Proposed Syllabus and Scheme of Examination

for

Four Year Undergraduate (Biological Sciences)

Exit options

One Year Undergraduate Certificate in Biological Sciences

Two Year Undergraduate Diploma in Biological Sciences

Three Year B.Sc. (Hons) in Biological Sciences

Four Year B.Sc. (Hons. with Research) in Biological Sciences

SCHOOL OF BIOLOGICAL SCIENCES,
DOON UNIVERSITY, DEHRADUN-248001, UTTARAKHAND

(w.e.f. Academic Session 2022-2023)
(The syllabus of only First Year is Finalized)

B.Sc. (Hons) Biological Sciences/ B.Sc. (Hons) Biological Sciences with Research

1. About the Programme

The School of Biological Sciences offers the undergraduate programme in Biological Sciences with multiple exit options keeping in line with New Education Policy (NEP-2020). The undergraduate programme in Biological Sciences is a three/four year i.e., six/eight semester course. The course provides an in-depth study of the biological science and the related areas and involves courses having both theory and practical components. The aim of this programme is to introduce biology as an integrating natural science domain rather than sub- disciplines.

The foundation of the subject is built through Discipline Specific Core (DSC) Courses related to biological sciences disciplines coupled with Discipline Specific Elective (DSE) courses which are choice-based specialization courses of different streams of modern biology with an interdisciplinary perspective. DSC courses are rigorous in-depth courses that build on the foundation and develop critical thinking and problems solving skills. Since the subjects involve a lot of experimental work, therefore, substantial laboratory work is an integral part of almost all types of courses. Along with the DSC and DSE courses, student can also opt generic elective courses (GE), Skill Enhancement Course (SEC), Ability Enhancement Courses (AEC) and Value Addition Courses (VAC).

The fifth and sixth semesters also provide Internship/ Apprenticeship/Project/Community Outreach opportunities to the students. All the students in seventh and eighth semester have to undertake a research project under the guidance of faculties and the outcome of the research will be reported in the form of a dissertation.

Programme outcome (POC)

- **Critical Thinking:** Students will demonstrate an understanding of major concepts in biological sciences. Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.
- **Effective Communication**: Development of various communication skills such as reading, listening, speaking, etc., which will help in expressing ideas and views clearly and effectively.
- **Social Interaction**: Development of scientific outlook not only with respect to biological science subject but also in all aspects related to life.
- **Effective Citizenship**: Imbibe moral and social values in personal and social life leading to highly cultured and civilized personality.
- **Ethics**: Follow the ethical principles and responsibilities to serve the society.

- **Environment and Sustainability**: Understand the issues of environmental contexts and sustainable development.
- **Self-directed and Lifelong learning:** Students will be capable of self-paced and self-directed learning aimed at person

Programme specific outcome (PSOC)

After completing a degree in the School of Biological Sciences, graduates will be able to:

- Develop understanding of the basic principles of biological sciences
- Demonstrate proficiency in common lab and field techniques for biological sciences
- Integrate statistics, physical sciences and technology to answer biological questions and problems
- Students will be able to communicate scientific ideas effectively in both oral and written formats.
- Students will be able to think critically and evaluate, design, conduct and quantitatively assess innovative research in a biological discipline.
- Develop and communicate biological ideas and concepts relevant in everyday life for the benefit of society.
- Students will have acquired the skills and knowledge needed for employment or advanced graduate or professional study in discipline related areas.

2. Programme Duration and Exit Options

The undergraduate programme has multiple exit options with different type of undergraduate award. After successful completion of second semesters with 44 credits, student will be eligible for the award of *Undergraduate Certificate* in Biological Sciences. The student will be awarded *Undergraduate Diploma* in Biological Sciences after successful completion of fourth semester with 88 credits. *Bachelor of Science (Hons)* in Biological Sciences will be awarded to student after successful completion of sixth semester with 132 credits. The student will be awarded *Bachelor of Science (Hons)* in Biological Sciences with Research after successful completion of sixth semester with 176 credits.

Table 1: Exit options with Award and mandatory credit requirement

S. No.	Name of Award	Stage of Exit	Mandatory credits
1	Undergraduate Certificate in Biological Sciences	After successful completion of Semester II	**44**
2	Undergraduate Diploma in Biological Sciences	After successful completion of Semester IV	**88**
3	Bachelor of Science Biological Sciences (Hons.)	After successful completion of Semester VI	**132**
4	Bachelor of Science Biological Sciences (Hons. with Research)	After successful completion of Semester VIII	**176**

Major Discipline (Biological Sciences)

A student pursuing four-year undergraduate programme in Biological Sciences (Core course) shall be awarded B.Sc. Honours degree with Major in Biological Sciences on completion of VIII Semester, if s/he secures at least 50% of the total credits Biological Sciences i.e., at least 88 credits in Biological Sciences out of the total of 176 credits. S/he shall study 20 DSCs and at least 2 DSEs of Biological Sciences in eight semesters.

Minor Discipline (Discipline - 2)

A student of B.Sc. (Hons.) Biological Sciences may be awarded Minor in a discipline, other than Biological Sciences, on completion of VIII Semester, if s/he earns minimum 28 credits from seven GE courses of that discipline.

Definitions and Abbreviations

(i) *Academic Credit*: An academic credit is a unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/ field work per week.

(ii) *Courses of Study*: Courses of the study indicate pursuance of study in a particular discipline. Every discipline shall offer four categories of courses of study, viz. Discipline Specific Core (DSC) courses, Discipline Specific Electives (DSEs), Skill Enhancement Courses (SECs) and Generic Electives (GEs). Besides these four courses, a student will select Ability Enhancement Courses (AECs) and Value-Added Courses (VACs) from the respective pool of courses offered by the University.

(a) *Discipline Specific Core (DSC)*: Discipline Specific Core is a course of study, which should be pursued by a student as a mandatory requirement of his/her programme of study. In Bachelor of Science (Hons.) Biological Sciences programme, DSCs are the core credit courses of Biological Sciences which will be appropriately graded and arranged across the semesters of study, being undertaken by the student, with multiple exit options as per NEP 2020. A student will study three DSC courses each in Semesters I to VI; and one DSC course each in semesters VII and VIII.

(b) *Discipline Specific Elective (DSE)*: The Discipline Specific Electives (DSEs) are a pool of credit courses of Biological Sciences from which a student will choose to study based on his/ her interest. A student of Bachelor of Science (Hons.) Biological Sciences, gets an option of choosing one DSE of Biological Sciences in each of the semesters III to VI, while the student has an option of choosing a maximum of three DSE courses of Biological Sciences in semesters VII and VIII.

(c) *Generic Elective (GE)*: Generic Electives is a pool of courses offered by various disciplines of study (excluding the GEs offered by the parent discipline) which is meant to provide multidisciplinary or interdisciplinary education to students. In case a student opts for DSEs beyond his/ her discipline specific course(s) of study, such DSEs shall be treated as GEs for that student.

(d) *Skill Enhancement Courses (SECs)* are skill-based courses in all disciplines and are aimed at providing hands-on training, competencies, proficiency and skills to students. SEC courses may be chosen from a pool of courses designed to provide skill-based instruction. A student will study one Skill Enhancement Course of 2 credits each (following 1T+ 1P/ 0T+2P credit system) in all the semesters from I to VI. It is to be noted that in the semesters III, IV, V and VI; students can choose either one SEC paper or can join any Internship/ Apprenticeship/ Project (following two credit system).

(e) *Ability Enhancement Course (AEC)* are the courses based upon the content that leads to knowledge enhancement through various areas of study. They are Language and Literature and Environmental Science and Sustainable Development which are mandatory for all disciplines. Every student has to study "Environmental Science and Sustainable Development" courses I and II of two credits each in the first year (I/ II semester) and the second year (III/ IV semester), respectively.

(f) *Value Added courses (VAC)* are common pool of courses offered by different disciplines and aimed towards personality building, embedding ethical, cultural and constitutional values; promote critical thinking, Indian knowledge systems, scientific temperament, communication skills, creative writing, presentation skills, sports and physical education and teamwork which will help in all round development of students.

Programme and Framework

Semester	Discipline Specific Core Course (4 Credits)	Discipline Specific Elective (DSE)/ Generic Elective (GE) (4 Credits)	Ability Enhancement Course (AEC) (2 Credits)	Skill Enhancement Course (SEC)/ Project/ Dissertation (2/6 Credits)	Value Addition Course (VAC) (2 Credits)	Total Credits earn
1.	DSC1 DSC2 DSC3	DSE1/GE1	AEC1	SEC1	VAC1	22
2.	DSC4 DSC5 DSC6	DSE2/GE2	AEC2	SEC2	VAC2	22
Exit option after one year with 44 credits to get Undergraduate Certificate in Biological Sciences						
3.	DSC7 DSC8 DSC9	DSE3/GE3	AEC3	SEC3	VAC3	22
4.	DSC10 DSC11 DSC12	DSE4/GE4	AEC4	SEC4	VAC4	22
Exit option after Two years with 88 credits to get Undergraduate Diploma in Biological Sciences						
5.	DSC13 DSC14 DSC15	DSE4/GE4 DSE5/GE5		Internship/ Apprenticeship/ Project/Community Outreach		22
6.	DSC16 DSC17 DSC18	DSE6/GE6 DSE7/GE7		Internship/ Apprenticeship/ Project/Community Outreach		22
Exit option after Three years with 132 credits to award the degree of B.Sc. (Honours) in Biological Sciences (if S/he earned 80 credits (from 18 DSC's and 2 DSE's) in Biological Sciences						
7.	DSC19	DSE8/GE8 DSE9/GE9 DSE10/GE10		Dissertation / Academic Project (6 Credits)		22
8.	DSC20	DSE11/GE11 DSE12/GE12 DSE13/GE13		Dissertation / Academic Project (6 Credits)		22
Exit option after Four years with 176 credits to award the degree of B.Sc. (Honours with Research) in Biological Sciences (Major Biological Sciences) and Minor (Other Discipline)						

The detailed framework of undergraduate degree programme in Biological Sciences is provided in following Table 2 (a-d).

Table 2a: Semester-wise Course Frame Work (Semester I and II)

S. No.	Course Code	Course Type	Name of the Course	L	T	P	Total Credits
Semester I							
1	BSC101	DSC1	Chemistry – I	3	0	1	4
2	BSC102	DSC2	Light and Life	3	0	1	4
3	BSC103	DSC3	Biodiversity	3	0	1	4
4		GE1	choose from the pool of courses*	3	1	0	4
5		SEC1	choose from the pool of courses**				2
6		AEC1	choose from the pool of courses offered by the University				2
7		VAC1	choose from the pool of courses offered by the University				2
Total Credits 22							
Semester II							
1	BSC151	DSC4	Chemistry – II	3	0	1	4
2	BSC152	DSC5	Biophysics	3	0	1	4
3	BSC153	DSC6	Ecology	3	1	0	4
4		GE2	choose from the pool of courses*				4
5		SEC2	choose from the pool of courses**				2
6		AEC2	choose from the pool of courses offered by the University				2
7		VAC2	choose from the pool of courses offered by the University				2
Total Credits 22							
Exit option after one year with 44 credits to get Undergraduate Certificate in Biological Sciences							

Table 2b: Semester-wise Course Frame Work (Semester III and IV)

S. No.	Course Code	Course Type	Name of the Course	L	T	P	Total Credits
Semester III							
1	BSC201	DSC7	Biomolecules – I	3	0	1	4
2	BSC202	DSC8	Cell Biology – I	3	0	1	4
3	BSC203	DSC9	System Physiology	3	1	0	4
4		GE3/DSE1	choose from the pool of courses*	3	1	0	4
5		SEC3	choose from the pool of courses**				2
6		AEC3	choose from the pool of courses offered by the University				2
7		VAC3	choose from the pool of courses offered by the University				2
Total Credits 22							
Semester IV							
1	BSC251	DSC10	Biomolecules – II	3	0	1	4
2	BSC252	DSC11	Cell Biology – II	3	0	1	4
3	BSC253	DSC12	Molecular Biology	3	0	1	4
4		GE4/DSE2	choose from the pool of courses*				4
5		SEC4	choose from the pool of courses**				2
6		AEC4	choose from the pool of courses offered by the University				2
7		VAC4	choose from the pool of courses offered by the University				2
Total Credits 22							
Exit option after two years with 88 credits to get Undergraduate Diploma in Biological Sciences							

Table 2c: Semester-wise Course Frame Work (Semester V and VI)

S. No.	Course Code	Course Type	Name of the Course	L	T	P	Total Credits
Semester V							
1	BSC301	DSC13	Metabolism and Integration	3	0	1	4
2	BSC302	DSC14	Growth and Reproduction	3	0	1	4
3	BSC303	DSC15	Defense Mechanism	3	1	0	4
4 5		GE5/DSE3	Choose one GE and one DSE from the pool of courses*				4 4
6	BSI301/ BSP301/ BSO301	Internship/ Project/ Community outreach					2
Total Credits 22							
Semester VI							
1	BSC351	DSC16	Evolutionary Biology	3	1	0	4
2	BSC352	DSC17	Immunology	3	0	1	4
3	BSC353	DSC18	Genetics	3	0	1	4
4 5		GE6/DSE4	Choose GE and DSE from the pool of courses*				4 4
6	BSI351/ BSP351/ BSO351	Internship/ Project/ Community outreach					2
Total Credits 22							
Exit option after three years with 132 credits to get B.Sc. (Hons) in Biological Sciences if S/he earned 80 credits (from 18 DSC's and 2 DSE's) in Biological Sciences							

Table 2d: Semester-wise Course Framework (Semester VII and VIII)

S. No.	Course Code	Course Type	Name of the Course	L	T	P	Total Credits
Semester VII							
1	BSC401	DSC19	Genomics and Proteomics	3	0	1	4
2 3 4		GE/DSE*	Choose three DSE courses OR Choose two DSE and one GE courses OR Choose one DSE and two GE courses				4 4 4
5	BSD401	Dissertation (Part-1)					6
Total Credits 22							
Semester VIII							
1	BSC451	DSC20	Bioprocess Technology	3		1	4
2 3 4		GE/DSE*	Choose three DSE courses OR Choose two DSE and one GE courses OR Choose one DSE and two GE courses				4 4 4
5	BSD451	Dissertation (Part-2)					6
Total Credits 22							
Exit option after Four years with 176 credits to award the degree of B.Sc. (Honours with Research) in Biological Sciences and Minor (Discipline 2)							

Discipline Specific Core Papers (DSC): (Credit: 04 each)

A student will study three Discipline Specific Core Courses each in Semesters I to VI and one core course each in semesters VII and VIII. The semester wise distribution of DSC courses over eight semesters is listed in Table 3.

Table 3: Details of Discipline Specific Core (DSC) Courses

Course Courses	Course Code	Semester	Name of the Course
DSC1		I	Chemistry – I
DSC2		I	Light and Life
DSC3		I	Biodiversity
DSC4		II	Chemistry – II
DSC5		II	Biophysics
DSC6		II	Ecology
DSC7		III	Biomolecules – I
DSC8		III	Cell Biology – II
DSC9		III	System Physiology
DSC10		IV	Biomolecules – II
DSC11		IV	Cell Biology – II
DSC12		IV	Molecular Biology
DSC13		V	Metabolism and Integration
DSC14		V	Growth and Reproduction
DSC15		V	Defense Mechanism
DSC16		VI	Evolutionary Biology
DSC17		VI	Immunology
DSC18		VI	Genetics
DSC19		VII	Genomics and Proteomics
DSC20		VIII	Bioprocess Technology

Details of Discipline Specific Elective Papers: (4 credits each)

The Discipline Specific Electives (DSEs) are a pool of credit courses offered by the School of Biological Sciences from which a student will choose to study based on his/ her interest. A student of Bachelor of Science (Hons.) in Biological Sciences gets an option of choosing one DSE of Biological Science in each of the semesters III to VI, while the student has an option of choosing a maximum of three DSE courses of Biological Science in semesters VII and VIII. The distribution of DSE courses is listed in Table 4.

Table 4: Pool of Discipline Specific Elective Courses (DSE)*

S. No.	Course Code	Name of the Course
1	BSE101	Plant Biochemistry
2	BSE102	Animal behaviors and Chronobiology
3	BSE103	Biomaterials
4	BSE104	Microbiology
5	BSE105	Endocrinology
6	BSE106	Stress biology
7	BSE107	Microbial Pharmaceutical Technology
8	BSE107	Research Methodology
9	BSE108	Applied Biology
10	BSE109	Genetic Engineering
11	BSE110	Bioinformatics
12	BSE111	Molecular Basis of infectious Diseases
13	BSE112	Molecular Basis of non-infectious Diseases
14	BSE113	Environmental Biotechnology
15	BSE114	Microbes in Sustainable Agriculture and Development

In addition to the above proposed courses, students may select courses from the Swayam.org as MOOCs courses up to the permissible limit.

Details of Skill Enhancement Courses (2 credits)**

In order to enhance the skills required for advanced studies, research and employability of students various Skill Enhancement Courses (SEC) will be offered to students that are listed in Table 5.

Table 5: Pool of Skill Enhancement Courses (SE)**

S. No	Course Code	Name of the Course
1	BSS101	Wildlife Conservation & Management - I
2	BSS102	Wildlife Conservation & Management - II
3	BSS103	Medical Diagnostics
4	BSS104	Biofertilizers
5	BSS105	Biofertilizers
6	BSS106	Biotechnology and Human Welfare
7	BSS107	Recombinant DNA Technology
8	BSS108	Biochemical Techniques
9	BSS109	Water Analysis and Testing
10	BSS110	Intellectual Property Right
11	BSS111	Himalayan ecology and traditional knowledge

In addition to the above proposed courses, students may select courses from the Swayam.org as MOOCs courses up to the permissible limit.

Details of Generic Elective Courses (GE) (4 credits)*

Generic Elective courses offer interdisciplinary education to students. Various generic elective courses offered by the School of Biological Sciences are listed below in Table 6.

Table 6: Pool of Generic Elective Courses (GE)*

S. No	Course Code	Name of the Course
1	BSG101	Biostatistics
2	BSG102	Natural Resource Management
3	BSG103	Plant diversity and animal diversity
4	BSG104	Environment and Public Health
5	BSG105	Food, Nutrition and Health

6	BSG106	Human Physiology
7	BSG107	Gene organization, Expression and Regulation
8	BSG108	Biotechnology and Human Welfare
8	BSG109	Fundamentals of Genetic Engineering
9	BSG110	Industrial and Food Microbiology
10	BSG111	Microbial Metabolism
11	BSG112	Bioethics and Biosafety

In addition to the above proposed courses, students may select courses from the Swayam.org as MOOCs courses up to the permissible limit.

DISCIPLINE SPECIFIC COURSES

Course Code	**:**	**BSC101**
Course Title	**:**	**Chemistry – I (Basic concepts of Organic Chemistry)**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**I**

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. It also aimed to develop the basic understanding This basic knowledge will empower the students to develop an understanding about chemistry of biomolecules such as proteins, nucleic acids, carbohydrates and lipids.

Course Outcome:

- Students will understand and apply the fundamental principles of chemistry to biological molecules.
- Students will learn to recognize stereochemistry of a biomolecule and give a rational explanation of its biological reactivity based on stereochemistry.
- Students will learn basic concepts of concentrations, pH, buffer, acid and bases.

Course Content (Chemistry – I)

Unit I: Aqueous Solutions and Concentrations

Water, pH and buffers, concept of pKa (titration curves of amino acids), Henderson-Hasselbach equation, buffering zone, buffer index, concept of pI and zwitter ion.

Concentrations (percentage composition, molarity, molality, normality, mole fraction and parts per million).

Unit II: Concept of Acids and Bases.

Arrhenius concept, Bronsted Lowry concept, Lewis's concept, the levelling effect, effect of pH on the structure of biomolecules.

Unit III: Chemical Bonding and Molecular Forces

Introduction to ionic interactions and covalent bond, inter-molecular and intra-molecular forces, types of intermolecular forces and their characteristics: ion-dipole, dipole-dipole, dipole-induced dipole, and dispersion (London) forces, hydrogen bond (intra-molecular and inter-molecular), effect of inter/intra-molecular forces on structure of different biomolecules.

Unit IV Stereochemistry

Stereochemistry and its importance. Geometrical isomerism, cis-trans and E/Z nomenclature Optical isomerism – optical activity, plane polarized light, enantiomerism, chirality, specific molar rotation, Stereoisomerism with two chiral centers: Diastereomers, mesoisomers, Resolution of racemic modification. Projection diagrams of stereoisomers: Fischer, Newman, and Sawhorse projections. Relative Configuration: D/L designation. Absolute Configuration: R/S designation of chiral centres, Conformational isomerism – ethane, butane and cyclohexane, diagrams, and relative stability of conformers.

Recommended Texts:

1. Patrick E. McMahon, Bohdan B. K.; Claes W., Organic Chemistry CRC Press, 2017
2. Clayden J., Greeves N.,Warren S., Organic Chemistry 2nd Edition Oxford University Press
3. David R. Klein Organic Chemistry, 2nd Edition - Standalone Book 2nd Edition Willey Publication
4. David R. Klein Organic Chemistry As a Second Language: First Semester Topics 4th Edition Willey Publication
5. Bruice P.Y. Organic Chemistry, Global Edition 8th Edition Pearson Publication

List of Experiments (Chemistry – I)

Practical

1. Preparation of solutions based on molarity, normality, percentage, dilutions etc.
2. Preparation of buffers.
3. Estimation of Mohr's salt/ oxalic acid by titrating with $KMNO_4$.
4. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
5. To find pKa value of given acetic acid

Course Code	**:**	**BSC102**
Course Title	**:**	**Light and Life**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**I**

Course Objectives:

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 organisms produce their own (Bioluminescence). Maintaining coordination with the surrounding light regime is fundamentally important to the inherent biological clock in organisms which needs re-calibration almost every 24 hours (Circadian Rhythms); whereas a disruption may lead to adverse effects. 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.

Course Outcome:

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

Course Content (Light and Life)

Unit I

Nature of light, spectrum of light which is useful/ harmful (ionizing radiation) for various biological processes in life of plants and animals. Unit of light energy (Photon, quantum), the different Photo Biological reactions. Measurement of light (Lux, Foot Candle). Comparative account of chemistry and functional roles of pigments associated with harvesting light energy: pigments/receptors of light, chlorophylls, caroteniods, phycobilinoproteins, bacteriochlorophylls, phytochromes rhodopsin etc. Photoreception in animals, evolution of eye and visual processing in vertebrate retina.

Unit II

Photosynthesis: History, Photosynthetic equation, Light and dark reactions, mechanism of photolysis of water and oxygen evolution, Q cycle, O_2 evolving complex; C_3, C_4, CAM plants, spectrum of photoautotrophs, photoautotroph vs photoheterotrophs; Photoautotroph vs. chemoautotroph, structure of chloroplast and quantasome, Anoxygenic and oxygenic photosynthesis, reaction centers. Bacterial Photosynthesis

Unit III

Bioluminescence: definition, discovery, diversity of organisms (plants and animals), photoreceptors - distribution, mechanism; General account of effect of light on morphology and physiology (stomatal opening and closing, transpiration, respiration, growth and differentiation) Phytochrome mediated photomorphogenesis phenomena - seed germination etc. Photoperiodism: LDP, SDP, DNP plants, vernalization, vernalin, etiolation and de- etiolation. Changes during fruit ripening process as affected by light.

Unit IV

Behavioural aspects of ecology and physiology: circadian rhythms, jetlag, rhythm of heart beat, melanocytes and skin colour, chromatophores and colour changes in animals. Light as an inducer for biosynthesis of enzymes, hormones and other biomolecules.

Recommended Texts:

1. Hall D. O., Rao K. K. Photosynthesis (New Studies in Biology) Cambridge University Press
2. Kochhar S. L., Gujral Sukhbir Kaur. Plant Physiology: Theory and Applications October 2021. Cambridge University Press
3. Alison M. Smith George Coupland Liam Dolan Plant Biology Garland Science 2009
4. John Alcock Animal Behavior: An Evolutionary Approach, 7 April 2009 Sinauer Associates
5. Agarwal V.K. Animal Behaviour (ethology) S Chand & Company 2010

List of Experiments (Light and Life)

Practical

1. Demonstration of
   (a) etiolation and de etiolation;
   (b) Light and CO_2 are essential for photosynthesis (Moll's half leaf experiment)and measure oxygen evolution during photosynthesis
   (c) Oxygen liberation during photosynthesis using *Hydrilla,* Measurement of lightusing Luxmeter, light penetration in water using Secchi dis*c*
   (d) *Berle*se funnel experiment to demonstrate the effect of light on soil fauna
   (e) Animal migration in aquatic ecosystems during day and night (pictures only)
   (f) To study the estrous cycle of rat
2. Chemical separation of chloroplast pigments/Chromatographic separation ofchloroplast pigments.
3. Demonstration of Hill's reaction and study of the effect of light intensity (any twolight conditions).
4. Study of the effect of red and blue light on seed germination and development ofpigments during fruit ripening.
5. Photographs/slides/specimens of photoautotrophic and photosynthetic bacteria, chloroplast, quantasome, bioluminescent organisms (plants and animals)
6. To test / survey for colour blindness using Ishihara charts

Course Code	**:**	**BSC103**
Course Title	**:**	**Biodiversity**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**I**

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, its components and relevance of conservation. Emphasis will be on developing interest and invoking a sense of responsibility among students towards conservation of plant and animal biodiversity. The course explores different tools and techniques used to study biodiversity such as mapping of forests and animal populations of rare and endangered species.

Course Outcome:

- Impart knowledge of biodiversity and understand characteristic features of different plant and animal life forms.
- Understand recent advances in technology used in mapping and conservation of biodiversity
- Learn basic concepts of bioremediation and its applications in environmental remediation

Course Content (Biodiversity)

Unit I Defining Biodiversity

Components of Biodiversity. Biodiversity crisis and biodiversity loss. Importance of biodiversity in daily life. Biodiversity and climate change.

Unit II Ecosystem and Biodiversity

Types of Ecosystems: India as mega biodiversity Nation. Hot spots and biodiversity in India. Biodiversity and Ecosystem functioning. Plant and Animal systematic. Species concept in biodiversity studies.

Unit III Modern Tools and Techniques in Biodiversity Assessment

Endemism, endemic plants and animals**;** Assessment of mapping of biodiversity**;** GIS/Remote sensing**;** Biotechnology and Conservation, IUCN**;** Germplasm banks, National Parks, Botanical Gardens**;** Wildlife Sanctuaries, Bioresources, Biodiversity for ecological restoration

Unit IV Bio-prospecting

Representative type (one each) studies from Cryptogams, Phanerogams, Non-chordates and Chordates**;** Sacred flora and fauna. Bio-prospecting - Microorganisms as a source of novel enzymes, antibiotics, antiviral agents; Immunosuppressive agents and other therapeutic agents. Botanicals for Biocontrol, Health and biodiversity.

Recommended Texts:

1. Chapman, J.L. & Reiss, M.J. 1992. Ecology: Principles and applications. Cambridge Univ. Press. 294 pages.
2. Cunningham, W.P. & Cunningham, M.A. 2003. Principles of environmental science, inquiry and applications. Tata McGraw-Hill Publ. Co. Ltd. 424 pages.
3. Faurie, Claude et al. 2001. Ecology: Science and practice. Oxford & IBH Publ. Co. Pvg. Ltd. 321 pages.
4. Kemp, David D. 1994. Global environmental issues: A climatological approach. Routledge, London. 224 pages.
5. Klarke, G.L. 1954. Elements of ecology. John Wiley & Sons, Inc. 560 pages.
6. Kendeigh, S.C. 1975. Ecology, with special reference to animals and man. Prentice-Hall, India Pvt. Ltd. 474 pages.

List of Experiments (Biodiversity)

Practical

1. Measuring biodiversity of ecological communities
2. Study of a simple ecosystem (suggested habitats: pond, river, estuarine, grassland, forest and desert) and description of the biotic and abiotic components of the ecosystem.
3. Study of five endangered plant species of India
4. Enlist the biodiversity of Localized area
5. Study of five endangered animal species of India

Course Code	**:**	**BSC151**
Course Title	**:**	**Chemistry – II (Physical Chemistry for Bioscience)**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**II**

Course Objectives:

The objective of this course is to develop a basic understanding of thermodynamic studies with the calculation of energies and interaction of biomolecules with their neighboring environment. The fundamentals of chemical kinetics are also covered to gives an understanding of chemical kinetic of biomolecules. This basic knowledge will empower the students to develop an understanding about chemistry of biomolecules such as proteins, nucleic acids, carbohydrates and lipids.

Course Outcome:

- Students will be able to identify the type of metabolic reaction and draw reaction mechanisms for key metabolic processes
- The students will gain an insight into thermodynamics and basic principles of thermochemistry and successfully extend the concepts learnt in this course to biological systems
- The students will learn the fundamentals of photochemistry and its importance in biology.

Course Content (Chemistry - II)

Unit I: Chemical Energetics

Review of the Laws of Thermodynamics.
Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data.
Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.
Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit II: Chemical Equilibrium

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^{o}, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Unit III: Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero and first order reactions. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

Unit 6: Photochemistry

Laws of photochemistry. Fluorescence and phosphorescence. Quantum efficiency and reasons for high and low quantum yields. Primary and secondary processes in photochemical reactions. Photochemical and thermal reactions.

Recommended Texts:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 9th Ed., Oxford University
1. Press (2011).
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
5. Chang, R. Physical Chemistry for the Biosciences. University Science Books (2005).

List of Experiments (Chemistry - II)

Practical

1. Determination of heat capacity of a calorimeter for different volumes.
2. Determination of the enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of integral enthalpy of solution of salts (endothermic and exothermic).
4. Initial rate method: Iodide-persulphate reaction
5. Integrated rate method: (Acid hydrolysis of methyl acetate with hydrochloric acid; Saponification of ethyl acetate)
6. Study the kinetics of interaction of crystal violet with sodium hydroxide colourimetrically.

Course Code	**:**	**BSC152**
Course Title	**:**	**Biophysics**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**II**

Course Objectives:

This interdisciplinary course introduces the basic concepts of physics and their applications in biology for better understanding of various biological processes at cellular and molecular level. This knowledge will empower the students to develop a basic understanding about the principles and concepts of Biophysics and will enable the students to develop quantitative approaches to solve physical/biological problems.

Course Outcome:

- Develop a basic understanding about the principles and concepts of Biophysics
- Develop quantitative approaches to solve biological problems involving principles of physics
- Understand the spectroscopic principles and their applications in biomolecules analysis
- Understand the fundamental principles involved in the structure and function of biological membrane

Course Content (Biophysics)

Unit I Mechanics

Newton's Laws of motion. Dynamics of a system of particles, Conservation of momentum and energy, work energy theorem. Conservation of angular momentum, torque, Motion of a particle in central force field. Special Theory of Relativity: Constancy of speed of light, postulate of Special theory of relativity, length contraction, time dilation, relativistic velocity addition, Mass-energy momentum relations.

Unit II Waves and Oscillations

Fundamentals of waves and oscillation, Doppler effect, effects of vibrations in humans, physics of hearing, heartbeat. Modern optics: Two slit Interference, Diffraction, Resolving power, Resolution of the eye, Laser characteristics, Principle, Population inversion, Application of laser in medical science, Polarization of EM wave, Malus Law, Polarizing materials, Polarizer, Analyzer.

Unit III Biological membranes

Colloidal solution, Micelles, reverse micelles, bilayers, liposomes, phase transitions of lipids, active, passive and facilitated transport of solutes and ions, Fick's Laws, Nernst Planck Equations, Diffusion, Osmosis, Donnan effect, permeability coefficient. Ionophores, transport equation, membrane potential, water potential.

Unit IV Spectroscopic techniques

Basic principles of electromagnetic radiation, energy, wavelength, wave numbers and frequency. Review of electronic structure of molecules (Molecular Orbital theory), absorption and emission spectra. Beer-Lambert law, light absorption and its transmittance. UV and visible spectrophotometry-principles, instrumentation and applications. fluorescence spectroscopy, static & dynamic quenching, energy transfer, fluorescent probes in the study of protein, nucleic acids, Infra-red spectroscopy, light scattering in biology, circular dichroism, optical rotatory dispersion, magnetic resonance spectroscopy.

Recommended Texts:

1. Meyer B. Jackson Molecular and Cellular Biophysics 2006
2. Donald L. Pavia Introduction to Spectroscopy 2015, Cengage India Private Limited
3. Keith Wilson, John Walker Principles and Techniques of Biochemistry and Molecular Biology Cambridge University Press, 21-Mar-2005
4. Nelson Philip Biological Physics: Energy, Information, 2007, W. H. Freeman
5. William Bialek Biophysics: Searching for Principles, Princeton University Press

List of Experiments (Biophysics)

Practical

1. Determination of acceleration due to gravity using Kater's Pendulum
2. Determination of the acceleration due to gravity using bar pendulum
3. Determination of the frequency of an electrically maintained tuning fork by Melde's Experiment
4. Determination of the coefficient of Viscosity of water by capillary flow method (Poiseuille's method)
5. Verification of Beer Law
6. Determination of Molar Extinction coefficient
7. Determination of CMC for a detergent
8. Effect of different solvents on UV absorption spectra of proteins.

Course Code	**:**	**BSC153**
Course Title	**:**	**Ecology**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**II**

Course Objectives:

The course will enable students to understand the basic concepts in ecology and levels of organization. It will help them understand various aspects of a population and interactions among individuals of same as well as different species. It will help them to understand the structure and functions of community and its processes. Students will be able to understand the components of an ecosystem, energy flow and nutrient cycling.

The course covers basics concepts as well as applied aspects required in restoration of degraded ecosystems. Students will be able to understand trade-off in life history characteristics of organism and various behaviors shown by organisms.

Course Outcome:

- Students will be able to comprehend the principles and applications of ecology and ecosystem.
- Aware about the importance of ecosystem in general and the effects of changes in ecosystem.
- Understand the principles and applications of ecology and ecosystem.
- Learn the techniques used for the quantitative and qualitative estimation of biotic and abiotic components of an ecosystem.
- Gain knowledge about the density, frequency and diversity of species in an ecosystem and key factors responsible for changes in natural ecosystem

Course Content (Ecology)

Unit I: Introduction to Ecology
Relevance of studying ecology, History of ecology, Autecology and synecology, levels of organization, Laws of limiting factors, detailed study of temperature and light as physical factors.

Unit II: Population
Unitary and Modular populations, Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; Exponential and logistic growth, equation and patterns, r and K strategies, Population regulation - density-dependent and independent factors; Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses

Unit III: Community
Community characteristics: Dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect; Ecosystem development (succession) with example; Theories pertaining to climax community

Unit 4: Ecosystem
Types of ecosystems with one example in detail, Food chain, Detritus, and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids, and Ecological efficiencies. Nutrient and biogeochemical cycle with one example of Nitrogen cycle

Practical

1. Study through specimens/photographs/slides of Parasitic angiosperms, Saprophytic angiosperms, VAM fungi, Root nodules, Corolloid roots, Mycorrhizal roots, Velamen roots, Lichen as pollution indicators.
2. Principle and function of Sechi disc, Atmometer, Anemometer, Hygrometer, Hair hygrometer, Luxmeter, Rain guage, Soil thermometer, Min-Max thermometer
3. To determine a minimal quadrat area for sampling in the given simulation sheet
4. To determine density/frequency/abundance of the vegetation by quadrat method in thefield or on given simulation sheet
5. To determine soil texture, soil density, bulk density, particle density and pore space.
6. To determine water holding capacity and percolation rate of soil.
7. To determine pH, Cl, SO_4, NO_3, base deficiency, organic matter, cation exchange capacity in the soil.
8. Plotting of survivorship curves from hypothetical life table data.

Course Code	**:**	**BSG101**
Course Title	**:**	**Biostatistics**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**I**

Course Objectives:

The objective of this course is to acknowledge, appreciate and effectively incorporate the basic statistical concepts indispensable for carrying out and understanding biological hypothesis, experimentation as well as validations. It is aimed at creating awareness about the applications of statistics in biological sciences along with building confidence in students to logically test their experimental data with an appropriate set of test of significance.

Course Outcome:

- Students will be acquainted with the concept of statistics and its application in biological sciences.
- It will introduce students to statistical methods in order to understand the underlying principles, as well as practical guidelines of “how to do it” and “how to interpret it” statistical data particularly for biosystems.

Course Content (Biostatistics)

UNIT I

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT II

Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson, and Normal distributions.

UNIT III

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)

UNIT IV

Correlation and Regression. Emphasis on examples from Biological Sciences.

Recommended Texts:

1. Jan Lepš, Petr Šmilauer Biostatistics with R: An Introductory Guide for Field Biologists Cambridge University Press 2000
2. A.K. Sharma Text Book of Biostatistics Discovery Publishing House, 2005
3. Chap T. Le, Lynn E. Eberly Introductory Biostatistics 2nd Edition Wiley Publications 2012
4. John E. Havel, Raymond E. Hampton, Scott J. Meiners Introductory Biological Statistics, Fourth Edition 4th Edition Waveland Press, Inc. 2019.

Practical

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square

Course Code	**:**	**BSS101**
Course Title	**:**	**Wildlife Conservation & Management - I**
Total Credits	**:**	**2 (Theory 2)**
L-T-P	**:**	**2-0-0**
Total Hours	**:**	**Theory 45**
Semester	**:**	**I**

Course Objectives:

The course aims to familiarize students with diverse aspects of wildlife and their conservation, including the significance of wildlife, analysis of habitats using the conventional and advance techniques. It will also give insights to the human-wildlife conflicts and strategies to avoid it.
The main objective of this course is to develop interest and invoke a sense of responsibility among students towards wildlife conservation. This course will motivate students to pursue career in the field of wildlife conservation and management

Course Outcome:

- Students will learn about the importance of wildlife, its conservation and management.
- Students will learn about major causes of wildlife depletion and important *in-situ* and *ex-situ* strategies for the conservation of their genetic diversity.
- Students will learn about reasons of human-wildlife conflicts.
- Students will gain knowledge about the Protected Area Networks in India, Ecotourism, Human-animal conflict and other challenges in wildlife management.
- Students will be encouraged towards critical thinking, literature review; scientific writing as well as presentations and participation in citizen science initiatives with reference to wildlife.

Course content (Wildlife Conservation & Management – I)

UNIT - I: Scope and Importance of Wildlife of India

Definition of Wildlife: Causes of wildlife depletion; Economic importance of wildlife; need for wildlife conservation; rare, endangered, threatened and endemic species of fishes, amphibians, reptiles, birds and mammals in India- India as a mega wildlife diversity country.

Unit II: Habitat analysis

Evaluation and management of wildlife - Physical parameters and Biological Parameters.
Standard evaluation procedures: Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method, Geographical Information System (GIS), Global Positioning System (GPS), and Remote Sensing (RS).

Unit III: Human-wildlife conflict

Poaching, illegal trading, conflict management and shifting from extraction to preservation.
effect of extinction of a species on ecosystem; Forest landscape restoration.

UNIT - IV: Conservation of Wildlife

In-situ and ex-situ conservation: Wildlife Sanctuaries, National Parks, Tiger Reserves and Biosphere reserves: Definition, formation, management, and administration; Wildlife Projects: Tiger, Elephant, and Lion; Zoos and Zoological Parks: Definition- Aims of Zoos- Formation and Management of Zoos and Zoological Parks - Central Zoo Authority of India; Captive breeding: Aims, Principles, methods; Role of Government and Non-Governmental organizations in conservation.

Recommended Texts:

1. Douglas W. Tallamy Nature's Best Hope: A New Approach to Conservation That Starts in Your Yard Hardcover – Illustrated, Timber Press Publications February 4, 2020
2. DK, Don E. Wilson, Smithsonian Institution Wildlife of the World Hardcover – Illustrated, October 6, 2015
3. Tapashi gupta Ecology, Wildlife Conservation & Management Paperback – 1 January 2017
4. Fred Van Dyke, Rachel L. Lamb Conservation Biology: Foundations, Concepts, Applications 3rd ed. 2020 Edition Springer Publications

Course Code	**:**	**BSG102**
Course Title	**:**	**Natural Resource Management**
Total Credits	**:**	**4 (Theory 4)**
L-T-P	**:**	**4-0-0**
Total Hours	**:**	**Theory 45**
Semester	**:**	**I**

Course Objectives:

The course will enable students to understand the role of natural resources in maintaining ecological balance. It will help them to appreciate different types of natural resources and the threats faced by them. The course covers basics concepts as well as applied aspects required in conservation and management of natural resources.

Course Outcome:

- Students will be able to define and differentiate between biological and physical natural resources.
- Students will appreciate the role of natural resources in ecological, economic and socio-cultural activities.
- Students will understand the effect of anthropogenic interference on natural resources.
- Students will understand and appreciate the laws and policies associated with resource management and conservation.

Course Code	**:**	**BSG102**
Course Title	**:**	**Natural Resource Management**
Theory/Practical	**:**	**Theory**
Credits	**:**	**4**
Semester	**:**	**I**

Unit I: Natural resources and Sustainable utilization

Definition and types of natural resources; Concept and approaches (economic, ecological and socio-cultural) of Sustainable utilization

Unit II: Land and Water

Land utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management. Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands;Threats and management strategies

Unit III: Forests

Definition, Cover and its significance (with special reference to India); Major and minorForest products; Depletion; Management.

Unit IV: Energy

Renewable and non-renewable sources of energy, and their management

Unit V: Contemporary practices in resource management

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

Recommended Texts:

1. Chad P. Dawson, John C. Hendee. Introduction to Forests and Renewable Resources, Ninth Edition, Waveland Press, Inc.
2. Enric Sala The Nature of Nature: Why We Need the Wild Hardcover – August 25, 2020
3. Crebs C. J. Ecology Pearson Publication, 2013
4. Whittaker R. H. Communities and Ecosystems Macmillan USA Publication
5. Sharma P. D. Ecology and Environment Rastogi Publications

Course Code	**:**	**BSS102**
Course Title	**:**	**Wildlife Conservation & Management - I**
Total Credits	**:**	**2 (Theory 2)**
L-T-P	**:**	**2-0-0**
Total Hours	**:**	**Theory 45**
Semester	**:**	**I**

Course Objectives:

The course aims to familiarize students with wildlife of Uttarakhand, major natural and anthropogenic threats as well as management of their population and habitats. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals. The main objective of this course is to develop interest and invoke a sense of responsibility among students towards wildlife conservation. This course will motivate students to pursue career in the field of wildlife conservation and management

Course Outcome:

- Students will learn about the wildlife and microbial diversity in Uttarakhand.
- Students will learn about the importance of wildlife, its conservation and management.
- Students will learn about the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and restoration.
- Students will be encouraged towards critical thinking, literature review; scientific writing as well as presentations and participation in citizen science initiatives with reference to wildlife.

Course content (Wildlife Conservation & Management – II)

UNIT - I: Wildlife in Uttarakhand

National Parks (Corbett National Park; Nanda Devi National Park; Valley of Flowers National Park; Rajaji National Park; Gangotri National Park; Govind National Park), *Sanctuaries* (Govind wildlife sanctuary; Kedarnath wildlife sanctuary; Askot wildlife sanctuary; Sonanadi wildlife sanctuary; Binsar wildlife sanctuary; Mussoorie wildlife sanctuary; Nandhaur Wildlife Sanctuary), *Conservation reserves* in Uttarakhand; Microbial Diversity in Uttarakhand.

UNIT - II: Wildlife Census Techniques

Planning census – Total counts - Sample counts – Basic concepts and applications - Direct count (block count, transect methods, Point counts, visual encounter survey, waterhole survey); Indirect count (Call count, track and signs, pellet count, pugmark, camera trap)-Identifying animals based on indirect signs; Capture-recapture techniques.

UNIT - III: Management of excess population & translocation

Bio- telemetry; Common diseases of wild animal; Quarantine; Population Viability and Habitat Analysis (PVHA), captive breeding and propagation, rescue, rehabilitation and reintroduction, gene banks, ex-situ and in-situ conservation.

Unit IV: Sustainable wildlife management

Eco tourism / wild life tourism in forests; various Environmental movements in India: Bishnoi movement, Chipko movement, Narmada bachao andolan, Silent valley movement, Baliyapal movement.

Recommended Texts:

1. Enric Sala The Nature of Nature: Why We Need the Wild Hardcover – August 25, 2020
2. Bikram Grewal Wildlife of India (Princeton Pocket Guides, 18) Paperback Princeton University Press May 10, 2022
3. Gusain OP, Kandari OP. Garhwal Himalaya Nature, Culture & Society Srinagar: Transmedia. 2001
4. A. Kumar Bioresources of Uttarkhand: Their Conservation and Management Hardcover 16 February 2011
5. Sanjeeva Pandey & Anthony J Gaston The Great Himalayan National Park: The Struggle to Save the Western Himalayas Hardcover Niyogi Books Pvt. Ltd. – 17 December 2018