

UNIVERSITY OF DELHI

DEPARTMENTS (Botany, Biochemistry, Zoology, Chemistry and Physics)

COURSE NAME: B.Sc. (Hons) Biological Sciences

(SEMESTER - I)

based on

Undergraduate Curriculum Framework 2022 (UGCF)

(Effective from Academic Year 2022-23)



University of Delhi

Course name: **BSc(H) Biological Sciences**

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/ Prerequisite	Contents of the course and reference is in
			Lecture	Tutorial	Practical		
Basic concepts of Biomolecules	DSC-101	4	2	0	2	Class 12 th bio and chem	Annexure-I
Photobiology	DSC-102	4	2	0	2	Class 12 th bio and chem	Annexure-II
Diversity in Life forms I	DSC-103	4	2	0	2	Class 12 th bio and chem	Annexure-III

B.Sc. (HONOURS) BIOLOGICAL SCIENCE (NEP STRUCTURE)
DISCIPLINE SPECIFIC CORE

Basic Concepts of Biomolecules (BS-DSC-101)
Semester – I

1. Course Objectives

The objective of this course is to develop a basic understanding of the structure, bonding, stability, stereochemistry and reactivity of organic molecules with focus on biomolecules.

This basic knowledge will empower the students to develop an understanding about chemistry and biology of biomolecules such as proteins and nucleic acids. This course also provides a basic understanding of the chemistry of carbohydrates and lipids. This knowledge will help students to better understand the biological applications of these biomolecules.

2.1 Course Learning Outcomes

On successful completion of the course, a student will

- Understand and apply the fundamental principles of chemistry which include bonding, electronic effects, molecular forces and stability of reactive intermediates to biomolecules.
- Gain an insight into the influence of chemical bond polarization on a molecular structure and its reactivity.
- Identify the type of metabolic reaction and draw reaction mechanisms for key metabolic processes.
- Recognize stereochemistry of a biomolecule and give a rational explanation of its biological reactivity based on stereochemistry.
- Understand the chemistry and biological functions of carbohydrates and lipids

2.2 Course Contents:

THEORY

TOTAL HOURS: 30

CREDITS: 2

Unit I: Basic Concepts

No. of Hours: 5

Electronic displacements and their applications: Inductive, electromeric, resonance and hyperconjugation. Dipole moment, acidity and basicity. Types, shape and relative stability of carbocations, carbanions and free radicals. Electrophiles and nucleophiles, Intramolecular and intermolecular molecular forces including hydrophobic, hydrophilic interactions and hydrogen bond (emphasis on effect of these forces on the stability of biomolecules),

Unit II: Stereochemistry

No. of Hours: 7

Stereochemistry and its importance to biological systems, Stereoisomerism: Optical activity and optical isomerism, asymmetry, chirality, enantiomers, diastereomers. Mesomers, specific rotation; Resolution of racemic modification, Configuration and projection formulae: Newmann, Sawhorse, Fischer projections and their interconversion. Chirality in molecules with one and two stereocentres; CIP rules: Erythro/Threo, D/L and R/S designations.; Relative and absolute configuration; thalidomide case and chiral drugs; Geometrical isomerism: cis-trans, syn-anti and E/Z nomenclature.; Cis-trans isomerism in vision.

Unit III: Biologically significant chemical reactions**No. of Hours: 06**

Aldol condensation (Glucogenesis), Retro-aldol (Glycolysis), Benzoin condensation (umpolung-decarboxylation of pyruvate in the presence of TPP), Claisen condensation (Synthesis of fatty acids), Michael addition (Dehydrases), Cannizzaro (Sugar metabolism), Baeyer Villiger reaction (FAD dependent ketone synthesis), Pinacole-pinacolone rearrangement (1,2-carbon carbon shift), Isomerisation (Glycolysis), Redox reaction (Lactate dehydrogenase).

Unit IV: Carbohydrates

No. of Hours: 7

Classification of carbohydrates, reducing and non-reducing sugars, biological functions, linkage between monosaccharides, general properties and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, configuration, cyclic structure (exclude structure elucidation) and Haworth projection formulae of glucose and fructose: structure of disaccharides (sucrose, maltose, lactose); polysaccharides- classification, structure of important members, storage polysaccharides (Glycogen, Starch) and structural polysaccharides (Cellulose, chitin, peptidoglycans and glycosaminoglycans)

Unit V: Lipids

No. of Hours: 5

Introduction, classification, biological importance of triglycerides, phospholipids, glycolipids, eicosanoids and steroids (cholesterol). Oils, Fats and Waxes: Common fatty acids present in oils and fats, essential fatty acids, characteristics of fatty acids and fats (saponification, iodine, acid, acetyl and peroxide values). Rancidity and reversion of fats; waxes, trans-fats and their biological significance.

2.3 PRACTICALS**TOTAL HOURS: 60****CREDITS: 2**

1. Purification of organic compounds by recrystallization using the following solvents:
 - i. Water
 - ii. Water-Alcohol
 - iii. Alcohol
2. Criterion of purity of organic compound- melting point, mixed melting point and boiling point of organic compounds.
3. Estimation of saponification value of fat/oil.

4. Estimation of iodine value of fat/oil.
5. Qualitative tests for carbohydrates and lipids
6. Chromatography
 - a) To separate a mixture of sugars by circular paper chromatography
 - b) To separate a mixture of lipids in a sample by Thin Layer Chromatography

2.4 REFERENCES:

1. A Guidebook to mechanism in organic chemistry (2003) 6 th ed., Sykes, P. New York: John Wiley & Sons. Inc
2. Organic Chemistry (2014) 7 th ed., Morrison, R.T., Boyd, R.N., Bhattacharjee, S. K., Pearson Education
3. Stereochemistry of Organic Compounds (1994), Eliel, E. L., Wilen, S. H. John Wiley& Sons.
4. Stereochemistry: Conformation and Mechanism (2015) 8 th ed., Kalsi, P. S. New Age International
5. Organic Chemistry (2013), Madan, R. L. Tata McGraw Hill Education Private Limited, New Delhi
6. Organic Chemistry (2020) 8th Edn., Bruice, P. Y., Pearson

Teaching Learning Process and Assessment Methods

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	<p>Understand and apply the fundamental principles of chemistry which include bonding, electronic effects, molecular forces and stability of reactive intermediates to biomolecules.</p> <p>Gain an insight into the influence of chemical bond polarization on a molecular structure and its reactivity.</p>	Teaching will be conducted both through black board mode, power point presentation mode.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.

	Identify the type of metabolic reaction and draw reaction mechanisms for key metabolic processes		
II	Recognize the stereochemistry of a biomolecule and give a rational explanation of its biological reactivity based on stereochemistry.	Classical chalk and board teaching, oral discussions and power point presentation whenever needed. Use of models and animations to instill detailed understanding of stereochemistry	Open book tests will be held to promote self-learning. Students will also be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.
III	Understand the chemical logic behind some key reactions that are important in understanding Biochemistry and metabolism	Teaching will be conducted both through blackboard mode and power point presentation mode	Regular oral evaluation will be done. Internal assessment tests will be conducted
IV	Understand the chemistry carbohydrates and appreciate their biological functions	Teaching will be conducted both through blackboard mode and power point presentation mode. Practical assessment of glucose by the titrimetric method. Qualitative tests for carbohydrates will also be taken up in the practical class.	Regular class question-answer sessions. Students will be asked to prepare PowerPoint presentations on any sub-topic of interest relating to carbohydrate chemistry. Internal assessment tests will be conducted.
V	Understand the chemistry of lipids. Give a rational explanation of the biological functions of lipids	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity. Qualitative tests for lipids and some estimation and	Regular oral evaluation will be done. Internal assessment tests will be conducted

		separation methodologies of lipids will also be taken up in the practical class	
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Keywords

Reactive intermediates, Inter and Intra-molecular forces, Stereochemistry, Carbohydrates, Lipids,.

B.Sc. (HONOURS) Biological Science (NEP STRUCTURE)
DISCIPLINE SPECIFIC CORE

Photobiology (BS-DSC-102)
Semester – I

1. Course Objective:

The course explores the physical properties of light and its interplay with living organisms. Light as a source of energy and information has shaped life on earth over the last 3.6 billion years. We see the world around us because the light reflected to the retina is processed to our brain (Photoreception), we breathe in oxygen because it has been evolved by the plants around us due to the light dependent Photosynthesis. Where there is no natural light, some organisms produce their own (Bioluminescence). Maintaining coordination with the changing light regime with changing seasons is fundamentally important to various aspects of living organisms across latitudes (Photoperiodism). Every part of the spectrum is used in one way or the other by different life forms. In this paper students will be able to appreciate the delicate processes of life that are dependent on light.

2.1 Course Learning Outcomes:

On successful completion of the course, a student will:

- Understand and appreciate the dual nature of light.
- Comprehend the impact of light on biodiversity from pole to pole.
- Gain knowledge about the various photoreceptors in plants and animals and will appreciate and understand the mechanism of photosynthesis.
- Understand bioluminescence, photoperiodism and biological rhythms.
- Gain knowledge about the ecological and physiological responses to light.

2.2 Course Contents:**THEORY**

CREDITS: 2

TOTAL HOURS: 30

Unit 1: Introduction to Light and Life

No. of Hours: 4

Latitudinal Diversity gradient. Altitudinal and latitudinal variations in light intensity and photoperiod. Light as an ecological factor affecting distribution, physiological processes of plants and animals (Phyto and Zoo geography), in terrestrial and aquatic ecosystems.

Unit 2: Bioluminescence and Photoreception

No. of Hours: 6

Discovery, diversity and functions of Bioluminescence. Comparative account of chemistry and functional roles of photoreceptors in plants: chlorophylls, carotenoids, phycobiliproteins,

bacteriochlorophylls, etc. Photoreception in animals, evolution of eyes, color vision and visual processing in the human eye.

Unit 3: Photosynthesis

No. of Hours: 10

History, Spectrum of autotrophs, Photosynthetic equation, Photosynthetic electron transport (cyclic and non-cyclic), photolysis of water, oxygen-evolving complex (OEC), concept of Reaction centers, Q-cycle, Dark Reactions in Photosynthesis, C₃, C₄, CAM cycle, photorespiration (C₂ cycle).

Unit 4: Photoperiodism

No. of Hours: 5

Phytochrome mediated responses in Plants, Animal responses to changing photoperiodism. Morphological, Anatomical, Physiological and behavioral adaptations to extreme light conditions in plants and animals.

Unit 5: Ecological and physiological responses to Light

No. of Hours: 5

Morphological and physiological color change in animals. Light as an inducer for biosynthesis/activation of biomolecules (Vitamin D, Melatonin, Thymine dimer formation, RuBisCo). Three rhythm domains, Biological clocks and circadian rhythms, night shift disorders and jet lag.

2.3 PRACTICALS

CREDITS: 2

TOTAL HOURS: 60

1. To study light penetration in water using Secchi disc.
2. To demonstrate the effect of light on soil fauna using Berlese funnel setup.
3. To study the effect of light and darkness on the chromatophores of fish.
4. To test / survey for color blindness using Ishihara charts.
5. To study various Bioluminescent organisms using photographs- *Photinus pyralis*, *Aequorea victoria*, Vampire squid, Anglerfish, Lanternfish, Viperfish, Black dragonfish, *Omphalotus nidiformes*
6. Diel vertical migration using photographs
7. Measurement of light using Luxmeter under various conditions
8. To study structure of chloroplast- through photographs
9. Separation of Chloroplast pigments by Paper Chromatography/ Chemical Separation of Chloroplast pigments
10. To study the effect of Light intensity and CO₂ concentration on the rate of Photosynthesis
11. Demonstration of Hill's Reaction and study the effect of Light intensity (any 2 light conditions).
12. Demonstration of Etiolation and de-etiolation.

2.4 Essential Readings:

1. Björn, L. O. (2015) 3rd Ed. *Photobiology: Science of Light and Life*, L.O. Björn., Springer
2. Buchanan, B. B., Gruissem, W., and Jones, R. L. (2000). *Biochemistry and molecular biology of plants*. Rockville, Md.: American Society of Plant Physiologists.
3. Huner, N. and Hopkins, W. (2013). *Introduction to Plant Physiology*. In: 4th ed. John Wiley & Sons, Inc.
4. Kohen E., Santus R., Hirschberg J.G. (1995) 1st Ed., *Photobiology* Academic Press
5. Randall D., Burggren W., & French k. (2001) 5th Ed. *Eckert, Animal Physiology Mechanisms and Adaptations*. W.H. Freeman and Co.

Suggested Readings:

1. Gross M. (2003). *Light and Life*. Oxford University Press
2. Shimomura O., (2012) *Bioluminescence: Chemical Principles and Methods*, World Scientific,
3. Taiz, L., & Zeiger, E. (1991). *Plant physiology*. Redwood City, Calif: Benjamin/Cummings Pub. Co.

3. Teaching-Learning Process and Assessment

Facilitating the Achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about geographic variation of light throughout year and how it affects distribution of plants and animals	Teaching will be conducted both through black board mode and power point presentation mode.	Students will be given questions that are application based and require analytical skills. Quizzes will be held to gauge their conceptual understanding.
II	Students will learn about the various photoreceptors in plants as well as animals, evolution of the and vision in humans and bioluminescence	The traditional chalk and talk method. Short movies showing the importance of photoreceptors will be shown. Students will understand the different types of plant pigments by separating them from plant material.	Oral questions will be asked in the class. Problems will be assigned to encourage them to explore more about the concept. Class tests will be conducted for internal assessment.
III	Students will learn about	Students will understand the	Regular class question-

	the process of photosynthesis and the various factors that affect it. They will also understand about its variations.	importance of an electron acceptor through Hills Reaction. A practical understanding of the various factors affecting rate of photosynthesis will be developed	answer sessions. Problems will be assigned to test student's analytical ability. Class tests will be conducted for internal assessment
IV	Students will learn about photoperiodism, adaptations to extreme light conditions and biological rhythms.	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity.	Group discussion on the given topic will be organized. Students will be asked to give short presentations or written assignments.
V	Students will learn how organisms respond to light induced changes in their surroundings by changing color, synthesizing biomolecules.	Teaching will be conducted through black board and power point presentation. Useful video clips will be shown for better clarity.	Oral questions will be asked in the class. Class tests will be conducted for internal assessment.

(**Assessment tasks enlisted here are indicative in nature)

4. Keywords

Light, Pigments, Photoreceptors, Bioluminescence, Photosynthesis, Photoperiodism, Animal Color, Biogeography

B.Sc. (HONOURS) Biological Science (NEP STRUCTURE)
DISCIPLINE SPECIFIC CORE

Diversity of Life Forms 1 (BS-DSC-103)
Semester – I

1. Course Objectives

The course will acquaint students with variations and variability in the living world and the objectives of biological classification. The course covers important aspects of biodiversity and its components with emphasis on understanding the features of Kingdom Animalia and Plantae and systematic organization of the same based on their evolutionary relationships. Students will also understand the importance of taxonomy and structural organization of animals from Protista to Echinodermata to appreciate the diversity of non-chordates living in varied habitats. They will study about the general characteristics and significance of Algae, Fungi, Bryophytes and Pteridophytes

2.1 Course Learning Outcomes

On successful completion of the course, a student will:

- Understand characteristic features of different plant and animal life forms.
- Identify, classify and differentiate diverse non-chordates based on their morphological, anatomical and systemic organization.
- Understand similarities and differences in life functions among various non-chordates.
- Appreciate and understand the relevance of wild relatives of cultivated plants, their domestication and green revolution.
- Understand the general characteristics, classification, economic importance, morphology, asexual and sexual reproduction of Algae, Fungi, Bryophytes and Pteridophytes

2.2 Course Contents

THEORY

CREDITS: 2

TOTAL HOURS: 30

Unit I: Algae and Fungi

No. of Hours: 9

Importance of biodiversity in daily life. Biodiversity crisis and biodiversity loss,

Five kingdom classification and the position of Algae, Fungi, Bryophytes and Pteridophytes.

Algae: Study of general characteristics, Outline Classification, Economic Importance, Thallus Organization and Reproduction in Nostoc, Polysiphonia, Ectocarpus.

Fungi – General Characteristics, Outline Classification, Economic Importance, Thallus Organization and Reproduction in Rhizopus and Puccinia,

Lichens (crustose, foliose and fruticose), Mycorrhiza (ectomycorrhiza and endomycorrhiza, VAM)

Unit II: Bryophytes and Pteridophytes

No. of hours: 6

Bryophytes: General Characteristics; Outline Classification; Ecological and Economic Importance; Morphology, Structure and Reproduction (comparative) in *Marchantia* and *Anthoceros*

Pteridophytes: General Characteristics; Outline Classification; Economic Importance; Morphology, Structure and Reproduction in *Selaginella*

Unit III Introduction to Animal Life Forms

No. of Hours: 5

Introduction to animal diversity, Basic Taxonomy (Linnaean system of classification, Whittaker's five kingdom classification, ICZN Rules), General Characteristics of Non-Chordata and Chordata.

Unit IV: Non-Chordata Taxonomy and Diversity

No. of Hours: 10

Study of General Characteristics and Classification up to classes (Protista, Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata)

2.3 PRACTICALS

CREDITS: 2

TOTAL HOURS: 60

FLORA

1. Study of Vegetative and Reproductive Structures through Temporary Preparations and Permanent Slides- *Nostoc*, *Oedogonium*, *Polysiphonia*; *Chlamydomonas* (Through Photograph/Electron photomicrograph)
2. Study of Asexual Stage from Temporary/ Tease Mounts- *Rhizopus Albugo*; *Puccinia* -WM uredospores, teleutospores, Section of Leaf through pustules to show conidia
3. *Marchantia*-Morphology of Thallus, W.M. Rhizoids, V.S. Thallus through Gemma Cup, Antheridiophore (Permanent slide), Archegoniophore (Permanent Slide)), *Funaria*-Morphology of Gametophyte bearing Sporophyte, W.M. Rhizoids, W.M. Leaf, W.M. Operculum, W.M. Peristome, W.M. Spores (all Temporary Slides), L.S. Capsule (Permanent Slide).
4. *Selaginella*- Morphology, T.S. Stem, W.M. Strobilus, W.M. Microsporophyll and Megasporephyll (all Temporary Slides), L.S. Strobilus (Permanent Slide), *Pteris*-Morphology, V.S. Sporophyll, W.M. Sporangium, W.M. Spores (all Temporary Slides), W.M. Prothallus with Sex Organs (Permanent Slide).

FAUNA

5. **Study of following specimens:** *Euglena*, *Paramecium*, *Sycon*, , *Tubipora*, *Taenia solium*, *Ascaris Phertima*, *Hirudanaria*, *Peripatus*, *Scolopendra*, *Julus*, *Cancer*, *Daphnia*, *Apis*, *Pila*, *Dentalium*, *Octopus*, *Asterias*
6. **Dissections / Virtual demonstration:** Nervous system of Cockroach, Salivary apparatus and Ovary of Cockroach.
7. Study of adult *Fasciola hepatica*, *Taenia solium* and their life stages (Slides/micro-

- photographs).
8. Study of following permanent Slides.
 - a. T.S. and L.S. of *Sycon*.
 - b. Crustacean larvae (W.M. Mysis, W.M. Megalopa, W.M. Zoea).
 9. To study faunal composition of water samples (Lucky drop method).
 10. Field trip on: Biodiversity park/reserve/ NBPGR. (Botany + Zoology)

2.4 Essential readings:

1. Barnes, R.D. (1982). *Invertebrate Zoology*, 5th. Edition
2. Campbell N. A., (2008). *Biology* 8th Edition, Pearson
3. Barrington, E.J.W. (2012). *Invertebrate Structure and Functions*. II Edition, EWP Publishers
4. Singh, V. (2010). *A text book of botany*. Rastogi Publications.
5. Ennos, R., & Sheffield, E., (2000). *Plant Life*. UK: University Press, Cambridge.

Suggested readings:

1. Ingrowille, M., (1992). *Diversity and Evolution of land plants*. Chapman and Hall
2. Wilson, E. O., (1998). *Biodiversity*. National Academic Press.
3. Barnes, R.D. (2006). *Invertebrate Zoology*, VII Edition, Cengage Learning, India.

3. Teaching Learning Process and Assessment Methods

Facilitating the achievement of Course Learning Outcomes**

Unit No.	Course Learning Outcomes	Teaching and Learning Activity	Assessment Tasks
I	Students will learn about the basic concepts of biodiversity and characteristic features and systems of classification of plants and animals	Powerpoint presentations; Teaching using chalk and board; Group discussion sessions in the Class	Questions will be asked in the class. Assignments and Class tests will be conducted for internal assessment.
II	Students will learn about the diversity of non-chordates living in diverse habits and habitats.	Powerpoint presentations; Teaching using chalk and board; Group discussion sessions in the Class	Questions will be asked in the class. Assignments and Class tests will be conducted for internal assessment.

III	Students will learn about the basic concepts of biodiversity and characteristic features of algae and fungi	Teaching using chalk and board; Power point presentations; Group discussion sessions in the class	Discussions in class will help students gather better understanding. In the practical classes, student will study them in depth
IV	Students will learn about the basic concepts of biodiversity and characteristic features of bryophytes and pteridophytes	Teaching using chalk and board; Power point presentations; Group discussion sessions in the class	Discussions in class will help students gather better understanding. In the practical classes, student will study them in depth

(Assessment tasks enlisted here are indicative in nature)**

4. Keywords

Biodiversity, Conservation of Biodiversity, Algae, Fungi, Taxonomy, Classification, non Chordata , Chordata