Estd. 1962
"A++" Accredited by NAAC(2021) With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR - 416004, MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर - ४१६००४,महाराष्ट्र
दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दुरध्वनी विभाग २३१–२६०९०९३/९४

SU/BOS/Science/ 46 **Date: 20/ 10/ 2022**

To,
The Principal,
All Affiliated Concerned Science Colleges/Institutions
Shivaji University, Kolhapur.

Subject :- Regarding syllabi of M. Sc. Part- I (NEP-2020) degree programme Under the Faculty of Science and Technology as per National Education Policy 2020.

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 syllabi and Nature of question paper of **M. Sc. Part- I** under the Faculty of Science and Technology **as per National Education Policy 2020 .**

Sr. No.	Faculty of Science and Technology	Programme/ Course
1	Micro-Biology	M.Sc. Part -I General Microbiology
		M.Sc. Part -I Microbiology & Pharmaceutical Microbiology
		M.Sc. Part -I (Biochemistry/Biotechnology/Microbiology/ Pharmaceutical Microbiology) Horizontal Mobility

This syllabi and nature of question paper shall be implemented from the Academic Year **2022-2023** onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in (students Online Syllabus)

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

Thanking you,

Yours faithfully,

Dy Registrar

Copy to:

1	The Dean, Faculty of Science & Technology	7	Appointment Section
2	Director, Board of Examinations and Evaluation	8	P.G.Seminar Section
3	The Chairman, Respective Board of Studies	9	Computer Centre (I.T.)
4	B.Sc. Exam	10	Affiliation Section (U.G.)
5	Eligibility Section	11	Affiliation Section (P.G.)

SHIVAJI UNIVERSITY, KOLHAPUR.

Accredited By NAAC with 'A++' Grade

Syllabus For

M.Sc. Programme Structure M.Sc. Part – I (Level-8)

M.Sc. (Biochemistry/Biotechnology/Microbiology/Pharmaceutical Microbiology) CBCS Common Structure under Horizontal Mobility

(NEP-2020 PATTERN)

SEMESTER I AND II

(Syllabus to be implemented from June, 2022 onwards.)

SHIVAJI UNIVERSITY, KOLHAPUR

Horizontal Mobility

(Biochemistry, Biotechnology, Microbiology, Pharmaceutical Microbiology)
(To be implemented from June, 2022)

After going through syllabi of Biochemistry, Biotechnology, Microbiology and Pharmaceutical Microbiology subjects, it has been observed that there are many common papers and it could be possible to design a syllabus of such relevant courses under the concept of Horizontal Mobility (M.Sc. Sem I & II) where the common courses will be taught and the specialized courses in M.Sc. II, Sem III & IV will be opted for the second year from respective department. This could also help the stands from various courses to broaden their views as well asacquire interdisciplinary approach in the era of modern technology.

Specially, this Horizontal Mobility nurtures the knowledge of Biochemistry, Biotechnology, Microbiology & Pharmaceutical Microbiology among all students and make them able to face the challenges of 21st century. Under this roof, students can acquire knowledge of Biochemistry, Molecular Biology, Research Methodology, Tissue culture, Fermentation Technology & Bioinformatics, Biostatistics etc.

For the smooth conduct of the scheme and to implement this Horizontal Mobility Scheme effectively, University authorities have decided a common policy, which should be adopted by each department. Clarification is as under-

1. The syllabus of various departments Horizontal Mobility can be designed; in such a manner that I st year (sem I &II) syllabus of various courses under H.M. will be common and addition/deletion can be made by the department with approval of the concerned authorities.

2. Lectures of common paper will be conducted by Biochemistry department and all practical of M.Sc. I-II (sem I,II,III,IV) will be conducted by respective departments.

3. Flexibility is given to the concern department for M.Sc. II year (Sem III & Sem IV) far opting either common paper or separate paper as per the need of course

4. All infrastructures (equipment / laboratories / classrooms) will be shared by Biochemistry / Biotechnology / Microbiology department.

5. The course structure of all the courses will remain same.

6. There should be at least 15 weeks of actual teaching in each semester as per the UGC requirement. The department should prepare academic calendar of teaching lecture hours. Workload is as per UGC & State Govt. norms.

7. Under Evaluation Scheme, internal (C.I.E.) and External Evaluation Scheme, wherever applicable, will be in 20 : 80, i.e.80 marks for External University Examination and 20 marks for Internal Examination.

8. The record of Internal Test marks, theory papers, and answer books will be preserved in the department for a period of 1.5 years from the date of declaration of result. The review/ monitoringCommittee will verify/inspect the records of the department from time.

9. The flexibility given to department is related to syllabus, examination and teaching. However, it does not include financial flexibility or financial autonomy., It will be as per delegation of powers circulated by the Finance and Accounts Department.

10. The flexibility is not related to M.Phil. and Ph.D. Courses. For such courses existing rules willbe applicable.

11. Study tours/excursions will be conducted as per the existing guidelines decided by the Management Council.

12. Any other action/activity inviting financial implications should be undertaken only with the prior permission of the concerned authority or of the Hon.ble Vice- Chancellor.

13. The transparent system and procedures should be followed.

14. The standard of passing Examination Ordinances and Rules will be applicable as per the existing system.

15. The present scheme of class improvement will remain applicable. For students appearing under improvement of class. The internal marks already obtained will be final and will be carried forward.

16. The examination time-table / schedule should be prepared in consultation with Examination Section. If the dates of the examinations proposed by the department vary from those of University dates, then the department should conduct examination of their own department withtheir own teaching and non-teaching staff. However, stationary will be provided by the University.Remuneration will be paid as per University rules.

17. The appointments of paper setters, examiners, moderators, supervisors, junior supervisors and administrative staff etc. will be made as per University Act/Conventions.

18. Three sets of each question paper should be prepared by the paper-setters. The said should besubmitted to branch board of examination for final selection draw and printing before 30 days. Nature of question paper should be per UGC guidelines and suggested by Examination Reform Committee.

19. There will be chairman for each examination.

20. The assessment of the University theory examination will be done in the department However, coding and decoding and such other matters will be done by the Examination Section. Result-sheet should be forwarded to Director Board of examination signed by Head and Chairmanin ledger form (provided by the University).

21. Director Board of examination will declare the results and issue the mark list and other certificates under his signature.

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Choice Based Credit System with Multiple Entry and Multiple Exit Option (NEP-2020)
M.Sc. Programme Structure M.Sc. Part – I (Level-8)
M.Sc. (Biochemistry/Biotechnology/Microbiology/Pharmaceutical Microbiology) CBCS Common Structure under Horizontal Mobility

SEMESTER-I (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 101A:** Cell Biochemistry and Nucleic Acids **OR** **CC-101B**: Cell Biology, Microbiology and Virology	4	4	4	80$	32	3	20	8	1
	2	**CC-102**: Proteins: Structure and Functions	4	4	4	80$	32	3	20	8	1
	3	**CC-103**: Biomolecules	4	4	4	80$	32	3	20	8	1
	4	**CC-104A:** Basics of Physiology and Endocrinology **OR** **CC-104B**: Biostatistics and Computer Applications	4	4	4	80$	32	3	20	8	1
	5	**CCPR-105:** Laboratory Course	16	16	8	200*	80	-	-	-	*
Total (A)			**-**	**-**	**24**	**520**	**-**	**-**	**80**	**-**	**-**
Non-CGPA	1	**AEC-106**	2	2	2	-	-	-	50	20	2
SEMESTER-II (Duration- Six month)											
CGPA	1	**CC-201:** Enzymology	4	4	4	80$	32	3	20	8	1
	2	**CC-202**: Molecular Biology	4	4	4	80$	32	3	20	8	1
	3	**CC-203:** Bioenergetics	4	4	4	80$	32	3	20	8	1
	4	**CC-204:** Tools and Techniques in Biosciences	4	4	4	80$	32	3	20	8	1
	5	**CCPR-205**: Laboratory Course	16	16	8	200*	80	-	-	-	*
Total (B)			**-**	**-**	**24**	**520**	**-**	**-**	**80**	**-**	**-**
Non-CGPA	1	**SEC-206**	2	2	2	-	-	-	50	20	2
Total (A + B)			**-**	**-**	**48**	**1040**	**-**	**-**	**160**	**-**	**-**

1. ***Practical Examination will be internal/external as per department choice**
2. **$ Question no. 1 of each question paper will be subjective (short answer question / objective questions)**
3. **# Duration of Practical Examination will be 5 days (1 inspection day and 4 Practical days)**

• Student contact hours per week : **32** Hours (Min.)	• Total Marks for M.Sc.-I : **1200**
• Theory and Practical Lectures : **60** Minutes Each	• Total Credits for M.Sc.-I (Semester I & II) : **48**
• CC-Core Course • CCPR-Core Course Practical • AEC-Mandatory Non-CGPA compulsory Ability Enhancement Course • SEC- Mandatory Non-CGPA compulsory Skill Enhancement Course	• Practical Examination is annual. • Examination for CCPR-105 shall be based on Semester I Practicals. • Examination for CCPR-205 shall be based on Semester II Practicals. • *Duration of Practical Examination as per respective BOS guidelines • *Separate passing is mandatory for Theory, Internal and Practical Examination*
• **Requirement for Entry at Level 8:** A candidate possessing B.Sc. Degree with minimum 50% marks with Biotechnology/ Chemistry/ Biochemistry/ Microbiology/ Botany /Zoology/B.Pharma./ MBBS / B.E. / B.Sc. Agri /life sciences as principal subject with chemistry at B.Sc. I, and who have passed the entrance examination conducted by the Shivaji University shall be held eligible for admission to M.Sc. Students from other Universities with B.Sc. General degree and who have passed the entrance examination conducted by the University are also eligible.	
• **Exit Option at Level 8:** Students can exit after Level 8 with **Post Graduate Diploma in Pharmaceutical Microbiology** if he/she completes the courses equivalent to minimum of 48 credits.	

SYLLABUS OF M. Sc. DEGREE COURSES OFFERED UNDER HORIZONTAL MOBILITY PROGRAM

(Biochemistry/ Biotechnology/Microbiology/Pharmaceutical Microbiology)

Nodal Department: Department of Biochemistry
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 Biotechnology, Plant Biotechnology, Microbiology and Microbial Technology.

SEMESTER I **600 Marks**

CC-101A	**Cell Biochemistry and Nucleic Acids (CBCS)**
	OR
CC -101B	**Cell Biology, Microbiology and Virology (CBCS)**
	(Offered by Department of Microbiology)
CC- 102	**Proteins: Structure and Functions**
CC -103	**Biomolecules**

CC-104A	**Basics of Physiology and Endocrinology (CBCS)**
	OR
CC -104B	**Biostatistics and Computer Applications (CBCS)**
	(Offered by Department of Microbiology)
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 Bioscience**
CCPR -205	**Laboratory Course**
SEC- 206	**Mandatory Non-CGPA compulsory Skill Enhancement Cou**

SEMESTER I		
CC -101A: 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, Van der 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 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.	**15 Hrs**

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 Lubert Stryer, 4th Edition
6. Biochemistry by David Rawn

OR

CC -101B: 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 Pseudo gene. Polytene and lamp brush 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

- Clark M S & Wall W. J. (1996) Chromosomes, Chapman & Hall, London.
- Textbook of Medical Physiology by A.C. Guyton and J. E. Hall, W.B. Saunders Publication, 9th Edition , 1996
- Physiology Illustrated by Lipfold and Cogdell
- Cells by David Prescott
- Cell Structure and Function by Loewy and Gallant
- Essential Cell Biology by Albert Bray et al, Garland Publication New York 1997
- Introduction to Modern Virology by Dimmock and Primrose
- Molecular Virology by Alan Cann
- Madigam M.T., Martinko J.M and Parker J. (2001) Biology of Microorganisms 9th ed.
- Prentice Hall Int. (U.K.) Ltd, London.
- 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. Henderson and Hasselbaclh equation. 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, role of molecular chaperones in protein folding, lysosomal and membrane proteins, potassium ion channel. Structure function relationship - myoglobin and hemoglobin.	**15 Hrs**
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 prosthetic group, apoenzyme, holoenzyme, enzyme. 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

- Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
- Biochemistry by Lubert Stryer, 4th Edition
- Biochemistry by David Rawn
- Principles of protein structure by Shulz and Schirmer
- Fundamentals of Enzymology by Royer
- Fundamentals of enzymology by Price and Steavens

CC- 103: Biomolecules		**60 Hrs**
Credit I	Introduction and classification of carbohydrates, Stereoisomers in monosaccharides, Reactions of glucose and fructose, Reducing sugar, Mutarotation, Osazone formation, Cyclic structure of glucose and fructose , Glycosidic bonds , Disaccharides, Polysaccharides: Glycogen , Starch Cellulose. Carbohydrates as informational Molecules- The Sugar Code. Digestion and absorption of carbohydrates. Complex carbohydrates: Chitin, Pectin Xylan Agarose Dextran Peptidoglycan Blood group antigens, Lectins carbohydrate binding proteins. Selectins. Glycosaminoglycans, Glycoconjugates: Proteoglycans, Glycoproteins, Enzymes responsible for oligosaccharide assembly, Glycoproteins Oligosaccharide linkages in glycoproteins, Protein glycosylation , Glycolipids, Lipopolysaccharides, Methods of carbohydrate analysis.	**15 Hrs**
Credit II	Principles of bioenergetics ,Glycolysis, Feeder pathways for glycolysis ,Fates of pyruvate 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, The Metabolism of glycogen in animals, Coordinated regulation of glycolysis and gluconeogenesis, Coordinated regulation of glycogen synthesis and breakdown, Analysis of metabolic control.	**15 Hrs**
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, Characterization of lipids.	**15 Hrs**
Credit IV	Digestion, mobilization, and transport of fats, Beta oxidation of fatty acids pathway 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

- Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
- Biochemistry by Lubert Stryer, 4th Edition
- Biochemistry by Zubay
- Biochemistry By Garrett and Grisham
- Complex Carbohydrate by Nathan Sharon

CC- 104A: 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 Robbin Callander
4. Hormones by Norman Litwack.
5. Basic and Clinical Endocrinology by Greenspan and Baster.
6. Biochemistry of Tissues by Banks.

OR

CC- 104B: 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 andtwo-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, Data mining, Data management and interpretation.	**15 Hrs**

Suggested Readings

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

CCPR- 105: Laboratory Course	**(120 Hrs)**
	A **100 Marks**
•	Introduction to basic laboratory instruments like – pH meter, colorimeter, single pan balance - calibration, centrifuge etc.
•	Determination of total amino acid concentration by ninhydrin method.
•	Estimation of protein concentration by • Biuret method • Lowry method • Spectrophotometric method • Dye binding method
•	Estimation of reducing sugar concentration by DNSA method
•	Estimation total sugar concentration by • Phenol-H_2SO_4 method • Anthrone method
•	Estimation of glucose concentration by Glucose oxidase method
•	Determination of fructose concentration by resorcinol method.
•	Estimation of cholesterol
	B **100 Marks**
•	Estimation of vitamin C concentration by DCPIP method.
•	Isolation of Characterization of casein from milk.
•	Isolation and characterization of starch from potato.
•	Isolation of cholesterol and lecithin from egg yolk.
•	Formal titration
•	Detection of Carbohydrates
•	Detection of Amino acids
•	Studies on lipids: Acid value, saponification value and iodine number

AEC 106	**Mandatory Non-CGPA compulsory Ability Enhancement Course**	**30 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. 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, trypsin, 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, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and Km). Various	**15 Hrs**

	methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids) , microencapsulation and gel entrapment. Immobilized multienzyme systems Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors	

Suggested Readings

- Fundamentals of Enzymology Price and Stevens
- Enzymes Dixon and Webb
- Isoenzymes By D. W. Moss
- Immobilized Biocatalysts W. Hartneir
- 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, molecular components, DNA re-association kinetics (Cot curve analysis), repetitive and unique sequences, kinetics and sequence complexities, satellite DNA, DNA melting and buoyant density, packing and organization of chromatin, nucleosome phasing, DNase I hypersensitive regions, DNA methylation & Imprinting. **Mutation** Nonsense, missense and point mutations, intragenic and intergenic suppression, frameshift mutations, transitions, transversions, physical, chemical and biological mutagens.	**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 Credit, 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, ara, his, and gal operons, transcriptional control in lambda phage, Transcript processing, Processing of tRNA and rRNA Eucaryotic transcription and regulation: RNA 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, catalytic RNA.	**15 Hrs**

Credit IV	**Translation & Transport** The translation machinery, ribosomes, composition and assembly, Universal genetic code, degeneracy of codons, termination codons, isoaccepting tRNA, wobble hypothesis. Mechanism of initiation, elongation and termination, Co- and post-translational modifications, genetic code in mitochondria. Protein synthesis, Transport of proteins and molecular chaperones, protein stability, protein turnover and degradation	**15 Hrs**

Suggested reading

- Stryer L (1995) Biochemistry, 4 th / 5 th edition, W. H. Freeman & company, New York.
- 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.
- Benjamin Lewin (1999) Genes VII, oxford University Press, Oxford.
- Weaver R. F. (1999) Molecular biology, WCB McGraw-Hill companies, Inc, New York.
- Brown T A (1995) Essential molecular biology, vol. I, A practical approach, IR press, Oxford.
- Genes and Genomes Maxine Singer and Paul Berg

CC- 203: Bioenergetics		**60 Hrs**
Credit I	Principles of bioenergetics, Oxidative phosporylation Biochemical anatomy of a mitochondrion, Membrane-Bound electron carriers, Mitochondrial Electron-Transfer Chain, effects of inhibitors of electron transfer Agents that interfere with oxidative phosphorylation. ATP Synthesis Chemiosmotic model, Mitochondrial ATP synthase complex, Binding-Change mechanism for ATP Synthesis, , Malate-aspartate shuttle, Glycerol 3-phosphate shuttle, Regulation of oxidative phosphorylation, Heat generation by uncoupled mitochondria, Mitochondria evolved from endosymbiotic Bacteria, Mitochondrial genes: Their origin and the effects of mutations, Mutations in mitochondrial genes, The role of mitochondria in apoptosis and Oxidative stress.	**15 Hrs**
Credit II	Photosynthesis: Harvesting light energy General features of photophosphorylation, 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, A proton gradient couples electron flow and Phosphorylation, Chloroplasts Evolved from endosymbiotic bacteria, Carbohydrate biosynthesis in plants and bacteria, Photorespiration, Calvin cycle (C3) and Hatch-Slack pathway, (C4) CAM pathways, Biosynthesis of starch and sucrose ,Synthesis of cell wall polysaccharides.	**15 Hrs**
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, biotranformation in microorganisms, biotranformation in fungi, biotranformation in plants, modifications in biotransformation, syndromes associated.	**15 Hrs**

Suggested Readings:

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

CC -204: Tools and Techniques in Bioscience		60 Hrs
Credit I	**Technology 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 ofmembrane proteins.	**15 Hrs**
Credit II	**Chromatography** Basic principles and applications of ion-exchange, gel filtration, partition, affinity, HPLC and reverse phase chromatography, gas 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 electrophoresis. Pulse field gel electrophoresis. **Tracer Techniques** Principles and applications of tracer techniques in biology, Measurement ofalpha, beta and gamma radiations. Radiation dosimetry, Radioactive isotopes and half-life of isotopes, Autoradiography, Cerenkov radiation, Liquid Scintillation spectrometry.	**15 Hrs**
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:

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

CCPR- 205: Laboratory Course	**(120 Hrs)**
	A **100 Marks**
•	Separation and identification of amino acid mixture by • Paper chromatography technique. • Paper electrophoresis technique
•	Thin layer chromatographic separation of sugars and membrane lipids
•	Separation and identification of serum proteins by polyacrylamide/agarose gel Electrophoresis (BSA/Hb).
•	Separation of proteins (hemoglobin & cytochrome c) using molecular sieve chromatography.
•	Determination of capacity of ion exchange resin (Dowex- 50)
•	Purification of protein by ion exchange chromatography. (DEAE cellulose chromatography)
•	Determination of activity of invertase from immobilized cells of *Saccharomyces cerevisiae*
•	Isolation and characterization of glycogen.
•	Isolation and characterization of Glycogen from rat liver.
	B **100 Marks**
•	Identification and quantitation of activity of amylase/ amylase /cellulase/amyloglucosidase/invertase/alkaline phosphatase/Urease (salivary/microbial/animal/plant source).
•	Determination of specific activity.
•	Determination of activity in presence of activators.
•	Determination of activity in presence of inhibitors.
•	Determination of optimum pH.
•	Determination of optimum temperature.
•	Determination of Km.
•	Determination of Competitive, non-competitive inhibitors.

SEC 206	**Mandatory Non-CGPA compulsory Skill Enhancement Course**	**30 Hrs**