



Department of Biotechnology

B. Sc.

(Biotechnology)

Course Contents

&

Syllabus



Hemvati Nandan Bahuguna Garhwal University
(A Central University)

Srinagar, Garhwal, 246 174, Uttarakhand



B.Sc. (Biotechnology)

(Effective from July 2020)

Course Code	Courses	L T P C	MM
Semester I: (July to November)			
SOLS/BBT/C 0001	Cell Biology & Genetics	4 0 0 4	100
SOLS/BBT/AECC1	English / MIL Communication	4 0 0 4	100
SOLS/BBT/C 0002	Lab Course: Based on course - C0001	0 0 2 2	100
Core Credits = 10			300
Semester II: (December to April)			
SOLS/BBT/C 0003	Biochemistry & Metabolism	4 0 0 4	100
SOLS/BBT/AECC2	Environmental Science	4 0 0 4	100
SOLS/BBT/C 0004	Lab Course: Based on Course- C0003	0 0 2 2	100
Core Credits = 10			300
Semester III: (July to November)			
SOLS/BBT/C0005	Microbiology & Immunology	4 0 0 4	100
SOLS/BBT/SE001a	Cell Culture & Applications	4 0 0 4	100
SOLS/BBT/SE001b	Biological Tools & Techniques		
SOLS/BBT/C0006	Lab Course: Based on Course - C0005	0 0 2 2	100
Core Credits = 10			300
Semester IV: (December to April)			
SOLS/BBT/C 0007	Molecular Biology & Recombinant DNA Technology	4 0 0 4	100
SOLS/BBT/SE002a	Bioethics, Bio-safety & Human Welfare	4 0 0 4	100
SOLS/BBT/SE002b	Molecular Diagnostics		
SOLS/BBT/C0008	Lab Course: Based on Course - C0007	0 0 2 2	100
Core Credits = 10			300
Semester V: (July to November)			
SOLS/BBT/DSE01a	Virology & Vaccine Development	4 0 0 4	100
SOLS/BBT/DSE01b	Animal Biotechnology		
SOLS/BBT/DSE01c	Biostatistics & Basic Bioinformatics		
SOLS/BBT/SE003a	Intellectual Property Rights & Patenting	4 0 0 4	100
SOLS/BBT/SE003b	Environmental Biotechnology		
SOLS/BBT/DSE02	Lab Course: Based on Course - DSE01	0 0 2 2	100
Core Credits = 10			300
Semester VI: (December to April)			
SOLS/BBT/DSE03a	Medical Microbiology	4 0 0 4	100
SOLS/BBT/DSE03b	Plant Biotechnology		
SOLS/BBT/DSE03c	Basics of Forensic Science		
SOLS/BBT/SE004a	Bioprocess Technology	4 0 0 4	100
SOLS/BBT/SE004b	Enzymology		
SOLS/BBT/DSE04	Lab Course: Based on Course - DSE03	0 0 2 2	100
Core Credits = 10			300
Grand Total Credits: Core-24 + AECC-08 + DSE-16 + SE-12 = 60			1800

C (Core Courses)	Credits: 24
AECC (Ability Enhancement Compulsory Course)	Credits: 08
DSE (Discipline Specific Electives)	Credits: 16
SE (Skill Enhancement Courses)	Credits: 12

Maximum Marks 100 (70- End Semester; 30- Sessional Test)



Paper - I: Cell Biology & Genetics
(Course Code: S0LS/BBT/C0001)

No. of Credits: 4

UNIT – I

Cell Biology: History and origin; Prokaryotic and Eukaryotic cell. Plasma Membrane: Ultra structure, chemical composition and functions of plasma membrane. Structure and functions of Nucleus, Mitochondria, Chloroplast, Endoplasmic Reticulum, Ribosome, Golgi Bodies, Lysosomes and Peroxisomes. Cytoskeleton and its components

UNIT – II

Basic concept of cellular signal transduction; Role of G protein linked, Receptor tyrosine kinase and intracellular receptors. Cellular transport: Simple diffusion, facilitated diffusion, direct and indirect active transport. Basic idea of different types of cell junctions. Cell cycle and its regulation

UNIT – III

Mendel's law of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Sex-linked inheritance. Linkage and Crossing Over, Extra-chromosomal Inheritance, Polygenic inheritance, Human genetics: Pedigree analysis

UNIT – IV

Organization of chromosomes in eukaryotes and prokaryotes; Giant chromosomes, Chromosomal aberrations; Types of gene mutations, Transposons, Population genetics: Hardy Weinberg law

Recommended Books: -

1. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th ed. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th Ed. Lippincott Williams and Wilkins, Philadelphia.
3. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Ed. John Wiley & Sons.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Ed.. Benjamin Cummings.
6. Russell, P. J. (2009). Genetics- A Molecular Approach. III Ed. Benjamin Cummings.

Suggested practical: -

1. Cell division in onion root tip/ insect gonads.
2. Karyotyping with the help of photographs
3. Mendelian deviations in dihybrid crosses
4. Pedigree charts of some common characters like blood group, color blindness etc.
5. Permanent and temporary mount of mitosis and meiosis.
6. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.
7. Study of structure of any Prokaryotic and Eukaryotic cell.

**Practical exercises relevant to course, depending upon available Lab facilities, may also be designed*



Paper - III: Biochemistry & Metabolism
(Course Code: S0LS/BBT/C0003)

No. of Credits: 4

UNIT – I

Proteins & Amino acids: Structure and properties of Amino acids, Types of proteins and their classification. Different Level of structural organization of proteins. Fibrous and globular proteins.

UNIT – II

Lipids: Classification, nomenclature & properties of fatty acids, essential fatty acids. Basic introduction to the types of lipids such as Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Physical & chemical properties, Nucleosides & Nucleotides, purines & pyrimidines. Double helical model of DNA structure

UNIT – III

Enzymes: Nomenclature and classification, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories.

UNIT – IV

Carbohydrates: Structure, function and properties of Monosaccharides, Disaccharides and Polysaccharides. Glycoprotein's and their biological functions.

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. β -oxidation of fatty acids.

Recommended Books: -

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
3. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
4. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.

Suggested practical: -

1. Estimation of blood glucose by glucose oxidase method.
2. Preparation of buffers.
3. Qualitative/Quantitative tests for Carbohydrates, lipids and proteins
4. Quantitative estimation of enzyme activity
5. Separation of Amino acids by paper chromatography.
6. Standard curve preparation with the use of colorimeter/spectrophotometer
7. Study the effect of pH and temperature on enzyme activity.

**Practical exercises relevant to course, depending upon available Lab facilities, may also be designed*



Paper - V: Microbiology & Immunology
(Course Code: S0LS/BBT/C0005)

No. of Credits: 4

UNIT – I

General account of different group of microorganisms: Cyanobacteria, Fungi, Yeast, Protozoa, Viruses and Phages. Bacteria: Structure, General characteristics and Methods of identification. Staining techniques, Sterilization methods

UNIT II

Cultivation and Maintenance of microorganisms: Types of culture media and their preparation; Methods of isolation, pure culture preparation and preservation of microorganisms. Bacterial growth curve and generation time. Bacterial reproduction, General account of Transformation, Transduction and Conjugation.,

UNIT – III

General concept of Immunity, Innate and Acquired Immunity, Cellular & Humoral Immunity, Primary lymphoid organs – Thymus, Bone marrow. Secondary lymphoid organs- Spleen, Lymph Nodes. Hematopoiesis. Types and role of Cells of Immune System- lymphocytes (T-cells, B-cells and NK cells), neutrophils, and monocytes / macrophages.

UNIT – IV

Antigen and Antibody: Immunogenicity, Antigenicity, Adjuvants, Epitopes, Haptens. Molecular Structure of different immunoglobulins and their functions, antibody diversity. Antigen-Antibody interactions- Precipitation and Agglutination reactions. Complement fixation, Monoclonal Antibodies – Introduction and applications.

Recommended Books: -

1. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
2. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.
4. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education
5. Kuby- Immunology –W.H. Freeman
6. Roitt I. M.- Essentials of Immunology- Blackwell

Suggested practical: -

1. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Determination of bacterial cell size by micrometry.
4. Enumeration of microorganism - total & viable count.
5. Immunodiagnosics (demonstration using Kits- Widal, VDRL, Blood Group etc)
6. Immunodiffusion, Immuno Electrophoresis, Western Blotting, Leukocyte Count

**Practical exercises relevant to course, depending upon available Lab facilities, may also be designed*



Paper - VI: Cell Culture & Applications
(Course Code: S0LS/BBT/SE001a)

No. of Credits: 4

UNIT – I

Laboratory requirements for animal cell culture, media preparation and sterilization, Serum and serum free media, culture vessels. Primary culture and Cell lines. Adhesion and proliferation of cultured cell. Cytopathic effect

UNIT – II

Monolayer, suspension and immobilized culture. Large scale cultivation of animal cells. Applications of animal cell culture in vaccine, recombinant protein and monoclonal antibody production, diagnostics and cytotoxicity test. Introduction and applications of stem cells

UNIT – III

Introduction and Principles of plant tissue culture, history, Laboratory Organization, Media components, Different phytohormones, Stock solutions, Totipotency, De-Differentiation, Redifferentiation, Callus culture, micro propagation

UNIT – IV

Somatic Embryogenesis and artificial seed, Mass propagation, Protoplast fusion and somatic hybridization, Cybridisation, Improved crop varieties through somaclonal variation. Plant improvement for agriculture, horticulture and forestry. Preservation of plant genetic resources and germplasm conservation.

Recommended Books: -

1. Bhojwani and Razdan- Plant Tissue Culture- Elsevier
2. Butterworth- Heinemann - In Vitro Cultivation of Animal cells- Elsevier
3. John Masters- Animal Cell Culture – Oxford University Press
4. Karl-Hermann, A. Kumar- Plant Cell and Tissue Culture: A Tool in Biotechnology- Springer
5. M.K. Razdan-Introduction to plant tissue culture –Oxford and IBH
6. R Ian Freshney- Culture of Animal Cells- John Wiley
7. R Sasidhara- Animal Biotechnology – MJP Publisher



Paper - VI: Biological Tools & Techniques
(Course Code: S0LS/BBT/SE001b)

No. of Credits: 4

UNIT – I

Introduction to Microscopy, Principle, Types and Applications, Simple microscopy, phase contrast microscopy, fluorescence microscopy, Confocal Microscopy, electron microscopy (TEM and SEM)-instrumentation and use, absorption and emission spectroscopy.

UNIT – II

Principle and Applications of UV-Visible Spectrophotometer and Spectrofluorometer. Centrifugation – Basic Principle of Centrifugation, Sedimentation Co-efficient, Rotors- types and uses, Instrumentation of Ultracentrifuge (Preparative, Analytical), cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT – III

Chromatography: Introduction and concept of Chromatography, Adsorption and Partition Chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration.

UNIT – IV

Introduction to electrophoresis, Basic principle and Applications. Types of Electrophoresis, Starch-gel, polyacrylamide gel (native and SDS-PAGE), 2-D Electrophoresis, agarose-gel electrophoresis.

Recommended Books: -

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Saxena J, Baunthiyal M, Ravi I (2012). Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. Scientific Publisher
3. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.



Paper - VII: Molecular Biology & Recombinant DNA Technology
(Course Code: S0LS/BBT/C0007)

No. of Credits: 4

UNIT – I

DNA: structure, types, genetic material. Replication of DNA: Semi-conservative DNA replication, Replication in prokaryotes and eukaryotes, DNA polymerases, DNA damage: Causes and types of DNA damage. Mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, recombinational repair.

UNIT – II

Transcription: RNA structure and types of RNA, Transcription process and RNA modifications in prokaryotes and Eukaryotic systems, Translation process and Post-translational modifications of proteins.

UNIT – III

Chromosomal and Plasmid DNA isolation methods, Introduction to Gene Cloning, Enzymes used in gene cloning such as Restriction enzymes, Ligases, Polymerases, Alkaline phosphatases etc. Plasmid and Bacteriophage based Cloning Vectors, Cosmids, Expression vectors, Shuttle Vectors. Methods for transferring DNA into Host cell: Transformation, Microinjection, Electroporation.

UNIT – IV

Genomic and cDNA library, Principle and applications of Polymerase chain reaction (PCR), Random and site-directed mutagenesis, DNA sequencing methods, Gene therapy, GMO (Genetically Modified Organisms) and their applications.

Recommended Books: -

1. Karp, G. (2010). Cell & Molecular Biology: Concepts & Experiments. VI Ed. John Wiley & Sons.
2. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Ed.) Cold Spring Harbour Lab. Press, Pearson Pub.
3. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
4. Brown TA. (2016). Gene Cloning & DNA analysis..Wiley Black Well Publications
5. Molecular Cloning: A Laboratory Manual (3rd Ed.) Sambrook & Russell Vol. I to III, 1989.
6. Principles of Gene Manipulation 6th Edition, S. B. Primrose, R.M. Twyman and R.W. Old. Blackwell Science, 2001.

Suggested practical: -

1. Preparation of solutions for molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Qualitative and quantitative analysis of DNA
4. Isolation of Plasmid DNA by alkaline lysis method
5. Agarose gel electrophoresis of genomic DNA & plasmid DNA
6. Competent Cell preparation
7. Bacterial Transformation

**Practical exercises relevant to course, depending upon available Lab facilities, may also be designed*



Paper - VIII: Bioethics, Bio-safety & Human Welfare
(Course Code: SOLS/BBT/SE002a)

No. of Credits: 4

UNIT – I

Biotechnology and social responsibility, public acceptance issues in biotechnology, issues of ownership, monopoly, traditional knowledge, biodiversity, access and benefit sharing, environmental sustainability.

UNIT – II

Introduction to bioethics: Social and ethical issues in biotechnology. Principles of bioethics. Ethical conflicts in biotechnology- interference with nature, unequal distribution of risk and benefits of biotechnology, Ethical issues related to the use of molecular technologies.

UNIT – III

Definition and importance of Biosafety, Different laboratory Biosafety level and their requirements. Laboratory associated infections and biological hazards. International protocols on Biosafety. Genetic modified organism (GMOs) and living modified organisms (LMOs), Regulatory framework to approve the use and applications of recombinant DNA related work in India

UNIT – IV

Overview of Biotechnological innovations and applications in the field of Agriculture: Nitrogen fixation: transfer of biotic / abiotic stress resistance genes to plants; interaction between plants and microbes and uses; Environment: chlorinated and non-chlorinated organic pollutant, hydrocarbons and agricultural wastes degradation.

Recommended Books: -

1. Fleming, D.A., Hunt, D.L., (2000). Biotechnology and Safety Assessment (3rd Ed) Academic press.
2. H.K. Das. Text book of biotechnology 3rd edition.
3. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
4. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international Publishers
5. Thomas, J.A., Fuch, R.L. (1999). Biotechnology & safety assessment (3rd Ed). CRC press, Washington.
6. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and safety Assessment (3rd Ed) Academic press.



Paper - VIII: Molecular Diagnostics
(Course Code: S0LS/BBT/SE002b)

No. of Credits: 4

UNIT – I

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immunoblotting. Enzyme immunohistochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immunoassays. Applications of enzyme immunoassays in diagnostic microbiology.

UNIT – II

Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures.

UNIT – III

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Anti idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT – IV

Theory / principle, instrumentation & applications of GLC, HPLC, Electron microscopy, flow cytometry and cell sorting.

Recommended Books: -

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
3. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
4. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton- Century-Crofts publication.
5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
6. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.



Paper - IX: Virology & Vaccine Development
(Course Code: S0LS/BBT/DSE01a)

No. of Credits: 4

UNIT – I

Viruses- Introduction and Discovery, nature and definition of viruses, general properties. Introduction to viroids, virusoids and Prions. Properties of Viruses, Nomenclature & classification of Viruses (ICTV). Ultra structure of Virus- Nucleic acid, Nucleocapsid, Envelope- enveloped and non-enveloped viruses, Enzymes, modes of propagation.

UNIT – II

Life cycle and replication of RNA and DNA Viruses. Bacteriophages - λ , T4, M13. Animal Viruses- Adenovirus, Retrovirus. Plant Viruses- TMV, CaMV, Structure and Properties. Cultivation of viruses (animal, plant and bacterio phages).

UNIT – III

Vaccines-Historical development and general introduction, Active and passive immunization, Whole organism vaccine, Use of microbial macromolecules as vaccine. Recombinant vector vaccines, DNA Vaccine, Multivalent subunit vaccines.

UNIT – IV

Vaccine delivery systems (liposome, microsphere and nanoparticle mediated), Edible vaccines. Introduction to the different stages in development and clinical trials. Overview of the different steps in vaccine manufacture.

Recommended Books: -

1. Kuby- Immunology –W.H. Freeman
2. Roitt I. M.- Essentials of Immunology- Blackwell
3. A.K. Abbas- Immunology- Elsevier
4. Amita Biswas- An Introduction to Viruses- Vikas Publication
5. David Freifelder- Microbial Genetics- Narosa
6. John Carter, Venetia A. Saunders- Virology Principles and Applications- Wiley
7. Dimmock, Primrose - Introduction to Modern - Virology IV

Suggested practical: -

1. Isolation of bacteriophage from sewage/Titration / one step growth curve of bacteriophage
2. Enumeration of Bacteriophage by PFU method
3. Cultivation of Virus in Embryonated egg, Hemagglutination test
4. Isolation and study of plant virus
5. Immunization, collection of Serum
6. Purification of IgG from Serum
7. ELISA study and demonstration

**Practical exercises relevant to course, depending upon available Lab facilities, may also be designed*



Paper - IX: Animal Biotechnology
(Course Code: S0LS/BBT/DSE01b)

No. of Credits: 4

UNIT – I

Animal viruses based cloning and expression vectors. Gene transfer methods in Animals – Calcium phosphate precipitation, DEAE dextran mediated, Lipofection and Microinjection. Reporter genes.

UNIT – II

Techniques for creating transgenic animals. Applications of Transgenic Animals – Buffalo, Cow, Pig, Sheep, Goat, Mice, Bird, Insect. Molecular Pharming in animals

UNIT – III

Animal propagation – Artificial insemination, Animal Cloning, Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications. Animal/human cell lines: Concept and applications.

UNIT – IV

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, metabolic engineering, human genetic engineering, problems & ethics.

Recommended Books: -

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California, USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.
4. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA genes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

Suggested practical: -

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Preparation of Hanks Balanced salt solution
4. Preparation of Minimal Essential Growth medium
5. Isolation of lymphocytes for culturing
6. DNA isolation from animal tissue
7. Quantification of isolated DNA.
8. Resolving DNA on Agarose Gel.

**Practical exercises relevant to course, depending upon available Lab facilities, may also be designed*



Paper - IX: Biostatistics & Basic Bioinformatics
(Course Code: S0LS/BBT/DSE01c)

No. of Credits: 4

UNIT – I

Importance of Biostatistics. Primary and Secondary data, Methods of data collection. Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Classification and Graphical representation of Statistical data.

UNIT – II

Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis, Correlation and Regression. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA). Elementary idea of data calculation with MS Excel.

UNIT – III

Introduction and history of Bioinformatics, Different search engines and their applications, Biological databases: Primary, Secondary and Composite databases, Nucleotide and Protein Sequence databases, Structural databases, Introduction to Data mining and its applications.

UNIT – IV

Sequence Similarity Searches-BLAST, FASTA, Data Submission. Sequence alignment and its types, Sequence and Phylogeny analysis, Detecting Open Reading Frames. Microarray Technology, Basic concepts of genomics and proteomics.

Recommended Books: -

1. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
2. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Ghosh Z. & Bibekanand M. (2008) Bioinformatics: Principles & Applications. Oxford University Press.
5. Khan and Khanum. Fundamentals of Biostatistics. (2018). Ukaaz Publications, India
6. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
7. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
8. Sharma V, Munjal A, Shanker A (2008). A Text Book of Bioinformatics

Suggested practical: -

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on t, f and Chi-square test
4. Calculation of Correlation coefficient and drawing of regression line
5. Protein information resource (PIR)
6. Retrieval of information from nucleotide and protein databases.
7. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,
8. Understanding and using: PDB, Swissprot, TREMBL
9. Using various BLAST and interpretation of results.

**Practical exercises relevant to course depending upon available Lab facilities may also be designed*



Paper - X: Intellectual Property Rights & Patenting
(Course Code: SOLS/BBT/SE003a)

No. of Credits: 4

UNIT – I

Concept of property, Introduction to Intellectual Property- Importance of IPR, advantages of IP protection, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications. World intellectual property organization- Roles, functions etc.

UNIT – II

Features of IPR policy, Agreements and Treaties: History of WTO, GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments, UPOV convention, Convention on Biological Diversity, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology

UNIT – III

Discovery and invention, Basics of Patents and Concept of Prior Art. Patentability criteria, List of non-patentable inventions, Introduction to Patents: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Patent databases Patenting of Life Forms

UNIT – IV

Reading a patent- Patent Terminologies: (Abstract, Summary, Background, Drawings, description, Claims), Patent filing, Patent licensing and agreements, Patent infringement- meaning, scope, litigation, case studies, remedies to patent infringement, Legal issues in biotechnology and IPR

Recommended Books: -

1. Prabuddha Ganguli – Intellectual property rights: unleashing the knowledge economy, Tata McGraw Hill Publishing.
2. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
3. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007

<http://www.w3.org/IPR/>

<http://www.wipo.int/portal/index.html.en>

<http://www.patentoffice.nic.in>

<http://www.iprlawindia.org/> - 31k - Cached - Similar page

<http://www.cbd.int/biosafety/background.shtml>

<http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm>

<http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>



Paper - X: Environmental Biotechnology
(Course Code: S0LS/BBT/SE003b)

No. of Credits: 4

UNIT – I

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol: Gasohol

UNIT – II

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinated hydrocarbons and petroleum products.

UNIT – III

Treatment of municipal waste and Industrial effluents. Bio-fertilizers
Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT – IV

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

Recommended Books: -

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jeseff Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
6. Introduction to Environmental Biotechnology, Milton Wainwright
7. Principles of Environmental Engineering, Gilbert Masters
8. Wastewater Engineering – Metcalf & Eddy



Paper - XI: Medical Microbiology
(Course Code: S0LS/BBT/DSE03a)

No. of Credits: 4

UNIT – I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins. Morphology, pathogenesis, symptoms, laboratory diagnosis and biosafety, preventive measures and chemotherapy of gram positive bacteria: *S.aureus*, *S.pyogenes*, *B.anthraxis*, *C.perferinges*, *C.tetani*, *C.botulinum*, *C.diphtheriae*, *M.tuberculosis*, *M. leprae*.

UNIT – II

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli*, *N. gonorrhoea*, *N. meningitidis*, *P. aeruginosa*, *S. typhi*, *S. dysenteriae*, *Y. pestis*, *B. abortus*, *H. influenzae*, *V. cholerae*, *M. pneumoniae*, *T. pallidum*, *M. pneumoniae*, *Rickettsiaceae*, *Chlamydiae*.

UNIT – III

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT – IV

Fungal and Protozoan infections. Dermatophytoses (Trichophyton, Microsporun and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidioides) and opportunistic fungal infections (Candidiasis, Aspergillosis), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

Recommended Books: -

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Suggested practical: -

1. Growth curve of a bacterium.
2. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
3. Perform antibacterial testing by Kirby-Bauer method.
4. Prepare temporary mounts of *Aspergillus* and *Candida* by appropriate staining.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

*Practical exercises relevant to course, depending upon available Lab facilities, may also be designed



Paper - XI: Plant Biotechnology
(Course Code: S0LS/BBT/DSE03b)

No. of Credits: 4

UNIT – I

Introduction, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropropagation, Axillary bud proliferation, Meristem and shoot tip culture, bud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT – II

In vitro haploid production Androgenic methods: Anther culture, Microspore culture androgenesis. Significance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors affecting gynogenesis, chromosome elimination, techniques for production of haploids in cereals.

UNIT – III

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Soma clonal variation Nomenclature, methods, applications basis and disadvantages.

UNIT – IV

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria. Production of Transgenic plants and their applications.

Recommended Books: -

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Raven, P.H., Johnson, G.B., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
3. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
4. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

Suggested practical: -

1. Preparation of complex nutrient medium (Murashige & Skoog's medium)
2. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
3. Selection, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.

**Practical exercises relevant to course, depending upon available Lab facilities, may also be designed*



Paper - XI: Basics of Forensic Science
(Course Code: S0LS/BBT/DSE03c)

No. of Credits: 4

UNIT – I

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation. Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.

UNIT – II

Classification of fire arms and explosives, introduction to internal, external and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of handwriting, examination and comparison of handwritings and analysis of ink.

UNIT – III

Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification

UNIT – IV

Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Investigation Tools, e- Discovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

Recommended Books: -

1. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
2. M.K. Bhasin & S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
3. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
6. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

Suggested practical: -

1. Case studies to depict different types of injuries and death.
2. Documentation of crime scene by photography, sketching and field notes.
3. E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Recovering deleted evidences, Password Cracking
4. Investigate method for developing fingerprints by Iodine crystals.
5. PCR amplification on target DNA and DNA profiling,
6. Separation of nitro compounds (explosives)/ ink samples by thin layer chromatography.
7. Simulation of a crime scene for training. b. To lift footprints from crime scene.

**Practical exercises relevant to course, depending upon available Lab facilities, may also be designed*



Paper - XII: Bioprocess Technology
(Course Code: S0LS/BBT/SE004a)

No. of Credits: 4

UNIT – I

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle & components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture.

UNIT – II

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- CSTR, Airlift, bubble column, Packed bed and their application in production processes.

UNIT – III

Introduction to oxygen requirement in bioprocess; volumetric mass transfer coefficient and its measurement; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT – IV

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

Recommended Books: -

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.



Paper XII: Enzymology
(Course Code: S0LS/BBT/SE004b)

No. of Credits: 4

UNIT – I

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

UNIT – II

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of K_m and V_{max} and their physiological significance.

UNIT – III

Allosteric enzymes with special reference to aspartate transcarbamylase and phosphofructokinase. Qualitative description of concerted and sequential models. Enzyme - Enzyme interaction, Protein ligand binding. Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

UNIT – IV

Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry.

Recommended Books: -

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender, Kathleen
3. M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGrawHill, 2009.
4. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.
5. Biochemistry by Mary K. Campbell & Shawn O. Farrell, 5th Edition, Cengage Learning, 2005.
6. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University Press 1999