Name of faculty: Science	**Department:** Biotechnology
Program: B.Sc. Biotechnology	**Type:** Theory + Practical
Subject: DSC-3 Plant Science Paper-I	**Semester:** 2
Credit: 04 + 02	**Total learning hours:** 60

Course Description:
Inculcate strong fundamentals on modern and classical aspects of plant sciences and its different branches that will create a platform and facilitate students to take-up successful careers in Botany or higher studies in various other branches of plant sciences.

Student Learning Outcome: After completion of this course the students will be able to:

- Understand the morphology, structure and importance of the organisms
- State the meaning of scientific terms used in classification system
- Differentiate between various groups of Algae, Bryophytes and Pteridophytes, angiosperms and gymnosperms.
- Understand the morphology, structure and functions of various parts of plants.
- Learn the taxonomical terminology and understand the meaning of the same.
- Learn medicinal and commercial values of plants.

Unit-1 Introduction to Plant Science (Botany) (7 hrs)
1.1 Introduction and scope of botany
1.2 Division of the plant kingdom: Cryptogams and Phanerogams
1.3 Alteration of Generations
1.4 Branches of Botany: An overview, Basics of Molecular Taxonomy and DNA barcoding

Unit-2 Algal diversity (7 hrs)
2.1 General characters of Algae, Occurrence and habitat
2.2 Classification of algae with general characters(up to classes)
2.3 Mode of reproduction, economic importance of algae
2.4 General characters of Lichens and their role as bioindicators

Unit–3 Bryophytes (8 hrs)
3.1 General characters and occurrence: Classification (up to classes)
3.2 Origin and evolution of Bryophytes
3.3 Structure, reproduction affinities of *Ricca* and *Marchantia*, comparison between Liverworts and Mosses
3.4 Role of bryophytes in soil conservation

Unit–4 Pteridophytes (8 hrs)
4.1 General characters, classification (up to Classes)
4.2 Structure, reproduction and life history of Lycopodium, Fern and Marsilea
4.3 Heterospory and seed habit
4.4 Types and Evolution of stele in Pteridophytes

Unit–5 Gymnosperm (8 hrs)
5.1 General characters and occurrence
5.2 Classification of Gymnosperms (up to classes)
5.3 General morphology, reproduction and life history of Pinus and Gnetum
5.4 Economic importance with reference to wood, essential oils and drugs

Unit–6 Angiosperm (7 hrs)
6.1 Salient features of Angiosperms
6.2 Life cycle of Angiosperms
6.3 Salient features of classification system of angiosperms proposed by Linnaeus, Bentham & Hooker, Engler & Prantl
6.4 Features used in description of Angiosperm plants

Unit–7 Dicotyledons and Monocotyledons (8 hrs)
7.1 General characteristics of Dicotyledones
7.2 Distribution, features and economic importance of *Caesalpiniaceae, Cucurbiteceae, Malvaceae, Umbelliferae, Euphorbiaceae*
7.3 General characteristics of Monocot
7.4 Distribution, features and economic importance of *Musaceae, Liliaceae, Orchidaceae, Gramineae*

Unit- 8 Economic Botany (7 hrs)
8.1 Definition of Economic Botany, Methods of crop improvement
8.2 Food plants: Cereals, Millets, Pulses, Vegetables, Fruit, Spices
8.3 Plant products of Industrial Value, Indian raw material and Industrial Products
8.4 Introduction to Ethnobotany, Medicinal plants and drugs

References & Text Books:

- Vasishtha B.R. And Sinha A. K., 1st edition, Botany for degree students Part 1 ALGAE; S. Chand & Company Ltd, , revised 2005, ISBN: 9788121935210
- Dutta,A.C.; A Class book of Botany; 15th edition; Calcutta: Oxford University Press, 1976, ISBN: 9780195637489
- Gangulee, H.C., Das,K.S., Dutta C.T., College Botany Vol-I.; Kolkata: New Central Book Agency, 002. ISBN: 9788173810282
- Sundar Rajan S., College Botany Vol-II, Himalaya Publishing House, ISBN: 9789352620302
- Mukherjee S.K., College Botany Vol-III, New Central Book Agency, ISBN: 9788173813085
- Pandey B.P., Economic Botany, S. Chand Publication, ISBN: 9788121903417
- Pandey B.P; A Text Book of Botany: Angiosperms.; S.Chand Publishers, ISBN: 9788121904049

Practicals:

1. Study of Morphology (vegetative and reproductive structures) of any of the following: *Marchantia, Funaria, Lycopodium* and *Pinus* using specimen/ permanent slides / Photographs.
2. Structure of pollen grains using whole mounts of any (*Catharanthus, Hibiscus, Acacia*, Grass) and calculate the percentage of pollen germination (*Catharanthus*).
3. Study of developmental stages of dicot and monocot Embryos using specimen/ permanent slides / Photographs.

Reference and Textbooks for Practical:

- B.P Pandey, Modern Practical Botany-Vol. I, S Chand & Company, ISBN: 9788121904605
- B.P Pandey, Modern Practical Botany-Vol. II, 5th Edition, S Chand & Company, ISBN: 978-8121909204
- B.P Pandey, Modern Practical Botany-Vol. III, 2nd Edition, S Chand & Company, 978-8121935081

Name of Faculty: Science	**Department:** Biotechnology
Program: B.Sc. Biotechnology	**Type:** Theory +Practical
Subject: DSC-4 Animal Science – I	**Semester:** 2
Credit: 04 + 02	**Total Learning Hours:** 60
Course Description: This course will make students understand & know the fundamentals of animal taxonomy, animal body systems of both invertebrates & vertebrates, adaptive behaviour & comparative anatomy which will be useful for the student to learn further advanced subjects like animal tissue culture, animal biotechnology & apply the information for research in future.	
Student Learning Outcome: After completion of this course student will be ● Knowing the fundamentals of animal taxonomy with special features of each phylum & class with standard animal examples. ● Understanding the basic body plan of invertebrate & vertebrate animals. ● Able to compare the differences between different groups of animals by studying their organs. ● Knowing how animals adapt to their environment with suitable adaptation features & examples.	

Unit – 1 Invertebrates –I (07 hours)

1.1Introduction (Definition of invertebrates & non-chordates, general characters of invertebrates, brief outline of classification of Invertebrates)
1.2 Phylum Protozoa – General characters, Locomotory Organelles in Protozoa
1.3 Phylum Porifera – General characters, Canal System in Sycon
1.4 Phylum Cnidaria - General characters, Polymorphism in Hydrozoa
1.5 Phylum Platyhelminthes - General characters

Unit 2 - Invertebrates – II (08 hours)

2.1 Phylum Nematoda - GeneralCharacters
2.2 Phylum Annelida - General Characters, Metamerism in Annelida
2.3 Phylum Arthropoda - General Characters, Mouth parts of Insect
2.4 Phylum Mollusca - General characters, Torsion & Detorsion in gastropods
2.5 Phylum Echinodermata - General characters, Water-vascular system in Asteroidea & Brief Introduction Minor Phyla

Unit 3 - Chordates – I (06 hours)

3.1 Introduction (Definition of Chordates, Vertebrates & Protochordates, general characters of chordates, brief outline classification of chordates)
3.2 Comparison between Invertebrates & Vertebrates
3.3 General characters of Hemichordates & Urochordates
3.4 General characters of Cephalochordates
3.5 General characters of Cyclostomata

Unit – 4 Chordates – II (07 hours)

4.1 Class Pisces - General characters, Types of scales in Fishes
4.2 Class Amphibia - General characters, Parental Care in Amphibians
4.3 Class Reptilia - General characters, Keys to identify Poisonous and Non-poisonous Snakes
4.4 Class Aves - General characters, Feathers of Birds
4.5 Class Mammals - General characters & classification up to orders

Unit 5 - Type Study (Non-Chordates): *Pheretima posthuma* (07 hours)
5.1 Systematic Position, Habit & habitat, External Morphology, Body wall & coelom
5.2 Digestive System & Digestion
5.3 Circulatory System & Circulation
5.4 Excretory/ Nephridial System & Excretion
5.5 Respiration & Nervous System
5.6 Reproductive System & Reproduction

Unit 6 - Type Study (Chordates): *Haplobatrachus tigrinas* (08 hours)
6.1 Systematic Position, Habit & Habitat, External Features, Sexual Dimorphism, Coelom & Viscera
6.2 Digestive System & Digestion
6.3 Respiratory System & Respiration
6.4 Blood Vascular System (Heart, Arterial System, Venous System, Lymphatic System)
6.5 Neural System
6.6 Excretory System
6.7 Reproductive System & Reproduction

Unit 7 - Comparative Vertebrate Anatomy (09 hours)
(Frog, Varanus, Pigeon, Rat/Rabbit)
7.1 Pectoral girdles
7.2 Pelvic girdles
7.3 Forelimb
7.4 Hind limbs
7.5 Brain

Unit – 8 Animal Adaptations (08 hours)
8.1 Cursorial Adaptations
8.2 Desert Adaptations
8.3 Scansorial / Arboreal Adaptations
8.4 Fossorial Adaptations
8.5 Deep Sea Adaptations

List of References & Text Books

- Invertebrate Zoology by E L Jordan & Dr. P S Verma , S Chand pub.
- Modern Textbook of Zoology Invertebrates by RL Kotpal, Rastogi publications
- Chordate Zoology by E L Jordan & Dr. P S Verma, S Chand pub., 4th Edition
- Modern Textbook of Zoology Vertebrates by R L Kotpal, Rastogi publications, 4th Edition
- A manual of Practical Zoology Chordates by P S Verma, S Chand Pub.
- Cell Biology, Genetics, Molecular Biology, Evolution & Ecology by P S Verma & V K Agarwal, S. Chand Pub.
- Animal Behaviour by Dr V. K Agarwal, S Chand Pub.
- Animal Behaviour by M.P. Arora, Himalayan Pub.

Practicals
1) Study of Animal Specimen – one from each invertebrate & chordate phylum/ class
2) Study of Bones (Frog/Pigeon/Rat), feathers of birds & Fish Scales with the help of slides/models/specimen/project work

3) An “animal album” containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

References & Textbooks for Practicals

- Practical Zoology: Invertebrates by S S Lal, Rastogi Publications
- Practical Zoology: Vertebrates by S S Lal, Rastogi Publications
- Practical Zoology Volume III by S S Lal, Rastogi Publications

Name of faculty: Science	**Department:** Chemistry
Program: B.Sc.	**Type:** Theory
Subject: : DSE-2- Chemistry of New Material	**Semester-** 2
Credit: 02	**Total learning hours:** 30

Course description:

This course provides an overview of novel materials like composites, solid electrolytes, liquid crystal, self-healing materials, and nanomaterial.

This course emphasises on the introduction and application of modern material.

Student learning outcome:

Upon completion of this course, students will:

- Have understanding of importance and types of inorganic solids like electrolytes, , molecular compounds
- Get information regarding types, properties and classification of nanoparticles, preparation of metallic nanoparticles
- Know about carbon nanotubes as well as bio-nano material
- Get insight of characteristics of alloys, their classification and some application
- Find information regarding the various types of composites as engineering materials and environmental effects on composites
- Be able to discuss the synthesis and properties of speciality polymers
- Get knowledge about liquid crystal and some of the properties of liquid crystals
- Be familiar with new idea of self-healing materials and mechanism

Unit-1 Solid Electrolyte **(04Hrs)**

1.1 Introduction
1.2 Characteristics and advantage
1.3 Types of solid electrolyte
1.4 Application of solid electrolyte

Unit-2 Molecular Material **(04Hrs)**

2.1 Molecular material and fullerides
2.2 One-dimensional metals
2.3 Molecular magnets

Unit-3 Composites **(04Hrs)**

3.1 Definition, General characteristics and classification
3.2 Role of matrix in composites
3.3 Fibre-reinforced composites
3.4 Applications of composites

Unit-4 Nanomaterial **(04Hrs)**

4.1 Definition and types of nano-materials
4.2 Size dependent properties
4.3 Carbon nanotubes
4.4 Bio-inorganic nanomaterials and composites

Unit-5 Organic Conductors **(03Hrs)**

- **5.1** Conducting polymers - Introduction, conduction mechanism
- **5.2** Electrically conducting organic solids
- **5.3** Polyacetylene, polyparaphenylene and polypyrole
- **5.4** Applications

Unit-6 Liquid Crystal **(04Hrs)**

- **6.1** Mesomorphic behaviour
- **6.2** Thermotropic liquid crystal
- **6.3** Optical properties of liquid crystals
- **6.4** Optical storage memory switches and sensors

Unit-7 Alloys for Mechanical Construction **(04Hrs)**

- **7.1** Classification of alloys
- **7.2** Copper, aluminum and their alloys like duralumin, brasses and bronzes
- **7.3** High speed tool steel
- **7.4** Super alloys

Unit-8 Self-healing Material **(03Hrs)**

- **8.1** History
- **8.2** Self-healing cementitious material
- **8.3** Autonomic, autogenic and bio-based healing
- **8.4** Various Self-healing materials (Introduction only)

Reference Books:

1. Solid electrolytes and their applications, Subbarao, E. (Ed.). 2012, Springer Science & Business Media
2. Self‐healing materials, Advanced Materials, 22(47), 5424-5430, Hager, M. D., Greil, P., Leyens, C., van der Zwaag, S., & Schubert, U. S. (2010).
3. Self-healing materials: fundamentals, design strategies, and applications (pp. 138-217), Ghosh, S. K. (Ed.), 2009, Weinheim: Wiley-vch
4. Inorganic solids: an introduction to concepts in solid-state structural chemistry, Adams, D. M. (1974), John Wiley & Sons
5. Introduction to Nanotechnology, Charles P. Poole Jr., Frank J. Owens, 2003, John Wiley & Sons
6. Shriver and Atkins' inorganic chemistry, Atkins, P., & Overton, T., 2010, Oxford University Press, USA.
7. Descriptive inorganic, coordination, and solid state chemistry, Rodgers, G. E., 2011, Cengage Learning.
8. Principles of the solid state, Keer, H. V., 1993, New Age International
9. Introduction to Solids, Azároff, L. V., 1961, American Journal of Physics, 29(9), 647-647
10. Materials Science and Engineering, V. Raghavan, 6th edition, 2015, PHI publication
11. A textbook of engineering chemistry, DARA, S. S., 2008, S. Chand Publishing
12. Liquid Crystal-Applications And Uses (Volume 1) (Vol. 1), Bahadur, B. (Ed.),1990, World scientific

Name of faculty: Science	**Department:** Environmental Science
Program: B.Sc.	**Type:** Theory
Subject: : DSE-2- Microbial Ecology	**Semester-** 2
Credit: 02	**Total learning hours:** 30

Student learning outcome:

Upon completion of this course, students will:

- Have basic knowledge of microbial ecology and its fundamental concepts.
- Understand dynamics and interactions of microbial communities.
- Understand microbial association with higher plants.

Unit-1 Scope and overview of microbial ecology

1.1 The scope of microbial ecology
1.2 Historical overview
1.3 Relation of microbial ecology with environmental science
1.4 Sources of information

Unit-2 Microbial Evolution and Biodiversity

2.1 Chemical evolution
2.2 Cellular evolution
2.3 Bacterial and Archaeal Biodiversity
2.4 Eukaryal biodiversity

Unit-3 Physical Environment of microorganisms

3.1 Microenvironment and niche
3.2 Biofilms and microbial mats
3.3 Microorganisms and ecosystems
3.4 Microorganism movement between ecosystems

Unit-4 Biogeochemical cycling

4.1 Carbon cycle
4.2 Nitrogen cycle
4.3 Phosphorus cycle
4.4 Sulfur cycle

Unit-5 Microbial interactions: Mutualism

5.1 Microorganism-insect mutualism
5.2 Zooxanthellae
5.3 Sulfide-based mutualisms
5.4 Methane-based mutualisms
5.5 Rumen ecosystem

Unit-6 Other Microbial interactions

6.1 Cooperation
6.2 Commensalism
6.3 Predation
6.4 Parasitism
6.5 Amensalism and Competition

Unit-7 Microorganism association with vascular plants

7.1 Phyllosphere, rhizosphere and rhizoplane microorganisms
7.2 Mycorrhizae
7.3 Symbiotic nitrogen fixation: Rhizobia
7.4 Symbiotic nitrogen fixation: Actinorhiza and stem-nodulating bacteria

Unit-8 Other associations with plants

8.1 Fungal and bacterial endophytes
8.2 Agrobacterium
8.3 Other plant pathogens
8.4 Tripartite and Tetra-partite associations

References and Textbooks: (With Author, Edition, Publishers, ISBN)

- Atlas RM, Bartha R. Microbial ecology: fundamentals and applications. The Benjamim. Cummings Publ., Menlo Park. 1987. 978-8131713846
- Willey J, Sherwood L, Woolverton CJ. Prescott's microbiology. McGraw-Hill, New York, NY. 2013. 978-0071313674

Practicals:

1. Demonstration of presence of bacteroids in root nodules and isolation of *Rhizobium* from it.
2. Isolation of plant pathogenic fungi from sugarcane red rot.
3. Study of lichens using permanent slides.

Name of faculty: Science	**Department:** Chemistry
Program: B.Sc.	**Type:** Theory
Subject: DSE-2- Polymer Chemistry	**Semester-**2
Credit: 02	**Total learning hours:** 30

Course description:

The course gives a general introduction to polymers. Focus is placed on the classification and systematics of polymers. It also deals with the polymerization techniques, kinetics of polymerization, molecular weight and size, polymer structures and physical properties, polymer reaction, polymer solutions and individual polymers**.**

Student learning outcome:

Students will be able:

- To understand the Chemistry of polymers.
- To recognize the types of polymers, the significance and determination of their molecular mass and understand the relationships between polymer molecular weight, molecular weight distribution, and the properties of polymeric materials.
- To acknowledge in detail the mechanisms of the reactions that lead to the formation of polymers.
- To understand different levels of polymer structure.
- To apprehend an overview of polymer reactions and reactivity of polymers.
- To understand factors that influence the degradation of polymers.
- To learn about the properties of polymers in solution and biopolymers.

Unit-1 The Genesis of Polymers **(04 Hrs)**

1.1 A Brief History
1.2 Monomer: Basic concept, Types, Functionality, Purification
1.3 Polymer: Basic concept, Types of Polymer structure, Effect of functionality, IUPAC nomenclature of polymer
1.4 Classification of Polymers
1.5 Chemistry of Polymerization

Unit-2 Molecular Weight and Size **(04Hrs)**

2.1 "Average" molecular weight
2.2 Number-Average and Weight-average molecular weights
2.3 Molecular weight and Degree of Polymerization
2.4 The Practical significance of Polymer molecular weight

Unit-3 Kinetics of Polymerization **(03Hrs)**

3.1 Introduction
3.2 Free-radical Chain Polymerization
3.3 Cationic Polymerization
3.4 Anionic Polymerization

Unit-4 Copolymerization **(03Hrs)**

4.1 Introduction

4.2 Kinetics of Copolymerization
4.3 Free-radical Copolymerization
4.4 Ionic Copolymerization

Unit-5 Polymer Structure and Physical Properties **(04Hrs)**

5.1 Polymer Microstructure
5.2 Glass Transition Temperature
5.3 Crystallinity in Polymer
5.4 Viscoelasticity

Unit-6 Polymer Reactions **(04Hrs)**

6.1 Introduction
6.2 Hydrolysis, Acidolysis, Aminolysis, Hydrogenation
6.3 Addition and Substitution Reactions
6.4 Cyclization Reactions

Unit-7 Polymer Solutions **(04Hrs)**

7.1 Polymer Dissolution
7.2 Thermodynamics of Polymer Dissolution
7.3 The Flory-Huggins Theory of Polymer Solution
7.4 Nature of Polymer Molecules in Solution

Unit-8 Individual Polymers **(04Hrs)**

8.1 Hydrocarbon Plastics and Elastomers:Polyethylene, Polypropylene, Polyisoprene, Polybutadiene
8.2 Carbon-Chain Polymers:Polystyrene,Polyacrylonitrile, Polyesters, PVC, PFC
8.3 Hetero Chain Thermoplastics: Polyamide, Polypeptides, Cellulosic Polymers
8.4 Inorganic Polymers and Biopolymers

Reference books:

1. Polymer Science, V R Gowarikar, N V Vishwanathan, Jaydev Sreedhar, 1987, Wiley–Blackwell
2. Text Book of Polymers Vol I to III, M S Bhatnagar, 2004, S. Chand Publication
3. TextBook of Polymer Science, F W Billmeyer, 2007, Wiley
4. Principles of Polymerization, George Odian, 2004, Wiley-Interscience
5. Introductory Polymer Chemistry, S Misra, 1994, Wiley–Blackwell
6. TextBook of Polymer Science, P L Nayak and S Lenka, 2001, Kalyani Publishers
7. Polymer Science and Technology, A Ghosh, 2001, Tata McGraw Hill Education
8. Polymer Chemistry, M G Arora and M Singh, 2003, Anmol Publisher