biotechnological Applications of Microorganisms. I.K. International Publishing House, New Delhi.

10. Rehm, H. J., and Reed, G.2008. Biotechnology: Genetic Fundamentals and Genetic Engineering (2nd Ed.).Wiley India Pvt Ltd.
11. https://www.khanacademy.org
12. https://www.classcentral.com/

Weblink:

- https://www.slideshare.net/SECBIO/genetic-engineering-13933607
- https://www.cabarrus.k12.nc.us/cms/lib/NC01910456/Centricity/Domain/7718/Biotechnology%20PP_Genetic%20Engineering_RD.pptx

MOLECULAR DIAGNOSTICS(FCSC)

Total Credit: 03 Total Marks-Theory 70+30 (100 M) Total Hours: 48 hours

Learning Objectives: Students should study this paper to know

a. The course focuses on learning and understanding how the various molecular techniques that were studied can be developed and utilized in diagnosis.
b. The course explains common analytical techniques and molecular techniques related to the development and use of diagnostics.
c. Students learn about the clinical applications of molecular diagnostic in patients with infectious disease.

Module-1 **08 hours**

Introduction and History of diagnostics:

1. Introduction and History of diagnostics of diseases, mode of infection, types of infectious diseases, philosophy and general approach to clinical specimens. genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, inborn errors of metabolism.
2. Traditional disease diagnosis methods: Diagnosis of infectious diseases caused by bacteria, fungi, viruses, protozoa and Helminthes, Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results, Normal microbial flora of the human body, Host - Parasite relationships.

Module- 2 **14 hours**

Molecular techniques for diagnosis

1. Basics and Implication of Moleculartechniques in Genome resolution, detection and analysis of pathogen causing disease : PCR,Real-time; Multiplex; FISH; RFLP; DGGE; SSCP; Nucleic acid sequencing: new generations of automated sequencers; Microarray chips; EST; SAGE; microarray data normalization & analysis; molecular markers: 16S rRNA typing; MALDITOF-MS; Metabolite profile for biomarker detection the tissues in various disorders by making using LCMS & NMR technological platforms.
2. Biochemical tests & Immunoassays: Detection and quantification of biochemical parameters

Types: RIA,ELISA,Chemiluminescent IA, FIA and specific applications; Immunohistochemistry – principle and techniques. Different Levels of Biosafety, Containment.

Module-3 **12 hours**

Major Metabolic & Genetic disorders:

1. Traditional methods for the diagnosis of metabolic errors(Diabetes Type 1 & Type 2, hyperthyrodis&Hypothyrodism). Disease due to genetic disorders(Sickle cell anemia& Cystic fibrosis).Identifying human disease genes., Methods available for the diagnosis of genetic diseases and metabolic disorders.Blood (formation, composition, function and pathology of blood disorders (haemoglobinopathies,hemophilia), Muscle disorders (Duchene muscular dystrophy-DMD, Becker's muscular dystrophy-BMD, spinal muscular atrophy-SMA), Bone disorders
2. (Osteogenesis imperfecta, Rheumatoid arthritis), Skin disorder (Muir-Torre *syndrome*), Eye disorder (Retinitis pigmentosa).
3. Neonatal and Prenatal disease diagnostics. Gender identification using amelogenin gene locus. Amplification of Y chromosome specific Short Tandem Repeats (Y-STR). Analysis of mitochondrial DNA for maternal inheritance,Karyotyping& characteristics of Karyotyping.. Molecular diagnosis for early detection of cerebral palsy, Down syndrome etc.

Module-4 **14hours**

Cancer diagnosis:

1. Molecular Oncology Tests, Analysis of the Expression of Multiple Genes and Cancer Prognosis, Analysis of Lymph Nodes to Detect Metastasis of Breast Cancer, Screening for Colorectal Cancer: Stool-Based DNA Screening, Leukemias and Lymphomas, DNA Methylation Tests and Cancer, Predicting Risk of Developing Cancer.
2. Personalized Medicine: Pharmacogenomics and Companion Diagnostics, Cytochrome P450 and Drug Metabolism, Targeted Cancer Therapies and Companion Diagnostics Tests, Testing for HER2/neu Overexpression in Breast Cancer, Testing for Epidermal Growth Factor Receptor (EGFR), UGT1A1 Genetic Variants, Pharmacogenetics and Response to Antiretroviral Therapy, Thiopurine Methyltransferase and Metabolism of Thiopurine Drugs

Learning Outcomes: After studying this paper the students will know –

a. The student will get an idea about the concept of molecular diagnosis.

b. And underpinning the successful application of gene therapy or biologic response modifiers as well,

c. They can find their future focus in biotechnology companies developing and marketing Diagnostic kits.

REFERENCES:

1. Bruns, D. E., Ashwood, E. R., and Burtis, C. A. 2007. Fundamentals of Molecular Diagnostics. Saunders Group.
2. Buckingham, L., and Flaws, M. L. 2007. Molecular Diagnostics: Fundamentals, Methods & Clinical applications. F.A. Davis Company
3. Burtis, C. A., Ashwood,E. R., and Bruns, D. E.2007: Tietz Textbook of Clinical Chemistry and Molecular Diagnosis (5^{th} Ed.). Elsevier.
4. Coleman, W. B., and Tsongalis, G. J. 2006. Molecular diagnostics: for the clinical laboratorian. Springer Science & Business Media.
5. Greenwood, D., Slack, R.C.B., and Peutherer, J.F. 1997.Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control. (15^{th} Ed.).Churchill Livingstone, London.
6. Leonard, D. G., Bagg, A., Caliendo, A. M., Deerlin, V. M., and Kaul, K. L. (Eds.) 2007. Molecular pathology in clinical practice, pp. 411-424, Springer.
7. McPherson, R. A., and Pincu, M. R. 2007. Henry's Clinical Diagnosis and Management by Laboratory Methods, Elsevier Health Sciences.

Weblinks :

- https://www.slideshare.net/Dentist_abdurrahman/genetic-disorders-47095869
- https://www.ihrp.uic.edu/files/4%20Screening%20and%20Diagnosis.ppt

PRACTICALSIIB:

Total Credit: 02

Total hours: 32

1. Hormone assay for thyroid (TSH, T3, T4)
2. Isolation of Genomic DNA from Spleen or Liver ,Quality / Quantity checking of Nucleic acids by a) UV Spectrophotometer and Agarose Gel Electrophoresis

3. Isolation of Metagenome (sediment/soil).
4. Qualitative detection of HBsAg in human serum or plasma.using ELISA.
5. Nucleic acid labelling and Southern Hybridization.
6. RNA isolation &PAGE .
7. Culture independent analysis of microbes by DGGE (Denatured Gradient Gel Electrophoresis).
8. Molecular diagnosis of parasitic disease.
9. Identification of human bacterial pathogens by Polymerase chain reaction.
10. Demonstration of Karyotype analysis.

FOOD AND ENVIRONMENTAL BIOTECHNOLOGY(SC)

Total Credit: 03 Total Marks-Theory 70+30 (100 M) Total Hours: 48 hours

Learning Objectives: Students should study this paper to know

a. The knowledge about fermentation and fermented products and nutrition.
b. The functional foods and genetically modified foods.
c. The detailed account of Environment and bioremediation of pollutants.

Module-I **12 hours**

Introduction to Food biotechnology: Fermented foods, milk-based products, fermented vegetables, fermented meats, fish, beverages, vinegar, mould fermentation - tempeh, soy sauce, rice wine. Enzymatic processing of fruit juices; DNA-based methods for food authentication, comparative methods of toxicity testing in (novel) foods, application of generic technologies in food and nutritional sciences; anti-cancer components in foods.

Module-II **12 hours**

Functional foods and Biotechnology: Biochemical processing in the improvement of functional foods with targeted health benefits and increased nutrient value; Pre- and Pro-biotics, single cell protein, single cell lipids. Manipulation of fruit ripening process.Food processing, principles and practices, food ingredients and processing aids from biotechnological processes, corn sweeteners, bacterial starter cultures, cold-adapted enzymes.Food spoilage, preservation, mycotoxins in food commodities.Genetically modified foods, designer foods, detection of GM foods, Nutraceuticals, Concept of food parks.

Module-III **12 hours**

Introduction to Environment, Renewable and non-renewable resources, current status of biotechnology in environment protection. Waste water management: Bioreactors for waste-water treatment, treatment of industrial effluents-dairy, distillery, paper and sugar industries. Membrane-based waste water treatment.Biotechnology &Environment, Biodiversity and its conservation, Microbial ecology.

Module-IV **12 hours**

Bioremediation: Concepts and principles, bioremediation using microbes, in situ and ex situ bioremediation, biosorption and bioaccumulation of heavy metals. Phytoremediation Xenobiotics: Degradation capabilities of microorganisms with reference to toxicology, pesticides, herbicides, polyaromatic hydrocarbons

Learning Outcomes: After studying this paper the students will know –

a. The application of generic technologies in food and nutritionalsciences.
b. The concept of Food processing, principles and practices.
c. The knowledge of phytoremediation

REFERENCES:

1. Bagchi, D., Ghosh, D, K., Lau, F. C. 2010. Biotechnology in Functional Foods and Nutraceuticals (1st Ed.).CRC Press.
2. Das, S. 2014. Microbial Biodegradation and Bioremediation (1st Ed.). Elsevier.
3. Johnson-Green, P. 2018.Introduction to Food Biotechnology(1stEd.).CRC Press.
4. Prasad, M. N. V., and Hasanuzzaman, M. 2020. Handbook of Bioremediation Physiological, Molecular and Biotechnological Interventions,(1st Ed .) Elsevier.
5. Sati, V. P. 2012.An Introduction to Environment, Rawat.

Weblink:

- https://www.slideshare.net/HumairSindhi/applications-of-environmental-biotechnology-by-hameer-khan
- https://www.slideshare.net/IMANELADRAA/food-biotechnology-91606605

PRACTICALS IIB :

Total Credit: 02

Total hours: 32

1. Detection of coli forms for determination of the purity of potable water.
2. Methods of Water and Soil sampling and assessment of pH.
3. Determination of dissolved oxygen (DO) concentration of different water samples.
4. Determination of Biological oxygen demand (BOD) and Chemical oxygen demand (COD) of a sewage sample.
5. Isolation of Bacteriophages from sewage sample.
6. Determination of Total dissolved solids (TDS) of water sample.
7. Detection and Enumeration of Pathogenic and Indicator Organisms in Food.
8. Enumeration of Microbes from Fermented Foods.
9. Detection of Adulterants in Foods.

BIOPROCESS TECHNOLOGY(SC)

Total Credit: 03 **Total Marks-Theory 70+30 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. The design of fermenters and the types of fermenters.
b. The concepts of downstream processing.
c. The role of bioprocess in agro -industry.

Module I: **12 hours**

Basic principles: Isolation, screening and maintenance of industrially important microbes;effect of nutrients, temperature, pH for the growth of industrially important microorganisms; strainimprovement for increased yield.

Batch and continuous fermenters: types of fermenters, chemostat, turbidostat, upstream processing:media formulation and optimization; sterilization; aeration, agitation, pH.

Module II: **12 hours**

Downstream processing:

Separation of insoluble products – separation of cells and foam; filtration (plate filters, rotaryvacuum filter), centrifugation (continuous, basket and bowl centrifuge), Stokes law,sedimentation, flocculation; cell disruption (mechanical and non-mechanical methods);chromatographictechniques,drying (spray, drum, freeze driers); storage and packaging.

ModuleIII: **12 hours**

Microbial products: Microbial production and application of vitamins, enzymes, organic acids (acetic, citric, gluconic, itaconic, lactic,), amino acids(glutamic acid, lysine, tryptophan), polymers (polysaccharides – xanthan, curdlan, dextran,pullulan,), antibiotics, ethanol,biosurfactants.

Module IV: **12 hours**

Bioprocess in agro-industry: Isolation and screening of bioagents for the production ofbiofertilizers, biopesticides and plant growth promotion; masscultivation, formulation and storage life; Bioprocess in sustainable agriculture (organic matterrecycling, composting, Jeevamrutha).

Production of vaccines,Mab technology

Learning Outcomes: After studying this paper the students will know –

a. The student will get an idea about microbial production of industrial important products.
b. The production of biofertilizers and biopesticides.
c. The mass production of vaccines and Mab Technology.

REFERENCES:

1. Biotol, 2004. Product Recovery in Bioprocess Technology. Elsevier India.
2. Casida, L.E. 2016. Industrial Microbiology (2nd Ed). New Age International Publishers.
3. CruegerW., and Crueger A. 1989. Biotechnology – A Textbook of Industrial Microbiology (2nd Ed).Panima Publishing Corporation, New Delhi.
4. Doran, P.M. 2012. Bioprocess Engineering Principles. Elsevier Science & Technology Books.
5. Manjula, P., and Dawn, S.S. 2004. Bio & Enzyme Engineering. Scitech Publications (India) Pvt. Ltd., Chennai.
6. Narayan, C.M. 2011. Biotechnology and Bioprocess Engineering. Galgotia Publications Pvt. Ltd.
7. Ravindra, P. 2015. Advances in Bioprocess Technology. (1st Ed).Springer.
8. Reed, G. 2004. Prescott & Dunn's Industrial Microbiology.CBS Publishers & Distributors.
9. Stanbury, P.G., and Whitaker, A. 2008. Principles of Fermentation Technology. Elsevier.
10. Shuler, M.L., and Kargi, F. 2002. Bioprocess Engineering: Basic Concepts. Prentice HallInternational, Englewood Cliffs.
11. Waites, M.J., Morgan, N.L., Rockey, J.S., and Higton, G. 2001.Industrial Microbiology – An Introduction. Blackwell Science.

Weblink:

- https://www.slideshare.net/SMCTCR/biotechnologybioprocess-development-and-technology
- https://www.slideshare.net/yongkangbirdnest/lecture-2-introduction-to-bioprocess

PRACTICALS IIB :

Total Credit: 02

Total hours: 32

1. Immobilization of yeast by calcium alginate gel entrapment and assay for enzymes-invertase and catalase.

2. Screening of antibiotic producing microorganisms .
3. Study of alcohol fermentation- alcohol from different substrates-estimation of alcohol content.
4. Bioassay methods- Vitamins and amino acids.
5. Production and analysis of SCP.
6. Cell disruption for endoenzymes by sonication.
7. Microbial production of glutamic acid.
8. Downstream process –purification of any one protein / enzyme from fermented broth.
9. Study of fermenter (demonstration).

OPEN ELECTIVE

BIOTECHNOLOGY AND ITS APPLICATIONS

Total Credit: 04 **Total Marks-Theory 70+30 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. To gain advanced knowledge and understanding of the core principles of Biotechnology to equip the students for a career in research and industry.
b. To provide strong fundamentals of Biotechnology and its industrial applications.
c. To skill the students in developing independent analytical thinking in all areas of Biotechnology.

Module I : **12 hours**

Introduction to biotechnology. Principles of biotechnology, classification. Recombinant DNA Technology Introduction, outline of genetic engineering procedure, restriction endonucleases, cloning & expression vectors- plasmids, cloning in plasmid, transformation and detection of transformants- lacZ, genomic and cDNA libraries, gene analysis techniques-hybridization: Southern, Northern, Western, in situ, Polymerase chain reaction.

Module II : **12 hours**

Microbial and food and environmental Biotechnology Basics of fermentation technology: Types of microbial culture- batch, continuous and fedbatch. Microbial production: Use of microbes in production of vitamins, enzymes, organic acids, amino acids, polysaccharides, flavors, sweeteners, proteins and antibiotics. Fermented food products- yogurt, cheese, tempeh, sauerkraut; beverages- wine and beer. Pre- and Pro-biotics, single cell proteins, Genetically modified foods, designer foods. Current status of biotechnology in environment. Bioconservation, biofuels, gasohol, biogas. Bioremediation: Concepts and principles, bioremediation using microbes, in situ and ex situ bioremediation, biosorption and bioaccumulation of heavy metals.

Module III : **12 hours**

Plant Biotechnology Landmarks in Plant tissue culture. Types of cultures- embryo, organ, callus and cell cultures, Somatic embryogenesis, Haploid Production, Androgenesis, Protoplast culture and somatic hybridization. Micropropagation- Methods and stages, applications. Synthetic seeds, somaclonal variation. Production of secondary metabolites by plant cells, Biotransformation. Plant transformation techniques: Direct and indirect methods of gene transfer in plants. Transgenic

plants and crop improvement- herbicide tolerance, disease resistance, abiotic stress tolerance, delayed ripening, improvement of nutritional quality, molecular pharming.

Module IV : **12 hour**

Animal Biotechnology Basics of animal cell culture techniques, cell lines, physical conditions for culturing animal cells, equipments required, scale-up of culture methods. Application of animal cell culture- Hybridomas, production of therapeutic antibodies, stem cell technology, cell and tissue engineering. Genetic engineering of animals: Methods for gene transfer in animals, microinjection, nuclear transplantation, retrovirus-mediated gene transfer, gene knockdown techniques. Transgenic- animals- sheep, pigs, cattle, chickens; applications of transgenic animals.

Learning Outcomes: After studying this paper the students will know –

a. The students will be exposed to basic and applied aspects of the subject through theory and practical sessions.
b. The students will be able to apply their knowledge for advancing the area of Biotechnology through academic and industrial research.

REFERENCES:

1. Chawla, H. S. 2000. Introduction to Plant Biotechnology(1st Ed.). Enfield, NH: Science Publishers.
2. Freshney, R. I. 2015.Culture of Animal Cells, A Manual of Basic Technique and Specialized Applications (7th Ed.). Wiley-Blackwell.
3. Nair, A. J. 2001. Principles of Biochemistry and Genetic Engineering.Laxmi Publications.
4. Razdan, M. K. 2003.Introduction to Plant Tissue Culture(2nd Ed.). Enfield, NH: Science Publishers.
5. Singh, R. 2003.Introduction to Biotechnology: Principles of biotechnology (2nd Ed.). Global Vision Publishing House.
6. Slater, A., Scott, N. W., and Fowler, M. R. 2008.Plant Biotechnology: an Introduction to Genetic Engineering. Oxford, Oxford University Press.
7. Thangadurai, D., Tanasupawat, S., Kanekar, P. P . 2019 Biotechnology of Microorganisms, Diversity, Improvement, and Application of Microbes for Food Processing, Healthcare, Environmental Safety, and Agriculture (1st Ed.).Apple Academic Press.

Weblink:

- https://www.slideshare.net/sardar1109/biotechnology-and-its-application-37416651
- https://slideplayer.com/slide/4372321/
- https://bichep.com/biotechnology-and-its-applications-ppt-revision/

III Semester

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Plant Biotechnology	HC	3	1	0	4
2		Animal Biotechnology	HC	3	1	0	4
3		Immunology	FCHC	3	1	0	4
4		**Practical-III:** Plant Biotechnology. Animal Biotechnology &Immunotechnology	HC	0	0	4	4
Soft Core (Any TWO)							
1		Natural products & Drug discovery	SC	3	0	0	3
2		Biostatistics & Bioinformatics	SC	3	0	0	3
3		Genomics& Proteomics	SC	3	0	0	3
TOTAL CREDITS 4 Hard Core (3 theory + 1 practical's) :16 credits ,2Softcore: 06 credits							**22 CREDITS**

PLANT BIOTECHNOLOGY(HC)

Total Credit: 04 **Total Marks-Theory 70+30 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. The goal of this course is to introduce biotechnology methods in plants.
b. Handling of classical and modern plant biotechnology processes.
c. And understanding breeding of healthy plants for improved characteristics and plants for biomolecule production.

Module I: Techniques in plant tissue culture **12 hours**

Methods in Plant Tissue culture: Concept of cellular Totipotency, Role of phytohormones in tissue culture techniques. Establishment of cultures- Nutritional requirements forin vitro cultures, Media preparation and sterilization. **Micropropagation:** Propagation from shoot apical meristem, node cultures, stages ofmicropropagation and applications. **Germplasm preservation**: Plant germplasm storage using different methods. **Haploid Production**: Methods of androgenic haploid cultures. **Protoplast Culture and SomaticHybridization**: Protoplast isolation, purification and culture, protoplast fusion, somatichybridization, applications of somatic hybrids.

Module II:Genetic manipulation of plants **12 hours**

Plant transformation techniques: Agrobacterium-plant interaction, Tiplasmids,T-DNA transfer, disarmed Ti plasmid. Agrobacterium-mediated genedelivery- binary and co-integrated vectors. **Direct gene transfer methods**- Particle bombardment, PEG-mediated, electroporation.**Transgenic plants:** Herbicide resistance, pest resistance, plant disease resistance, improvement of nutritional quality. Biosafety regulations of transgenics.

Module III: Applications of Plant Tissue culture **12 hours**

Secondary metabolite production: Major secondary metabolic pathways-Phenylpropanoidpathways, Shikimate pathway; Induction of bioactive secondary metabolites by plant tissueculture; Value addition via biotransformation; hairy root culturesfor production ofpharmaceuticals. Bioreactor systemsfor mass cultivation of plant cells, Molecular pharming: edible vaccines

Module IV : Commercial product development **12 hours**

Micro algal biotechnology: Cyanobacteria, culture media, cultivation methods, Medicinalcompound from cyanobacteria.**Single-Cell Proteins (SCP):** Spirulina, Chlorella, Yeast as SCP; Production and process;Health benefits of SCP.**Agricultural products:** biofertilizers and Vermiculture.**Biofuels:** production of Ethanol, Methane, and their applications.**Intellectual Property Rights (IPR):** IPRs and agricultural technology- implications for India. Plant Breeder's Rights.Labeling of GM crops and foods.Biodiversity, traditional knowledge, access and benefitsharing.

Learning Outcomes: After studying this paper the students will know –

a. Understanding of biotechnological processes.
b. Understanding the genetic manipulation in plants.
c. The application in pharmaceutical and food industry, in agriculture and in ecology.

REFERENCES:

1. Abdin, M.Z., Kiran, U., Kamaluddin and Ali, A. 2017. Plant Biotechnology: Principles and Applications. Springer.
2. Buchanan , B. B., Gruissem, W and Jones, R. L. 2015. Biochemistry & Molecular Biology of Plants. John Wiley& Sons.
3. Chawla, H. S. 2000. Introduction to Plant Biotechnology (3rded.). CRC Press.https://www.perlego.com/book/1573809/introduction-to-plant-biotechnology-3e-pdf.
4. Glick, B. R., Pasternak, J. J. and Patten, C.L. 2010. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
5. Kumar, K. D. 2017. Plant Tissue Culture. New Central Book Agancy (P) Ltd.
6. Kumar, S.,Mishra, S., andMishra,A.P.2016.PlantTissueCulture:TheoryandTechniques.ScientificPublishers.
7. Razdan, M. K. 2003.Introduction to Plant Tissue Culture (2nded.). Science Publishers.
8. Sangita, S., Prasad, B.D., and Kumar, P. 2017. Plant Biotechnology : Transgenics, Stress Management, and Biosafety Issues (2nd Vol.). Apple Academic Press.
9. Slater, A., Scott, N., and Flower, M. 2008. Plant Biotechnology: the genetic manipulation of plants (2nded.). OxfordUniversity Press.
10. Umesha, S. 2013. Plant Biotechnology. TERI Press.

Weblink:

- https://www.slideshare.net/Wabworld/plant-biotechnology-129050729

- https://www.austincc.edu/awheeler/Files/BIOL%201414%20Fall%202010/chapter%206.ppt

ANIMAL BIOTECHNOLOGY (HC)

Total Credit: 04 **Total Marks-Theory 70+30 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. Culturing of animal cells and steps in production of transgenic animals
b. Techniques in animal cell culture
c. Cloning of animals
d. Approaches for tissue engineering

Module I: **12 hours**

Culture of animal cells: Advantages and limitations of tissue culture, aseptic handling, facilities required, media and cell lines, Different types of media ,preparation& Storage etc., Primary culture: Isolation of mouse and chickembryos, human biopsies, methods for primary culture, nomenclature of cell lines, sub culture and propagation, immortalization of cell lines, cell line designation, selection of cell line and routine maintenance. Secondary cell culture,

Cloning and Selection: Cloning protocol, stimulation of plating efficiency, suspension cloning, isolation of clones, isolation of genetic variants, interaction with substrate, selective inhibitors.

Module II: **12 hours**

Cell separation and characterization: Density based, antibody based, magnetic and fluorescence based cell sorting. Characterization of cells based in morphology, chromosome analysis, DNA content, RNA and protein, enzyme activity, antigenic markers, cytotoxicity assays, cell quantitation, cell culture contamination: monitoring and eradication, cryopreservation.

Culturing of specialized cells: Epithelial, mesenchymal, neuro ectodermal, hematopoietic gonad and tumor cells, Lympocyte preparation, culture of amniocytes, fish cells, confocal microscopy. Stem cell culture and its applications

Organic and embryo culture: Choice of models, organ culture, histotypic culture, filter-well inserts, neuronal aggregates whole embryo culture eggs, chick and mammalian embryos.

Module III: **12 hours**

Cell and Tissue engineering: Growth factors for *in situ* tissue regeneration, biomaterials intissue engineering, approaches for tissue engineering of skin, bone grafts, nerve grafts. Haemoglobin-based blood substitutes, bio artificial or biohybrid organs. Limitations and possibilities of tissue engineering, 3D bioprinting. ***In vitro*** **fertilization and Embryo transfer:** *In vitro* fertilization in Humans, Embryo transfer in Humans, Super ovulation and embryo transfer in farm animals e.g.:

Cow.

Cloning of Animals: Methods and uses. Introduction, nuclear transfer for cloning, cloning from-embryonic cells, adult and fetal cells. Cloning from short-term cultured cells: cloning of sheep, monkeys, mice, pets, goats and pigs. Cloning from long-term cultured cells: Cloning of cows from aged animals. Cloning efficiency, cloning for production of transgenic animals, gene targeting for cloned transgenic animals, cloning for conservation, human cloning: ethical issues and risks.

Module IV: **12 hours**

Transfection methods and transgenic animals: Gene transfer, transfection of fertilized eggs or embryos, unfertilized eggs, cultured mammalian cells, targeted gene transfer.Transgenic animals and applications: mice and other animals, sheep, pigs, goats, cows and fish. The legal and socio-economic impact of biotechnology at national and international levels, public awareness.Biosafety regulations- guidelines for research in transgenic animals, public awareness of the processes of producing transgenic organisms.

Learning Outcomes: After studying this paper the students will know –

a. Knowledge about cell and tissue engineering
b. In vitro fertilization and embryo transfer
c. The legal and socio-economic impact of biotechnology at national and international levels

REFERENCES:

1. Ashish, S.V. andAnchal,S. 2013. Animal Biotechnology: Models in Discovery and Translation.Academic Press.
2. Freshney, R.I. 2015. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. John Wiley& Sons.
3. Gordon, I. 2004. Reproductive Techniques in Farm Animals. Oxford: CAB International.
4. Gorakh, M., Manishi, M., Birbal, S. andSanjeev, K. G.2019. Advances in Animal Biotechnology. Springer.
5. Myrone, M. L.,Gordon, D., Michael, F. G., Margaret A. L.,Gary J. N.,James P. N.AndRino, R.New Generation Vaccines (4th Ed.). CRC Press.
6. Niemann, H., and Wrenzycki,C. 2018. Animal Biotechnology 1:Reproductive Biotechnologies. Springer.
7. Niemann,H., and Wrenzycki,C. 2018. Animal Biotechnology 2: Emerging Breeding Technologies. Springer.
8. Portner, R. 2007. Animal Cell Biotechnology: Methods and Protocols. Humana Press.

9. Richard, T. 2004. Gene Transfer to Animal Cells. Taylor & Francis.
10. Srivastava,A.K., Singh, R. K., and Yadav, M.P. 2018. Animal Biotechnology. Oxford and IBH Publishing Press.

Weblink:

- https://www.slideshare.net/Pure-man/introduction-to-animal-biotechnology
- https://www.slideshare.net/Pure-man/introduction-to-animal-biotechnology
- https://slideplayer.com/slide/3514424/

IMMUNOLOGY (FCHC)

Total Credits: 04…..Total Marks: Theory 80+20 (100M)…..... Total Hours:48 hours

Learning Objectives: Students should study this paper to know –

1. Role of immune system in maintaining health
2. Cellular and molecular basis of immune responses
3. How immune responses are triggered and regulated

Module-I **14 Hours**

a) **Over view and Types of immunity:**
Innate immunity: anatomic barriers, physiologic barriers, phagocytic barriers, microbial antagonism, acute phase reactants, anti-microbial peptides, interferons, inflammation, Pattern Recognition Receptors (PRRs), Pathogen Associated Molecular Patterns (PAMPs) and Damage Associated Molecular Patterns (PAMPs). Complement system: components, pathways of activation and biological consequences.

Acquired immunity: Active **(**Naturally acquired and artificially acquired), Passive (Naturally acquired and artificially acquired), Adoptive immunity, Humoral and Cell mediated immune response

b) **Tissues of immune system:** Structural organization and functions of Lymphatic system, Primary lymphoid organs (Bone marrow, Thymus) Secondary lymphoid organs and tissues (Spleen, Lymph node, Tonsils, Adenoids, Peyer's patches, Lamina propria, Mucosa-associated lymphoid tissue, Gut-associated lymphoid tissue).
c) **Cells of the immune system:**Hematopoiesis, Biology, Development and Functions of PMNLs, NK cells, Macrophages, T-Lymphocytes, B-Lymphocytes, Dendritic cells

Module-II **12 Hours**

a) **Antigens, and Antibodies:** Antigens, Immunogens and Haptens, Factors influencing immunogenicity, adjuvants, epitopes, Structure and functions of immunoglobulins, Synthesis of immunoglobulins, Genetic basis of immunoglobulin diversity.
b) **MHC molecules:** Types, structure, diversity and functions
c) **Antigen recognition:** Thymus dependent and independent Antigens, Clonal selection and immunological memory of B and T cells, Antigen processing and presentation (Endogenous pathway, Exogenous pathway, Cross presentation), Superantigens.
d) **Monoclonal Antibodies:**Hybridoma technology and production of mAbs, types, and applications.Advantages and disadvantages of mAbs in therapy.

Module-III **12 Hours**

a) **Immune System in Health and Disease:** Immunological Tolerance and Autoimmunity, Autoimmune Diseases (Organ specific autoimmune diseases-Graves' disease, Myasthenia Gravis, Systemic autoimmune diseases-Multiple Sclerosis, Rheumatoid Arthritis, Systemic Lupus Erythematosus), Immunosuppression, Hypersensitivity(Type I, II, III & IV).

b) Vaccines and Vaccination: Principles of vaccination, Immune response to vaccines (Primary and Secondary response), Whole-Organism vaccines, Purified macromolecules as vaccines, Recombinant vaccines, DNA vaccines, Multivalent subunit vaccines and Edible vaccines, Vaccine safety, Reverse vaccinology. Overview of COVID-19 vaccines.

c) Primary & Secondary Immuno-Deficiency Disorders:

Primary: Wiscott-Aldrich syndrome, Severe combined immunodeficiency disease (SCID), DiGeorge syndrome, Ataxia-telangectasia, Leucocyte adhesion defects, Chronic granulomatous disease, X-linked agammaglobulinemia, Complement deficiencies. Gammopathies (Multiple myeloma).

Secondary: AIDS, Malnutrition, Drug regimen, Diabetes, Chronic infection.

Module-IV **10 Hours**

a) **Clinical Immunology**: **Transplantation of tissues and organs:** Nomenclature of transplantations, Transplantation reactions, HvG and GvH. Exception from rejections, Major and minor blood groups, Blood transfusion, tissue typing, Kidney and bone marrow transplantations. Immunosuppressive drugs. **Tumor immunology**: Neoplasms, tumor-associated antigens, immune response to tumor antigens, immunologic factors favoringtumor growth, immune surveillance,Tumor necrosis factor α and β.Metastatic processes, Immunodiagnosis, Antitumour drugs, Immunotherapy.

b) **Immunological Techniques:**.*In vitro* antigen-antibody reactions, serotyping, agglutination, complement fixation, immunoprecipitation, Immunodiffusion, ELISA, RIA, IHC, Immunoelectrophoresis.

Learning Outcomes: After studying this paper the students will know –

a. Organs, tissues, cells and molecules of the immune system
b. The immunological methods used to detect the disease
c. How the knowledge of immunology can be transferred into clinical decision-making through case studies presented in class.

REFERENCES:

1. Abbas A.K., Lichtman A.H. and Pillai S. (2014). Cellular and Molecular Immunology (10th Edition). Online Access: Elsevier Health Sciences.
2. Abbas, AK., Andrew,H., Lichtman, H., Pillai, S. 2012.Basic Immunology: Functions and Disorders of the Immune System, ; Saunders
3. Abul, K.A., Andrew, H. L. and Shiv, P. 2019. Basic Immunology: Functions and Disorders of the Immune System. Elsevier India.
4. Ajoy, P. 2015. Textbook of Immunology: including Immunotechnology& Immunotherapy. Books & Allied Press.
5. Ashim, K. C. 2006. Immunology and Immunotechnology (1sted.). Oxford University Press.
6. Berg J.M., Tymoczko J.L. and Stryer L. (2002). Biochemistry (5th Edition). International edition: WH Freeman & Company Limited
7. Brostoff, J., Seaddin, J. K., Male, D. and Roitt, I. M. 2002. Clinical Immunology. London: Gower Medical Pub.
8. Chapel,H., Haeney,M., Misbah,S., Snowden, N. 2014. Essentials of Clinical Immunology; Wiley-Blackwell
9. Coico, R. and Sunshine, G. 2015. Immunology – A Short Course (7thed.). Wiley.
10. Delves P.J., Martin S.J., Burton D.R. and Roitt I.M. (2011) Roitt's essential immunology: John Wiley & Sons.
11. Hawley,L., Clarke, B., Ziegler, RJ. 2013. Microbiology and Immunology; LWW

12. MadhaveeLatha, P. 2012. A Textbook of Immunology. S. Chand Press.
13. Murphy, K., Travers, P., Walport, M. and Janeway, C. 2012. Janeway'sImmunobiology. Taylor & Francis.
14. Nelson D.L., Lehninger A.L. and Cox M.M. (2008). Principles of Biochemistry (12th Edition). Macmillan.
15. Owen J.A., Punt J., Stranford S.A. and Jones P.P. (2013) Kuby immunology: WH Freeman New York.
16. Parham, P. 2005. The Immune System. New York: Garland Science.
17. Paul, W. E. 2012. Fundamental Immunology. Raven Press.
18. Peter,DJ., Seamus, MJ., Dennis, BR. 2011. Roitt's Essential Immunology; Wiley & Sons, Incorporated, John
19. Pinchuk, G. 2001. Schaum's Outline of Immunology; McGraw-Hill
20. Ramesh, S. R. 2016. Immunology. Mc Graw Hill Education India Pvt. Ltd.
21. Richard C. and Geoffrey S. (2003). Immunology: A short course (6th Edition). Willey Blackwell.
22. Voet D. and Voet J.G. (2010). Text book of Biochemistry (4thEdition). New York: J. Wiley & Sons.

Videos on Immunology: www.imm.ox.ac.uk - from University of Oxford

PRACTICAL III:

Total hours: 32

Total credits: 04

1. Preparation of plant tissue culture media ,Callus induction
2. Establishment of cell suspension cultures for plant secondary metabolite production
3. Encapsulation of somatic embryos and production of synthetic seeds
4. Organ cultures: Shoot tip, nodal, anther and leaf cultures
5. Secondary metabolite estimations: Colorimetry and TLC methods
6. Preparation of media, culture and maintenance of cell lines, trypsinization
7. MTT assay for cytotoxicity
8. Purification of IgG.
9. Slide agglutination test/ Blood grouping.
10. Immunoprecipitation test- Ouchterlony double diffusion.
11. Purification of IgY.
12. Immunofluorescence for localization of an antigen.
13. ELISA for quantification of an antigen.
14. Western blotting and detection.
15. Complement fixation
16. Clinical laboratory visits

NATURAL PRODUCTS AND DRUG DISCOVERY (SC)

Total Credit: 03 **Total Marks-Theory 70+30 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. The prospects of Natural products in 21st Century.
b. The use of different natural sources for discovery of drug.
c. To perform molecular modelling.

Module I: **12 hours**

Prospects of Natural Products research in the 21st Century: Introduction, use of natural products in traditional medicines, Marine natural products, Use of herbal remedies and the potential of drug development from natural products and novel drug templates: paclitaxel, podophyllotoxin, artimisinin etc. Recent development in the research on naturally occurring polyphenolic compounds: - Introduction, biosynthetic pathway, isolation and characterization, biological and pharmacological activities of different class of phytoconstituents - alkaloids, flavonoids, terpenoids, glycosides, steroids, saponins, (Antioxidant activity, cyto-toxic activity, anticancer and anti-microbial activity etc). aid design of clinical studies.

Module II: **12 hours**

Natural product drug discovery from different sources (marine, microbial, mineral etc): Introduction, recent developments, applications. Extraction and Isolation techniques: Introduction, Principle and Applications of different extraction & isolation methods vizSoxhlet extraction, microwave extraction, supercritical fluid extraction, solid phase extraction,Column chromatography, Flash chromatography.

Module III: **12 hours**

Target identification and molecular modelling: Identification of target or drug leads associated with a particular disease by different techniques including combinations of molecular modeling, combinatorial libraries and high-throughput screening (HTS); Use of bioinformatics and data processing in identification of lead compounds; Rational drug design, Modelling drug/receptor interactions with the emphasis on molecular mechanisms, molecular dynamics simulations and homology modelling; Conformational sampling, macromolecular folding, structural bioinformatics, receptor-based and ligand-based design and docking methods, in silico screening of libraries, semi-empirical and ab-initio methods, QSAR methods, molecular diversity, design of

combinatorial libraries of drug-like molecules, macromolecular and chemical databases.

ModuleIV: **12 hours**

Lead optimization: Identification of relevant groups on a molecule that interact with a receptor and are responsible for biological activity; Understanding structure activity relationship; Structure modification to increase potency and therapeutic index; Concept of quantitative drug design using Quantitative structure–activity relationship models (QSAR models); Bioanalytical assay development in support of in vitro and in vivo studies (LC/MS/MS, GC/MS and ELISA). Preclinical development: Principles of drug absorption, drug metabolism and distribution - intestinal absorption, metabolic stability, drug-drug

interactions, plasma protein binding assays, metabolite profile studies, Principles of toxicology, Experimental design for preclinical and clinical PK/PD/TK studies, Selection of animal model; Regulatory guidelines for preclinical PK/PD/TK studies; Scope of GLP, SOP for conduct of clinical & non clinical testing, control on animal house, report preparation and documentation. Integration of nonclinical and preclinical data tool.

Learning Outcomes: After studying this paper the students will know –

a. Identification of target or drug leads associated with a particular disease by different techniques
b. Concept of quantitative drug design using Quantitative structure
c. Regulatory guidelines for preclinical studies

REFERENCES:

1. Brahmachari, G. 2011. Bioactive Natural Products: Opportunities and Challenges in Medicinal Chemistry. World Scientific Publishing Company.
2. Charis, G. 2019. Nutraceuticals And Natural Product Pharmaceuticals. Academic Press.
3. Kratika, D., Swapnil, G., Naveen, C,.andVivek, D. 2015. Drug Discovery and Development in Medicinal Chemistry. NiraliPrakashan.
4. Kshirsagar, T. 2008. High-Throughput Lead Optimization in Drug Discovery. CRC Press.
5. Moll, J., and Carotta, S. 2019. Target Identification and Validation in Drug Discovery: Methods and Protocols. Springer.
6. Olga, G. and Francisca, V. 2012. Drug Discovery From Natural Products. Royal Society Of Chemistry.

7. Roessner, U.,and Dias, D. A. 2013. Metabolomics Tools For Natural Product Discovery: Methods and protocols. Humana Press.
8. Subhash, C. M., Vivekananda, M., and Tetsuya, K. 2018. Natural Products and Drug Discovery: An Integrated Approach. Elsevier.
9. Vincent, P. G. 1994.The Discovery of Natural Products withTherapeautic Potential. Elsevier.
10. Wade, R.C. and Salo-Ahen, O.M.H. 2019. Molecular Modeling in Drug Design.MDPI Press.

Weblink:

- https://www.slideshare.net/rahulbs89/role-of-natural-product-in-drug-discovery
- http://ccc.chem.pitt.edu/wipf/courses/5119_05_files/lecture_files/lecture.ppt

BIOSTATISTICS AND BIOINFORMATICS (SC)

Total Credit: 03 **Total Marks-Theory 70+30 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. Knowledge of basic statistical methods to solve problems.
b. Students are taught to operate various statistical software packages.
c. The in-depth knowledge about the bioinformatics.

Module I: **12 hours**

Biostatistics

Statistical concepts: Data structure, sampling methods, descriptive statistics - data collection, tabulation Measures of central tendency: mean, median, mode Measures of dispersion: Range, interquartile range, mean deviation, standard deviation, standard error, coefficient of variation, confidencelimits.

ModuleII : **12 hours**

Types of distribution of data: Normal, Binomial, Poisson

Hypothesis testing: Z-test, t-test, ANOVA, multiple comparisons – LSD and DMRT, chi- square test; Regression and correlation; Non-parametric significance tests; Experimental designs- CRBD, RCBD, LSD, factorial; data transformation- arcsine, log, square-root. Probability

Module III: **12 hours**

Bioinformatics- an overview, Definition and History, Applications of Bioinformatics. Introduction to Genomics: Genome mapping, Genome sequencing, human Genome project. Introduction to Proteomics: Tools and techniques in proteomics.Sequence formats. Homology and similarity. Introduction to Data mining, NCBI, EBI, DDBJ, Database search software:ENTREZ, SRS, Expasy.Protein Sequence Databases, UNIPROT, Structure Database: PDB.

Sequence Analysis: definition of sequence analysis, Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pair wise Alignment, and significance of alignment, Tools of sequence alignment, Homology sequence search, Nucleotide Sequence Analysis, Protein Sequence Analysis, Parameters of Blast, BlastN, BlastP, Interpreting Blast Results.

Module IV: **12 hours**

Multiple sequence analysis, scoring pattern, exhaustive and heuristic algorithms; Parameters of CLUSTAL-W and CLUSTALX for multiple sequence alignment, interpretation;

Phylogenetic analysis: methods and tools.RASMOL Display Styles- Wire Frame, Ball and Stick, Space Fill, Ribbons, Cartoons

Drug discovery: Introduction, drug discovery technologies, virtual high-throughput *in silico* screening, Target validation EMBOSS Introduction to emboss Software package and its key features, other latest commercial softwares.

Learning Outcomes: After studying this paper the students will know –

- The importance of statistics in research and prepares them for a career in research
- The student will be able to apply statistics to basic principles of biology.
- Understanding about the sequence analysis tools and also about the drug discovery.

REFERENCES:

1. Amdekar, S.J. 2014.Statistical Methods for Agricultural and Biological Sciences. Narosa Publishing House.
2. Baxevamis, A.D. and Ouellette, F.B.E. 2004. Bioinformatic: A practical guide to the analysis of genes and proteins. John Wiley& Sons.
3. Chen, D.G.,and Zhao, Y. 2018. New Frontiers of Biostatistics and Bioinformatics. Springer.
4. Emden, H.V. 2008. Statistics for Terrified Biologists. Blackwell Publishing Press.
5. Higgins, D. and Taylor, W. 2000. Bioinformatics – Sequence, Structure and Data Banks. Oxford University Press.
6. Hodgman, C., French, A. and Westhead, D. 2010. BIOS Instant Notes: Bioinformatics. Taylon& Francis.
7. MacKenzie, G., and Defen Peng, D. 2014. Statistical Modelling in Biostatistics and Bioinformatics: Selected Papers. Springer.
8. McCleery, R.H., Watt, T.A., and Hart, T. 2007. Introduction to Statistics for Biology (3rd Ed.). CRC Press.
9. Rastogi, S.S., Mendivata, N., and Rastogi, P. 2013. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. PHI Press.
10. Srinivas, V.R. 2005. Bioinformatics: A modern approach. Prentice Hall India Learning Pvt. Ltd.

Weblink:

- https://www.slideshare.net/hafidztio/biostatistics-and-statistical-bioinformatics

- https://www.slideserve.com/minna/statistics-in-bioinformatics-powerpoint-ppt-presentation
- https://www.powershow.com/viewfl/58edf7-MzAxN/Biostatistics_and_Statistical_Bioinformatics_powerpoint_ppt_presentation

GENOMICS&PROTEOMICS (SC)

Total Credit: 03 **Total Marks-Theory 70+30 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. The concepts of genome, genome sequencing and genome mapping
b. The role of molecular markers in comparative genomics
c. The knowledge about structural and functional proteomics

Module I: **12 hours**

Genome: Brief overview of prokaryotic and eukaryotic genome organization; extrachromosomal DNA: bacterial plasmids, mitochondria and chloroplast

Genome mapping: Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, *in situ* hybridization, comparative gene mapping.

Genome sequencing: Next generation sequencing, Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.

Module II: **12 hours**

Comparative genomics: Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.

Functional genomics: Transcriptome analysis for identification and functional annotation of gene, Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function- forward and reverse genetics, gene ethics,Pharmacogenomics& Personalized medicine.

Module III: **12 hours**

Introduction to proteomics: Proteome and nature of proteome, Proteins - amino acids, peptides and polypeptides, separation of proteins /peptides by single and two-dimensional gel electrophoresis and detection- staining and immunoblot

ModuleIV: **12 hours**

Structural and functional proteomics: Mass spectrometry – fundamentals, mass spectrometry ionization techniques, mass analyzers – MALDI-TOF, MS-MS, LC-MS-MS; In-gel digestion, PMF, Mass spectra analysis – search engines: Mascot, swiss-prot, protein prospector, identification, molecular weight, determination of peptide sequence, determination of post-translational modifications, peptide sequencing using tandem mass spectrometry, quantitative proteomics-iTRAQ, functional annotation of proteins, protein chips and functional proteomics; clinical and biomedical applications of proteomics.

Learning Outcomes: After studying this paper the students will know –

- Genetic and physical maps, markers for genetic mapping.
- Next generation sequencing, Human Genome Project.
- Understanding about the mass spectra analysis.

REFERENCES:

1. Attwood, T.K., Smith, P., andPhukan, S. 2008. Introduction to Bioinformatics. Dorling Kindersley (India) Pvt. Ltd.
2. Baxevamis, A.D., and Ouellette, F.B.E. 2004. Bioinformatic: A practical guide to the analysis of genes and proteins. John Wiley& Sons.
3. Brown, T. A. 2006. Genomes (3rd Ed.). Garland Science Publication.
4. Higgins, D., and Taylor, W. 2000. Bioinformatics: Sequence, Structure and Data Banks. Oxford University Press.
5. Primrose, S. B., and Twyman, R.M. 2006.Principles of Gene Manipulation and Genomics. Blackwell Publication.
6. Singh, R. 2015. Bioinformatics: Genomics and Proteomics. Vikas Publishing House.
7. Thangadurai, D., and Sangeetha, J. 2015.Genomics and Proteomics: Principles, Technologies, and Applications. CRC Press.
8. Varga, G.M. 2014. Genomics and Proteomics for Clinical Discovery and Development. Springer.
9. Wajapeyee, N. 2014. Cancer Genomics and Proteomics: Methods and Protocols (2nd Ed.). Humana Press.
10. Winnacker, E. L. 2003. From Genes to Clones. VCH Press.

Weblink:

- https://www.slideshare.net/lasaga_garry/genes-genomics-and-proteomics
- https://slideplayer.com/slide/4786114/

IV Semester

Sl No	Code	Title of the Paper	Course Type	Credit Pattern L	T	P	Total Credits
1		Project Work	HC	0	0	10	10
Soft Core (Any One)							
1		Molecular plant pathology	SC	3	0	0	3
2		Stem cell & regenerative medicine	SC	3	0	0	3
3		Research Methodology	SC	3	0	0	3
TOTAL CREDITS **1 Hard Core :10 credits ,1 Softcore: 03 credits**							**13** **CREDITS**

MOLECULAR PLANT PATHOLOGY (SC)

Total Credit: 03 **Total Marks-Theory 80+20 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. The concepts of plant pathology
b. The host pathogen interaction.
c. The genetics of plant diseases and resistance.

Module I: **12 hours**

The fundamentals of plant pathology: The concept of plant disease, the causal agents, thesignificance of plant diseases, the control of plant diseases.Fungal diseases: establishing infection – dispersal spores, finding a suitablehost, spore attachment, germination process, penetration, germ-tube elongation, inductionappressoria, cell-wall degrading enzymes. Development of disease – Basic concepts ofnecrotrophy and biotrophy, host barriers, the role of toxins and enzymes, biotrophy.

Module II: **12 hours**

Bacterial and viral diseases: communication between bacteria, plant penetration,attachment, stimulation gene expression, cell wall degrading enzymes, toxins, hormones,extracellular polysaccharides, determinants of host specificity. Plant viruses: Structure andreplication, infection, types of viruses, viroids.

Module III: **12 hours**

Genetics of plant diseases and resistance: Genes and diseases, Mechanism of variability,stages of variation in pathogens, Types of plant disease resistance to pathogens. Defencemechanism of plants, Pre-existing, structural, chemical and induced biochemical defences.Resistance genes: Gene-for-gene resistance, features of cloned resistance genes. MAPkinases, ion fluxes and calcium homeostasis, The oxidative burst, Nitric oxide, (p)ppGppsignaling,

Module IV: **12 hours**

Application of molecular biology to conventional disease control strategies: Breeding forresistance, the use of tissue culture in plant breeding, marker-assisted breeding, identificationof novel resistance gene specificities, the use of chemicals for disease control, biologicalcontrol-PGPR and PGPF. Transgenic approaches for crop protection- Bt cotton and brinjal.

Learning Outcomes: After studying this paper the students will know –

a. The development of plant diseases and control of plant diseases.
b. The defense mechanism in plants and types of disease resistance.
c. Application of molecular biology to conventional disease control strategies

REFERENCES:

1. Haq, I. U., and Ijaz, S., 2020. Plant Disease Management Strategies for Sustainable Agriculture Through Traditional and Modern Approaches. Springer Nature Switzerland.
2. Dickinson, M. 2004. Molecular Plant Pathology. Garland Science.
3. Singh, U. S., and Singh, R. P. 2017. Molecular Methods in Plant Pathology. CRC Press.
4. Wani, S. H. 2019. Disease Resistance in Crop PlantsMolecular, Genetic and Genomic Perspectives. Springer.

Weblink:

- https://www.slideshare.net/jeevaraj9/moleecular-mechanism-of-disease-diagnosis
- https://slideplayer.com/slide/10526875/

STEM CELL & REGENERATIVE MEDICINE(SC)

Total Credit: 03 **Total Marks-Theory 70+30 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. The introduction to stem cells and the role of stem cells in organ development.
b. The concepts of tissue engineering and perspectives.
c. The cancer stem cell theory and regenerative medicines

Module I: **12 hours**

Introduction to Stem Cells Overview of basic and translational research of stem cells. Differentiation in early development, Preimplantation development; From implantation to gastrulation. Pluripotent stem cells I: Rodent embryonic stem cells – Origin, properties, self-renewal pathways, application. Human embryonic stem cells- Derivation and maintenance, self-renewal pathways. Induced pluripotent stem cells- Generation, Characterization, Induced pluripotency-the underlying mechanism. Primordial and embryonic germ cells- Origin, Properties, Derivation and maintenance. Stem cells: Molecular and cellular basis of organ development

Module II: **12 hours**

Tissue engineering principles and perspectives; Limitations and hurdles of using embryonic stem cells in tissue engineering; Amniotic fluid and amniocentesis; Isolation and characterization of amniotic fluid-derived stem cells.New technologies for genetic modification in stem cells, CRISPR/Cas9, TALENs/ZFN. Neurogenesis and neural stem cells I- Establishment of neural tissue, Molecular basis of neural induction. Neurogenesis and neural stem cells II- Neural stem cells in brain; Pluripotent stem cell-derived neural stem cells Hematopoietic stem cells-Embryonic hematopoiesis; Hematopoietic stem cell niche; Embryonic stem cell-derived Hematopoietic stem cells. Cord blood hematopoietic stem cells, Cord blood transplantation; Characteristics, Genomics and proteomics of cord blood stem cells

Module III: **12 hours**

Stem cells in retina and inner ear- Sources and Properties Skin organization, Skin stem cells, bulge as a residence of skin stem cells, Cell signaling in skin stem cells. Skeletal muscle stem cells-Sources, Intrinsic and extrinsic regulation Stem cells in kidney-Anatomy of kidney development, Sources and characterization of kidney stem cells. Stem cells in liver, pancreas and intestine-Organization of adult liver and pancreas, Liver/Pancreatic stem cells, Intestinal stem cells. iPSCsfor disease modeling; Models of nuerological diseases, hematopoietic disorders,

cardiovascular conditions, metabolic disorders. Mesenchymal stem cells- Location, isolation and culture; tissueengineering.

Tissue engineering strategies for bone and cartilage defects. Neural stem cells for central nervous system repair, Therapeutic potential of neural stemcells; Cell replacement using neural stem cells.

Module IV: **12 hours**

Therapeutic uses of stem cells Stem cells to treat diabetes and liver disease, β-cell replacement therapy; Sources of insulinproducing cells; Hepatocyte transplantation; Challenges and future directions Cancer stem cell theory – Isolation and characterization of cancer stem cells; Implications for cancer treatment: Stem cells to treat heart disease, Distribution of stem cells in heart; Preclinical studies. Orthopedic applications of stem cells, Biology of musculoskeletal tissues; engineering.

Stem cells for the treatment of muscular dystrophy, Celluar environment of a dystrophic muscle; Myogenic stem cells from embryonic stem cells and inducible pluripotent stem cells; Current stem cell-based therapeutic approaches. Regeneration of epidermis, Epidermal stem cells; Stem cells in burned and skin ulcers Regulatory aspects for stem cell research; Regulation of use of human embryonic stem cells.

Learning Outcomes: After studying this paper the students will know –

a. The limitations and hurdles using embryonic stem cells in tissue engineering.
b. Therapeutic uses of stem cells
c. Regulatory aspects for stem cell research

REFERENCES:

1. Appasani, K., and Appasani, R. K. 2011. Stem Cells & Regenerative Medicinefrom Molecular Embryology to Tissue Engineering. Humana Press.
2. Dos Santos Goldenberg, R. C. · 2012. Resident Stem Cells and Regenerative Therapy. Academic Press.
3. Institute of Medicine , Board on Neuroscience and Behavioral Health , National Research Council, Division on Earth and Life Studies, Board on Life Sciences, Committee on the Biological and Biomedical Applications of Stem Cell Research2002. Stem Cells and the Future of Regenerative Medicine. National Academies Press.

Weblink:

- https://www.slideshare.net/ManashPaul/stem-cell-and-regenerative-medicine
- https://slideplayer.com/slide/5663236/

RESEARCH METHODOLOGY(FCSC)

Total Credit: 03 **Total Marks-Theory 70+30 (100 M)** **Total Hours: 48 hours**

Learning Objectives: Students should study this paper to know

a. The evolution of science & research.
b. The concepts of research methodology.
c. The importance of data collection and analysis of data.

Module- I **10 hours**

Science and Research: Definition – History – Evolution of Scientific Inquiry, Scientific Research: Definition, Characteristics, types, need of research. Identification of the problem, assessing the status of the problem, formulating the objectives, preparing design (experimental or otherwise), Actual investigation.

Module- II **14 hours**

Introduction to Research Methodology :Meaning and importance of Research – Types of Research – Selection and formulation of Research Problem Research Design – Need – Features – Inductive, Deductive and Development of models Developing a Research Plan – Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Designs. Analysis of Literature Review – Primary and Secondary Sources, Web sources –critical Literature Review Hypothesis – Different Types – Significance – Development of Working Hypothesis, Null hypothesis Research Methods: Scientific method vs Arbitrary Method, Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive, pattern of Deductive – Inductive logical process – Different types of inductive logical methods.

Module- III **10 hours**

Data Collection and Analysis Sources of Data : Primary, Secondary and Tertiary – Types of Data – Categorical, nominal & Ordinal. Methods of Collecting Data : Observation, field investigations, Direct studies – Reports, Records or Experimental observations. Sampling methods – Data Processing and Analysis strategies- Graphical representation – Descriptive Analysis – Inferential Analysis- Correlation analysis – Least square method - Data Analysis using statistical package – Hypothesis – testing – Generalization and Interpretation – Modeling Scientific Writing

Bioinformatics: Use of database- NCBI, EMBLDDBJ, Protein structural data bank, sequence analysis of protein and nucleic acids, structure prediction, molecular modelling ,data mining methods ,primer designing ,web based tools for sequence searches, BLAST and FASTA.

Module- IV **14 hours**

Structure and components of Scientific Reports : Types of Report – Technical

Reports and Thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports - Illustrations and tables – Bibliography, Referencing and foot notes – Importance of Effective Communication. Preparing Research papers for journals, Seminars and Conferences Design of paper using TEMPLATE, Calculations of Impact factor of a journal, citation Index, ISBN & ISSN. Preparation of Project Proposal - Title, Abstract, Introduction – Rationale, Objectives, Methodology – Time frame and work plan – Budget and Justification – References ,Documentation and scientific writing Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar,

Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper,authorship& authorship related issues, Bibliography, Mentor-mentee relationship.

Ethical Issues – Ethical Committees – Commercialization – copy right – royalty – Intellectual ,Property rights and patent law – Track Related aspects of intellectual property Rights – Reproduction of published material – Plagiarism – Citation and Acknowledgement – Reproducibility and accountability , website for funding agencies : https://dst.gov.in , https://dbtindia.gov.in , http://dhr.gov.in , https://www.csir.res.in , http://www.birac.nic.in , https://www.icmr.gov.in.

Learning Outcomes: After studying this paper the students will know –

a. The meaning and importance of research.
b. The role of bioinformatic, scientific reports in research.
c. The ethical issues in research.

REFERENCES:

1. Bulakh, P. M., Patki P. S., and Chodhary A. S. 2010. Research Methodology. Expert Trading Corporation Dahisar West, Mumbai.
2. Garg, B.L., Karadia, R., Agarwal,F., and Agarwal, U.K. 2002. An Introduction to Research Methodology, RBSA Publishers.
3. Gupta, S.P. 2008. Statistical Methods (37th Ed.). Sultan Chand and Sons. New Delhi.
4. Kothari, C.R.2008. Research Methodology: Methods and Techniques (2nd Ed.) New Age International Publishers, New Delhi.
5. Leon, A., and Leon, M. 2012 Internet for everyone, Vikas Publishing House.
6. Sinha, S.C., and Dhiman, A.K. 2002. Research Methodology (2 Volume), EssEss Publications.

7. Wadehra, B.L.2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

Weblink:

- https://www.slideshare.net/sheetal321/researchmethodologyppt
- http://www.mgcub.ac.in/pdf/material/20200406083102645461 84c6.pdf
- https://slideplayer.com/slide/12202349/