

SU/BOS/Science/497

Date: 10/07/2023

To,

The Principal, All Concerned Affiliated Colleges/Institutions Shivaji University, Kolhapur	The Head/Co-ordinator/Director All Concerned Department (Science) Shivaji University, Kolhapur.
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Subject: Regarding syllabi of M.Sc. Part-II (Sem. III & IV) as per NEP-2020 degree programme under the Faculty of Science and Technology.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, nature of question paper and equivalence of M.Sc. Part-II (Sem. III & IV) as per NEP-2020 degree programme under the Faculty of Science and Technology.


M.Sc.Part-II (Sem. III & IV) as per NEP-2020			
1.	Microbiology (HM)	8.	Food Science & Nutrition
2.	Pharmaceutical Microbiology (HM)	9.	Food Science & Technology
3.	Microbiology	10.	Biochemistry
4.	Computer Science	11.	Biotechnology
5.	Computer Science (Online Mode)	12.	Medical Information Management
6.	Data Science	13.	Environmental Science
7.	Information Technology (Entire)	14.	Physics

This syllabus, nature of question and equivalence shall be implemented from the academic year 2023-2024 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2023 & March/April 2024. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,


Dy Registrar
Dr. S. M. Kubal

Copy to:

1	The Dean, Faculty of Science & Technology	8	P.G. Admission/Seminar Section
2	Director, Board of Examinations and Evaluation	9	Computer Centre/ Eligibility Section
3	The Chairman, Respective Board of Studies	10	Affiliation Section (U.G.) (P.G.)
4	B.Sc. Exam/ Appointment Section	11	Centre for Distance Education

Shivaji University, Kolhapur



Accredited By NAAC with 'A++' grade with CGPA 3.52

Syllabus for

Master of Science (M.Sc.)

In

Biochemistry (H.M.)

(NEP-2020)

(Under Faculty of Science and Technology)

M.Sc. Part II

(Subject to modifications to be made time to time)

Syllabus to be implemented from 2023-2024

Choice Based Credit System with Multiple Entry and Multiple Exit Option (NEP-2020)
M.Sc. Programme Structure
M.Sc. Part – II (Level-9)
M.Sc. Biochemistry (Horizontal Mobility) CBCS NEP Pattern

SEMESTER-III (Duration- Six month)											
	Sr. No.	Course code	Teaching Scheme			Examination Scheme					
			Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
			Lectures (per week)	Hours (per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
CGPA	1	CC-301: Genetic Engineering	4	4	4	80\$	32	3	20	8	1
	2	CCS-302: Biomembrane & Cytoskeleton	4	4	4	80\$	32	3	20	8	1
	3	CCS-303 A: Fermentation Technology-I OR CCS-303 B: Clinical Biochemistry-I OR CCS-303 C: Biochemical and Environmental Toxicology-I	4	4	4	80\$	32	3	20	8	1
	4	DSE-304: Immunology	4	4	4	80\$	32	3	20	8	1
	5	CCPR-305: Laboratory Course	16	16	8	200*	80	-	-	-	#
	Total (C)			-	-	24	520	-	-	80	-
Non-CGPA	1	AEC-306	2	2	2	-	-	-	50	20	2
	2	EC (SWMMOOC)-307:	Number of lectures and credit shall be as specified on SWAYAM MOOC								
SEMESTER-IV (Duration- Six month)											
CGPA	1	CC-401: Research Methodology, Entrepreneurship Development & Communication skills	4	4	4	80\$	32	3	20	8	1
	2	CCS-402: Neurochemistry and Carcinogenesis	4	4	4	80\$	32	3	20	8	1

	3	CCS-403: Bioinformatics	4	4	4	80\$	32	3	20	8	1
	4	DSE-404 A: Fermentation technology-II OR DSE-404 B: Clinical Biochemistry-II OR DSE-404 C: Biochemical & Environmental Toxicology-II	4	4	4	80\$	32	3	20	8	1
	5	CCPR-405: Laboratory Course and Project	16	16	8	200*	80	-	-	-	#
Total (D)			-	-	24	520	-	-	80	-	-
Non-CGPA	1	SEC-406	2	2	2	-	-	-	50	20	2
	2	GE-407 : Research Methodology and Entrepreneurship	2	2	2	-	-	-	50	20	2
Total (C + D)			-	-	48	1040	-	-	160	-	-

1. * Practical Examination Internal/External as per departmental choice.
2. \$ Question no. 01 of each question paper will be subjective (Short question instead of objective).
3. # Duration of practical examination will be 5 days (1 inspection day and 4 practical days).

<ul style="list-style-type: none"> • Student contact hours per week : 32 Hours (Min.) 	<ul style="list-style-type: none"> • Total Marks for M.Sc.-II : 1200
<ul style="list-style-type: none"> • Theory and Practical Lectures : 60 Minutes Each 	<ul style="list-style-type: none"> • Total Credits for M.Sc.-II (Semester III & IV) : 48
<ul style="list-style-type: none"> • CC-Core Course • CCS- Core Course Specialization • CCPR-Core Course Practical and Project • DSE-Discipline Specific Elective • AEC-Mandatory Non-CGPA compulsory Ability Enhancement Course • SEC- Mandatory Non-CGPA compulsory Skill Enhancement Course 	<ul style="list-style-type: none"> • Practical Examination is annual. • Examination for CCPR-305 shall be based on Semester III Practicals. • Examination for CCPR-405 shall be based on Semester IV Practicals. • *Duration of Practical Examination as per respective BOS guidelines • <i>Separate passing is mandatory for Theory, Internal and Practical Examination</i>

<ul style="list-style-type: none"> • EC (SWM MOOC) - Non-CGPA Elective Course • GE- Multidisciplinary Generic Elective 	
<ul style="list-style-type: none"> • Requirement for Entry at Level 9: Completed all requirements of the relevant Post Graduate Diploma (Level 8) in Post Graduate Diploma in Biochemistry 	
<ul style="list-style-type: none"> • Exit at Level 9: Students will exit after Level 9 with Master's Degree in Biochemistry if he/she completes the courses equivalent to minimum of 96 credits. 	

	M.Sc.-I	M.Sc.-II	Total
Marks	1200	1200	2400
Credits	48	48	96

I. CGPA course:

1. There shall be 10 Core Courses (CC) per programme.
2. There shall be 04 Core Course Specialization (CCS) of 16 credits per programme.
3. There shall be 02 Discipline Specific Elective (DSE) courses of 08 credits per programme
4. Total credits for CGPA courses shall be of 96 credits per programme

II. Mandatory Non-CGPA Courses:

1. There shall be 02 Mandatory Non-CGPA compulsory Ability Enhancement Courses (AEC) of 02 credits each per programme.
2. There shall be 01 Mandatory Non-CGPA compulsory Skill Enhancement Course (SEC) of 02 credits per programme.
3. There shall be one Elective Course (EC) (SWAYAM MOOC). The credits of this course shall be as specified on SWAYAM MOOC.
4. There shall be one Generic Elective (GE) course of 02 credits per programme. Each student has to take generic elective from the department other than parent department.
5. The total credits for Non-CGPA course shall be of 08 credits + 2-4 credits of EC as per availability.
6. The credits assigned to the course and the programme are to be earned by the students and shall not have any relevance with the work load of the teacher.

**Choice Based Credit System with Multiple Entry and Multiple
Exit Option (NEP-2020)
M.Sc. Part – II (Level-9)
M.Sc. Biochemistry (Horizontal Mobility) CBCS NEP Pattern**

SEMESTER III

CC 301	: Genetic Engineering
CCS 302	: Biomembranes & Cytoskeleton
CCS 303 A	: Fermentation Technology-I
	OR
CCS 303 B	: Clinical Biochemistry – I
	OR
CCS 303 C	: Biochemical and Environmental Toxicology- I
DSE 304	: Immunology
CCPR 305	: Laboratory Course
AEC 306	: Mandatory Non-CGPA compulsory Ability Enhancement Course
EC 307	: Non-CGPA Elective Course
(SWMMOOC)	Food Microbiology and Food Safety

SEMESTER IV

CC 401	: Research Methodology, Entrepreneurship Development & Communication skills
CCS 402	: Neurochemistry and Carcinogenesis
CCS 403	: Bioinformatics
DSE 404 A	: Fermentation Technology– II
	OR
DSE 404 B	: Clinical Biochemistry – II
	OR
DSE 404 C	: Biochemical and Environmental Toxicology- II
CCPR 405	: Laboratory Course and Dissertation (Project)
SEC 406	: Mandatory Non-CGPA compulsory Skill Enhancement Course
GE 407	: Generic Elective: Research Methodology and Entrepreneurship

	SEMESTER III	
	CC 301: Genetic Engineering	60 Hrs
Unit 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 assay.	15 Hrs
Unit II	Cloning Vectors Gene Cloning Vectors: Plasmids (Natural and synthetic), bacteriophages, M13, MP vectors, phagemids, Lambda vectors; insertion and replacement vectors, EMBL, λ DASH, λ gt10/11, λ ZAP etc. Cosmid vectors. Artificial chromosome vectors (YACs, BACs), Animal Virus derived vectors- SV-40, vaccinia/baculo & retroviral vectors. Expression vectors; pMal, GST, pET-based vectors Baculovirus and <i>Pichia</i> 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
Unit 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 (<i>Saccharomyces</i> , <i>Pichia</i> 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 DNA libraries in lambda vector, jumping libraries. Principles in maximizing gene expression.	15 Hrs

Unit IV	<p>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.</p> <p>Applications Sequencing methods: Enzymatic DNA sequencing, Chemical sequencing of DNA, principle of automated DNA sequencing, NextGene DNA sequencing Methods (SOLiD, Illumina and pyrosequencing), RNA sequencing, Chemical Synthesis of oligonucleotides.</p> <p>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.</p> <p>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.</p> <p>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.</p>	15 Hrs
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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: Biomembranes & Cytoskeleton	60 Hrs
Unit I	<p>Structure Historical perspectives, organization of lipids in micelles, liposomes. Components, properties and characterization of lipid bilayer. Assymetry, fluidity, lipid-lipid and lipid-protein interactions. Merits and demerits of various membrane models. Singer and Nicolson - fluid mosaic model.</p> <p>Assembly Of Biomembrane Biosynthesis and transport of phospholipids to plasma membrane and other organelle membranes. Role of transport proteins and flippase. Biosynthesis of membrane proteins. Topology of membrane proteins, Role of endoplasmic reticulum - post translational modifications, core glycosylation and targeting of proteins. Temporal problems in membrane flow and cycling. Targetting of proteins to plasma membrane, cell organelle and exoplasmic location, targetting signals and adaptor proteins. Role of Golgi bodies in protein glycosylation and targetting. Diseases associated with defect in protein targeting.</p>	15 Hrs
Unit II	<p>Transport Across Biomembranes Active , passive and facultative transport and ion channels. Symport and antiport system. Organization, mechanism and significance of Na^+ - K^+ ATPase, Na^+ - H^+ ATPase, and Ca^{++}-ATPase pumps. Inhibitory studies. Special bacterial transport systems.</p> <p>Permeases, Phosphotransferase system, transport through binding proteins. Transport of macromolecules. Endocytosis, pinocytosis and phagocytosis, receptor mediated endocytosis, transcytosis. Role of calcium, clathyrin and other associated proteins in receptor mediated endocytosis. Fates of receptors and ligands. Specialized transport systems. Transport antibiotics, gap junctions and nuclear pores. Transport of water – Aquaporins, Transepithelial transport of glucose / amino acids.</p>	15 Hrs
Unit III	<p>Signaling At Cell Surface Signaling molecules and cell surface receptors – hormones, growth factors. Signaling Molecules, Modes of Cell-Cell Signaling and their receptors. Synthesis of Nitric Oxide and Carbon Monoxide and their physiological significance</p>	15 Hrs

	Receptor Families G Protein – coupled receptors, Activation & inhibition of adenylyl cyclase, Activation of phospholipase C, Activation of gene transcription – CREB proteins, Cell adhesion – Cadherins, Selectins and Integrins, Extracellular matrix of cells – Proteoglycans, collagens, elastin, fibronectin and laminin	
Unit IV	Cytoskeleton Elements of cytoskeleton - microtubules, microfilaments and intermediary filaments. Role of cytoskeleton in maintenance of cell shape, providing structural rigidity, cell movement, phagocytosis, cell viscosity, transport and other functions. Factors influencing polymerisation of cytoskeletal elements. Inhibitors of association and dissociation of cytoskeletal elements. Mechanism of treadmilling. Erythrocyte and non-erythrocyte cytoskeletons. Microvillar cytoskeleton Cell – cell interactions - tight junctions, gap junctions, desmosomes and spot desmosomes.	15 Hrs

Suggested Readings

1. Molecular Cell Biology by H. Lodish, David Baltimore, et al W. H. Freeman Publication, 1996
2. Biological Membranes Findlay and Evans
3. Cell by Cooper
4. Biochemistry, Lubert Strayer IIIrd Edition.

	CCS 303 A : Fermentation Technology-I	60 Hrs
Unit 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 inocula 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
Unit II	Fermentation Design of fermenter, construction materials, various sterilization techniques for solid, liquid and gases, aeration and	15 Hrs

	agitation, foam, auxillary equipments. Control of various parameters – online and offline monitoring, rheological properties of fermenter, role of computer in fermenter operation.	
Unit 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
Unit 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 2nd ed. Aditya Books Pvt. Ltd, N.Delhi.
7. Mukhopadhyaya 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.

OR

	CCS 303 B: Clinical Biochemistry – I	60 Hrs
Unit I	Nutrition Major and minor nutrients, composition of food - calorific values, physiological fuel value, biological value and nitrogen	15 Hrs

	balance. Protein calorie malnutrition, Kwashiorkor and Marasmus. Nutrition in childhood, pregnancy old age and disorders such as diabetes, obesity, coronary disorders and in starvation.	
Unit II	Laboratory Setup And Safety Requirements of setting up of clinical laboratory, SI units in clinical laboratory, collection preparation, preservation, and handling of clinical samples, quality control, Safety measures in clinical laboratory. Formulation of clinical and diagnostic kits, Safety aspects. Enzymes And Analytes In Clinical Biochemistry Use of LDH, SGPT, SGOT, acid and alkaline phosphatase, amylase, lipase, cholesterol, albumin, creatinine etc. in diagnosis and monitoring of disorders	15 Hrs
Unit III	Blood Total and differential blood count, blood groups and Rh factor incompatibility, plasma proteins, types of anaemias and porphyries, molecular basis of hemoglobinopathies. Liver Bilirubin metabolism, types of jaundice and clinical assesment, Acute and chronic liver diseases, cirrhosis, viral, metabolic and drug induced/toxic liver diseases, liver cancer, liver function tests, non-invasive investigations of liver function.	15 Hrs
Unit IV	Kidney Glomerular filtration rate, Renal threshold and clearance values, disorders of kidney, renal failure and proteinuria, renal tubular disorders and renal stones Renal function tests, artificial kidney. Heart Ischemic heart disease, role of enzymes and other proteins in assessment of myocardial infarction. Hypertension – types and causes of hypertension, basis of drug therapy for hypertension.	15 Hrs

Suggested Readings

1. Clinical Chemistry by Kaplan L.A. and Pesce A. J. C. V. Mosby, 1989
2. Clinical Biochemistry by W. J. Marshall and S. K. Bangert, Churchill Livinston N.Y. 1995
3. Practical Clinical Biochemistry (Varley) by Gowenlock
4. Biochemical Aspects of Human Diseases by Elkeles and Tavill

OR

	CCS 303 C: Biochemical and Environmental Toxicology- I	60 Hrs
Unit I	Principles Of Toxicology Toxicants, therapeutic dose, dose-response curve, multiple	15 Hrs

	toxicants response, serum enzymes behavior, hepatic and non-hepatic enzyme change during toxicity.	
Unit II	Biotransformation Of Toxicants Toxicants entry and fate in living system, absorption, distribution, excretion and detoxification, phase I and phase II reactions and their interrelationships, components of mixed function oxidases, substrate - cytochrome P450 interactions, isoenzymes of cytochrome P450, inducers and inhibitors of microsomal metabolic transformation, lipoxygenase, lipid peroxidation, influence of various factors on the manifestation of toxicity. Extramicrosomal enzymes and their role in detoxification.	15 Hrs
Unit III	Mechanism Of Action Of Toxicants Chemotherapy - relation of chemical structure and biological activity, drug receptor interactions, effect of toxicants on structure, biosynthesis and catabolism of proteins lipids, carbohydrates and nucleic acids, toxic response of different tissues and organelles, tissue specificity.	15 Hrs
Unit IV	TOXICITY TESTING Test protocol, genetic toxicity testing and mutagenesis assays: In vitro test system- bacterial mutation test, reversion test, Ames test, fluctuation tests and eukaryotic mutation test. In vivo mammalian mutation tests, host mediated assay and dominant lethal test. DNA repair assays. Chromosome damage test. Toxicological evaluation of recombinant DNA-derived proteins.	15 Hrs

Suggested readings

1. Klaassen C D, Amdur M O & Doull J (1986) Casarett and Doull's Toxicology, III rd edition, Macmillan publishing company, New York.
2. Williams P L & Burson J L (1985) Industrial Toxicology, Van- Nostrand Reinhold, New York.
3. Hayes A W (1988) Principles and methods of toxicology, II nd edition, Raven press New York.
4. Stewart C P & Stolman A (1960) Toxicology, vol I, Academic press, New York.

	DSE 304 : Immunology	60 Hrs
Unit 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.	15 Hrs

	C) The anatomy of the immune response: - Cells and organs of immune system. Regulation of immune response – Humoral and Cell mediated response.	
Unit II	<p>Immunity to infection</p> <p>A) Antigen processing and presentation, MHC, complement system, T & B cell activation.</p> <p>B) Bacterial, viral, protozoal and parasitic infections with reference to (Diphtheria, influenza virus, malaria and helminthes) with specific representative examples of each group.</p> <p>C) Vaccines – Active and passive immunization, DNA vaccines, multivalent subunit vaccines, synthetic peptide vaccines.</p>	15 Hrs
Unit III	<p>Clinical Immunology</p> <p>A) Hypersensitivity: - Type I, II, III, and IV reactions. Autoimmunity – organ specific and systemic autoimmune diseases. Treatment of autoimmune diseases.</p> <p>B) Transplantation and tumor immunology: - Graft rejection, tissue typing, immunosuppressive therapy and clinical transplantation. Tumor antigens, cancer immunotherapy.</p> <p>C) Immunodeficiency diseases - Phagocytic, humoral, cell mediated deficiencies and SCID. AIDS- causes, syndrome, diagnostic tools, treatment and development of vaccine</p>	15 Hrs
Unit IV	<p>Immunotechnology</p> <p>A) Antigen antibody interactions – Principles, types and applications of agglutination, precipitation, complement fixation, viral neutralization, immunodiffusion, immunoelectrophoresis, ELISA and RIA.</p> <p>B) Monoclonal antibodies – Hybridoma technology and various cellular technologies.</p> <p>C) Automation in immunological techniques – auto analyzers used in immunology, FACS etc.</p>	15 Hrs

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.	Isolation of DNA and RNA. a) Separation of DNA by agarose gel electrophoresis
2.	Estimation of DNA and RNA a) Estimation of DNA by diphenyl amine method. b) Estimation of DNA by Spectrophotometric method. c) Estimation of RNA by orcinol method
3.	Induction of beta galactosidase in <i>E. coli</i>
4.	Estimation of specific aminoacids (Histidine, arginine, tyrosine and tryptophan)
5.	Isolation and characterization of cytochrome C - spectral analysis
6.	Isolation and characterization of hemoglobin
7.	Molecular cloning a) Plasmid vectors – extraction and purification b) Restriction sites in plasmid vectors c) Transformation of <i>E. coli</i> .

	Part B
1.	Isolation of lectin and study of sugar specificity – mannose, glucose, galactose, amino sugars
2.	Isolation of chlorophyll a and b - study of ratio in different plant material and absorption spectrum
3.	Separation of plant pigments by chromatographic methods.
4.	Immunodiffusion - antigen antibody interaction, precipitin lines immunoelectrophoresis.
5.	Assay of antibiotics - penicillin, gentamycin and streptomycin.
6.	Quantitative determination of Na ⁺ and K ⁺ by flame photometry
7.	Production and characterization of alcohol and alcoholic beverages
8.	Induction of Nitrate reductase in plant sources

Suggested Readings

1. Practical Biochemistry : An Introductory Course by Fiona Fraiss.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
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 Manual in Biochemistry by S. Jayaraman.

	AEC 306 : Mandatory Non-CGPA compulsory Ability Enhancement Course	30 Hrs
Unit I	Syllabus and nature of paper will be opted as per committee decision.	15 Hrs
Unit II		15 Hrs

	EC (SWMMOOC) 307 : Non-CGPA Elective Course Food Microbiology and Food Safety	
Unit I	Syllabus and nature of paper will be opted as per swayam portal.	
Unit II		

	SEMESTER IV	
	CC 401: Research Methodology, Entrepreneurship Development & Communication Skills	60 Hrs
Unit I	Research methodology Aims and objectives of research, Types of research – basic, novel and applied research. Tools for searching research topic – books, journals, internet, discussions etc. Research hypothesis, Steps in research design. Research Aptitude, Qualities of a researcher, Ethics in research – plagiarism Intellectual Property Rights Copyright, Trademark, geographical indicators, design, Patent, Role of patent in R & D, Criteria for patentability, Indian patent act, Provisional and final patent filing, writing claims, procedure for patent granting	15 Hrs
Unit II	Entrepreneurship Development Definitions, types, characteristics of Entrepreneur, Basics of Start-Ups, Definition of micro, small and medium scale industries, government facilities and subsidies/financial institutes supporting Start-Ups, Steps in setting up a business, selecting a business idea, market survey, information, market segmentation, market trends, SWOT analysis, Preparation of a Project Report Executive summary, Project description, Marketing plan, Capital structure and operating cost, Management/Financial/Technical plan, Project implementation.	15 Hrs
Unit III	GMP Definitions, requirements -Quality assurance, quality management, design of quality systems, -Principles for documentation in GMP, Monographs, Protocols (production protocols, standard operating procedures, SOP) -Quality control, chemical and radiochemical identity and purity, Guidelines for microbial and animal cell cultivation and animal usage. Communication Skills Basic process of communication; Types – verbal, nonverbal, channels, barriers. Aggressiveness, Assertiveness and submissiveness. Active listening, Modern tools of communication, Essential element of business communication: letters, minutes of the meeting, CV preparation, presentations, Interview skills.	15 Hrs
Unit IV	BIOSTATISTICS Basic terms, measures of central tendency and dispersion	15 Hrs

	<p>Population, Sample, variable, parameter, Frequency distribution, Mean median, mode, quartiles and measures of dispersion: range, variance, standard deviation, coefficient of variation, Graphical representation of data</p> <p>Probability And Distributions</p> <p>Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, Examples Bernoulli, Binomial, Poisson and Normal distributions. Mean and variance of these distributions (without proof).</p> <p>Bivariate Data</p> <p>Scatter plot, correlation coefficient (r), properties (without proof), Interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination.</p> <p>Hypothesis Testing</p> <p>Hypothesis, critical region, and error probabilities. Tests for proportion, equality of proportions, equality of means of normal populations when variance known and when variances are unknown. Chi-square test for independence. P-value of the statistic. Confidence limits, Introduction to one way and two-way analysis of variance, ANNOVA, Power Statistics.</p>	
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Suggested Readings

1. Principles of Management by Philip Kotlar.
2. E-book "Business Communication" by Lori Harvillmore
3. How to Effectively Communicate? By Paul Newton
4. Research Methodology: Methods and Techniques by C. R. Kothari, 2nd Edition, New Edge Publication.
5. Biostatistics by Sai Subramanian
6. Understanding Biostatistics by Kallen

	CCS 402: Neurochemistry and Carcinogenesis	60 Hrs
Unit I	<p>Neurotransmission</p> <p>Membrane potentials, Resting potential – Depolarization, repolarization and hyperpolarization, Action potential. Mechanism of axonal neurotransmission.</p> <p>Membrane channels – Types of channels, ion gated, voltage gated, chemically gated, mechanically gated and responsive to intracellular messengers.</p> <p>Neurotransmitters</p> <p>Synthesis, storage, release, uptake, degradation and action of neurotransmitters. Acetyl choline, GABA, Serotonin, Dopamine, Glutamate, Aspartate, Nitrous oxide, etc. Neuropeptides.</p> <p>Synaptic transmission – Cholinergic receptors – Nicotinic and</p>	15 Hrs

	<p>Muscarinic receptors, Agonists and Antagonists – their mode of action and effects. Adrenergic receptors, serpentine receptors and intracellular signaling. Fast and slow receptors.</p> <p>Exocytosis of neurotransmitter – Role of synapsins, synaptogamins, SNAP, SNARE and other proteins in docking, exocytosis and recycling of vesicles.</p>	
Unit II	<p>Learning and Memory Mechanism of short term memory and Long Term Potentiation. NMDA and AMPA glutamate receptors. Retrograde messengers in synaptic transmission. Role of CAM kinase II, Calcium, protein kinases, cAMP, NO, Calpain and other proteins in memory and learning process. Synaptic plasticity.</p> <p>Diseases Of Nervous System Molecular basis of Parkinson's disease, Alzheimer's disease, Schizophrenia, Myasthenia gravis and Multiple sclerosis.</p>	15 Hrs
Unit III	<p>Causes of Cancer Mutations: Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, transitions, transversions, physical, chemical and biological mutagens. Genetic factors, Viruses, Chemical carcinogenesis, Physical stresses, Hormonal factors</p>	15 Hrs
Unit IV	<p>Molecular Basis of Cancer Tumor cells and onset of Cancer, Characteristics of neoplastic and transformed cells, mechanism of metastasis, Angiogenesis, A multi-hit model of cancer induction, Gain and loss of function mutations, Accumulation of mutations and cancer, Oncogenes: RAS, SARC, ABL Tumor suppressors.</p> <p>Cancer Therapy Radiation, Chemotherapy and Immunotherapy</p>	15 Hrs

Suggested Readings

1. Neurochemistry by Ferdinand Hucho, VCH Publication, 1986
2. Molecular cell Biology by Lodish, Baltimore, et al W.H. Freeman & Co. !996
3. Basic Neurochemistry by M. P. Spiegel
4. Neuroscience by Dale Purvase
5. Cancer Biology by Raymond Ruddon
6. Oncogenes Burck Liu and Larrick
7. Toxicology by Stewart and Stoleman
8. Molecular Biology of Gene by Watson
9. Molecular Biology of the Cell by Alberts Bruce, Garland Publication, 1997

	CCS 403: Bioinformatics	60 Hrs
Unit I	<p>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.</p> <p>Proteomics; Strutural 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, protein folding and functional sites.</p>	15 Hrs
Unit II	<p>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.</p> <p>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.</p>	15 Hrs
Unit III	<p>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.</p> <p>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.</p>	15 Hrs
Unit IV	<p>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 (ESI), Tandem mass spectroscopy (MS/MS)</p>	15 Hrs

	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.	
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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 A : Fermentation Technology– II	60 Hrs
Unit I	Pharmaceutical Biotechnology Manufacturing by fermentative process and uses of Solvents – Ethanol, beer, wine, rum, whisky, butanol, Organic acids – Citric acid, Acetic acid, Lactic acid, Amino acids – l-glutamic acid, l-lysine, Extracellular enzymes – Amylase, protease, lipase, Renin, Glucose isomerase, Vitamins – Vitamin B group, Extracellular polysaccharides – Xanthan, pullulan, Antibiotics – B lactam - Penicillin, Anticancer – Adriamycin, Semisynthetic antibiotics.	15 Hrs
Unit II	Therapeutic proteins : Interferon, Monoclonal Antibodies L-asparaginase, Hormones – insulin, Single cell protein, Single cell oil, Bioplastics : Polyhydroxyalkonates, Biogas, Flavor enhancers – MSG, Biotransformation reactions, Ergot alkaloids, Flavor and fragrances	15 Hrs
Unit III	Environmental Biotechnology Bioremediation, Role of microbe in petroleum industry, Bioleaching / Biomining, Biotechnological applications of extremophiles, Waste treatment, Microbial desulphurisation of coal Food Biotechnology Cheese, Sauerkaut, edible mushroom, Baker's yeast	15 Hrs
Unit IV	Animal Tissue Culture Media requirements, preparation of medium and sterilization techniques. Advantages and disadvantages of natural and	15 Hrs

	synthetic media. Culture methods – hanging drop, suspension and monolayer culture. Behavior and characteristics of cells in culture. Primary and established cell lines, characteristics of transformed cells. Methods of cell preservation. Organ culture – clot grid, chorioallantoic and ocular culture, Applications of animal tissue culture – vaccines, cell biology, drug testing, medical applications, etc., Stem cells and their applications in medicine and tissue engineering	
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Suggested Readings

- 1 Moo-Young M. ed. (1985) Comprehensive Biotechnology vol: III & IV. Pergamon press. N.Y.
- 2 Rehm H.J and Reed G eds. (1985) Biotechnology vol: III – VIII. VCH, Basel.
- 3 Ratledge C and Kristiansen B eds. (2001) Basic Biotechnology 2nd ed. Cambridge Univ. Press. Cambridge.
- 4 Klegerman, M.E and Groves M.J. (1992) Pharmaceutical Biotechnology: Fundamentals and Essentials. Interpharm Press Ltd. Buffalo Grove IL.
- 5 Reed G. Ed. Prescott and Dunn's Industrial Microbiology . 4th edition CBS Pub. New Delhi.
- 6 Culture of Animal Cells by Ian Freshney.

OR

	DSE 404 B: Clinical Biochemistry– II	60 Hrs
Unit I	Inborn Errors Of Metabolism Disorders associated with carbohydrate metabolism- glycogen storage diseases, galactosemia Protein metabolism – phenylketonuria, albinism, alkaptonuria Lipid metabolism – Niemann – Pick disease, Tay-Sach's disease, I-cell disease Disorders due to chromosomal aberrations – Down's syndrome, Turner's syndrome, Klinefelter's syndrome molecular basis and symptoms.	15 Hrs
Unit II	Ageing Physiological and biochemical changes in ageing. Different theories of ageing, importance of superoxide dismutase in ageing, plasticity and regeneration.	15 Hrs
Unit III	Endocrine Disorders Disorders of pituitary, thyroid, pancreatic and adrenal secretions, biochemical assessment, handling of samples, biological and immunological assays, use of ELISA, RIA and IRMA techniques in assay of hormones.	15 Hrs

Unit IV	Neurological And Psychiatric Disorders Schizophrenia – types, symptoms, antipsychotic drugs Affective disorders - Unipolar and bipolar disorders, antidepressants Alzheimer's disease, Wernicke-Korsakoff syndrome, dementia, Wilson's disease Metabolic Disorders Gout, Atherosclerosis, Multiple sclerosis	15 Hrs
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Suggested Readings

1. Clinical Chemistry by Kaplan L.A. and Pesce A. J. C. V. Mosby, 1989
2. Clinical Biochemistry by W. J. Marshall and S. K. Bangert, Churchill Livingstone N.Y. 1995
3. Practical Clinical Biochemistry (Varley) by Gowenlock
4. Biochemical Aspects of Human Diseases by Elkeles and Tavill

OR

	DSE 404 C: Biochemical and Environmental Toxicology– II	60 Hrs
Unit I	Genetic Toxicology Chemical mutagenesis, screening of mutagens, genetic diseases. Nature, mechanism and biological features of chemical carcinogenesis, carcinogens. Teratogenesis, teratogens and their action. Pesticide Toxicology Insecticides: organochlorines, anticholinesterases-organophosphates and carbamates. Fungicides, herbicides. Environmental consequences of pesticide toxicity. Biopesticides.	15 Hrs
Unit II	Food Toxicology Toxicology of food additives, animal and plant toxins. Metal Toxicity Heavy metals: arsenic, mercury, lead and cadmium. Environmental factors affecting metal toxicity.	15 Hrs
Unit III	Environmental Toxicology Air, water and soil pollution, environmental pollutants and their control. Pathogenic microorganisms, use of microorganisms in waste management, leaching of environmental pollutants. Industrial effluent toxicology.	15 Hrs
Unit IV	An Overview Of Regulatory Agencies Responsibilities of regulatory agencies. Management of toxicological risk, regulatory approaches, regulatory system and organizations.	15 hrs

Suggested readings

1. Klaassen C D, Amdur M O & Doull J (1986) Casarett and Doull's Toxicology, III rd edition, Macmillan publishing company, New York.
2. Williams P L & Burson J L (1985) Industrial Toxicology, Van- Nostrand Reinhold, New York.
3. Hayes A W (1988) Principles and methods of toxicology, II nd edition, Raven press New York.
4. Stewart C P & Stolman A (1960) Toxicology, vol I, Academic press, New York.

	CCPR 405: Laboratory Course Marks	(120 Hrs) 200
	Part A	
1.	Estimation of Urea by DAM method	
2.	Determination of conjugated and total bilirubin by Van den Bergh's method.	
3.	<i>In vitro</i> amplification of sample DNA using PCR.	
4.	<i>Agrobacterium</i> mediated transformation and hairy root culture induction.	
5.	Western blot of intestinal alpha glucosidase.	
6.	Study of apoptosis / oxidative stress / DNA damage using fluorescent dyes.	
7.	Identification of caffeine using HPLC.	
8.	Separation of anthraquinones using HPTLC.	
9.	Identification of serum proteins using slab gel electrophoresis.	
10.	Isolation and separation of bacterial DNA using agarose gel electrophoresis.	
11.	Isolation of plant genome by CTAB microprep method.	
12.	<i>In vitro</i> callus development using leaf explants and its characterization.	
13.	Cultivation of hepatocytes and study of epinephrine action on hepatocytes.	
14.	Enzyme linked immuno-sorbent assay - peroxidase, Phosphatase.	
15.	Experiments with everted sacs of intestines, rate of absorption of amino acids and sugars.	
16.	Clinical Biochemistry a. analysis of blood group, creatinine, SGPT, SGOT b. Hemocytometric analysis	

17	Using RasMol through command line.
18	Pair-wise sequence alignment.
19	Multiple sequence alignment.
20	Introduction of BioEdit.
21	Construction of three-dimensional model by using SPARTAN.
22	Model Building and Energy minimization.
23	Introduction to Chimera.
24	Molecular Docking and Drug designing.
	Part B (100 Marks)
	Research Project

Suggested Readings

1. Practical Biochemistry: An Introductory Course by Fiona Fraiss.
2. Methods in Enzymology Vol. I by S.P.Colowick and N.O.Kaplan eds.
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 Manual in Biochemistry by S. Jayaraman.
8. Developing Bioinformatics computer skills – Cynthia Gibas and Per Jambeck
9. An introduction to Computational Biochemistry- C. Stan Tsai John Wiley and Sons, Inc., publications

	SEC 406 : Mandatory Non-CGPA compulsory Skill Enhancement Course	30 Hrs
Unit I	Syllabus and nature of paper will be opted as per committee decision.	15 Hrs
Unit II		15 Hrs

	GE 407 :Generic Elective: Research Methodology and Entrepreneurship	30 Hrs
Unit I	Research methodology Aims and objectives of research, Types of research – basic, novel and applied research. Tools for searching research topic –	15 Hrs

	<p>books, journals, internet, discussions etc.</p> <p>Research hypothesis, Steps in research design. Research Aptitude, Qualities of a researcher, Ethics in research – plagiarism</p> <p>Intellectual Property Rights</p> <p>Copyright, Trademark, geographical indicators, design, Patent, Role of patent in R & D, Criteria for patentability, Indian patent act, Provisional and final patent filing, writing claims, procedure for patent granting</p>	
Unit II	<p>Entrepreneurship Development</p> <p>Definitions, types, characteristics of Entrepreneur, Basics of Start-Ups, Definition of micro, small and medium scale industries, government facilities and subsidies/financial institutes supporting Start-Ups, Steps in setting up a business, selecting a business idea, market survey, information, market segmentation, market trends, SWOT analysis,</p> <p>Preparation of a Project Report</p> <p>Executive summary, Project description, Marketing plan, Capital structure and operating cost, Management/Financial/Technical plan, Project implementation.</p>	15 Hrs