National Curriculum and Credit Framework (NCCF)

Syllabus

For

B.Sc. BIOTECHNOLOGY

w.e.f. Academic Session 2023-24

Kazi Nazrul University

Asansol, Paschim Bardhaman

West Bengal 713340

SEMESTER- I

MAJOR COURSE - 1

Course Name : Fundamentals of Biotechnology (Theory)

Course Code : BSCBTLMJ101

<table>
<tr><td rowspan="2">Course Type: Major (Theoretical & Practical)</td><td colspan="3" rowspan="2">Course Details: MJC-1</td><td colspan="2" rowspan="2">L-T-P: 3 – 0 – 4</td></tr>
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<tr><td rowspan="3">Credit: 5</td><td rowspan="3">Full Marks: 100</td><td colspan="2">CA Marks</td><td colspan="2">ESE Marks</td></tr>
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UNIT I:

A historical perspective to the subject of biotechnology. Contribution of Paul Berg, HW Boyer and SN Cohen. Biotechnology & industry. Scope of biotechnology: research, jobs & others. Principles of Biotechnology; Biotechnology is an applied science with contribution from all basic sciences (plant, animal, microbial, physics, chemistry, statistics, ethics and law). Application of biotechnology for the welfare of human, animals and our planet Earth.

UNIT II:

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA. Basics concepts of Gene cloning, Gene transfer, Recombinant DNA (definition, use and creation), cDNA Library: Creation of cDNA library, Isolation of gene from gene library, restriction enzymes, structural features of pBR322, cosmid vector, and bacteriophage. Principle, application and ethical issues related to Transgenic animals, Scopes and limitations of Genetically Modified Organisms (GMO).

UNIT III:

Basic concept on plant tissue culture. Role of plant hormones. Basic concept on animal cell culture. Concept of stem cell & its utility. Animal cloning.

UNIT IV:

Principle and application of various tools & techniques in Biotechnology (you can include up to 10-15 techniques). Enzyme Technology: Methods for large scale production of enzymes.

Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Application of Immobilized and soluble enzyme in health and industry.

Paper MJC-1- Fundamentals of Biotechnology (Practical) 50 marks (2 Credit)

1. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein and DNA. (ii) To study relation between absorbance and % transmission.

2. Preparation of buffers.

3. Extraction of DNA and RNA.

4. PCR and Gel electrophoresis

5. SDS-PAGE and Western Blotting

SUGGESTED READING

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.

2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender.

3. Brown, T.A. (1998). Molecular biology Labfax 11: Gene analysis. II Edition. Academic Press, California, USA.3. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.

4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning, 2005.

5. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA.

SKILL ENHANCEMENT COURSE - 1

Course Name : Introduction to Biochemistry (Theory)

Course Code : BSCBTLSE101

<table>
<tr><td>Course Type: SE (Theory)</td><td colspan="2">Course Details: SEC-1</td><td colspan="2">L-T-P: 3-0-0</td></tr>
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</table>

UNIT I:

A historical perspective of Biochemistry. Molecular logics of life. Different levels of organization. Amino acids & Proteins: Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins. Denaturation and renaturation of proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoproteins and their biological functions

UNIT II

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

UNIT III

Carbohydrates Metabolism: Reactions, energetics. 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. ß-oxidation of fatty acids. Carbohydrates Metabolism: Reactions, energetics. 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. ß-oxidation of fatty acids. Human diseases associates with metabolic errors and or disorders.

UNIT – IV

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action and techniques for studying mechanisms of action, chemical modification of active site groups, specific examples-: chymotrypsin, lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feedback control, covalent modification. kinetics of allosteric enzymes. Isoenzymes Multienzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acid synthase.

SUGGESTED READING

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.

2. Harper's illustrated Biochemistry by Robert K. Murray, David A Bender.

3. Kathleen M.Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition,

McGrawHill, 2009.

4. Biochemistry by Mary K.Campbell & Shawn O.Farrell, 5th Edition, Cenage Learning, 2005.

5. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.

SEMESTER- II

MAJOR COURSE - 2

Course Name : Cell Biology (Theory)

Course Code : BSCBTLMJ201

<table>
<tr><td>Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-2</td><td colspan="2">L-T-P: 3 –0 – 4</td></tr>
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</table>

UNIT I

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III

Lysosomes: Vacuoles and micro bodies: Structure and functions Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.

UNIT IV

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cell cycle. Cell division: basic concept, types and check points. Cancer:

Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Paper MJC-2- Cell Biology (Practical) 50 marks (2 Credit)

1. Demonstration of dialysis.

2. Demonstration of plasmolysi and de-plasmolysis by Tradescantia/ Rhoeo leaf peel.

3. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.

4. Study of structure of any Prokaryotic and Eukaryotic cell.

5. Section cutting, double staining of plant parts like stem, root and leaves.

6. Mitotic Cell division in onion root tip

7. Meiotic cell division in Allium cepa and insect gonads (Grasshopper testis).

8. Study of chromosome aberration in Rhoeo discolor.

SUGGESTED READING

1. Karp, G. Cell and Molecular Biology: Concepts and Experiments. Latest Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology. Latest Edition.Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. Latest edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. The World of the Cell. Latest edition. Pearson Benjamin Cummings Publishing, San Francisco.

SKILL ENHANCEMENT COURSE - 2

Course Name : Industrial Fermentation (Theory)

Course Code : BSCBTLSE201

<table>
<tr><td>Course Type: SE (Theory)</td><td colspan="2">Course Details: SEC-2</td><td colspan="2">L-T-P: 3-0-0</td></tr>
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</table>

UNIT I:

Basic concept on Fermentation reaction and process. Types. Fermenters. Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes, microbial flavours andfragrances, newer antibiotics, anti-cancer agents.

UNIT II

Microbial products of pharmacological interest, steriod fermentations and transformations. Over production of microbial metabolite, Secondary metabolism - its significance and products. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT III

Purification & characterization of proteins. Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth. Ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT – IV

Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous cultureoperations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Easter Limited.

2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrin 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 Teclmology. 2nd edition, Elsevier Science Ltd.

SEMESTER- III

MAJOR COURSE - 3

Course Name : Genetics (Theory)

Course Code : BSCBTLMJ301

<table>
<tr><td>Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-3</td><td colspan="2">L-T-P: 3 – 0 – 4</td></tr>
<tr><td rowspan="3">Credit: 5</td><td rowspan="3">Full Marks: 100</td><td colspan="2">CA Marks</td><td colspan="2">ESE Marks</td></tr>
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UNIT I:

Classical and Modern concept of Gene (cistron, muton, recon, alleles etc).
Mendel's laws of inheritance, Verification of segregates by test and back crosses.
Chromosomal basis of inheritance.
Mendelian traits in man: Sex linked, Sex limited, Sex influenced inheritance.

UNIT II:

Exceptions to Mendelian Inheritance: Incomplete dominance, Codominance, Multiple allelism, Lethal alleles, Pleiotropy, Epistasis (Recessive, Duplicate recessive, Dominant and Duplicate dominant), Phenocopy, Polygenic inheritance.

UNIT III:

Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation (reciprocal and Robertsonian), position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy.

UNIT IV:

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, multiple crossing over Genetic mapping.

Paper MJC-3- Genetics (Practical) 50 marks (2 Credit)

1. Study of Rhoeo translocation.

2. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.

3. Study of polyploidy in onion root tip by colchicine treatment.

SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

MAJOR COURSE - 4

Course Name : Mammalian Physiology (Theory)

Course Code : BSCBTLMJ302

<table>
<tr><td>Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-4</td><td colspan="2">L-T-P: 3 –0 – 4</td></tr>
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UNIT I

Digestion: Mechanism of digestion & absorption of carbohydrates, proteins, lipids. Composition of saliva, bile, gastric and intestinal juice. Gastrointestinal hormones & their role in digestion.

UNIT II

Circulation: Composition of blood (blood plasma & blood cells); Hematopoiesis; Mechanism of coagulation of blood; Cardiac output, cardiac cycle, origin & conduction of heart beat.

Respiration: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Bohr effect, Haldane effect, Chloride shift.

UNIT III

Muscle physiology: Types of muscles; Structure of skeletal muscle; All or None law; Single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Excretion: Modes of excretion; Urea cycle; Ultra structure of nephron; Mechanism of urine formation (Glomerular filtration and tubular reabsorbtion).

UNIT IV

Nervous system: Mechanism of propagation of nerve impulse (in myelinated & non-myelinated fibre); Structure of synapse, synaptic conduction; Neurotransmitters.

Endocrine system: Structure & function of different endocrine glands: Hypothalamus, pituitary, pineal, thymus, thyroid, pancreas and adrenal glands; neuroendocrine integration.

Paper MJC-4- Mammalian Physiology (Practical) 50 marks (2 Credit)

1. Finding the coagulation time of blood

2. Determination of blood groups

3. Counting of mammalian RBCs

4. Determination of TLC and DLC

5. Demonstration of action of salivary amylase

6. Haemoglobin estimation [Sahli's method]

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.

2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition.John wiley & sons,Inc.

SEMESTER- IV

MAJOR COURSE - 5

Course Name : General Microbiology (Theory)

Course Code : BSCBTLMJ401

<table>
<tr><td>Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-5</td><td colspan="2">L-T-P: 3 – 0 – 4</td></tr>
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UNIT I:

History of Microbiology;

Classification of microorganisms: Microbial taxonomy & the criteria used (including molecular approaches), Microbial phylogeny and current classification of bacteria.

Morphology and cell structure: Major groups of microorganisms (e.g. Bacteria, Algae, Fungi, Protozoa and unique features of viruses).

UNIT II:

Cultivation and Maintenance of microorganisms; Nutritional categories of micro-organisms; Methods of isolation; Purification and preservation.

UNIT III:

Microbial growth: Growth curve, Generation time, Synchronous batch and continuous culture, Measurement of growth and factors affecting growth of bacteria.

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, transduction and conjugation; Endospores and sporulation in bacteria.

UNIT IV:

Control of Microorganisms: Use of physical, chemical and chemotherapeutic agents (antibacterial, antifungal & antiviral) and their mode of action.

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food microbiology (Moulds, Yeasts, bacteria). Major food born infections and intoxications. Preservation of various types of foods. Fermented foods.

Paper MJC-5- General Microbiology (Practical) **50 marks (2 Credit)**

1. Isolation of bacteria & their biochemical characterization.

2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.

3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.

4. Determination of bacterial cell size by micrometry.

5. Enumeration of microorganism - total & viable count.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 th edition. John and Sons, Inc.

2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi, India.

3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.

4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.

5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.

8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

MAJOR COURSE - 6

Course Name : Plant Physiology (Theory)

Course Code : BSCBTLMJ402

<table>
<tr><td>Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-6</td><td colspan="2">L-T-P: 3 –0 – 4</td></tr>
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UNIT I

Anatomy: Primary structure of shoot & root; Shoot and root apical meristem and their histological organization; Permanent tissues (simple & complex); Secondary growth, growth rings; Leaf anatomy (dorsi-ventral and isobilateral leaf)

UNIT II

Plant water relations and micro & macro nutrients: Plant-water relations, importance of water to plant life

Physiological processes: diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing.

Micro- & macro- nutrients: Definition & examples, Criteria for identification of essentiality of nutrients; Roles and deficiency symptoms of nutrients, Mechanism of uptake of nutrients, Mechanism of food transport

UNIT III

Carbon metabolism: Photosynthesis: Photosynthetic pigments, Concept of two photosystems, Photophosphorylation, Calvin cycle, C4 cycle, CAM plants, SAM, Photorespiration, Compensation point

Nitrogen metabolism: Nitrogen cycle; Nitrogen fixation in plants

UNIT IV

Growth and development: Definitions, Phases of growth, Growth curve, Growth hormones & their roles & mode of action (auxins, gibberlins, cytokinins, abscisic acid, ethylene), Phytochrome and its role, Seed dormancy and seed germination.

Paper MJC-6- Plant Physiology (Practical) 50 marks (2 Credit)

1. Study of evolution of oxygen during photosynthesis

2. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.

3. Demonstration of opening & closing of stomata

4. Preparation of root nodules from a leguminous plant.

5. Seed viability test using TTC.

6. Study of rate of transpiration per unit area of leaf.

SUGGESTED READING

1. Dickinson, W.C. Integrative Plant Anatomy. Harcourt Academic Press, USA.

2. Esau, K. Anatomy of Seed Plants. Wiley Publishers.

3. Fahn, A. Plant Anatomy. Pergmon Press, USA and UK.

4. Hopkins, W.G. and Huner, P.A. Introduction to Plant Physiology. John Wiley and Sons.

5. Mauseth, J.D. Plant Anatomy. The Benjammin/Cummings Publisher, USA.

6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, latest edition, W.H. Freeman and Company, New York, USA.

7. Salisbury, F.B. and Ross, C.W. Plant Physiology, Wadsworth Publishing Co. Ltd.

8. Taiz, L. and Zeiger, E. Plant Physiology, latest edition, Sinauer Associates Inc .MA, USA

SKILL ENHANCEMENT COURSE - 3

Course Name : Drug Designing (Theory)

Course Code : BSCBTLSE401

<table>
<tr><td>Course Type: SE (Theory)</td><td colspan="2">Course Details: SEC-3</td><td colspan="2">L-T-P: 3-0-0</td></tr>
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UNIT I:

Drug discovery: historical perspective and challenges.

Drug targets: Protein receptors (GPCR, enzyme-linked receptors & ion channel-linked receptors), Ion channels & pumps, transporters (GLUT 1 to 5); Inhibitors of transcription

Drug target identification and validation: Genetic mapping loci approaches for disease, Bioinformatics approaches (DNA & protein sequence/structural analysis)

Structure based drug design: active site detection, docking

Ligand based drug design: computational methods

UNIT II

Applications of Molecular Markers in Plant Breeding: strategies of drug designing & generation.

Preparation of active compounds: natural products, synthetic, semi synthetic compounds.

Identification procedures: high throughput screening and hit generation for small-&-large molecule drugs,

Optimization procedures: properties of druggable compounds (Lipinski Rule), pharmacokinetics and pharmacodynamics. Screening of lead molecules from phase I-IV to final drug molecules.

Pharmacogenomics: definition, its role in drug development and optimization.

SUGGESTED READING

1. Textbook of Drug Design Krogsgaard-Larsen, Liljefors and Madsen (Editors), Taylor and Francis, London UK, 2002.

2. Drug Discovery Handbook S.C. Gad (Editor) Wiley-Interscience Hoboken USA. 2005.

3. Advanced Computer Assisted Techniques in Drug Discovery in Methods and Principles in Medicinal Chemistry by Han van de Waterbeemd (ed.) Volume 3, 1994, Publishers, New York, NY (USA).

4. Virtual Screening for Bioactive Molecules by in Methods and Principles in Medicinal Chemistry, Edited by Hans-Joachim Bohm and Gisbert Schneider, Volume 10, 2000

5. Burger's Medicinal Chemistry and Drug Discovery, 6th Edition, Vol. 1. Principles and Practice, edited by M.E. Wolff, John Wiley & Sons: New York, 2003

6. Real world drug discovery: A chemist's guide to biotech and pharmaceutical research by Robert M. Rydzewski, Elsevier Science, I edition (2008)

7. Drug discovery and development: Technology in transition by Raymond G Hill, Churchill Livingstone, 2 edition (2012)

SEMESTER- V

MAJOR COURSE - 7

Course Name : Molecular Biology

Course Code : BSCBTLMJ501

<table>
<tr><td>Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-7</td><td colspan="2">L-T-P: 3 – 0 – 4</td></tr>
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UNIT I: DNA structure and replication

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases.

UNIT II: DNA damage, repair and homologous recombination

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, and site specific recombination.

UNIT III: Transcription and RNA processing

RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, RNA splicing and processing: processing of pre-mRNA: 5’ cap formation, polyadenylation, splicing, rRNA and tRNA splicing, Exon- shuffling; RNAi

UNIT IV: Regulation of gene expression and translation

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Posttranslational modifications of proteins.

PRACTICALS:

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method.
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell.

4. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

5. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

6. Maniatis, T., Fritsch, E. E., and Sambrook, J. (2003). Molecular Cloning, A laboratory Manual, Cold Spring Harbor Laborotory.

MAJOR COURSE - 8

Course Name : Animal Biotechnology

Course Code : BSCBTLMJ502

Course Type: **Major (Theoretical & Practical)**	Course Details: **MJC-8**			L-T-P: **3–0–4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

MINOR COURSE - 5

Course Name : Animal Biotechnology

Course Code : BSCBTLMN501

Course Type: **Minor (Theoretical & Practical)**	Course Details: **MNC-5**			L-T-P: **3–0–4**	
Credit: **5**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**15**	**20**	**35**

UNIT I

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

UNIT II

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

UNIT III

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and Its Applications.

UNIT IV

Modification in Gene - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

PRACTICALS:

1. Sterilization techniques: Theory and Practical: Glassware sterilization, Media sterilization, Laboratory sterilization
2. Sources of biological contamination and their decontamination measures.
3. Preparation of Hank's Balanced Salt Solution
4. Preparation of Minimal Essential Growth Medium
5. DNA isolation from animal tissue
6. Quantification of isolated DNA.
7. Resolving DNA on Agarose Gel.

SUGGESTED READING

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 DNAgenes and genomes- A short course. III Edition. Freeman and Co., N.Y., USA.

MAJOR COURSE - 9

Course Name : Chemistry-I: Physical and Organic Chemistry

Course Code : BSCBTLMJ503

<table>
<tr><td>Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-9</td><td colspan="2">L-T-P: 3–0–4</td></tr>
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<tr><td>30</td><td>15</td><td>20</td><td>35</td></tr>
</table>

UNIT I

Thermodynamics - Concept of energy, heat and work. Thermodynamies functions. internal energy, entropy, enthalpy and free energy. Bioenergetics Spontaneity equation in terms of entropy and concept of equilibrium. Transport across membranes. Donnan equilibrium.

UNIT II

Spectroscopy, Idea of electromagnetic radiation orbital theory. Concept of orbital. Beer'slaw and its importance. Fluorescence spectroscopy. Steady state fluorescence application in biology, UV-Vis spectroscopy.

UNIT III

Radioactivity: Alpha, beta, gamma radiation. Law of radioactive decay. Unit of radioactivity. Ides of artificial. Radioactivity and Application of radioactivity- Radiolabelling.

UNIT IV

Properties of molecules structure of atom, Electronic theory of valency, Dipole moment. Hydrogen bonds, Van der waal's interactions. Electrostatic interactions. Hydrophobic interactions Transition state theory. Arrhenius equation. Preliminary ideas about zero. 1 and 2 order reactions.

UNIT VI

Stereochemistry: Different types of isomerism- Geometric and Optical isomerism, Diostereoisomerism, Enantiomers, Chirality and asymmetricity in relation to biomolecules. Mesomerism. Racemic mod ifications.Stereochemical nomenclature, RS EZ, DL. Pro-R. Pro-S, Erythro and Threo designation of enantiotropic atoms. Fischer, Newman, Sawhorse and Wedge structures and their interconversion.

UNIT VII

Alkanes structural formulae, Nomenclature, Homologous series, Alkene, Conformational analysis, Alkenes and alkynes, orbital picture. Aliphatic compounds of sulphur, phosphorus, organometallic compounds. Grignard Reagent and use.

PRACTICALS:

1. Determination of partition coefficient of iodine between water and an organic solvent.
2. Determination of solubility product of a sparingly soluble salt by titrimetric method.
3. Detection of special elements (N,S,CI) and any one of the following functional groups in solid organic compounds: -NH2, -NO2, -CONH2, phenolic-OH, COOH, =CO, -CHO.
4. Verification of Beer's law and finding strengths of unknown solutions by colorimetry; (also, colour matching principle to find unknown concentrations

SEMESTER- VI

MAJOR COURSE - 10

Course Name : Plant Biotechnology

Course Code : BSCBTLMJ601

<table>
<tr><td>Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-10</td><td colspan="2">L-T-P: 3 – 0 – 4</td></tr>
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<tr><td>30</td><td>15</td><td>20</td><td>35</td></tr>
</table>

UNIT I

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

UNIT II

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

UNIT III

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation.

UNIT IV

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

PRACTICALS:

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

SUGGESTED READING

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

MAJOR COURSE - 11

Course Name : Immunology

Course Code : BSCBTLMJ602

<table>
<tr><td>Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-11</td><td colspan="2">L-T-P: 3–0–4</td></tr>
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<tr><td>30</td><td>15</td><td>20</td><td>35</td></tr>
</table>

UNIT I

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors.

UNIT II

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory

UNIT III

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing, Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV

Vaccines & Vaccination – adjuvants, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization.

PRACTICALS:

1. Haemagglutination assay
2. Haemagglutination inhibition assay
3. Double immunodiffusion test using specific antibody and antigen.
4. ELISA.

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.

2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.

3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.

4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.

5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.

6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

MAJOR COURSE - 12

Course Name : Bioanalytical Tool

Course Code : BSCBTLMJ603

<table>
<tr><td colspan="2">Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-12</td><td colspan="2">L-T-P: 3–0–4</td></tr>
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<tr><td>30</td><td>15</td><td>20</td><td>35</td></tr>
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UNIT I

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

PRACTICALS:

1. Native gel electrophoresis of proteins
2. Preparation of protoplasts from leaves.
3. Separation of amino acids by paper chromatography.
4. To identify lipids in a given sample by TLC.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
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.

MAJOR COURSE - 13

Course Name : Chemistry-II: Inorganic and Organic Chemistry

Course Code : BSCBTLMJ604

<table>
<tr><td colspan="2">Course Type: Major (Theoretical & Practical)</td><td colspan="2">Course Details: MJC-13</td><td colspan="2">L-T-P: 3–0–4</td></tr>
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<tr><td>Practical</td><td>Theoretical</td><td>Practical</td><td>Theoretical</td></tr>
<tr><td>30</td><td>15</td><td>20</td><td>35</td></tr>
</table>

UNIT I

Atomic Structure: Bohr's theory and its limitations, dual behaviour of matter and radiation,de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. Significance of quantum numbers, Shapes of s, p and d atomic orbitals Rules for filling electrons in various orbitals, Electronic configurations of the atoms,

UNIT II

Perlodic table and periodic properties: Periodic law,Periodic classification of elements on the basis of electron distribution,s,p-and d- block elements, positions of the elements in the long form of periodic table.Periodic properties; Atomic radii,lonic radii, Covalent radil, lonisation Potential, Electron affinity and electronegativity.

UNIT III

Radioactivity: Theory of disintegration, rate constant, half life period units of radioactivity,idea of disintegration series, artificial radioactivity, radioactive equilibrium,group displacement law,nuclear fission, fusion and spallation. Uses and abuses of radioactivity Stability of atomic nucleus,n/p ratio, binding energy, mass defect.

UNIT IV

Amino acids and protein: Essential and non essential amino acid, Isoelectric point, detection of amino acid (Ninhydrin reaction), peptide linkage, classification of protein, elementary idea about primary and secondary structure of protein, denaturation of proteins.

UNIT V

Carbohydrate Chemistry: Chemistry of monosaccharides; Structure and configuration of D-glucose and fructose, Structure determination of D- glucose, epimers and anomers,

mutarotation, osazone formation, stepping up and stepping down of monosaccharides, conversion of aldose to ketose and vice-versa

PRACTICALS: (2 Credits)

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of Fe (II) ions by titrating it with KCrO, using internal indicator.
3. Estimation of oxalic acid by titrating it with KMnO
4. Estimation of Cu (I) ions iodometrically using Na2S2O).