

SCHOOL OF BIOTECHNOLOGY SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA, J&K

Program Structure of the M. Sc. (Biotechnology) Program (2021-22)

Semester I

Course Code	Course Title	L-T-P	Credits
BTL6021	Cell & Molecular Biology-I	3-1-0	4
BTL6043	Fundamentals of Biochemistry	3-1-0	4
BTL6072	Fundamentals of Microbiology	3-1-0	4
BTL6173	Analytical Approaches in Biotechnology	3-0-0	3
BTL6161	Biostatistics	2-0-0	2
XXXXXX	Basics of Computers & IT/Entrepreneurship Management (Open Elective - I)	3-0-0	3
BTP6046	Fundamentals of Biochemistry lab	0-0-3	1.5
BTP6075	Fundamentals of Microbiology lab	0-0-3	1.5
		17-3-6	23

Semester II

Course Code	Course Title	L-T-P	Credits
BTL6022	Cell & Molecular Biology -II	3-0-0	3
BTL6201	Plant Cell Culture	2-0-0	2
BTL6191	Animal Cell Culture	2-0-0	2
BTL6182	Principles of Immunology	3-0-0	3
BTL7152	Genetic Engineering and Applications	3-0-0	3
BTL6091	Molecular Genetics	3-1-0	4
BTP6023	Cell & Molecular Biology -II lab	0-0-3	1.5
BTP6176	Cell Culture lab	0-0-3	1.5
BTP6185	Principles of Immunology Lab	0-0-3	1.5
BTP7155	Genetic Engineering and Applications Lab	0-0-3	1.5
		16-1-12	23

Note: Practical Training to be performed in the summer vacation following the second semester for 50 days

Semester III

Course Code	Course Title	L-T-P	Credits
BTL7222	Computational Biology & Bioinformatics	3-0-0	3
BTL6272	Applied Enzyme Catalysis	3-0-0	3
BTL7234	Bioprocess Engineering and Technology	3-1-0	4
BTEXXX	School Elective - I (4 choices)	3-0-0	3
BTEXXX	School Elective - II (4 choices)	3-0-0	3
BTC7211	Colloquium	---	1.5
BTP7225	Computational Biology & Bioinformatics Lab	0-0-3	1.5
BTP6275	Applied Enzyme Catalysis Lab	0-0-3	1.5
BTP7237	Bioprocess Engineering and Technology Lab	0-0-3	1.5
PCL7067	Discourse on Human Virtues (Open Elective - II)	3-0-0	3
		18-1-9	25

Semester IV

Course Code	Course Title	L-T-P	Credits
BTD7012	Dissertation & Viva Voce	---	20
			20

Total Credits = 23 + 23 + 25 + 20 = 91 Credits

List of School Electives (M. Sc.) (Biotechnology)

For School Elective - I
BTE7292 Food Science & Technology BTE7081 Microbial Biotechnology BTE7413 Principles of Intellectual Property Rights & Biosafety BTE7352 Stem Cell Biology and Applications
For School Elective - II
BTE7211 Applications of Plant Biotechnology BTE7341 Radiation Biology BTE7332 Genome stability Regulation and Drug Development BTE7402 Drug Delivery and Pharmacokinetics

SCHOOL OF BIOTECHNOLOGY
Program Structure of the
M. Sc. (Biotechnology) Program (Specialization in Genetics) (2021-22)

Semester I

Course Code	Course Title	L-T-P	Credits
BTL6021	Cell & Molecular Biology-I	3-1-0	4
BTL6043	Fundamentals of Biochemistry	3-1-0	4
BTL6072	Fundamentals of Microbiology	3-1-0	4
BTL6173	Analytical Approaches in Biotechnology	3-0-0	3
BTL6161	Biostatistics	2-0-0	2
XXXXXX	Basics of Computers & IT/Entrepreneurship Management (Open Elective - I)	3-0-0	3
BTP6046	Fundamentals of Biochemistry lab	0-0-3	1.5
BTP6075	Fundamentals of Microbiology lab	0-0-3	1.5
		17-3-6	23

Semester II

Course Code	Course Title	L-T-P	Credits
BTL6022	Cell & Molecular Biology -II	3-0-0	3
BTL6201	Plant Cell Culture	2-0-0	2
BTL6191	Animal Cell Culture	2-0-0	2
BTL6182	Principles of Immunology	3-0-0	3
BTL7152	Genetic Engineering and Applications	3-0-0	3
BTL6091	Molecular Genetics	3-1-0	4
BTP6023	Cell & Molecular Biology -II lab	0-0-3	1.5
BTP6176	Cell Culture lab	0-0-3	1.5
BTP6185	Principles of Immunology Lab	0-0-3	1.5
BTP7155	Genetic Engineering and Applications Lab	0-0-3	1.5
		16-1-12	23

Note: *Practical Training* to be performed in the summer vacation following the second semester for 50 days

Semester III

Course Code	Course Title	L-T-P	Credits
BTL7234	Bioprocess Engineering and Technology	3-1-0	4
BTL7223	Advanced Bioinformatics	3-0-0	3
BTL7471	Medical Genetics and Genomics	3-0-0	3
BTL7473	Agricultural Genetics and Crop Improvement	3-0-0	3
BTL7472	Population: Phylogenetics and Forensics	3-0-0	3
BTC7211	Colloquium	---	1.5
BTP7237	Bioprocess Engineering and Technology Lab	0-0-3	1.5
BTP7223	Advanced Bioinformatics Lab	0-0-3	1.5
BTP7471	Medical Genetics and Genomics Lab	0-0-3	1.5
PCL7067	Discourse on Human Virtues (Open Elective - II)	3-0-0	3
		18-1-9	25

Semester IV

Course Code	Course Title	L-T-P	Credits
BTD7012	Dissertation & Viva Voce	---	20
			20

Total Credits = 23 + 23 + 25 + 20 = 91 Credits

BTL6021: Cell & Molecular Biology-I (3-1-0=4)

Plasma membrane: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility; Historical development of molecular biology

Genetic material and genome replication-DNA and RNA as genetic materials, DNA&RNA - structure, forms and function ,Replication mechanism, enzymes in replication, regulation of genome replication. Topology of nucleic acids.

DNA damage and repair – Mutations, molecular mechanisms of mutagenesis, DNA Repair systems.

Genome organization in prokaryotes and eukaryotes- chromatin structure and function, genome packaging, kinetics of DNA reassociation, chloroplast and mitochondrial genome.

Protein synthesis-transcription and translation, ribosome structure and function. Genetic code –nature and deciphering; Regulation of prokaryotic gene expression.

Recommended Books:

1. Molecular Biology of the Cell by Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter, Peter; 4th Edition; New York and London: Garland Science; c2002
2. Cell Biology (by E.D.P. DeRobertis, Francisco A. Saez and E.M.F. DeRobertis); by Eduardo D P De Robertis; 6th Edition; Published by Saunders, 1975
3. Molecular Biology of the Gene by James Watson, Richard Losick, Michael Levine, Alexander Gann, Tania Baker, Stephen Bell; 5th Edition; Published by Benjamin-Cummings Publishing Company, 2003
4. Molecular cell biology by Harvey F. Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Paul Matsudaira; 6th Edition; Published by W.H. Freeman, 2007
5. Gupta, P.K.: Cytology Genetics and Evolution - Meerut: Rastogi Publications, 2005. 574.87 P05GUP Acc.No. 40832

BTL6043: Fundamentals of Biochemistry (3-1-0=4)

Principles of Bioenergetics: Study of metabolite pathways such as glycolysis, citric acid cycle, oxidative phosphorylation, Photophosphorylation, pentose phosphate pathway and gluconeogenesis and their regulation. Carbohydrate biosynthesis, Lipid biosynthesis. Biosynthesis of aminoacids, nucleotides and related molecules.

Carbohydrates: Classification, structure of mono, di, oligo and polysaccharides, methods for compositional analysis of polysaccharides.

Amino acids & peptides: classification, chemical reactions and physical properties; Proteins: Classification, criteria of homogeneity, end group analysis, primary, secondary, α -helix and β sheet structure, quaternary and domain structure, Disulphide bridges, Ramachandran plot; Protein folding, Protein stability.

Lipids: classification, structure and function of lipids & fatty acids

Chemistry of Biomolecules: Nucleic Acids – structures of purines, pyrimidines, nucleosides and nucleotides. Stability and formation of phosphodiester bonds, Denaturation and renaturation of DNA-Melting Curves. Calculation of T_m for oligonucleotides and DNA.

Enzymes and nucleic acids – Ligases, Nucleases, phosphatases and polynucleotide kinases, chemical and enzymatic susceptibility of Nucleic acids.

Recommended Books:

1. Voet, Donald: Biochemistry.- 3rd ed.- London: John Wiley & Sons, 2004. 574.192 P04VOE
2. Lehninger, Albert L.: Biochemistry - Ludhiana: Kalyani, 1975. 574.192 N75LEH
3. Biochemistry by Jeremy Berg,, John Tymoczko and Lubert Stryer, WH Freeman and comp. 6th edition.
4. Harper's Illustrated Biochemistry by Robert K. Murray ,Darryl K. Granner, Peter A. Mayes, Victor W. Rodwell

BTL6072: Fundamentals of Microbiology (3-1-0=4)

General characters of microbes – Historical developments in microbial biotechnology, the concept of microbial origin of fermentation ,Microscopy Techniques; Structure and general characteristics of Bacteria, Archea, Fungi and Algae; Identification methods of bacteria and other microorganisms, Fundamentals of classification of bacteria, fungi and algae. Recent trends in microbial taxonomy.

Virology – Ultrastructure, classification and replication mechanism in viruses and phages. Importance of viruses in biotechnology with reference to -Retroviruses, TMV, HIV, SV40, Prions-Kuru. Methods of cultivation of viruses.

Microbial techniques - Concept of sterilization, Methods of sterilization and their application in industry, Concept of pure culture and methods of pure culture development. Methods of preservations of microbial cultures of industrial applications, methods of measurement of growth.

Microbial nutrition and growth - Nutrition in microorganisms and assimilation of nutrients , Nutritional groups of microorganisms and their importance in fermentation industry, Culturing of microorganisms in laboratory and industry, Long term preservation. Microbial media and their application, Microbial growth and growth curve, influence of environmental factors on growth. Growth measurement techniques.

Microbial Metabolism - Energy transduction in microbial systems. Aerobic and anaerobic pathways.Sulfate reduction, Nitrogen metabolism – nitrate reduction, nitrifying and denitrifying bacteria, Nitrogen fixation and Microbes used as biofertilizer.

Role of microbial biota in natural environment .Microbial ecology; Microbial pathogenecity.

Recommended Books:

1. Pelczar, Michael J.: Microbiology. -5th ed. - New York: McGraw-Hill, 1986. 576 N86PEL
2. Lansing M Prescott, Microbiology 6th edition Mc Graw Hill.
3. Stanier, Ingram, Wheelis and Painter : The microbial world 1990 edition.
4. Stent and Calender , Molecular Genetics edition 2
5. Tartora, Gerard 1: Microbiology: An Introduction. - 9th ed. 2007 - San Francisco: Peason Education.

BTL6161: Biostatistics (2-0-0=2)

Basic terms, measures of central tendency and dispersion: Population, sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves. Mean median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation.

Probability and distributions: Sample space, events, equally likely events. Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, examples bernoulli, binomial, poisson and normal distributions. Mean and variance of these distributions (without proof). Sketching of p.m.f. And p.d.f, use of these distributions to describe in biological models. Model sampling and simulation study.

Methods of sampling: Use of random numbers to generate simple random samples with replacement and without replacement. Sampling distribution and standard deviation of sample mean. Stratified sampling and its advantages.

Hypothesis testing: Hypothesis, critical region, and error probabilities. Tests for proportion, equality of proportions, equality of means of normal populations when variance known and when variances are unknown. Chi-square test for independence. P-value of the statistic. Confidence limits, introduction to one way and two-way analysis of variance.

Recommended Books:

1. Gupta S.P.: Statistical Methods Sultanchand & Co.
2. Mood M. Alexander, Graybill Frankline, Boes C. Duane: Introduction to the theory of statistics, McGraw Hill & Co.
3. Goon A.M. Gupta, M.K. Das Gupta: Fundamentals of Statistics Vol. I & II
4. Paul D. Leedy, Jeanne Ellis Ormrod, Jeanne E. Ormrod: Practical Research: Planning and Design
5. Oscar Krisen Buros: Research and Statistical Methodology: Books and Reviews.. 1933/38 Rutgers University School of Education, School of Education, Rutgers University, Rutgers University Press, 1938

BTP6046: Fundamentals of Biochemistry Lab (0-0-3=1.5)

Colorimetry and spectrophotometry

- Protein estimation by Lowry's method.
- Estimation of sugars by Anthrone method.
- Estimation of sugars by Bradford method.

Analysis of fats/oils

- Determination of acid value of a fat.
- Determination of saponification value of a fat.
- Determination of Iodine number of a fat.

Chromatographic Techniques

- Identification of sugars in milk by paper chromatography.
- Separation of lipids by thin layer chromatography.
- Separation of amino acids by ion-exchange chromatography.

Electrophoresis Techniques

- Native polyacrylamide Gel Electrophoresis.
- SDS polyacrylamide Gel Electrophoresis Enzyme characterization.

Enzyme Characterization

- Estimation of alkaline phosphatase enzyme activity.
- Effect of temperature and pH on enzyme activity.

BTL6173: Analytical Approaches in Biotechnology (3-0-0=3)

Spectroscopy Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lamberts law, Principles and applications of colorimetry; Chromatography Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC.

Centrifugation Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

Electrophoretic techniques Principles of electrophoretic separation. Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, pulse field gel electrophoresis.

Viscosity Viscosity of macromolecules, relationship with conformational changes.

Electron microscopy Transmission and scanning, freeze fracture techniques, specific staining of biological materials. ORD, CD, X-ray diffraction, X-ray absorption, NMR. Basics of radioactivity and autoradiography, Safety aspects of radiation, Biosensors

Recommended Books:

1. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by David M. Freifelder
2. Analytical Biotechnology (Methods and Tools in Biosciences and Medicine) by Thomas G.M. Schalkhammer
3. Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker

BTP6075: Fundamentals of Microbiology Lab (0-0-3=1.5)

Light Microscopy – Principle, various parts, uses and care, Isolation and purification of microorganisms (bacteria) from soil/water/air by streak plate method and serial dilution; Size measurement of the purified bacterial strain, To perform the Gram staining of the purified bacterial culture, To perform the negative staining of the purified bacterial culture, To perform acid fast staining, To perform spore staining by the Schaeffer Fulton method, To perform capsule staining to distinguish between capsular material and the bacterial cell, To test for the antibiotic sensitivity of the bacterial sample.

To perform the MIC test for antibiotic sensitivity of a bacterial strain against a specific antibiotic, To perform IMVIC test for Coliform bacteria, To study the motility of bacterial strain using the hanging drop technique, To perform standard growth curve of purified bacterial strain, Preservation of microbial strain.

BTL6022: Cell and Molecular Biology –II (3-0-0=3)

Control of eukaryotic gene expression, post transcriptional gene regulation and nuclear transport.

Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation. Cell division and cell cycle, Cell division and cell cycle: Regulation and mechanism.

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Recommended Books:

1. Molecular Biology of the Cell by Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Roberts, Keith; Walter, Peter; 4th Edition; New York and London: Garland Science; c2002
2. Essentials of Molecular Biology by George Malacinski, David Freifelder; 3rd Edition; published by Jones & Bartlett Pub. ; January 1998
3. Molecular cell biology by Harvey F. Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Paul Matsudaira; 6th Edition; Published by W.H. Freeman, 2007

BTP6023: Cell and Molecular Biology –II Lab (0-0-3=1.5)

Isolation of genomic DNA from different plant tissues, Isolation of genomic DNA from *E coli* cells, Spectrophotometric analysis of DNA. –determination of base composition by UV spectroscopy, determination of base composition by thermal denaturation, Measurement of reassociation kinetics, Restriction digestion of DNA, Gel analysis of restricted and unrestricted samples, Isolation of total RNA, Isolation of plasmid, Ultrapurification of plasmid by CsCl density gradient centrifugation, Making competent cells of *Ecoli*, Transformation of competent *Ecoli* cells.

BTL6201: Plant Cell Culture (2-0-0=2)

Concepts & basic techniques in tissue culture. Conventional breeding vs tissue culture. Tissue culture media (composition & preparation), sterilization techniques, Initiation and maintenance of callus and suspension cultures, differentiation, organogenesis & somatic embryogenesis, Production and application of artificial seeds. Shoot tip culture for rapid clonal propagation & production of virus-free plants, stages of micropropagation.

Importance of variability, somaclonal and gametoclonal variations, practical application of somaclonal variations Protoplast isolation, fusion & culture, somatic hybridization, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids.

Haploid production and its significance, ovary, pollen culture, Embryo culture / embryo rescue, role of haploids in agriculture. Germplasm preservation & storage. Plant secondary metabolites, synthesis & extraction, central mechanism and manipulation using plant cell and tissue cultures.

Recommended Books:

1. S.S. Bhojwani & M.K. Razdan:- Plant Tissue Culture : Theory & Practice – Revised Edition, Elsevier Science Publishers
2. John H. Dodds & L.W. Roberts:- Experiments in Plant Tissue Culture – 3rd Edition, Cambridge University Publishers
3. Kumar A.: -Methods in Plant Tissue Culture Agribios Publishers
4. I.K. Vasil & T.A.: -Thorpe Plant Cell & Tissue Culture ISBN -07923-2493-4

BTL6191: Animal Cell Culture (2-0-0=2)

Introduction: historical background, advantages and limitation of tissue culture. Biology of Cultured Cells, Different equipment used in cell culture laboratory, Aseptic Technique: objectives, elements of aseptic environment, sterile handling, standard procedures, apparatus and equipment; Culture vessels and substrates.

Cell culture media and supplements: physicochemical properties, balanced salt solutions, complete media; Importance of serum and serum-free media, adaptation to serum free media. Role of CO₂ in cell culture.

Primary and cell line cultures: Tissue disaggregation and primary culture establishment; Subculture and cell lines: difference between cell line and strain, cell line designations, Maintenance and subculturing cell culture. Cell cloning and separation methods, cells transformation, cell immobilization and cell synchronization.

Contamination types, detection and removal; Cryopreservation and transportation of cells; Measurement of growth and viability of cells in culture; Scale up methods for propagation of anchorage dependent and suspension cell culture.

Applications of animal cell culture; stem cell cultures, embryonic stem cells, *induced pluripotent stem cells* and their applications; cell micromanipulation, animal and human cloning. Organ and histotypic cultures.

Recommended Books:

Culture of Animal cells, 6th Edition, R. Ian Freshney. Wiley-Blackwell publications.

Animal Cell Culture- Practical Approach, 3rd Edition, John R.W. Masters, Oxford University Press.

Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.

Animal Cell Biotechnology, Methods and protocols, Nigel Jenkins, Humana Press.

BTP6176: Cell Culture Lab (0-0-3=1.5)

Micropropagation, surface – sterilization of field grown tissues, callus induction, initiation of suspension cultures, role of hormones in plant morphogenesis, regeneration of shoots and roots from callus cultures. conditioning of tissue culture plants, transfer of plants to green house.

Isolation and purification of protoplasts, viability tests for protoplasts, protoplast cultures.

Acquaintance to aseptic technique and cell culture laboratory equipment; Preparation of cell culture media and reagents, apparatus and materials, sterilization of apparatus and liquids; Primary cell culture establishment; Cell counting and cell viability testing; Maintenance and Sub culturing of cultured cells; Cryopreservation and thawing; Measurement of cell growth; Detection of apoptosis in cultured cells; Cell cloning in microtitration plates.

BTL6182: Principles of Immunology (3-0-0=3)

Immune System - Innate Immune response and Adaptive Immune response, Humoral and cellular component of the Immune response., The lymphoid organs, their interaction Antigens, Epitopes and Immunogenicity. Antibody- structure, function, diversity, engineering and MABs.

Major histocompatibility complex - - MHC molecules structure and function of gene products and organisation of their genes. Antigen presentation.

T Cell receptor- structure and interaction with MHC I and MHC II. Organisation of TCR gene segments. Activation of T cells and apoptosis. B Cell maturation. Complement. Cytokines-structure, function and receptors. Complement System Cell mediated effector responses. Hypersensitivity. Infectious diseases. Autoimmunity. Organ Transplantation, graft vs host rejection, immunosuppression and immunomodulation, AIDS, Tumor immunology, Hybridoma technology and monoclonal antibodies production. Vaccine development, DNA vaccine, principle of diagnostic kits.

Recommended Books:

1. Kuby: Immunology by Thomas J. Kindt, Richard A. Goldsby, Janis Kuby, Barbara A. Osborne; 6th Edition; published by W H Freeman & Co., 2006.
2. Roitt, Ivan M.: Roitt's Essential Immunology - Massachusetts: Blackwell Science, 2001. 616.079 P01ROI Acc.No.40467

BTP6185: Principles of Immunology Lab (0-0-3=1.5)

Total leukocyte count, Differential leukocyte count, Precipitation tests (a) ring test (b) slide test in solution given an antigen and antibody, Precipitation reactions in gel by Ouchterlony Technique given an antigen and antibody (double immunodiffusion), Single radial immunodiffusion (Mancini's Technique) using an antigen and antibody, Immunoelectrophoresis given an antigen and antibody, Rocket immunoelectrophoresis on given antigen and antibody, ELISA, Polyacrylamide gel electrophoresis and western blotting, Separation and purification of antibodies from serum.

Recommended Books:

1. A Handbook of Practical Immunology - G.P. Talwar
2. Practical Immunology, 4th ed., Blackwell Sciences, U.K., Hay, F.C., Westwood, O.M.R. (2002).
3. Manual of Molecular and Clinical Laboratory Immunology, 7th Edition, ASM Press- Barbara Detrick, Robert G. Hamilton, and James D. Folds (2006).

BTL6091: Molecular Genetics (3-1-0=4)

Mendelian Genetics: Principles, Mendelian experiments, Probability in mendelian inheritance, Patterns of single gene inheritance, autosomal recessive, autosomal dominant, sex-linked inheritance, pedigree analysis

Linkage, Crossing -Over, Molecular mechanism, Chromosome Mapping

Gene transfer in Bacteria: History, Transduction – generalized and specialized, Conjugation – F, F', Hfr, F transfer, Hfr-mediated chromosome transfer, Transformation – natural and artificial transformation, Merodiploid generation, Interrupted gene mapping, Genetic analysis using phage and plasmid

Concept of the gene: Evolution of the one gene – one polypeptide concept, Discovery of recombination within the gene, Complementation test, Colinearity of gene and polypeptide
Genomic variations – SNPs, RFLPs, Tandem repeat polymorphisms, Copy number polymorphisms

Genetic marker techniques – RFLP, RAPD, AFLP, SSR, ISSR, VNTRs, CAPS, SNP, SSCP, DNA microarrays, FISH, RNA interference, Applications of genetic markers, Genetic and physical genome mapping

Population and Evolutionary genetics: Allele frequencies, Hardy – Weinberg principle, Processes altering allele frequencies, Genetic equilibrium, Speciation, Patterns and modes of substitutions, Molecular clocks, Concepts of molecular phylogeny.

Basic concepts of development: Potency, commitment, specification, induction, competence, determination & differentiation; morphogenetic gradients; cell fate & cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants & transgenics in analysis of development. Genes in early development, Maternal effect genes, Pattern formation genes, Homeotic genes

Recommended Books:

1. Principles of Genetics by Gardner, Simmons and Snustad, 8th Edition; published by John Wiley & Sons Inc., 1991
2. Microbial Genetics, David Freifelder, Narosa publishing House, 1995
3. Principles of Developmental Genetics by Sally A. Moody.
4. Developmental Biology, Eighth Edition by Scott F. Gilbert.
5. Genetics – A molecular approach, P. Russell, Pearson Benjamin Cummings
6. Genetics – Analysis of genes and genomes, Hartl and Jones, Jones and Bartlett
7. Genetics, Strickberger, Pearson Education
8. Concepts of genetics, Klug and Cummings, Pearson Education

BTL7152: Genetic Engineering and Applications (3-0-0=3)

Isolation and purification of nucleic acids.

Restriction enzymes- properties and uses in recombinant DNA technology

Gene cloning vectors: Plasmids, bacteriophages, phagemids, cosmids, binary vectors, artificial chromosomes: YAC, BAC, PAC, MAC, TAC and other commonly used vectors in microbes, plants and animals.

cDNA synthesis, Gene Libraries, construction of recombinant DNA with plasmids, cloning in plasmids, construction of DNA libraries with phages, construction of genomic libraries in cosmid vectors, screening of recombinants, use of selectable and scorable markers, characterization of recombinants.

Radiolabelling of DNA, Nucleic acid hybridization, DNase-I footprinting, functional analysis of promoters, Sequencing of nucleic acids.

Concept and applications of PCR, RT-PCR, Q-PCR, RACE.

Genetic transformation of eukaryotes – genetic transformation of plants and animal cells.

Applications of genetic engineering: Transgenic animals, production of recombinant pharmaceuticals, gene therapy, disease diagnosis

Recommended Books:

1. Principles of gene manipulation by Old and Primrose; 5th Edition; published by Blackwell Science Inc., 1994
2. Gene Cloning and DNA analysis : An introduction by T.A. Brown; 5th Edition; published by Blackwell pub., 2006
3. Gupta, P. K (1996). Elements of Biotechnology, Rastogi and Co., Meerut.
4. Gene VIII by Benjamin Lewin; published by Pearson Prentice Hall. 2004
5. Recombinant DNA : A short course by Watson, Tooze and Kurtz; published by Scientific American Books, 1983
6. Recombinant DNA Technology and Applications by Alex Prokop, Rakesh K. Bajpai, and Chester S. Ho
7. The DNA Story: A Documentary History of Gene Cloning by James D. Watson and John Tooze

BTP7155: Genetic Engineering And Applications Lab (0-0-3=1.5)

Cloning of foreign DNA in plasmid. Southern blotting and hybridization, Northern blotting of RNA gel, PCR technique, Nucleotide sequencing, demonstration of promoter activity, *Agrobacterium tumefaciens* mediated plant transformation, construction of genomic and cDNA library

Recommended Books:

1. Maniatis, T., Fritsch, E.F. and Sambrook, J. (2001). Molecular cloning 3rd ed.: A laboratory manual, 1st edition. Cold Spring Harbour Laboratory, Cold Spring Harbour, New York.

BTL6272: Applied Enzyme Catalysis (3-0-0=3)

Introduction: Discovery, classification and nomenclature of enzymes, Enzyme isolation, Enzyme assay. Units of activity, cofactors, coenzymes, Prosthetic groups and enzyme specificity. Isoenzymes and nature of active sites identification of functional groups at active sites.

Mechanism enzyme catalysis: Factors responsible for catalytic efficiency of enzymes, i.e proximity and orientation effects, covalent catalysis, nucleophilic and electrophilic catalysis, manifestation of enzyme specificity in maximum velocities, induced fit hypothesis,

strain and distortion theory, mechanism of action of selected enzymes i.e chymotrypsin lysozyme, papain trypsin ribonuclease.

Enzyme regulation: General mechanisms of enzyme regulation, product inhibition enzyme induction and repression allosteric enzymes positive and cooperatively.

Enzyme immobilization: Immobilization techniques and methods influence of immobilization on enzyme activity. Production and application of free and immobilized enzymes in food and feed, detergents and textiles, pulp and paper pharmaceutical diagnostic, bios mass.

Recommended Books:

2. Dixon, M. and E.C. Webb. 1979. Enzymes, 3rd Ed. Academic Press, New York.

3. Segal, L.H. 1975. Enzyme Kinetics, Wiley Interscience, USA.

4. Trever, P. 1981. Understanding of Enzymes. Ellis Horwood Ltd, UK.

5. Biochemical Engineering Fundamentals, James Bailey and David Ollis

BTP6275: Applied Enzyme Catalysis Lab (0-0-3=1.5)

Assay of enzyme activity, Isolation and purification of Urease, Influence of substrate concentration on the rate of enzymatic reaction, Effect of pH and temperature on the rate of enzyme reaction, To find out k_m and V_{max} of free enzyme, To calculate activation energy and Arrhenius constant of free enzyme, Inhibition of enzyme activity. Determination of k_i values, Molecular weight determination of enzyme by gel filtration, Isozyme detection, Immobilization studies, Preparation of enzyme entrapped in alginate beads and determination of percent entrapment, Study of the kinetics of the rate of enzymatic reaction by enzyme entrapped alginate beads, Study of new ability and storage stability of enzyme entrapped alginate beads.

BTL7222: Computational Biology and Bioinformatics (3-0-0=3)

Experimental Methods for Molecular Structure Determination: Brief account of structure determination by X-ray crystallography and NMR spectroscopy. Validation of experimentally obtained NMR structures. Genomics and proteomics: Introduction to genomics, functional and structural genomics, sequencing strategies for whole genome analysis, sequence data analysis. Comparative genomics, genome annotation.

Strategies in proteomics. Structural/functional proteomics. Computational approach for studying protein-protein interactions. Proteomics methodologies. The Protein Data Bank (PDB) and the Nucleic Acid Data Bank (NDB) Proteomics applications: drug development, screening of diagnostic markers, identification and characterization of novel proteins. Global analysis of gene expression. Transcriptomics and microarray. Toxicogenomics. Pharmacogenomics.

Sequence Comparison Methods: Method for the comparison of two sequences viz., Dot matrix plots, Needleman-Wusch & Smith-Waterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method. Theory of scoring matrices and their use for sequence comparison

Introduction to databases: Concepts, Sequence structure and Derived databases (Genbank, EMBL, Swiss prot and PDB). Database access and retrieval tools ENTREZ, SRS. Information system; NCBI, EBI, BTIs.

Recommended Books:

1. Bioinformatics and Functional Genomics, by Jonathan Pevsner. A readable introduction to the field. Aimed primarily at biologists, provides somewhat less detail than Mount, but is slightly more approachable.

2. An Introduction to Bioinformatics Algorithms, by N. Jones and P. Pevzner. A new algorithms text focusing on examples motivated by computational biology. Helpful if you've never taken an algorithms class; provides a more gentle introduction to selected topics than the following book.

3. Introduction to Algorithms, by T. Cormen, C. Leiserson, R. Rivest, and C. Stein. The canonical algorithms textbook. Has nothing to do with biology, but should be on every computer scientist's bookshelf.

4. Introduction to Computational Molecular Biology, by J. Setubal and J. Meidanis. A detailed text focused on computational biology algorithms, aimed at computer scientists, from 1997.

BTP7225: Computational Biology and Bioinformatics Lab (0-0-3=1.5)

1. An introduction to the computing platforms

2. Molecular databases and how they are organized and accessed
3. Unknown DNA -- rational probe design and analysis
4. DNA fragment contig assembly and restriction enzyme mapping
5. Database similarity searching and the dynamic programming algorithm
6. Gene finding strategies. How are coding sequences recognized in genomic DNA
7. Multiple sequence alignment, expectation maximization, profiles, and Markov models Molecular evolutionary phylogenetic inference
8. Estimating protein secondary structure and physical attributes
9. Molecular modelling and visualization

BTL7234: Bioprocess Engineering and Technology (3-1-0=4)

Screening and Improvement of industrially important microorganisms. Microbial Growth and Death Kinetics. Media for Industrial Fermentation. Air and Media Sterilization. Types of Fermentation Processes: Analysis of batch, fed-batch and continuous bioreactors, stability of microbial bioreactors, analysis of mixed populations, specialized bioreactors-pulsed, fluidized, photo bioreactors etc. Measurement and Control of bioprocess parameters. Downstream processing, Whole cell immobilization and their industrial applications. Industrial production of chemicals – Ethanol, Acids (citric, acetic and gluconic acid), solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracyclin), Semi-synthetic antibiotics, Amino acids (lysine, glutamic acid), single cell protein. Agitation and aeration: requirement in industrial processes, concept of volumetric oxygen transfer coefficient and its determination (K_{La}), Factors affecting K_{La} . Uses of microbes in mineral beneficiation and oil recovery.

Introduction to food technology

- . Elementary idea of canning and packaging
- . Sterilization and pasteurization of food products

Recommended Books:

1. P.M. Doran; Bioprocess Engineering Principles, Academic Press
2. M. Shuler, F. Kargi; Bioprocess Engineering, Prentice Hall
3. J.E. Bailey and D. F. Ollis; Biochemical Engineering Fundamentals
4. D.G Rao; Introduction to Biochemical Engineering, McGraw Hill Companies
5. W. Creuger and A. Creuger; Biotechnology-A textbook of Industrial Microbiology, Sinaeur Associates
6. G. Reed; Prescott & Dunn's Industrial Microbiology, CBS Publishers
7. N.Glazer and H. Nikaido; Microbial Biotechnology Fundamentals of Applied Microbiology, Cambridge University Press
8. F.W.Richter; Biotechnology: Research, Technology and Applications, Nova Science Publishers

BTP7237: Bioprocess Engineering and Technology Lab (0-0-3=1.5)

Mutagenesis for strain development, Study different phases of microbial growth, Media sterilization in Bioreactor, Thermal deactivation kinetics, Monod kinetics in batch reactor, Production of organic acids in Submerged fermentation, Production of enzymes in Submerged fermentation, Study of production formation kinetics in a fermenter, K_{La} determination in the bioreactor.

BTC7211: Colloquium (1.5)

Fifty (50) working days or 400 hours of practical training in an industry at the end of one year of study. Besides presenting a report on the industry training, each student is required to present a seminar covering critical review of an area of Biotechnology. The objective is to develop confidence in handling a topic with articulation and in time frame.

ELECTIVE COURSES (3-0-0=3)

Microbial Biotechnology [BTE6081]

Microbes as bio control agents, Environmental applications of microbes, Microbial fuels, Algal biotechnology, Recombinant and synthetic vaccines, Plant microbe interactions, Microbial Polysaccharides and Polyesters, Bio catalysis in organic chemistry, Food and dairy microbiology.

Food Science and Technology [BTE6292]

Food Chemistry: Food quality characteristics; Composition and nutritive value of common foods, Structure, properties and metabolic function of food constituents.

Food Microbiology: Growth and inactivation kinetics; Harmful and beneficial effects of microbes, microbes in food industry; Food spoilage, poisoning and intoxication.

Food Process Principles: Basic principles of food preservation and processing; Preservation of food by removal or supply of heat, dehydration, irradiation, addition of chemicals and fermentation; CA/MA storage; Water activity and food stability.

Food Technology: Technological processes for industrial manufacture of selected foods of commercial importance from plants and animal sources. Laws and Standards: Food additives; Food packaging; Quality control in food industry.

Applications of Plant Biotechnology [BTE6211]

Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance –Bacterial resistance; Viral resistance; Fungal resistance; Insects and pathogens resistance; Herbicide resistance; Drought, salinity, thermal stress, flooding and submergence tolerance.

Genetic Engineering for Plant Architecture and Metabolism – Seed storage proteins; Protein engineering; Vitamins and other value addition compounds; Introduction to post-harvest bioengineering

Plants as Biofactories – Concept of bio factories; production of industrial enzymes, vitamins and antibiotics and other biomolecules; Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds; Bioenergy generation.

Plant Biochemistry [BTE6051]

Photosynthesis in higher plants and bacteria. Chemistry of light energy utilization; Plant pigments; Light and dark reactions, C₃/C₄ pathway and crassulacean acid metabolism. Regulation of Rubisco in crop plants. Photophosphorylation and photorespiration; Biosynthesis and degradation of nucleic acids. Plant hormones; Storage proteins. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Stress physiology- Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress.

Metabolic Engineering [BTE6312]

Basic concepts of Metabolic Engineering – Overview of cellular metabolism ,different models for cellular reactions. Synthesis of Primary Metabolites, Amino acid synthesis pathways and its regulation at enzyme level and whole cell level. Biosynthesis of Secondary Metabolites, regulation of secondary metabolite pathways and applications of secondary metabolites. Bioconversions- Applications of Bioconversions, Factors affecting bioconversions. Regulation of Enzyme Production, Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation, optimization and control of metabolic activities. The modification of existing - or the introduction of entirely new - metabolic pathways. Metabolic flux, integration of anabolism and catabolism, metabolic flux distribution analysis, bioprocess, material balance, kinetic types, equilibrium reaction. Experimental determination method of flux distribution, Metabolic flux analysis and its applications. Applications of Metabolic Engineering-Application in pharmaceuticals, chemical bioprocess, food technology, agriculture, environmental bioremediation and biomass conversion.

Biocatalysis & Enzymes in Organic Reactions [BTE6463]

Introduction to biocatalysis, advantages/disadvantages of biocatalysis and concept of novel biocatalysis. Introduction to engineered enzymes, evolved enzymes, enzyme models and mimics, catalytic antibodies, immobilization, biocatalytic applications of enzyme and associated techniques, use of enzymes such as - Acyl transferases *i.e.* lipases, esterases, peptidases and amidases, acylases; Carbohydrate processing enzymes *i.e.* glycotransferases, glycosidases; Hydrolytic enzymes *i.e.* epoxidases, nitrilases and nitrile hydratases. Biocatalytic applications of enzymes in Reduction reactions *i.e.* reduction of C=C, C=O and C=N bonds; Oxidation reactions *i.e.* oxidation of alcohols and aldehydes, hydroxylation of alkenes, dihydroxylation, epoxidation of alkenes, Baeyer-Villiger

oxidations; Carbon-carbon bond formation using aldolases, oxynitrilases; Addition and elimination reactions; halogenation and dehalogenation reactions.

Genome Stability Regulation and Drug Development [BTE6332]

Model Organisms, Structure of DNA, Nucleotide Metabolism, Cell cycle regulation in Eukaryotes, Fundamentals of DNA Transaction, Mechanisms of Genome Stability regulation, Unit of replication, Enzymes involved, Replication Origin and Replication Fork, Fidelity of Replication, Extra-Chromosomal Replicons, DNA Damage and Repair Mechanisms, Homologous and Site-Specific Recombination, System Biology and Genetic Networks, Protein Degradation Mechanisms and Drug Targeting, Emerging Pathogen and Drug Targets.

Recommended Books:

1. Eukaryotic DNA Replication (2006) by M. De-Phamphilis CSHL press ISBN-10: 0879694599
2. Genes IX by Benjamin Lewin 2007
3. Biochemistry by A.L. Lehninger
4. Hartwell, L., Hood, L., Goldberg, M. and Reynolds, A. (2008). Genetics: From Genes to Genomes. McGraw-Hill Higher Education, 3rd Ed.

Environmental and Evolutionary Biology [BTE6302]

Principles of ecology and environment: physical, chemical and environmental factors and their relationship with living systems; ecological adaptations and dynamics of natural ecosystems. Materials and energy flow in natural ecosystems; physical and biological characteristics of ecosystems and their relationships; major ecosystems; environmental chemistry and microbiology: plant biomass (cellulose, starch, pectin, gum materials), animal biomass (chitin, milk whey, slaughter house waste), microbial biomass (algal blooms, fresh and sea waters, fungal-Mushrooms, yeasts and bacterial fermentation biomass wastes); bioremediation and bioleaching: types and sources of pollution - inorganic, organic and biotic, clinical examples of air, water and land pollutions; environmental impact of pollution and measurement methods; composting of organic wastes, microbial bioremediation of oil spills; concepts of bioremediation (in-situ, ex-situ), bioremediation of toxic metal ions-biosorption and bioaccumulation principles; water treatment technologies, sedimentation, coagulation and flocculation, primary, secondary and tertiary treatments; Biodiversity-major drivers of biodiversity change; biodiversity management approaches; Principles of conservation, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves); EVOLUTION AND BEHAVIOUR: Emergence of evolutionary thoughts, Origin of basic biological molecules, evolution of prokaryotes, origin of eukaryotic cells, The evolutionary time scale; eras, periods and epoch; major events in the evolutionary time scale, Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny.

Principles in Human Genetic Disorders [BTE6122]

Human genomic sequence and annotations, Comparative homologies of human genomic sequence, evolutionary changes and SNPs, Genetic variations and molecular evolution, functional characterizations of mutant alleles, Genotype-phenotype correlations, Application and subdivisions of human population genetics, Hardy-Weinberg law and its application for autosomal locus, Non-recurrent and recurrent mutation, Mutation pressure, Genetic load, Heterozygous advantages, Equilibrium between mutation and selection, Genetic drift, Founder effect, Bottleneck effect, Consanguinity and inbreeding, Biological consequences of inbreeding, Admixture, Basic concepts of inheritance — Mendelian inheritance, Sex-linked inheritance, Multifactorial traits. Spectrum of genetic diseases (single gene, chromosomal, multifactorial, mitochondrial, somatic cell genetic diseases) and patterns of their inheritance. Human gene and mutation nomenclature, Mutations and their clinical consequences, Human genetic variations and use of polymorphisms in medical genetics. Twin studies, Linkage Studies, Candidate Gene Association Studies, Congenital anomalies and birth defects, Genetic Counseling, Impact of disease on the patient and family, Introduction to treatment and management of genetic diseases. The Human Genome Project, Human genetic variations, and human Evolution, Human Genographic project, Hapmap Project, 1000 genomes Project, ENOCDE project.

Recommended Books:

1. Hinde, A. (1998). Demographic Methods. Oxford University Press, Inc., New York.
2. Adkison, L. and Brown, M.D. (2007). Elsevier's Integrated Genetics (Elsevier's Integrated S.). Mosby (St. Louis).
3. Hartwell, L., Hood, L., Goldberg, M. and Reynolds, A. (2008). Genetics: From Genes to Genomes. McGraw-Hill Higher Education, 3rd ed.
4. Jorde, L.B., Carey, J.C. and Bamshad, M.J. (2010). Medical Genetics. Elsevier, Mosby, 4th ed.
5. Strachan, T. and Read, A. (2010). Human Molecular Genetics. Garland Publishers, London, 4th ed.
6. Brownstein, M.J., Khodursky and Arkady, B. (Eds.) (2003). Functional Genomics. Humana Press, New Jersey.
7. Jobling, MA, Hurler M and Tyler-Smith C (2004) Human Evolutionary Genetics: Origins, Peoples and Disease. Garland Science, Abingdon and New York

Radiation Biology [BTE6341]

Introduction to principles and concepts underlying the biological effects of ionizing radiation at the molecular, cellular and whole-tissue level. Selected aspects of microdosimetry, radiation damage to DNA, DNA repair mechanisms, cell-cycle kinetics (repopulation effects), cell death mechanisms and clonogenic survival, Linear Energy Transfer (LET) effects and relative biological effectiveness (RBE), oxygen effects, apoptosis, acute effects of whole body irradiation, radiation carcinogenesis, hereditary effects of radiation, the tumor control probability (TCP), clinical responses of normal tissues to radiation, cancer biology, and biological indicators of treatment effectiveness, such as biologically equivalent dose (BED) and equivalent uniform dose (EUD) concepts. Examples and discussion related to radiation therapy treatment planning and radiation protection are covered.

Stem Cell Biology and Applications [BTE6352]

Basic biology of stem cells; types & sources of stem cell with characteristics: embryonic, adult, haematopoietic, mesenchymal stem cells, primordial germ cells, cancer stem cells, induced pluripotent stem cells. Molecular basis of pluripotency and stem cell niche.

Stem cell characterizations: isolation & characterizations, markers & their identification, growth factor requirements and their maintenance in culture. Feeder and feeder free cultures. Cell cycle regulators in stem cells. Mechanisms of stem cell self-renewal.

Applications of stem cells: neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopaedic applications, eye diseases, stem cells and gene therapy.

Ethical and regulatory issues in the use of stem cells.

Recommended Books:

1. Handbook of Stem Cells, 2nd edition (2012) by Anthony Atala and Robert Lanza; Academic Press.
 2. Essential of Stem Cell Biology, 2nd edition (2009) by R. Lanza *et al*; Elsevier Academic press.
 3. Translational Approaches in Tissue Engineering & Regenerative Medicine (2007) by J. J. Mao *et al.*; Artech House.
 4. Stem Cell Repair and Regeneration, Volume-2, (2007) by Nagy A. Habib, Nataša Y Leviear, Myrtle Gordon, Long Jiao and Nicholas Fisk; Imperial College Press
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