SHIVAJI UNIVERSITY, KOLHAPUR - 416004,
MAHARASHTRA
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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

Biotechnology

Under
Faculty of Science and Technology

(To Be Implemented from Academic Year 2026-27)

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SHIVAJI UNIVERSITY, KOLHAPUR

Syllabus for the
Bachelor of Science in Biotechnology
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 Biotechnology – Apprenticeship Embedded Degree Programme (AEDP) under NEP 2020 is an innovative, industry-aligned undergraduate programme proposed by the Department of Biotechnology, 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 Biotechnology.

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 Biotechnology, including biomolecular structure and function, metabolism, enzymology, molecular biology, clinical research, bioinstrumentation, medical biotechnology and forensics. 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. Biotechnology (AEDP) programme aims to produce competent, confident, and career-ready graduates capable of addressing real-world challenges in healthcare, pharmaceuticals, food and nutrition, environmental management, and life sciences.

2. Title: B. Sc. (Biotechnology) 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 Biotechnology (AEDP) program include:

- ❖ Understand the fundamental principles, concepts, and laws of Biotechnology, including biomolecular structure, metabolism, enzymology, genetics, and molecular biology.
- ❖ Develop analytical and problem-solving skills to identify, study, and address biotechnological 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 biotechnological applications.
- ❖ Gain hands-on experience with biotechnological 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 Biotechnology in medical, pharmaceutical, industrial, agricultural, and environmental sectors, supporting higher studies and research.
- ❖ Apply theoretical and conceptual knowledge to practical biotechnological 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, analyse, and interpret biotechnological 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 Biotechnology, also acquired interdisciplinary skills in cell biology, genetics, biochemistry, microbiology and molecular biology.
- **PO2:** Scientific Skills – Apply laboratory techniques, safety practices, and scientific methodologies to analyze and solve biotechnological problems.
- **PO3**: Problem-Solving – Critically analyzes scientific data, design experiments, and develop innovative solutions to challenges for Biotechnological applications.
- **PO4**: Employability & Entrepreneurship – Acquire industry-relevant skills through internships, apprenticeship training, and practical exposure, pharmaceutical, Clinical research, forensic data analysis and allied industries.
- **PO5**: Digital Competence – Apply tools of bioinformatics in various sectors of biotechnology including health and food.
- **PO6**: Communication Skills – Demonstrate communication skills, scientific writing, data collection and interpretation abilities in all fields of Biotechnology.
- **PO7**: Social & Ethical Responsibility – Demonstrate professional ethics, environmental awareness, and adherence to biosafety and bioethical principles in biotechnological practices.
- **PO8**: Lifelong Learning – Pursue higher education, research, and continuous learning in Biotechnology and allied disciplines to adapt to scientific advancements.

7. Program Specific Outcomes:

- **PSO1**: Apply fundamental and advanced biotechnological concepts to analyze and characterize biomolecules such as proteins, nucleic acids, lipids, and carbohydrates using classical and molecular techniques.
- **PSO2**: Demonstrate technical ability in handling laboratory instruments, including spectrophotometers, chromatography, electrophoresis, PCR, Biosafety cabinets, and other analytical tools.
- **PSO3**: Integrate theoretical and practical knowledge of Biotechnology in medical, pharmaceutical, industrial, agricultural, food, clinical, forensics and environmental applications.
- **PSO4**: Perform data analysis, statistical evaluation, and hypothesis-driven research for scientific investigation and development.
- **PSO5**: Gain work-integrated practical experience through internships and apprenticeships in biotechnology-related industries such as pharmaceuticals, diagnostics, food, environment, clinical, forensics etc.
- **PSO6**: Develop entrepreneurial skills for start-ups like bioferlilizers, clinical data management, nutraceuticals, diagnostics, and fermentation-based industries.
- **PSO7**: Contribute to sustainable development by applying biotechnological principles to environmental management, waste treatment, and efficient bioresource utilization.

8. Duration of the degree programme:

- Bachelor of Science (B.Sc.) in Biotechnology (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 (Biotechnology) AEDP (Level 4.5) will be of Two Semesters (Semester I and Semester II).

1. 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.

2. **Medium of Instruction:** English

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

4. **Fee structure:** As per Shivaji University guidelines.

5. 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

6. 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 Biotechnology 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.

7. 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.

8. 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)

9. 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**	

10. Syllabus

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

Sr. No.	Semester	Title of Paper	Credits	Hours
1.	I	DSC-I: **Cell biology and Genetics**	2 Credits	30 Hours
2.		DSC-II: **Microbiology and Microbial Technology**	2 Credits	30 Hours
3.		DSC-P-I: Practical based on DSC-I and DSC- II	2 Credits	60 Hours
4.	II	DSC-III: **Biochemistry and Basic Metabolism**	2 Credits	30 Hours
5.		DSC-IV: **Enzymology**	2 Credits	30 Hours
6.		DSC-P-II: Practical based on DSC-III and DSC- IV	2 Credits	60 Hours
7.	I	OE-I: **The Role of Biotechnology in Human Life**	2 Credits	30 Hours
8.	II	OE-II: **Applied Biotechnology & Entrepreneurship**	2 Credits	30 Hours

B. Sc. Biotechnology (AEDP) Part-I; Semester-I (NEP 2020)		
DSC-I : Cell biology and Genetics		
Credits: 02	**Lectures: 30 hours**	**Lectures per week: 02**

Learning Objectives:

1. To make students aware of fundamentals of Cell Biology
2. To introduce vide areas in Genetics
3. To introduce the role of Genetics in Human well-being

Unit I	Cell Biology	No. of hours: 15

A. **Structure and functions of cell organelles:** Cytosol, endoplasmic reticulum, golgi complex, mitochondria, chloroplast, ribosomes, lysosomes, peroxisomes, nucleus, nucleolus, vacuole and cytoskeletal structures (microtubules, microfilaments and intermediate filaments) (3)

B. **Chromosomes** : General introduction, discovery, morphology and structural organization – Centromere, secondary constriction, telomere, chromonema, euchromatin and heterochromatin, chemical composition and karyotype. Single-stranded and multi- stranded hypothesis, folded-fibre and nucleosome models (5)

C. **Special type of chromosomes:** Salivary gland chromosome and lampbrush chromosmes (2)

D. **Cell cycle**: phases of cell division, mitosis and meiosis, cell cycle checkpoints, enzymes involved in regulation, significance of cell cycle, achromatic apparatus, synaptonemal complex, senescence and programmed cell death (5)

Unit II	Genetics	No. of hours:15

A. **History of genetics**: Mendelian theory; Laws of inheritance - dominance, segregation, incomplete dominance, codominance with an example. Law of independent assortment, test cross, back cross and non-Mendelian inheritance. (3)

B. **Maternal inheritance**: Plastid inheritance in Mirabilis, Kappa particles in paramecium, and Petite characters in yeast, Sex-linked inheritance, Chromosome theory of inheritance. (3)

C. **Gene interaction**: Supplementary factors: comb pattern in fowls, Complementary genes – flower colour in sweet peas, Multiple factors – skin colour in human beings, Epistasis – plumage colour in poultry, Multiple allelism: blood groups in human beings. (3)

D. **Linkage:** General introduction, coupling and repulsion hypothesis, linkage in maize and Drosophila, mechanism of crossing over and its importance, chromosome mapping-linkage map in maize. (3)

E. **Mutations**: Types of mutations; spontaneous and induced mutagens: Physical and chemical, mutation at the molecular level, mutations in plants, animals and microbes and its merits and demerits. (3)

Course Outcomes:

Students will able to learn,

1. Basics and modern Cell biology and Genetics concepts
2. Various aspects of Genetics and their applications
3. Use of Genetics for human welfare

Suggested readings:

1. Ambrose, and Dorothy, M., Easty 1970. Cell Biology, ELBS Publications.
2. Benjamin Lewin, 1985. Genes II –Wiley & Sons Publications.
3. Benjamin Lewin, 1987. Genes III Wiley & Sons Publications.
4. Benjamin Lewin, 1994. Genes V. By Oxford University Press, Oxford and New York, 1,272 pp.

5. Bruce Alberts, Alexander Johnson, Julian Lewis, et al., 2014 Molecular Biology of Cell – Garland publications.
6. Daniel L. Hartl, E.W. Jones, Jones, 2005. Genetics: Analysis of Genes and Genomes, Barlett Publishers.
7. De Robertis and EMF Robertis, 1980. Cell Biology & Molecular Biology – EDP Saunder College.
8. Edgar Altenburg, 1970. Genetics, Oxford & IBH publications.
9. Gardener, E.J., Simmons M.J. and Snustad D.P. 1991. Principles of Genetics –John Wiley and Son Publications.
10. Gupta P.K., 2018-19. Genetics - 5th Revised Edition, Rastogi Publication, Meert, India.
11. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. 2000. Molecular Cell Biology - Daniel, Scientific American Books.
12. Jack D Bruke. 2002. Cell Biology, The William Twilkins Company.
13. Monroe W Strickberger, 1976. Genetics, Macmillain Publishers, New York
14. Sandy, B. Primrose, Richard Twyman, 2006. Principles of Gene Manipulations 7th Edition Black Well Scientific Publications.
15. Sharp, L.W. 1943. Fundamentals of Cytology - New York,McGraw-Hill Book Company, inc.
16. Singh B. D. 2023 Fundamentals of Genetics Kalyani Publications
17. Sinnott, L.C. Dunn, Dobzhansky 1985. Principles of Genetics - McGraw-Hill.
18. White, M.J.D. 1980. Animal Cytology and Evolution, Cambridge University Publications.

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

Learning Objectives:

1. To make the student aware of basic concepts of Cell, Cell organelles.
2. To make the student aware of basic concepts cytoskeleton
3. To make the student aware of basics of Cell membrane and membrane transport .

Unit I	**Introduction of Microbiology**	**No. of hours: 15**

A. Morphology of bacteria:

1. Cell size, shape and arrangement

B. Biology 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

Unit II	**Microbial techniques**	**No. of hours:15**

A) Microscopy Principle:

1. **Light Microscopy:** History, Scope, Principle construction and application of bright field microscopy.
2. **Advanced microscopy:** Introduction to dark-field, Phase contrast, and fluorescent microscopy

B) Fermentation Techniques:

1. **Fermentation:** Definition, Types: - Batch, Continuous, Fed Batch methods. Designs operation parameters etc
2. **Application:** Dairy industries, beverages (wineries), probiotics, antibioticsetc. production**,**

Course outcome

Students will be able to

1. Explain difference in prokaryotes and Eukaryotes
2. Explain the fermentation principle and microbial metabolism
3. Understand bioreactor design and operation
4. Apply fermentation technology in food, pharma and biofuel industries

Suggested readings:

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

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

DSC-III : Biochemistry and Basic Metabolism

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

Learning Outcome:

Students will be able to learn,

1. Differentiate Organic Macromolecules
2. Analyze carbohydrate Architecture
3. Evaluate Amino Acid Chemistry
4. Deconstruct Saccharide and Lipid Metabolism

Unit I	**Carbohydrates Proteins and Lipids**	**No. of hours:15**

A) Carbohydrates: Definition, structures, classification, reducing non-reducing sugars, Oligosaccharides and polysaccharides

B) Amino acids and Proteins: Structure and classification amino acids, Essential and non-essential amino acids, Physical, chemical and optical properties of amino acids, Proteins classification and role

C) Lipids: Introduction and Basic Chemistry**,** Classification of Lipids: simple, compound and derived lipids**,** Biological Functions.

Unit II	**Carbohydrates and Lipid Metabolism**	**No. of hours:15**

A) Carbohydrates metabolism: Reaction, energetic & regulation: Glycolysis: Fate of pyruvate under aerobic & anaerobic condition. Pentose phosphate pathway & its digestion. Gluconeogenesis, Glycogenolysis & Glycogen synthesis (insulin Glucagon and epinephrine). TCA Cycle, Electron transfer chain,

B) Clinical correlations: Brief Overview of Dibetes Milltus and Glycogen storage disease

C) Lipid metabolism: Oxidative phosphorylation, beta oxidation of fatty acids. Fatty acid synthase complex, Ketone bodies: ketogenesis, ketolysis, and metabolic significance of ketoacidosis during starvation.

D) Clinical Correlation: Brief overview on Atherosclerosis, Fatty Liver, Hypercholesterolemia.

Course Outcomes:

Students will able to learn,

1. How the structure influence the health and how it interfere macromolecular assembly in cells
2. How amino acid influence protein structure function .
3. Explain various types of weak interactions between the biomolecules.
4. Know how the simple precursors give rise to large biomolecules such as proteins, carbohydrates, lipids, nucleic acids.
5. Correlate the structure-function relationship in various biomolecules.

Suggested readings:

1. Lehninger Principles of Biochemistry-Nelson and Cox
2. Biochemistry-Stryer
3. Biochemistry-Voiet and Voiet
4. General Biochemistry-J. H.Well
5. Biochemistry –U. Satyanarayanan
6. Biochemistry- J.L.Jain
7. Practical biochemistry – Keith, Wilson and Walker
8. Cell Biology- C.B.Pawar

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

Learning

Students will be able to

1. Explain enzyme structure and catalytic mechanism
2. Apply enzymology in biotechnology
3. Analyse Michaelis-Menten equation And Lineweaver-Bruk plot
4. Discuss enzyme regulation and inhibitions.

Unit I	Enzymes	No. of hours: 15

A) Enzymes: Definition, History, importance of enzymes, IUBMB classification example,

B) Structure: Enzyme structure-apoenzyme, coenzyme, cofactors, prosthetic group.

C) Enzyme kinetics: Michaelis-Menten equation K_m, V_{max} and Lineweaver-Bruk plot

Unit II	Factors Affecting Enzyme Mechanism	No. of hours: 15

A) Enzyme Mechanism: enzyme mechanism and key role of amino acids in its mechanism.

B) Enzyme inhibition: competitive noncompitative and uncompitative inhibition

C) Allosteric regulation: feedback inhibition and cooperativity, Isoenzymes

D) Enzyme immobilization: techniques advantages and application-food, textiles, detergents, diagnostics and therapeutics

Course outcomes:-

Students will be able to

1. Understand the fundamentals of enzymes
2. Relate the enzyme structure with its mechanism
3. Understand enzyme kinetics enzyme regulation and its application in various fiends
4. Bridge the biochemistry band biotechnology

Suggested readings:

1. Lehninger Principles of Biochemistry-Nelson and Cox
2. Biochemistry-Stryer
3. Enzymes-Trevor Palmer
4. Biochemistry-Voiet and Voiet
5. Industrial Enzymology by Tony Godfrey and Stuart West

B. Sc. Biotechnology (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. Demonstrate working knowledge of core laboratory instruments
2. Operate, calibrate, and troubleshoot equipment while strictly adhering to biosafety and aseptic protocols.
3. Execute standard analytical procedures to quantify water pollution and evaluate food safety.
4. Apply bioprocess and research methodology

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

1. Operation and working principle of simple and compound microscope.
2. Use of Micrometry, measurement of onion epidermal cells/ pollen grains/ fungal spores, and yeast.
3. Study of mitosis in onion root tips.
4. Study of meiosis in onion/Rhoeo flower buds.
5. Mounting of polytene chromosomes.
6. Karyotype analysis – human (normal & abnormal) and onion.
7. Simple genetic problems based on theory.

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

1. Preparation, isolation and enumeration of microorganism in Simon citrate agar (Synthetic media) using standard plate count method.
2. Isolate pure culture through serial dilution method
3. Motility by hanging drop method.
4. Learn the different media preparation for a particular microbe
5. Simple staining technique
6. Negative staining technique
7. Different types of streaking techniques
8. Differential staining techniques
9. Perform basic microbial assay for identification and characterization

Course Outcomes:

Students will able to learn,

1. Operate, calibrate, and troubleshoot essential laboratory equipment
2. Execute Microscopic and Analytical Techniques

3. Synthesize technical experimental data into a structured mock grant proposal
4. Formulate precise molar buffers

Suggested readings:

1. Microbiology: A Laboratory Manual-James G. Cappuccino and Chad T. Welsh.
2. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology- J. Saxena, M. Baunthiyal, and I. Ravi.
3. Biotechnology Procedures and Experiments Handbook- S. Harisha
4. Practical Guide to Plant and Microbial Biotechnology-Kunal Jain
5. Principles and Techniques of Biochemistry and Molecular Biology-Keith Wilson and John Walker.
6. Bioanalytical Techniques-Sekhar Blackburn.
7. Plant Tissue Culture: Theory and Practice- S.S. Bhojwani and M.K. Razdan.
8. Plant Microtechniques and Protocols- Edward C.T. Yeung.
9. Laboratory Manual in Food Microbiology-Field Museum of Natural History
10. Academia to Biotechnology: Career Changes at Any Stage-Jeffrey M. Gimble.
11. Standard Methods for the Examination of Water and Wastewater-AWWA, APHA, and WEF.

B. Sc. Biotechnology (AEDP) Part-I; Semester-I (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:

Students will get knowledge of

1. All the basic equipment's in lab
2. Know the chemical constituents of cells, the basic units of living organisms.
3. Students will learn identification and classification of biomolecules
4. To make the students attentive of basics of chemical sciences in relevance to biological systems

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

1) Introduction to basic lab instrumentation: Analytical balance, pH meter, colorimeter, laminar Air Flow, UV-Visible spectrophotometer, electrophoresis unit etc.
2) Qualitative estimation of sugars
3) Qualitative estimation of amino acids

4) Qualitative estimation of proteins
5) Quantitative estimation of proteins (Folin-Phenol).
6) Quantitative estimation of sugars (DNS method)
7) Separation of amino acid by paper chromatography
8) Analysis, saponification value of fat.
9) Estimation of histidine by Fiske Subbarao method

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

1) Preparation of different buffer-phosphate buffer/acetate buffer/Tris HCl/Tris base
2) Effect of salivary amylase on starch
3) Effect of temperature on enzyme activity
4) Effect of pH on enzyme activity
5) Effect of time on enzyme activity
6) Isolate the enzyme from given sample

Course outcomes: -

Students will be able to

1. To identify give sample by performing particular test
2. Decide the proper environment for maximum activity of any enzyme
3. Perform the qualitative test for different macromolecule
4. Specify the role of enzyme in specific environment

Suggested Readings for Practical

1) Principles and Techniques of Biochemistry and Molecular Biology by Wilson and Walker
2) Introduction to Practical biochemistry by David T Plummer

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: 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	**Practicals: 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	**Practicals: 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	**Practicals: 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	**Practicals: 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.