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 ०२३१—२६०९०९४
०२३१—२६०९४८७

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

Ref.No.SU/BOS/Science/249 **Date: 08/07/2026**

The Head /Director/Co-ordinator
All Concerned Department (Science)
Shivaji University, Kolhapur.

Subject: Regarding Structure and syllabus of **B.Sc. Part I** under the Faculty of Science and Technology as per **Apprenticeship Embedded Degree Programme (AEDP).**

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 structure and syllabi, nature of question paper of **B.Sc. Part I** under the Faculty of Science & Technology as per **Apprenticeship Embedded Degree Programme (AEDP).**

B.Sc. Part-I (Sem. I & II) as per AEDP			
1.	Cyber Security & Digital Forensics	3.	Biochemistry
2.	Digital Marketing and AI	4.	Biotechnology

This structure and syllabi shall be implemented from the academic year 2026- 2027 onwards. A soft copy containing structure and syllabus is attached herewith and it is also available on university website **www.unishivaji.ac.in>Syllabus>Syllabus as per NEP2020.** This programme is introduce subject to approval of university authority for converted.

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

Thanking you,

Yours faithfully,

Dy Registrar

Encl: as above
for information and necessary action

Copy to:

1	Dean, Faculty of Science & Technology	7	Appointment A & B Section
2	Director, Board of Examinations and Evaluation	8	I.T.Cell /Computer Centre
3	Chairman, Respective Board of Studies	9	Eligibility Section
4	B.Sc.-M.Sc. Exam Section	10	Affiliation (T.1) Section
5	Internal Quality Assurance Cell (IQAC Cell)	11	Affiliation (T.2) Section
6	Est PG Section	12	P.G. Seminar Section

SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962
A^{++} Accredited by NAAC (2021) with CGPA 3.52

Structure and Syllabus in accordance with
National Education Policy 2020
for

Bachelor of Science

(Part I / Semester – I and II)
Apprenticeship Embedded Degree Programme
(AEDP)

in

Biochemistry

Under
Faculty of Science and Technology

(To Be Implemented from Academic Year 2026-27)

INDEX

SHIVAJI UNIVERSITY, KOLHAPUR

Syllabus for the
Bachelor of Science in Biochemistry
Apprenticeship Embedded Degree Programme (AEDP)
(As per NEP 2020)

Applicable from the Academic Year 2026 –27

1. Preamble:

The three-year Bachelor of Science (B.Sc.) in Biochemistry – Apprenticeship Embedded Degree Programme (AEDP) under NEP 2020 is an innovative, industry-aligned undergraduate programme proposed by the Department of Biochemistry, Shivaji University, Kolhapur. Developed in accordance with UGC guidelines and the Government of Maharashtra GR dated 22 April 2025 on the implementation of the Apprenticeship Embedded Degree Programme (AEDP), it aims to bridge the gap between academic learning and industry requirements in the dynamic field of Biochemistry.

The programme integrates rigorous academic instruction with structured apprenticeship training, enabling students to build strong theoretical foundations alongside practical and industrial exposure. It provides comprehensive education in core areas of Biochemistry, including biomolecular structure and function, metabolism, enzyme technology, molecular biology, clinical biochemistry, bioinstrumentation, bioinformatics and biotechnology. A distinctive feature of the programme is the full-semester industrial apprenticeship in the final semester, offering hands-on experience in areas such as diagnostics, bioprocessing, quality control, and regulatory practices.

Designed to enhance employability and entrepreneurial potential, the AEDP equips students with skill-based training, analytical thinking, and problem-solving abilities aligned with industry expectations. It promotes interdisciplinary learning, innovation, and ethical scientific practices while encouraging flexibility, experiential learning, and multidisciplinary engagement.

Through strong academic–industry collaboration, the B.Sc. Biochemistry (AEDP) programme aims to produce competent, confident, and career-ready graduates capable of addressing real-world challenges in healthcare, pharmaceuticals, food and nutrition, drug designing, environmental management, and life sciences.

2. Title: B. Sc. (Biochemistry) Apprenticeship Embedded Degree Programme (AEDP)

3. Faculty: Faculty of Science and Technology.

4. Year of Implementation: From June 2026

5. Objectives of a Bachelor of Science (B.Sc.) in Biochemistry (AEDP) program include:

- ❖ Understand the fundamental principles, concepts, and laws of Biochemistry, including biomolecular structure, metabolism, enzymology, genetics, bioinformatics and molecular biology.
- ❖ Develop analytical and problem-solving skills to identify, study, and address biochemical challenges in healthcare, agriculture, food science, environmental science, and industry.
- ❖ Enhance employability by bridging the gap between academic learning and industry requirements through apprenticeship training, internships, and exposure to real-world biochemical applications.
- ❖ Gain hands-on experience with biochemical techniques and instruments, while developing strong laboratory practices and safety skills essential for research and industrial work.
- ❖ Benefit from practical, work-integrated learning alongside academic studies, ensuring job readiness and a smooth transition into industrial, clinical, or research careers.
- ❖ Acquire knowledge of advanced concepts and applications of Biochemistry in medical, pharmaceutical, industrial, agricultural, and environmental sectors, supporting higher studies and research.
- ❖ Apply theoretical and conceptual knowledge to practical biochemical work, including analysis of biomolecules such as proteins, carbohydrates, lipids, and nucleic acids.
- ❖ Interpret biochemical and molecular phenomena through experimental evidence, fostering scientific reasoning, critical thinking, and innovation.
- ❖ Develop the ability to collect, analyze, and interpret biochemical data accurately using modern experimental techniques, statistical tools, and hypothesis-driven research approaches.

6. Program Outcomes:

- **PO1**: Knowledge & Understanding – Demonstrate comprehensive knowledge of basic sciences and Biochemistry, including biomolecules, metabolism, enzymology, molecular biology, genetics, bioinformatics and biochemical techniques.
- **PO2:** Scientific Skills – Apply biochemical laboratory techniques, safety practices, and scientific methodologies to analyze and solve biochemical problems.
- **PO3**: Problem-Solving – Critically analyze biochemical data, design experiments, and develop innovative solutions to challenges in biochemistry and related fields.
- **PO4**: Employability & Entrepreneurship – Acquire industry-relevant skills through internships, apprenticeship training, and practical exposure in biochemical, pharmaceutical, and allied industries, fostering employability and entrepreneurship.
- **PO5**: Digital Competence – Utilize bioinformatics tools, computational methods, and modern analytical instruments for biochemical data analysis and interpretation.
- **PO6**: Communication Skills – Communicate effectively through scientific reports, presentations, and teamwork in interdisciplinary and professional environments.
- **PO7**: Social & Ethical Responsibility – Demonstrate professional ethics, environmental awareness, and adherence to biosafety and bioethical principles in biochemical practices.
- **PO8**: Lifelong Learning – Pursue higher education, research, and continuous learning in Biochemistry and allied disciplines to adapt scientific advancements.

7. Program Specific Outcomes:

- **PSO1**: Apply fundamental and advanced biochemical concepts to isolate, analyze, and characterize biomolecules such as proteins, nucleic acids, lipids, and carbohydrates using classical and modern techniques.
- **PSO2**: Demonstrate technical proficiency in handling biochemical laboratory instruments, including spectrophotometers, chromatography systems, electrophoresis units, PCR, centrifuges, and other analytical tools.
- **PSO3**: Integrate theoretical and practical knowledge of Biochemistry in medical, pharmaceutical, industrial, agricultural, food, and environmental applications.
- **PSO4**: Perform biochemical data analysis, statistical evaluation, and hypothesis-driven research for scientific investigation and development.
- **PSO5**: Gain work-integrated learning experience through internships and apprenticeships in biochemistry-related industries such as pharmaceuticals, biotechnology, diagnostics, and food processing.
- **PSO6**: Develop entrepreneurial skills for establishing ventures in areas like enzyme technology, nutraceuticals, diagnostics, bioproducts, bioinformatics and fermentation-based industries.
- **PSO7**: Contribute to sustainable development by applying biochemical principles to environmental management, waste treatment, and efficient bioresource utilization.

8. Duration of the degree programme:

- Bachelor of Science (B.Sc.) in Biochemistry (Apprenticeship Embedded Degree Programme) is three-year full-time degree course, comprising six semesters with last semester full time apprenticeship in industry establishments.
- The B. Sc. Part I (Biochemistry) AEDP (Level 4.5) will be of Two Semesters (Semester I and Semester II).

9. Eligibility Criteria for Admission to B. Sc. Part I AEDP (Level 4.5):

i. 12^{th} Science OR Maharashtra State Board of Technical Education (MSBTE**)** 3 year Diploma Course.

OR

ii. An Examination of any other Statutory Board or an examining Body recognized as equivalent thereto.

10. Medium of Instruction: English

11. Pattern of Examination: The Examinations will be conducted semester-wise for Theory and Practical.

12. Fee structure: As per Shivaji University guidelines.

13. Structure of course: Given in Framework Chart

Particulars:	**Description**	
B. Sc. Part I (Sem I and II)	Theory + Practical	Theory + Practical
B. Sc. Part II (Sem III and IV)	Theory + Practical	Theory + Practical
B. Sc. Part III (Sem V and VI)	Theory + Practical	Apprenticeship

14. Teaching and Examination Scheme:

a. Each theory course paper constitute of 2-5 units require 30 hours of teaching lectures and there shall be two lectures per theory (2 Cr) course per week.

b. B. Sc. I Biochemistry AEDP Course will be of 44 Credits (1100 marks)

c. Examination of each theory course shall be of 50 marks (30 marks university examination + 20 marks internal assessment).

d. University examination of 30 marks (1.5 hours' duration) will be conducted at the end of each Semester. Internal assessment of 20 marks will be done before the semester examination during each semester.

e. Examination of practical course shall be of 50 marks per semester.

f. Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus. Weightage should be provided to each unit as per the hours allotted for teaching.

15. Standard of Passing: The standard of passing shall be as per the following table.

Particulars:	**Maximum Marks**	**Minimum Marks required for passing**
Semester End Exam	30	12
Internal Assessment	20	08
Course Theory Exam (Total)	50	20

i) There shall be a separate head of passing for semester-end examination and internal examination.

ii) Minimum 20 marks out of 50 are required for passing of practical examination of each course.

16. Nature of Question paper and scheme of marking:

As per Shivaji University rules and guidelines.

Nature of question paper (for 2 Credit Course)

Total Marks: 30 **Time:** 1 and half Hrs (90 minutes)

Instructions:
1. All questions are compulsory.
2. Figures to the **RIGHT** indicate **FULL MARKS.**

Q.1 Select Correct Answer (Multiple choice questions) ---- 10 marks

a)
b)
:
:
j)

Q.2 Attempt any ONE of the following.

(Essay type / Broad answer questions) ---- 10 marks
a)

b)

Q.3 Attempt any TWO of the following ---- 10 marks
a)

b)

c)

17. Credit Framework

B.Sc. Apprenticeship Embedded Degree Programme (AEDP)
Structure in accordance with National Education Policy – 2020 and UGC-AEDP
With Multiple Entry and Multiple Exit Options

SHIVAJIUNIVERSITY,KOLHAPUR NEP-2020: Credit Framework for UG (B.Sc.) Apprenticeship Embedded Degree Programme (AEDP)									
SEM (Level)	**COURSES**			**OE**	**VSC/SEC**	**AEC/VEC/IKS**	**CEP/CC/AEDP**	**Total Credits**	**Degree/Cum. Cr MEME**
	Course-1	**Course-2**	**Course-3**						
SEMI (4.5)	DSC-I(2) DSC-II(2) DSC P-I(2)	DSC-I(2) DSC-II(2) DSC P-I(2)	DSC-I(2) DSC-II(2) DSC P-I(2)	OE-1(2) (T/P)	--	IKS-I(2)	--	22	**UG Certificate 44**
SEMII (4.5)	DSC-III(2) DSC-IV(2) DSCP-II(2)	DSC-III(2) DSC-IV(2) DSC P-II(2)	DSC-III(2) DSC-IV(2) DSC P-II(2)	OE-2(2) (T/P)	--	VEC-I(2) (Democracy, Election and Constitution)	--	22	
Credits	**8(T)+4(P)=12**	**8(T)+4(P)=12**	**8(T)+4(P)=12**	**2+2=4 (T/P)**	**--**	**2+2=4**	**--**	**44**	**Exit Option:4 credits NSQF/Internship/ Skill courses**
	MAJOR		**MINOR**						
SEMIII (5.0)	Major V(2) Major VI(2) Major P III (2)	--	Minor V(2) Minor VI(2) Minor P III(2)	OE-3(2) (T/P)	VSC I (2) (P) (Major specific) SEC I(2) (T/P)	AEC I(2) (English)	CC-I (2)	22	**UG Diploma 88**
SEMIV (5.0)	Major VII(2) Major VIII (2) Major P IV (2)	--	Minor VII(2) Minor VIII (2) Minor P IV (2)	OE-4(2) (T/P)	SEC-II(2) (T/P)	AEC-II(2) (English) VEC-II(2) (Environmental studies)	CEP-I(2)	22	
Credits	**8(T)+4(P)=12**		**8(T)+4(P)=12**	**2+2=4(T/P)**	**4(T/P)+2(P)=6**	**2+4=6**	**2+2=4**	**44**	**Exit Option:4 credits NSQF/Internship/ Skill courses**
SEMV (5.5)	Major IX(2) Major X (2) Major P V (2)	Major I (ELEC)(2) Major P-I (ELEC) (2)	---	OE-5(2) (T/P)	VSC II (4) (Major specific)(P)	AEC III(4) (English) IKS II (Major specific) (2)	--	22	**UG Degree 132**
SEMVI (5.5)	--	--	--	--	SEC III(2) (T/P)	--	Apprenticeship Training (20)	22	
Credits	**4(T)+2(P)=6**	**2(T)+2(P)=4**	-	**2(T/P)**	**2(T/P)+4(P)=6**	**4+2=6**	**20**	**44**	
Total Credits	**30+16=46**		**24**	**10**	**12**	**16**	**24**	**132**	

18. Syllabus

Structure of B. Sc. Part I : Biochemistry (AEDP)

Sr. No.	Semester	Title of Paper	Credits	Hours
1.	I	DSC-I: Cell Biology and Nucleic Acids	2 Credits	30 Hours
2.		DSC-II: Biomolecules and Industrial Applications	2 Credits	30 Hours
3.		DSC-P-I: Practical based on DSC-I and DSC- II	2 Credits	60 Hours
4.	II	DSC-III: Lipids and Human Diseases	2 Credits	30 Hours
5.		DSC-IV: Biophysical and Analytical Techniques	2 Credits	30 Hours
6.		DSC-P-II: Practical based on DSC-III and DSC- IV	2 Credits	60 Hours
7.	I	OE-I: Human Health and Infectious Diseases	2 Credits	30 Hours
8.	II	OE-II: Lifestyle and Metabolic Disorders	2 Credits	30 Hours

B. Sc. Biochemistry (AEDP) Part-I; Semester-I (NEP 2020)		
DSC-I: Cell Biology and Nucleic Acids		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives

To introduce students to the structural and functional organization of cells.

To develop understanding of cellular components and their physiological significance.

To provide knowledge of the chemistry, structure and biological functions of nucleic acids.

To establish the foundation for advanced studies in biochemistry, molecular biology and biotechnology.

To provide a comprehensive understanding of the structure and functions of DNA and RNA.

Unit I	Cell Biology	No. of hours: 15

Historical development of Cell Biology, Cell Theory and its modern concepts, cell as the basic structural and functional unit of life, diversity of cells and overview of prokaryotic and eukaryotic cell organization, ultrastructure and functions of bacterial, plant and animal cells.

Structure, composition and functions of plasma membrane, fluid mosaic model of membrane structure, Structure and functions of cellular organelles including nucleus, nuclear envelope, nucleolus and chromatin, endoplasmic reticulum (smooth and rough), Golgi apparatus, lysosomes, peroxisomes, mitochondria, chloroplasts, cytoskeleton and its components including microfilaments, microtubules and intermediate filaments.

Cell cycle and its regulation, phases of cell cycle, checkpoints in cell cycle, mitosis and meiosis, significance of mitosis and meiosis in growth, development and reproduction.

Unit II	Nucleic Acids	No. of hours: 15

Introduction, discovery and significance of nucleic acids, structure and properties of purines, pyrimidines, nucleosides and nucleotides; biologically important nucleotides (ATP, GTP); Watson and Crick model of DNA, structure and forms of DNA, DNA denaturation and renaturation, hyperchromic effect and DNA melting temperature.

Organization of genetic material including chromatin, nucleosomes and chromosomes; structure and functions of RNA types (mRNA, tRNA, rRNA, hnRNA, snRNA and miRNA). Gene as a hereditary material and its significance.

Suggested Reading

1. Alberts, B., Johnson, A., Lewis, J., et al. Molecular Biology of the Cell, Garland Science.
2. Karp, G. Cell and Molecular Biology: Concepts and Experiments, Wiley.
3. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach, Sinauer Associates.
4. Nelson, D.L. and Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman.
5. Voet, D. and Voet, J.G. Biochemistry, Wiley.

6. Satyanarayana, U. and Chakrapani, U. Biochemistry, Elsevier.
7. Lodish, H. et al. Molecular Cell Biology, W.H. Freeman.
8. Berg, J.M., Tymoczko, J.L. and Stryer, L. Biochemistry, W.H. Freeman.
9. Harper's Illustrated Biochemistry, McGraw-Hill.
10. Powar, C.B. Cell Biology, Himalaya Publishing House.

B. Sc. Biochemistry (AEDP) Part-I; Semester-I (NEP 2020)		
DSC-II: Biomolecules and Industrial Applications		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives

To understand the chemistry, classification, structure and biological functions of carbohydrates and proteins.

To develop knowledge of stereochemistry and structural organization of biomolecules.

To correlate the structural features of carbohydrates and proteins with their physiological functions.

To introduce students to basic analytical and purification methods used for carbohydrate and protein studies along with industrial applications.

Unit I	Carbohydrates	No. of hours: 15

Carbohydrates

Introduction, occurrence, biological importance and classification of carbohydrates; monosaccharides, oligosaccharides and polysaccharides; aldoses and ketoses.

Structure and stereochemistry of monosaccharides: D- and L-forms, epimers, anomers, mutarotation, Fischer and Haworth projections, reducing and non-reducing sugars.

Structure and biological significance of glucose, fructose, galactose, ribose and deoxyribose; glycosidic bonds.

Structure and functions of disaccharides and oligosaccharides: maltose, lactose, sucrose and cellobiose.

Structure, occurrence, storage and functions of polysaccharides: starch, glycogen, cellulose, dextran, inulin and chitin; glycosaminoglycans and their biological roles.

Introduction to glycoconjugates: glycoproteins, glycolipids and proteoglycans, glycoproteins, glycolipids and proteoglycans, their structure, biological significance and metabolic pathways. Industrial applications of carbohydrates.

Unit II	Proteins	No. of hours: 15

Water as a biological solvent, physical and chemical properties of water, hydrogen bonding, hydrophobic interactions, biological importance of water, concept of pH, acids, bases, buffers and physiological buffer systems.

Introduction to proteins, occurrence and biological significance of proteins, classification

of proteins based on composition and function, simple proteins, conjugated proteins and derived proteins, functions of proteins. Classification and properties of amino acids, zwitterions and isoelectric point.

Peptide bond formation, peptides and polypeptides, biologically important peptides including glutathione, oxytocin and vasopressin.

Levels of protein structure, primary structure and peptide sequencing, secondary structure including α-helix, β-pleated sheet tertiary structure, and forces stabilizing protein conformation, quaternary structure with examples of hemoglobin and immunoglobulins.

Protein folding, Structure, properties and biological functions of fibrous proteins including collagen, elastin and keratin, globular proteins including hemoglobin, myoglobin and serum albumin. Industrial applications of peptides and proteins.

Suggested Reading

1. Nelson, D.L. and Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman.
2. Voet, D. and Voet, J.G. Biochemistry, Wiley.
3. Berg, J.M., Tymoczko, J.L. and Gatto, G.J. Biochemistry, W.H. Freeman.
4. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Weil, P.A. Harper's Illustrated Biochemistry, McGraw-Hill.
5. Satyanarayana, U. and Chakrapani, U. Biochemistry, Elsevier.
6. Stryer, L. Biochemistry, W.H. Freeman.
7. Devlin, T.M. Textbook of Biochemistry with Clinical Correlations, Wiley.
8. Rastogi, S.C. Biochemistry, Tata McGraw-Hill.
9. Plummer, D.T. An Introduction to Practical Biochemistry, McGraw-Hill.

B. Sc. Biochemistry (AEDP) Part-I; Semester-I (NEP 2020)		
DSC P-I : Practical based on DSC-I and DSC-II		
Credits: 02	**Total hours: 60 hours**	**Hours per week: 04**

Learning Objectives:

1. Students able to handle basic lap equipment.
2. Students will learn isolation and estimation of biomolecules.

Unit I	Practical based on DSC-I	No. of hours: 30

1. Fundamentals of Biochemical analysis
2. Demonstration of some lab equipment: -Colorimeter, Hot air Oven, Incubator, Centrifuge, Water bath, Water distillation unit, etc.
3. **Isolations**: Isolation and characterization of starch from potatoes.
4. **Colorimetric estimations:**

   Verification of Beer Lambert's law and estimation of copper sulphate.

   Estimation of protein by Biuret method.

   Estimation of glucose from DNSA method.
5. Isolation of DNA/RNA. Problems on DNA - RNA sequence, Genetic code

Unit II	Practical based on DSC-II	No. of hours: 30

1. **Volumetric Estimations:**
   Estimation of glycine by formal titration.
2. **Qualitative Analysis:**
   Detection of Carbohydrates Glucose, Starch.
   Detection of Amino acids
3. **Detection of enzymes (any two)**
   Urease, Amylase, Invertase, Phenol oxidase, Alkaline-Phosphatase.
4. Immobilization of baker's yeast cells by gel entrapment for invertase activity.

Suggested readings:

1. Stains and Staining procedures by Desai and Desai.
2. Introduction to Practical Biochemistry by D. Plummer, J Wiley and Sons.
3. Bacteriological techniques by F. J.Baker.
4. Introduction to Microbial techniques by Gunasekaran.
5. Biochemical methods by Sadashivan and D.Manickam.
6. Laboratory methods in Biochemistry by J.Jayaraman.
7. Experimental Microbiology – Patel &Patel

B. Sc. Biochemistry (AEDP) Part-I; Semester-II (NEP 2020)		
DSC-III: Lipids and Human Diseases		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives

To understand the classification, structure, properties and biological functions of lipids

To develop knowledge of the role of lipids in membrane structure, energy storage and cellular signaling.

To establish a foundation for advanced studies in lipid profiling, metabolism and clinical aspects of lipids.

To understand role of lipids in human diseases.

Unit I	Introduction to Lipids	No. of hours: 15

Introduction to lipids, occurrence and biological significance of lipids, classification of lipids into simple lipids, compound lipids and derived lipids, physical and chemical properties of lipids, fatty acids and their classification based on chain length and degree of saturation, saturated, monounsaturated and polyunsaturated fatty acids, essential fatty acids and their nutritional significance, nomenclature and properties of fatty acids.

Simple lipids, structure and functions of triacylglycerols (triglycerides), waxes and their biological importance, compound lipids including phospholipids, glycolipids and lipoproteins, structure, classification and biological functions of phosphatidylcholine, phosphatidylethanolamine, phosphatidylserine, cardiolipin and sphingomyelin.

Glycolipids and sphingolipids, cerebrosides, gangliosides and their biological significance, sterols and steroids, structure and functions of cholesterol, bile acids, steroid hormones.

Biological membranes, membrane lipids and membrane organization, lipid bilayer structure, fluid mosaic model, role of lipids in membrane fluidity and permeability, membrane lipid asymmetry.

Unit II	Lipid Profile and Human Diseases	No. of hours: 15

Lipoproteins, classification and composition of chylomicrons, VLDL, LDL and HDL, transport of lipids in blood, dyslipidemia, hypercholesterolemia and atherosclerosis, role of omega-3 and omega-6 fatty acids in human health.

Diabetes mellitus, types of diabetes including Type 1, Type 2 and gestational diabetes, pathophysiology and biochemical basis of diabetes, insulin resistance, complications of diabetes including nephropathy, neuropathy, retinopathy and cardiovascular diseases, diagnosis, monitoring and prevention of diabetes, glycemic control and lifestyle interventions.

Cardiovascular and lipid disorders, metabolism of cholesterol and lipoproteins, dyslipidemia, hypercholesterolemia and atherosclerosis, hypertension and cardiovascular diseases, risk factors and preventive strategies, role of nutrition and physical activity in cardiovascular health.

Metabolic disorders related to liver and kidney function, non-alcoholic fatty liver disease (NAFLD), metabolic liver disorders, hyperuricemia and gout, chronic kidney disease and

metabolic complications, lifestyle approaches for prevention and management

Biochemical markers and diagnostic approaches in metabolic disorders, blood glucose, glycated hemoglobin (HbA1c), lipid profile, liver function tests, kidney function tests and hormonal assays.

Suggested Reading

1. Nelson, D.L. and Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman.
2. Voet, D. and Voet, J.G. Biochemistry, Wiley.
3. Berg, J.M., Tymoczko, J.L. and Gatto, G.J. Biochemistry, W.H. Freeman.
4. Murray, R.K. et al. Harper's Illustrated Biochemistry, McGraw-Hill.
5. Satyanarayana, U. and Chakrapani, U. Biochemistry, Elsevier.
6. Stryer, L. Biochemistry, W.H. Freeman.
7. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. Molecular Biology of the Gene, Pearson.
8. Lodish, H. et al. Molecular Cell Biology, W.H. Freeman.
9. Devlin, T.M. Textbook of Biochemistry with Clinical Correlations, Wiley.
10. Rastogi, S.C. Biochemistry, Tata McGraw-Hill.

B. Sc. Biochemistry (AEDP) Part-I; Semester-II (NEP 2020)		
DSC-IV: Biophysical and Analytical Techniques		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives

To introduce students to the principles and applications of biophysical and analytical techniques used in biochemical investigations.

To develop an understanding of spectroscopic, microscopic and separation techniques used in life sciences.

To familiarize students with modern analytical instruments employed in biochemical, clinical and industrial laboratories.

To provide a foundation for advanced laboratory techniques used in molecular biology, biotechnology and clinical diagnostics.

Unit I	**Spectroscopic and Microscopic Techniques**	**No. of hours: 15**

Introduction to biophysical techniques, importance of analytical methods in biochemistry, principles of electromagnetic radiation, electromagnetic spectrum and interaction of light with matter, concepts of absorbance, transmittance and molar absorptivity, Beer-Lambert law and its applications in quantitative biochemical analysis.

Colorimetry, visible spectrophotometry and ultraviolet (UV) spectrophotometry, determination of concentration of biological molecules using spectrophotometric methods, applications in estimation of proteins, nucleic acids and metabolites.

Fluorescence spectroscopy, principles of fluorescence and phosphorescence, fluorochromes and their applications in biological research.

Atomic absorption spectroscopy and flame photometry, principles, instrumentation and applications in estimation of biologically important metals and minerals.

Microscopy, light microscopy, compound microscope and its components, resolving power and magnification, phase contrast microscopy, fluorescence microscopy, electron microscopy including scanning electron microscopy (SEM) and transmission electron microscopy (TEM), applications of microscopy in biological and medical sciences.

Imaging techniques, confocal microscopy, digital imaging systems and their applications in biological investigations.

Unit II	Separation and Analytical Techniques	No. of hours: 15

Principles and applications of separation techniques in biochemistry, chromatography as an analytical tool, classification of chromatographic techniques, paper chromatography, thin layer chromatography (TLC), column chromatography, ion exchange chromatography, gel filtration chromatography, affinity chromatography and high-performance liquid chromatography (HPLC).

Electrophoresis, factors affecting electrophoretic mobility, paper electrophoresis, agarose gel electrophoresis, polyacrylamide gel electrophoresis (PAGE), sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE), applications in protein and nucleic acid analysis.

Centrifugation, principles of sedimentation, centrifugal force and sedimentation coefficient, types of centrifuges and rotors, differential centrifugation, density gradient centrifugation and ultracentrifugation, applications in cell fractionation and purification of biomolecules.

Radioisotope techniques, radioactive isotopes and their properties, tracer techniques, autoradiography, applications of isotopes in biological research and medicine, safety measures in handling radioactive materials.

Suggested Reading

1. Wilson, K. and Walker, J. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
2. Upadhyay, A., Upadhyay, K. and Nath, N. Biophysical Chemistry: Principles and Techniques, Himalaya Publishing House.
3. Chatwal, G.R. and Anand, S.K. Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
4. Plummer, D.T. An Introduction to Practical Biochemistry, McGraw-Hill.
5. Keith Wilson and John Walker Practical Biochemistry, Cambridge University Press.
6. Skoog, D.A., Holler, F.J. and Crouch, S.R. Principles of Instrumental Analysis, Cengage Learning.
7. Freifelder, D. Physical Biochemistry, W.H. Freeman.
8. Pattabhi, V. and Gautham, N. Biophysics, Narosa Publishing House.
9. Rodney Boyer Modern Experimental Biochemistry, Pearson Education.
10. Sharma, B.K. Instrumental Methods of Chemical Analysis, Goel Publishing House.

B. Sc. Biochemistry (AEDP) Part-I; Semester-II (NEP 2020)		
DSC P-II: Practical based on DSC-III and DSC-IV		
Credits: 02	**Total hours: 60 hours**	**Hours per week: 04**

Learning Objectives:

1. Students will be able to perform experiments with lipids and biomolecules.
2. Students will learn various chromatographic separations.

Unit I	Practical based on DSC-III	No. of hours: 15

1. Saponification value of fat/oil
2. Estimation of Fatty acids
3. Determination of iodine value of an oil
4. Practical on lipid profile
5. Demonstration Experiments: Extraction of lecithin from egg yolk.

Unit II	Practical based on IV	No. of hours:15

1. Paper chromatographic separation & identification of sugars from binary mixture**.**
2. Paper chromatographic separation & identification of amino acids from binary mixture**.**
3. Thin Layer Chromatography
4. Estimation and characterization of DNA
5. Estimation and characterization of RNA

Suggested readings:

1. Stains and Staining procedures by Desai and Desai.
2. Introduction to Practical Biochemistry by D. Plummer, J Wiley and Sons.
3. Bacteriological techniques by F. J.Baker.
4. Introduction to Microbial techniques by Gunasekaran.
5. Biochemical methods by Sadashivan and D.Manickam.
6. Laboratory methods in Biochemistry by J.Jayaraman.
7. Experimental Microbiology – Patel &Patel

B. Sc. Biochemistry (AEDP) Part-I; Semester-I (NEP 2020)		
OE-I : Human Health and Infectious Diseases		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives

To provide students with a basic understanding of human health and factors influencing health and disease.

To introduce major infectious diseases affecting humans and their causative agents.

To develop awareness regarding disease transmission, prevention and control measures.

To understand the role of immunity, vaccination and public health interventions in

disease management.

To familiarize students with emerging infectious diseases and global health challenges.

Unit I	Human Health, Immunity and Disease Prevention	No. of hours: 15

Concept of health and disease, Introduction to human body defense mechanisms, innate and acquired immunity, physical and chemical barriers of body, cells and organs of the immune system, antigen, antibody and immune response, humoral and cell-mediated immunity, immunological memory and its significance in disease protection.

Vaccination and immunization, principles of vaccination, active and passive immunization, types of vaccines including live attenuated, killed, subunit, recombinant and mRNA vaccines, national immunization programs, role of vaccination in disease prevention and eradication.

Public health and disease prevention, personal hygiene, sanitation, safe drinking water, waste management, nutrition and healthy lifestyle practices, health education and awareness, role of public health agencies in disease control and prevention, introduction to epidemiology and disease surveillance.

Unit II	Infectious Diseases and Control Measures	No. of hours:15

Introduction to infectious diseases, classification based on causative agents including bacterial, viral, fungal and parasitic diseases, host-pathogen interactions, sources and reservoirs of infection, modes of disease transmission including direct contact, airborne, waterborne, foodborne, vector-borne and zoonotic transmission.

Bacterial infectious diseases, causative organisms, symptoms, diagnosis, prevention and control of tuberculosis, typhoid fever, cholera, diphtheria and leprosy.

Viral infectious diseases, causative agents, transmission, prevention and control of influenza, dengue, hepatitis, HIV/AIDS, COVID-19 and rabies, antiviral therapies and importance of vaccination programmes.

Parasitic and fungal diseases, malaria, amoebiasis, filariasis, ascariasis, candidiasis and dermatophytic infections, life cycle of important parasites, prevention and control strategies, vector management and environmental interventions.

Emerging and re-emerging infectious diseases, antimicrobial resistance (AMR), hospital-acquired infections, outbreak investigation and management, role of molecular diagnostics in disease detection, global health initiatives and preparedness for future pandemics.

Recent advances in infectious disease management, development of new vaccines, immunotherapies, and public health technologies for disease monitoring and control.

Suggested Reading

1. Park, K. Park's Textbook of Preventive and Social Medicine, Banarsidas Bhanot Publishers.
2. Ananthanarayan, R. and Paniker, C.K.J. Textbook of Microbiology, Universities Press.
3. Jawetz, Melnick and Adelberg's Medical Microbiology, McGraw-Hill.
4. Willey, J., Sherwood, L. and Woolverton, C. Prescott's Microbiology, McGraw-Hill.
5. Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction, Pearson.
6. Abbas, A.K., Lichtman, A.H. and Pillai, S. Basic Immunology, Elsevier.
7. Murphy, K. and Weaver, C. Janeway's Immunobiology, Garland Science.
8. World Health Organization (WHO). Infectious Disease Guidelines and Reports.
9. Madigan, M.T. et al. Brock Biology of Microorganisms, Pearson.
10. Chakraborty, P. Human Health and Disease, New Central Book Agency.

B. Sc. Biochemistry (AEDP) Part-I; Semester-II (NEP 2020)

OE-II : Lifestyle and Metabolic Disorders

Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives

To understand the biochemical and physiological basis of lifestyle and metabolic disorders.

To study the role of nutrition, physical activity and lifestyle factors in health and disease.

To develop awareness regarding prevention, management and control of common metabolic disorders.

To understand the biochemical markers used in the diagnosis and monitoring of metabolic diseases.

To familiarize students with current strategies for promoting healthy lifestyle and improving quality of life.

Unit I	**Lifestyle and Nutrition**	**No. of hours: 15**

Concept of lifestyle and health, definition and characteristics of healthy lifestyle, impact of modernization and urbanization on human health, role of diet, physical activity, sleep, stress and environmental factors in maintaining health, relationship between lifestyle and chronic diseases, global and national burden of lifestyle-related disorders.

Concepts of basal metabolic rate (BMR), body mass index (BMI), obesity indices and body composition, regulation of energy metabolism, role of carbohydrates, proteins and lipids in energy homeostasis, hormonal regulation of metabolism by insulin, glucagon, thyroid hormones and cortisol.

Nutrition and metabolic wellness, balanced diet and dietary guidelines, recommended dietary allowances (RDA), importance of micronutrients and dietary fiber, nutritional deficiencies and excesses, role of functional foods, nutraceuticals and probiotics for healthy lifestyle.

Obesity and overweight, causes and risk factors, genetic, environmental and behavioral determinants of obesity, adipose tissue as a metabolic organ, biochemical basis of obesity, metabolic syndrome and associated health complications.

Stress and metabolic health, physiological stress response, role of stress hormones in metabolism, effects of chronic stress on cardiovascular health, immunity and endocrine functions, strategies for stress management including yoga, meditation, physical activity and behavioral interventions.

Unit II	**Metabolic Disorders, Diagnosis and Prevention**	**No. of hours:15**

Introduction to metabolic disorders, classification and causes of metabolic diseases, role of genetic and environmental factors, metabolic disturbances associated with modern lifestyles.

Endocrine and bone-related metabolic disorders, thyroid disorders including hypothyroidism and hyperthyroidism, osteoporosis and metabolic bone diseases, role of calcium, vitamin D and hormones in bone health, role of trace elements.

Recent advances in management of metabolic disorders, personalized nutrition, digital health technologies, wearable health monitoring devices, precision medicine, next generation sequencing and emerging therapeutic approaches.

Modalities of disease prevention, prevention and management through diet, exercise and lifestyle modifications.

Suggested Reading

1. Murray, R.K. et al. Harper's Illustrated Biochemistry, McGraw-Hill.
2. Nelson, D.L. and Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman.
3. Satyanarayana, U. and Chakrapani, U. Biochemistry, Elsevier.
4. Srilakshmi, B. Nutrition Science, New Age International.
5. Park, K. Park's Textbook of Preventive and Social Medicine, Banarsidas Bhanot Publishers.
6. Mahan, L.K. and Raymond, J.L. Krause's Food and the Nutrition Care Process, Elsevier.
7. Shils, M.E., Olson, J.A., Shike, M. and Ross, A.C. Modern Nutrition in Health and Disease, Lippincott Williams & Wilkins.
8. Devlin, T.M. Textbook of Biochemistry with Clinical Correlations, Wiley.
9. Gropper, S.S. and Smith, J.L. Advanced Nutrition and Human Metabolism, Cengage Learning.
10. WHO Reports on Non-Communicable Diseases and Metabolic Health.

Structure of B. Sc. Part I : Chemistry

Sr. No.	Semester	Title of Paper	Credits	Hours
1.	I	DSC-I: Inorganic Chemistry	2 Credits	30 Hours
2.		DSC-II: Organic Chemistry	2 Credits	30 Hours
3.		DSC-P-I: Practical based on DSC-I and DSC- II	2 Credits	60 Hours
4.	II	DSC-III: Physical Chemistry	2 Credits	30 Hours
5.		DSC-IV: Analytical Chemistry	2 Credits	30 Hours
6.		DSC-P-II: Practical based on DSC-III and DSC- IV	2 Credits	60 Hours

B. Sc. Chemistry Part-I; Semester-I (NEP 2020)		
DSC-I : Inorganic Chemistry		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. To learn and understand basic knowledge of inorganic chemistry.
2. To understand size, shape and electronic distribution in shells and sub-shells of an atom.
3. To learn and understand the properties and uses of the compounds of Boron, Carbon and Nitrogen from p-block elements.
4. To Understand the role of acids and bases in chemistry.

Unit I	Atomic Structure and Periodicity of Elements	No. of Hours: 10

1.1 Bohr's theory of hydrogen atom and its limitations

1.2 Wave particle duality

1.3 Heisenberg uncertainty principle

1.4 Quantum numbers and their significance

1.5 Shapes of s, p and d atomic orbital's

1.6 Electrons filling rules in various orbitals:

a) Aufbau's principle b) Hunds rule of maximum multiplicity c) Pauli's exclusion principle.

1.7 Electronic configuration of elements. Stability of empty, half-filled and completely filled orbitals.

1.8 Periodicity of the elements: General discussion of the following properties of the elements with reference to S- block elements:

a) Electronic configuration b) Atomic radii c) Ionic radii d) Ionization energy e) Electron affinity f) Electronegativity g) Metallic characters h) Reactivity i) Oxidation state j) Melting and boiling points k) Chemical properties.

Unit II	P-Block Elements (Group 13, 14, 15)	No. of Hours: 9

2.1 Position of elements in periodic table.

2.2 Characteristics of group 13th, 14th and 15th elements with special reference to electronic configuration and periodic properties.

2.3 Compounds of group13th, 14th and 15th elements.

2.3.1 Boron – Diborane (only structure).

2.3.2 Allotropes of Carbon and Phosphorus.

2.3.3 Oxyacids of Nitrogen (HNO_2, HNO_3).

Unit III	Chemical Bonding and Molecular Structure: Ionic Bonding	No. of Hours: 7

3.1 Types of Chemical Bonds: a) Ionic Bond b) Covalent Bond c) Co-ordinate bond d) Metallic bond e) Hydrogen Bond f) Van-der walls force.

3.2 Definition and formation of ionic bond. General characteristics of ionic bonding

3.3 Energetic in Ionic bond formation.

3.4 Born-Haber cycle for NaCl and its applications.

3.5 Fajan's Rule and its applications.

Unit IV	Acids and Bases	No. of Hours: 4

4.1 Theories of Acids and Bases – Arrhenius concept, Bronsted –Lowry concept, Lewis concept, Lux-Flood concept. (Definition and examples only).

4.2 Hard and Soft Acids and Bases (HSAB concept).

4.2.1 Classification of Acids and Bases as hard soft and borderline.

4.2.2 Pearson's HSAB concept.

4.2.3 Applications and limitations of HSAB concept.

Reference Books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B. E., McDaniel, D. H. & Alexander, J. J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J. E., Keiter, E. A., Keiter, R. L. & Medhi, O. K. Inorganic Chemistry:
5. Principles of Structure and Reactivity, Pearson Education India, 2006.
6. Puri, Sharma, Kalia. Principles of Inorganic Chemistry
7. Madan R. L. Chemistry for Degree Students (B. Sc. First year), S. Chand

B. Sc. Chemistry Part-I; Semester-I (NEP 2020)		
DSC-II : Organic Chemistry		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. To understand the fundamentals and basic principles involved in organic chemistry.
2. To understand the spatial arrangement of atoms of organic molecule and types of stereoisomers.
3. Knowledge of general properties and fundamental reactions of aromatic compounds.
4. To understand the basic knowledge of heterocyclic compounds.
5. To get knowledge of methods to preparation, physical and chemical properties of some heterocyclic compounds with five and six membered heterocycles containing N as the hetero atom (Pyrrole and Pyridine).

Unit I	Basic Concepts in Organic Chemistry	No. of Hours: 9

1.1 Introduction, Curved arrow notations, Cleavage of Bonds: Homolysis and Heterolysis.

1.2 Organic molecular species: Nucleophiles and electrophiles. Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyper conjugation effect,

1.3 Reactive Intermediates: Generation, Structure, Stability and Reactions of Carbocations, Carbanions, Carbon free radicals, Carbene and Nitrene.

Unit II	Stereochemistry	No. of Hours: 9

2.1 Introduction, Types of Stereoisomerism, Representation of organic molecules using Wedge, Fischer, Sawhorse and Newman formula,

2.2 Optical Isomerism: Concept of Chirality, Elements of Symmetry, Optical Isomerism in tartaric acid, 2, 3 Dihydroxy butanoic acid, Enantiomerism, Diastereomerism and Meso compounds, Geometrical isomerism in C=C, C=N and alicyclic compounds.

2.3 Nomenclature of stereoisomers: D and L, Erythro and Threo, R and S, E and Z.

Unit III	Aromaticity	No. of Hours: 6

3.1 Introduction, Characteristics properties of aromatic compounds, Meaning of terms: Aromatic, Non aromatic, Antiaromatic, Pseudoaromatic , Classification of aromatic compounds

3.2 Structure of Benzene: Kekule structure, Resonance structure, M.O. picture, Modern theory of Aromaticity

3.3 Mechanism of Electrophilic substitution reactions: Nitration, Sulphonation, Halogenation and Friedel - Crafts reaction

Unit IV	Heterocyclic Compounds	No. of Hours: 6

4.1 Introduction, Classification and Nomenclature of heterocyclic compounds. Nitrogen Heterocycles:

a) Pyrrole: Introduction, Synthesis, Physical and chemical properties.

b) Pyridine: Introduction, Synthesis, Physical and chemical properties.

Reference Books:

1. Graham Solomon, T. W., Fryhle, C. B. & Snyder, S. A. Organic Chemistry, John Wiley & Sons (2014).
2. McMurry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Pvt Ltd, Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4. Eliel, E. L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
5. Finar, I. L. Organic Chemistry (Vol. I & II), E.L.B.S.
6. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Pearson, 2010.
7. Bahl, A. & Bahl, B. S. Advanced Organic Chemistry, S. Chand, 2010.
8. Nasipuri, D. Stereochemistry of Organic compounds: Principles and Applications.
9. Madan, R. L. Chemistry for Degree Students (B. Sc. First Year), S. Chand Publication.
10. Heterocyclic chemistry, J.A. Joule and K. Mills, 4th ed., Blackwell Publishing 2000
11. John A. Joule, Keith Mills.; Heterocyclic Chemistry, 5th Edition, April 2010, ©2010, Wiley Blackwell,
12. Gilchrist, T. L. Heterocyclic chemistry; 3rd ed.; Addison Wesley Longman: Edinburgh Gate, 1997.
13. Joule, J. A.; Mills, K.; Heterocyclic chemistry; 4th ed.; Blackwell Science: Oxford, 2000.

B. Sc. Chemistry Part-I; Semester-I (NEP 2020)		
DSC P-I: Practical based on DSC-I and DSC-II		
Credits: 02	**Practical: 60 hours**	**Hours per week: 04**

Learning Objectives:

1. To learn and understand basic knowledge of inorganic chemistry.
2. To understand size, shape and electronic distribution in shells and sub-shells of an atom.
3. To learn and understand the properties and uses of the compounds of Boron, Carbon and Nitrogen from p-block elements.
4. To Understand the role of acids and bases in chemistry.

Unit I	Inorganic Chemistry	No. of Hours: 30

1) To prepare standard 0.1 N KMnO4 solution and to determine the strength of given oxalic acid solution.

2) To determine quantity of Fe (II) ions from the given solutions by titrating it with 0.1N K2Cr2O7 solution by using internal indicator

3) To estimate amount of Cu (II) ions by iodometric titration by using Na2S2O3 solution.

4) To standardize supplied EDTA solution by titrating with 0.01 M ZnSO4 solution and to estimate amount of calcium from given solution by using Eriochrome Black- T as an indicator.

5) Quality control -To determine percentage purity of the given sample of soda ash (Na2CO3) by titrimetric method.

6) Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method

7) Chromatography: Separation and identification of cations by Paper Chromatography technique from the following mixtures :

a) $Ni^{2+} + Cu^{2+}$ b) $Ni^{2+} + Co^{2+}$ c) $Cu^{2+} + Co^{2+}$

8) Spot Test : Identify the following metal ions by spot test method:

Cu^{2+}, Ni^{2+}, Co^{2+}, Fe^{3+}, Al^{3+}, Pb^{2+}, Zn^{2+}, Hg^{+2}, Mg^{+2}, Mn^{+2}

Unit II	Organic Chemistry	No. of Hours: 30

1) Estimations:

i) Estimation of Aniline (by Bromination method)

ii) Estimation of Acetamide.

2) Organic Qualitative Analysis: Detection of physical constant, type, elements, functional group, and Confirmatory test. Identification of Organic Compounds (at least eight) (four containing at least one extra element- N, S, Cl)

a) Acids: Oxalic acid, Benzoic acid, Cinnamic acid

b) Phenols: Beta-Naphthol, p-Nitrophenol

c) Base: Aniline, p-Nitroaniline

d) Neutral: Acetone, Acetanilide, Chloroform, m-Dinitrobenzene, Thiourea, Bromobenzene

3) Purification of organic compounds by crystallization (from water and alcohol) and distillation.

Reference Books:

Inorganic Chemistry:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

Organic Chemistry

3. Vogel's Text Book of Quantitative Chemical Analysis. (Longmann) ELBS Edition.
4. Hand book of Organic Qualitative Analysis: Clarke.
5. Comprehensive Practical Organic Chemistry – Qualitative Analysis by V. K. Ahluwalia, Sunita Dhingra. University Press. Distributor – Orient Longman Ltd.
6. Comprehensive Practical Organic Chemistry preparation and Quantitative Analysis: V. K. Ahluwalia, Renu Aggarwal. University Press. Distributor – Orient Longman Ltd.
7. A Laboratory Hand - Book of Organic Qualitative Analysis and Separation: V. S. Kulkarni. Dastane Ramchandra & Co. Pune

B. Sc. Chemistry Part-I; Semester-II (NEP 2020)		
DSC-III: Physical Chemistry		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. Learning and coherent understanding of basic concepts and rules of logarithms, graphs, derivative and integrations.
2. Knowledge and coherent understanding of basic concepts in thermodynamics will be gained by the student.
3. Learning and understanding the knowledge about basic concepts in kinetics and first order, second order reactions with characteristics and suitable examples.
4. Learning and coherent understanding of surface tension, viscosity and refractive index with suitable examples.
5. Learning and coherent understanding of basic concepts in electrochemistry, conductors and conductivity cells, measurement of conductance with suitable examples and numerical problems.

Unit I	**Basic Mathematical Concepts**	**No. of Hours: 3**

1.1 Logarithm: Basic rules and calculations.

1.2 Graph - Quadrants, drawing of linear graph, Slopes and Intercept.

1.3 Derivative and Integration: Basic rules.

Unit II	**Thermodynamics**	**No. of Hours: 5**

2.1 Introduction, Basic terms used in thermodynamics, Zeroth law of thermodynamics.

2.2 First law of thermodynamics: Mathematical equation, sign conventions, statements of first law and its limitations.

2.3 Spontaneous and non-spontaneous processes, Second law of thermodynamics.

2.4 Heat engine, Carnot's Cycle and efficiency of heat engine.

2.5 Numerical Problems.

Unit III	**Chemical Kinetics**	**No. of Hours: 8**

3.1 Introduction, rate of reaction, definition, and units of rate constant.

3.2 Factors affecting rate of reaction.

3.3 Order and Molecularity of reaction.

3.4 First order reaction: Derivation of rate constant. Characteristics of the first order reaction.

3.5 Pseudo- first order reactions –i) Hydrolysis of methyl acetate in presence of acid, ii) Inversion of cane sugar.

3.6 Second order reaction: Derivation of rate constant for equal and unequal concentration of the reactants.

3.7 Examples of Second order reaction:

i) Reaction between $K_2S_2O_8$ and KI

ii) Saponification of ethyl acetate.

3.8 Characteristics of Second order reactions.

3.9 Numerical problems.

Unit IV	Physical properties of liquids	No. of Hours: 6

4.1 Introduction to states of matter, qualitative description of intermolecular forces in liquids, structure of liquids, classification of physical properties.

4.2 Surface tension and its determination using stalagmometer and differential rise method.

4.3 Viscosity and its determination using Ostwald's viscometer.

4.4 Refractive index (Snell's law) specific and molecular refractivities and its determination using Abbe's refractometer.

4.5 Numerical Problems.

Unit V	Electrochemistry	No. of Hours: 8

5.1 Introduction, types of cell, phenomenon of electrolysis, Faradays Laws of electrolysis.

5.2 Types of conductors.

5.3 Explanations of Conductance, specific conductance, equivalence and molecular conductance.

5.4 Variation of specific conductance, equivalence and molecular conductance with dilution, equivalent conductance at infinite dilution.

5.5 Dipping type of conductivity cell, modifications in the technique used before measurement of conductance w.r.to use of alternating current, use of conductivity water, conductivity cell and temperature control.

5.6 Measurement of conductance by Wheatstone bridge.

5.7 Cell constant and its determination.

5.8 Numerical problems.

Reference Books:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Kotz, J.C. Treichel, P. M. &Townsend, J. R. General Chemistry, Cengage Learning India Pvt Ltd: New Delhi (2009).
3. Mahan , B.H. University Chemistry, 3rd Ed. Narosa(1998).
4. Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co,: New York(1985).
5. Elements of Physical Chemistry S., Glasstone, D. Lewis. (2010)
6. Principles of physical Chemistry Marron and Prutton. (2007).
7. Elements of Physical Chemistry P. W. Atkins (2017-18)
8. Essentials of Physical Chemistry Bahl and Tuli. S. Chand,2010.
9. Physical Chemistry Danials and Alberty (2016)
10. Principles of Physical Chemistry, Puri, Sharma and Pathania 47th Edison, Vishal Publishing Co.
11. Physical Chemistry, A. J. Mee
12. Physical Chemistry, R. A. Alberty

B. Sc. Chemistry Part-I; Semester-II (NEP 2020)		
DSC-IV: Analytical Chemistry		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. Learning various analytical procedures and importance also sampling, accuracy and precision
2. Distinguish between classical and industrial chemistry.
3. Learning and understanding basic concepts and concentration terms.
4. To understands the importance of IPR.
5. Knowledge of chromatographic separation technique and terms involved in it. Learning paper chromatography and thin layer chromatography.
6. Knowledge of various type of titrations, neutralization curves, indicators used in various titrations.

Unit I	Introduction to Analytical Chemistry	No. of Hours: 7

1.1 Introduction

1.2 Importance of analysis

1.3 Analytical processes (Qualitative and Quantitative)

1.4 Methods of analysis (Only classification)

1.5 Sampling of solids, liquids and gases

1.6 Errors, types of errors (determinate and indeterminate), methods of expressing accuracy (Absolute and relative error)

1.7 Significant figures, mean, median, standard deviation (Numerical problems expected)

Unit II	Fundamentals of Industrial Chemistry and IPR	No. of Hours: 7

2.1 Difference between classical and industrial chemistry, Raw materials for chemical industry, Material safety data sheets (MSDS)

2.2 Definition and Explanation of terms - Molecular weight, Equivalent weight, Molarity, Normality, Molality, Molarity of mixed solution, Acidity of base, Basicity of acid, ppt, ppm, ppb solutions, Mole Fraction, Weight fraction, Percentage composition by W/W, W/V, V/V, Problems based on Normality, Molarity, mole fraction, mixed solution, etc.

2.3 IPR- Introduction to IPR and its significance in presence scenario

Unit III	Chromatography	No. of Hours: 7

3.1 Introduction, Basic Principle of Chromatography, Basic terms, Classification of Chromatography

3.2 Paper Chromatography- Principle, Methodology-types of papers and treatment, sample loading, choice of solvent, development-ascending, descending, circular, location of spots, determination of Rf value, Applications, advantages and disadvantages

3.3 Thin layer chromatography- Principle, Solvent system, stationary phases, preparation of TLC plate, Detecting reagents, methodology-sample loading, development, detection of spot, Rf value, Applications, advantages and disadvantages

Unit IV	Theory of Titrimetric Analysis	No. of Hours: 9

4.1 Introduction

4.2 Acid-base indicators

4.3 Theory of indicators w.r.t. Ostwald's ionization theory

4.4 Neutralization curves and choice of indicators for

a. Strong acid-strong base

b. Strong acid-weak base

c. Strong base-weak acid

4.5 Complexometric titrations

a. Introduction

b. Types EDTA titrations

c. Metallochromic indicators-Eriochrome black- T

d. Indicator Action of Eriochrome black- T

4.6 Redox Titrations

a. Introduction

b. KMnO4 Vs Oxalic acid titration; theory of KMnO4 as self-indicator.

4.7 Precipitation Titrations

a. Introduction

b. Silver nitrate Vs NaCl solution using Potassium chromate indicator

Reference Books:

1. Text Book of Quantitative Inorganic analysis – A. I. Vogel
2. Instrumental methods of Chemical analysis –Willard, Merit & Dean
3. Instrumentals methods of Chemical analysis – Chatwal & Anand
4. Vogel's textbook of qualitative Inorganic analysis – Bassett, Denny etc.
5. Textbook of qualitative Inorganic analysis – Kolthoff and Sandel
6. Fundamentals of analytical chemistry – Skoog and West
7. Basic concepts of analytical chemistry – S. M. Khopkar
8. Text book of qualitative organic analysis – A. I. Vogel
9. Qualitative organic chemistry – A. I. Vogel
10. Instrumental methods of chemical analysis – H. Kaur
11. A text book of Quantitative chemical analysis Vogel's by J. Mendham, R. C. Denney
12. Quantitative Chemical Analysis – Daniel C. Harris
13. Chemical process industries – Shrieve & Brink
14. Industrial Chemistry – B. K. Sharma
15. Industrial Chemistry – R. K. Das
16. Text book of qualitative organic analysis – A. I. Vogel

B. Sc. Chemistry Part-I; Semester-II (NEP 2020)		
DSC-P-II: Practical based on Paper III and Paper IV		
Credits: 02	**Practical: 60 hours**	**Hours per week: 04**

Learning Objectives:

1. To learn and understand basic knowledge of inorganic chemistry.
2. To understand size, shape and electronic distribution in shells and sub-shells of an atom.
3. To learn and understand the properties and uses of the compounds of Boron, Carbon and Nitrogen from p-block elements.
4. To Understand the role of acids and bases in chemistry.

Unit I	Physical Chemistry	No. of Hours: 30

1) Determination of viscosity of given liquids A and B (Density data of liquids, viscosity of water to be given) [Any two liquids from Acetone, Carbon tetra chloride, Chloroform, Ethyl alcohol, Benzyl alcohol, Ethylene glycol and n- propyl alcohol.
2) To study the velocity constant of hydrolysis of methyl acetate in presence HCl.
3) To study the velocity constant of hydrolysis of methyl acetate in presence H_2SO_4.
4) To study the reaction between Potassium persulphate and Potassium iodide kinetically (equal concentration).
5) Determination of heat of ionization of weak acid by using polythene bottle.
6) Determination of Surface tension of the given liquids by Stalagmometer.
7) Determination of heat of solution of salt KCl.
8) Determination of equivalent weight of Mg by eudiometer.

Unit II	Analytical Chemistry	No. of Hours: 30

1) Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method
2) Estimation of Aspirin tablet.
3) Estimation of Vitamin C from fruit juice.
4) Determination of Cell constant of given conductivity cell using KCl solution. (N/10 and N/50 KCl) (Solutions should be prepared by the students).
5) Preparation and standardization of HCl/ H_2SO_4 solution from the bulk.
6) Separation and identification of amino acids by paper chromatography.
7) Estimation of Ca from pharma tablets by complexometric method.

Reference Books:

1. Practical book of Physical Chemistry: Nadkarni, Kothari & Lawande.
2. Experimental Physical Chemistry: A. Findlay.
3. Systematic Experimental Physical Chemistry: S. W. Rajbhoj, Chondhekar. (Anjali Publication.)
4. Experiments in Physical Chemistry: R. C. Das and B. Behra. (Tata McGraw Hill)
5. Advanced Practical Physical Chemistry: J. B. Yadav (Goel Publishing House.)
6. Practical Physical Chemistry: B. D. Khosala. (R. Chand & Sons)

7. Experiments in Chemistry: D. V. Jahagirdar.
8. A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis: A.I. Vogel (Third Ed) (ELBS)
9. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009

Structure of B. Sc. Part I : Microbiology (AEDP)

Sr. No.	Semester	Title of Paper	Credits	Hours
1.	I	DSC-I: Introduction to Microbiology	2 Credits	30 Hours
2.		DSC-II: Basic Techniques in Microbiology	2 Credits	30 Hours
3.		DSC-P-I: Practical based on DSC-I and DSC- II	2 Credits	60 Hours
4.	II	DSC-III: Bacteriology	2 Credits	30 Hours
5.		DSC-IV: Applied Microbiology	2 Credits	30 Hours
6.		DSC-P-II: Practical based on DSC-III and DSC- IV	2 Credits	60 Hours
7.	I	OE-I: Fermented Foods And Preservation Technology	2 Credits	30 Hours
8.	II	OE-II: Food Science And Food Processing	2 Credits	30 Hours

B. Sc. Microbiology (AEDP) Part-I; Semester-I (NEP 2020)		
DSC-I : Introduction to Microbiology		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

6. Describe the historical milestones and contributions of prominent microbiologists.
7. Identify and explain the diversity of microorganisms and compare their structural organization.
8. Understand the principles of microbial taxonomy and apply classification systems for microorganisms.
9. Explain the beneficial and detrimental roles of microorganisms in different environments.
10. Recognize the scope of microbiology and its interdisciplinary applications in various industries and sectors.

Unit I	History and scope of microbiology	No. of hours: 15

A. History of Microbiology:

1 Spontaneous generation vs. biogenesis.

2. Contributions of - Antony von Leeuwenhoek, Edward Jenner,

Louis Pasteur, Robert Koch, Ivanowsky, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky.

B. Introduction to types of Microorganism:

1. General characteristics of different groups:

Cellular microorganisms - Bacteria, Algae, Fungi and Protozoa

Acellular microorganisms -Viruses, Viroids and Prions

2. Ultra structure of Prokaryotic and eukaryotic cell, difference between prokaryotic and eukaryotic microorganisms.

C. Bacterial Nomenclature and Classification:

1. Taxonomic rank, Common or Vernacular name, Scientific or International name,

2. Three domain classification systems by Carl Woese.

3. Five kingdom classification by Whittaker

D. An overview of scope of microbiology:

1. Beneficial and harmful activities of microorganisms.

2. Introduction to applied branches of Microbiology:

Air microbiology, Water microbiology, Sewage microbiology, Soil microbiology, Dairy microbiology, Food microbiology, Medical microbiology, Industrial microbiology, Geomicrobiology and Biotechnology

Unit II	Bacterial Cell Structure and Functions	No. of hours:15

A. Morphology of bacteria:

Cell size, shape and arrangement

B. Cytology of Bacteria:

1. Cell wall: Composition and detailed structure of Gram-positive and Gram-negative bacterial cell walls
2. Cell Membrane: Structure, function & chemical composition of bacterial cell membranes.
3. Structure and functions of Capsule, Slime layer, Flagella and Pilli.
4. Structure and functions of cytoplasmic components:
   Ribosomes, Mesosomes, Nucleoid, Plasmids, Endospore - structure and stages of sporulation, Reserve food materials - Nitrogenous and non-nitrogenous

Suggested readings:

1. Microbiology by Pelczar, M.J.Jr., Chan E.C.S., Krieq, N.R. 5th edition, 1986 (McGraw Hills Publication).
2. Microbiology by Prescott, Herley and Klein, IInd edition.
3. General Microbiology Vol I and II by Powar and Daginawala, Himalaya Publications.
4. A textbook of Microbiology by Ananthnarayan – Orient Longman, Bombay
5. Fundamental Principles of bacteriology by A. J. Salle, Tata McGraw Hill.

B. Sc. Microbiology (AEDP) Part-I; Semester-I (NEP 2020)		
DSC- II : Basic Techniques in Microbiology		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. To introduce the principles, types, and mechanisms of staining techniques used in microbiology.
2. To provide knowledge about the structure, functioning, and types of microscopes and their role in visualizing microorganisms.
3. To familiarize students with the fundamental concepts and practical approaches for the control of microorganisms.
4. To develop an understanding of the mode of action and applications of physical and chemical agents used in sterilization, disinfection, and antisepsis.

Unit I	Staining Techniques and Microscopy	No. of hours: 15

A. Stains and staining procedures:

1. Definition and Classification of stains - Acidic, Basic and Neutral
2. Principles, Procedure, Mechanism and applications of staining procedures
   i) Simple staining
   ii) Negative staining
   iii) Differential staining: Gram staining and Acid fast staining
3. Special staining methods
   i) Cell wall (Chance's method)
   ii) Capsule (Maneval's method) iii) Volutin granule (Albert's method)

B. General Principles of Microscopy:

1. Types of microscopes: light and electron microscopes
2. Light microscopy: Parts, Image formation, Magnification, Numerical aperture (uses of oil immersion objective), Resolving power and Working distance.
3. Ray diagram, special features, applications and comparative study of: Compound Microscope, Electron Microscope

Unit II	Control of Microorganisms	No. of hours:15

A. Introduction to - Sterilization, Disinfection, Antiseptic, Germicide, Microbiostasis, Antisepsis and Sanitization

B. Mode of action, applications and advantages of physical agents:

a. Temperature – i) Dry heat ii) Moist heat
b. Desiccation
c. Osmotic pressure
d. Radiations - U.V. Ray, Gamma rays,
e. Filtration – Asbestos and Membrane filter

C. Mode of action, applications and advantages of chemical agents:

a. Phenol and Phenolic compounds

b. Alcohols (Ethyl alcohol)

c. Halogen compounds (chlorine and iodine)

d. Heavy metals (Cu and Hg)

e. Gaseous Agents – Ethylene oxide, Beta-propiolactone and formaldehyde

Suggested readings:

1. Microbiology by Pelczar, M.J.Jr., Chan E.C.S., Krieq, N.R. 5th edition, 1986 (McGraw Hills Publication).
2. Microbiology by Prescott, Herley and Klein, IInd edition.
3. General Microbiology Vol I and II by Powar and Daginawala, Himalaya Publications.
4. A textbook of Microbiology by Ananthnarayan – Orient Longman, Bombay
5. Fundamental Principles of bacteriology by A. J. Salle, Tata McGraw Hill.

B. Sc. Microbiology (AEDP) Part-I; Semester-I (NEP 2020)		
DSC P-I : Practical based on DSC-I and DSC-II		
Credits: 02	**Total hours: 60 hours**	**Hours per week: 04**

Learning Objectives:

3. Apply biosafety and aseptic techniques essential for safe handling of microbes.
4. Operate compound microscope and interpret microbial cell morphology.
5. Demonstrate working knowledge of core microbiology laboratory instruments.
6. Perform basic and differential staining for visualization and identification of bacteria.
7. Prepare, sterilize, and use different types of microbiological media effectively.

Unit I	Practical based on DSC-I	No. of hours: 30

1. To study basic biosafety practices in the microbiology laboratory.
   Aseptic techniques, Disinfection procedures, Hand sanitation, Laboratory safety practices, Personal protective equipment (PPE), Cleaning and sterilization of glassware, Proper disposal of used laboratory materials.
2. To study the parts, use, and care of the compound / light microscope
3. To study the principle, working, and applications of common microbiology laboratory instruments.
   Bio-safety cabinets (Laminar Air Flow), autoclave, incubator, hot air oven, colorimeter, colony counter, pH meter
4. To perform bacterial staining techniques
   Monochrome staining, Negative staining, Gram's staining, Cell wall staining by Chance's method, Capsule staining by Maneval's method, Volutin granule staining by Albert's method

Unit II	Practical based on DSC-II	No. of hours: 30

1. To demonstrate bacterial motility by hanging drop method.
2. To prepare and sterilize microbiological culture media for preparation of agar plates, butts, and slants etc.
3. To prepare liquid culture media for bacterial growth and biochemical tests.
   1% and 2% peptone water, nutrient broth, glucose phosphate broth, Koser's citrate broth,
4. To prepare selective and differential media
   Sabouraud's agar, MacConkey's agar, Starch agar, Milk agar

Suggested readings:

1. A Textbook of Practical Microbiology, By R.C. Dubey and D.K. Maheshwari; S. Chand & Company
2. Practical Microbiology, By Rajan S. Bhosale; Himalaya Publishing House
3. Short Protocols in Microbiology, Edited by John Wiley & Sons
4. Laboratory Exercises in Microbiology by Harley and Prescott; McGraw-Hill
5. Practical Handbook of Microbiology, Lorrence H. Green; CRC Press
6. Microbiology: A Laboratory Manual, by James Cappuccino and Natalie Sherman; Pearson Education
7. Basic Practical Microbiology: A Manual; Published by The Society for General Microbiology (UK)
8. Laboratory Manual in Microbiology, By P. Gunasekaran; New Age International

B. Sc. Microbiology (AEDP) Part-I; Semester-II (NEP 2020)		
DSC- III: Bacteriology		
Credits - 02	**Lectures - 30 hours**	**Lectures per week - 02**

Learning Objectives:

1. Identify the nutritional requirements and growth factors essential for microbial growth.
2. Classify microorganisms based on their carbon and energy sources.
3. Differentiate and select appropriate culture media for various microbial applications.
4. Perform isolation and cultivation techniques for aerobic and anaerobic microorganisms.
5. Apply preservation and characterization methods for maintaining pure microbial cultures.

Unit I	Microbial Nutrition and Culture Media	No. of hours: 15

A. Nutritional requirements of microorganisms:

1. Water
2. Energy source
3. Macronutrients - Carbon, Oxygen, Hydrogen, Nitrogen, Sulphur, Phosphorus
4. Micronutrients –
5. Growth factors – concept of auxotrophs, prototrophs and fastidious organisms

B. Nutritional types of microorganism based on carbon and energy sources:

1. Autotrophs, Heterotrophs, Phototrophs, Chemotrophs, Photoautotrophs, Chemoautotrophs, Photoheterotrophs, Chemoheterotrophs,

C. Composition and types of culture media:

1. Components of media
2. Natural and Synthetic media
3. Chemically defined media
4. Complex media, Selective media, Differential media, Enriched media, Enrichment media.

D. Cultivation of microorganisms:

1. Use of culture media for cultivation of microorganisms
2. Conditions required for growth of the microorganisms

Unit II	Isolation, Cultivation and Preservation of Microorganisms	No. of hours:15

A. Isolation of Microorganisms from natural habitats:

1. Pure culture techniques – Streak plate, Spread plate, Pour Plate and micromanipulator, Serial dilution technique
2. Isolation and cultivation of anaerobic organisms by using media components and by exclusion of air/O_2.

B. Preservation of microbial cultures:

1. Sub culturing
2. Overlaying of cultures with mineral oils
3. Storage at low temperature
4. Lyophilisation

C. Systematic study of pure cultures:

1. Morphological characteristics.
2. Cultural characteristics:
   Colony characteristics on solid media, growth in liquid media, growth on agar slants,
3. Biochemical Characteristics –
   Sugar fermentation, Production of metabolites - H_2S gas, Production of enzymes - Amylase, Caseinase and Catalase.

Suggested readings:

1. Microbiology by Pelczar, M.J. Jr., Chan E.C.S., Krieq, N.R. 5th edition, 1986 (McGraw Hills Publication).
2. Microbiology by Prescott, Herley and Klein, IInd edition.
3. General Microbiology Vol I and II by Powar and Daginawala, Himalaya Publications.
4. A textbook of Microbiology by Ananthnarayan – Orient Longman, Bombay
5. Fundamental Principles of bacteriology by A. J. Salle, Tata McGraw Hill.

B. Sc. Microbiology (AEDP) Part-I; Semester-II (NEP 2020)		
DSC- IV: Applied Microbiology		
Credits - 02	**Lectures: 60 hours**	**Lectures per week: 02**

Learning Objectives:

1. To develop a very good understanding of applied branches of microbiology.
2. To develop the knowledge of how the microorganisms play role in water microbiology
3. To make well conversant about food preservation techniques
4. To develop knowledge of milk processing and milk testing.

Unit I	Air and Water Microbiology	No. of hours: 15

A. Air Microbiology:

i. Sources of microorganisms in air.
ii. Definitions of - Infectious dust, Droplets & Droplet nuclei
iii. Sampling methods for microbial examination of air
iv. Solid impaction - Sieve device
v. Liquid Impingement – Bead-bubbler device

B. Water Microbiology:

i. Sources of microorganisms in water.
ii. Fecal pollution of water, Indictors of fecal pollution of water – E. coli
iii. Routine Bacteriological analysis of water.
   a. SPC b. Tests for coliforms
iv. Qualitative-Detection of coliforms - Presumptive test, Confirmed Test, Completed test, Differentiation between coliforms - IMViC test, Eijkman test.
v. Quantitative – MPN, Membrane filter technique
vi. Municipal water purification process and its significance.

Unit II	Food and Dairy Microbiology	No. of hours: 15

A. Food Microbiology:

i. Introduction
ii. Microbial spoilage of food
iii. Food Preservation:
   a. General Principle and methods and Application
   b. Asepsis, Removal of Microorganisms, Dehydration,
   c. Use of Heat, Irradiation, Anaerobiosis, Chemicals

B. Milk Microbiology:

i. Sources of microorganisms in milk
ii. General composition of Milk.
iii. Microbiological examination of Milk – DMC, SPC and dye reduction test- MBRT test
iv. Pasteurization - Definition, Methods – LTH, HTST, UHT,
v. Efficiency of Pasteurization– Phosphatase test (Qualitative)

Suggested readings:

1. Microbiology by Pelczar, M.J.Jr., Chan E.C.S., Krieq, N.R. 5th edition, 1986 (McGraw Hills Publication).
2. Microbiology by Prescott, Herley and Klein, IInd edition.
3. General Microbiology Vol I and II by Powar and Daginawala, Himalaya Publications.
4. A textbook of Microbiology by Ananthnarayan – Orient Longman, Bombay
5. Fundamental Principles of bacteriology by A. J. Salle, Tata McGraw Hill.

B. Sc. Microbiology (AEDP) Part-I; Semester-II (NEP 2020)		
DSC P-II: Practical based on DSC-III and DSC-IV		
Credits: 02	**Total hours: 60 hours**	**Hours per week: 04**

Learning Objectives:

3. Perform preparation, sterilization, and differentiation of culture media for microbial cultivation.
4. Isolate, observe, and characterize microorganisms using plating, staining, and biochemical techniques.
5. Analyze bacterial growth patterns under varying environmental conditions (temperature, pH, salt, UV).
6. Determine metabolic activity through fermentation and enzyme assays.
7. Apply microbial preservation methods and interpret physiological responses to stress.

Unit I	Practical based on DSC-III	No. of hours: 15

1. Isolation of pure cultures using streak, pour, and spread plate methods
2. Cultivation of aerobic and anaerobic bacteria using appropriate media and techniques
3. Study of colony morphology and growth patterns on agar and in liquid media
4. Gram staining and microscopic observation of bacterial cell morphology
5. Biochemical characterization of bacteria: sugar fermentation, catalase, amylase, and H_2S production
6. Preservation of microbial cultures using mineral oil overlay and low-temperature storage

Unit II	Practical based on IV	No. of hours:15

6. Isolation of pure cultures of bacteria by four quadrant streaking method and study of Colony characteristics, Gram staining and motility of:
   a. *Escherichia coli* b. *Bacillus subtilis* c. *Staphylococcus aureus*
7. Enumeration of microorganisms from air
8. Enumeration of microorganisms from water.
9. MPN, IMViC test
10. Enumeration of microorganisms from milk.
11. MBRT
12. Platform test for quality of raw milk.

Suggested readings:

8. A Textbook of Practical Microbiology, By R.C. Dubey and D.K. Maheshwari; S. Chand & Company
9. Practical Microbiology, By Rajan S. Bhosale; Himalaya Publishing House
10. Short Protocols in Microbiology, Edited by John Wiley & Sons
11. Laboratory Exercises in Microbiology by Harley and Prescott; McGraw-Hill
12. Practical Handbook of Microbiology, Lorrence H. Green; CRC Press
13. Microbiology: A Laboratory Manual, by James Cappuccino and Natalie Sherman; Pearson Education
14. Basic Practical Microbiology: A Manual; Published by The Society for General Microbiology (UK)
15. Laboratory Manual in Microbiology, By P. Gunasekaran; New Age International

B. Sc. Microbiology (AEDP) Part-I; Semester-I (NEP 2020)		
OE-I : Fermented Foods And Preservation Technology		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

6. Demonstrate the role played by microbes in food production and food spoilage
7. Make student familiar with the traditional and modern fermented foods.
8. Give an overview of food borne illnesses.
9. Make students understand the concepts of food preservation and food safety

Unit I	Introduction to Fermented Foods	No. of hours: 15

1. Fermented Foods:

1.1 Introduction to fermentation
1.2 Classification of fermented foods
1.3 Ethnic and Modern Indian fermented foods
1.4 Overview of other fermented foods
1.5 Pre and Probiotics

2. Production of Traditional Foods

2.1. Fermented foods: Bread, Yoghurt, Butter
2.2. Cottage Cheese, Soy sauce.
2.3. Pickles: Sauerkraut, Cucumber, Olives

3. Beverages:

3.1 Non-alcoholic beverages: Coffee, tea
3.2 Alcoholic beverages:
a. Wine: Industrial production of Red table wine, Sparkling wine – champagne
b. Beer: Ale beer, Lager beer

Unit II	Preservation Technology	No. of hours:15

1. Methods of food preservation:

1.1 Removal of microorganisms from food
1.2 Preservation by low temperature and high temperature
1.3 Preservation by use of chemicals / food preservations
1.4 Preservation by Irradiation
1.5 Canning

2. Newer Preservation & Processing technology:

2.1. Natural antimicrobials, Bio-preservation
2.2. Hydrostatic pressure
2.3. Electric pulse
2.4. High magnetic pulse
2.5. Minimally processed foods
2.6. Hurdle technology

Suggested readings:

1. Mudambi R and Rajagopal M. V. 2001. Fundamentals of food and nutrition. 4t Edi. New Age International Ltd. Publ.
2. Swaminathan M. Principles of Nutrition and Dietetics. 2nd Edi
3. Banerjee G. C. 1998. 8th Edi. Text book of Animal Husbandary.
4. Modern Food Science Jou. 2007.
5. Food Microbiology by Frazier.
6. Food Microbiology by H.A .Modi. (Vol. I&II)
7. Industrial Microbiology by A.H.Patel.
8. Industrial Microbiology by Prescott & Dunn.

B. Sc. Microbiology (AEDP) Part-I; Semester-II (NEP 2020)		
OE-II : Food Science And Food Processing		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. Understand the interaction between microbes and food.
2. Know and explore more about Indian fermented foods.
3. Appreciate the science behind food preservation techniques.
4. Practice food hygiene and sanitization to overcome food borne illnesses

Unit I	Food Science and Nutrition	No. of hours: 15

1. Chemical Nature, Sources and Functions of nutrients:
Introduction to fermentation Proteins, Carbohydrates, Fats, Minerals, Vitamins, Water, Fibre, Antioxidants and phytochemicals.

2. Food Additives:
Intentional / Unintentional: Antioxidants, chelating agents, colouring agents, emulsions, flavours and flavour enhancers, flavour improvers, humectants and anticaking agents, leavening agents, nutrient supplements, non-nutritive sweeteners, pH controlling agents

3. Energy Value of Foods:
Methods of measurement of energy

4. Nutritional Disorders due to deficiency and excess of nutrients.:
4.1 Vitamin deficiency: pernicious anaemia, scurvy, night blindness, rickets.
4.2 Protein deficiency: Kwashiorkor
4.3 Mineral deficiency due to iron, iodine and calcium.

Unit II	Principles of Food Processing	No. of hours:15

1. Cereal based foods:
1.1 Pasta. Macaroni. Semolina,
1.2 Processed Soy bean products - soy milk, soy flour, and soy-based snacks
1.3 Fermented Soybean Products – miso, tofu, soy sauce

2. **Nutraceuticals:**
3. **Probiotic foods:** Production and quality control
4. **Convenience foods**
5. **Processing of fruits and Vegetables:** Jam, Jelly, squash, ketchup
6. **Foods of Microbial Origin:** SCP and Mushrooms,
   6.1 Production of SCP: Introduction, Production – Algae (Spirulina), Product quality and safety
   6.2 Mushroom cultivation

Suggested readings:

1. Mudambi R and Rajagopal M. V. 2001. Fundamentals of food and nutrition. 4t Edi. New Age International Ltd. Publ.
2. Swaminathan M. Principles of Nutrition and Dietetics. 2nd Edi
3. Modern Food Science Jou. 2007.
4. Food Microbiology by Frazier.
5. Food Microbiology by H.A .Modi. (Vol. I&II)
6. Industrial Microbiology by A.H.Patel.
7. Industrial Microbiology by Prescott & Dunn.
8. Modern Food Science Jou. 2007.
9. The Hindu Survey of Indian Agriculture. 2007.
10. Van Garde S. J. And Woodburn M. 19909. Food Preservation and Safety- Principles and Practice.
11. Manay N. S., and Shadasaraswamy. 2001. Foods –facts and principles. New Age International Pvt Ltd. 2nd Edi. 11. Clive de Blackburn and Peter Mc Clure. Food Bourne pathogens- Hazards, Risks analysis and Control. CRC Wood Publ. Co.

Structure of B. Sc. Part I : Botany

Sr. No.	Semester	Title of Paper	Credits	Hours
1.	I	DSC-I: Phycology and Microbiology	2 Credits	30 Hours
2.		DSC-II: Biomolecules and Cell Biology	2 Credits	30 Hours
3.		DSC-P-I: Practical based on DSC-I and DSC- II	2 Credits	60 Hours
4.	II	DSC-III: Mycology and Phytopathology	2 Credits	30 Hours
5.		DSC-IV: Archegoniate	2 Credits	30 Hours
6.		DSC-P-II: Practical based on DSC-III and DSC- IV	2 Credits	60 Hours

B. Sc. Botany Part-I; Semester-I (NEP 2020)		
DSC-I : Phycology and Microbiology		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. To study the general characteristics, diversity, classification, and economic importance of algae.
2. To understand the life cycles of representative algae such as Nostoc and Spirogyra.
3. To describe the discovery, structure, types, and economic significance of viruses.
4. To explain bacterial cell structure, morphology, reproduction, and genetic recombination.
5. To analyze the role and applications of algae, viruses, and bacteria in human life and industries.

Unit I	Phycology	No. of Hours: 14

A. Algae:

i) General characteristics

ii) Diversity with respect to habit and habitats

iii) Economic importance

iv) Classification (as per G. M. Smith, 1955) up to classes

v) Life cycle (excluding developmental stages of sex organs) of the following types

a) Cyanophyceae: Nostoc

b) Chlorophyceae: Spirogyra

Unit II	Microbiology	No. of Hours: 16

B. Viruses:

i) Discovery and General characteristics

ii) General structure of viruses: Helical, Icosahedral and Complex

iii) Types of viruses- DNA viruses (T- Phage), RNA viruses (TMV)

iv) Economic importance

C. Bacteria:

i) Discovery and General characteristics

ii) Cell structure

iii) Forms of bacteria based on shapes

iv) Reproduction – vegetative, asexual and recombination (conjugation)

vi) Economic importance

Reference Books:

1. Introductory Phycology. Kumar, H. D. 1988, Affiliated East-West Press Ltd., New York.
2. Algae - Kumar H. D. and H. N. Singh (1991)
3. Algae - Sharma O. P. (1986)
4. Algae - Pandey B. P. (1994)
5. A Text book of Algae - Chopra G. L. (1969)
6. A Text book of Algae - Kumar H. D., Singh H. N. (1977)
7. A Text book of Botany - V. Singh, P. C. Pandey, Jain D. K. (1999)
8. A Text book of Botany Vol. I – Pandey S. N., S. P. Misra, P. S. Trivedi (1.982)
9. A Treatise on Algae - K. N. Bhatia (1980)
10. Plant Cell Biology-A practical approach.-Harris N. and Oparka K. J. (1994). (IRL-Press of oxford University UK.).
11. Cell Biology- De. Robert et.al. (1982), (Publ. Sundar and Company).
12. Cell Biology –C. B. Powar (1992), Himalaya Publ. House, Delhi.
13. Plant Biochemistry-Cell-Sumps P.K. and Connie's. (1981).
14. Molecular Cell Biology-Albert's B. Bray D. Lewis J. Faff M. Robert K. & Watson J.D. (1999). (Publ. Garlands publishing co-In, New York U.S.A.)
15. Text Book of cell and molecular biology –Gupta P.K. (1999), Rastogi publication, Meerat.
16. Molecular and Cellular Biology-Wolfe S.L. (1993), Wadsworth publishing Company, California, U.S.A.
17. Applied Microbiology- Vinita Kale and Kishore Bhusari (2007) Himalaya Publishing House, Mumbai.
18. Virology- Saravanan P. MJP, Publishers, Chennai. 600005.
19. Chromatographic Methods- Stock, R. and C. B. F. Rince (1978).
20. Biological Techniques- Srivastava, H. S. (1999).

B. Sc. Botany Part-I; Semester-I (NEP 2020)		
DSC-II : Biomolecules and Cell Biology		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. To understand the classification, properties, and biological roles of carbohydrates, lipids, proteins, and nucleic acids.
2. To explain the structural organization and differences between prokaryotic and eukaryotic cells.
3. To study the structure and functions of plant cell walls and plasma membranes.
4. To describe the stages, processes, and significance of the cell cycle, mitosis, and meiosis.
5. To analyze the structure and role of major cell organelles such as the nucleus, mitochondria, chloroplast, ribosomes, and peroxisomes.

Unit I	Biomolecules	No. of Hours: 15

1.1. Carbohydrates:

Introduction, Nomenclature, classification and definition of Monosaccharides, Disaccharides, Oligosaccharides and Polysaccharides with one example

1.2. Lipids:

Introduction, Definition, Properties and Significance.

1.3. Proteins:

Introduction, Definition, Properties and Biological role of proteins.

1.4. Carbohydrates:

Introduction, Watson and Crick model of DNA, Types of RNA and Role of nucleic acids.

1.5. Nucleic acids:

Introduction, Nomenclature, classification and definition of Monosaccharides, Disaccharides, Oligosaccharides and Polysaccharides with one example

Unit II	The cell	No. of Hours: 15

2.1. Cell:

Introduction, Structure of prokaryotic and eukaryotic cells.

2.2. Cell wall and plasma membrane:

Introduction, structure and function of Plant cell wall. Plasma membrane: fluid mosaic model.

2.3. Cell division:

Cell cycle, mitosis, meiosis and significance

2.4. Cell Organelles:

Structure and functions of Nucleus, Chloroplast, Mitochondria, Ribosomes, Peroxisomes, Glyoxisome

Reference Books:

1. Plant Cell Biology –Structure and function-Gunning B.E.S and Steer M.W. (1996).
2. Plant Cell Biology-A practical approach.-Harris N. and Oparka K. J. (1994). (IRL-Press of oxford University UK.).
3. Cell Biology- De. Robert et.al. (1982), (Publ. Sundar and Company).
4. Cell Biology –C. B. Powar (1992), Himalaya Publ. House, Delhi.
5. Plant Biochemistry-Cell-Sumps P.K. and Connie's. (1981).
6. Molecular Cell Biology-Albert's B. Bray D. Lewis J. Faff M. Robert K. & Watson J.D. (1999). (Publ. Garlands publishing co-In, New York U.S.A.)
7. Text Book of cell and molecular biology –Gupta P.K. (1999), Rastogi publication, Meerat.
8. Molecular and Cellular Biology-Wolfe S.L. (1993), Wadsworth publishing Company, California, U.S.A.
9. Applied Microbiology- Vinita Kale and Kishore Bhusari (2007) Himalaya Publishing House, Mumbai.
10. Virology- Saravanan P. MJP, Publishers, Chennai. 600005.
11. Chromatographic Methods- Stock, R. and C. B. F. Rince (1978).
12. Biological Techniques- Srivastava, H. S. (1999).

B. Sc. Botany Part-I; Semester-I (NEP 2020)		
DSC-P-I: Practical based on DSC I and II		
Credits: 02	**Practical: 60 hours**	**Hours per week: 04**

Learning Objectives:

1. To familiarize students with the use of microscopes and the study of microorganisms, viruses, and bacterial forms.
2. To understand the vegetative and reproductive structures of representative algae.
3. To perform basic biochemical tests for identification of biomolecules.
4. To study plant cell structure, cell division, and organelles through experimental and model-based approaches.
5. To observe physiological effects on cell permeability and enzyme activity, supplemented by field excursion learning.

Unit I	Practical based on DSC I and II	No. of Hours: 60

1. Study of compound and dissecting microscope.
2. Study of T-Phage and TMV viruses with the help of Electron microphotographs/models
3. Study of Bacterial forms (Temporary / permanent slides/ photographs).
4. Study of vegetative and reproductive structures of Nostoc and Spirogyra
5. Study of Qualitative tests for carbohydrates, lipids and proteins (Any two test of each)
6. Study of plant cell structure with the help of epidermal peel
7. Study of mitosis
8. Study of meiosis
9. Study of cell organelles with the help of microphotograph/model
10. Study the effect of organic solvent on permeability of plasma membrane.
11. Study the effect of temperature on the activity of peroxisome.
12. Botanical excursion / visit to botanical garden

B. Sc. Botany Part-I; Semester-II (NEP 2020)		
DSC-III : Mycology and Phytopathology		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. To introduce students to the general characters, classification, and economic importance of fungi.
2. To study the life cycle patterns of representative fungi (Mucor and Penicillium).
3. To understand the occurrence, nature of association, types, and economic significance of lichens.
4. To learn the basic concepts, components, and terminology of phytopathology.
5. To identify symptoms and understand control measures of representative plant diseases caused by viruses, bacteria, fungi, and mycoplasma.

Unit I	Mycology	No. of Hours: 15

1.1. Fungi:

i. Introduction
ii. General characters of fungi
iii. Classification of fungi up to class as per Ainsworth (1973).
iv. Economic importance

1.2. Life cycle of fungi (excluding developmental stages of sex organs) of the following types:

a) Zygomycotina: Mucor

b) Ascomycotina: Penicillium

1.3. Lichens:

i. Occurrence and General characters
ii. Nature of association
iii. Types of lichens (Crustose, Foliose and Fruticose)
iv. Economic importance

Unit II	Phytopathology	No. of Hours: 15

2.1. Concepts in Phytopathology:

i. Introduction to phytopathology
ii. Plant disease triangle components.
iii. Koch's postulate
iv. Terminology of plant Diseases - Localized, Systemic, Soil borne, Air borne, Seed borne, Endemic, Epidemic, Sporadic diseases.
v. General symptoms of plant diseases- (Leaf spot, Blight, damping off, wilting, Dieback, Cankers, Chlorosis, Smut, Rust, Powdery mildew.

2.2. Plant diseases:

i. Introduction to phytopathology
ii. Study of following plant diseases with respect to symptoms and control measures-
a) Viral – Yellow vein mosaic of Bhendi
b) Bacterial – Citrus Canker
c) Fungal – White rust of crucifers
d) Mycoplasma (MLO)- Grassy shoot of sugarcane

Reference Books:

1. A Hand book of Lichens - D. D. Awasthi (2000)
2. An Introduction to Fungi - Dube H. C. (1990)
3. Morphology of Plants and Fungi --Blod, H.C., Aloxopoulos, G. J. and Delevoryas, T. 1980. (4th Edition) Harper and Foul Co., New York.
4. An Introduction to Fungi.--Dube, H. C. 1990. Vikas Publishing House Pvt. Ltd.,Delhi.
5. Cryptogamic Botany Vol. I & II (2nd Edition), Gilbert, M. S. 1985. Tata McgrawHill Publishing Co., Ltd New Delhi.
6. Fungi- Vashishtha B. R. (1996)
7. Fungi- Pandey B. P. (1994)
8. Introduction to Fungi - Sundrarajan (2001)
9. Introductory Mycology - C. J. Alexopoulos, C. W. Mims, M. Blackwell
10. Cryptogamic Botany Vol. I - Algae and Fungi - G. M. Smith (1974)
11. Plant diseases –Singh R. S. (1963).
12. Manual of plant pathology –Padoley S. K. & Mistry P. B.
13. Hand book of field crop diseases- Ny. Vall (1979).
14. Experiments in Microbiology, Plant pathology and Tissue culture- Aneja K. R. (1993).
15. Plant pathology- R. S. Mehrotra, (1980) Dean, Faculty of science, Kurkshetra University, Kurukshetra.
16. Plant Diseases- F.T. Brooks, periodical Expert book Agency, D-42, VivekVihar, Delhi 1100032.
17. Plant diseases –RajaniShrma, Campus books international, 4831/24 Prahlad Street, An sari Road, Daryaganj, New Dehli-110002.
18. Diseases of crop plant in India –Dr. Rangaswami.
19. Plant diseases –R.S. Singh
20. Modern plant pathology – R. S. Bilgrami and H. C. Dube.

B. Sc. Botany Part-I; Semester-II (NEP 2020)		
DSC-III : Archegoniate		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. To introduce students to the general characters, importance, and classification of Bryophytes, Pteridophytes, and Gymnosperms.
2. To understand the diversity and ecological significance of Bryophytes with emphasis on Funaria.
3. To study the morphology, anatomy, and life cycle of representative Pteridophytes such as Pteris.
4. To learn the structural and reproductive features of Gymnosperms with reference to Cycas.
5. To appreciate the evolutionary significance and economic importance of cryptogams and gymnosperms.

Unit I	Bryophytes	No. of Hours: 10

1.1. Bryophytes:

i. Introduction
ii. General characters and importance
iii. Diversity with respect to habitats
iv. Classification as per G.M. Smith (1955) up to classes
v. Important features and life history (excluding developmental stages) of Funaria

Unit II	Pteridophytes	No. of Hours: 10

2.1. Pteridophytes:

i. Introduction
ii. General characters and importance
iii. Classification as per G.M. Smith (1955) up to classes.
iv. Morphology, anatomy (leaf and stem) and life cycle (excluding developmental stages sex organs) of Pteris

Unit III	Gymnosperms	No. of Hours: 10

3.1. Gymnosperms:

i. Introduction
ii. General characters and importance
iii. Classification as per Sporne (1965) up to classes
iv. Important features and life history (excluding developmental stages) of Cycas

Reference Books:

Bryophytes:

1. Bryophytes. Puri, P. 1985. Amarm& Sons, Delhi.

2. College Botany - S. Sundararajan (1999)

3. College Botany Vol. I - Gangulee H. C., Das K. S. and Datta C. T. (1991)

4. College Botany Vol. II - Gangulee H. C., Kar A. K. (1999)

5. College Botany Vol. III -- S. K. Mukharji (1990)

6. Cryptogamic Botany Vol. I- G. M. Smith (1955)

7. Cryptogamic Botany: Bryophytes and Pteridophytes - Smith G. C. (1955)

Pteridophytes:

1. An Introduction to Pteridophytes - Rashid A. (1978)

2. An Introduction to Pteridophyta (Diversity and Differentiation) -A. Rashid (1976)

3. A Text book of Pteridophyte – S. N. Pandey, P. S. Trivedi, S. P. Misra (1995)

4. An Introduction to Embryophyta - Parihar N. S. (1961)

5. Morphology and Evolution of Vascular Plants Gifford, E. M. and Foster, A. S. 1989. W.H. Freeman & Co., New York.

6. Morphology of vascular Plant (lower groups) -- A. J. Eames.

7. Illustrated Manual of Ferns of Assam -S. K. Borthakur, P. Deka, K. K. Nath (2000)

8. Pteridophyta – Vascular Cryptogams - P. C. Vashishta (1972)

9. Botany for Degree Students- Pteridophyta (Vascular Cryptogams) - P. C. Vashishta, A. K. Sinha, Anil Kumar – S Chad –Multicolour Illustrative Revised Edition- 2006.

Gymnosperms:

1. Botany for Degree Students- Gymnosperms (Vascular Cryptogams) - P. C. Vashishta, A. K. Sinha, Anil Kumar – S Chad –Multicolour Illustrative Revised Edition- 2006.

2. The Morophology of Gymmosperms. -- Sporne, K. R. 1991. B. I. PublicationsPvt., Bombay, Calcutta, Delhi.

3. Morphology of Gymnosperms -- J. M. Coulter and C. J. Chamberlain.

4. Gymnosperms – Structure & Evolution.--C. J. Chamberlain

5. Morphology of Gymnosperms.--K. R. Sporne.

6. Gymnosperms- Vashishta P. C. (1976)

7. Gymnosperms- C. J. Chamberlein (1966)

8. Indian Gymnosperms in Time and Space - Ramanujan C. G. K. (1979)

9. Origin and Evolution of Gymnosperms - Ed Charles B. Beck (2002)

10. Phylogeny and form in the plant Kingdom - H. C. Dittmer (1964)

B. Sc. Botany Part-I; Semester-II (NEP 2020)		
DSC-P-II: Practical based on DSC III and IV		
Credits: 02	**Practical: 60 hours**	**Hours per week: 04**

Learning Objectives:

1. To study the morphology and characteristics of representative fungi and lichens.
2. To identify major plant diseases caused by bacteria, viruses, mycoplasma, and fungi.
3. To understand the vegetative and reproductive structures of lower and higher cryptogams (Funaria, Pteris, Cycas).
4. To develop skills in recognizing general symptoms of plant diseases.
5. To encourage systematic submission and documentation of plant disease specimens.

Unit I	Practical based on DSC III and IV	No. of Hours: 60

1. Study of Mucor
2. Study of Penicillium
3. Study of types of Lichens
4. Study of any four general symptoms on plant diseases (As per theory)
5. Study of bacterial plant disease – Citrus canker
6. Study of Viral plant disease – Yellow vein mosaic of Bhendi
7. Study of Mycoplasmal plant disease – Grassy Shoot of Sugarcane
8. Study of fungal plant disease – White rust of Crucifers
9. Study of vegetative and reproductive structures of Funaria
10. Study of vegetative and reproductive structures of Pteris
11. Study of vegetative and reproductive structures of Cycas
12. Submission of plant diseases.

Structure of B. Sc. Part I : Zoology

Sr. No.	Semester	Title of Paper	Credits	Hours
1.	I	DSC-I: Animal Diversity	2 Credits	30 Hours
2.		DSC-II: Cell Biology	2 Credits	30 Hours
3.		DSC-P-I: Practical based on DSC-I and DSC- II	2 Credits	60 Hours
4.	II	DSC-III: Genetics	2 Credits	30 Hours
5.		DSC-IV: Ecology, Ethology. Evolution, And Entomology	2 Credits	30 Hours
6.		DSC-P-II: Practical based on DSC-III and DSC- IV	2 Credits	60 Hours

B. Sc. Zoology Part-I; Semester-I (NEP 2020)		
DSC-I : Animal Diversity		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. Understand the concept and importance of biodiversity
2. Enable the students to identify the similarities and differences among the animals in different Phyla and classes.
3. Develop sensitivity for the conservation of biodiversity in their day-to-day life.
4. Equip the students with the skills of dissection.

Unit I	Classification	No. of Hours: 10

1. Introduction
2. Principles of classification, Five Kingdom classification
3. Binomial nomenclature
4. Levels of Organizations in Kingdom Animalia
5. Germ layers and coelom concept
6. Different modes of nutrition
7. Non-chordates concept, Phyla with prominent characters and examples
8. Phylum Chordata: Characters, subphyla/ classes with prominent characters and examples
9. Difference between non-chordates and chordates
10. Generalized body plans of non-chordates (Annelida/Arthropods) and chordates

Unit II	Biodiversity	No. of Hours: 10

1. Introduction to biodiversity
2. Biodiversity concept and its importance
3. Zoogeographical regions and distribution of animals: Global and Indian biodiversity.
4. Extinct and threatened animals
5. Hotspots of biodiversity and Biodiversity Centres
6. Need for conservation and conservation strategies

Unit III	Anatomy	No. of Hours: 10

1. Cockroach: a representative of non-chordates
2. Habit and habitat
3. Systematic position
4. Morphology
5. Anatomy: Digestive system, nervous system, blood vascular system, Respiratory system, excretory system, reproductive system, and receptor organs.

Reference Books:

1. Hyman, L. H. – The invertebrate, Vol. I (McGraw Hill)
2. Hyman, L. H. – The invertebrate, Vol. II (McGraw Hill)
3. Barnes, R. D. – Invertebrate Zoology (W. B. Saunders Co.). 1987
4. Parker and Haswell – A Text Book of Zoology – Invertebrate Vol. I Edited by Marshall and Williams, C. B. S. Publishers and Distributors, New Delhi. 1972

5. P.S. Dhami and J. K. Dhami – Invertebrates, S. Chand and Company, New Delhi 1979
6. A Text Book of Invertebrates – N. C. Nair, N. Soundara Pandian, S. Leelavathy, T. Murugan Saras Publication 2010
7. Invertebrate Zoology by R. L. Kotpal Rastogi Publications 2020

B. Sc. Zoology Part-I; Semester-I (NEP 2020)		
DSC-II : Cell Biology		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. Understand the general organization of cell organelles and their functions.
2. Apply their knowledge to study the functioning of a cell and cell divisions and its regulation.
3. Analyze the role of cell organelles and cell cycle checkpoints with examples of anemia, diabetic wounds, and cancer.
4. Equip the students with skills like handling the microscope, micrometry, staining techniques, etc.

Unit I	The cell	No. of Hours: 10

General organization of cell:

1. Organization of prokaryotic and eukaryotic cells
2. Nucleus: nuclear membrane, nucleoplasm, chromatin, and nucleolus
3. Chromosome: morphology of metaphase chromosome and its organization (Solenoid model)
4. Cytoskeleton

Unit II	Cytology	No. of Hours: 10

Ultra-structure and functions of:

1. Plasma membrane (Fluid Mosaic Model)
2. Mitochondria
3. Endoplasmic reticulum
4. Golgi complex
5. Lysosome
6. Ribosome

Unit III	Cell cycle and its regulation	No. of Hours: 10

Cell cycle and its regulation:

1. Concept of Cell cycle and its regulation
2. Mitosis
3. Meiosis
4. Abnormalities in cell division: Hypoproliferation (Anemia and diabetic wound) and Hyperproliferation (Cancer)

Reference Books:

1. Cell and Molecular Biology by De Roberties EDP and De Roberties EME VIII ED ©1997
2. Principles of Cell and Molecular Biology by Kleinsmith and Kish Pearson Publisher ©1997
3. Molecular cell biology by Harvey Lodish, Berk A, Matsudaira P., Baltimore, D & Darnel I. W. H. Freeman and Co. © 2001
4. Becker's World of the Cell by Jeff Hardin and James P. Lodolce, Pearson Publisher © 2020
5. Molecular biology of the cell by Bruce Alberts, Johnson A., Lewis J.,Raff M., Roberts K & Walter P., 4th Ed. Garland Science Publishing, New York© 2002
6. The Cell: A molecular approach by Geoffrey Cooper. OUP USA, © 2019

B. Sc. Zoology Part-I; Semester-I (NEP 2020)		
DSC-P I: Practical based on DSC I and II		
Credits: 02	**Practical: 60 hours**	**Hours per week: 04**

Learning Objectives:

1. To introduce students to animal diversity through representative specimens of non-chordates, chordates, and their adaptations.
2. To familiarize students with the morphology and anatomy of insects (cockroach) and their physiological systems.
3. To provide knowledge of global distribution of animals and their conservation status.
4. To train students in the use of microscopy, micrometry, and cytological techniques for cell structure studies.
5. To develop understanding of cell division, organelle staining, and pathological conditions through laboratory observations.

Unit I	**Practical based on DSC I (Animal Diversity)**	**No. of Hours: 30**

1. One example of each non-chordate phyla
2. One example of each chordate subphyla/class
3. One example of each mode of nutrition
4. Demonstration of cockroach digestive system
5. Demonstration of cockroach nervous system
6. Demonstration of mountings of mouth parts, trachea and cornea of cockroach
7. Placing the animals on a world map according to zoo-geographical distribution
8. One example of each rare, endangered, critically endangered, and extinct animal as per the red data book.

Unit II	**Practical based on DSC II (Cell Biology)**	**No. of Hours: 30**

1. Cytological experiments
   a. Study of light microscope: Principles of microscopy; study of its parts; focusing of a slide at low and high power and study of Image Formation.
   b. Micrometry: Measuring size of microscopic structures.
   c. Study of osmosis using salt solutions

2. Cytological Preparations:
   a. Study of facultative heterochromatin (Barr body)
   b. Isolation of Nucleus and Staining of the nucleus by any nuclear stain
   c. Staining of mitochondria by Janus green B in oral mucosa or any suitable tissue.

3. Study of mitosis in onion root tips
4. Study of meiosis – observation of permanent slides
5. Study of anemia and diabetic wound and histology of cancerous tumor

B. Sc. Zoology Part-I; Semester-II (NEP 2020)		
DSC-III : Genetics		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. Understand heredity and variation.
2. Apply their knowledge to draw the genetic crosses based on patterns of heredity.
3. Culture the Drosophila and handling skills among the students.
4. Enable the students to develop: a. A gene map using data of crossing over and linkage study, b. draw, and analyze pedigree and c. analyze karyotypes.

Unit I	Basics of Genetics	No. of Hours: 10

1. Molecular Basis of Genetic Information (Central Dogma)
2. Mendel's work and Principles of Inheritance
3. Test cross, back cross, and reciprocal cross
4. Incomplete dominance and co-dominance

Unit II	Gene interaction	No. of Hours: 10

1. Gene interaction (Epistasis): Supplementary gene interaction. Complementary gene interaction
2. Multiple alleles: definition, ABO blood group system, and coat colour in rabbit,
3. Sex-linked inheritance: definition, Haemophilia, and colour blindness
4. Linkage and crossing over: Linkage, types of linkage and process of crossing over, Cytological evidence of crossing over.

Unit III	Chromosomal Abnormalities	No. of Hours: 10

1. Chromosomal Abnormalities
2. Human karyotype analysis
3. Numerical abnormalities: Aneuploidy and Polyploidy,
4. Chromosomal aberrations: Deletion, Duplication, Inversion, Translocation,
5. Pedigree analysis
6. Sex determination : Chromosomal theory of sex determination, Genic balance theory, Haploidy - Diploidy mechanism, Environmental sex determination.

Reference Books:

1. Genetics by Strickberger, M.W. 3rd Edition Pearson Education India, © 2015
2. Human Genetics by Winchester A.M. Charles E.Merrill Publishing International; 4th Revised edition© 1983
3. Concepts of Genetics by Klug, Cummings, Spencer, and Palladino. Pearson Education India, 2015
4. Principles of Genetics by Tamarin, R. H. McGraw-Hill Education © 2001
5. Fundamental of Genetics by B. D. Singh. Medtech Science Press © 2022

B. Sc. Zoology Part-I; Semester-II (NEP 2020)		
DSC-IV: Ecology, Ethology. Evolution, And Entomology		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. Understand the basic concepts.
2. Enable the students to identify the amazing features of the insect world.
3. Train students to arrange the animals on a geological time scale.
4. Mold the student to apply their knowledge to construct food chains, food webs, and ecological pyramids.

Unit I	Ecology	No. of Hours: 10

Ecology

1. Introduction and Scope of Ecology
2. Basic concepts in ecology: Biosphere, biome, Species, Population, Community, Niche
3. Ecosystem: Definition, concept, types, pond ecosystem, and grassland ecosystem
4. Food chain, food web
5. Ecological pyramids
6. Ecological adaptations
7. Symbiotic relationships

Unit II	Ethology and Evolution	No. of Hours: 10

Ethology

1. Introduction to the study of animal behavior
2. Mimicry in Monarch butterfly and stick insect
3. Camouflage in chameleon and Leaf insect
4. Courtship behavior in scorpion and weaver birds
5. Social behavior in honeybee

Evolution

1. Types of fossils, Formation and dating of fossils
2. Incompleteness of Fossil record
3. Geological time scale

Unit III	Entomology	No. of Hours: 10

Entomology

1. Introduction to Entomology
2. Brief morphology of insects (Grasshopper) and types of mouth parts
3. Entomophagy: Introduction, Nutritional value, economic importance, Examples.
4. Wonders in insects:
   Mud wasp , Praying mantis, Giant cockroach, Ladybird beetle, Firefly, Parasitoids - Apenteles in Helicoverpa

Reference Books:

1. Environmental Studies – Based on UGC Syllabus – N. Arumugam and V. Kumaresan. Saras Publisher 2014

2. Organic Evolution – N. Arumugam. Saras Publisher ©2019
3. Organic Evolution – Lul. Forgotten Books ©2018
4. Ecology by E. P. Odum. Oxford and LBH 2008
5. Fundamentals of Ecology – Odum – Saunders Publisher ©1971
6. Ecology – Rickelfs. W. H. Freeman Publisher ©1999
7. Immelmann- Introduction to Ethology. Plenum Press, ©1980
8. The Foundations of Ethology. Springer Verlag, ©1981
9. Economic Zoology – Shukla and Upadhyaya – Rastogi Publications
10. Economic Zoology – Venkitaraman (Sudarshana Publishers)
11. The Insect structure function and biodiversity by Ambrose P. Kalyani Publisher ©2015

B. Sc. Zoology Part-I; Semester-II (NEP 2020)		
DSC-P-II: Practical based on DSC III and IV		
Credits: 02	**Practical: 60 hours**	**Hours per week: 04**

Learning Objectives:

1. To introduce students to the fundamental principles of genetics, including inheritance, gene mapping, and chromosomal analysis.
2. To provide training in Drosophila culture techniques for studying genetic variations and mutations.
3. To familiarize students with ecological concepts through the study of food chains, food webs, and ecological pyramids.
4. To impart knowledge of evolutionary, ethological, and entomological aspects using specimens and models.
5. To encourage understanding of biodiversity, ecosystem dynamics, and animal behavior through laboratory and field observations.

Unit I	**Practical based on DSC III (Genetics)**	**No. of Hours: 30**

1. Study Mendel's work with the help of different coloured beads and other simulations.
2. Examples based on Gene mapping using data of crossing over and linkages
3. Study of sex-linked inheritance by pedigree study.
4. Study of normal human spread chromosomes and sex determination
5. Identification of genetic syndrome by karyotype analysis
6. Identification of chromosomal aberration by studying karyotype
7. Identification ABO blood group
8. Drosophila culture, handling, Life cycle, and identification of male and female Drosophila and mutants (After induction of mutation)
9. Examples based on Gene interactions and Multiple alleles

Unit II	**Practical based on DSC IV (Ecology, Ethology, Evolution, and Entomology)**	**No. of Hours: 30**

1. Ecology – Preparation of the following about pond and grassland ecosystems.
   a. Arranging the organisms in the Food chain and food web
   b. Arranging the organisms in different trophic levels of Ecological Pyramids
2. Ethology –
   a. Mimicry in – monarch butterfly and stick insect
   b. Castes of Honey bee
3. Evolution –
   a. Types of fossils
   b. Arrangement of the animals as per the Geological Time Scale
4. Entomology –

a. Types of insect Mouthparts (House fly, Honeybee, Mosquito, Butterfly, cockroach)

b. Entomophagy – Examples of edible insects according to theory

c. Wonders in insects (Based on theory)

5. Visit to any suitable place to study the ecosystem, animal diversity, animal behaviour etc.