SCHEME

For Integrated Five Years Program

(UG Three Years Program (Multidisciplinary) + PG Two Years Program)

Name of the Program: Integrated B.Sc. (Life Sciences) - M.Sc. Environmental Sciences/Botany/ Zoology/ Biotechnology/ Food Science & Technology

According to National Education Policy 2020

Approved by Board of Studies

Session: 2026-2027

Department of Bio-Sciences
Faculty of Life Sciences

Gurugram University Gurugram, (Haryana) India – 122003

B.Sc.–M.Sc. Integrated Program in Life Sciences

(Coordinated by the Department of Bio-Sciences)

Aligned with the provisions of the **National Education Policy (NEP) 2020**, this program is designed to foster a strong interdisciplinary foundation in the life sciences by integrating core disciplines such as Botany, Zoology, and Chemistry with emerging applied fields, including Environmental Science, Biotechnology and Food Science,. The curriculum aims to develop conceptual understanding, analytical competence, practical laboratory skills, and a strong research orientation, enabling students to effectively address complex biological and chemical phenomena. Upon completion of the program, graduates will be equipped to apply fundamental principles across disciplines, recognize interconnections within natural systems, and contribute meaningfully to sustainable solutions for environmental and societal challenges. This multidisciplinary approach also enhances employability and broadens career opportunities compared to conventional life science programs. The program emphasizes experiential and technology-enabled learning beyond the classroom. Students are encouraged to undertake research projects, participate in internships across industrial, governmental, manufacturing, and service sectors, subject to availability and suitability. The teaching–learning process integrates lectures and classroom instruction with field visits, industrial exposure, seminar presentations, laboratory experimentation, in-plant training, and educational tours, ensuring a holistic and practice-oriented academic experience.

Special Features of the Program

- **Multiple Entry and Exit Options:** Students may exit after three years with a B.Sc. degree or continue to pursue a M.Sc. in disciplines such as Environmental Science, Botany, Zoology, Chemistry, Biotechnology, or Food Science.
- **Industry Interface:** The program emphasizes internships, industrial visits, and collaborative research to enhance practical exposure and industry readiness.
- **Career Pathways:** Graduates are well-prepared for careers in research, teaching, and research & development (R&D) across sectors including environment, biotechnology, food, chemistry, and life sciences, as well as entrepreneurship.
- **Infrastructure and Facilities:** The Departments of Environmental Science, Botany, Zoology, Chemistry, Biotechnology and Food Science are equipped with adequate infrastructure and well-established laboratory facilities to support both theoretical and practical learning.
- **Experienced Faculty:** The program is delivered by a blend of senior and young faculty members with extensive experience, peer recognition, and exposure to national and international organizations, ensuring high-quality teaching and valuable learning opportunities for students.

Programme Structure

The B.Sc.–M.Sc. Integrated Life Sciences Programme is a 10-semester undergraduate (Six semesters) and postgraduate (Four Semesters) programme. The curriculum comprises Discipline-Specific

Courses (DSC), Minor/Vocational Courses (MIC/VOC), Multidisciplinary Courses (MDC), Skill Enhancement Courses (SEC), and Value-Added Courses (VAC).

Programme Outcomes

1. **Foundational Knowledge:** Demonstrate a comprehensive understanding of fundamental and advanced concepts in Botany, Zoology, and Chemistry, along with their interrelationships with Environmental Science, Food Science, and Biotechnology.
2. **Analytical and Practical Skills:** Develop the ability to design and conduct experiments, analyze data, and interpret results using appropriate techniques and instrumentation relevant to the life sciences.
3. **Interdisciplinary Competence:** Integrate knowledge across biological, chemical, environmental, food, and biotechnological domains to address complex challenges related to health, nutrition, and environmental sustainability.
4. **Research Capability:** Acquire the competence to undertake ethical and systematic research, culminating in the preparation of a substantive dissertation or thesis.
5. **Professional Preparedness:** Gain the skills required for employment or higher studies in environmental organizations at national and international institutions, as well as in sectors such as biotechnology, botany, zoology, chemical and pharmaceutical industries, food and allied industries, and in both public and private domains.
6. **Communication and Collaboration:** Effectively communicate scientific concepts through classroom discussions, seminars, reports, internships, and industrial engagements, while collaborating with organizations of national and international repute.
7. **Social and Environmental Responsibility:** Understand the societal and ecological implications of scientific advancements and contribute responsibly towards sustainable development, including the achievement of Sustainable Development Goals (SDGs) and environmental stewardship.

General Pattern

The courses offered during the first three years (Semesters I to VI) are designed to provide a strong foundational and introductory understanding of Botany, Zoology, and Chemistry. These courses are common and mandatory for all students and include three theory and three laboratory courses in each discipline. The curriculum is structured to familiarize students with fundamental concepts, methodologies and analytical approaches, thereby preparing them for advanced studies in subsequent years. In addition, students undertake interdisciplinary courses in Environmental Science, Biotechnology and Food Science & Technology, along with courses focusing on industrial skills. Transdisciplinary components, such as Scientific Inquiry and Conceptual Inquiry, are also integrated to promote critical thinking and a holistic understanding of scientific principles.

During the fourth and fifth years (Semesters VII to X), students are offered the flexibility to choose advanced courses from disciplines such as Environmental Science, Botany, Zoology, Biotechnology and Food Science and Technology, based on their interests and career aspirations. The foundational training in the initial years enables students to make informed academic choices aligned with their

aptitude. The final year of the programme is dedicated to a research-based thesis, fulfilling the requirements of the degree.

Credits and Coursework

As per the undergraduate ordinance, students are required to register for 24 credits in each of the first three semesters (1st 2nd and 3rd). In Semesters IV, V, and VI, students must earn 20 credits per semester, leading to a total of 132 credits across six semesters. The credit distribution includes Discipline-Specific Courses (DSC) – 72 credits, Minor/Vocational Courses (MIC/VOC) – 24 credits, Multidisciplinary Courses (MDC) – 9 credits, Ability Enhancement Courses (AEC) – 8 credits, Value-Added Courses (VAC) – 6 credits, and Skill Enhancement Courses (SEC) – 9 credits, along with internships carrying 4 credits.

Details of Courses

A comprehensive list of courses offered under each discipline, along with brief descriptions, detailed syllabi, assessment pattern and recommended reference materials is provided in the official programme syllabus.

Botany

The Botany curriculum is designed to provide a comprehensive foundation in plant sciences, encompassing the diversity, structure, development, and functional biology of plants from the cellular to the ecosystem level. During the initial semesters, students are introduced to core areas such as plant diversity, taxonomy, morphology, physiology, and basic genetics, supported by laboratory work and field-based studies. Emphasis is placed on plant–environment interactions, ecological processes, and conservation strategies. Advanced courses in later semesters focus on molecular plant biology, plant pathology, stress physiology, ethnobotany, and applied plant biotechnology. Practical components, including herbarium preparation, ecological surveys, and research-based projects, foster analytical and investigative skills. The programme prepares students for careers in academia, forestry, agriculture, and conservation biology.

Zoology

The Zoology component aims to develop a comprehensive understanding of animal biology across cellular, organismal, and ecological levels. Foundational courses in the early semesters cover animal diversity, comparative anatomy, physiology, and developmental biology, complemented by laboratory practicals and dissections. Advanced courses in subsequent semesters include cell and molecular biology, genetics, entomology, parasitology, immunology, endocrinology, and animal behaviour. Fieldwork and project-based learning enhance skills in biodiversity assessment, wildlife studies, and experimental zoology. The curriculum prepares graduates for careers in research, teaching, and sectors such as biodiversity conservation, fisheries, agriculture, and public health.

Chemistry

The Chemistry curriculum is structured to provide a balanced and rigorous understanding of physical, organic, and inorganic chemistry, integrating both theoretical and experimental approaches. In the

initial semesters, key concepts such as atomic structure, chemical bonding, thermodynamics, kinetics, spectroscopy, and stereochemistry are covered, with strong laboratory support. In advanced semesters, students may pursue specialised areas including analytical chemistry, materials science, environmental chemistry, and medicinal chemistry through elective and interdisciplinary courses. Research-oriented laboratory work and internships enhance practical skills and prepare students for careers in academia, chemical industries, pharmaceuticals, and related sectors.

Environmental Science

The Environmental Science component is designed to develop scientific understanding and awareness of environmental sustainability and resource management. Initial courses cover fundamental concepts in ecology, environmental chemistry, biodiversity and pollution studies. Advanced courses provide in-depth knowledge of environmental impact assessment, climate change, waste management, renewable energy, Earth System Processes, and Environmental, Social, and Governance (ESG) frameworks. Field studies, environmental monitoring and practical training enhance analytical and technical skills. The curriculum aligns with national and global environmental priorities and prepares students for careers in academia, research institutions, consultancy, NGOs, and regulatory bodies.

Biotechnology

The Biotechnology stream offers interdisciplinary training by integrating biological sciences with modern technological applications. Foundational courses include cell biology, genetics, molecular biology, and microbiology. In advanced semesters, students study specialised areas such as recombinant DNA technology, immunotechnology, genomics, proteomics, and industrial biotechnology. Laboratory training emphasizes techniques such as DNA isolation, PCR, cloning, and bioinformatics analysis. Research projects and internships further strengthen technical expertise and problem-solving abilities. The programme prepares students for careers in biotechnology industries, research laboratories, diagnostics, agriculture, and pharmaceuticals, while also providing a strong foundation for higher studies and entrepreneurship.

Food Science and Technology

The Food Science and Technology stream focuses on the scientific and technological aspects of food production, processing, preservation, and safety. Early coursework introduces students to food chemistry, microbiology, and nutrition. Advanced modules address food processing technologies, quality control, packaging, and functional foods. Practical training includes analytical techniques, quality assessment, and pilot-scale processing. Emerging areas such as food microbiology, nutraceuticals, nanotechnology, food packaging, and regulatory frameworks are also covered. Industry internships and research projects equip students with the skills required for careers in the food industry, research organisations, and quality assurance sectors.

Learning Outcomes

Graduates of the programme will be able to:

- Apply practical laboratory skills and analytical techniques effectively in research and related professional domains.
- Demonstrate comprehensive knowledge of life sciences and allied disciplines.
- Integrate interdisciplinary concepts to address scientific and societal challenges.
- Exhibit professional ethics, effective communication and teamwork abilities.
- Engage in lifelong learning and adapt to evolving academic and professional environments.

Discipline-wise Course Structure for the B.Sc.–M.Sc. Integrated Life Sciences Programme

1. Course Structure of the Department of Botany

DSC (Discipline Specific Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/BOT/DSC-101	Microbiology and Plant Pathology	4
2	BSC+MSC/BOT/DSC-102	Plant Diversity	4
3	BSC+MSC/BOT/DSC-103	Plant Taxonomy and Ecology	4
4	BSC+MSC/BOT/DSC-104	Plant Anatomy and Embryology	4
5	BSC+MSC/BOT/DSC-105	Plant Physiology and Biochemistry	4
6	BSC+MSC/BOT/DSC-106	Applied Botany and Plant Tissue Culture	4
VAC (Value Added Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/BOT/VAC-101	Ethnobotanical Knowledge of Plants	2
2	BSC+MSC/BOT/VAC-102	Traditional Medicinal Systems	2
3	BSC+MSC/BOT/VAC-103	Herbal Science and Technology	2
MDC (Multidisciplinary courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/BOT/MDC-101	Plants and Human Welfare	3
2	BSC+MSC/BOT/MDC-102	Mushroom Cultivation	3

2. Course Structure of the Department of Zoology

DSC (Discipline Specific Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/ZOO/DSC-101	Diversity of Non Chordates	4
2	BSC+MSC/ZOO/DSC-102	Diversity of Chordates	4
3	BSC+MSC/ZOO/DSC-103	Cell Biology and Genetics	4

4	BSC+MSC/ZOO/DSC-104	Biochemistry and Animal Physiology	4
5	BSC+MSC/ZOO/DSC-105	Aquaculture and Pest management	4
6	BSC+MSC/ZOO/DSC-106	Developmental and evolutionary Biology	4
VAC (Value Added Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/ZOO/VAC-101	Ecology and Environment	2
2	BSC+MSC/ZOO/VAC-102	Indian Biodiversity and Conservation	2
3	BSC+MSC/ZOO/VAC-103	Vermicomposting and Sustainability	2
MDC (Multidisciplinary courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/ZOO/MDC-101	Economic Zoology	3
2	BSC+MSC/ZOO/MDC-102	Insect Vectors Diseases & Control	3

3. Course Structure of the Department of Chemistry

DSC (Discipline specific courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/CHEM/DSC-101	Inorganic Chemistry - I	4
2	BSC+MSC/CHEM/DSC-102	Organic Chemistry - I	4
3	BSC+MSC/CHEM/DSC-103	Physical Chemistry - I	4
4	BSC+MSC/CHEM/DSC-104	Inorganic Chemistry - II	4
5	BSC+MSC/CHEM/DSC-105	Organic Chemistry - II	4
6	BSC+MSC/CHEM/DSC-106	Physical Chemistry - II	4
VAC (Value Added courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/CHEM/VAC-101	Atmospheric Chemistry	2
2	BSC+MSC/CHEM/VAC-102	Analytical Techniques in Chemistry	2
3	BSC+MSC/CHEM/VAC-103	Green Chemistry	2
MDC (Multidisciplinary courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/CHEM/MDC101	Fundamentals of Environmental Chemistry	3
2	BSC+MSC/CHEM/MDC102	Chemistry of Biomolecules	3

4. Course Structure of the Department of Environmental Sciences

MIC (Minor Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/EVS/MIC-101	Fundamentals of Environmental Science	4
2	BSC+MSC/EVS/MIC-102	Basics of Environmental Pollution	4
3	BSC+MSC/EVS/MIC-103	Climate Change: Causes and Consequences	4
VAC (Value Added courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/EVS/VAC-101	Environmental Protection: Laws and Policies	2
2	BSC+MSC/EVS/VAC-102	Disaster and Management Strategies	2
MDC (Multidisciplinary Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/EVS/MDC-101	Fundamentals of Sustainable Development	3
2	BSC+MSC/EVS/MDC-102	Traditional Knowledge for Environmental Protection	3
3	BSC+MSC/EVS/MDC-103	Government Initiatives for Environmental Protection	3
SEC (Skill Enhancement Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/EVS/SEC-101	Environmental Footprints – Anthropogenic impact	3
2	BSC+MSC/EVS/SEC-102	Environmental Monitoring of Air and Noise	3
3	BSC+MSC/EVS/SEC-103	Integrated Resource Management	3
4	BSC+MSC/EVS/SEC-104	Green Economy	3

5. Course Structure of the Department of Biotechnology

MIC (Minor Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/DBT/MIC-101	Fundamentals of Biotechnology	4
2	BSC+MSC/DBT/MIC-102	Basics of Molecular Biology	4
3	BSC+MSC/DBT/MIC-103	Theories of Biomolecules	4
VAC (Value Added Courses)			

1	BSC+MSC/DBT/VAC-101	Industrial Biotechnology	2
MDC (Multidisciplinary Courses)			
1	BSC+MSC/DBT/MDC-101	Enzyme Technology	3
2	BSC+MSC/DBT/MDC-102	Technique in Biotechnology	3
SEC (Skill Enhancement Courses)			
1	BSC+MSC/DBT/SEC-101	Computational Biology	3
2	BSC+MSC/DBT/SEC-102	Genetic Engineering	3

6. Course Structure of the Department of Food Science and Technology

MIC (Minor Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/FST/MIC-101	Introduction to Food Technology	4
2	BSC+MSC/FST/MIC-102	Fundamentals of Food Microbiology	4
3	BSC+MSC/FST/MIC-103	Ayurveda and Nutrition	4
VAC (Value Added Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/FST/VAC-101	Traditional Indian Food	2
MDC (Multidisciplinary Courses)			
Sr. No.	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/FST/MDC-101	Food Science, Nutrition and Public Health	3
2	BSC+MSC/FST/MDC-102	Functional Foods and Nutraceuticals	3
SEC (Skill Enhancement Courses)			
Sr. No	**Course Code**	**Course Title**	**Credits**
1	BSC+MSC/FST/SEC-101	Food Contamination & Adulteration	3
2	BSC+MSC/FST/SEC-102	Fermentation Technology	3

Semester Wise Scheme and Syllabus of B.Sc.-M.Sc. Lifesciences (Integrated)

Semester - 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
DSC-01	Microbiology and Plant Pathology	BSC+MSC/BOT/DSC-101	3	0	2	3	0	1	04					**100**
DSC-02	Inorganic Chemistry - I	BSC+MSC/CHEM/DSC-101	3	0	2	3	0	1	04					**100**
DSC-03	Diversity of Non Chordates	BSC+MSC/ZOO/DSC-101	3	0	2	3	0	1	04					**100**
MIC-01	Fundamentals of Environmental Science	BSC+MSC/EVS/MIC-101	3	0	2	3	0	1	04					**100**
MDC -01	Enzyme Technology	BSC+MSC/DBT/MDC-101	3	0	0	3	0	0	03					**75**
VAC- 01	Environmental Protection: Laws and Policies Or Ethnobotanical Knowledge of Plants	BSC+MSC/EVS/VAC-101 Or BSC+MSC/BOT/VAC-101	2	0	0	2	0	0	02					**50**
SEC-01	Food Contamination & Adulteration	BSC+MSC/FST/SEC-101	3	0	0	3	0	0	03					**75**
AEC -01*	One from the Pool		2	0	0	2	0	0	02					**50**
Total Credits									**26**					**650**

DSC-01: Microbiology and Plant Pathology **CR-04 (Hr - 5; T-3, P-2)**

Course outcome

- *CO 1: Ability to understand and classify different life forms, including bacteria, viruses, & fungi.*
- *CO2: Ability to perform microbiological and plant science experiments, including the preparation of microbiological media, isolation of pure microbial cultures, and their identification and characterization.*
- *CO3: Ability to identify and characterize different plant groups along with their pathogens.*

Course content

Unit I: History and scope of Microbiology General account, distribution and classification of microorganisms..

Unit II: *Viruses*: Discovery, general structure, DNA viruses, RNA viruses, replication (general account), lytic and lysogenic cycle, retroviruses.

Bacteria: Discovery, General characteristics and cell structure; Gram-positive and Gram-negative bacteria, Archaea: Discovery, General characteristics and cell structure, extremophiles.

Unit III: Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle. Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit IV: History of Plant Pathology. Modes of Infection and general symptoms, physiology of parasitism, defense mechanism in plants, role of environment in disease development, Disease resistance in plants. Causal organisms, symptoms, disease cycle and control of the following plant diseases: Citrus canker, TMV, wilt of tomato, bacterial blight of rice, mosaic of sugarcane. Late blight of potato and Loose smut of Wheat,

Lab -1

1. Introduction to microbial growth media. Media preparation.
2. Bacterial growth on solid and broth media
3. Bacterial colony morphology and diversity
4. Gram staining of bacteria
5. Study of fungi: colony, view of the hyphae under microscope
6. Study of plant diseases with the help of infected plant specimens- TMV, citrus canker, little leaf of brinjal, loose smut of wheat, downy mildew of crucifers, rust of pea, smut of bajra

Suggesting readings

- Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
- Griffiths, A.J.F et al (2008) Introduction to Genetic Analysis, 9th edition, W.H. Freeman & Co. NY.
- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 12. 2nd edition.
- Lucas, John, A., 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.
- Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
- Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi.
- Singh, R.S. Plant diseases, 9th edition (2009). Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi
- Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Willey JM, Sherwood L, Woolverton CJ (2013) Prescott's Microbiology, 9th edition, McGraw-Hill, New York

DSC-02: Inorganic Chemistry – I **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Ability to understand fundamental concepts of inorganic chemistry and atomic structure.*
- *CO2: Ability to analyze periodic trends and chemical bonding.*
- *CO3: Ability to understand metallurgical principles and properties of elements.*
- *CO4: Ability to explain properties and reactions of s- and p-block elements.*

Course Content

Unit I: Basics of Inorganic Chemistry and Atomic Structure

Scope and importance of inorganic chemistry; classification of elements; laws of chemical combination; mole concept and stoichiometry; oxidation-reduction reactions and oxidation number.

Atomic structure: Bohr's theory and limitations; de Broglie equation; Heisenberg uncertainty principle; Schrödinger wave equation; quantum numbers; shapes of atomic orbitals (s, p, d, f); Pauli exclusion principle, Hund's rule, Aufbau principle.

Unit II: Periodicity and Chemical Bonding

Periodic properties: effective nuclear charge, shielding effect, atomic and ionic radii, ionization enthalpy, electron gain enthalpy, electronegativity and trends.

Chemical bonding: ionic and covalent bonding; lattice energy and Born-Haber cycle (basic concept); Valence Bond theory; hybridization; resonance; Molecular Orbital theory (basic idea); VSEPR theory and molecular shapes.

Intermolecular forces: hydrogen bonding and van der Waals interactions.

Unit III: General Principles of Metallurgy

Occurrence and extraction of metals; concentration of ores; basic idea of Ellingham diagrams; reduction methods (chemical and electrolytic); hydrometallurgy (cyanide process – basic concept); purification methods (electrolytic refining, zone refining).

Unit IV: s- and p-Block Elements

s-block elements: general characteristics; anomalous behavior; diagonal relationship; reactions with air, water and hydrogen; properties of oxides, hydroxides and salts; basic idea of complexes.

p-block elements: general trends (electronic configuration, size, ionization enthalpy, electronegativity); allotropy of carbon, phosphorus and sulphur; inert pair effect; diagonal relationship; general properties and behavior of p-block elements.

Lab – 2

1. ***Basic Laboratory Techniques***
    - Calibration and use of laboratory apparatus
    - Preparation of standard solutions
2. ***Acid–Base Titrations***
    - Estimation of sodium carbonate using standard acid
    - Estimation of mixtures (carbonate, bicarbonate, hydroxide)
3. ***Redox Titrations***
    - Estimation of Fe(II) using $KMnO_4$
    - Estimation using $K_2Cr_2O_7$
    - Iodometric/iodimetric titrations
4. ***Inorganic Preparations***
    - Preparation of simple inorganic salts

Suggesting readings

- Cotton, F.A. and Wilkinson, G. (1999). Advanced Inorganic Chemistry. Wiley.
- Douglas, B.E., McDaniel, D.H. and Alexander, J.J., 1994. Concepts and models of inorganic chemistry.
- Greenwood, N.N. and Earnshaw, A. (1997). Chemistry of the Elements. Butterworth-Heinemann.
- Huheey, J.E. et al. (2006). Inorganic Chemistry: Principles of Structure and Reactivity. Pearson Education.
- Lee, J.D. (2010). Concise Inorganic Chemistry. Pearson Education.
- Marr, G. and Rockett, R.W. (1972). Practical Inorganic Chemistry. Van Nostrand Reinhold.
- Miessler, G.L. and Tarr, D.A. (2009). Inorganic Chemistry. Pearson.
- Shriver, D.F. and Atkins, P.W. (1994). Inorganic Chemistry. Oxford University Press.
- Vogel, A.I. (1978). A Textbook of Quantitative Inorganic Analysis. ELBS.

DSC-03: Diversity of Non-chordate **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *Student will be able to describe unique characters and recognize life forms of phylum Protozoa and Porifera.*
- *Student will be able to describe unique characters and recognize life forms of phylum Coelenterata and Helminthes.*
- *Student will be able to describe unique characters and recognize life forms of phylum Annelida and Arthropoda.*
- *Student will be able to describe unique characters and recognize life forms of phylum Mollusca, Echinodermata and Hemichordates 5. Students will be capable of identifying the characters and classification of non-chordates*

Course Content

Unit I: Phylum Protozoa

General characters and classification up to class level Type study of Plasmodium Phylum Porifera: General characters and classification up to class level, Type study of Sycon***.***

Unit II: Phylum – Coelenterata

General characters and classification up to class level Type Study of Obelia Phylum – Platyhelminthes and Aschelminths: General characters and classification up to class level, Type study of Liver Fluke, Fasciola hepatica

Unit III:

General characters and classification up to class level, Type study of Earthworm, Pheretima posthuma (Habitat, habits, metamerism, digestive System, circulatory system, nervous system, reproductive system) Phylum – Arthropoda: General characters and classification up to class level, Type study of Cockroach, Periplaneta americana (Habitat, habits, external morphology, digestive system, respiratory system, excretory system, reproductive system)

Unit IV:

General characters and classification up to class level, Type study of Pila Phylum – Echinodermata: General characters and classification up to class level, Type study of Asterias (Sea Star) (Habitat, habits, external morphology, water vascular system, Circulatory System) Phylum Hemichordata: General characters of Hemichordates with examples.

Lab – 3

Classification up to orders with ecological note and economic importance of the following animals:

1. Protozoa: Lamination of cultures of Amoeba, Euglena and Paramecium; permanent prepared slides: Amoeba, Euglena, Trypanosoma, Noctiluca, Eimeria, Paramecium (binary

fission and conjugation), Opalina, Vorticella, Balantidium, Nyctotherus, radiolarian and formaniferan ooze.

2. Parazoa (Porifera): Sycon, Grantia, Euplectella, Hyalonema, Spongilla, Euspongia.
3. Coelenterata: Porpita, Valella, Physalia, Aurelia, Rhizostoma, Metridium, Millipora, Alcyonium, Tubipora, Zoanthus, Madrepora, Favia, Fungia, and Astrea. Permanent prepared slides: Hydra (W.M.), Hydra with buds, Obelia (colony and medusa), Sertularia, Plumularia, Tubularia, Bougainvillea, Aurelia (sense organs and stages of life history).
4. Playhelminthes: Dugesia, Fasciola, Taenia, Echinocoecus. Permanent prepared slides: Miracidium, Sporocyst, Redia, Cercaria, Scolex and Proglotttids of Taenia (mature and gravid).
5. Aschelminthes: Ascaris (male and female), Trichinella, Ancylostoma, Meloidogyne.
6. Annelida: Pheretima, Heteronereis, Polynoe, Aphrodite, Chaetopterus, Arenicola, Tubifex and Pontobdella.
7. Arthropoda: Peripatus, Palaemon (Prawn), Lobster, Cancer (crab), Sacculina, Eupagurus (hermit crab), Lepas, Balanus,Cyclops, Daphnia, Lepisma, Periplaneta (cockroach), Schistocerca (locust), Poecilocerus (ak 30 34(775) hopper), Gryllus (cricket), Mantis (praying mantis), Cicada, Forticula (earwig), Dragon fly, termite queen, bug, moth, beetle, Polistes (wasp), Apis (honey bee), Bombyx (silk moth), Cimex (beg bug), Pediculus (body louse), Millipede, Scolopendra (centipede), Palamnaeus (scorpion), Aranea (spider), Limulus (king crab).
8. Mollusca: Mytilus, Ostrea, Cardium, Pholas, Solen (razor/Fish), Pecten, Holiotis, Patella, Aplysia, Doris, Limax, Loligo, Sepia, Octopus, Nautilus (complete and T.S.), Chiton and Dentalium.
9. Echinodermata: Asterias, Echinus, Cucumaia, Ophiothrix, Antedon and Asterophyton.
10. Hemichordata: Balanoglossus.
11. Study of slides of non-chordates phyla; Staining of Obelia and Sertularia

Suggesting readings

- Anderson D.T. (1999) Invertebrate Zoology, Oxford University Press.
- Ayyar, E.K and T. Ananthakrishnan. 1992. Manual of Zoology Vol.1 Invertebrates Part I and II, S.Viswanathan Printers and Publishers Pvt. Ltd. Madras.
- Edward E. Ruppert, Robert D. Barnes (1994)· Invertebrate Zoology ; Saunders College Pub.
- Jordan, E.L and P.S. Verma. 2009. Invertebrate Zoology, S. Chand Co. Ltd. New Delhi.
- Kotpal, R.L. 2021. Zoology Invertebrates. Rastogi Publications, Meerut.
- Lal S.S. (2019) Practical Zoology Invertebrates. Rastogi Publications, Meerut.
- Nair, N.C., N. Arumugam, N. Soundarapandian, T. Murugan and S. Leelavathy. 2010. A textbook of Invertebrates. Saras Publication, Nagercoil.
- Rastogi V.B. 2021 . Invertebrate Zoology. Kedar Nath Ram Nath , Meerut.

MIC-01: Fundamentals of Environmental Science **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course outcome

- *CO1: Ability to understand the fundamental concepts of environmental science and ecosystem structure.*
- *CO2: Ability to identify major environmental issues such as pollution, climate change, and biodiversity loss.*
- *CO3: Ability to analyze the relationship between human activities and environmental degradation.*
- *CO4: Ability to apply basic environmental monitoring and conservation techniques.*

Course Content

Unit I: Introduction to Environmental Science

Definition, scope and importance of environmental science; components of environment (biotic and abiotic); interdisciplinary nature of environmental science; concept of sustainability.

Natural Resources and its Management: Renewable and non-renewable resources; water, forest, land and mineral resources; conservation and management of natural resources.

Unit II: Ecosystem and Biodiversity

Structure and function of ecosystem; types of ecosystems (terrestrial and aquatic); energy flow and ecological pyramids; food chains and food webs.

Biodiversity: types, values, threats and conservation strategies, Biodiversity Hotspote.

UNIT–III: Environmental Pollution and Global Environmental Issues

Environmental Pollution: Concept, major sources, types and impacts; Air, water, soil and noise pollution: sources, effects and control measures; Solid and hazardous waste management.

Global Environmental Issues: Climate change and global warming; greenhouse effect; ozone depletion; acid rain; desertification and biodiversity loss; environmental impacts of urbanization and industrialization.

Environment and Human Health: Environmental pollution and human health; major environmental health concerns.

Unit IV: Environmental Management and Conservation

Environmental monitoring- basic techniques and indicators; environmental impact assessment (EIA) (basic concept).

Environmental conservation strategies- sustainable development, waste management (solid and hazardous waste), renewable energy resources.

Lab – 4

- Measurement/assessment of basic environmental parameters.
- Analysis of selected water quality parameters.
- Assessment of ambient air quality using basic monitoring techniques/data.
- Measurement of noise levels at selected locations.
- Identification of common plant species and assessment of local biodiversity.
- Study of ecosystem structure through field observation.
- Preparation of a simple environmental impact assessment for a hypothetical project.
- Preparation of a waste management plan for an institution/local community.
- Analysis and interpretation of environmental monitoring data.
- Field visit to a natural ecosystem, waste management facility, water treatment plant, or environmental monitoring station.

Suggesting readings

- Bharucha, E. (2005). Textbook of Environmental Studies. Universities Press, Hyderabad.
- Cunningham, W.P. and Cunningham, M.A. (2012). Environmental Science: A Global Concern. McGraw-Hill, USA.
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi.
- Miller, G.T. and Spoolman, S. (2014). Environmental Science. Brooks/Cole, USA.
- Misra, R. (1968). Ecology Workbook. Oxford & IBH Publishing Co., New Delhi.
- Odum, E.P. and Barrett, G.W. (2005). Fundamentals of Ecology. Thomson Brooks/Cole, USA.
- Sharma PD, Sharma PD. Ecology and environment. Rastogi Publications; 2009.

MDC – 01: Enzyme technology **CR-03 (Hr - 3; L-03, T-0, P-0)**

Course outcome

- *CO1:To enable the students to understand in detail about the fundamentals of enzymes and their functions.*

Course Content

Unit – I

Nomenclature and classification of enzymes: characteristics of enzymes, Enzyme cofactors, Catalytic power, Catalytic strategies, Substrate specificity, Lock and key model, Induced fit hypothesis, Active site- structure, substrate binding, role of catalytic amino acid residues, Catalytic mechanisms of enzymes with representative examples, Types of enzyme inhibition, regulation, kinetics of enzyme catalyzed reactions, effect of pH and temperature. Isozymes.

Unit – II

Enzyme technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes.

Unit – III

Application of enzymes: Enzymes used in different industries, Enzyme catalysis in organic solvents, enzyme replacement therapy – definition, modes of administration, enzyme deficiency disorders and enzyme therapy; Application of enzymes: Cosmetic benefits, Enzyme-based biosensors; Enzymes in clinical diagnosis: primary and secondary serum enzymes, Intracellular distribution of diagnostic enzymes, Enzyme markers of Xenobiotic toxicity - Pharmacogenomics related to polymorphism of drug metabolizing enzymes, , KEGG (Kyoto Encyclopedia of Genes and Genomes) pathway

Suggesting readings

- Donald Voet, & Judith Voet, (1995). Biochemistry (2nd ed.). John Wiley and Sons.
- Lubert Stryer, (2006). Biochemistry (6th ed.). WH Freeman.
- Mary K., & Shawn O. Farrell, (2005). Biochemistry (5th ed.). Cenage Learning.
- Nicholas Price, & Lewis Stevens (1999) Fundamentals of Enzymology. Oxford University Press.
- Robert Murray, K., David Bender, A., Kathleen Botham, M., Peter Kennelly, J., Victor Rodwell, W., Anthony Weil, P. (2009). Harper's illustrated Biochemistry (28th ed.). McGrawHill.

VAC-01: Environmental Protection: Laws and Policies **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: Ability to understand the legal framework for environmental protection at national and international levels.*
- *CO2: Ability to analyze major environmental laws, policies, and regulations.*
- *CO3: Ability to evaluate the role of institutions and governance in environmental management.*
- *CO4: Ability to assess environmental issues from legal and policy perspectives.*

Course Content

Unit I: Foundations of Environmental Law

Concept and need for environmental laws; principles of environmental protection (precautionary principle, polluter pays principle, sustainable development); constitutional provisions related to environment in India; role of judiciary in environmental protection; overview of major environmental legislations: Water Act, 1974; Air Act, 1981; Environment Protection Act, 1986.

Unit II: Environmental Policies and Governance

National environmental policies and frameworks; Environmental Impact Assessment (EIA); role of governmental and non-governmental organizations; international environmental agreements (Stockholm Conference, Rio Earth Summit, Kyoto Protocol, Paris Agreement); environmental governance and sustainable development.

Suggesting readings

- Birnie, P., Boyle, A. and Redgwell, C. (2009). International Law and the Environment. Oxford University Press.
- Devi Rani (2023); Socio-Environmental Conditions and Policies of Government and its Impact on Environment, Arihant Books, New Delhi, India.
- Divan, S. and Rosencranz, A. (2001). Environmental Law and Policy in India. Oxford University Press, New Delhi.
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi.
- Leelakrishnan, P. (2010). Environmental Law in India. LexisNexis, New Delhi.
- Shastri, S.C. (2012). Environmental Law. Eastern Book Company, Lucknow.
- Singh, G. (2015). Environmental Law in India. Macmillan, New Delhi.

VAC-01: Ethnobotanical Knowledge of Plants **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: To attain knowledge about ethnobotany and its significance.*
- *CO2: To understand the concept of traditional medicinal practices by Indian tribals.*
- *CO3: To apply the methods to transform ethnobotanical knowledge for the preparation of value added products.*
- *CO4: To know the value of ethnopharmacognosy.*

Course Content

Unit I:

Concept, scope and importance of ethno botany - sub-disciplines, inter- disciplines of ethnobotany, approaches in ethnobotanical studies with special reference to India –conservation of selected plant species: sacred groves, forestry and unique ecosystems and their ethnobiolgical values

Unit II:

Major tribes of India Some common ethnic groups; Plants used by the Tribals: a) Food plants b) Medicines and miscellaneous uses. Role of ethno botanical practices in modern medicine with example of some common medicinal plants. Biopiracy, Intellectual property rights and traditional knowledge.

Suggesting readings

- Ali, Mohammad (2010) Text Book of Pharmacognosy (2nd Edition).CBS Publishers & Distributor Pvt .Ltd, New Delhi, India.
- Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons-Chichester
- Hill, A. - (1972) Economic Botany.
- Jain, S.K(1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur.
- Jain, S.K., 1989. Methods and approaches in ethnobotany. Society of ethnobotanists,
- Singh, G K and A Bhandari A (2011) Text Book of Pharmacognosy, CBS Publishers & Distributor Pvt .Ltd, New Delhi, India.

SEC-01: Food Contamination & Adulteration **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: The students would gain knowledge about food adulteration, contaminants and Identify commonly adulterated foods and assess their harmful effects.*
- *CO2: An understanding about household and lab methods for adulterants in milk, spices and additives*
- *CO3: . The students would be able to understand the role of FSSAI in food safety regulation and licensing and registration procedures for food businesses under FSSR.*

Course Content

Unit I:

Introduction and concept: Food Adulteration – Definition, classification of adulterants, Food Contaminants, difference between adulterants and contaminants Common food adulterants: List of foods commonly adulterated, harmful effects of adulterants. Economic effect of adulteration. Common adulterants in spices, food and milk products.

Unit -II*:*

Household and laboratory scale methods to detect adulterants. Indian Food Laws and Standards for food safety: FSSAI, Licensing and Registration Procedure for food business (FSSR, Licensing and Registration of Food Business, 2011). Role of FSSAI in ensuring Food Safety.

Suggesting readings

- N. Shakuntala Manay and M. Shadakshara swamy (2008) Food Facts and Principles
- Edwin M. Bruce Edwin M Bruce Detection of the Common Food Adulterants
- Shyam Narayan Jha (2016) Rapid Detection of Food Adulterants and Contaminants
- M. Shafiur Rahman. Handbook of Food Preservation. 2nd edition. CRC Press.
- James G. Brennan. Food Processing Handbook (2006). Wiley VCH Verlag GmbH & Co. KGaA.

Semester Wise Scheme and Syllabus of B.Sc.-M.Sc. Lifesciences (Integrated)

Semester – 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
DSC-04	Plant Diversity	BSC+MSC/BOT/DSC-102	3	0	2	3	0	1	04					**100**
DSC-05	Organic Chemistry - I	BSC+MSC/CHEM/DSC-102	3	0	2	3	0	1	04					**100**
DSC-06	Diversity of Chordates	BSC+MSC/ZOO/DSC-102	3	0	2	3	0	1	04					**100**
MIC-02	Fundamentals of Biotechnology Or Ayurveda and Nutrition	BSC+MSC/DBT/MIC-101 or BSC+MSC/FST/MIC-103	3	0	2	3	0	1	04					**100**
MDC -02	Food Science, Nutrition and Public Health Or Mushroom Cultivation	BSC+MSC/FST/MDC-101 Or BSC+MSC/BOT/MDC-102	3	0	0	3	0	0	03					**75**
VAC- 02	Industrial Biotechnology OR Traditional Medicinal Systems	BSC+MSC/DBT/VAC-101 Or BSC+MSC/BOT/VAC-102	2	0	0	2	0	0	02					**50**
SEC-02	Environmental Footprints – Anthropogenic impact	BSC+MSC/EVS/SEC-101	3	0	0	3	0	0	03					**75**
AEC -02*	One from the Pool		2	0	0	2	0	0	02					**50**
Total Credits									**26**					**650**

Note:

- *Internship or field training or project of 4-6 weeks during summer vacation @ 4 credits.*
- *Students exiting the programme after second semester and securing 48 credits including 4 credits of summer internship will be awarded UG Certificate in the relevant Discipline/Subject.*

DSC-04: Plant Diversity **CR-04 (Hr - 5; T-3, P-2)**

Course outcome

- *CO 1: Ability to understand and classify different life forms, including Algae, bryophytes, pteridophytes, and gymnosperms.*
- *CO2: Gain the skill to identify and describe the vegetative and reproductive structures of different plant life forms.*
- *CO3: Illustrate and differentiate between gametophytic and sporophytic stages through the study of permanent slides and fresh specimens.*

Course content

Unit I: Algae:

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles, Economic importance of algae.

Unit II: Bryophytes:

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction, Ecology and economic importance of bryophytes

Unit III: Pteridophytes:

General characteristics, classification, Early land plants, Classification (up to family), morphology, anatomy and reproduction, Heterospory and seed habit, stelar evolution. ecological and economical importance of Pteridophytes.

Unit IV: Gymnosperms:

General characteristics, classification. Classification (up to family), morphology, anatomy and Reproduction, Ecological and economical importance.

Lab - 05

1. Introduction to Archegoniates growth media. Media preparation.
2. Specimen study of Bryophytes
3. Specimen study of Pteridophytes
4. Specimen study of Gymnosperms

Suggested Readings

- Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
- Griffiths, A.J.F et al (2008) Introduction to Genetic Analysis, 9th edition, W.H. Freeman & Co. NY.

- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 12. 2nd edition.
- Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
- Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
- Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
- VanDenHoeket al.(1997) Algae: An Introduction to Phycology, Cambridge University Press, Cambridge
- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

- Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

DSC-05: Organic Chemistry – I **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Ability to understand fundamental concepts and reaction mechanisms in organic chemistry.*
- *CO2: Ability to analyze stereochemistry and structure–reactivity relationships.*
- *CO3: Ability to understand preparation, properties and reactions of hydrocarbons.*
- *CO4: Ability to explain chemistry of oxygen-containing functional groups.*

Course Content

Unit I: Basics of Organic Chemistry and Stereochemistry

Basics of organic chemistry: hybridization, shapes of molecules; electronic effects (inductive, resonance, hyperconjugation – basic idea); homolytic and heterolytic cleavage; electrophiles and nucleophiles; reactive intermediates (carbocations, carbanions, free radicals – stability).

Types of organic reactions: addition, substitution and elimination (introductory).

Stereochemistry: projection formulae (Fischer, Newman); geometrical isomerism (cis–trans, E/Z); optical isomerism (chirality, enantiomers, diastereomers – basic concept)**.**

Unit II: Aliphatic and Aromatic Hydrocarbons

Alkanes: preparation and properties; free radical halogenation (basic mechanism).

Alkenes and alkynes: preparation and properties; electrophilic addition reactions (Markovnikov/anti-Markovnikov – basic idea); elimination reactions (E1, E2 – concept only).

Conjugated dienes and Diels–Alder reaction (introductory concept).

Aromatic hydrocarbons: concept of aromaticity (Hückel's rule); electrophilic aromatic substitution (nitration, halogenation, Friedel–Crafts – basic mechanism); directing effects.

Unit III: Halogenated Hydrocarbons and Alcohols/Phenols

Alkyl halides: preparation and properties; nucleophilic substitution reactions (SN1, SN2 – basic idea).

Aryl halides: basic properties and reactivity.

Grignard reagent: preparation and synthetic applications (basic reactions).

Alcohols: classification, preparation and reactions (oxidation, dehydration).

Phenols: acidity and electrophilic substitution reactions (basic concept).

Unit IV: Carbonyl Compounds and Carboxylic Acids

Aldehydes and ketones: structure, preparation and nucleophilic addition reactions; aldol condensation (basic mechanism).

Carboxylic acids: preparation, properties and acidity.

Acid derivatives (esters and amides): preparation and simple reactions (hydrolysis).

Introduction to active methylene compounds and keto–enol tautomerism (basic concept).

Lab - 06

1. ***Basic Laboratory Techniques***
    - Calibration of thermometer
    - Determination of melting and boiling points
    - Purification by crystallization
2. ***Chromatography***
    - Paper chromatography (amino acids/sugars)
    - Thin layer chromatography (TLC)
3. ***Qualitative Analysis***
    - Detection of extra elements
    - Functional group tests (alcohols, phenols, carbonyls, acids)
4. ***Organic Preparations***
    - Bromination/nitration reactions
    - Aldol condensation
    - Simple oxidation/reduction reactions

Suggested Readings

- Ahluwalia, V.K. (2000). Comprehensive Practical Organic Chemistry.
- Finar, I.L. (2006). Organic Chemistry (Vol. I). Pearson.
- Furniss, B.S. et al. (2012). Practical Organic Chemistry. Pearson.
- Kalsi, P.S. (2005). Stereochemistry and Mechanism. New Age International**.**
- Mann, F.G. and Saunders, B.C. (2009). Practical Organic Chemistry. Pearson.
- Morrison, R.T. and Boyd, R.N. (2010). Organic Chemistry. Pearson.
- Solomons, T.W.G. (2011). Organic Chemistry. Wiley.
- Suggested Readings
- Suggested Readings (Lab)

DSC-06: Diversity of chordate **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1:* Student will be able to describe unique characters and recognize life functions of Urochordates.
- *CO2:* Student will be able to describe unique characters and recognize life functions of Pisces.
- *CO3:* Student will be able to describe unique characters and recognize life functions of Amphibians & Reptiles.
- *CO4:* Student will be able to describe unique characters and recognize life functions of Birds & Mammals

Course Content

Unit I: Chordates:

Salient features of chordates; Principles of classification; Protochordates: Urochordata: Systematic position, distribution, ecology, morphology and affinities Urochordata: Type Study of Herdmania.

Unit II: Pisces:

General characters and classification up to classes with examples emphasizing their biodiversity, Scales & Fins, Type study of Labeo.

Unit III: Amphibia:

General characters and Classification up to class level; Type study of frog, Parental Care and Neoteny in Amphibia Reptilia: General characters and Classification up to classes.

Unit IV:

Flight/Aerial adaptation in birds, Archaeopteryx as missing link Mammals: General characters and classification up to classes; Type study of Rat.

Lab – 07

Classification up to orders, habit, habitats, external characters and economic importance (if any)

1. Protochordata: Molqula, Hetryllus, Pyrosoma, Doliolum, Olikopleura, and Amphioxus.
2. Cyclostomata: Myxine, Petromyzon and Ammocoetus larva.
3. Chondrichthyes: Zygaena, Pristis, Narcine (electric ray), Trygon, Rhinobatus, Raja and Chimaera.

4. Osteichthyes: Acipenser, Lepidosteus, Muraena, Mystus, Catla, Hippocampus, Syngnathus, Exocoetus, Anabas, Diodon, Ostracion, Tetradon, Echinus, Lophius, Solea and Polypterus. Any of the Lung Fishes.
5. Amphibia: Necturus, Proteus, Amphiuma, Salamandra, Ambystoma, Axolotl larva, Alytes, Bufo, Rana.
6. Reptilia: Hemidactylus, Calotes, Draco, Varanus, Phrynosoma, Chamaeleon, Typhlops, Python, Eryx, Ptyas, Bungarus, Naja, Hydrus, Viper, Crocodilus, Gavialis, Chelone (Turtle) and Testudo (Tortoise).
7. Aves: Casuarius, Arden, Anas, Milvus, Pavo, Eudynamis, Tyto, Alcedo, Halcyon.
8. Mammalia: Ornithorhynchus, Echidna, Didelphis, Macropus, Loris, Macaque, Hystrix, Funambulus, Felix, Panthera, Canis, Herpestes, Capra, Pteropus.
9. Study of the skeleton of Scoliodon, Labeo, Rana (Frog), Varanus, Pigeon or Gallus and Oryctolagus/rat.
10. Study of the following permanent slides: Tornaria larva, T.S. Amphioxus (through different regions). Oikopleura, Histology of rat (compound tissues), different types of scales.
11. Make permanent stained preparations of the following: Salpa, Spicules, and Pharynx of Herdmania, Amphioxus, Cycloid scales.
12. Field Visit to Protected areas/National Park/Wildlife Sanctuary or Zoo

Suggested Readings

- R.L. Kotpal. Modern Textbook of Zoology.
- E.L. Jordan and Verma. Chordate Zoology.
- Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver and Boyd, Edinbourgh.
- Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.
- Kent, C.G. Comparative anatomy of vertebrates.
- S.S. Lal. Practical Zoology Vertebrate

MIC-02: Fundamentals of Biotechnology **CR-04 (Hr - 5; T-3, P-2)**

Course outcome

- *CO1: Demonstrate the knowledge of the concept and applications of biotechnology in animals and plants.*
- *CO2: Give an insight of the scope and applications of biotechnology in agriculture, environment, food and chemical industries*

Course Content

Unit I:

Definition and scope of Biotechnology; introduction of genetic engineering; plant and animal tissue culture; Animal Biotechnology; Plant Biotechnology; fermentation technology; immobilized enzymes; monoclonal antibodies and hybridoma technology; embryo transfer technology; preservation techniques**.**

Unit II:

Application of biotechnology in agriculture; animal and veterinary sciences, Environment biotechnology; pharmaceutical industry, food industry and chemical industry. Bioremediation and waste treatment biotechnology. Biotechnology research in India. Biotechnology in context of developing world. Brief account of safety guidelines and risk assessment in biotechnology. Ethics in Biotechnology, Intellectual property rights.

Unit III:

Introduction to gene and genomes, Proteins and proteome, history of genetic manipulations; recombinant DNA technology, DNA fingerprinting and forensic analysis.

UNIT–IV:

Biosafety and Risk Assessment: Principles of biosafety; risk assessment and management; health and environmental concerns of biotechnology.

Bioethics and Regulation: Ethical issues in genetic engineering; GMOs: benefits and concerns; regulatory framework and safety guidelines.

Intellectual Property Rights: IPR and patents in biotechnology; biotechnology and sustainable development.

Lab – 8

- Basic laboratory techniques used in biotechnology.
- Preparation and observation of plant tissue culture.
- Study of animal cell/tissue culture techniques through demonstrations.
- Demonstration of DNA isolation.

- Study of gel electrophoresis through demonstration/data interpretation.
- Study of fermentation processes.
- Demonstration of enzyme immobilization.
- Study of applications of biotechnology in agriculture and environmental management.
- Case study on bioremediation and biotechnology-based waste treatment.
- Case study on biosafety, GMOs, and ethical issues in biotechnology.

Suggested Readings

- Gupta, P.K. Elements of Biotechnology. Rastogi Publications.
- Jogdand, S.N. Gene Biotechnology. Himalaya Publishing House.
- Smith, J.E. Biotechnology. Cambridge University Press.
- Renneberg, R. Biotechnology for Beginners. Academic Press.
- Glick, B.R. and Pasternak, J.J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
- Thieman, W.J. and Palladino, M.A. Introduction to Biotechnology. Pearson.

MIC-02: Ayurveda and Nutrition **CR-04 (Hr - 5; T-3, P-2)**

Course Outcome

- *CO1: Student will get awareness of traditional food cultures of India·*
- *CO2 Students will be able to evaluate changing food patterns and lifestyle over the years.*
- *CO3 Students will understand Indian Knowledge Systems (IKS) and key Vedic principles with respect to Food and Nutrition.*

Course Content

Unit I:

Introduction to Ayurvedic Nutrition: Ayurveda and Indian food cultures, Nutrition and lifestyle transition over the years, Regional Food Traditions of India Definition of Swasthapurush, introduction of parameters of Swasthya and Tray-upastambha. The concept of Roga, Main etiological factors, Chikitsa and its types

Unit -ll*:*

Basic principles of Food and Nutrition and Ayurveda, Ayurvedic Principles of food habits and factors determining quality of food Concept of Ahara, Astahara vidhivishesha ayatana in various classics, FSSAI regulations on Ayurvedic Aahar

Unit -lll*:*

Ayurvedic Diets Principles of Diet: Aharavidhi vidhan, Sattvic, Rajasi, Tamasic foods, Incompatible food (Viruddha Ahara), Pathya; Apathya; Viprita Ahaar, Lifestyle Management with Dincharya and Ritucharya, Application of Ayurvedic diets to stress linked food behaviour. Ayurveda and Modern concept of Immunity, Immunization.

Unit–IV

Ayurveda and Immunity: Concept of Ojas and immunity; Ayurveda and modern perspectives on immunity.

Contemporary Relevance: Food, nutrition and lifestyle-related health concerns; role of Ayurvedic nutrition in preventive health; integration of traditional food practices with modern nutrition and food safety.

Lab – 8

- Documentation of traditional and regional food practices of India.
- Preparation of a comparative chart of Ayurvedic and modern nutritional concepts.
- Identification and classification of Sattvic, Rajasic, and Tamasic foods.
- Preparation of sample Ayurvedic diet plans based on season and lifestyle.
- Study of Pathya, Apathya, and Viruddha Ahara through case examples.

- Documentation of Dincharya and Ritucharya practices.
- Assessment of changing dietary patterns and lifestyle practices through a questionnaire survey.
- Study of FSSAI regulations related to Ayurveda Aahara.

Suggested Readings

- Frawley D (2012) Ayurvedic healing: A comprehensive guide. Lotus Press, India.
- FSSAI regulations on Ayurveda Aahar Regulations 2022. Gazette of India CG-DL-E-07052022-235642. New Delhi, Friday, May 6, 2022/ Vaisakha 16, 1944.
- Rastogi S (2010) Building bridges between Ayurveda and modern science. Int J Ayurveda Res. 1(1):41-46.
- Rastogi S {2014) Ayurvedic Science of Food and Nutrition. ASIN: BOOHWMV094, Springer: ISBN-13:978-1461496274

MDC-02: Food Science, Nutrition and Public Health **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: Course will provide understanding about nutrient requirements, the role of different food groups, and making informed dietary choices. Students will also learn about the basic terminologies.*
- *CO2 Students will learn about the various types of nutrients, their functions in the body, and their sources in food.*
- *CO3: This course will provide basic information about food carbohydrate, fat and protein.*
- *CO4: The students will be benefitted by getting knowledge about various therapeutic functional foods required to combat chronic health problems*

Course Content

Unit I:

Basic terminologies- nutrition, health, RDA (recommended dietary allowance), diet, hunger, satiety, BMR (basal metabolic rate), BMI (body mass index). Food and nutrients- basic definitions, function of food and nutrients, Water and its role in human health and nutrition. Obesity- it causes, body composition, weight for height measure, health implication of obesity. BMI and factor affecting BMI.

Unit II:

Carbohydrates- classification, dietary importance and function of carbohydrates. Fat- functions of fats, cholesterol, LDL & HDL and their health importance.

Protein - nature and function of proteins, biological value, net protein utilization, protein efficiency ratio, applications of amino acids

Unit III:

Vitamins- sources and requirements of vitamins, functions of vitamin- A, D, E, K, C and vit. B complex. Minerals- minerals in human health, macro and micro minerals, food sources and requirements of minerals**.**

National and International agencies in uplifting the nutritional status WHO, UNICEF, CARE, ICMR, ICAR, CSIR, CFTRI. Various nutrition related welfare program, ICDS, SLP, MOM, and others (in brief)

Suggested Readings

- Essentials of Food and Nutrition: Swaminathan.
- Food Nutrition: M. Swami Nathan Vol. I, II.
- Food Science and Nutrition: Sunetra Roday.

- N. Shakuntala Manay and M. Shadakshara swamy (2008) Food Facts and Principles.
- Sukhneet Suri and Anita Malhotra. Food Science, Nutrition and Safety. Pearson. (2014).

MDC-02: Mushroom Cultivation **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: Understands prospects of Mushroom cultivation and composting for Mushroom cultivation & different methods of composting.*
- *CO2: To gain knowledge of diseases and pests affecting Mushroom and their control in Mushroom cultivation.*
- *CO3: Students will acquire practical skills through engaging in laboratory experiments and field activities. These hands-on sessions will enable them to explore and understand the wide-ranging applications of Mushroom.*

Course Content

Unit I:

Definition, Scope & importance of Mushroom cultivation in India. Composting in Mushroom cultivation, Appropriate materials to prepare different types of compost, Methods of composting – preparation and pasteurization. Selection of types of Mushroom

Unit II:

Mushroom cultivation – methods, Selection of commercially important types of Mushroom. Sites for cultivation, Disease control and pest Management. Harvesting of Mushroom, Identification of right stage of Mushroom, Methods of harvesting

Unit III:

Packaging storing and grading of Mushroom & post-harvest procedures, Sorting the Mushrooms on the size and quality. Use of spent Mushroom in vermin- composting and in organic farming, Preparation of value added products of Mushroom

Suggested Readings

- Pandey, R.K. and Ghosh, S.K. (1996). A handbook of Mushroom Cultivation. Emkey Publication.
- Tewari, P. and Kapoor S.C. (1998). Mushroom Cultivation, Mittal Publication, New Delhi.
- Nita, B. (2000). Handbook of Mushrooms. Vol 1 & 2. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Pathak, V.N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.

VAC-02: Industrial Biotechnology **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: Students will be able to design and evaluate the full lifecycle of an industrial fermentation process.*
- *CO2: Students will be able to quantify enzyme kinetics and optimize microbial production of high-value bioproducts*

Course Content

Unit I: INTRODUCTION TO INDUSTRIAL BIOPROCESS:

Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

Unit II: PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS:

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation. PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS: Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

Suggested Readings

- Satyanarayana, U. “Biotechnology” Books & Allied (P) Ltd., 2005.
- Kumar, H.D. “A Textbook on Biotechnology” 2 nd Edition. Affiliated East West Press Pvt. Ltd., 1998.
- Balasubramanian, D. etal., “Concepts in Biotechnology” Universities Press Pvt.Ltd., 2004.
- Ratledge, Colin and Bjorn Kristiansen “Basic Biotechnology” 2 nd Edition Cambridge University Press, 2001.
- Dubey, R.C. “A Textbook of Biotechnology” S.Chand & Co. Ltd., 2006.

VAC-02: Traditional Medicinal Systems **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: Students will be able to understand various traditional methods of medical treatments in various communities of India.*
- *CO2 Infer the various applications of ethnomedicine in modern pharmaceutical systems BT4.*
- *CO3: To understand the concept of traditional medicinal practices by Indian tribals.*
- *CO4: To apply the methods to transform ethnobotanical knowledge for the preparation of value added products.*

Course Content

Unit I:

History, Scope and Importance of Medicinal Plants: Ethnobotanical uses of indigenous medicinal plants, indigenous medical systems- Ayurveda and Siddha. Conservation of Endangered and Endemic Medicinal Plants: Introduction to endemic and endangered medicinal plants, red list criteria; In situ and Ex situ conservation strategies of indigenous medicinal plants. Herbal gardens.

Unit II:

Ethnobotany and Folk medicines: Examples of ethnobotanically important plants of India. Paleo-ethnobotany. Folk medicines ethnic communities of India. Use of natural products for treatment of - jaundice, cardiac ailments, infertility, diabetes, hypertension and skin diseases. Ethnomedicine in India :* Case Studies

Suggested Readings

- Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
- S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, 6. Internet based latest research papers.
- S.K. Jain (ed.) Glimpses of Indian Ethnobotany, Oxford and I B H, New Delhi – 1981
- S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.

SEC-02: Environmental Footprints – Anthropogenic impact CR-03 (Hr - 3; L-3, T-0, P-0)

Course Outcome

- *CO1: Ability to understand the concept of environmental footprints and human impacts on ecosystems.*
- *CO2: Ability to analyze different types of footprints such as carbon, water, and ecological footprints.*
- *CO3: Ability to evaluate the impact of anthropogenic activities on natural resources and environment.*
- *CO4: Ability to apply strategies for reducing environmental footprints and promoting sustainability.*

Course Content

Unit I: Introduction to Environmental Footprints

Concept and definition of environmental footprint; types of footprints (ecological, carbon, water); methods of footprint calculation; carrying capacity and ecological limits; overview of human-induced environmental changes.

Unit II: Anthropogenic Impacts on Environment

Impact of industrialization, urbanization and agriculture; deforestation and land-use change; resource depletion; pollution and waste generation; impacts on biodiversity, ecosystems and climate systems.

Unit III: Footprint Assessment and Sustainable Practices

Tools and techniques for footprint assessment; life cycle assessment (LCA); strategies to reduce carbon and water footprints; sustainable consumption and production; role of individuals, industries and governments in minimizing environmental impact.

Suggested Readings

- Fang, K., 2021. Environmental footprints: Assessing anthropogenic effects. Cham: Springer.
- IPCC (2014). Climate Change: Synthesis Report. Intergovernmental Panel on Climate Change.
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi.
- Miller, G.T. and Spoolman, S. (2014). Environmental Science. Brooks/Cole, USA.
- UNEP (2011). Towards a Green Economy. United Nations Environment Programme.
- Wackernagel, M. and Rees, W. (1996). Our Ecological Footprint. New Society Publishers.
- Wiedmann, T. and Minx, J. (2008). A Definition of Carbon Footprint. ISA Research Report.

Semester Wise Scheme and Syllabus of B.Sc.-M.Sc. Lifesciences (Integrated)

Semester - 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
DSC-07	Plant Taxonomy and Ecology	BSC+MSC/BOT/DSC-103	3	0	2	3	0	1	04					**100**
DSC-08	Physical Chemistry - I	BSC+MSC/CHEM/DSC-103	3	0	2	3	0	1	04					**100**
DSC-09	Cell Biology and Genetics	BSC+MSC/ZOO/DSC-103	3	0	2	3	0	1	04					**100**
MIC-03	Introduction to Food Technology	BSC+MSC/FST/MIC-101	3	0	2	3	0	1	04					**100**
MDC -03	Fundamentals of Sustainable Development Or Fundamentals of Environmental Chemistry	BSC+MSC/EVS/MDC-101 Or BSC+MSC/CHEM/MDC101	3	0	0	3	0	0	03					**75**
VAC- 03	Traditional Indian Food or Herbal Science and Technology	BSC+MSC/FST/VAC-101 Or BSC+MSC/BOT/VAC-103	2	0	0	2	0	0	02					**50**
SEC-03	Computational Biology	BSC+MSC/DBT/SEC-101	3	0	0	3	0	0	03					**75**
AEC -03*	One from the pool		2	0	0	2	0	0	02					**50**
Total Credits									**26**					**650**

DSC-07: Plant Taxonomy and Ecology **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Ability to understand the principles and systems of plant classification, nomenclature, and identification.*
- *CO2: Ability to identify and classify plants using morphological and taxonomic characters.*
- *CO3: Ability to understand ecological principles, plant communities, and ecosystem dynamics.*
- *CO4: Ability to analyze the relationship between plants and their environment, including adaptation and distribution patterns.*

Course Content

Unit I: Plant Taxonomy:

Principles and Methods**:** Introduction to plant taxonomy; importance and scope; systems of classification (artificial, natural, phylogenetic); taxonomic hierarchy; concept of species; binomial nomenclature; rules of botanical nomenclature; Modern trends in taxonomy (numerical taxonomy, chemotaxonomy, molecular taxonomy).

Unit II: Plant Identification and Systematics**:**

Morphological characteristics of vegetative and reproductive parts; identification using keys; study of major plant families (e.g., Brassicacae, Fabaceae, Asteraceae, Solanaceae, Poaceae , Orchidaceae); economic importance of plant families**.**

Unit III: Fundamentals of Ecology:

Introduction to ecology; levels of organization; abiotic factors (light, temperature, water, soil) and their ecological significance; biotic interactions (competition, predation, symbiosis); ecological adaptations in plants.

Unit IV: Ecosystem and Plant Communities:

Structure and function of ecosystems; energy flow and nutrient cycling; ecological pyramids; plant communities and succession; biodiversity and conservation; ecological significance of forests, grasslands, and aquatic ecosystems.

Lab – 09

1. Study of vegetative and floral morphology of plants
2. Identification of plants using taxonomic keys
3. Study of herbarium techniques (collection, pressing, mounting)
4. Identification and description of common plant families
5. Study of ecological factors (soil, light, temperature)
6. Analysis of plant communities (quadrat method)

7. Field visit for plant identification and ecological observations

Suggested Readings

- Bendre, A.M. and Kumar, A. (2007). Practical Botany. Rastogi Publications, Meerut.
- Jain, S.K. and Rao, R.R. (1977). A Handbook of Field and Herbarium Methods. Today & Tomorrow's Printers, New Delhi.
- Judd, W.S. et al. (2007). Plant Systematics: A Phylogenetic Approach. Sinauer Associates, USA.
- Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, India.
- Misra, R. (1968). Ecology Workbook. Oxford & IBH Publishing Co., New Delhi.
- Odum, E.P. and Barrett, G.W. (2005). Fundamentals of Ecology. Thomson Brooks/Cole, USA.
- Sharma, O.P. (2011). Plant Taxonomy. Tata McGraw-Hill, New Delhi.
- Simpson, M.G. (2010). Plant Systematics. Academic Press, USA.
- Singh, G. (2010). Plant Systematics: Theory and Practice. Oxford & IBH Publishing Co., New Delhi.
- Singh, V. and Jain, D.K. (1981). Taxonomy of Angiosperms. Rastogi Publications, Meerut.

DSC-08: Physical Chemistry – I **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Ability to understand basic properties of gases, liquids and solids.*
- *CO2: Ability to explain concepts of ionic equilibrium and pH.*
- *CO3: Ability to understand laws of thermodynamics and energy changes.*
- *CO4: Ability to apply thermodynamic principles to chemical processes.*

Course Content

Unit I: States of Matter (Gas, Liquid and Solid)

Gaseous state: kinetic theory of gases (basic postulates); ideal gas equation; real gases and deviations (van der Waals equation – concept only).

Liquid state: properties of liquids – vapour pressure, surface tension and viscosity (qualitative idea).

Solid state: types of solids; crystal systems and basic concepts of unit cell; Bragg's law (introductory idea).

Unit II: Ionic Equilibrium

Electrolytes: strong and weak electrolytes; degree of ionization.

pH and pOH; ionization of weak acids and bases.

Buffer solutions and Henderson equation (basic application).

Solubility product and its applications.

Acid–base titration curves (qualitative idea) and indicators.

Unit III: Chemical Thermodynamics

Basic concepts: system (isolated, closed and open systems), surroundings, state functions.

First Law of Thermodynamics: Enthalpy (H) and heat capacities; Calculations of ΔU and ΔH for isothermal and adiabatic processes.

Thermochemistry: Heats of reactions and standard states; Enthalpy of formation and combustion. Effect of temperature (Kirchhoff's Equation).

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics. Calculation of entropy change for reversible and irreversible processes.

Third Law of Thermodynamics: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Third Law and absolute entropy; Free Energy; Gibbs free energy

(G); Free energy and spontaneity; Thermodynamic Relations; Joule–Thomson effect; Gibbs–Helmholtz equation

Unit IV: Chemical Equilibrium and Solutions

Systems of Variable Composition: Partial molar quantities; Chemical Potential; Gibbs–Duhem Equation.

Chemical Equilibrium: Criteria of equilibrium; Degree of advancement of reaction; Equilibrium Constant (K).

Thermodynamic Relations: Relation between ΔG and reaction quotient (Q); Dependence of equilibrium on temperature, pressure and concentration; Le Chatelier's Principle (Quantitative Treatment).

Solutions: Raoult's Law and Henry's Law; Vapour pressure of solutions.

Colligative Properties: Relative lowering of vapour pressure; Elevation of boiling point; Depression of freezing point; Osmotic pressure.

Thermodynamic Derivations: Relation of colligative properties with solute concentration.

Applications: Determination of molar masses of normal, associated and dissociated solutes.

Lab - 10

1. ***Surface Tension and Viscosity***
    - Determination of surface tension using stalagmometer
    - Determination of viscosity using Ostwald viscometer
2. ***pH and Buffer Studies***
    - Preparation of buffer solutions
    - pH measurement and pH-metric titration
3. ***Thermochemistry (Basic Experiments)***
    - Determination of enthalpy of neutralization
    - Determination of heat capacity of calorimeter
4. ***Miscellaneous***
    - Study of solubility and its temperature dependence

Suggested Readings

- Assael, M.J., Maitland, G.C., Maskow, T., von Stockar, U., Wakeham, W.A. and Will, S., 2022. Commonly asked questions in thermodynamics. CRC Press.
- Athawale, V.D. (2001). Experimental Physical Chemistry. New Age.
- Atkins, P. and de Paula, J. (2006). Physical Chemistry. Oxford University Press.
- Atkins, P., De Paula, J. and Friedman, R., 2014. Physical chemistry: quanta, matter, and change. Oxford University Press.

- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Ball, D.W. (2007). Physical Chemistry. Thomson Press.
- Castellan, G.W. (2004). Physical Chemistry. Narosa.
- Castellan, G.W., 2004. Physical Chemistry 4th Ed. Narosa.
- Engel, T. and Reid, P. (2012). Physical Chemistry. Prentice Hall.
- Garland, C.W. et al. (2003). Experiments in Physical Chemistry. McGraw-Hill.
- Khosla, B.D. et al. (2011). Senior Practical Physical Chemistry. R. Chand & Co.
- Suggested Readings (Lab).

DSC-09: Cell biology and Genetics **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Students will understand the nature and basic concept of cell biology and genetics.*
- *CO2: Students will be able to apply the knowledge of internal structure of cell and their role in many metabolic functions of organism.*
- *CO3: Students will have acquaintance with the basic causes associated with inborn errors and other genetic disorder and will be able to give counselling to general people.*
- *CO4: Students will be able to explain the concept of gene interactions; Sex linked inheritance and their role in medical sciences.*
- *CO5: Students will be able to conduct the morphometric analysis of chromosomes and demonstrate cell division*

Course Content

Unit I:

General structure of animal cell. Plasma Membrane: Fluid mosaic model, various modes of transport across the membrane, mechanism of active and passive transport, endocytosis and exocytosis. Endoplasmic reticulum (ER): types and functions. Golgi complex: Structure, associated enzymes and role of golgi-complex in animal cell***.***

Unit II:

Ribosomes: Types, biogenesis and role in protein synthesis. Lysosomes: Structure, enzymes and their role; polymorphism Mitochondria: Structure, Mitochondria as semiautonomous body, biogenesis, functions of mitochondria. Cilia and Flagella: Structure and Functions Ultrastructure and functions of Nucleus: Nuclear membrane, nuclear lamina, nucleolus, fine structure of chromosomes, nucleosome concept and role of histones, euchromatin and heterochromatin.

Unit III:

Introduction and Mendel's Laws of Inheritance, Linkage and recombination: Cell Cycle, crossing-over and chiasma formation; gene mapping. Sex determination and its mechanism: male and female heterozygous systems, genetic balance system; role of Y-chromosome, male haploidy, cytoplasmic and environmental factors, role of hormones in sex determination. Sex linked inheritance: Haemophilia and colour blindness in man, eye colour in Drosophila, Non-disjunction of sex-chromosome in Drosophila, Sex-linked and sex-influenced inheritance Extra chromosomal and cytoplasmic inheritance: Kappa particles in Paramecium, Shell coiling in snails, Milk factor in mice.

Unit IV:

Multiple allelism: Eye colour in Drosophila; A, B, O blood group in man. Human genetics: Human karyotype, Chromosomal abnormalities involving autosomes and sex chromosomes,

monozygotic and dizygotic twins. Inborn errors of metabolism (Alcaptonuria, Phenylketonuria, Albinism, sickle-cell anaemia). Applied genetics: Genetic counseling, pre-natal diagnosis, DNA-finger printing, transgenic animals.

Lab – 11

1. Cell division: Prepared slides of stages of mitosis and meiosis.
2. Salivary gland and polytene chromosomes of Drosophila/ Chironomus.
3. Temporary squash preparations of onion root tip/grasshopper testis for the study of mitosis.
4. Blood antigens and antibodies: Blood group testing.
5. Preparation of Human Karyotype and Ideogram.
6. Barr Body and Drum stick slide Preparations.

Suggested Readings

- Molecular Cell, Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
- Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P. S. Verma and V.K. Aggarwal.
- Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
- Cell Biology and Genetics by P.K. Gupta.
- Cell Biology and Genetics by Veer Bala Rastogi.
- Principles of Genetics by M. Gardner, J. Simmons, D. P. Snustad.
- Genetics by D. P. Snustad, J. Simmons.

MIC-03: Introduction to Food Technology **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Students will learn about the chemical and physical properties of different food components and how they influence food behavior during processing and storage.*
- *CO2: The course will cover various methods of food preservation, such as heat processing, refrigeration, freezing, and dehydration, and their effectiveness in preventing spoilage and maintaining quality.*
- *CO3: The course will address the social, economic, and environmental implications of food technology, including issues related to food security, sustainability, and nutrition.*
- *CO4: Students will be able to apply their knowledge to practical problems in the food industry, such as designing new food products, improving processing efficiency, or ensuring food safety. To attain knowledge about ethnobotany and its significance.*

Course Content

Unit I:

Fundamentals of Food Science and Technology: Introduction, scope and importance of food technology; major food components and their properties; food quality and spoilage; basic principles of food processing and preservation; food safety and hygiene; food technology, nutrition and sustainability.

Unit II:

Wheat: structure and composition, types (hard, soft/strong, weak) Diagrammatic representation of longitudinal structure of wheat grain. Gelatinization of starch, types of browning- Maillard & caramelization. Rice: structure, composition and application Corn: structure, composition and uses.

Meat: Definition of carcass, composition of meat, marbling, and post-mortem changes in meat-rigor mortis, tenderization of meat, ageing of meat.

Unit -lll:

Fruits and Vegetables: Classification of fruits and vegetables, general composition, Postharvest changes in fruits and vegetables: Climacteric rise, horticultural maturity, physiological maturity, physiological changes, physical changes, chemical changes, pathological changes during the storage of fruits and vegetables.

Unit -lV*:*

Milk and Milk Products: Definition of milk, chemical composition of milk, its constituents and their importance, physicochemical properties of milk, factor affecting the composition of milk. Processing of milk: Pasteurization, homogenization, standardization and sterilization of milk.

Poultry: Structure of hen's egg, composition and nutritive value, egg proteins, characteristics of fresh egg, deterioration of egg quality.

Lab – 12

- Determination of basic physicochemical properties of food materials.
- Estimation of moisture, ash, protein, or fat in selected food samples.
- Study of starch gelatinization and browning reactions.
- Quality assessment of wheat, rice, and other cereals.
- Study of physical and chemical changes in fruits and vegetables during storage.
- Demonstration of milk pasteurization and quality testing.
- Study of egg quality and freshness.
- Demonstration of food preservation techniques such as drying, refrigeration, and freezing.
- Study of food packaging and storage methods.
- Preparation and evaluation of a simple processed food product.

Suggested Readings

- B. Srilakshmi, Food science, New Age Publishers, 2002.
- Bawa, A.S., Chauhan, O.P. et.al., Food Science. New India Publishing agency, 2013.
- De Sukumar, Outlines of Dairy Technology, Oxford University Press, 2007.
- Meyer, Food Chemistry, New Age,2004.
- Roday, S. Food Science, Oxford publication, 2011.

MDC-03: Fundamentals of Sustainable Development **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: Ability to understand the concept and principles of sustainable development.*
- *CO2: Ability to analyze the relationship between environment, economy, and society.*
- *CO3: Ability to evaluate sustainable practices and development strategies.*
- *CO4: Ability to apply sustainability concepts to real-world environmental issues.*

Course Content

Unit I: Introduction to Sustainable Development

Concept, definition and evolution of sustainable development; principles and pillars (environmental, economic, social); need and importance; global environmental issues and sustainability; intergenerational and intragenerational equity.

Unit II: Resources and Sustainable Management

Natural resources (water, forest, land, energy) and their sustainable use; renewable and non-renewable resources; sustainable agriculture and industry; energy conservation and renewable energy sources; sustainable consumption and production patterns.

Unit III: Policies, Goals and Sustainable Practices

Sustainable Development Goals (SDGs); national and international initiatives for sustainable development; environmental policies and governance; role of stakeholders (government, industry, community); sustainable urban development and climate resilience.

Suggested Readings

- Devi Rani (2023). Socio-Environmental Conditions and Policies of Government and its Impact on Environment, Arihant Books, New Delhi, India.
- Dresner, S. (2008). The Principles of Sustainability. Earthscan, London.
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi.
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi.
- Miller, G.T. and Spoolman, S. (2014). Environmental Science. Brooks/Cole, USA.
- Roorda, N., (2025). Fundamentals of sustainable development. Routledge.
- Sachs, J.D. (2015). The Age of Sustainable Development. Columbia University Press.
- Surampalli, R.Y., Zhang, T.C., Goyal, M.K., Brar, S.K. and Tyagi, R.D. eds., (2020). Sustainability: Fundamentals and applications. John Wiley & Sons.
- United Nations (2015). Transforming Our World: The 2030 Agenda for Sustainable Development.

- WCED (1987). Our Common Future. Oxford University Press.

MDC 03: Fundamentals of Environmental Chemistry **CR-03 (Hr - 3; L- 3, T-0, P-0)**

Course Outcome

- *CO1: Understand basic concepts and chemical processes in the environment.*
- *CO2: Explain the chemistry of air, water, and soil systems.*
- *CO3: Identify sources, reactions, and impacts of environmental pollutants.*
- *CO4: Analyze environmental issues and suggest suitable control measures.*

Course Content

Unit I: Fundamentals and Atmospheric Chemistry

Introduction to Environmental Chemistry- Definition, scope and importance; Composition and structure of atmosphere; Chemical processes in the atmosphere;

Air pollutants- sources, types and effects; Photochemical reactions; Smog formation;

Acid rain- formation, reactions and environmental impact;

Ozone layer- chemistry of formation and depletion; Greenhouse effect and global warming.

Unit II: Aquatic and Soil Chemistry

Water chemistry- properties of water, dissolved oxygen, BOD, COD;

Water pollution- sources, types and effects;

Chemical processes in natural waters- carbonate system, alkalinity and hardness;

Soil chemistry- composition, properties and nutrient cycles;

Soil pollution- sources, effects and control measures.

Unit III: Environmental Pollution and Control

Environmental pollutants- classification and sources;

Heavy metals and toxic chemicals- sources and effects;

Solid waste and hazardous waste- types and management;

Principles of green chemistry and sustainable development;

Pollution control strategies- air, water and soil;

Basic analytical methods in environmental monitoring.

Suggested Readings

- Baird, C.; Cann, M. Environmental Chemistry, W.H. Freeman.
- De, A.K. Environmental Chemistry, New Age International.

- Harrison, R.M. Understanding Our Environment, Royal Society of Chemistry.
- Manahan, S.E. Environmental Chemistry, CRC Press.
- Moore, J.W.; Moore, E.A. Environmental Chemistry, Academic Press.
- Sawyer, C.N.; McCarty, P.L.; Parkin, G.F. Chemistry for Environmental Engineering, McGraw Hill.
- Sharma, B.K. Environmental Chemistry, Goel Publishing House.

VAC-03: Traditional Indian Foods **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: Student will be able to understand the historical and traditional perspective of foods and food habits.*
- *CO2 Student will be able to co-relate the wide diversity and common features of traditional Indian foods and meal patterns.*

Course Content

Unit I:

Introduction: historical and cultural perspectives food production Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture -variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits.

Traditional methods of food processing: Traditional methods of milling grains – rice, wheat and corn Traditional methods of food preservation -sundrying, osmotic drying, brining, pickling and smoking.

Unit -II*:*

Commercial production of traditional foods: Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods –role of SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, buttermilk etc.

Health aspects of traditional foods: traditional foods used for specific ailments /illnesses.

Suggested Readings

- Davidar, Ruth N. “Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001. 2007.
- Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005. 79 80 2.

VAC-03: Herbal Science and Technology **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1. Develop conceptual skill about traditional Indian medicinal system, herbal medicines, their processing, storage and marketing.*
- *CO2. Gain knowledge about developing commercial enterprise of herbal medicines.*
- *CO3. Learn the basic tools and techniques for phytochemical analysis and propagation of the medicinal plants.*

Course Content

Unit I:

Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation, harvesting, processing, storage, marketing and utilization of medicinal plants.

Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; Catharanthus roseus (cardiotonic), Withania somnifera (drugs acting on nervous system), Clerodendron phlomoides (anti-rheumatic) and Centella asiatica (memory booster)

Unit II:

Pharmacognosy - systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Suggested Readings

- Arber, A. (1999). Herbal plants and Drugs. Mangal Deep Publications.
- C.S.I.R, New Delhi.
- Chopra, R.N., Nayar S.L. and Chopra, I.C. (1956). Glossary of Indian Medicinal Plants.
- Green, A. (2000). Principles of Ayurveda, Thomsons, London.
- Kokate, C.K. (1999). Pharmacognosy, Nirali Prakashan.
- Miller, L. and Miller, B. (1998). Ayurveda and Aromatherapy. Banarsidass, Delhi.
- Oxford IBH publishing Co.
- Sivarajan V.V. and Balachandran I. (1994). Ayurvedic drugs and their plant source.

SEC-03: Computational Biology **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: Articulate the different approaches in computational modelling of various biological systems.*
- *CO2: Articulate the significance of systems biology and its relevance in scientific research.*
- *CO3: Explain the basics of graph theory and its applications in biology*

Course Content

Unit I:

System biology: introduction; significance of systems biology. Towards system level understanding of biological systems: measurement technologies and experimental methods for systems biology; system structure identification; system behaviour analysis.

Introduction to modelling: definition of a model; practice of modelling – model scope, making assumptions, modelling paradigms, building the model - variables, parameters, and constants, model analysis, simulating the model. Model examples - Lotka Volterra model.

Unit II:

Graph theory: basics, types of graphs; computational representations of graphs - data structures, adjacency matrix, Laplacian matrix. Representation of biological networks using graph: gene regulatory networks; protein structure networks; metabolic networks. Software tools for network analysis.

Unit III:

Analysis of networks: different network parameters used; canonical network models – ER model; community detection - similarity-based clustering, Girvan-Newman algorithm; network perturbations; software tools used. Applications of network biology: protein structure and conformational networks.

Suggested Readings

- A First Course in System Biology by Eberhard O. Voit, Garland Science, 2013.
- An introduction to computational systems biology: system level modelling of cellular networks by Karthik Raman, 1st Edition, CRC Press, 2021.
- An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon, 2nd edition, 2020.
- Computational Systems Biology from Molecular Mechanisms to Disease 1 st Edition by Andres Kriete, Elsevier science, 2013.

Semester Wise Scheme and Syllabus of B.Sc.-M.Sc. Lifesciences (Integrated)

Semester - 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
DSC-10	Plant Anatomy and Embryology	BSC+MSC/BOT/DSC-104	3	0	2	3	0	1	04					**100**
DSC-11	Inorganic Chemistry - II	BSC+MSC/CHEM/DSC-104	3	0	2	3	0	1	04					**100**
DSC-12	Biochemistry and Animal Physiology	BSC+MSC/ZOO/DSC-104	3	0	2	3	0	1	04					**100**
MIC-04	Basics of Environmental Pollution Or Theories of Biomolecules	BSC+MSC/EVS/MIC-102 or BSC+MSC/DBT/MIC-103	3	0	2	3	0	1	04					**100**
MDC -04	Technique in Biotechnology OR Insect Vectors Diseases & Control	BSC+MSC/DBT/MDC-102 Or BSC+MSC/ZOO/MDC-102	3	0	0	3	0	0	03					**75**
VAC- 04	Disaster and Management Strategies Or Ecology and Environment	BSC+MSC/EVS/VAC-102 Or BSC+MSC/ZOO/VAC-101	2	0	0	2	0	0	02					**50**
SEC-04	Fermentation Technology Or Genetic Engineering	BSC+MSC/FST/SEC-102	3	0	0	3	0	0	03					**75**
AEC -04*	One from the pool		2	0	0	2	0	0	02					**50**
Total Credits									**26**					**650**

Note:

- *Internship or field training or project of 4-6 weeks during summer vacation @ 4 credits.*
- *Students exiting the programme after fourth semester and securing 98 credits including 4 credits of summer internship will be awarded UG Diploma in the relevant Discipline/Subject.*

DSC-10: Plant Anatomy and Embryology **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Ability to understand the internal structure and organization of plant tissues and organs.*
- *CO2: Ability to identify and analyze different plant tissues using microscopic techniques.*
- *CO3: Ability to understand the process of plant reproduction, embryogenesis, and seed development.*
- *CO4: Ability to correlate anatomical features with plant function and adaptation.*

Course Content

Unit I: Plant Anatomy: Basics

Introduction to plant anatomy; scope and importance; cell structure and organization; meristematic tissues (apical, lateral, intercalary); permanent tissues (simple and complex tissues); tissue systems.

Unit II: Internal Structure of Plant Organs

Anatomy of root, stem, and leaf (dicots and monocots); secondary growth in stem and root; anomalous secondary growth; structure and function of vascular tissues (xylem and phloem).

Unit III: Reproductive Biology of Angiosperms

Structure and development of anther and pollen grains (microsporogenesis); structure and development of ovule and embryo sac (megasporogenesis); pollination and fertilization; double fertilization.

Unit IV: Embryology and Seed Development

Development of embryo and endosperm; types of embryos; seed structure and germination; apomixis and polyembryony; significance of embryology in plant breeding.

Lab – 13

1. Study of plant cell structure using microscope
2. Identification of meristematic and permanent tissues
3. Preparation and observation of transverse sections (T.S.) of root, stem, and leaf
4. Study of secondary growth in stem (dicot)
5. Microscopic observation of pollen grains and ovules
6. Study of embryo development stages (permanent slides)
7. Seed structure and germination study

Suggested Readings

- Bendre, A.M. and Kumar, A. (2007). Practical Botany. Rastogi Publications, Meerut.

- Bhojwani, S.S. and Bhatnagar, S.P. (2012). The Embryology of Angiosperms. Vikas Publishing House, New Delhi.
- Eames, A.J. and MacDaniels, L.H. (1947). An Introduction to Plant Anatomy. McGraw-Hill, USA.
- Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, USA.
- Fahn, A. (1990). Plant Anatomy. Pergamon Press, USA.
- Maheshwari, P. (1950). An Introduction to the Embryology of Angiosperms. McGraw-Hill, USA.
- Pandey, B.P. (2010). Plant Anatomy. S. Chand & Company, New Delhi.

DSC-11: Inorganic Chemistry – II **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Ability to understand structure, bonding and properties of coordination compounds.*
- *CO2: Ability to analyze behavior and chemistry of transition elements.*
- *CO3: Ability to explain organometallic compounds and their applications.*
- *CO4: Ability to understand basic concepts of bioinorganic chemistry and reaction mechanisms.*

Course Content

Unit I: Coordination Chemistry – Basic Concepts

Werner's theory; basic idea of valence bond theory and crystal field theory (CFT); crystal field splitting and factors affecting it (qualitative only).

Octahedral and tetrahedral complexes (basic comparison); IUPAC nomenclature; isomerism (geometrical and optical – basic idea).

Chelate effect; labile and inert complexes (introductory concept).

Unit II: Transition Elements

General properties: electronic configuration, variable oxidation states, colour, magnetism and catalytic properties.

Important compounds of Cr, Mn and Fe (dichromate, permanganate, ferro/ferricyanide – basic properties and uses).

Brief idea of lanthanides: electronic configuration and lanthanide contraction.

Unit III: Organometallic Chemistry

Definition and classification of organometallic compounds.

Metal carbonyls: 18-electron rule (basic idea), structure and bonding (introductory concept of back bonding).

Ferrocene: structure, aromaticity and simple reactions.

Brief idea of metal alkyls (structure only).

Unit IV: Bioinorganic Chemistry and Basic Mechanism

Role of metal ions in biological systems; haemoglobin and myoglobin (basic structure and function).

Toxicity of heavy metals (Hg, Pb, Cd – basic idea); chelation therapy (introductory concept).

Basic idea of substitution reactions in coordination compounds; kinetic vs thermodynamic stability (qualitative).

Lab - 14

1. ***Gravimetric Analysis***
    - Estimation of Ni(II) using DMG
    - Estimation of Cu as CuSCN
    - Estimation of Fe as Fe_2O_3
    - Estimation of Al using oxine
2. ***Inorganic Preparations***
    - Tetraamminecopper(II) sulphate
    - Acetylacetonate complexes of Cu^{2+}/Fe^{3+}
    - Tetraamminecarbonatocobalt(III) nitrate
    - Potassium tris(oxalato)ferrate(III)
3. ***Properties of Complexes***
    - Measurement of crystal field splitting (Δo) (basic spectrophotometric idea)
    - Verification of spectrochemical series
    - Ligand substitution reactions of Ni(II) complexes
4. **Chromatographic Separation**
    - Separation of Ni(II) and Co(II)
    - Separation of Cu(II) and Cd(II)

Suggested Readings

- Cotton, F.A. and Wilkinson, G. (1999). Advanced Inorganic Chemistry. Wiley.
- Greenwood, N.N. and Earnshaw, A. (1997). Chemistry of the Elements. Elsevier.
- Huheey, J.E. et al. (2006). Inorganic Chemistry: Principles of Structure and Reactivity. Pearson.
- Lee, J.D. (2008). Concise Inorganic Chemistry. Wiley.
- Lippard, S.J. and Berg, J.M. (1994). Principles of Bioinorganic Chemistry.
- Marr, G. and Rockett, B.W. (1972). Practical Inorganic Chemistry.
- Miessler, G.L. and Tarr, D.A. (2010). Inorganic Chemistry. Pearson.
- Powell, P. (1988). Principles of Organometallic Chemistry. Chapman and Hall.
- Svehla, G. (1996). Vogel's Qualitative Inorganic Analysis. Pearson.
- Vogel, A.I. (1986). A Textbook of Quantitative Analysis. ELBS.

DSC-12: Biochemistry and Animal Physiology **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Students will be able to understand and explain the mechanism that works to keep the human body functioning.*
- *CO2: Students will be able to explain the interaction and interdependence of physiological and biochemical processes.*
- *CO3: It will make the students understand the appropriate functioning of each body system in animals and mechanism of working.*
- *CO4: Students will be able to explain the mechanism of action of hormones and related molecules involved in various physiological processes.*
- *CO5: Students will be able to understand and perform biological and analytical techniques in labs to explain biological activities.*

Course Content

Unit I:

Introduction, classification, structure, function and general properties of proteins, carbohydrates and lipids. Nomenclature, classification and mechanisms of enzyme action; Enzyme Kinetics, factors affecting enzyme activity, inhibition of enzymes Transport through bio membranes (Active and Passive), osmotic pressure, hydrogen ion concentration and buffers.

Unit II: Transition Elements

Nutrition: Nutritional components: Carbohydrates, fats, lipids, Vitamins and Minerals; Types of nutrition & feeding, Digestion of lipids, proteins, carbohydrates & nucleic acids; symbiotic digestion, lactose intolerance, Physico-chemical mechanism of Absorption of nutrients & assimilation; control of secretion of digestive juices. Muscles: Types of muscles, ultra-structure of skeletal muscle, neuromuscular junction. Bio-chemical and physical events during muscle contraction, single muscle twitch, tetanus, muscle fatigue, muscle tone, oxygen debt., Cori's cycle, single unit smooth muscles, their physical and functional properties***.***

Unit III: Organometallic Chemistry

Circulation: Origin, conduction and regulation of heart beat; cardiac cycle, electrocardiogram, cardiac output, fluid pressure and flow pressure in closed and open circulatory system; Composition and functions of blood & lymph; Mechanism of coagulation of blood, coagulation factors; anticoagulants, haemopoiesis. Respiration: Exchange of respiratory gases, transport of gases, lung air volumes, oxygen dissociation curve of haemoglobin, Bohr's effect, Hamburger's phenomenon (Chloride shift), control / regulation of respiration (peripheral reflexes, chemical control and Higher centres), Myoglobin. Excretion: Patterns of excretory products viz. Amonotelic, ureotlic uricotelic, ornithine cycle (Kreb's – Henseleit cycle) for urea formation in

liver; Urine formation, composition of Urine, counter-current mechanism of urine formation, osmoregulation, micturition.

Unit IV: Bioinorganic Chemistry and Basic Mechanism

Neural Integration: Nature, origin and propagation of nerve impulse alongwith medullated & non-medullated nerve fibre, conduction of nerve impulse across synapse, synaptic delay and synaptic fatigue, Neurotransmitter. Chemical integration of Endocrinology: Structure, chemical nature and mechanism of peptide and steroid hormone action; physiology of hypothalamus, pituitary, thyroid, parathyroid, adrenal, pancreas and gonads, Hormonal disorders. Reproduction: Spermatogenesis, Capacitation of spermatozoa, oogenesis, ovulation, formation of corpus luteum, oestrous-anoestrous cycle, Menstrual cycle in human, fertilization, implantation and gestation, parturition.

Lab – 15

1. Qualitative tests for identification of simple sugars, disaccharides and polysaccharides.
2. Study of human salivary amylase activity: Effect of temperature, pH, Concentration.
3. Estimation of abnormal constituents of urine (Albumin, sugar, ketone bodies).
4. Use of Kymograph unit & respirometer.
5. Haematin crystal preparation.
6. Estimation of Hb.
7. DLC of Man/RBC count/WBC count.
8. Study of permanent slides of endocrine glands
9. Blood antigens and antibodies: Blood group testing

Suggested Readings

- Agarwal R A, Srivastava A. K., Kumar K. Animal Physiology and Biochemistry; S Chand Publishing; Twenty Third edition, 1978.
- Arumugam N, Fatima D, Narayanan L.M. (2016) Animal Physiology and Biochemistry; Saras Publication.
- Moyes C, Schulte P (2015). Principles of Animal Physiology, Pearson; 3rd edition.
- Satyanarayana (2021) Biochemistry, Elsevier; 6th edition
- Vasantika Kashyap (2021) A Text-Book of Animal Physiology and Biochemistry; Kedar Nath Ram Nath Publisher.

MIC-04: Basics of Environmental Pollution **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Ability to understand the types, sources, and classification of environmental pollution.*
- *CO2: Ability to analyze the impact of pollutants on air, water, soil, and living organisms.*
- *CO3: Ability to understand methods of pollution monitoring and control techniques.*
- *CO4: Ability to evaluate environmental issues and suggest sustainable mitigation measures.*

Course Content

Unit I: Introduction to Environmental Pollution

Definition, types and classification of pollution; natural and anthropogenic sources; concept of pollutants and contaminants; primary and secondary pollutants; environmental quality standards.

Unit II: Air and Noise Pollution

Sources and types of air pollutants; effects on human health, vegetation and climate; greenhouse gases and global warming; control measures of air pollution; noise pollution: sources, effects and control measures.

Unit III: Water and Soil Pollution

Sources, types and effects of water pollution; water quality parameters (DO, BOD, COD); eutrophication; methods of water pollution control; soil pollution: sources, effects and remediation techniques.

Unit–IV: Waste Pollution, Monitoring and Control

Solid and hazardous waste: sources, impacts and management; e-waste and biomedical waste; waste minimization, recycling and resource recovery; pollution monitoring and control; sustainable pollution management.

Lab – 16

- Measurement of ambient noise levels at selected locations.
- Determination of pH, EC and turbidity of water samples.
- Determination of DO in water samples.
- Determination of BOD and COD of water samples.
- Assessment of water quality using selected parameters.
- Determination of soil pH, EC and organic matter.
- Assessment of soil pollution using selected indicators.
- Characterization and segregation of solid waste.

- Preparation of a household/institutional waste management plan.
- Preparation of an environmental pollution monitoring and control report.

Suggested Readings

- APHA (2005). Standard Methods for the Examination of Water and Wastewater. American Public Health Association, USA.
- Cunningham, W.P. and Cunningham, M.A. (2012). Environmental Science: A Global Concern. McGraw-Hill, USA.
- Gupta, O.P., 2016. Elements of environmental pollution control. Khanna Publishing House.
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi.
- Miller, G.T. and Spoolman, S. (2014). Environmental Science. Brooks/Cole, USA.
- Misra, R. (1968). Ecology Workbook. Oxford & IBH Publishing Co., New Delhi.
- Peavy, H.S. and Row, D.R. (1984). Environmental Engineering. McGraw-Hill, USA.
- Rao, C.S. (2006). Environmental Pollution Control Engineering. New Age International, New Delhi.
- Trivedi, R.K. and Goel, P.K. (1986). Practical Methods in Ecology and Environmental Science. Environmental Publications, Karad.

MIC-04: Theories of Biomolecules **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- CO1: Students will learn basic structure and function of biomolecules.
- CO2: Students will also understand basic physical & chemical properties of macromolecules**.**
- CO3: Students will learn principles of bioenergetics

Course Content

Unit I: Fundamentals of Biomolecules and Bioenergetics

General concepts of biomolecules; chemical bonds and molecular interactions; structure–function relationship of biomolecules; principles of bioenergetics; laws of thermodynamics; energy transformation in living systems; overview of glycolysis, TCA cycle and electron transport chain.

Unit–II: Carbohydrates

Classification and structure of carbohydrates; monosaccharides and stereochemistry; disaccharides and oligosaccharides; sugar derivatives; homo- and heteropolysaccharides; glycoproteins, proteoglycans and glycosaminoglycans; biological functions of carbohydrates; blood group substances and lectins.

Unit–III: Lipids

Classification, structure and properties of lipids; saturated and unsaturated fatty acids; essential and non-essential fatty acids; phospholipids, glycolipids and sphingolipids; biological functions of lipids.

Unit–IV: Proteins and Nucleic Acids

Classification and chemistry of amino acids; protein structure: primary, secondary, tertiary and quaternary; globular and fibrous proteins; protein folding and molecular chaperones; peptide synthesis; nucleic acids: types, structure and biological functions; A, B and Z forms of DNA.

Lab – 16

- Qualitative tests for carbohydrates.
- Estimation of carbohydrates in a given sample.
- Qualitative tests for proteins and amino acids.
- Estimation of protein concentration.
- Qualitative tests for lipids.
- Determination of fat/lipid content in a food sample.
- Separation of amino acids/sugars by chromatography.
- Isolation and estimation of DNA from biological material.

- Study of factors affecting enzyme activity.
- Demonstration/analysis of major bioenergetic pathways.

Suggested Readings

- Nelson, D.L. and Cox, M.M. (2012) Lehninger's Principle of Biochemistry, W.H. Freeman, New York.
- Voet, D. and Voet, J.G. (2010) Biochemistry. John Wiley and Sons Inc., New Jersey.
- Garrett, R.H. and Grisham, C.M. (2016). Biochemistry, Cengage Learning, Mason. Ohio.
- Berg, J.M., Tymoczko, J.L., Stryer, L. (2011) Biochemistry, W. H. Freeman, New York.
- Harris, D.A. (1995) Bioenergetics at a glance. Willey J. and Sons Inc., New Jersey.

MDC-04: Technique in biotechnology **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: The students acquire the basic knowledge in handling of equipment and its principles*

Course Content

Unit I:

Acid, base and buffers: Definition and theories proposed for acids and bases, titration curves of amino acids, Henderson-Hasselbalch equation and its application. Determination of pH - standard hydrogen electrode, glass electrode. Definition of colloids: types and properties of colloids, colloidal state of membrane.

Unit II:

Colorimetry: Principle, Beer and Lambert laws, instrument and techniques. Spectrophotometry: Description of the instrument - photometer, single beam and dual beam spectrophotometers; FTIR, ESR, NMR.

Chromatography: Principle, types of chromatography: (i) Paper chromatography – separation of amino acids by ascending chromatography, (ii) Adsorption chromatography: Principle and separation of phospholipids, (iii) Ion-exchange chromatography: Principle, resin types and separation of amino acids, proteins, (iv) Affinity chromatography: Principle and separation of enzymes.

Unit III:

Electrophoresis: Principle, types of electrophoresis, separation of serum proteins: (i) moving boundary electrophoresis, (ii) paper electrophoresis, (iii) starch gel electrophoresis, (iv) agar gel electrophoresis. Ag-Ab reaction – Immuno electrophoresis; DNA electrophoresis, DNA ladders, PFGE; Staining methods.

Suggested Readings

- Wilson, K. and Walker, J. Principles and Techniques of Biochemistry and Molecular Biology Cambridge University Press. 2010.
- Morris and Morris Separation methods in Biochemistry. Pitman London, 1960.

MDC-04: Insect Vectors Diseases & Control **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: Student shall be able to Develop awareness about the causative agents and control measures of commonly occurring diseases.*
- *CO2: Develop understanding about the favourable breeding conditions for the vectors.*
- *CO3: Devise strategies to manage the vectors population below threshold levels, public health importance.*

Course Content

Unit I:

Introduction to vectors: Types and morphological peculiarities of vectors such as mosquitoes, flies, fleas, lice, bugs, ticks and mites. Host-vector relationship. Primary and secondary vector concept. Larval habitats and host biting preferences, human and animal biting indices. Vector incrimination. Human practices and the occurrence of pests. Salient features of the vectors belonging to Diptera, Siphonaptera, Siphunculata, Hemiptera, Arachnida, Blattaria, Acarina (families Ixodidae and Argasidae) etc.

Unit II:

Vector and diseases transmission: Role of blood sucking flies, lice and bugs in transmission of plague and typhus, trench fevers, Vagabond's disease and Phthiriasis, Chaga's disease. Brief account of mites and the associated diseases. Physical and biological Control of vector: Physical methods like screening, fly traps, electrocution, light trap etc. Biological control by natural parasites and predators; biological control of mosquitoes by the use of viruses, bacteria, fungi, parasites, nematodes and larvivorous fishes.

Unit III:

Chemical control of vector: Efficacy of synthetic pyrethroids, residual spray of insecticides, treated bed nets/curtains and fumigations. Poison baits and outdoor residual sprays. Sterile insect technique, eradication, pheromones/allelochemicals, mating disruptors, and oviposition disruptors. The Integrated Pest (vector) Management: IPM approach, damage thresholds estimation, forecasting, increasing agroecosystem resistance, Pesticide selection, eradication versus control, up to what limits IPM should be adopted.

Suggested Readings

- Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK.
- Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK.
- Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and other Insect Vector borne Diseases. Wiley-Blackwell.

- Belding, D.L. (1942). Textbook of Clinical Parasitology. Appleton-Century Co., Inc., New York.
- Roy, D.N. & Brown, A.W.A. (2004). Entomology. Biotech Books, Delhi

VAC-04: Disaster and Management Strategies **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: Ability to understand the types and causes of natural and man-made disasters.*
- *CO2: Ability to analyze the impacts of disasters on environment and society.*
- *CO3: Ability to understand disaster management cycle and mitigation strategies.*
- *CO4: Ability to apply preparedness, response, and recovery measures in disaster situations.*

Course Content

Unit I: Introduction to Disasters

Definition and classification of disasters (natural and anthropogenic); Hazards and Disaster, types of natural disasters (earthquakes, floods, cyclones, droughts, landslides); man-made disasters (industrial, chemical, biological); causes and impacts of disasters; vulnerability and risk assessment.

Unit II: Disaster Management Strategies

Disaster management cycle (mitigation, preparedness, response, recovery); early warning systems; disaster risk reduction (DRR); role of government and institutions (NDMA, NDRF); community-based disaster management; climate change and disaster risk; policies and planning for disaster management.

Suggested Readings

- Coppola, D.P. (2015). Introduction to International Disaster Management. Butterworth-Heinemann.
- Dave, R.K., 2018. Disaster management in India: Challenges and strategies. Prowess Publishing.
- Gupta, H.K. (2010). Disaster Management. Universities Press, Hyderabad.
- Singh, R.B. (2006). Natural Hazards and Disaster Management. Rawat Publications, Jaipur.
- Subramanian, R., 2018. Disaster management. Vikas Publishing House.
- Wisner, B. et al. (2004). At Risk: Natural Hazards, People's Vulnerability and Disasters. Routledge.

VAC-04: Ecology and environment **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: Students will understand development of animals like chick and frog.*
- *CO2: Students will be able to better understand the diverse relationships that the organisms have in the environment.*
- *CO3: Students will learn about the major events in history of life and major theories of evolution.*
- *CO4: Students will learn about fundamental concepts of natural selection, speciation, mass extinction and macro-evolution.*

Course Content

Unit I:

Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of following ecosystem a) Forest ecosystem, b) grass land ecosystem c) Desert ecosystem, d) Aquatic ecosystems (ponds, stream, lakes, river, oceans, estuaries***.***

Unit II:

Environment ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone, layer depletion, nuclear accidents and holocaust, environment protection act of air, water, forest and wild life with prevention and control of pollution.

Suggested Readings

- Agarwal KC, 2001, Environmental Biology, Nidhi publ. Ltd, Bikaner
- Brunner R.C.., 1998, Hazardous Waste Incineration, Me Sray Hill inc
- Cunningham W.P., Cooper TH et al., 2001, Environmental Encyclopaedia, Jaico publ. House, Mumbai.
- Wagner K.D.., 1998, Environmental management, W.B. Saunders Co. Philadelphia, USA.
- Trivedi R.K. handbook of environment law, rules, guidelines, Compliances and Standers, Vol I and II, Enviro. Media

SEC-04: Fermentation Technology **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: The students would know about the history, scope, and future prospects of fermentation microbiology and analyze microbial growth, death rates, and classification of food fermentations.*
- *CO2: The students would know about compare aerobic and anaerobic fermentation processes and various fermentation techniques*
- *CO3: An understanding about key components of fermenters and their functions and different types of fermenters based on operational principles.*

Course Content

Unit I:

Introduction to fermentation, Fermentation an ancient tradition, Developments in fermentation technology, Scope and future prospects of fermentation microbiology, Rate of microbial growth and death, Classification of food fermentations - Alcoholic, lactic and acetic acid fermentations

Unit -II*:*

General methods of fermentation – Aerobic fermentation, Anaerobic fermentation, Solid state fermentation, and submerged fermentation, Batch and continuous fermentation. Fermenter/Bioreactors: Component of a fermenter, Types of fermenter, Application of fermenter in biomass production

Suggested Readings

- Biotechnology: Food Fermentation by VK Joshi & Ashok Pandey.
- Charles W. Bamforth. Food, Fermentation and Microorganisms. Blackwell Publishing (2005).
- Comprehensive Biotechnology by Moo and young (4 volumes).
- Michael J. Waites et al., Industrial Microbiology: An Introduction. Blackwell Science.
- Principles of Fermentation Technology by Stanbury and Whittaker.

SEC-04: Genetic Engineering **CR-02 (Hr - 2; L-2, T-0, P-0)**

Course Outcome

- *CO1: The Demonstrate a thorough understanding of the fundamental principles and techniques of genetic engineering.*
- *CO2: Apply the knowledge of genetic engineering to diverse applications in agriculture, medicine, biotechnology, and environmental science.*
- *CO3: Perform laboratory procedures and develop practical skills in genetic engineering techniques.*

Course Content

Unit I:

Definition, scope, and historical overview of genetic engineering. Importance and applications in various fields. Isolation techniques of DNA and RNA- Techniques for DNA isolation and purification methods (Plants, animals, microorganisms and plasmids) and RNA. Methods for quantification and characterization.

Recombinant DNA technology – Introduction to molecular cloning. Prokaryotic and eukaryotic host cell. Overview of cloning vectors. Plasmids, phage, cosmid, BAC, and YAC. Features and applications of cloning vectors in genetic engineering. Enzymes used in recombinant DNA technology: Restriction endonucleases, Polymerases, Ligase, kinases, and phosphatases. Expression vectors.

Unit -II*:*

Gene library: Types and applications. Genome Editing - Introduction to genome editing techniques- Principles and applications of genome editing techniques- CRISPR-Cas9 and Site-directed mutagenesis. Overview of the diverse applications of genetic engineering. DNA fingerprinting and its applications in forensics. Production of biopharmaceuticals using recombinant DNA technology.

Suggested Readings

- Gene Cloning and DNA Analysis: An Introduction (2019) 7th ed., Brown, TA, Wiley Blackwell, ISBN: 978-1119072560.
- Genome 4 (2017) 4th ed., Brown, TA, Garland Science, ISBN: 978-0815345084.
- Genomics and Personalized Medicine: What Everyone Needs to Know (2016) 1st ed., Snyder, M, OUP-USA, ISBN: 978-0190234768.
- Introduction to Genomics (2015) 2nd ed., Lesk, AM, Oxford University Press India, ISBN: 978-0198745891.
- Molecular Biology of the Gene (2014) 7th ed., Watson, JD, Baker, TA, Bell, SP, Gann, A, Levine, M, and Losick, R, Pearson, ISBN: 978-0321762436.

- Principles of Gene Manipulation and Genomics (2016) 8th ed., Primrose, SB, and Twyman, R, Wiley Blackwell, ISBN: 978-1405156660.

Semester Wise Scheme and Syllabus of B.Sc.-M.Sc. Lifesciences (Integrated)

Semester - 5

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
DSC-13	Plant Physiology and Biochemistry	BSC+MSC/BOT/DSC-105	3	0	2	3	0	1	04					**100**
DSC-14	Organic Chemistry - II	BSC+MSC/CHEM/DSC-105	3	0	2	3	0	1	04					**100**
DSC-15	Aquaculture and Pest management	BSC+MSC/ZOO/DSC-105	3	0	2	3	0	1	04					**100**
MIC-05	Climate Change: Causes and Consequences	BSC+MSC/EVS/MIC-103	3	0	2	3	0	1	04					**100**
MDC -05	Government Initiatives for Environmental Protection Or Chemistry of Biomolecules	BSC+MSC/EVS/MDC-103 Or BSC+MSC/CHEM/MDC102	3	0	0	3	0	0	03					**75**
SEC-05	Environmental Monitoring of Air and Noise	BSC+MSC/EVS/SEC-102	3	0	0	3	0	0	03					**75**
INTR -01*	Internship	BSC+MSC/EVS/INT-101	2	0	4	2	0	4	04					**50**
Total Credits									**26**					**650**

DSC-13: Plant Physiology and Biochemistry **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Importance of water and the mechanism of transport.*
- *CO2: To understand biosynthesis and breakdown of biomolecules.*
- *CO3: Role of plant hormones in plant development and about secondary metabolites*
- *CO4: To understand the importance of nutrients in plant metabolism and crop yield.*

Course Content

Unit I:

Plant water relations: Diffusion, osmosis, imbibition, osmotic pressure, osmotic potential, turgor pressure and wall pressure. Mechanism of water absorption, Factors affecting water absorption. Transpiration. Types and process, Mechanism of guard cell movement, K+ ion mechanism, Anti transpirants. Mechanism of ascent of sap: Vital and physical force theories. Phloem Transport: Transport of organic solutes. Path of transport, vein loading and unloading. Transcellular hypothesis, mass flow hypothesis.

Unit II:

Photosynthesis: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3,C4 and CAM pathways of carbon fixation; Photorespiration. Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Oxidative Pentose Phosphate Pathway.

Unit III:

Plant growth regulators: Definition and classification, site of synthesis, biosynthesis pathway and influence on plant growth development-Auxins, Gibberellins, cytokinins, ABA and ethylene. Sensory Photobiology: Biological clocks, photoperiodism, function & structure of phytochromes, phototropins &cryptochromes. Senescence and aging.

Unit IV:

Biomolecules: Classification and functions of Carbohydrates. Enzymes: Classification, kinetics and mechanism of action. Proteins and amino acids: Classification, structure-primary, secondary, tertiary and quaternary. Classification of Amino acids. Lipids: Classification, structure, function and biosynthesis of fatty acids.

Lab – 17

1. Experiment to demonstrate the phenomenon of exosmosis and endosmosis.
2. To determine the osmotic pressure of the cell sap by plasmolytic method.
3. To demonstrate root pressure/transpiration pull in plants.
4. To demonstrate that oxygen is liberated in the process of photosynthesis.

5. Separation of photosynthetic pigments by paper chromatography.
6. Estimation of total chlorophyll content by Arnon method.
7. To isolate and identify the amino acids from a mixture using paper chromatography.
8. To Study of Phototrophism.
9. Qualitative test for Starch, Protein, Reducing Sugars and Lipids

Suggested Readings

- Fundamentals of Biochemistry 2nd Ed, John Wiley and Sons Inc. Wilson, K. and Walker, J. 1994.
- JainV K, 2008. Fundamentals of Plant Physiology.S Chand and Co.
- Kochhar P L, Krishnamoorthy H N. Plant Physiology. Atmaram and sons, Delhi.
- Kumar and Purohit. 2002. Plant Physiology: Fundementals and Applications. Agrobotanical Publishers.
- Malik CP, 2002. Plant Physiology. Kalyani publishers.
- Sinha A K, 2004. Modern Plant Physilogy. Narosa publishing House, New Delhi.
- Srivastava H S, 2004. Plant physiology and Biochemistry. Rasthogi publications.
- Verma V, 2007. Text Book of Plant Physiology. Ane Books Pvt. Ltd.

DSC-14: Organic Chemistry – II **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Ability to understand basic chemistry of nitrogen-containing and heterocyclic compounds.*
- *CO2: Ability to explain fundamental principles of organic spectroscopy.*
- *CO3: Ability to understand structure and functions of biomolecules.*
- *CO4: Ability to relate organic chemistry with biological and pharmaceutical applications.*

Course Content

Unit I: Nitrogen Compounds and Heterocyclic Chemistry

Nitro compounds and amines: preparation and basic reactions; basicity of amines (qualitative idea).

Diazonium salts: preparation and simple synthetic applications.

Heterocyclic compounds: introduction, classification and aromaticity (basic idea).

Simple heterocycles: pyrrole, furan, thiophene and pyridine (structure and basic reactions).

Unit II: Spectroscopy (Basic Principles and Applications)

Introduction to spectroscopy: absorption and emission (basic idea).

UV spectroscopy: electronic transitions and chromophores (introductory concept).

IR spectroscopy: functional group identification (basic idea).

NMR spectroscopy: chemical shift and simple interpretation of spectra.

Application of UV, IR and NMR in identification of simple organic compounds.

Unit III: Biomolecules

Carbohydrates: classification and biological importance; structure of glucose (basic idea).

Amino acids and proteins: structure, properties and classification; peptide bond (introductory).

Lipids: fats and oils, properties and importance.

Basic concept of enzymes and their functions.

Nucleic acids: basic structure of DNA and RNA.

Basic metabolism: concept of energy, ATP (introductory idea).

Unit IV: Applied Organic Chemistry

Introduction to drugs and pharmaceuticals: simple examples (paracetamol, ibuprofen – uses only).

Introduction to polymers: classification and common applications (basic idea).

Lab – 18

1. ***Qualitative Analysis***
    - Functional group tests (amines, amides, nitro compounds)
    - Identification of simple organic compounds
2. ***Biochemical Experiments (Basic)***
    - Estimation of amino acids (glycine)
    - Study of enzyme activity (amylase)
    - Determination of saponification value of fats
3. ***Preparations***
    - Preparation of azo dye (methyl orange)
    - Simple organic synthesis
4. ***Spectroscopy (Introductory)***
    - Identification of compounds using IR/NMR spectra (given data)

Suggested Readings

- Acheson, R.M., 1967. An Introduction to the Chemistry of Heterocyclic compounds.
- Ahluwalia, V.K. (2000). Comprehensive Practical Organic Chemistry**.**
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
- Billmeyer, F. W. Textbook of Polymer Science, John Wiley & Sons, Inc.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Finar, I.L. (2006). Organic Chemistry (Vol. I&II). Pearson.
- Furniss, B.S. et al. (2012). Practical Organic Chemistry. Pearson.
- Gowariker, V. R.; Viswanathan, N. V. &Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.
- Kalsi, P.S., 2007. Spectroscopy of organic compounds. New age international.
- Morrison, R.T. and Boyd, R.N. (2010). Organic Chemistry. Pearson.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.
- Nelson, D.L. and Cox, M.M. (2009). Lehninger Principles of Biochemistry.
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010).
- Solomons, T.W.G. (2011). Organic Chemistry. Wiley.

DSC-15: Aquaculture and pest management **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcomes (CO)

- *CO1: Students will understand about fresh water fishes of India.*
- *CO2: Students will capable to undertake about fishing crafts and gears and will make the students understand about the seed production in fishes.*
- *CO3: Students will be able to explain the culture technology in fishery and will be able to identify fish specimens.*

Course Content

Unit I: Introduction to world fisheries:

Production, utilization and demand, Major species cultured Fresh Water fishes of India: River system, reservoir, pond, tank fisheries; captive and culture fisheries, cold water fisheries. Fishing crafts and gears. Fin fishes, Crustaceans, Molluscs and their culture. Traits of important cultivable fish and shellfish and their culture methods – Indian major carps, exotic carps, air breathing fishes, cold water fishes, freshwater prawns, mussels.

Unit II: Seed production

Natural seed resources – its assessment, collection, Hatchery production Nutrition: Sources of food (Natural, Artificial) and feed composition (Calorie and Chemical ingredients). Field Culture: Culture, Culture in Pond-running waters; recycled water culture, cage culture; poly culture. Culture technology: Induced breading in fishes, techniques and hormones; Fish Biotechnology (Transgenesis and Cryopreservation of gametes).

Unit III: Study of important insect pests of crops and vegetables:

Sugarcane: (With their systematic position, habits and nature of damage caused.

(a) Sugarcane leaf-hopper (*Pyrilla perpusilla*)

(b) Sugarcane Whitefly (*Aleurolobus barodensis*)

(c) Sugarcane top borer (Sciropophaga nivella)

(d) Sugarcane root borer (Emmalocera depresella)

(e) Gurdaspur borer (Bissetia steniellus)

Life cycle and control of Pyrilla perpusilla only. Cotton: (With their systematic position, habits and nature of damage caused.

(a) Pink bollworm (*Pestinophora gossypfolla*)

(b) Red cotton bug (*Dysdercus cingulatus*)

(c) Cotton grey weevil (*Myllocerus undecimpustulatus*)

(d) Cotton Jassid (*Amrasca devastans*)

Life cycle and control of *Pectinophore gossypiella*

Unit IV: Pest control

Biological control, its history, requirement and precautions and feasibility of biological agents for control. Chemical control: History, Categories of pesticides, important pesticides from each category to pests against which they can be used, insect repellents and attractants. Integrated pest management.

Lab – 19

1. External morphology, identification marks, nature of damage and host of the following pests: -
    - Sugarcane: Sugarcane leaf-hopper, Sugarcane whitefly, Sugarcane top borer, Sugarcane root borer, 30 Gurdaspur borer (any two).
    - Cotton: Red Cotton bug
2. Stages of life history of silk moth and honey bee.
3. Preparation of permanent/temporary slides for identification of mosquitoes.

Suggested readings:

- Arumugam N. (2014). Aquaculture and Fisheries, Saras Publication
- Bardach, JE, Ryther & McLarney, Wo (1972) Aquaculture, New York: Wiley-Interscience. 896pp.
- David Dent, Richard Binks (2020). Insect Pest Management CABI Publishing; 3rd edition.
- John R. Ruberson (2019) Handbook of Pest Management, CRC Press; 1st edition.
- Kalatia M.K. (2021) Introduction to principles of pest and disease management; Walnut Publication.
- Khanna S S, & Singh H R (2014). Textbook of Fish Biology and Fisheries 3rd edn. Narendra Publishing House.
- Lagler, KF, Bardach, JE, Miller, RR & Passino, DRM (1977) Ichthyology, 21nd Edition, New York, Wiley, 506 pp.
- Smith K M (2013) A Textbook of Agricultural Entomology by Hill, Cambridge University Press

MIC-05: Climate Change: Causes and Consequences CR-04 (Hr - 5; L-3, T-0, P-2)

Course Outcome

- *CO1: Ability to understand the scientific basis of climate change and its driving factors.*
- *CO2: Ability to analyze the causes and impacts of climate change on natural and human systems.*
- *CO3: Ability to evaluate mitigation and adaptation strategies for climate change.*
- *CO4: Ability to interpret climate data and assess global and regional climate trends*.

Course Content

Unit I: Climate Change and its Causes

Definition and concepts of climate and weather; historical perspective of climate change; greenhouse effect; major greenhouse gases; global warming and its indicators.

Natural causes (volcanic activity, solar radiation, orbital variations); anthropogenic causes (fossil fuel burning, deforestation, industrialization); carbon cycle and its imbalance; role of aerosols and land-use changes.

Unit III: Impacts of Climate Change

Impacts on ecosystems, biodiversity and agriculture; sea-level rise and melting glaciers; extreme weather events; impacts on human health and water resources; regional impacts with special reference to India.

UNIT–III: Climate Data, Trends and Vulnerability

Sources of climate data and basic climate indicators; analysis of temperature and precipitation trends; climate variability and extremes; climate projections and scenarios; climate vulnerability, exposure, and adaptive capacity; climate risk assessment; regional climate change assessment with special reference to India.

Unit IV: Mitigation and Adaptation Strategies

Climate change mitigation (renewable energy, carbon sequestration, energy efficiency); adaptation strategies; international agreements (UNFCCC, Kyoto Protocol, Paris Agreement); climate policies and sustainable development.

Lab – 20

- Analysis of long-term temperature trends.
- Analysis of rainfall variability and trends.
- Calculation of temperature and rainfall anomalies.
- Analysis of extreme weather events.
- Study of greenhouse-gas concentration trends.

- Assessment of glacier/land-cover change using satellite data.
- Climate vulnerability assessment of a selected region.
- Preparation of a basic climate risk map using GIS.
- Calculation of individual/institutional carbon footprint.
- Preparation of a climate change mitigation and adaptation plan.

Suggested Readings

- Archer, D. (2012). Global Warming: Understanding the Forecast. Wiley-Blackwell.
- Cunningham, W.P. and Cunningham, M.A. (2012). Environmental Science: A Global Concern. McGraw-Hill, USA.
- Dessler, A.E. (2016). Introduction to Modern Climate Change. Cambridge University Press.
- IPCC (2014). Climate Change: Synthesis Report. Intergovernmental Panel on Climate Change.
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi.
- Lal, R. et al. (2011). Climate Change and Food Security. Springer.
- Miller, G.T. and Spoolman, S. (2014). Environmental Science. Brooks/Cole, USA.
- Sharma, P.D. (2013). Ecology and Environment. Rastogi Publications, Meerut.
- Singh, J.S., Singh, S.P. and Gupta, S.R. (2014). Ecology, Environmental Science and Conservation. S. Chand, New Delhi.

MDC-05: Government Initiatives for Environmental protection CR-03 (Hr - 3; L-3, T-0, P-0)
Course Outcome

- *CO1: Ability to understand various government initiatives and policies for environmental protection.*
- *CO2: Ability to analyze national programs and institutional frameworks for environmental management.*
- *CO3: Ability to evaluate the effectiveness of government schemes in conservation and sustainability.*
- *CO4: Ability to assess the role of governance in addressing environmental challenges.*

Course Content

Unit I: Environmental Governance in India

Concept of environmental governance; role of central and state governments; institutional framework (MoEFCC, CPCB, SPCBs); environmental planning and policy-making; role of local bodies in environmental management.

Unit II: National Environmental Programs and Initiatives

Major government initiatives: National Action Plan on Climate Change (NAPCC); Swachh Bharat Mission; National Afforestation Programme; Namami Gange Programme; National Biodiversity Action Plan; renewable energy and clean energy initiatives; waste management rules and policies.

Unit III: Policies, Implementation and Challenges

Implementation of environmental policies; monitoring and evaluation of programs; public participation and awareness; role of NGOs and stakeholders; challenges in policy implementation; future strategies for sustainable environmental governance.

Suggested Readings

- Divan, S. and Rosencranz, A. (2001). Environmental Law and Policy in India. Oxford University Press, New Delhi.
- Government of India (2015). National Action Plan on Climate Change (NAPCC)
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi. Devi Rani (2023).
- Ministry of Environment, Forest and Climate Change (MoEFCC) Reports and Publications
- Shastri, S.C. (2012). Environmental Law. Eastern Book Company, Lucknow.
- Socio-Environmental Conditions and Policies of Government and its Impact on Environment, Arihant Books, New Delhi, India.
- UNEP (2019). Global Environment Outlook.

MDC 05: Chemistry of Biomolecules **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: Understand the structure and classification of major biomolecules.*
- *CO2: Explain chemical properties and functions of carbohydrates, proteins, and lipids.*
- *CO3: Describe the structure and role of nucleic acids and enzymes.*
- *CO4: Analyze the importance of biomolecules in biological systems and metabolism.*

Course Content

Unit I: Carbohydrates and Lipids

Introduction to Biomolecules- Definition, classification and biological importance;

Carbohydrates- Classification (mono-, di-, polysaccharides); structure and properties of glucose and fructose; concept of epimers and anomers;

Disaccharides (sucrose, lactose, maltose) and polysaccharides (starch, cellulose, glycogen);

Lipids- Classification (simple, compound, derived lipids); fatty acids; structure and functions of triglycerides, phospholipids and steroids;

Properties of lipids- saponification, rancidity and hydrogenation.

Unit II: Amino Acids, Proteins and Enzymes

Amino acids- Classification, structure, zwitterion, isoelectric point;

Peptides and proteins- Structure and classification; primary, secondary, tertiary and quaternary structure of proteins;

Properties and functions of proteins; denaturation;

Enzymes- Introduction, classification and mechanism of enzyme action; factors affecting enzyme activity; coenzymes and cofactors.

Unit III: Nucleic Acids and Metabolism

Nucleic acids- Components (nucleosides and nucleotides); structure of DNA and RNA;

Functions of nucleic acids; basic concepts of replication and transcription;

Bioenergetics- ATP as energy currency;

Introduction to metabolism- catabolism and anabolism;

Overview of major metabolic pathways (glycolysis, Krebs cycle);

Role of biomolecules in living systems and health.

Suggested Readings

- Berg, J.M.; Tymoczko, J.L.; Stryer, L. Biochemistry, W.H. Freeman.
- Conn, E.E.; Stumpf, P.K. Outlines of Biochemistry, Wiley.
- Jain, J.L.; Jain, S.; Jain, N. Fundamentals of Biochemistry, S. Chand.
- Nelson, D.L.; Cox, M.M. Lehninger Principles of Biochemistry, W.H. Freeman.
- Plummer, D.T. An Introduction to Practical Biochemistry, McGraw Hill.
- Rastogi, S.C. Biochemistry, Tata McGraw Hill.
- Voet, D.; Voet, J.G. Biochemistry, Wiley.

SEC-05: Environmental Monitoring of Air and Noise **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: Ability to understand the principles of air and noise pollution monitoring.*
- *CO2: Ability to analyze different air pollutants and noise parameters and their impacts.*
- *CO3: Ability to use basic instruments and techniques for environmental monitoring.*
- *CO4: Ability to interpret monitoring data and suggest control measures.*

Course Content

Unit I: Fundamentals of Air and Noise Pollution

Introduction to air pollution: sources, types and classification of air pollutants; primary and secondary pollutants; effects on human health and environment; introduction to noise pollution: sources, types and impacts; standards for air and noise quality.

Unit II: Monitoring Techniques and Instruments

Air quality monitoring: sampling methods (stack and ambient air monitoring); measurement of particulate matter (PM_{10}, $PM_{2.5}$), SO_2, NO_x, CO; noise monitoring: sound level meter, noise indices (Leq, dB scale); calibration and data collection techniques**.**

Unit III: Data Analysis and Control Measures

Interpretation of air and noise quality data; air quality index (AQI); noise standards and regulations; control and mitigation measures for air and noise pollution; role of regulatory agencies and environmental monitoring programs.

Suggested Readings

- APHA (2005). Standard Methods for the Examination of Water and Wastewater. American Public Health Association, USA.
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi.
- Miller, G.T. and Spoolman, S. (2014). Environmental Science. Brooks/Cole, USA.
- Peavy, H.S. and Row, D.R. (1984). Environmental Engineering. McGraw-Hill, USA.
- Rao, C.S. (2006). Environmental Pollution Control Engineering. New Age International, New Delhi.
- Trivedi, R.K. and Goel, P.K. (1986). Practical Methods in Ecology and Environmental Science. Environmental Publications, Karad.

Semester Wise Scheme and Syllabus of B.Sc.-M.Sc. Lifesciences (Integrated)

Semester - 6

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
DSC-16	Applied Botany and Plant Tissue Culture	BSC+MSC/BOT/DSC-106	3	0	2	3	0	1	04					**100**
DSC-17	Physical Chemistry - II	BSC+MSC/CHEM/DSC-106	3	0	2	3	0	1	04					**100**
DSC-18	Developmental and evolutionary Biology	BSC+MSC/ZOO/DSC-106	3	0	2	3	0	1	04					**100**
MIC-06	Basics of Molecular Biology OR Fundamentals of Food Microbiology	BSC+MSC/DBT/MIC-102 Or BSC+MSC/FST/MIC-102	3	0	2	3	0	1	04					**100**
MDC -06	Fundamentals of Environmental Chemistry Or Functional Foods and Nutraceuticals	BSC+MSC/CHEM/MDC101 Or BSC+MSC/FST/MDC-102	3	0	0	3	0	0	03					**75**
SEC-06	Integrated Resource Management OR Green Economy	BSC+MSC/EVS/SEC-103 or BSC+MSC/EVS/SEC-104	3	0	0	3	0	0	03					**75**
Total Credits									**22**					**550**

Note:

- *Internship or field training or project of 4-6 weeks during summer vacation @ 4 credits.*
- *Students will be awarded 3 years UG Degree in relevant major Discipline/Subject upon securing 136 credits.*

Prerequisite: Students are required to opt for at least 3 MDC courses, 4 SEC courses, 4 VAC courses and 4 AEC courses across Semesters I–VI.

DSC-16: Applied Botany and Plant Tissue culture **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Understand the significance and role of botany*
- *CO2: Gain the knowledge about employments or startup opportunities in the field of botany*
- *CO3: Understand the historical development, media composition, and fundamental concepts of plant tissue culture including totipotency, organogenesis, embryogenesis, and protoplast techniques*
- *CO4: Apply tissue culture techniques for micropropagation, and germplasm conservation*

Course Content

Unit I:

Introduction, objective and importance of applied botany, History and evolution of botany

Phytoremediation: Air, water, soil, noise and thermal pollutants (any 5 plants with botanical name, family) and their role in pollution control

Unit II:

Ancient agricultural practices. Modern agriculture practices: polyhouse, drip irrigation, hydroponics, computer-based agriculture, terrace farming., Organic farming: introduction, objective and brief technique

Horticulture: definition and role in human welfare, Forestry: definition, branches and role in human welfare , Silviculture: definition and management practices

Unit III:

Plant Tissue Culture Introduction; Sterilization techniques, preparation and Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion

Unit IV:

Tissue culture applications (micropropagation, and regeneration, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation, Germplasm Conservation)

Lab – 21

1. Preparation of soil health card of any agricultural field
2. Study of vermicompost and composting of kitchen waste
3. Preparation of MS medium.

4. Demonstration of in vitro sterilization and inoculation methods using leaf explants of Datura, or Brassica.
5. Study of anther, embryo and endosperm culture micro propagation

Suggested Readings

- Bhojwani, Sant Saran, and Prem Kumar Dantu. *Plant tissue culture: an introductory text*. Vol. 318. India: Springer, 2013.
- Levetin E. And Mcmahon K. “Plants and Society” Mc Graw Hill Education. 2007
- Maiti R., Rodrigues H.G. and Thakur A.S. “Applied Botany” American Academic Press.2017
- Razdan, Maharaj K. *An introduction to plant tissue culture*. Oxford and IBH publishing, 2002.

DSC-17: Physical Chemistry – II **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: Ability to understand phase equilibria and thermodynamic systems.*
- *CO2: Ability to apply electrochemical principles and conductance concepts.*
- *CO3: Ability to understand chemical kinetics and surface phenomena.*
- *CO4: Ability to explain quantum chemistry and spectroscopic techniques.*

Course Content

Unit I: Phase Equilibria and Surface Chemistry

Phase Equilibria: Concept of phases, components and degrees of freedom***;*** Gibbs Phase Rule (derivation and applications)***;*** Clausius–Clapeyron Equation and its applications

One and Two Component Systems: Phase diagrams of one-component systems (H_2O, S)***;*** Two-component systems: eutectic, congruent and incongruent melting points***.***

Binary and Ternary Systems: Partially miscible liquids, critical solution temperature (CST)***;*** Azeotropes and fractional distillation***;*** Nernst Distribution Law and applications***;*** Ternary systems (triangular diagrams – basic idea)

Surface Chemistry: Adsorption: physisorption and chemisorption; Adsorption Isotherms: Langmuir and Freundlich; Qualitative idea of BET theory

Unit II: Electrochemistry and Conductance

Electrochemical Cells: Oxidation–reduction reactions and half-cell potentials

Types of cells: reversible and irreversible; EMF of a Cell and its measurement; Nernst Equation and applications

Electrode Systems: Standard electrode potentials

Electrodes: hydrogen, glass (basic applications in pH determination)***;*** Concentration cells (basic concept)

Applications of EMF: Determination of free energy and equilibrium constant***;*** pH determination***.***

Conductance: Conductivity, molar conductivity and their variation with dilution***;*** Kohlrausch's Law of Independent Migration of Ions**;** Ionic mobility and transference number (basic idea)

Applications of Conductance: Degree of dissociation; Ionic product of water; Solubility product; Conductometric titrations.

Unit III: Chemical Kinetics and Photochemistry

Chemical Kinetics: Rate of reaction, order and molecularity*;* Integrated rate equations (up to second order)*;* Methods of determining rate laws*.*

Complex Reactions: Parallel and consecutive reactions (basic idea)*;* Chain reactions (introductory)

Temperature Dependence: Arrhenius Equation and activation energy*;* Collision theory (qualitative)*.*

Catalysis: Types of catalysis; Mechanism of catalytic reactions; Enzyme catalysis (Michaelis–Menten mechanism, basic idea).

Photochemistry: Laws of Photochemistry; Lambert–Beer Law and limitations; Quantum yield and photochemical reactions; Photosensitization and quenching (basic idea).

Unit IV: Quantum Chemistry and Spectroscopy

Quantum Chemistry: Postulates of quantum mechanics*;* Schrödinger Equation (basic applications)*;* Particle-in-a-box model and energy quantization*;* Heisenberg Uncertainty Principle*.*

Atomic and Molecular Models: Harmonic oscillator and rigid rotator (qualitative idea)*;* Hydrogen atom (basic concept)*.*

Chemical Bonding (Quantum Approach): Valence bond and molecular orbital theory (basic comparison)*;* LCAO-MO approach (qualitative idea)*.*

Molecular Spectroscopy: Interaction of radiation with matter*;* Born–Oppenheimer Approximation*.*

Types of Spectroscopy: Rotational and Vibrational Spectroscopy (basic concepts)*;* Raman Spectroscopy (introductory)*;* Electronic Spectroscopy -Franck–Condon principle*.*

Magnetic Resonance: NMR Spectroscopy- chemical shift and basic interpretation*;* ESR Spectroscopy - basic principle.

Lab - 22

1. ***Phase Equilibria***
    - CST determination (phenol–water system)
    - Phase diagram (eutectic systems)
    - Distribution law experiments
2. ***Electrochemistry***
    - Potentiometric titrations
    - Conductometric titrations
    - Determination of conductivity and dissociation constant
3. ***Chemical Kinetics***

- Kinetics of ester hydrolysis and redox reactions

4. ***Spectroscopy and Colorimetry***
    - Verification of Lambert–Beer Law
    - Determination of concentration using colorimetry
    - UV-Visible spectral studies
5. ***Adsorption***
    - Verification of Langmuir and Freundlich isotherms

Suggested Readings

- Assael, M.J., Maitland, G.C., Maskow, T., von Stockar, U., Wakeham, W.A. and Will, S., 2022. Commonly asked questions in thermodynamics. CRC Press.
- Atkins, P. & de Paula, J. Physical Chemistry
- Banwell, C.N. and McCash, E.M., 2017. Fundamentals of molecular spectroscopy. Indian Edition.
- Banwell, C.N. Fundamentals of Molecular Spectroscopy
- Castellan, G.W. Physical Chemistry
- Chandra, A.K., 1974. Introductory quantum chemistry.
- Engel, T. & Reid, P. Physical Chemistry
- Garland, C.W. Experiments in Physical Chemistry
- Halpern, A.M. Experimental Physical Chemistry
- House, J.E., 2004. Fundamentals of quantum chemistry. Academic Press.
- Kakkar, R., 2015. Atomic and Molecular Spectroscopy. Cambridge University Press.
- Khosla, B.D. Senior Practical Physical Chemistry
- McQuarrie, D.A. and Simon, J.D., 2004. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi.
- Rogers, D.W., 2011. Concise physical chemistry. John Wiley & Sons.
- Silbey, R.J., Alberty, R.A., Papadantonakis, G.A. and Bawendi, M.G., 2022. Physical chemistry. John Wiley & Sons.

DSC-18: Developmental and evolutionary Biology **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcomes (CO)

- *CO1: Students will understand development of animals like chick and frog.*
- *CO2: Students will be able to better understand the diverse relationships that the organisms have in the environment.*
- *CO3: Students will learn about the major events in history of life and major theories of evolution.*
- *CO4: Students will learn about fundamental concepts of natural selection, speciation, mass extinction and macro-evolution.*

Course Content

Unit I:

History & Basic concepts of development: Overview of how the modern era of developmental biology emerged through multidisciplinary approaches stages of development- zygote, blastula, gastrula ,neurula cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation ,lineages of three germ layers, fate map Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development Pattern formation-- axis specification, positional identification (regional specification) Morphogenetic movements Model organisms in Developmental biology

Unit II:

Early Development in invertebrate /vertebrate models Drosophila, C. elegans, Xenopus, Mouse/ human Cleavage, gastrulation, Axis specification (Dorsoventral, anterior posterior), & body plan patterning, left right asymmetry in vertebrates. Late Development in invertebrate /vertebrate models; Organogenesis- development of central nervous system in vertebrates, vulval formation in C. elegans

Unit III

Introduction to Evolutionary Biology: A brief history of Evolutionary Thought, Darwinism, The nature of Natural Selection. Evolutionary History of Life on Earth: Origin of Life, Pre-cambrian evolution, Cambrian Explosion and future radiation.

Unit IV

Phylogeny of horse, process of evolutionary changes, Direct evidences of evolution: types of fossils, incompleteness of fossil record, dating of fossils, Species concept and extinction:

biological species concept with advantage and limitations, Mass extinction, their causes and five major extinctions

Lab – 23

1. Identification of developmental stages of chick and frog embryo using permanent mounts.
2. Types of eggs based on quantity and distribution of yolk
3. Study of the developmental stages of Drosophila from stock culture/ photographs.
4. Study of different types of placentas.
5. Study of homologous and analogous organs.
6. The study of fossils and vestigial organs.
7. Study of adaptive radiations

Suggested readings

- Balinsky, B.I. (2012). An introduction to Embryology, Cengage Learning India
- Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.
- Developmental Biology, Eighth Edition" by Scott F Gilbert.
- Developmental Biology, Werner A Muller
- Essential Developmental Biology by Jonathan Slack
- Mayr, E. Systematics and the Origin of Species, Columbia Univ. Press, 1942.
- Mayr: Animal Species and Evolution. Belknap Press, 1966.
- Moody: Introduction to evolution (Indian Edition) Kalyani Publ., 1978.
- Richard Swann Lull: Organic Evolution Seema Publications, 1976
- Strick Berger: Evolution, (Indian Edition). CBS Publ., 1994.
- V.B.Rastogi; Organic Evolution, Kedar Nath Ram Nath Publication, Meerut

MIC-06: Basics of Molecular biology **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcomes (CO)

- *CO1: Ability to Understand the core molecular processes of DNA replication, transcription, and translation to explain how genetic information drives cellular life.*
- *CO2: To develop technical proficiency in experimental tools like PCR and cloning, enabling students to interpret genomic data and solve research problems.*
- *CO3: Student will learn how to use common lab tools like PCR and gel electrophoresis to study genes and analyze simple biological data.*

Course Content

Unit I:

Historical developments of molecular biology; Nucleic acids as genetic material; Chemistry, structure and properties of DNA and RNA.

Genome organization in prokaryotes and eukaryotes; Chromatin structure and function; DNA replication; DNA polymerases, topoisomerases, DNA ligase, etc; Molecular basis of mutations; DNA repair mechanisms.

***Unit II*:**

Transcription process; RNA processing; Reverse transcriptase; RNA editing; Ribosomes structure and function; Organization of ribosomal proteins and RNA genes; Genetic code; Aminoacyl tRNA synthases.

Unit III:

Translation and post-translational modifications; Operon concept; Attenuation of trp operon; important features of gene regulation in eukaryotes.

Unit–IV:

Molecular Biology Techniques and Applications: DNA and RNA isolation; agarose gel electrophoresis; PCR and its applications; DNA cloning and recombinant DNA technology; restriction enzymes and vectors; DNA sequencing and basic genomic analysis; applications of molecular biology in research, medicine, and biotechnology.

Lab – 24

- Isolation of genomic DNA from plant/animal material.
- Qualitative and quantitative assessment of isolated DNA.
- Isolation of RNA from biological material through demonstration.
- Preparation and analysis of agarose gel electrophoresis.
- Demonstration of PCR and interpretation of PCR results.

- Restriction digestion of DNA and analysis by gel electrophoresis.
- Demonstration of DNA cloning using a suitable vector.
- Study of DNA sequence/chromatogram data.
- Bioinformatics-based analysis of a nucleotide or protein sequence.
- Analysis and interpretation of molecular biology experimental data.

Suggesting readings

- Lewin B. 2008. Gene IX. Peterson Publications/ Panima.
- Malacinski GM & Freifelder D. 1998. Essentials of Molecular Biology. 3rd Ed. Jones & Bartlett Publishers.
- Nelson DL & Cox MM. 2007. Lehninger's Principles of Biochemistry. W.H. Freeman & Co.
- Primrose SB. 2001. Molecular Biotechnology. Panima.
- Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. Molecular Biology of the Gene. 6th Ed. Pearson Education International.

MIC-06: Fundamentals of Food Microbiology **CR-04 (Hr - 5; L-3, T-0, P-2)**

Course Outcome

- *CO1: The students would gain knowledge about different types of microorganisms including their features, classification, sources and the factors affecting their growth in food.*
- *CO2: An understanding of the various methods for detects microorganism in food products and explain fermentation types and microbial involvement and outline fermentation processes for foods like vinegar, beer, and wine.*
- *CO3: Describe microbial and biochemical aspects of food spoilage and recognize bacterial foodborne infections and intoxications and assess spoilage mechanisms across diverse food products.*

Course Content

Unit I:

Introduction to food microbiology, general features and importance of different groups of bacteria, yeasts and molds in foods. Microbial growth: Food as nutrient for various microorganisms, factor affecting the growth and survival of microorganisms in foods.

Unit -II*:*

Methods for microbial examination of food (Traditional, non-traditional and rapid methods). Fermentation: definition and types, microorganisms used in food fermentations, fermented foods, types, methods of manufacture for vinegar, sauerkraut, beer, and wine.

UNIT–III:

Food Fermentation: Principles and types of food fermentation; microorganisms used in food fermentation; fermented foods and beverages; basic processes of vinegar, sauerkraut, beer, and wine production; role of microorganisms in food quality and preservation.

Unit -IV*:*

Food Spoilage: Microbial and biochemical aspect of food spoilage, role of bacteria, yeast and molds in food spoilage, foodborne infections and intoxications (Bacterial)

Spoilage of cereal and cereal products, fruits and vegetables, meat and meat products, milk and milk products, fish and fish products, spoilage of egg and poultry and heated canned foods.

Lab – 24

- Preparation of culture media and basic microbiological techniques.
- Aseptic handling and microbial cultivation.
- Isolation and enumeration of microorganisms from food samples.

- Identification of bacteria, yeasts and molds using basic morphological characteristics.
- Microbial quality assessment of selected food samples.
- Study of food spoilage microorganisms.
- Demonstration of fermentation using yeast.
- Preparation/study of a fermented food product.
- Detection of microbial contamination in milk or other food samples.
- Study of foodborne pathogens through culture characteristics/case studies.
- Effect of temperature, pH, or salt concentration on microbial growth.
- Microscopic examination and staining of food-associated microorganisms.

Suggesting readings

- Adams MR and Moss MO “Food microbiology” New Age International (P) Ltd.1996.
- Charles W. Bamforth. Food, Fermentation and Microorganisms. Blackwell Publishing (2005).
- Frazier WC and Westoff DC “Food Microbiology” 4th edition Tata Mcgraw-Hill Publishing
- Gunasekaran P. “Laboratory Manual in Microbiology”, New Age International (P) Ltd. 1996.
- Jay JM “Modern Food Microbiology” 3rd edition CBS Publishers and distributors Delhi 1987.

MDC-06: Fundamentals of Environmental Chemistry **CR-03 (Hr - 3; L- 3, T-0, P-0)**

Course Outcome

- *CO1: Understand basic concepts and chemical processes in the environment.*
- *CO2: Explain the chemistry of air, water, and soil systems.*
- *CO3: Identify sources, reactions, and impacts of environmental pollutants.*
- *CO4: Analyze environmental issues and suggest suitable control measures.*

Course Content

Unit I: Fundamentals and Atmospheric Chemistry

Introduction to Environmental Chemistry- Definition, scope and importance; Composition and structure of atmosphere; Chemical processes in the atmosphere;

Air pollutants- sources, types and effects; Photochemical reactions; Smog formation;

Acid rain- formation, reactions and environmental impact;

Ozone layer- chemistry of formation and depletion; Greenhouse effect and global warming.

Unit II: Aquatic and Soil Chemistry

Water chemistry- properties of water, dissolved oxygen, BOD, COD;

Water pollution- sources, types and effects;

Chemical processes in natural waters- carbonate system, alkalinity and hardness;

Soil chemistry- composition, properties and nutrient cycles;

Soil pollution- sources, effects and control measures.

Unit III: Environmental Pollution and Control

Environmental pollutants- classification and sources;

Heavy metals and toxic chemicals- sources and effects;

Solid waste and hazardous waste- types and management;

Principles of green chemistry and sustainable development;

Pollution control strategies- air, water and soil;

Basic analytical methods in environmental monitoring.

Suggesting readings

- Baird, C.; Cann, M. Environmental Chemistry, W.H. Freeman.
- De, A.K. Environmental Chemistry, New Age International.

- Harrison, R.M. Understanding Our Environment, Royal Society of Chemistry.
- Manahan, S.E. Environmental Chemistry, CRC Press.
- Moore, J.W.; Moore, E.A. Environmental Chemistry, Academic Press.
- Sawyer, C.N.; McCarty, P.L.; Parkin, G.F. Chemistry for Environmental Engineering, McGraw Hill.
- Sharma, B.K. Environmental Chemistry, Goel Publishing House.

MDC-06: Functional Foods and Nutraceuticals **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: The student's knowledge explored about various functional foods and their functional nutraceutical compounds with their basic health benefits.*
- *CO2: The student's knowledge explored about the use of various functional foods and their useful bioactive compounds for curing of different chronic health problems.*
- *CO3: Knowledge regarding nutraceuticals of various cereal, legumes, oilseeds, milk, fruits, vegetables, tea, coffee and sea foods would be able to explore their knowledge about developing various beneficial functional foods.*
- *CO4: The students would be able to find jobs in R&D in the food and drug industries related with isolation and utilization of various nutraceutical compounds for functional food formation and novel food product development.*

Course Content

Unit I:

Nutraceuticals: basic concepts and origin. Classification of nutraceuticals on the basis of food source and chemical/biochemical nature. Functional foods: basic concepts and their categories. Plant and animal source based functional foods. Role of functional foods in health promotion.

Unit II:

Introduction to probiotics: basic concepts, their attributes, need and mechanisms of action, synbiotics, Role of probiotics in human health. Bioactive compounds: Alkaloids and polyphenols as nutraceuticals and functional foods.

Unit III:

Significance of functional foods and nutraceuticals in management of various chronic diseases: cancer, CVDs, diabetes, stress, joints and bone problems. Tea and coffee as functional food beverages: their nutritional significances and bioactive compounds.

Suggesting readings

- John Shi. Functional Food Ingredients and Nutraceuticals. CRC Taylor and Francis.
- Maria Saarela. Functional Foods: Concept to Product. 2nd Edition. Woodhead Publishing.
- Robert E.C. Wildman (2001). Handbook of Nutraceuticals and Functional Foods. CRC Press. Boca Raton, London, New York, Washington, D.C.
- Robert E.C. Wildman (2007). Handbook of Nutraceuticals and Functional Foods. (2nd edition) CRC Press. Boca Raton, London, New York, Washington, D.C.

SEC-06: Integrated Resource Management **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: Ability to understand the concept and importance of integrated resource management.*
- *CO2: Ability to analyze the sustainable use of natural resources such as water, land, and energy.*
- *CO3: Ability to evaluate strategies for efficient resource utilization and conservation.*
- *CO4: Ability to apply integrated approaches for resource planning and management.*

Course Content

Unit I: Introduction to Resource Management

Concept and scope of natural resources; classification (renewable and non-renewable); need for integrated resource management; principles of sustainability; resource use patterns and challenges.

Unit II: Integrated Management of Natural Resources

Water resource management (watershed management, rainwater harvesting); land resource management (soil conservation, land-use planning); forest and biodiversity management; energy resources and conservation; role of technology in resource management.

Unit III: Strategies and Policy Framework

Integrated resource planning approaches; community participation and stakeholder involvement; environmental impact assessment (EIA); policies and regulations for resource management; sustainable development and resource governance.

Suggested Readings

- Barrow, C.J. (2006). Environmental Management for Sustainable Development. Routledge.
- Campbell, B.M. and Sayer, J. eds., 2003. Integrated natural resource management: linking productivity, the environment and development. Cabi.
- Kaushik, A. and Kaushik, C.P. (2010). Perspectives in Environmental Studies. New Age International, New Delhi.
- Klee, G.A. (1991). Conservation of Natural Resources. Prentice Hall.
- Miller, G.T. and Spoolman, S. (2014). Environmental Science. Brooks/Cole, USA.
- Misra, R. (1968). Ecology Workbook. Oxford & IBH Publishing Co., New Delhi.
- Singh, J.S., Singh, S.P. and Gupta, S.R. (2014). Ecology, Environmental Science and Conservation. S. Chand, New Delhi.
- Thakur, B. ed., (2007). Perspectives in Resource Management in Developing Countries,Concept Publishing Company.

- UNEP (2011). Towards a Green Economy. United Nations Environment Programme.

SEC-06: Green Economy **CR-03 (Hr - 3; L-3, T-0, P-0)**

Course Outcome

- *CO1: Ability to understand the concept and principles of green economy and sustainable development.*
- *CO2: Ability to analyze the relationship between economic growth and environmental sustainability.*
- *CO3: Ability to evaluate green technologies, policies, and practices.*
- *CO4: Ability to apply green economy concepts in real-world scenarios for sustainable development.*

Course Content

Unit I: Introduction to Green Economy

Concept, definition and principles of green economy; relationship between economy, environment and society; need for green economy; sustainable development and green growth; indicators of green economy.

Unit II: Green Sectors and Technologies

Renewable energy sources (solar, wind, biomass); green agriculture and sustainable practices; green industries and cleaner production; waste management and recycling; green buildings and sustainable urban development.

Unit III: Policies, Strategies and Implementation

Green economy policies and initiatives (national and global); role of government and private sector; green finance and investment; circular economy; challenges and opportunities in transition to green economy.

Suggested Readings

- Barbier, E.B. (2010). A Global Green New Deal. Cambridge University Press.
- Gupta, V.P., Haghi, A.K. and Sharief, S. eds., 2025. Green economy and sustainable development. Springer Nature Switzerland, Imprint: Springer.
- Miller, G.T. and Spoolman, S. (2014). Environmental Science. Brooks/Cole, USA.
- Pearce, D., Markandya, A. and Barbier, E. (1989). Blueprint for a Green Economy. Earthscan.
- UNEP (2011). Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. United Nations Environment Programme.
- World Bank (2012). Inclusive Green Growth: The Pathway to Sustainable Development.