SYLLABUS OF M. Sc. DEGREE COURSES OFFERED UNDER HORIZONTAL MOBILITY PROGRAM
(Biochemistry/ Biotechnology/Microbiology/ Pharmaceutical Microbiology)
Department of Microbiology
Shivaji University, Kolhapur

The two years M. Sc. program under Horizontal Mobility concept is formulated for developing competent biochemists/biotechnologists/microbiologists for which significant job opportunities exist in this country and abroad. The course is based on interdisciplinary nature of Chemistry, Quantitative Biology, Genetics, Microbiology and Biophysics. The program obliges students to read original publications and envisages significant inputs in laboratory work, communication skill, creativity, planning, execution and critical evaluation of the studies undertaken. This program gives common basic knowledge (Biochemistry, Biomolecules, Enzymology, Molecular Biology, Tools and techniques, Basics of Physiology & Endocrinology) at first year level to become good biochemists/biotechnologists/microbiologists. The specializations introduced in the course at second year level are in the disciplines of Immunochemistry, Neurochemistry and Carcinogenesis, Genetic Engineering, Fermentation Technology, Bioinformatics, Clinical Biochemistry, Environmental Biochemistry and Toxicology, General Biotehnology, Plant Biotechnology, Microbiology and Microbial Technology.

SEMESTER I **600 Marks**

CC 101 A : Cell Biochemistry and Nucleic Acids (CBCS)

OR

CC 101 B : Cell Biology, Microbiology and Virology (CBCS)

CC 102 : Proteins: Structure and Functions

CC 103 : Biomolecules

CC 104 A : Basics of Physiology and Endocrinology (CBCS)

OR

CC 104 B : Biostatistics and Computer Applications (CBCS)

CCPR 105 : Laboratory Course

AEC 106 : Mandatory Non-CGPA Compulsory Ability Enhancement Course

SEMESTER II **600 Marks**

CC 201 : Enzymology

CC 202 : Molecular Biology

CC 203 : Bioenergetics

CC 204 : Tools and Techniques in Biosciences

CCPR 205 : Laboratory Course

SEC 206 : Mandatory Non-CGPA Compulsory Skill Enhancement Course

SEMESTER III **600 Marks**

CC 301 : Genetic Engineering

CCS 302 : Microbial Diversity and Extremophiles

CCS 303 : Fermentation Technology-I

DSE 304 B : Immunology

CCPR 305 : Laboratory Course
AEC 306 : Mandatory Non-CGPA Compulsory Ability Enhancement Course
EC 307 : (SWMMOOC) Food Microbiology and Food Safety

SEMESTER IV **600 Marks**

CC 401 : Food and Dairy Microbiology
CCS 402 : Microbial Fermentation Technology
CCS 403 : Bioinformatics
DSE 404 : Medical Microbiology
CCPR 405 : Laboratory Course and Project
SEC 406 : Mandatory Non-CGPA Compulsory Skill Enhancement Course
GE 407 : Basics of Microbiology

	SEMESTER I	
	CC 101 A: Cell Biochemistry and Nucleic Acids(CBCS)	**60 Hrs**
Credit I	**Water** Structure of water, interactions viz. ionic, polar-non polar, colligative properties of aqueous solutions. **Concept of pH** Henderson Hasselbalch equation, Concept of pKa,Buffers, titration curves, blood buffers and their regulation **Chemical Foundation** Concept of covalent bond, ionic bond, and coordinate bond,hydrogen bond,Vander Waals interactions, hydrophobic interactions, electrostatic interactions and London forces bond length and bond energy, **Thermodynamics** Laws of thermodynamics and their application to living systems. Concept of free energy, enthalpy, entropy and their relation to chemical equilibrium. Energy rich compounds ATP, Creatine phosphate. **Basics of evolution** Evolution of biomolecules, Miller's experiment, RNA as primitive catalysts, Evolution of prokaryotes and eukaryotes, **Introduction to Cell Biology** Cell as a basic unit of life. Cell organization of prokaryotic and eukaryotic cells. Structural and functional properties of cell organelles –mitochondria, chloroplast, lysosomes, golgi bodies, plasma membrane , cell wall, and nucleus.	**15 Hrs**
Credit II	**Cell cycle and cell division** Mitosis and meiosis, Chromosome structure, gene. Polytene and Lampbrush chromosome. Packing of DNA and supercoiled DNA, nucleosome, inverted repeats,satellite DNA, gene number, gene clusters and pseudogene.	**15 Hrs**
Credit III	**Nucleic Acids** Bases, sugars, nucleosides, nucleotides, oligonucleotides, polynucleotides. RNA: Ribosomal RNA (rRNA), messenger RNA (mRNA), small nuclear RNA (snRNA), transfer RNA (tRNA) and HnRNA DNA: Structure, base pairing, double helix, coding of genetic information, sense and antisense strands Molecular models of DNA: B-DNA, A-conformation, Z-confirmation	**15 Hrs**
Credit IV	**Nucleic Acid Metabolism** Biosynthesis and degradation of nucleotides: *de novo* pathways	**15 Hrs**

	and the salvage pathway. Degradation of nucleotides: difference in purine and pyrimidine degradation, generation of inosine monophosphate (IMP), allantoin, allantoinic acid, glyoxylate, release of uric acid and thyamine as intermediates, β-alanin, γ-aminoisobutyrate.	

Suggested Readings

1. Cells by David Prescott
2. Cell Structure and Function by Loewy and Gallant
3. Molecular Biology of the Cell by Albert Bruce et al, Garland Publication New York 1997
4. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
5. Biochemistry by LubertStryer, 4th Edition
6. Biochemistry by David Rawn

OR

	CC 101 B: Cell Biology, Microbiology and Virology (CBCS) (Offered by Department of Microbiology)	**60 Hrs**
Credit I	**Cell Biology** Cell as a basic unit of life. Cell organization of prokaryotic and eukaryotic cells. Structural and functional capitalization of cell – mitochondria, chloroplast, lysosomes, golgi bodies, plasma membrane and cytoskeleton, cell wall, nucleus.	**15 Hrs**
Credit II	Cell cycle, cell division - mitosis and meiosis.Chromosome structure, gene, gene number, gene clusters and Pseudogene. Polytene and lampbrush chromosomes. Packing of DNA, supercoiled DNA, nucleosome, Inverted repeats, repetitive DNA sequence, satellite DNA.Cell trafficking.	**15 Hrs**
Credit III	**Microbiology** Structure, classification and general characteristics of Bacteria (including ribotyping), Micoplasma, Protozoa, archea and yeast, fungi. Association of bacteria. Methods in microbiology: Pure culture techniques, principles of microbial nutrition, construction of culture media, enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. Sterilization-Application of sterilization methods in biotechnology, Various sterilization methods, Microbial contamination control and Sterility testing. Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture.	**15 Hrs**

Credit IV	**Virology** Classification and General properties of plant, animal and bacterial viruses, Bacteriophages - lytic cycle &lysogeny. Structure of viruses, assembly of viral membrane. Life cycle and replication of viruses:RNA-negetive strand (VSV), positive strand (Polio), segmented [Influenza], Retrovirus- RSV and HIV, DNA- adenovirus and SV-40, Cultivation in cell culture, chick embryo and animal inoculation.Persistent chronic and acute viral infections.Mechanism of interferon and antiviral therapy. Host virus interactions; plant and animal.	**15 Hrs**

Suggested Readings

1. Clark M S & Wall W. J. (1996) Chromosomes, Chapman & Hall, London.
2. Textbook of Medical Physiology by A.C. Guyton and J. E.
3. Hall, W.B. Saunders Publication, 9th Edition , 1996
1. Physiology Illustrated by Lipfold and Cogdell
2. Cells by David Prescott
3. Cell Structure and Function by Loewy and Gallant
4. Essential Cell Biology by Albert Bray et al, Garland
4. Publication New York 1997
5. Introduction to Modern Virology by Dimmock and
6. Primrose
7. Molecular Virology by Alan Cann
8. Madigam M.T., Martinko J.M and Parker J. (2001) Biology of Microorganisms 9th ed. Prentice Hall Int. (U.K.) Ltd, London.
9. General Microbiology by Stanier, Adelberg and Ingraham, The Macmillan Press Ltd, Hong Kong.

	CC 102: Proteins : Structure and Functions	**60 Hrs**
Credit I	**Amino Acids** Chemical structure and general properties,pI of amino acids, acid base concepts. General metabolism scheme of amino acids and Urea cycle. **Proteins** Classification- size, shape, degree of association, complexity. Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural, defense and regulatory). Structure of peptide bond - restricted rotation, cis - trans bending, Ramchandran plot.	**15 Hrs**
Credit II	Types of protein structures; Primary, Secondary structures - alpha helix and beta pleated structure, triple helix (collagen), Tertiary and quaternary structures, forces stabilizing tertiary and quaternary structures, prediction of secondary and tertiary structures. Unfolding / refolding experiment. Dynamics of protein folding,	**15 Hrs**

	role of molecular chaperones in protein folding, lysosomal and membrane proteins, structure function relationship - myoglobin and hemoglobin.	
Credit III	Techniques for studying primary sequence of proteins, end group analysis, finger printing and sequenators. Chemical synthesis of peptides/ solid phase automated synthesis, prediction of conformation from amino acid sequence, zymogens and their conversion into active proteins Protein evolution - convergent and divergent trees, Protein turnover: Ubiquitination, proteasome and protein degradation	**15 Hrs**
Credit IV	Concept of apoenzyme, holoenzyme, co-enzyme, prosthetic group. Vitamins as coenzymes: sources, requirements, functions and deficiency symptoms of water soluble vitamins, structure and biochemical role. Cofactors: Role of trace elements, their bound forms in biological systems and in enzyme structure and function.	**15 Hrs**

Suggested Readings

1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2. Biochemistry by LubertStryer, 4th Edition
3. Biochemistry by David Rawn
4. Principles of protein structure by Shulz and Schirmer
5. Fundamentals of Enzymology by Royer
6. Fundamentals of enzymology by Price and Steavens

	CC 103: Biomolecules	**60 Hrs**
Credit I	Introduction and classification of carbohydrates, Stereoisomerism in monosaccharides, Reactions of glucose and fructose, Mutarotation, Osazone formation, Cyclic structure of glucose and fructose , Glycosidic bonds , Disaccharides:maltose, lactose and sucrose Polysaccharides: Glycogen , Starch, Cellulose. Carbohydrates as informational molecules- The Sugar Code. Complex carbohydrates: Chitin,Pectin,Xylan,Agarose, Dextran, Peptidoglycan, Blood group antigens Lectins and Selectins. Glycosaminoglycans, Glycoconjugates: Proteoglycans, Glycoproteins, Enzymes responsible for oligosaccharide assembly, Glycoproteins Oligosaccharide linkages in glycoproteins, Protein glycosylation , Glycolipids, Lipopolysaccharides	**15 Hrs**
Credit II	Glycolysis, Feeder pathways for glycolysis ,Fates of pyruvate	**15 Hrs**

	under anaerobic conditions: Fermentation, Gluconeogenesis, Citric acid cycle, Glyoxylate cycle, Pentose phosphate pathway of glucose oxidation, Entner–Doudoroff pathway, Glucuronate pathway, Cori cycle. Principles of metabolic regulation illustrated with the metabolism of glucose and glycogen through insulin and glucagon, epinephrine action.Carbohydrate metabolic disorders.	
Credit III	**Lipids** Lipids- Introduction, Definition, Functions, Classification. Storage lipids, Fatty acids, Triacylglycerols, Waxes, Steroids, Structural lipids in membranes Lipids as signals, Prostaglandins, Clinical significance of lipids – LDL,HDL,VLDL,and chylomicrons .	**15 Hrs**
Credit IV	Beta oxidation of fatty acids and regulation, Role of acyl carnitine in fatty acyl transport. Synthesis of fatty acid - fatty acid synthetase complex, pathway and regulation. Synthesis of triacyl glycerides. Ketone bodies. Lipid metabolism disorders.	**15 Hrs**

Suggested Readings

1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2. Biochemistry by LubertStryer, 4th Edition
3. Biochemistry by Zubay
4. Biochemistry By Garrett and Grisham
5. Complex Carbohydrate by Nathan Sharon

	CC 104 A: Basics of Physiology &Endocrinology (CBCS)	**60 Hrs**
Credit I	**Gastro intestinal system**- General structure of alimentary canal and functions, Gastric secretion, Pancreatic secretion, Gastrointestinal hormones Digestion of carbohydrates, lipids and proteins **Liver** Structure and functions of liver in carbohydrate and lipid metabolism, synthesis of serum proteins, detoxification reactions Liver function tests – albumin/globulin, AST-ALT, alkaline phosphatase, Bilirubin – direct and indirect **Kidney** Structure and function of kidney. Structure of nephrons, Glomerular filtration, reabsorption and secretion mechanism. Kidney function tests - inulin clearance, urea, albumin/creatine ratio, GFR	**15 Hrs**

Credit II	**Nervous system** Structure and function of the brain. Central Nervous System, Peripheral and Autonomic Nervous system. Cells of Nervous System – Neurons, Astrocytes, Glial cells, Oligodendrocytes and Schwan cells. Utilization and uptake of glucose and amino acids, Blood – Brain barrier **Vision** Rod and cone cells, visual cycle, regulation of vision and color vision **Biochemistry of muscle contraction** Thick and thin filaments, interaction of actin and myosin in skeletal muscle contraction, regulation of muscle contraction by calcium Smooth muscle contraction and its regulation	**15 Hrs**
Credit III	General classification of hormones – Peptide hormones, steroid hormones and derivatives of amino acids. Secondary messenger signaling – cAMP, Ca^{++}, IP3, DAG cGMP **Pituitary Hormones** Hormones of anterior and posterior pituitary, Growth hormone – Gigantism, dwarfism and acromegaly, ACTH, TSH, prolactin, Vasopressin (ADH), Oxytocin and gonadotrophic hormones **Sex hormones** Estrogen, progesterone, testosterone functions. Menstrual cycle, and pregnancy	**15 Hrs**
Credit IV	**Thyroid hormones** Thyroxin (T3 & T4) its synthesis and regulation. Hyper and hypothyroidism, Graves disease, Myxoedema, Goitre and cretinism **Adrenal hormones** Adrenal cortical hormones – Glucocorticoids and mineralocorticoids, Cushings syndrome and Addisons disease, Adrenal medullary hormones – Epinephrine and nor- epinephrine – functions	**15 Hrs**

Suggested Readings

1. A Text Book of Medical Physiology by Guyton (Recent Edition).
2. Human Physiology by Davidson.
3. Illustrated Physiology by B. R. Mackenna and RobbinCallander
4. Hormones by Norman Litwack.
5. Basic and Clinical Endocrinology by Greenspan and Baster.
6. Biochemistry of Tissues by Banks.

OR

	CC 104 B: Biostatistics and Computer Applications (CBCS) **(Offered by Department of Microbiology)**	**60 Hrs**
Credit I	**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, pie diagram, histograms, cumulative frequency curves. Mean, median, mode, quartiles, measures of dispersion: range, quartile deviation, mean deviation, variance, standard deviation, coefficient of variation, symmetry: measures of skewness and kurtosis, examples. **Bivariate Data** Scatter plot, correlation coefficient (r), properties (without proof), Interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination, examples.	**15 Hrs**
Credit II	**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, error probabilities, level of significance, critical region, and P-value of the statistic. Tests for means, equality of means of normal populations when variances are unknown, test for proportions, test for equality of proportions. Chi-square test for independence, Confidence limits, Introduction to one way and two-way analysis of variance.	**15 Hrs**
Credit III	History of development of computers, generations of computers; (I, II, III, IV and V), classifications of computers; analog computers, digital computers, mainframe computers, miniframe computers, microcomputers, Hardware; CPU, input, output, storage devices. Software; operating systems, Programming languages (Machine, Assembly and Higher level). **Memory** Primary memory or main memory; magnetic core memory, RAM, ROM, PROM, EPROM, EEPROM. Secondary memory or auxillary memory	**15 Hrs**
Credit IV	**Computer Applications** Modern computers; Workstations, parallel processing computers, super-computers and servers for analysis of biological data. **Application Software** Introduction to MS-EXCEL, MS-WORD. Introduction to Internet and use of the same for communication, internet related programmes, searching of database, PubMed, NCBI, ENTREZ,	**15 Hrs**

	Data mining, Data management and interpretation.	

Suggested Readings:

1. Biostatistics: A foundation for Analysis in the Health Sciences 7/E Wayne W. Daniel, Wiley Series in Probability and Statistics.
2. Introductory Statistics. Fifth Edition. (2004) Prem S. Mann. John Wiley and Sons (ASIA) Pte Ltd.
3. Basic Statistics-Aprimer for Biomedical Sciences- (Olive Jean Dunn).
4. Biostatistics-An introductory text - (Auram Gold Stein).
5. Statistics : An Introductory Analysis (Taro Yamane) Harper and Row Publisher 1964,67,73
6. Computer Fundamentals, 6th Edition, P. K. Sinha and PritiSinha, BPB Publications, 2007.
7. Computational Biochemistry, By: C. Stan Tsai, A John Wiley & Sons, Inc., publication.

	CCPR 105: Laboratory Course **(120Hrs)** **200 Marks**
	Part A
1.	Introduction to basic laboratory instruments like – pH meter, colorimeter, single pan balance - calibration, centrifuge etc.
2.	Determination of total amino acid concentration by ninhydrin method.
3.	Estimation of protein concentration by i. Biuret method ii. Lowry method iii. Spectrophotometric method iv. Dye binding method
4.	Estimation of reducing sugar concentration by DNSA method
5.	Estimation total sugar concentration by i. Phenol-H_2SO_4 method ii. Anthrone method
6.	Estimation of glucose concentration by Glucose oxidase method
7.	Determination of fructose concentration by resorcinol method.
8.	Estimation of cholesterol

	Part B
1.	Estimation of vitamin C concentration by DCPIP method.

2.	Isolation and characterization of casein from milk.
3.	Isolation and characterization of starch from potato.
4.	Isolation of cholesterol and lecithin from egg yolk.
5.	Formal titration
6.	Detection of Carbohydrates
7.	Detection of Amino acids
8.	Studies on lipids: Acid value, saponification value and iodine number

Suggested Readings

1. Practical Biochemistry: An Introductory Course by Fiona Frais.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplaneds.
3. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M. Griffith
4. Biochemical Methods 2nd ed. by S. Sadasivam and A. Manickam.
5. Hawk's Physiological Chemistry ed. by Bernard L Oser.
6. A Textbook of Practical Biochemistry by David Plummer.
7. Laboratory Mannual in Biochemistry by S. Jayaraman.

	AEC 106 : Ability Enhancement Course	**30 Hrs**
Credit I	Syllabus and nature of paper will be opted as per committee decision.	**15 Hrs**
Credit II		**15 Hrs**

	SEMESTER II	
	CC 201: Enzymology	**60 Hrs**
Credit I	**Enzymes** Classification - IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Concept of binding energy. Transition state theory. **Enzyme Catalysis** Factors affecting catalytic efficiency - proximity and orientation effects , distortion or strain, acid - base and nucleophilic catalysis. Methods for studying fast reactions. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes.	**15 Hrs**
Credit II	**Enzyme Kinetics** Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions. Graphical procedures in enzymology - advantages and disadvantages of alternate plotting. Enzyme inhibition - types of inhibitors - competitive, non-competitive and uncompetitive, their mode of action and experimental determination. Enzyme activity, international Credits, specific activity, turnover number, end point kinetic assay	**15 Hrs**
Credit III	**Structure Function Relations** Lysozyme, ribonuclease, chymotrypsin, carboxypeptidase, phosphorylase, aspartate transcarbamylase, glutamine synthetase and phosphofructo kinase. Multi enzyme complexes - pyruvate dehydrogenase and fatty acid synthetase; Na^{+}-K^{+} ATPase.	**15 Hrs**
Credit IV	**Allosteric Interactions** Protein ligand binding including measurements, analysis of binding isotherms, co-operativity **,**Hill and Scatchard plots and kinetics of allosteric enzymes. **Enzyme Regulation** Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation. **Immobilized Enzymes** Relative practical and economic advantage for industrial use, Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids) ,microencapsulation and gel entrapment. Immobilized multienzyme systems	**15 Hrs**

	Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies based biosensors	

Suggested Readings

1. Fundamentals of Enzymology Price and Stevens
2. Enzymes Dixon and Webb
3. Isoenzymes By D. W. Moss
4. Immobilized Biocatalysts W. Hartneir
5. Selected papers Allosteric Regulation M. Tokushige

	CC 202: Molecular Biology	**60 Hrs**
Credit I	**Genome organization** Organization of bacterial genome, Structure of eukaryotic chromosomes; role of nuclear matrix in chromosome organization and function, matrix binding proteins, heterochromatin and euchromatin, transposable elements, DNA re-association kinetics (Cot curve analysis), repetitive and unique sequences, kinetics and sequence complexities, satellite DNA, DNA melting and buoyant density, DNase I hypersensitive regions, DNA methylation & imprinting.	**15 Hrs**
Credit II	**DNA Replication, Repair & Recombination** Concepts of replication initiation, elongation and termination in prokaryotes and eukaryotes, enzymes and accessory proteins involved in DNA replication, Fidelity in replication, replication of single stranded circular DNA. Gene stability and DNA repair DNA repair enzymes, photoreactivation, nucleotide excision repair, mismatch correction, SOS repair. Recombination: homologous and non-homologous recombination, site specific recombination, Holliday structure, resolution, chi sequences in prokaryotes, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination RecA and other recombinases.	**15 Hrs**
Credit III	**Prokaryotic & Eukaryotic Transcription** Prokaryotic Transcription & Regulation: Promoters, Regulatory elements, Transcription unit, constitutive and inducible promoter, operators, Initiation, Attenuation, Termination, Rho-dependent and independent termination, Anti-termination, Transcriptional regulation, positive and negative regulation, operon concept, Regulation of transcription of lac, trp, his operons, transcriptional control in lambda phage, Transcript processing, Processing of tRNA and rRNAEucaryotic transcription and regulation: RNA	**15 Hrs**

	polymerase structure and assembly, RNA polymerase I, II, III, Eukaryotic promoters and enhancers, General Transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), Activators and repressors, transcription initiation, elongation and termination, activation and repression, Transcriptional and post-transcriptional gene silencing, expression and processing of heterogeneous nuclear RNA, tRNA, rRNA, 5'-Cap formation,3'-end processing and polyadenylation, Splicing, RNA editing, Nuclear export of mRNA, mRNA stability.	
Credit IV	**Translation & Transport** The translation machinery, ribosomes, composition and assembly, Universal genetic code, degeneracy of codons, termination codons, isoacceptingtRNA, wobble hypothesis. Mechanism of initiation, elongation and termination, Co- and post-translational modifications, genetic code in mitochondria. Protein synthesis,	**15 Hrs**

Suggested reading

1. Stryer L (1995) Biochemistry, 4 th / 5 th edition, W. H. Freeman & company, New York.
2. Watson J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A. and Weiner, A. M. (1988) Molecular biology of the gene, 4 th edition, The Benjamin/Cummings publishing companies, inc, California.
3. Benjamin Lewin (1999) Genes VII, oxford University Press, Oxford.
4. Weaver R. F. (1999) Molecular biology, WCB McGraw-Hill companies, Inc, New York.
5. Brown T A (1995) Essential molecular biology, vol. I, A practical approach, IR press, Oxford.
6. Genes and Genomes Maxine Singer and Paul Berg

	CC 203: Bioenergetics	**60 Hrs**
Credit I	Oxidative phosporylation Biochemical anatomy of a mitochondrion, Mitochondrial Electron-TransportChain ,effects of inhibitors of electron transport. ATP Synthesis, Malate-aspartate shuttle, Glycerol 3-phosphate shuttle, Theories of oxidative phosphorylation, Peter Mitchell's Chemiosmotic model, Mitochondrial ATP synthase complex, Binding-Change mechanism for ATP Synthesis, , Regulation of oxidative phosphorylation, Uncouplers and ionophores	**15 Hrs**
Credit II	Photosynthesis: Harvesting light energy, Light absorption, Reaction centers organization of photosystems in the thylakoid membrane. Hill reaction, The central photochemical event: Light-driven electron flow ATP synthesis by photophosphorylation, Cyclic, noncyclic photophosphorylation, Carbohydrate biosynthesis in plants and bacteria, Photorespiration, Calvin cycle (C3) and Hatch-Slack pathway (C4), CAM	**15 Hrs**

	pathways, Biosynthesis of starch and sucrose ,Synthesis of cell wall polysaccharides.	
Credit III	Types of nitrogen fixation, Symbiotic and non-symbiotic nitrogen fixation. Nitrogen cycle, Root nodule formation,Nitrogenase enzyme complex - azoferredoxin and molybdoferrodoxin. Physiological electron donors and mechanism of nitrogen reduction, Nif genes and its regulation, Microbial fertilizers. Marine nitrogen fixation.	**15 Hrs**
Credit IV	Biotransformation of toxicants, Uptake and excretion of hydrophilic and lipophillic compounds, reactions phase I (modifications) phase II (conjugation) and phase III (transport) and their interrelationships, Monooxygenases, Cytochrome P450 (CYP) enzymes and Mixed function oxidases, biotranformation in animals, microorganisms, fungi, and plants, modifications in biotransformation, syndromes associated.	**15 Hrs**

Suggested Readings:

1. Biochemistry by LubertStryer 4th Edition.
2. Lehningers Principles of Biochemistry by Nelson and Cox.
3. Biological nitrogen fixation by Frans J. de Bruijn.
4. Detoxication Mechanisms by R.T.Williams 2nd Edition.

	CC 204: Tools and Techniques in Bioscience	**60 Hrs**
Credit I	**Fundamentals (Life Science)** General scheme for purification of bio-components. Methods for studying cells and organelles. Sub-cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cell. Ultrafiltration, freeze drying and fractional precipitation. Use of detergents in isolation of membrane proteins.	**15 Hrs**
Credit II	**Chromatography** Basic principles and applications of adsoption, ion-exchange, gel filtration, partition, affinity, HPLC and reverse phase chromatography, TLC, Paper chromatography. Chromatofocussing. **Centrifugation** Ultracentrifugation - velocity and buoyant density determination. Density gradient centrifugation, molecular weight determination.	**15 Hrs**
Credit III	**Electrophoresis** Basic techniques, poly acrylamide/ starch/ agarose gel electrophoresis, use of SDS/urea, isoelectric focusing, capillary	**15 Hrs**

	electrophoresis. Pulse field gel electrophoresis. **Tracer Techniques** Principles and applications of tracer techniques in biology, Measurement of alpha, beta and gamma radiations. Radiation dosimetry, Radioactive isotopes and half life of isotopes, Autoradiography, Cerenkov radiation, Liquid Scintillation spectrometry.	
Credit IV	**Principles and Biological Applications of Biophysical Techniques** X-ray diffraction, fluorescence, UV, visible, CD/ORD, NMR and Mass spectroscopy, atomic absorption spectroscopy. plasma emission spectroscopy, scanning and transmission electron microscopy, Atomic force microscopy **Plant Tissue Culture** Media requirements, sterilization and role of growth regulators. Requirements of a plant tissue culture laboratory. Caulogenesis and rhizogenesis, Micropropogation, Somatic cell hybridization, Haploid (anther) culture, Embryo culture, Protoplast fusion, Somatic embryogenesis Somaclonal variations, Cybrides and Allopheny. Cell suspension and callus culture. *Agrobacterium* mediated hairy root culture. Production of industrially important secondary plant metabolites like taxol, bioinsecticides, pigments, etc. Conditioning of tissue culture plants (weaning and hardening). Active principles in medicinal plants and phytochemistry of the metabolites of medicinal importance.	**15 Hrs**

Suggested Readings:

1. Protein Purification by Robert Scopes, Springer Verlag Publication, 1982
2. Tools in Biochemistry David Cooper
3. Methods of Protein and Nucleic acid Research, Osterman Vol I – III
4. Centrifugation D. Rickwood
5. Practical Biochemistry, V th edition, Keith, Wilson and Walker.
6. Wetter L.R and Canstabel eds. (1982) Plant Tissue Culture methods. Natl. Res. Council, Canada.
7. Marris. P., Scragg, A.H., Standford, A and Fowlew M.W eds. (1986) Secondary metabolism in plant tissue cultures. Cambridge UnivPress, Cambridge.
8. Komamine A., Misawa M and Dicosmo F eds. (1991) Plant cell culture in Japan. CMC Co. Ltd, Tokyo.

	CCPR 205: Laboratory Course **(120Hrs)** **200 Marks**
	Part A
1.	Separation and identification of amino acid mixture by i. Paper chromatography technique.

	ii. Paper electrophoresis technique
2.	Thin layer chromatographic separation of sugars and membrane lipids
3.	Separation and identification of serum proteins by polyacrylamide/agarose gel Electrophoresis (BSA/Hb).
4.	Separation of proteins (hemoglobin & cytochrome c) using molecular sievechromatography.
5.	Determination of capacity of ion exchange resin (Dowex- 50)
6.	Purification of protein by ion exchange chromatography. (DEAE cellulose chromatography)
7.	Determination of activity of invertase from immobilized cells of *Saccharomyces cerevisiae*
8.	Isolation and characterization of Glycogen from rat liver.

	Part B
1.	Identification and quantitation of activity of α amylase/ β amylase /cellulase/amyloglucosidase/invertase/alkaline phosphatase/Urease (salivary/microbial/animal/plant source).
2.	Determination of specific activity.
3.	Determination of activity in presence of activators.
4.	Determination of activity in presence of inhibitors.
5.	Determination of optimum pH.
6.	Determination of optimum temperature.
7.	Determination of Km.
8.	Determination of Competitive, non-competitive inhibitors.

Suggested Readings

1. Practical Biochemistry: An Introductory Course by Fiona Frais.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplaneds.
3. Basic Biochemical Methods 2nd ed by R.R.Alexander and J.M. Griffith
4. Biochemical Methods 2nd ed. by S. Sadasivam and A. Manickam.

5. Hawk's Physiological Chemistry ed. by Bernard L Oser.
6. A Textbook of Practical Biochemistry by David Plummer.
7. Laboratory Mannual in Biochemistry by S. Jayaraman.

	SEC 206 : Skill Enhancement Course	**30Hrs**
Credit I	Syllabus and nature of paper will be opted as per committee decision.	**15 Hrs**
Credit II		**15 Hrs**

	SEMESTER III	
	CC 301: Genetic Engineering	**60 Hrs**
Credit I	**Basics Of Recombinant DNA Technology** Restriction analysis: Types of restriction enzyme, Type I, II and III, restriction modification systems, type II restriction endonucleases and properties, isoschizomers and neoschizomers, mcr/mrr genotypes, Cohesive and blunt end ligation, linkers, adaptors, homopolymeric tailing. Labeling of DNA:Nick translation, random priming, radioactive and non-radioactive probes, use of Klenow enzyme, T4 DNA polymerase, bacterial alkaline phosphatase, polynucleotide kinase. Hybridization techniques: Northern, Southern, Western and Colony hybridization, Fluorescence in situ hybridization, Restriction maps and mapping techniques, DNA fingerprinting, chromosome walking & chromosome jumping. DNA-Protein Interactions: Electro mobility shift assay, DNase I footprinting, methyl interference	**15 Hrs**
Credit II	**Cloning Vectors** Gene Cloning Vectors: Plasmids (Natural and synthetic), bacteriophages, M13,MP vectors, phagemids, Lambda vectors; insertion and replacement vectors, EMBL, λDASH, λgt10/11, λZAP etc. Cosmid vectors. Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors- SV-40, vaccinia/bacculo& retroviral vectors. Expression vectors; pMal, GST, pET-based vectorsBaculovirus and *Pichia* vectors system. Applications: His-tag, GST-tag, MBP-tag etc. Restriction proteases, intein-based vectors. Inclusion bodies, methodologies to reduce formation of inclusion bodies.	**15 Hrs**
Credit III	**Cloning Methodologies** Insertion of Foreign DNA into Host Cells: Transformation, Transduction, Conjugation, Transfection: Chemical and physical methods, liposomes, microinjection, macroinjection, electroporation, biolistics, somatic cell fusion, gene transfer by pronuclear microinjection. Plant transformation technology: Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use of Ti and Ri as vectors. Cloning and expression in yeasts (Saccharomyces, Pichia etc.), animal and plants cells, methods of selection and screening, cDNA and genomic cloning, expression cloning, yeast two hybrid system, phage display. DNA Libraries: Construction of cDNA libraries in plasmids and screening methodologies, Construction of cDNA and genomic	**15 Hrs**

	DNA libraries in lambda vector, jumping libraries. Principles in maximizing gene expression.	
Credit IV	**PCR** Primer design, Fidelity of thermostable enzymes, DNA polymerases, Types of PCR: multiplex, nested, reverse transcriptase, real time, touchdown, hot start, colony, cloning of PCR products, T-vectors, proof reading enzymes, PCR in gene recombination, deletion, addition, overlap extension, and SOEing, site directed mutagenesis, PCR in molecular diagnostics, viral and bacterial detection, PCR based mutagenesis. **Applications** Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing, NextGene DNA sequencing Methods (SOLiD, Ilumina and pyrosequencing), RNA sequencing,Chemical Synthesis of oligonucleotides. Gene silencing techniques: Introduction to siRNA and siRNA technology, micro RNA, construction of siRNA vectors, principle and application of gene silencing. CRISPR, CRISPR/Cas9 technology. Gene knockouts and Gene Therapy: Creation of knockout mice, disease model, somatic and germ-line therapy in vivo and ex-vivo, suicide gene therapy, gene replacement, gene targeting. Other applications: Transgenics, Genome projects and their implications, application in global gene expression analysis. Applications of recombinant DNA technology in medicine, agriculture, veterinary sciences and protein engineering.	**15 Hrs**

Suggested readings:

1. Sambrook J, Fritsch E. F. and Maniatis (1989) Molecular cloning, vol. I, II, III, II nd edition, Cold spring harbor laboratory press, New York.
2. DNA Cloning : A practical approach D.M. Glover and D.B. Hames, RL Press, Oxford, 1995
3. Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W. Wu , D. Kim and L.J. Cseke, CRC Press Florida 1995
4. Methods in Enzymology Guide to Molecular Cloning Techniques, Vol. 152 S.L. Berger and A. R. Kimmel, Academic Press Inc, San Diego, 1996
5. Methods in Enzymology Gene Expression Technology, Vol. 185D. V. Goedel, Academic Press Inc, San Diego, 1990
6. DNA Science: A First Course in Recombinant Technology, D. A. Mickloss and G. A Freyer, Cold Spring Harbor Laboratory Press, New York, 1990
7. Molecular Biotechnology, 2nd Ed. S. B. Primrose, Blackwell Scientific publishers, Oxford, 1994
8. Milestones in Biotechnology, Classic Papers on Genetic Engineering, J. A. Davis and W. S. Reznikoff, Butterworth-Heinemann Boston 1992

9. Route Maps in Gene Technology, M. R. Walker, and R. Rapley, Blakwell Science, Oxford, 1997
10. Genetic Engineering : An Introduction to Gene Analysis and Exploitation in Eukaryotes, S. M. Kingsman, Blackwell Scientific Publications, Oxford, 1998
11. An Introduction to Genetic Engineering, 3rd Edition. Desmond S. T. Nicholl, Cambridge University press, 2008.
12. Gene Cloning and Manipulation, 2nd Ed. Cristopher Howe, Cambridge University Press, 2007.

	CCS 302: Microbial Diversity and Extremophiles	**60 Hrs**
Credit I	Microbial Ecology: Basic ecological principles, Ecosystems, Habitats, Ecological niches, microbial community, Population dynamics and ecosystem management, mathematical definitions and suitable examples of microbe-microbe interactions, microbe-plant interactions and microbe – animal interactions.	**15 Hrs**
Credit II	Microbial taxonomy: Brief study on: Algae: Classification, distribution, structure, nutrition and metabolism, reproduction, importance of Algae. Fungi; Classification, distribution, structure, nutrition and metabolism, reproduction, importance of Fungi. Protozoa ; Classification, nutrition, morphology, reproduction, of protozoa. Viruses; .General properties, classification and reproduction of viruses. Viroids and virusoids, Prions.	**15 Hrs**
Credit III	Study of types of Microbes with examples: Concept of autotrophy, Photosynthetic bacteria, Methanogens and methanotrophs, Nitrogen fixing bacteria, Acidophilic bacteria, Halophilic bacteria and Thermophilic bacteria.	**15 Hrs**
Credit IV	Other microbial interactions and its controls, with certain abiotic components of environment like wood, plastic, paints, rubber, pesticides, toxic heavy metals, etc.: Biodeteriorations, Bioremediations, Biotransformations and Biomagnifications and their significance with respect to environment and biodiversity. Role of microbes in secondary and tertiary recovery of petroleum.	**15 Hrs**

Suggested Readings

1. Extremophiles (2000) By B.N.Johari, Springer Verlag
2. Microbial Diversity (1999) By D. Colwd, Academic press
3. Microbial Ecology (1979) By J.M. Lynch and N.J.Poole, Blackwell Scientific Publications, Oxford.
4. Introduction to Modern Virology (2001) eds.: N.J.Dimmock and K.N.Leppard, Blackwell Scientific Publications, Oxford.

	CCS 303 A: Fermentation Technology-I	60 Hrs
Credit I	**Upstream Processing** Microbial cell growth, kinetics and stoichiometry, various methods for growth measurement, strain improvement by mutation, genetic engineering, etc. Overproduction of metabolites, alternative carbon and nitrogen sources and their composition. Development of innocula for industrial fermentation, design of industrial production media. Alternate metabolic routines for utilization of carbon sources with their regulation and inter-linkage especially for glucose and hydrocarbons, preservation and maintenance of microbes.	**15 Hrs**
Credit II	**Fermentation** Design of fermenter, construction materials, various sterilization techniques for solid, liquid and gases, aeration and agitation, foam, auxillaryequipments. Control of various parameters – online and offline monitoring, rheological properties of fermenter, role of computer in fermenter operation.	**15 Hrs**
Credit III	Batch, fed-batch, continuous fermentation and solid state fermentation. Effluent treatment, scale up and scale down. Types of fermenters, process economics, fermentation economics.	**15 Hrs**
Credit IV	**Downstream Processing** Principle, methodology, instrumentation and applications of cell homogenization techniques liquid-liquid extraction centrifugation, filtration, , distillation, ultrafiltration, precipitation, adsorption chromatography, ion exchange chromatography, gel filtration and affinity chromatography in clarification, concentration, isolation and purification of various metabolites from fermented media	**15 Hrs**

Suggested Readings

1. Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: I & II, Pergamon Press N.Y.
2. Ratledge C and Kristiansen B. eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ Press Cambridge.
3. Old R.W and Primose S.D (1995) Principles of Gene Manipulation 5th ed. Blackwell Scientific Pub. Oxford.
4. Bailey J.E and Ollis D.F. (1986) Biochemical Engineering Fundamentals 2nd ed. McGraw Hill Book Company, N. Delhi.
5. Aiba S, Humphrey A. E. and N. F. Millis (1973) Biochemical Engineering, 2nd Edition University of Tokyo Press, Tokyo, Japan.

6. Stanbury P.F., Whitaker A, and Hall S.J. (1997) Principles of Fermentation Technology 2 nded.Aditya Books Pvt. Ltd, N.Delhi.
7. Mukhopadhaya S.N. (2001) Process Biotechnology Fundamentals.Viva Books Pvt. Ltd. N.Delhi.
8. Rehm H.J and Reed G. (1985) Biotechnology vol. I & II. VCH, Basel.
9. Stainer R. Y. Ingrahm J. L., Wheelis M. L. and Painter P. R. (1987) General Microbiology 5th Edition, Macmillan Press Ltd. London.

	DSE 304 : Immunology	**60 Hrs**
Credit I	Immunology – fundamentals and anatomy of immune system A) Immunity – Innate and acquired immunity. Components of innate and acquired immunity. B) Antigen, Haptens, adjuvants, mitogens. Antibodies – structure, functions. C) The anatomy of the immune response: - Cells and organs of immune system. Regulation of immune response – Humoral and Cell mediated response.	**15 Hrs**
Credit II	Immunity to infection A) Antigen processing and presentation, MHC, complement system. T and B cell activation. B) Bacterial, viral, protozoan and parasitic infections with reference to (Diphtheria, influenza virus, malaria and helminthes) with specific representative examples of each group. C) Vaccines – Active and passive immunization, DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines.	**15 Hrs**
Credit III	Clinical Immunology A) Hypersensitivity: - Type I, II, III, and IV reactions. Autoimmunity – organ specific and systemic autoimmune diseases. Treatment of autoimmune diseases. B) Transplantation and tumor immunology: - Graft rejection, tissue typing, immunosuppressive therapy and clinical transplantation. Tumor antigens,cancer immunotherapy. C) Immunodeficiency diseases - Phagocytic, humoral, cell mediated deficiencies and SCID. AIDS- causes, syndrome, diagnostic tools, treatment and development of vaccine	**15 Hrs**
Credit IV	Immunotechnology A) Antigen antibody interactions – Principles, types and applications of agglutination, precipitation, complement fixation, viral neutralization, immunodiffusion, immunoelectrophoresis, ELISA and RIA. B) Monoclonal antibodies – Hybridoma technology and various cellular technologies.	**15 Hrs**

	C) Automation in immunological techniques – auto analyzers used in immunology, FACS etc.	

Suggested readings:

1. Kuby : Immunology; RA Goldsby, Thomas J. Kindt, Barbara A. Osborne.
2. Immunology by Roitt I. M., Brostoff J. and Male D. Gower medical publishing London.
3. Fundamentals of immunology 4th ed., Paul 1999, Lippencott Raven.

	CCPR 305: Laboratory Course (120 hrs) 200 Marks
	Part A
	1.Screening of antibiotic producers- crowded plate technique 2. Screening of organic acid producers & amine producers 3. Screening of Amylase, Protease & Lipase producers 4. Screening of Vitamin producers 5. Enrichment and isolation of pesticide resistant bacteria from soil 6. Isolation of thermophilic bacteria from soil 7. Isolation of acidophilic and alkalophilic bacteria from soil 8. Isolation of psychrophilic bacteria from soil 9. Isolation of halophilic and halotolerant bacteria 10. Determination of effective dilution of the given disinfectant to disinfect tables & vessels 11. Determination of effective dilution of the given disinfectant for effective disinfection of skin. 12. Determination of preservative effect of the given preservative 13. Determination of potability of the given water sample from microbiological point of view. 14. Estimation of heterotrophic bacterial count of the given sample. 15. Isolation of lysozyme from egg.

	Part B
	1. production of citric acid by *Aspergillus niger* 2. Transformation 3. Conjugation 4. ELISA 5. Western blot. 6. Transduction 7. Protoplast fusion 8. Gene expression 9. Preparation of plant tissue culture, formulation of media. 10. Isolation of cell wall and study of cell wall polysaccharide by chromatographic technique. 11. Laboratory Production of Bacillus thuringinesis insecticide and testing of its efficiency. 12. Production of biomass Azotobacter, Rhizobium, Azolla and preparation of biofertilizer from it.

	AEC 306 : Ability Enhancement Course	**30 Hrs**
Credit I	Syllabus and nature of paper will be opted as per committee decision.	**15 Hrs**
Credit II		**15 Hrs**

	EC (SWMMOOC) 307 : Food Microbiology and Food Safety	
Credit I	Syllabus and nature of paper will be opted as per SWAYAM portal.	
Credit II		

	SEMESTER IV	
	CC 401: Food and Dairy Microbiology	**60 Hrs**
Credit I	Contamination, Preservation and Spoilage of different kinds of foods: Cereal products, Sugar products, Vegetables and fruits, Meat and Meat products, Fish, Eggs, Milk and Milk products, Heated canned foods and other Miscellaneous foods. Fermented Foods: Pickles, Fermented soya products, Fermented products like Idli, Dhokla etc. Fermented vegetables -sauerkraut fermentation.Fermented bakery products.	**15 Hrs**
Credit II	Food poisoning: Staphylococal poisoning, botulinal poisoning, Salmonella, Vibrio, Bacillus cereus poisoning. Mycotoxins: Patulin, Aflatoxin, Ochratoxin, Luteoskyrin, Sterigmatocystin, ATA etc. Food borne infections: Study of food borne diseases Sterptococcal infections, Tuberculosis, Shigellosis, Brucellosis, Enteropathogenic viral infections, preventive measures.	**15 Hrs**
Credit III	Dairy Microbiology: Cheese fermentation, Fermented Milks, Butter, and other milk products. Indicator organisms. Spoilage and defects of fermented dairy products.	**15 Hrs**
Credit IV	Microbiological quality control of milk and milk products: ISI standards, FAO/WHO regulations, FDA regulations and APHA/IDF regulations. Principles of HACCP in Food industries, Quality Manuals and documentations for different products, Basic GMP in the industry.	**15 Hrs**

Suggested Readings:

1. Food Science (1996) Fifth Edition by Norman and Potter
2. Food Microbiology Frazier
3. Dairy Microbiology by J.S.Yadav, S. Grover, and V.K. Batish

	CCS 402: Microbial Fermentation Technology	**60 Hrs**
Credit I	Fermentation media: Functions of media components, media rheology and Newton's law of viscosity, Optimization of medium. Gas diffusion: Oxygen and Mass Balance Transfer relationship, Factors affecting gas diffusion Types of fermentations: Solid Surface culture type, Liquid surface culture, submerged fermentations.	**15 Hrs**
Credit II	Cultures: Isolation, Screening, Yield improvement by changing culture techniques, Strain improvement and preservation. Growth kinetics and yield kinetics.	**15 Hrs**

	Controls of fermentation: Principles of control system design, Flux control analysis, Command controls, Biosensors. Fermentation control options-Knowledge based system (KBS), Artificial neural networks (ANN) and Genetic algorithm (GA).	
Credit III	Modeling of fermentation processes: techniques of mathematical modeling. Process validation and quality assurance: bioprocesses, Approaches and Modeling a) Installation Qualification (IQ), Operational Qualification (OQ), and Performance Qualification (PQ) for laboratory instruments b) Methods of validation and calibration of equipments c) Documentation-importance and significance d) Current Good Manufacturing Practices (CGMP) and Currents Good Laboratory Practices (CGLP)	**15 Hrs**
Credit IV	Typical fermentation processes: Industrial production of i) Microbial enzymes ii) Bacitracin iii) Streptomycin vi) Riboflavin v) B-Carotene vi) Gibberellins vii) Surfactants	**15 Hrs**

Suggested Readings

1. Fermentation Microbiology and Biotechnology by M. Ei-Mansi and C. Bryce
2. Principles of Fermentation technology by Whitekar, Stanbury and Hall Modelling and Control of fermentation processes by J.R. Leigh
4. Microbial Technology Vol I and II by H. J. Peppler and D. Perlman. Academic Press

	CCS 403: Bioinformatics	**60 Hrs**
Credit I	**Proteomics: Protein Sequence Databases and Analysis** Protein sequence information, Primary protein sequence databases, Secondary protein sequence databases, Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM250, BLOSUM62, local and global sequence alignment, multiple sequence alignment, physicochemical properties using ExPASy, Useful programme; Clustal W. **Proteomics; Structural Databases, Protein Structure Prediction** Structural databases; Protein Data bank (PDB), Nucleic Acid Data Bank (NDB), Molecular modeling Data Bank (MMDB). Homology modeling, three-dimensional structure prediction,	**15 Hrs**

	protein folding and functional sites.	
Credit II	**Genomics: Nucleotide Sequence Databases And Analysis** Human Genome project (HGP); rough and final draft of HGP, goals of the HGP, genomics. Nucleotide Sequence databases: GenBank, EMBL, DNA Data Bank of Japan (DDBJ). Restriction enzymes, REBASE, Polymerase chain reaction, primer designing, Next Generation Sequencing, application of BioEdit. **Genomics: Gene Identification** Genome information and special features, coding sequences (CDS), untranslated regions (UTR's), cDNA library, expressed sequence tags (EST), 16S rDNA gene sequencing. Approaches to gene identification; masking repetitive DNA, database search, codon-bias detection, detecting functional sites in the DNA. Internet resources for gene identification. Construction of maps, genetic map, physical map, BLAST.	**15 Hrs**
Credit III	**Structural Biology** Ribose-ring puckering, RNA folding, Ramachandran plot, prediction of α-helix, β-sheet, and 3_{10}-helix, loop modeling, 3-D structure validation, molecular docking, protein-ligand interactions, biophysical aspects of proteins and nucleic acids. **Molecular Modeling** Functions of molecular modeling. Molecular mechanics, force field, potential energy functions, energy minimization methods, single point calculations, full-geometry optimization, conformational search, , molecular dynamics simulations, molecular modeling packages.	**15 Hrs**
Credit IV	**Microarrays** Concept of microarrays; spotted arrays, oligonucleotide arrays, Applications of microarray technology. Tools and Techniques in proteomics; Isotope Coded Affinity Tags (ICAT), Mass spectroscopy for protein analysis, MALDI-TOF, Electrospray ionization (EST), Tandem mass spectroscopy (MS/MS) analysis; tryptic digestion and peptide fingerprinting (PMF), profiling and diagnostics, drug target discovery. **Phylogenetic Analysis** Evolution, phylogenetic tree, methods of phylogenetic analysis; distance based and character based methods, phylogenetic analysis tool- Phylip.	**15 Hrs**

Suggested Readings

1. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
2. An introduction to Computational Biochemistry. (C. Stain Tsai, A John Wiley and Sons, Inc., publications).
3. Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).

4. Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
5. Bioinformatics, Sequence and Genome Analysis by David Mount, Cold Spring Harbor Laboratory Press, NY, 2004.
6. NCBI Web site: http://www.ncbi.nlm.nih.gov

	DSE 404: Medical Microbiology	**60 Hrs**
Credit I	Virulence: Invasion of pathogens through the different immunological barriers of human body. Establishment of infection. Role of portal of entry of the pathogen. Antigenic variations and virulence. Microbial toxins and super antigens. Carriers of infections. Epidemiology of certain diseases like urino-genital infections, upper respiratory tract infections, dermatological infections and gastero intestinal tract infections. Loss of virulence by many pathogens on subculturing on artificial media.	**15 Hrs**
Credit II	Epidemiology: Spread of certain infections in a population. Concept of epidemic, endemic and pandemic spread. Role of socioeconomic conditions in spread of disease. Epidemiological methods- descriptive, analytical and experimental epidemiology. Measurement of infection rate.	**15 Hrs**
Credit III	Chemotherapy: Development of drug resistance amongst pathogens – antibiotic resistance mechanisms. Disease management methods. Different prophylactic and therapeutic methods in control of infections.	**15 Hrs**
Credit IV	Clinical Microbiology: Collection and transportation of pathological samples with specialreference to samples like Cerebro Spinal Fluid (CSF), Sputum samples, Urine samples and swabs. Certain cultural techniques for pathogens like Dermatophytes, Salmonella, Meningococcus, Leptospira, Mycobacterium, Vibrio, Plasmodium spp, Wucheria bancriofti, and Ascaris lumbricoides. Rapid methods of identification of infection like ELISA, FAT, RIA and Western Blot techniques.	**15 hrs**

Suggested Readings

1. Introduction to Microbiology by Prescott, Harley, Klein
2. Medical Microbiology by Ananthanaryan
3. Medical Microbiology by Dey and Dey

	CCPR 405: Laboratory Course (120 Hrs) Total: 200 Marks **Part A (100 Marks)**	
	1. Fermentative production of gluconic acid. 2. Bioassay of streptomycin. 3. Fermentative production of wine. 4. Detection of adulteration in common food. 5. Detection of afla toxin in food and feed. 6. Chemical analysis of food – pH, benzoate, sorbate and colour. 7. Microbiological –MPN, Resazurin. Chemical – pH, fat, protein, sugar and ash, Physical – sp. gravity, different solid, test for grading of milk. 8. Platform test in dairy industry – COB, alcohol precipitation, titrable acidity test, quantitative phosphatase test. 9. Using RasMol through command line. 10. Pair-wise sequence alignment. 11. Multiple sequence alignment. 12. Introduction of BioEdit. 13. Construction of three-dimensional model by using SPARTAN 14. Model Building and Energy minimization. 15. Molecular Docking and Drug designing.	
	Part B (100 Marks)	
	Research Project	

	SEC 406 : Skill Enhancement Course	**30 Hrs**
Credit I	Syllabus and nature of paper will be opted as per committee decision.	**15 Hrs**
Credit II		**15 Hrs**

	GE 407 : Basics of Microbiology	**30 Hrs**
Credit I	**Introduction to Microbiology:** Origins of Microorganisms, differences between eukaryotic and prokaryotic cells, Bacterial cell structure and its physiology. Microbial growth: growth curves and kinetics of growth. Bacterial nutrition	**15 Hrs**
Credit II	**Techniques in microbiology:** Pure culture techniques: streak plate, pour plate, spread plate, Microscopy. Isolation of aerobic and anaerobic bacteria, Sterilization: different methods such as physical and chemical, antimicrobial test.	**15 Hrs**

Suggested readings:

1. Soil Microbiology by Alexender Martin
2. Soil and Soil Microbiology by Subbarao
3. Introduction to Microbiology by Prescott, Harley and Kein