SHIVAJI UNIVERSITY, KOLHAPUR - 416004,
MAHARASHTRA
PHONE:EPABX–2609000, www.unishivaji.ac.in, bos@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर - ४१६००४, महाराष्ट्र
दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दुरध्वनी विभाग ०२३१–२६०९०९४

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

जा.क्र.शिवाजी वि./अमं/732 दिनांक. 09/10/ 2023

प्रति,

मा. अध्यक्ष व सदस्य,
सर्व अभ्यास/अस्थायी मंडळे (सायन्स)
शिवाजी विद्यापीठ, कोल्हापूर

विषय :– शैक्षणिक वर्षे 2023–24 पासून एम.एस्सी. अभ्यासक्रमाच्या आराखडया (Structure) बाबत.

महोदय/महोदया,

उपरोक्त विषयास अनुसरून आदेशान्वये कळविण्यात येते की, राष्ट्रीय शैक्षणिक धोरण, 2020 ची राज्यातील अंमलबजावणीच्या अनुषंगाने विद्यापीठ अधिकार मंडळाच्या निर्णयानुसार शैक्षणिक वर्षे 2023–24 पासुन एम.एस्सी. अभ्यासक्रमासाठी सोबत जोडलेला कॉमन आराखडा **(Structure)** व **Formatting (Templet)** लागू करण्यात आले आहे याची नोंद घ्यावी.

सदरची बाब सर्व शिक्षक, विद्यार्थी व संबंधीतांच्या निदर्शनास आणावी.

कळावे,

आपला विश्वासू

(डॉ. एस. एम. कुबल)
उपकुलसचिव

प्रतः–

प्र.अधिष्ठाता विज्ञान व तंत्रज्ञान विद्याशाखा
मा.संचालक परीक्षा व मुल्यमापन मंडळ
परीक्षक नियुक्ती विभाग–1,2
सर्व परीक्षा विभाग (ऑन)
माहितीसाठी व पुढील योग्य त्या कार्यवाहीसाठी.

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दूरध्वनी - ईपीएबीएक्स - २६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९३/९४

SU/BOS/Science/499 **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.

Subject: Regarding syllabi of **M.Sc. Part-I (Sem. I & II) 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-I (Sem. I & II) as per NEP-2020 degree programme under the Faculty of Science and Technology.

M.Sc.-Part I (Sem. I & II) as per NEP-2020			
1.	Microbiology (HM)	10.	Data Science
2.	Pharmaceutical Microbiology (HM)	11.	Computer Science
3.	General Microbiology	12.	Information Technology (Entire)
4.	Electronics	13.	Food Science & Technology
5.	Embedded Technology	14	Food Science & Nutrition
6.	Geology	15.	Biochemistry
7.	Sugar Technology (Entire)	16.	Biotechnology
8.	Alcohol Technology (Entire)	17.	Medical Information Management
9.	Agro Chemical & Pest Management (AGPM)	18.	Environmental Science
		19.	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

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SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

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Structure and Syllabus in Accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

Master of Science Biotechnology (H.M.)

under
Faculty of Science and Technology

(To Be Implemented from Academic Year 2023-24)

INDEX

1. Preamble:

The two years M. Sc. in Biotechnology (HM) (NEP) subject under Horizontal Mobility (H.M.) program is formulated for developing competent biotechnologists/biochemists/ microbiologists for which significant job opportunities exist in this country and abroad. The course is based on interdisciplinary nature of Bio Chemistry, Quantitative Biology, Genetics, Biotechnology, 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, Proteins including Enzymology, Molecular Biology, Tools and Techniques, Basics in Research Methodology which includes Biostatistics and Computers and Advances in Drug and Clinical Research) at first year level to become good biotechnologists/biochemists/Microbiologists. The specializations introduced in the course at second year level are in the disciplines of Immunology, Genetic Engineering, Fermentation Technology, Bioinformatics, Advances in Plant and Animal Biotechnology, Forensic Biotechnology, Nanobiotechnology and Advanced Techniques in Biotechnology.

2. Duration:

Two-Year full-time course with Four semesters.

3. Eligibility for Admission:

i) A candidate possessing B. Sc. Degree with chemistry/ biochemistry/ biotechnology/microbiology/pharmamicrobiology/bioinformatics/forensicscience/botany/zoology/Nanotechnology/ food science and technology/B.Sc.Agri /B.E/M.B.B.S./B.Pharm/life sciences as principal subject.

ii) Student have to qualify the entrance examination conducted by Shivaji University for the respective academic year.

4. Medium of Instruction:

English

5. Program Structure:

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. Biotechnology (H.M.) Part – I (Level-6.0)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures (Hours / week)	Practical (Hours / week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Semester-I										
Major Mandatory Theory	BT 101	4	--	4	80	32	3	20	8	0.5
	BT 102	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	E-BT 103A **OR** E-BT 103B **OR** E-BT 103C	4	--	4	80	32	3	20	8	0.5
Major Mandatory Practical	P-BT 104	--	8	4	100	40	12	--	--	--
	P-BT 105	--	4	2	50	20	6	--	--	--
Research Methodology	RM-BT 106	4	--	4	80	32	3	20	8	0.5
Total				22	470			80		
Semester-II										
Major Mandatory Theory	BT 201	4	--	4	80	32	3	20	8	0.5
	BT 202	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	E-BT 203	4	--	4	80	32	3	20	8	0.5
Major Mandatory Practical	P-BT 204	--	8	4	100	40	12	--	--	--
	P-BT 205	--	4	2	50	20	6	--	--	--
OJT/FP	OJT-BT 206 **OR** FP-BT 206	--	--	4	--	--	--	100	40	*
Total				22	390			160		
Total (Sem I + Sem II)				44	860			240		

<table>
<tr><td>• BT – Major Mandatory Theory
• P-BT – Major Mandatory Practical
• E-BT – Major Elective Theory
• RM - BT - Research Methodology
• OJT- BT /FP- BT - On Job Training/ Field Project</td><td>• Total Marks for M.Sc.-I: 1100
• Total Credits for M.Sc.-I (Semester I & II): 44
• Separate passing is mandatory for University and Internal Examinations</td></tr>
<tr><td colspan="2">*Evaluation scheme for OJT/FP shall be decided by concerned BOS</td></tr>
<tr><td colspan="2">Requirement for Entry at Level 6.0:
B. Sc in chemistry/ biochemistry/biotechnology/microbiology/pharmamicrobiology/bioinformatics/forensic science/botany/zoology/ /Nanotechnology/food science and technology/B.Sc. Agri /B.E/M.B.B.S./B.Pharm/life sciences as principle subject and appeared for entrance examination. (as per eligibility)</td></tr>
<tr><td colspan="2">Requirement for Exit after Level 6.0:
Students can exit after completion of Level 6.0 (44 Credits) with Post Graduate Diploma in Biotechnology</td></tr>
<tr><td colspan="2">Requirement for Entry at Level 6.5:
Completion of Level 6.0</td></tr>
</table>

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. Biotechnology (H.M.) Part – II (Level-6.5)

	Course Code	Teaching Scheme			Examination Scheme					
		Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures Hours (Per week)	Practical Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Semester-III										
Major Mandatory Theory	BT 301	4	--	4	80	32	3	20	8	0.5
	BT 302	4	--	4	80	32	3	20	8	0.5
	BT 303	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	E-BT 304	4	--	4	80	32	3	20	8	0.5
Major Mandatory Practical	P-BT 305	--	4	2	50	20	6	--	--	--
Research Project	RP-BT 306	--	8	4	100	40	12#	--	--	--
Total				22	470			80		
Semester-IV										
Major Mandatory Theory	BT 401	4	--	4	80	32	3	20	8	0.5
	BT 402	4	--	4	80	32	3	20	8	0.5
	BT 403	4	--	4	80	32	3	20	8	0.5
Major Elective Theory	E-BT 404	4	--	4	80	32	3	20	8	0.5
Research Project	RP-BT 405	--	12	6	150	60	18##	--	--	--
Total				22	470			80		
Total (Sem III + Sem IV)				44	940			160		

<table>
<tr><td>BT – Major Mandatory Theory
P-BT – Major Mandatory Practical
E-BT – Major Elective Theory
RP-BT- Research Project</td><td>Total Marks for M.Sc.-II: 1100
Total Credits for M.Sc.-II (Semester III & IV): 44
Separate passing is mandatory for University and Internal Examinations</td></tr>
<tr><td colspan="2"># Evaluation Scheme for Research Project shall be decided by concerned BOS</td></tr>
<tr><td colspan="2">## Evaluation Scheme for Research Project shall be decided by concerned BOS</td></tr>
<tr><td colspan="2">Requirement for Exit after Level 6.5:
Students can exit after completion of Level 6.5 with Post Graduate in Biotechnology</td></tr>
</table>

Course Code Details: NEP – Biotechnology (H.M.) (NEP – 2023)

Semester I		Semester II	
BT 101	Proteins: Structure and Functions (4 Cr)	BT 201	Enzymology (4 Cr)
BT 102	Biomolecules (4 Cr)	BT 202	Molecular Biology (4 Cr)
E-BT 103A **OR** E-BT 103B **OR** E-BT 103C	Cell Biochemistry & Nucleic Acids (4 Cr) **OR** Taxonomy and Molecular Systematics (4 Cr) **OR** Advances in Drug and Clinical Research (4 Cr)	E-BT 203	Tools and Techniques in Biological Sciences (4 Cr)
P-BT 104	Laboratory Course - I (4 Cr)	P-BT 204	Laboratory Course - III (4 Cr)
P-BT 105	Laboratory Course - II (2 Cr)	P-BT 205	Laboratory Course - IV (2 Cr)
RM-BT 106	Research Methodology (4 Cr)	OJT-BT 206 **OR** FP-BT 206	On Job Training (4 Cr) **OR** Field Project (4 Cr)
Semester III		**Semester IV**	
BT 301	Genetic Engineering (4 Cr)	BT 401	Bioinformatics (4 Cr)
BT 302	Immunology (4 Cr)	BT 402	Advanced techniques in Biotechnology (4 Cr)
BT 303	Advance in Plant and Animal Biotechnology (4 Cr)	BT 403	Forensic Biotechnology (4 Cr)
E-BT 304	Fermentation Technology (4 Cr)	E-BT 404	Nanobiotechnology (4 Cr)
P-BT 305	Laboratory Course - V (2 Cr)	RP-BT 405	Research Project (6 Cr)
RP-BT 306	Research Project (4 Cr)		

6. Programme Outcomes (POs):

- Future ready Post Graduate in Biotechnology subject
- Well conversant with basic information needed for Biotechnology industries
- Aptitude for knowledge creation by opting for research
- Well equipped with the information needed for scientific competitive examinations
- Aptitude for knowledge transfer to next generation by opting for teaching profession

7. Course Codes:

M.Sc. Semester – I	
Major Mandatory	
BT 101 Proteins: Structure and Functions (4 Credit**)**	**MSU0325MML97G1**
BT 102 Biomolecules (4 Credit)	**MSU0325MML97G2**
P-BT 104 Practical Course - I (4 Credit)	**MSU0325MMP97G1**
P-BT 105 Practical Course - II (2 Credit)	**MSU0325MMP97G2**
PM-BT 106 Research Methodology (4 Credit)	**MSU0325RML97G**
Major Elective	
E-BT 103A Cell Biochemistry and Nucleic Acids (4 Credit) **OR**	**MSU0325MEL97G1**
E-BT 103B Taxonomy and Molecular Systematics (4 Credit) **OR**	**MSU0325MEL97G2**
E-BT 103C Advances in Drug and Clinical Research (4 Credit)	**MSU0325MEL97G3**
M.Sc. Semester – II	
Major Mandatory	
BT 201 Enzymology (4 Credit**)**	**MSU0325MML97H1**
BT 202 Molecular Biology (4 Credit**)**	**MSU0325MML97H2**
P-BT 204 Practical Course - III (4 Credit)	**MSU0325MMP97H1**
P-BT 205 Practical Course - IV (2 Credit)	**MSU0325MMP97H2**
FP-BT 206 Field Project (4 Credit) **OR**	**MSU0325FPP97H**
OJT-BT 206 On Job Training (4 Credit)	**MSU0325OJP97H**
Major Elective	
E-BT 203 Tools and Techniques in Biological Sciences (4 Credits)	**MSU0325MEL97H1**

8. Syllabus:

SEMESTER - I

BT 101	Proteins: Structure and Functions (4 Cr)	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, Ramachandran 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. Structure function relationship - myoglobin and hemoglobin, potassium ion channel Multidrug resistance, ABC transporters, Antimicrobial peptides, AMP.	**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 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. Applications of peptides and proteins in human therapeutics.	**15 Hrs**

Suggested Readings:

1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2. Biochemistry by Lubert Stryer, 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

BT 102	Biomolecules (4 Cr)	60 Hrs
Credit I	**Carbohydrates** Glycobiology. Introduction, Sources and Classification of carbohydrates, Stereoisomersm 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. Inulin, Fructan, Beet sugar, Guar gum. 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. Glycosaminoglycan, Glycoconjugates: Proteoglycans, Glycoproteins, Enzymes responsible for oligosaccharide assembly, Glycoproteins, Oligosaccharide linkages in glycoproteins, Protein glycosylation, Glycolipids, Lipopolysaccharides, Methods of carbohydrate analysis. Scarification, Dietary Fibers. RDA and AMDR for carbohydrates.	**15 Hrs**
Credit II	Essentials 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. Inborn errors of carbohydrate metabolism, Carbohydrate deficiency Net carbs and Glycemic index. Inborn errors of carbohydrate metabolism.	**15 Hrs**
Credit III	**Lipids** Different Biological forms, Sources, Introduction, Definition, Functions, Classification and Role of lipids in the body. Neurvous system lipids, Cerebrosides and gangliosides Vitamin absorption and Hormone production. Storage lipids, Fatty acids, Triacylglycerols, Phospho lipids Waxes, Steroids, Structural lipids in membranes Lipids as signals, Prostaglandins, Clinical significance of lipids, Characterization of lipids. LDL, HDL, VLDL and chylomicrons. Risk associated with high lipids. Atherosclerosis. Lipid Panel Test.	**15 Hrs**
Credit IV	Salivary and stomach 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. Antiphospholipid syndrome (APS). Lupus etc. Millet and their	**15 Hrs**

	importance in Diet. Occurrence of millet in different parts of India and their properties.	

Suggested Readings:

1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000
2. Biochemistry by Lubert Stryer,
3. Biochemistry by Zubay
4. Biochemistry by Garrett and Grisham
5. Complex Carbohydrate by Nathan Sharon
   Millets Properties, Processing, and Health Benefits by Anil Kumar Siroha, Sneh Punia, Sukhvinder Singh Purewal, Kawaljit Singh Sandhu

E-BT 103A	**Cell Biochemistry and Nucleic Acids (4 Cr)**	**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,	**15 Hrs**
Credit II	**Cell Cycle, Cell Division and Cell Death** Cell types - organization of prokaryotic and eukaryotic cells, Cell division - Mitosis and meiosis, Cell cycle - phases of cell cycle and regulation of cell growth and cell cycle, Cell aging and death - necrosis and apoptosis - mitochondrial and death receptor pathway	**15 Hrs**
Credit III	**Genes and Chromosomes** Chromosome structure, gene. Polytene and Lampbrush chromosome. Packing of DNA and supercoiled DNA, nucleosome, inverted repeats, satellite DNA, gene number, gene clusters and pseudogene. **Nucleic Acids**	**15 Hrs**

	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	
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. In born errors in nucleic acid metabolism	**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

E-BT 103B	**Taxonomy and Molecular Systematics (4 Cr)**	**60 Hrs**
Credit I	**Introduction to microbial Systematics:** Overview of microbial Systematics: Definition of microbial systematics and nomenclature, Steps in microbial Nomenclature and identification, Introduction of microbial Worlds history, hierarchical organization and the location of different taxa of microbes in Biological classification systems. Artificial and phylogenetic analysis – dendrogram. Haeckel's three-kingdom classification, Whittaker's five kingdom approach, three domain classification of Carl Woese.	**15 Hrs**
Credit II	**microbial Taxonomy:** Introduction and general idea of taxonomic ranks: concept and theory of Numerical Taxonomy, Chemotaxonomy. Characteristics applied in microbial taxonomy – morphological, physiological, metabolic, genetic, antigenic and molecular characteristics, comparison of proteins, nucleic acid hybridization, computer applications in taxonomy studies.	**15 Hrs**

Credit III	**Bacterial classification:** General characteristics of bacteria and archaea. Bacterial classification based on editions of Bergey's Manual of systematic Bacteriology: Bacterial identification based on Binomial Nomenclature and Numerical taxonomy. Bacterial characteristics used for nomenclature with some example – morphological, staining, physiological, biochemical and molecular (mol % G+C, nucleic acid hybridization, 16SrRNA sequencing) characters	**15 Hrs**
Credit IV	**Other microorganisms systematics introduction:** Systematics strategies used for other microbial classification: Fungal classification by Ainsworth, algal classification by Fritsch, ICTV classification of virus and Protozoal classification based on locomotion.	**15 Hrs**

Suggested Readings:

1. Methods in microbiology Volume 19th by R. R. Colwell and R. Grigrorova
2. Prescott's microbiology by Joanne Willey, Kathleen Sandman and Dorothy Wood
3. Brock Biology of microorganisms, 14th edition by michael T. Madigan Kelly S. Bender Daniel H. Buckley W Matthew Sattley and David A. Stahl

E-BT 103C	**Advances in Drug and Clinical Research (4 Cr)**	**60 Hrs**
Credit I	**Drug and Drug Development** 1. History Definition and Types 2. Drug Discovery & Development Process • Therapeutic concept selection • Drug Discovery • Pharmaceutical Development • Clinical Development	**15 Hrs**
Credit II	**Introduction to Clinical Research** 1. History of Clinical Research 2. Good Clinical Practices & ICH 3. Stakeholders in Clinical Research 4. Glossary	**15 Hrs**
Credit III	**Clinical Trial Methods** 1. Types of Clinical Trial 2. Clinical Trial Design 3. Randomized Controlled Trial 4. Safety Management 5. Identification and recruitment of participants for Clinical Trial 6. Record keeping and Data Handling 7. Essential Documents in Clinical Trial 8. Pharmacovigilance	**15 Hrs**
Credit IV	**Regulations in Clinical Trials**	**15 Hrs**

	1. Evolution of Regulation 2. Regulatory Affairs • Code of Federal Regulations • European Medical Agencies • Medicines and Healthcare Products Regulatory Agency, UK • Therapeutic Goods and Administration Australia • Regulatory Agencies in India 3. Quality Assurance	

Suggested Readings:

1. Basics of Clinical Research by S. D. Shewale, S. N. Shinde, V. G. Wawale
2. *Textbook of Clinical Trials*. By David Machin.
3. Textbook of Clinical Research by Vikas Dhikav
4. Essentials of Clinical Research by Dr Ravindra B Ghooi Sachin C Itkar

RM-BT 106	**RESEARCH METHODOLOGY (4 Cr)**	**60 Hrs**
Credit I	**Biostatistics** Basic terms, measures of central tendency and dispersion Population, Sample, variable, parameter, Frequency distribution, Mean median, mode, quartiles and measures of dispersion: range, variance, standard deviation, coefficient of variation, Graphicalrepresentation of data Probability and Distributions: 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). 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.	**15 Hrs**
Credit II	**Computer** History and generations of computers; (I, II, III, IV and V), Hardware; CPU, input, output, storage devices, classifications of computers; analog computers, digital computers, mainframe computers, miniframe computers, microcomputers. Memory: Primary memory or main memory; magnetic core memory, RAM, ROM, PROM, EPROM, EEPROM, Secondary memory or auxillary memory. Modern computers: Workstations, parallel processing computers, super-computers and servers for analysis of biological data. Computer Number system, fundamentals of logical concepts Machine level languages, assembly level languages, high levellanguages.	**15 Hrs**

Credit III	**Foundation of Research** Characteristics of scientific research, Formulation of Research Problem, Research Process, Literature Review, Sampling, Data collection, Data Analysis, Report writing and Research data presentations in conferences, Manuscript writing and publications in journals. **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**
Credit IV	**Introduction to Bioinformatics** Introduction to Bioinformatics, Internet and use of the same for communication, Internet and Related Programmes, HTML, HTTP, telnet, FTP, internet browsers, TCP/IP. NCBI, ENTREZ, Databases, Database search- Data mining, Data management and interpretation, literature database. BLAST, sequence alignment, protein modeling, protein structure analysis, docking, genomics and proteomics.	**15 Hrs**

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 Priti Sinha, BPB Publications, 2007.
7. Computational Biochemistry, By: C. Stan Tsai, A John Wiley & Sons, Inc., publication.

P-BT 104	**Laboratory Course I (4 Cr) (60 Hrs) 100 Marks**
1.	Estimation of protein concentration by Lowry method.
2.	Estimation of protein concentration by Spectrophotometric method.
3.	Estimation of protein concentration by Dye binding method.
4.	Estimation of reducing sugar concentration by DNSA method.
5.	Estimation of glucose concentration by Glucose oxidase- peroxidase method.

6.	Isolation and Characterization of Casein / Starch / Glycogen / Lecithin / Cholesterol.
7.	Fermentative production of Gluconic acid
8.	Bioassay & BT of Streptomycin
9.	Fermentative Production of Wine
10.	Detection of adulteration in food products
11.	Introduction to NCBI
12.	Introduction to protein and nucleic acid sequence databases

P-BT 105	**Laboratory Course II (2 Cr) (30 Hrs) 50 Marks**
1.	Lipid characterization using i. Saponification value ii. Acid value iii. Iodine number
2.	Separation and Characterization of amino acids /sugar using paper chromatography / Thin layer chromatography.
3.	Separation of proteins using gel filtration technique.
4.	Separation of proteins using ion exchange chromatography
5.	Detection of Aflatoxin in food and feed

Suggested Readings:

1. Practical Biochemistry: An Introductory Course by Fiona Frais.
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. M
5. anickam.
6. Hawk's Physiological Chemistry ed. by Bernard L Oser.
7. A Textbook of Practical Biochemistry by David Plummer.
8. Laboratory Manual in Biochemistry by S. Jayaraman.
9. Laboratory Manual by Cappuccino.

SEMESTER - II

BT 201	Enzymology (4 Cr)	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 units, 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 Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies based biosensors. Applications of enzymes in food, pharmaceutical, cosmetics, alcoholic, beverages and clinical.	**15 Hrs**

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

BT 202	Molecular Biology (4 Cr)	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,	**15 Hrs**

	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.	
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:

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

E-BT 203	**Tools and Techniques in Biological Sciences (4 Cr)**	**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 electrophoresis. Pulse field gel electrophoresis. **Tracer Techniques** Principles and applications of tracer techniques in biology, Measurement of alpha, beta and gamma radiations. Radiation	**15 Hrs**

	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.

P-BT 204	**Laboratory Course III (4 Cr) (60 Hrs) 100 Marks**
1.	Determination of specific activity of enzyme.
2.	Effect of pH and temperature on enzyme activity.
3.	Determination of michaelis –Menten constant of Amyloglucosidase / Invertase

	enzyme.
4.	Effect of various inhibitors / activators on enzyme catalysis.
5.	Immobilization of yeast cells.
6.	Isolation and characterization of DNA /RNA / Plasmid from various sources.
7.	In-vitro amplification of DNA using PCR reaction.
8.	Separation of DNA / Proteins using electrophoresis technique.
9.	Techniques used in molecular biology – HPLC / HPTLC /ELISA /Flow-cytometry / Western blot / etc.
10.	Chemical and microbiological Analysis of Food
11.	Chemical and microbiological Analysis of Milk
12.	Production of Amylase

Suggested Readings:

1. Practical Biochemistry: An Introductory Course by Fiona Frais.
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. Practical microbiology by Prescott.

P-BT 205	**Laboratory Course IV (2 Cr) (30 Hrs) 50 Marks**
1.	Using RasMol through graphics and command line.
2.	Pair-wise sequence alignment.
3.	Multiple sequence alignment.
4.	Introduction of BioEdit.
5.	Construction of three-dimensional model by using SPARTAN.
6.	Model Building and Energy minimization.

7.	Introduction to Chimera.
8.	Molecular Docking and Drug designing.

Suggested Readings:

1. Developing Bioinformatics computer skills – Cynthia Gibas and Per Jambeck
2. An introduction to Computational Biochemistry- C. Stan Tsai John Wiley and Sons, Inc., publications

OJT-BT 206	On Job Training (4 Cr)	**(60 Hrs) 100 Marks**
	OR	
FP-BT 206	Field Project (4 Cr)	

9. Scheme of Teaching:

- Each theory paper will have 4 lectures of 60 min. per week.
- The theory paper will have classroom teaching of 60 hours per paper per semester.
- The classroom teaching will be done by Blackboard Chalk, Power Point Presentation, various ICT Tools, Question Answer way, Debate, Seminars, Quiz etc.
- The practical teaching will be done initially by theoretical explanation of experiment, procedural explanation, allowing the student to perform the experiment individually, discussion of results, possible outcome of the result and documentation of observations in notebook and recording all the details in journal which will be examined at the of practical examination.

10. Examination Pattern:

Theory:

- University examination will be of 80 marks for 3 hours as per university time-table and internal examination will be of 20 marks for 30 min.by the respective teacher for each theory paper.

Practical:

- University examination will be conducted for practical after theory examination for 4 days including inspection day from 10:30 am to 05:30 pm. There will be no internal examination.

On Job Training:

- The student will submit his/her On Job Training report to the Teacher in Charge after completion of On Job Training. The department will conduct presentation cum viva for all the students. The internal evaluation committee/examiners will assess the On Job Training report and marks will be given.

Field Project:

- The student will submit his/her Field Project report to the Teacher in Charge completion of Field Project. The department will conduct presentation cum viva for all the students. The internal evaluation committee/examiners will assess the Field Project report and marks will be given.

Research Methodology:

- University examination will be of 80 marks and internal examination will be of 20 marks for Research Methodology theory paper.

11. Nature of Question Paper and Scheme of Marking:

a) University Theory Examination:
Skeleton of theory question paper:

M.Sc. Part – I/Sem. – I Examination – 2023 (NEP - 2023)

Biotechnology (HM)

Title of the Subject

(Subject Code)

Day & Date: **Total Marks**: 80

Time:

Instructions: 1) Question No. 1 is **COMPULSORY**.

2) All questions carry **EQUAL** marks.

3) Solve any **FOUR** questions such that at least **TWO** questions must be from **EACH** section.

Q. 1 Objective (16 Marks)

16 one line answer type questions

SECTION-I

Q.2 Essay type question (16 Marks)

Q.3 Essay type question (16 Marks)

Q.4 Essay type question (16 Marks)

SECTION-II

Q.5 Write notes on (2 x 08 Marks)

2 sub questions

Q.6 Write short notes on (4 x 04 Marks)

4 sub-questions

Q.7 Write short notes on (4 x 04 Marks)

4 sub-questions

The theory examination will be conducted by the department as per the university examination time-table. The appointment of Chairman, Paper setters, paper assessment, moderation, appointment of internal/external Sr. Supervisor, Junior supervisor, Clerk and Peon for examination and other theory examination work will carried out as per the university rules and regulations.

b) Internal Theory Examination:

The internal theory examination of 20 marks will be conducted by Teacher in-charge of the respective subject during the semester. The internal examination theory have 20 questions of 1 mark each. The internal theory paper will be solved on same question paper. Separate answer book will not be given. The examination time will be 30 mins. The internal theory marks will be submitted or uploaded in the university examination portal as per the instruction given by the examination section of the university.

c) University Practical Examination:

The university practical examination will be conducted in the department immediately after theory examination. The duration of practical examination will be 4 days including inspection day. The examination for both practical papers will be conducted simultaneously. The day, date, nature of question paper, marks distribution and internal/ external examiners will be decided by theory examination Chairman in consultation with practical paper in charge and laboratory staff. The separate sanction/approval will be required from examination section for practical examination time-table.

12. Equivalence of Courses:

M. Sc. Part I (Semester I and II)

Old Course				Equivalent Course		
Sem No.	**Course Code**	**Title of the Old Course**	**Credit**	**Course Code**	**Title of the New Course**	**Credit**
I	CC 101A	Cell Biochemistry and Nucleic Acids	4	E-BT 103A	Cell Biochemistry and Nucleic Acids	4
I	CC 101B	Cell Biology, Microbiology and Virology	4	E-BT 103B	Advance in Drug and Clinical Research	4
I	CC 102	Proteins: Structure and Functions	4	BT 101	Proteins: Structure and Functions	4
I	CC 103	Biomolecules	4	BT 102	Biomolecules	4
I	CC 104A	Basics of Physiology and Endocrinology	4	RM-BT106	-	4
I	CC 104B	Biostatistics and Computer Applications	4	RM-BT106	Research Methodology	4
I	CCPR 105	Laboratory Course	4	-	-	-
I	AEC 106	-	-	-	-	-
II	CC 201	Enzymology	4	BT 201	Enzymology	4
II	CC 202	Molecular Biology	4	BT 202	Molecular Biology	4
II	CC 203	Bioenergetics	4	-	-	-
II	CC 204	Tools and Techniques in Biosciences	4	E-BT 203	Tools and Techniques in Biological Sciences	4
II	CCPR 205	Laboratory Course	4	-	-	-
II	SEC 206	-	-	-	-	-