Syllabus

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)

(Updated on August, 2024)

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 semesterswith 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 and2 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	Evolutionary Biology - I	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– II	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	1	0	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/ Lab Course 1					6
Total Credits 22							
Semester VIII							
1	BSC451	DSC20	Bioprocess Technology	3	1	0	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/ Lab Course 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

CourseType	Course Code	Semester	Name of the Course
DSC1	BSC101	I	Chemistry – I
DSC2	BSC102	I	Light and Life
DSC3	BSC103	I	Biodiversity
DSC4	BSC151	II	Chemistry – II
DSC5	BSC152	II	Biophysics
DSC6	BSC153	II	Ecology
DSC7	BSC201	III	Biomolecules – I
DSC8	BSC202	III	Cell Biology – I
DSC9	BSC203	III	System Physiology
DSC10	BSC251	IV	Biomolecules – II
DSC11	BSC252	IV	Cell Biology – II
DSC12	BSC253	IV	Molecular Biology
DSC13	BSC301	V	Metabolism and Integration
DSC14	BSC302	V	Growth and Reproduction
DSC15	BSC303	V	Evolutionary Biology – I
DSC16	BSC351	VI	Evolutionary Biology – II
DSC17	BSC352	VI	Immunology
DSC18	BSC353	VI	Genetics
DSC19	BSC401	VII	Genomics and Proteomics
DSC20	BSC451	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	BSE108	Microbes in Sustainable Agriculture and Development
9	BSE109	Applied Biology
10	BSE110	Genetic Engineering
11	BSE111	Bioinformatics
12	BSE112	Molecular Basis of Infectious Diseases
13	BSE113	Molecular Basis of Non-infectious Diseases
14	BSE114	Plant Biotechnology
15	BSE115	Animal Biotechnology
16	BSE116	Environmental Biotechnology

In addition to the above proposed courses, students may select courses from the Swayam.org as MOOCs courses upto 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 (SEC)**

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	Scientific Communication
6	BSS106	Economic applications of plant and microbial secondary metabolites
7	BSS107	Recombinant DNA Technology
8	BSS108	Biochemical Techniques
9	BSS109	Water Analysis and Testing
10	BSS110	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 coursesoffered 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
9	BSG109	Fundamentals of Genetic Engineering
10	BSG110	Industrial and Food Microbiology
11	BSG111	Microbial Metabolism
12	BSG112	Bioentrepreneurship Development
13	BSG113	Intellectual Property Rights
14	BSG114	Research Methodology and Science Communication

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**
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 provide students with a comprehensive understanding of essential chemical principles, including aqueous solutions, acids and bases, chemical bonding, and stereochemistry. Students will learn to analyze pH, buffers, and amino acid titration curves, and master various concentration units. They will explore fundamental theories of acids and bases and examine the effects of pH on bimolecular structures. The course will also cover the nature of ionic and covalent bonds, intermolecular and intramolecular forces, and their influence on bimolecular stability. Additionally, students will gain insights into stereochemistry, learning to identify and represent different isomers and assign chiral configurations. Through this curriculum, students will develop critical analytical skills necessary for advanced studies and professional applications in chemistry.

Course Outcome:

- Upon completing this course, the students will be able to critically analyze the properties of aqueous solutions, including pH, buffering, and titration curves of amino acids.
- They will be proficient in calculating concentrations in various units and applying theoretical concepts of acids and bases to real-world scenarios.
- The students will demonstrate a thorough understanding of chemical bonding, including ionic and covalent interactions, and the influence of intermolecular forces on bimolecular structures.
- They will also develop the ability to evaluate the stability of conformational isomers.
- The students will possess the analytical skills and chemical knowledge essential for advanced academic pursuits and professional work in chemistry and related fields.

Course Content (Chemistry – I):

Unit I: Aqueous Solutions and Concentrations **No. of Hours: 10**

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 **No. of Hours: 10**

Arrhenius concept, Bronsted Lowry concept, Lewis's concept, the 16eveling effect, effect of pH on the structure of biomolecules.

Unit III: Chemical Bonding and Molecular Forces **No. of Hours: 10**

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 **No. of Hours: 15**

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.

List of Experiments:

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

Text and References:

1. R.L. Madam, Chemistry for degree students (2020). S. Chand Publishing, India
2. Arun Bahl, B. S. Bahl (2019). A Textbook Of Organic Chemistry (20^{th} Edn). S Chand Publishing
3. J.D. Lee. A new concise inorganic chemistry, USA: Wiley-Blackwell
4. Patrick E. McMahon, Bohdan B. K.; Claes W., Organic Chemistry CRC Press, 2017
5. Clayden J., Greeves N.,Warren S., Organic Chemistry 2^{nd} Edition Oxford University Press

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:

This course aims to elucidate the multifaceted roles of light in biological systems, examining its impact on both plant and animal physiology. Students will explore the nature and spectrum of light, understanding its beneficial and harmful effects, particularly ionizing radiation. The course will delve into the measurement of light and the chemistry and functionality of light-harvesting pigments. Detailed discussions will cover photosynthesis, including historical perspectives, mechanisms of photolysis, and distinctions between various types of photosynthetic organisms. The phenomenon of bioluminescence, its biological significance, and its effects on organismal morphology and physiology will be investigated. The course will also address the behavioral and physiological responses to light, such as circadian rhythms, photoperiodism, and the role of light in biosynthesis, providing students with a comprehensive understanding of photobiology.

Course Outcome:

- Students Upon successful completion of this course, students will have gained a thorough understanding of the fundamental principles and advanced concepts related to the interaction of light with biological systems.
- They will be able to explain the nature of light, its measurement, and its spectrum, including both beneficial and harmful effects on plants and animals.
- Students will develop expertise in the mechanisms of photosynthesis and bioluminescence, understanding their biological significance and practical applications.
- They will also be able to analyze the physiological and behavioral responses of organisms to light, such as circadian rhythms and photoperiodism.
- Additionally, students will be proficient in comparing and contrasting different types of photosynthetic organisms and their adaptations.

Course Content (Light and Life):

Unit I: **No. of Hours: 13**

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: **No. of Hours: 12**

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: **No. of Hours: 10**

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: **No. of Hours: 10**

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.

List of Experiments:

1. Demonstration of
    a. Etiolation and deetiolation;
    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 light using Luxmeter, light penetration in water using Secchidisc
    d. *Berlese* 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 of chloroplast pigments.
3. Demonstration of Hill's reaction and study of the effect of light intensity (any two light conditions).
4. Study of the effect of red and blue light on seed germination and development of pigments 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

Text and References:

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. Björn, L. O. (2015) 3rd Ed. Photobiology: Science of Light and Life, L.O. Bjorn., Springer
4. Shimomura O., (2012) *Bioluminescence: Chemical Principles and Methods*, World Scientific
5. Alison M. Smith George Coupland Liam Dolan Plant Biology Garland Science 2009
6. Singh V., Pande P.C., Jain D.K.- A Text Book Of Botany. Rastogi Publications

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:

This course provides a comprehensive exploration of biodiversity, focusing on its components, the current biodiversity crisis, and its critical importance in daily life and climate change contexts. Students will study India's diverse ecosystems, biodiversity hotspots, and their impact on ecosystem functions. The course also covers modern tools such as GIS/Remote sensing and biotechnology for biodiversity assessment and conservation, including germplasm banks and protected areas like national parks and wildlife sanctuaries. Additionally, students will explore bio-prospecting across various biological categories - from microorganisms to sacred plants and animals - for potential applications in health, biocontrol, and ecological restoration.

Course Outcome:

- Upon completion of this course, students will have a comprehensive understanding of biodiversity, encompassing its components, the global biodiversity crisis, and its significance in daily life and climate change dynamics.
- They will be proficient in identifying and categorizing ecosystems, with a particular focus on India's biodiversity hotspots.
- Students will acquire practical skills in utilizing modern tools such as GIS/Remote sensing and biotechnological methods for assessing and conserving biodiversity.
- Moreover, they will appreciate the importance of protected areas like national parks and wildlife sanctuaries, along with the role of germplasm banks in biodiversity conservation.
- The students will also be equipped to engage in bio-prospecting activities, exploring potential applications of diverse biological resources in health, biocontrol, and ecological restoration efforts.

Course Content (Biodiversity):

Unit I: Defining Biodiversity **No. of Hours: 10**

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

Unit II: Ecosystem and Biodiversity **No. of Hours: 10**

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 **No. of Hours: 10**

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 **No. of Hours: 15**

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.

List of Experiments (Biodiversity)

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

Text and References:

1. Wilson, E. O., (1998). *Biodiversity*. National Academic Press.
2. Cunningham, W.P. & Cunningham, M.A. 2003. Principles of environmental science, inquiry and applications. Tata McGraw-Hill Publ. Co. Ltd. 424 pages
3. Erach Bharucha (2022). Environmental Studies for Undergraduate courses. Universities Press (India) Private Limited.
4. Campbell N. A., (2008). Biology 8th Edition, Pearson
5. Chapman, J.L. & Reiss, M.J. Ecology: Principles and applications. Cambridge Univ. Press. 294 pages.
6. Faurie, Claude et al. 2001. Ecology: Science and practice. Oxford & IBH Publ. Co. Pvg. Ltd. 321 pages.

Course Code	**:**	**BSG101**
Course Title	**:**	**Biostatistics**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**I**

Course Objectives:

The course aims to provide students with a comprehensive understanding of foundational statistical concepts and their practical application in biological sciences. Starting with data types and collection methods, students will learn to classify data and represent it graphically. They will explore measures of central tendency, dispersion, skewness, and kurtosis to characterize data distributions. Probability theory will be introduced, covering classical and axiomatic definitions, along with key distributions like binomial, Poisson, and normal. Students will delve into sampling methods, hypothesis testing, and statistical inference techniques, including t-tests, chi-square tests, and ANOVA. Special focus will be placed on correlation and regression analysis, emphasizing their relevance and interpretation in biological research contexts.

Course Outcome:

- Upon completion of this course, students will demonstrate a proficient understanding of fundamental statistical principles and their application within biological sciences.
- They will be capable of effectively categorizing and graphically representing various types of data, employing measures of central tendency, dispersion, skewness, and kurtosis to interpret data distributions.
- Students will apply probability theory to analyze events and distributions, utilizing concepts from binomial, Poisson, and normal distributions in practical scenarios.
- They will master sampling methods, hypothesis testing techniques, and statistical inference procedures such as t-tests, chi-square tests, and ANOVA to draw reliable conclusions from data sets.
- Additionally, students will be adept at employing correlation and regression analysis to explore relationships and predict outcomes in biological contexts.

Course Content (Biostatistics):

UNIT I: **No. of Hours: 15**

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: **No. of Hours: 15**

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

UNIT III: **No. of Hours: 15**

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: **No. of Hours: 15**

Correlation and Regression. Emphasis on examples from Biological Sciences.

List of Experiments:

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

Text and References:

1. Jan Lepš, Petr ŠmilauerBiostatistics with R: An Introductory Guide for Field Biologists Cambridge University Press 2000
2. Chap T. Le, Lynn E. Eberly Introductory Biostatistics 2nd Edition Wiley Publications 2012
3. John E. Havel, Raymond E. Hampton, Scott J. Meiners Introductory Biological Statistics, Fourth Edition 4th Edition Waveland Press, Inc. 2019.
4. Banerjee Pranab Kumar (2007). Introduction To Bio-statistics: A Textbook of Biometry. S Chand & Company
5. P.S.S. Sundar Rao and J. Richard (2012). Introduction to Biostatistics and Research Methods (5th Edn). PHI Learning Pvt. Ltd.
6. Dutta, N. K. (2004). Fundamentals of Biostatistics, Kanishka Publishers.

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

Course Objectives:

The course aims to educate students on the scope and significance of wildlife in India, emphasizing the definition of wildlife, causes of depletion, and economic importance. Students will explore the necessity of wildlife conservation and understand categories such as rare, endangered, threatened, and endemic species across fishes, amphibians, reptiles, birds, and mammals in India, recognizing India's status as a mega wildlife diversity country. Habitat analysis will focus on evaluating and managing wildlife through physical and biological parameters, utilizing methods like GIS, GPS, and RS. The course will address human-wildlife conflicts, including poaching and illegal trading, and discuss strategies for conflict management and conservation. Conservation efforts will cover both in-situ and ex-situ approaches, including the management and administration of wildlife sanctuaries, national parks, tiger reserves, biosphere reserves, and zoos.

Course Outcome:

- Upon completing this course, students will demonstrate a comprehensive understanding of the scope and importance of wildlife in India.
- They will be able to articulate the definition of wildlife, identify the causes contributing to wildlife depletion, and evaluate its economic significance.
- Students will gain knowledge of rare, endangered, threatened, and endemic species across various taxa in India, recognizing the country's exceptional biodiversity.
- Students will be proficient in understanding and managing human-wildlife conflicts, including strategies for conflict resolution and conservation.
- They will also comprehend the principles and practices of wildlife conservation, including in-situ and ex-situ approaches, and the roles of governmental and non-governmental organizations in preserving India's wildlife heritage.

Course content (Wildlife Conservation & Management – I):

UNIT I: Scope and importance of Wildlife of India **No. of Hours: 10**

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 **No. of Hours: 10**

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 **No. of Hours: 10**

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

UNIT IV: Conservation of Wildlife **No. of Hours: 15**

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.

Text and References:

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. Fred Van Dyke, Rachel L. Lamb Conservation Biology: Foundations, Concepts, Applications 3rd ed. 2020 Edition Springer Publications
3. Tapashi gupta (2017). Ecology, wildlife conservation & management. Ebh publishers
4. Saha, G. K. and Mazumdar, S. (2017). *Wildlife Biology: An Indian Perspective*. PHI Publishing.

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

Course Objectives:

The course aims to provide students with a comprehensive understanding of key concepts in chemical energetics, equilibrium, kinetics, and photochemistry. It begins with a review of thermodynamics and thermochemistry, covering standard enthalpies, bond energies, and the application of Kirchhoff's equation. Students will then explore chemical equilibrium, focusing on Gibbs free energy, the law of chemical equilibrium, and Le Chatelier's principle. The kinetics unit will address reaction rates, factors influencing these rates, reaction order, and activation energy calculation using the Arrhenius equation. Finally, the course will delve into photochemistry, discussing laws of photochemistry, fluorescence, phosphorescence, quantum efficiency, and photochemical processes.

Course Outcome:

- Upon completing this course, students will possess a robust understanding of fundamental concepts in chemical energetics, equilibrium, kinetics, and photochemistry.
- They will be adept at applying the laws of thermodynamics and thermochemistry to calculate standard enthalpies, bond energies, and reaction enthalpy variations.
- Students will be able to analyze chemical equilibrium using Gibbs free energy, derive equilibrium laws, and apply Le Chatelier's principle.
- They will also master the principles of chemical kinetics, including determining reaction rates, reaction order, and activation energy.
- Students will gain insights into photochemistry, understanding the laws governing photochemical reactions, and phenomena such as fluorescence and phosphorescence.

Course Content (Chemistry - II):

Unit I: Chemical Energetics **No. of Hours: 15**

Review of the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standardenthalpies of formation, integral and differential enthalpies of solution and dilution. Calculationof 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 **No. of Hours: 10**

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 betweenKp, Kc and Kx for reactions involving ideal gases.

Unit III: Chemical Kinetics **No. of Hours: 10**

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 IV: Photochemistry **No. of Hours: 10**

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.

List of Experiments

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.

Text and References:

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 9th Ed., Oxford University Press.
2. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
3. Peter Atkins, Julio De Paula, James Keeler (2018). Physical Chemistry International Edition. Oxford University Press
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
5. Chang, R. Physical Chemistry for the Biosciences. University Science Books (2005).
6. R.L. Madam, Chemistry for degree students (2020). S. Chand Publishing, India

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 course provides a comprehensive foundation in mechanics, waves and oscillations, biological membranes, and spectroscopic techniques. Students will explore Newton's laws, conservation principles, and special relativity. They will study wave phenomena, modern optics, and laser applications. The course covers biological membranes, focusing on transport mechanisms, diffusion, osmosis, and membrane potential. Students will also learn spectroscopic techniques, including UV/visible spectrophotometry, fluorescence, and advanced methods like infrared and magnetic resonance spectroscopy. This course equips students with essential theoretical knowledge and practical skills for advanced study and research in physical chemistry and related fields.

Course Outcome:

- Upon completing this course, students will master key principles in mechanics, waves and oscillations, biological membranes, and spectroscopic techniques.
- They will apply Newton's laws, conservation principles, and special relativity to solve complex problems.
- Students will analyze wave phenomena, modern optics, and laser applications.
- They will understand biological membrane functions, including transport mechanisms, diffusion, and osmosis.
- They will be proficient in UV/visible spectrophotometry, fluorescence, and advanced spectroscopy methods like infrared and magnetic resonance.

Course Content (Biophysics):

Unit I: Mechanics **No. of Hours: 10**

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 **No. of Hours: 10**

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 **No. of Hours: 10**

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 **No. of Hours: 15**

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.

List of Experiments:

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.

Text and References:

1. Meyer B. Jackson Molecular and Cellular Biophysics 2006
2. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition, Cambridge University Press, 2005.
3. Donald L. Pavia Introduction to Spectroscopy 2015, Cengage India Private Limited
4. N. K. Bajaj (2017). The Physics of Waves and Oscillations. Tata McGraw Hill.
5. Nelson Philip Biological Physics: Energy, Information, 2007, W. H. Freeman
6. William Bialek Biophysics: Searching for Principles, Princeton University Press

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:

This course provides a comprehensive understanding of key ecological principles and their applications. Students will begin with an introduction to ecology, learning its relevance, history, and core concepts such as autecology, synecology, levels of organization, and the laws of limiting factors, with emphasis on temperature and light. The course then explores population ecology, covering population attributes, growth patterns, regulatory factors, and interactions, including models like Gause's Principle and the Lotka-Volterra equations. Community ecology is examined focusing on its characteristics, ecotones, edge effects, succession, and climax community theories. The course delves into ecosystem ecology, discussing types of ecosystems, food chains, energy flow, ecological pyramids, efficiencies, and nutrient cycles, with a detailed look at the nitrogen cycle.

Course Outcome:

- Upon completing this course, students will gain a comprehensive understanding of ecological principles and their practical applications.
- They will adeptly analyze ecological relationships across different levels, from individual organisms to entire ecosystems.
- Students will demonstrate proficiency in assessing population dynamics, including growth patterns, regulatory mechanisms, and interspecies interactions.
- They will also develop a deep understanding of community structure, succession dynamics, and the formation of climax communities.
- The students will acquire knowledge of ecosystem dynamics, including energy flow, nutrient cycles and the interconnected nature of ecological processes.

Course Content (Ecology):

Unit I: Introduction to Ecology **No. of Hours: 12**

Relevance of studying ecology, History of ecology, Autecology and synecology, levels oforganization, Laws of limiting factors, detailed study of temperature and light as physicalfactors.

Unit II: Population **No. of Hours: 18**

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 **No. of Hours: 14**

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

Unit IV: Ecosystem **No. of Hours: 16**

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 ofNitrogen cycle

List of Experiments:

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 Sechidisc, 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 the field or on a given simulation sheet
5. To determine soil texture, soil density, bulk density, particle density and porespace.
6. To determine water holding capacity and percolation rate of soil.
7. To determine pH, Cl, SO_4, NO_3, based eficiency, organic matter, cation exchange capacity in the soil.
8. Plotting of survivorship curves from hypothetical life table data.

Text and References:

1. Barrick, M., Odum, E. P., Barrett, G. W., (2017). Fundamentals of Ecology (5th Edition). Cengage India Private Limited.
2. Wilkenson DM - 2007 - Fundamental Processes in Ecology
3. PD Sharma (2017). *Ecology and Environment*.13th Edition.Meerut: Rastogi Publications.
4. Smith, T. M. & Smith, R. L. (2014). Elements of Ecology (8th Edition). Pearson
5. Aber J.D. & Melillo J M 1991- Terrestrial Ecosystems

Course Code	**:**	**BSG102**
Course Title	**:**	**Natural Resource Management**
Total Credits	**:**	**4 (Theory)**
L-T-P	**:**	**4-0-0**
Total Hours	**:**	**Theory 60**
Semester	**:**	**II**

Course Objectives:

This course provides a comprehensive exploration of natural resources and their sustainable utilization. Students will study land utilization practices such as agriculture, pastoralism, horticulture, and silviculture, alongside issues like soil degradation and management. Water resources, including rivers, lakes, aquifers, and watersheds, as well as marine, estuarine, and wetland ecosystems, will be analyzed with a focus on threats and management strategies. The course also covers forests, their significance in India, major and minor forest products, depletion concerns, and management practices. Energy resources, both renewable and non-renewable, and their management are discussed, followed by contemporary resource management practices such as Environmental Impact Assessment (EIA), Geographic Information Systems (GIS), participatory resource appraisal, ecological and carbon footprint analysis, resource accounting, and waste management.

Course Outcome:

- Upon completion of this course, students will achieve a thorough understanding of natural resource management and sustainable utilization.
- They will proficiently classify and evaluate various natural resources, considering their economic, ecological, and socio-cultural implications.
- Students will analyze land use practices such as agriculture, pastoralism, and silviculture, and develop strategies for soil conservation and effective water resource management across different ecosystems.
- They will gain expertise in renewable and non-renewable energy sources and their optimal management approaches.

Course Content (Natural Resource Management):

Unit I: Natural resources and Sustainable utilization **No. of Hours: 10**

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

Unit II: Land and Water **No. of Hours: 15**

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 **No. of Hours: 10**

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

Unit IV: Energy **No. of Hours: 10**

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

Unit V: Contemporary practices in resource management **No. of Hours: 15**

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

Text and References:

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. Rogers, P.P., Jalal, K. F., & Boyd, J. A. (2008). *Introduction to Sustainable Development*. New Delhi: Prentice Hall of India Private Limited
6. Singh, J. S., Singh, S. P., & Gupta, S. R. (2017). *Ecology and Environmental Science and Conservation*. New Delhi: S Chand and Company Ltd
7. Sharma P. D. Ecology and Environment Rastogi Publications

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

Course Objectives:

This course aims to equip students with a comprehensive understanding of wildlife conservation and management, focusing on the diverse ecosystems of Uttarakhand, India. The students will explore the biodiversity of national parks, wildlife sanctuaries, and conservation reserves in the region, along with the microbial diversity unique to Uttarakhand. They will learn essential wildlife census techniques, including planning, direct and indirect counting methods, and capture-recapture techniques. The course will also cover strategies for managing wildlife populations, such as bio-telemetry, disease management, and habitat analysis for sustainable conservation. Additionally, students will examine the role of ecotourism and key environmental movements in India, providing them with the knowledge and skills needed for effective wildlife conservation practices and careers in conservation biology.

Course Outcome:

- Upon completing this course, students will attain a thorough understanding of wildlife conservation and management in Uttarakhand, India.
- They will demonstrate proficiency in assessing and preserving biodiversity within national parks, wildlife sanctuaries, and conservation reserves, including microbial diversity.
- Students will develop practical skills in wildlife census techniques, encompassing direct counts, indirect methods such as camera traps and track analysis, and capture-recapture methods.
- They will also acquire expertise in managing wildlife populations through strategies like bio-telemetry, disease management, and habitat analysis to ensure sustainable conservation practices.
- The students will gain insights into the role of ecotourism and key environmental movements in India's conservation landscape.

Course content (Wildlife Conservation & Management – II):

UNIT I: Wildlife in Uttarakhand **No. of Hours: 15**

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 **No. of Hours: 10**

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 **No. of Hours: 10**

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 **No. of Hours: 10**

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

Text and References:

1. Enric Sala The Nature of Nature: Why We Need the Wild Hardcover, 2020
2. T A Bookhout (1996) Research and Management Techniques for Wildlife and Habitats, 5th Ed. The Wildlife Society, Allen Press.
3. Bikram Grewal Wildlife of India (Princeton Pocket Guides, 18) Paperback Princeton University Press, 2022
4. Gusain OP, Kandari OP. Garhwal Himalaya Nature, Culture & Society Srinagar: Transmedia.
5. A. Kumar Bioresources of Uttarkhand: Their Conservation and Management Hardcover, 2011
6. Sanjeeva Pandey & Anthony J Gaston The Great Himalayan National Park: The Struggle to Save the Western Himalayas Hardcover Niyogi Books Pvt. Ltd. 2018

Course Code	**:**	**BSC201**
Course Title	**:**	**Biomolecules - I**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**III**

Course Objectives:

This course aims to provide students with a foundational understanding of key biomolecules, including carbohydrates, lipids, and nucleic acids, and their roles in biological systems. Students will learn about the structure, classification, and function of these molecules, as well as their physical and chemical properties. The course will explore the biological significance of carbohydrates, the diversity of lipids, and the essential roles of nucleic acids in genetic information. By the end of the course, students will have a solid grasp of these biochemical concepts, preparing them for advanced studies and practical applications in biochemistry, molecular biology, and related fields.

Course Outcome:

- Upon completing this course, students will have a comprehensive understanding of the fundamental biomolecules crucial for life.
- They will be able to classify and describe the structure and function of carbohydrates, lipids, proteins, enzymes, and vitamins.
- The students will gain insights into the biological roles and physical properties of these molecules.
- They will also understand the structural and functional aspects of nucleic acids, including DNA and RNA.

Course content (Biomolecules-I):

Unit I: Introduction **No. of Hours: 10**

Definition, types of biomolecules; carbohydrates, lipids, fatty acids, proteins, enzymes. Vitamins- water soluble, fat soluble. Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy.

Unit II: Carbohydrates **No. of Hours: 15**

Classification of carbohydrates (mono, oligo polysaccharides), Physical - isomerism D & L, optical; epimers: anomers. Structure of monosaccharides- Hexoses and pentoses. Disaccharides- Sucrose, lactose, maltose. Storage and structural polysaccharides- Glycogen, starch and cellulose. Biological roles of carbohydrates.

Unit III: Lipids **No. of Hours: 10**

Role of lipids in cellular architecture and functions. Introduction to lipids, classification. Saturated and unsaturated fatty acids, Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Structure and biological importance of fatty acids, triacylglycerols, phospholipids and sterols (Cholesterol).

Unit IV: Nucleic acids: **No. of Hours: 10**

Components of Nucleic acids: Adenine, guanine, cytosine and thymine, other components of nucleic acids, Nucleosides and nucleotides. Watson-Crick model of DNA & its features, Types of DNA. Physical properties of DNA - Effect of heat on physical properties of DNA (Viscosity, buoyant density), Types of RNA. Nucleic acids: Role of nucleic acids in living system.

List of Experiments:

1. Separation of sugars by paper chromatography.
2. Qualitative identification of carbohydrates
3. Qualitative identification of lipids- solubility, saponification, acrolein test,
4. To estimate chlorophyll a and chlorophyll b in the given leaf sample.
5. Determination of glucose and starch content in a given plant material.
6. Quantitative estimation of DNA/RNA.

Text and References:

1. Nelson, D. L. and Cox, M. M. (2021). Lehninger, Principles of Biochemistry, (8^{th} Ed.). W.H. Freeman and Company (New York, USA).
2. Lubert Stryer (2019). Biochemistry (9^{th} Edition). W.H. Freeman
3. Cooper, T. G. (2009). The tools of biochemistry. Chichester: John Wiley.
4. Voet, D. and Voet, J.G. (2020). Biochemistry. (4^{th} Ed), John Wiley & Sons, Inc. USA
5. U. Satyanarayan and U. Chakrapani (2023). Biochemistry (6^{th} Ed.). Elsevier publications

Course Code	**:**	**BSC202**
Course Title	**:**	**Cell Biology - I**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**III**

Course Objectives:

This course aims to provide a thorough understanding of cellular biology. It covers the classification of organisms based on cell structure, cytosol, and compartmentalization, with a focus on cell fractionation techniques. Students will study the chemical components, organization, and dynamics of biological membranes, including the Fluid Mosaic Model, cell recognition, and membrane transport. The curriculum includes an in-depth analysis of the cytoskeleton, microtubules, microfilaments, intermediate filaments, endoplasmic reticulum, and Golgi complex. Moreover, the course explores the structure and function of lysosomes, vacuoles, microbodies, ribosomes, mitochondria, chloroplasts, and the nucleus. Topics on the extracellular matrix, cell adhesion, membrane receptors, signal transduction, and the molecular basis of cancer will also be covered to provide a holistic understanding of cellular processes.

Course Outcome:

- Upon completion of this course, students will achieve a precise understanding of cellular biology, enabling them to classify organisms by cell structure and comprehend cytosol and cell compartmentalization.
- They will demonstrate proficiency in explaining the chemical composition, organization, and dynamics of biological membranes, including membrane transport mechanisms.
- Students will acquire detailed knowledge of the cytoskeleton, microtubules, microfilaments, intermediate filaments, endoplasmic reticulum, and Golgi complex functions.
- They will also understand the structure and function of lysosomes, vacuoles, microbodies, ribosomes, mitochondria, chloroplasts, and the nucleus.
- The students will grasp the roles of cell adhesion molecules, membrane receptors, signal transduction pathways, and the molecular mechanisms underlying cancer development.

Course content (Cell Biology-I):

UNIT I: **No. of Hours: 10**

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II: **No. of Hours: 12**

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III: **No. of Hours: 10**

Lysosomes: Vacuoles and micro bodies: Structure and functions, Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure.

UNIT IV: **No. of Hours: 13**

Extra cellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

List of Experiments:

1. Cell division in Onion root tip/ Insect gonad.
2. Study of different stages of meiosis by temporary preparation/ permanent slides of onion flower buds.
3. Study of different stages of mitosis by temporary preparation/ permanent slides of onion root tips.
4. Preparation of temporary slides of the following (Onion epidermal peel/ root tips or any other suitable available material like Crinum, Wheat caryopsis etc.): Cytochemical staining of DNA by Fuelgen.
5. Study of ultrastructure of cell.

Text and References:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th edition, John Wiley & Sons. Inc.
2. De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinnauer Academic Press.
4. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San fransisco.

Course Code	**:**	**BSC203**
Course Title	**:**	**System Physiology**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**III**

Course Objectives:

The objective of this course is to provide students with a comprehensive understanding of physiological processes across different organisms. Students will explore cellular movements, including ciliary and flagellar structures, and their functions, along with an introduction to the musculo-skeletal system and various modes of locomotion. The course also covers gas exchange mechanisms, respiratory organs in aquatic and terrestrial environments, feeding patterns, and digestive tract systems. Students will learn about regulatory physiology, including mechanisms of stomatal regulation, osmoregulation in aquatic and terrestrial animals, transpiration in plants, and excretion of nitrogenous wastes. Moreover, they will explore thermoregulation patterns, adaptations to stress, neuronal structure and function, sensory physiology, endocrine systems in animals, plant hormones, and metabolic regulation in response to environmental stimuli.

Course Outcome:

- Upon completing this course, students will gain a precise understanding of physiological processes across organisms.
- They will master cellular movements, musculo-skeletal function, and various locomotion modes.
- Additionally, students will comprehend long-distance transport mechanisms in plants, circulatory system physiology, gas exchange in diverse environments, digestive processes, and regulatory mechanisms like osmoregulation and thermoregulation.
- They will also understand sensory physiology, endocrine systems, plant hormones, and metabolic responses to environmental cues.

Course content (System Physiology):

Unit I: Movements and Bulk Transport **No. of Hours: 15**

Cellular movements, ciliary and flagellar structure, and function**;** Introduction to Musculo-skeletal system; Terrestrial, aquatic and aerial locomotion**;** Locomotory cost**;** Long distance transport of water and nutrients in plants (xylem and phloem transport)**;** General plan and physiology of circulatory system in vertebrates and invertebrates.

Unit II: Gas exchange in organism; Generation and utilization of energy No. of Hours: 15

Exchange in unicellular organisms and plants; Respiratory organs in aquatic and terrestrial systems; Physiology of aquatic breathing and aerial breathing; Feeding patterns, digestive tract systems; Digestion of food.

Unit III: Regulatory Physiology **No. of Hours: 15**

Mechanism of opening and closing of stomata. Regulation of water and solutes in aquatic and terrestrial animals; Osmoregulatory organs. Transpiration in plants; Excretion of nitrogenous wastes in animals; Patterns of Thermoregulation: Ectotherms and Endotherms; Structural and functional adaptation to stress

Unit IV: Integrative Physiology **No. of Hours: 15**

An overview of neuronal structure and function; Sensory physiology-mechano, chemo, thermo, photo and electro receptors; Endocrine systems in animals and their physiological effects; Plant hormones and their physiological effects; Regulation of metabolism and response to environmental cues.

Text and References:

1. Knut Schmidt-Nielsen, Animal Physiology, Cambridge University Press
2. David Randall, Eckert's Animal Physiology, W.H.Freeman and Co.
3. Philips Withers; Comparative Animal Physiology. Books Cole Publishers
4. Moyes, C. D., & Schulte, P. M. (2008). Principles of Animal Physiology. San Francisco, CA: Pearson/Benjamin Cummings.
5. Schmidt-Nielsen, K. (2010). Animal Physiology: Adaptation and Environment. Cambridge: Cambridge University Press.
6. Randall, D. C., Burggren, W. W., & French, K. (2002). Eckert Animal Physiology. New York: W. H. Freeman.

Course Code	**:**	**BSE101**
Course Title	**:**	**Plant Biochemistry**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**III**

Course Objectives:

The objective of this course is to provide students with a comprehensive understanding of plant cell structure and function, focusing on the plasma membrane, vacuole, tonoplast membrane, cell wall, plastids, and peroxisomes. Students will explore the regulation of plant growth, including the effects of plant hormones on development and morphogenesis, and the influence of light on these processes. The course will also cover secondary metabolites in plants, including alkaloids, phenolic compounds like flavonoids and tannins, and terpenoids, detailing their biological functions and classification. The students will also learn cell and tissue culture techniques, including organ and explant culture, callus culture, and protoplast culture, along with plant regeneration pathways such as organogenesis and somatic embryogenesis.

Course Outcome:

- Upon completing this course, students will gain a precise understanding of plant cell structure.
- They will also learn about growth regulation via plant hormones and light responsiveness, as well as the diversity and biological roles of secondary metabolites such as alkaloids, phenolics, and terpenoids.
- They will acquire practical skills in plant tissue culture techniques, including organogenesis and somatic embryogenesis.
- This knowledge will enable students to apply their understanding in agricultural and biotechnological contexts, enhancing their ability to manipulate plant growth and secondary metabolite production for practical applications.

Course content (Plant Biochemistry):

Unit I: Introduction to Plant cell structure **No. of Hours: 12**

Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes.

Unit II: Regulation of plant growth **No. of Hours: 12**

Introduction to plant hormones and their effect on plant growth and development, regulation of plant morphogenetic processes by light.

Unit III: Secondary metabolites **No. of Hours: 18**

Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

Unit IV: Plant tissue culture **No. of Hours: 18**

Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

Text and References:

1. Caroline Bowsher, Martin steer, Alyson Tobin (2008) Plant Biochemistry, Garland science
2. P.M Dey and J.B. Harborne (1997) Plant Biochemistry. Academic Press
3. H. S. Srivastava, N. Shankar (2005). Plant Physiology and Biochemistry. Rastogi Publications
4. Buchanan. (2005) Biochemistry and molecular Biology of plant- (1st ed). Publisher: I K International.
5. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India

Course Code	**:**	**BSS108**
Course Title	**:**	**Biochemical Techniques**
Total Credits	**:**	**2 (Theory)**
L-T-P	**:**	**2-0-0**
Total Hours	**:**	**Theory 45**
Semester	**:**	**III**

Course Objectives:

This course aims to equip students with a comprehensive understanding of advanced analytical techniques essential for biochemical and chemical research. This includes UV-Visible absorption spectrophotometry, Fluorimetry, various chromatography modes (paper, thin layer, HPLC), and electrophoresis techniques (gel electrophoresis, SDS-PAGE). The course also covers centrifugation principles and methods, emphasizing their applications in separating and analyzing biomolecules based on sedimentation properties. Students will gain practical knowledge of instrumentation, theoretical principles, and real-world applications across these analytical methodologies.

Course Outcome:

- Upon completing this syllabus, students will demonstrate proficiency in UV-Visible absorption spectrophotometry, Fluorimetry, various chromatography techniques including HPLC, and electrophoresis methods.
- They will be adept at applying centrifugation principles for biomolecule separation.
- They will possess the skills to analyze biomolecules effectively using these advanced analytical tools
- This course prepares students to effectively utilize advanced analytical tools in biochemical and chemical research for diverse scientific applications.

Course content (Biochemical Techniques):

Unit I: Spectroscopic Techniques and Microscopy **No. of Hours: 10**

Spectroscopy: Principle of UV-Visible absorption spectrophotometry, instrumentation and applications. Microscopy: Types of microscope, Principle, working and uses of the microscopes- Simple Microscope, Compound Microscope, Dark Field Microscope, Bright Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal microscopy, Electron Microscopes: Scanning Electron Microscope (SEM), and Transmission Electron Microscope (TEM)

Unit II: Autoclave and Centrifugation **No. of Hours: 10**

Autoclaves; Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, differential centrifugation, density gradient centrifugation (Rate zonal and Isopycnic)

Unit III: Chromatography **No. of Hours: 13**

Basic principles of chromatography: Partition coefficient, concept of theoretical plates, various modes of chromatography (paper, thin layer, column), preparative and analytical applications, LPLC and HPLC. Principle and applications of: Paper Chromatography, Thin Layer Chromatography. Molecular Sieve Chromatography, Ion Exchange Chromatography, Affinity Chromatography

Unit IV: Electrophoresis **No. of Hours: 12**

Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native and denaturing gels. Agarose gel electrophoresis, buffer systems in electrophoresis. Electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification. Molecular weight determination, Isoelectric Focusing of proteins

Text and References:

1. Keith Wilson and John Walker (2005). Principles and Techniques of Biochemistry and Molecular Biology. 6th edition. Cambridge University Press
2. David Plummer (2017). An Introduction to Practical Biochemistry (3rd Edn). McGraw Hill Education
3. David Freifelder (2005). Physical Biochemistry- Applications to Biochemistry and Molecular Biology, 2nd Edition, W.H. freeman and Company
4. Beedu Sashidhar Rao, Vijay Deshpande (2020). Experimental Biochemistry. Dreamtech Press

Course Code	**:**	**BSC251**
Course Title	**:**	**Biomolecules-II**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**IV**

Course Objectives:

This course aims to provide a thorough understanding of the classification, structure, and function of proteins, with an emphasis on the diversity and properties of amino acids and the hierarchical structure of proteins such as myoglobin and hemoglobin. It also explores enzymes as biological catalysts, covering their chemical nature, classification, kinetics, and regulatory mechanisms, including enzyme inhibition. Additionally, the course delves into methods for enzyme isolation, purification, and immobilization. It also addresses the critical role of metal ions in biological systems, focusing on metalloproteins, metalloenzymes, and their functions in key processes like the mitochondrial electron transport chain. Through these topics, students will gain a deep and practical understanding of fundamental biochemical concepts and their applications.

Course Outcome:

- Upon completion of this course, students will have a comprehensive understanding of protein classification, structure, and function, as well as the physical properties and significance of amino acids.
- They will be adept at explaining the chemical nature, kinetics, and regulatory mechanisms of enzymes, and will be able to analyze various enzyme inhibition types and catalytic mechanisms.
- Students will acquire practical skills in enzyme isolation, purification, and immobilization techniques.
- They will gain insights into the vital role of metal ions in biological systems, including the functions of metalloproteins and metalloenzymes in processes like the mitochondrial electron transport chain.
- This knowledge will enable students to critically evaluate and apply biochemical concepts in research and professional contexts.

Course content (Biomolecules-II):

Unit I: Proteins **No. of Hours: 12**

Classification of proteins based on composition, conformation, and function-functional diversity of proteins. The amino acid building blocks-classification, structure, and physical properties of the standard amino acids. Proteinaceous and non-proteinaceous, essential, and non-essential amino acids. Primary, secondary, tertiary and quaternary structure of proteins. Structure of myoglobin and hemoglobin. Molecular physiology of myoglobin and hemoglobin, Bohr effect, Hill's coefficient. Concerted and sequential models for allosteric proteins.

UnitII: Enzymes **No. of Hours: 13**

Enzymes as biological catalysts. Enzyme classification and nomenclature. Chemical nature of enzymes, ribozymes. Concept of active site, specificity. Coenzymes, cofactors, and prosthetic groups. Kinetics of enzyme catalyzed reactions – Michaelis Menten equation. Determination of Km and Vmax. Factors influencing the rate of enzyme catalyzed reactions. Enzyme inhibitions- competitive, non-competitive and uncompetitive inhibitions. Catalytic mechanism of lysozyme or chymotrypsin. Regulation of enzyme activity allosteric enzymes, feedback inhibition with ATcase as an example.

Unit III: Isolation and purification of enzymes **No. of Hours: 10**

Methods of enzyme isolation and purification. Introduction to enzyme immobilization.

Unit IV: Role of Metal ions in Biology **No. of Hours: 10**

Metalloprotein, Metalloenzymes, metal base drug interaction and inhibition; metallo porphyrins, Redox. Carriers in mitochondrial electron transport chain.

List of Experiments:

1. Preparation of buffers
2. Determination of pKa value for acetic acid
3. Estimation of proteins by Biuret method
4. Estimation of proteins by Lowry's method
5. Separation of sugars by Thin Layer chromatography
6. Assay of the enzyme acid phosphatase from germinated moong dal or β-amylase from sweet potato beams
7. Effect of pH on the activity of an enzyme
8. Progress curve of an enzyme

Text and References:

1. Nelson, D. L. and Cox, M. M. (2021). Lehninger, Principles of Biochemistry, (8^{th} Ed.). W.H. Freeman and Company (New York, USA).
2. Voet, D. and Voet, J.G. (2020). Biochemistry. (4^{th} Ed), John Wiley & Sons, Inc. USA.
3. U. Satyanarayan and U. Chakrapani (2023). Biochemistry (6^{th} Ed.). Elsevier publications
4. Verma P.S. & Agarwal V.K. (2016). Cell Biology (Cytology, Biomolecules and Molecular Biology). S Chand

Course Code	**:**	**BSC252**
Course Title	**:**	**Cell Biology-II**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**IV**

Course Objectives:

This course provides a comprehensive understanding of cell biology, focusing on the diversity and complexity of cell types. Starting with the historical development and foundational principles of cell theory, students will explore the distinctions between prokaryotic and eukaryotic cells, as well as plant and animal cells, including notable exceptions. The curriculum will delve into the intricate hierarchy of cell structure and molecular composition, covering inorganic elements to complex macromolecules and organelles. Students will learn the cell cycle and its regulation, understand the mechanisms of cell signaling and communication, and gain insights into cancer biology, including tumor formation, oncogenes, and modern treatment approaches. Moreover, the course will equip students with essential skills in various advanced tools and techniques used in cell biology research.

Course Outcome:

- Upon completing this course, students will possess a thorough understanding of cell biology principles, including the distinctions between prokaryotic and eukaryotic cells.
- They will be proficient at identifying and explaining cell signaling pathways and their regulatory mechanisms.
- The students will gain insights into the biology of cancer, understanding the roles of oncogenes, tumor viruses, and modern therapeutic approaches.
- They will learn advanced research tools and techniques, such as various microscopy methods, PCR and RT-PCR, which will equip students with practical skills for scientific investigation.

Course content (Cell Biology-II):

Unit I: Cell Types **No. of Hours: 12**

History, Cell theory, Overview of Prokaryotic and Eukaryotic Cells, Plant and Animal cells, exceptions to cell theory, Phages, Virioids, Mycoplasmas, Prions, hierarchy in cell structure and cell molecules (inorganic elements, building blocks, macromolecules, supra macromolecules, cell organelles, cells, tissues, organs, organisms etc.), Cell cycle and its regulation.

Unit II: Cell signaling **No. of Hours: 10**

Signaling molecules and their receptors, functions; intracellular signal transduction pathways (with special reference to some selected pathways); GPCR, protein kinaseassociated receptors, signaling networks and cross talk.

Unit III: Cancer **No. of Hours: 10**

Programmed Cell Death; Biology and elementary knowledge of development and causes of cancer; Tumor viruses, Oncogenes and suppressor genes, Cancer Treatment- Molecular approach, Stem cells and therapeutic cloning.

Unit IV: Tools and techniques in cell biology **No. of Hours: 13**

Microscopy and its application, Extraction of DNA, Polymerase Chain Reaction (PCR) and RT-PCR: principle, procedure and application; DNA and Protein Sequencing; Microarray technology- Principle, procedure, types and applications.

List of Experiments:

1. Cytochemical staining of RNA by Methyl Green Pyronin Cytochemical staining of polysaccharides by PAS Cytochemical staining of proteins by Bromophenol blue Cytochemical staining of histones by fast green.
2. Vital staining of mitochondria by Janus green B in cheek epithelial cells
3. Identification and study of types of cancer, cancer cells by permanent slides/ photographs.
4. Study of the following microscopic techniques by photographs: Fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting
5. Study of cell organelle such as (Cell wall, Primary and secondary pits, Plasodesmata, Gap junctions, Tight junctions, Plasma membrane, Nucleus, Nuclear Pore Complex, Chloroplast, Mitochondrion, Golgi bodies, Lysosomes, SER and RER), Prokaryotic and Eukaryotic cell, Plant and Animal Cell, Phages: TMV and Bacteriophage

Text and References:

1. Arnold Berk, Chris A. Kaiser, Harvey Lodish, Angelika Amon, Hidde Ploegh, Anthony Bretscher, Monty Krieger, Kelsey C. Martin 1 April 2016. Molecular Cell Biology Hardcover WH Freeman publication.
2. De Robertis, E. D. P. and De Robertis R. E. 2009. Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper G. M. Hausman R. E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press and Sunderland, Washington D. C.; Sinnauer Academic Press.
4. Becker W. M., Kleinsmith L.J. and Bertni G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San fransisco.
5. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition, John Wiley & Sons. Inc.

Course Code	**:**	**BSC253**
Course Title	**:**	**Molecular Biology**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**IV**

Course Objectives:

The objective of this course is to provide students with an in-depth understanding of genetic and genomic organization, DNA replication, and gene expression. Students will learn about the structure and complexity of eukaryotic genes, DNA supercoiling, and packaging. The course covers DNA replication mechanisms in prokaryotes and eukaryotes, including the roles of polymerases and replication complexes. It also addresses DNA damage, repair mechanisms, and homologous recombination. Additionally, students will explore transcription and RNA processing, including RNA polymerases, transcription factors, and RNA splicing. Finally, the course examines the genetic code, translation processes, and regulation of gene expression in both prokaryotes and eukaryotes, providing a comprehensive understanding of these essential molecular biology concepts.

Course Outcome:

- Upon completion of this course, students will understand the molecular mechanisms of genetic organization, DNA replication, and gene expression.
- They will understand the complexity of eukaryotic genes and chromosomes, DNA supercoiling, and packaging.
- Students will demonstrate proficiency in DNA replication in prokaryotes and eukaryotes, DNA repair mechanisms, and homologous recombination.
- They will also be adept at explaining transcription, RNA processing, the genetic code, translation processes, and protein post-translational modifications.
- They will comprehend the regulation of gene expression in both prokaryotic and eukaryotic organisms, preparing them for advanced studies and research in molecular biology.

Course content (Molecular Biology):

Unit I: Genes and genomic organization No. of Hours: 10

Definition of a gene, complexity of eukaryotic genes and chromosomes, supercoiling of DNA and its importance, linking number, topoisomerases, nucleosome structure and packaging of DNA into higher order structures.

UNIT II: DNA Replication, Damage, Repair and Homologous Recombination No. of Hours: 13

Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, Replication complex: Pre-primming proteins, primosome, replisome; Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication. DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, recombinational repair. Homologous recombination: models and mechanism.

UNIT III: Transcription and RNA Processing No. of Hours: 12

Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains; Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation; RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV: Translation & Regulation of Gene Expression No. of Hours: 10

Genetic code and its characteristics; Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation; Posttranslational modifications of proteins. Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Regulation of gene expression in eukaryotes.

List of Experiments:

1. Isolation of DNA by CTAB method.
2. Agarose gel electrophoresis
3. Estimation of DNA by DPA method.
4. Estimation of RNA by Orcinol method.
5. Separation of nucleotide bases by paper chromatography.
6. Extraction of total nucleic acids from plant tissue.
7. Isolation of chromosomal DNA from E. coli cells.
8. Purity of isolated DNA by A260/A280 Ratio

Text and References:

1. George M Malacinski (2015) Freifelders Essentials of Molecular Biology (4th Edition) Jones and Bartlett
2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin (2016). Molecular Cell Biology (8th Edition). W. H. Freeman
3. James D. Watson (2021). Molecular Biology of The Gene (7th Edition). Pearson
4. Gerald Karp, James G. Patton (2013). Cell and Molecular Biology: Concepts and Experiments (7th Edition). John Wiley & Sons Inc
5. T.A. Brown, Essential Molecular Biology, Oxford University Press.
6. Verma P.S. & Agarwal V.K. (2010) Molecular Biology. S Chand
7. Nitin Suri (2010). Molecular Biology and Biochemistry. Oxford Book Company

Course Code	**:**	**BSG104**
Course Title	**:**	**Environment and Public Health Management**
Total Credits	**:**	**4 (Theory)**
L-T-P	**:**	**4-0-0**
Total Hours	**:**	**Theory 60**
Semester	**:**	**IV**

Course Objectives:

The objective of this course is to provide students with a comprehensive understanding of environmental health and its impact on human well-being. Students will study the sources and identification of environmental hazards, including the fate of toxic substances in the environment and methods for evaluating dose-response relationships and exposure. The course will cover various types of pollution such as air, water, and noise pollution, examining their sources and effects on ecosystems and human health. Students will also explore waste management practices, including the handling and disposal of biomedical and nuclear waste, alongside case studies of major environmental disasters like the Bhopal gas tragedy and Chernobyl disaster. The course will also analyze the social, economic, and organizational factors influencing disease patterns, including infectious diseases, lifestyle-related diseases, genetic disorders, immunological conditions, and cancers, with a focus on global health disparities.

Course Outcome:

- Upon completion of this course, students will understand environmental health issues thoroughly, including hazard identification, toxic substance fate, and dose-response evaluation.
- They will demonstrate proficiency in assessing air, water, and noise pollution sources and impacts.
- Students will also acquire knowledge of effective waste management strategies, including handling biomedical and nuclear wastes.
- They will be aware of the social, economic, and other factors influencing disease patterns, covering infectious diseases, lifestyle- related conditions, genetic disorders, immunological diseases, and cancers, with a global health perspective.

Course content (Environment and Public Health Management):

Unit I: Introduction **No. of Hours: 14**

Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

Unit II: Pollution **No. of Hours: 10**

Air, water, noise pollution sources and effects

Unit III: Waste Management and hazards **No. of Hours: 18**

Types and characteristics of wastes, Biomedical waste handling and disposal, nuclear waste handling and disposal, Waste from thermal power plants. Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath.

Unit IV: Diseases **No. of Hours: 18**

Social and economic factors of disease including role of health services and other organizations: Infectious (Bacterial-Tuberculosis, Typhoid; Viral- AIDS, Poliomyelitis, Hepatitis; Protozoan- Leishmaniasis, Malaria); Lifestyle and Inherited/genetic diseases, Immunological diseases; Cancer; Diseases impacting on Western versus developing societies.

Recommended Texts:

1. Cutter, S.L. (1999). Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Kolluru R., Bartell S., Pitblado R. and Stricoff, S. (1996). Risk Assessment and Management Handbook. McGraw Hill Inc., New York.
3. Kofi, A.D. (1998). Risk Assessment in Environmental management, John Wiley and sons, Singapore.
4. Joseph, F. L. and Louver, B.D. (1997). Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey.

Course Code	**:**	**BSS107**
Course Title	**:**	**Recombinant DNA Technology**
Total Credits	**:**	**2 (Theory)**
L-T-P	**:**	**2-0-0**
Total Hours	**:**	**Theory 45**
Semester	**:**	**IV**

Course Objectives:

This course aims to provide students with a comprehensive understanding of recombinant DNA technology (RDT). Students will learn the fundamentals of RDT, including the use of restriction endonucleases, gel electrophoresis, and the extraction of plasmid DNA. They will explore cloning vectors for both prokaryotes and eukaryotes, focusing on plasmids and bacteriophages, and understand techniques for introducing and selecting transformed cells. The course will cover methods for identifying recombinants, such as insertional inactivation and hybridization probing. Practical applications in medicine (e.g., producing pharmaceuticals and vaccines) and agriculture (e.g., genetic engineering of crops) will be discussed, along with an introduction to advanced techniques like DNA sequencing, polymerase chain reaction (PCR), and expression vectors.

Course Outcome:

- The objectives of this course are to equip students with a thorough understanding of recombinant DNA technology (RDT), focusing on the principles of restriction endonucleases and gel electrophoresis.
- Students will learn about cloning vectors, including plasmids and bacteriophages, and develop skills in DNA ligation.
- They will master techniques for introducing DNA into cells, selecting transformed cells, and identifying recombinants through methods like insertional inactivation and hybridization probing.
- Practical applications in medicine and agriculture will be emphasized, alongside the utilization of advanced techniques such as DNA sequencing, polymerase chain reaction (PCR), and expression vectors.

Course content (Recombinant DNA Technology):

Unit I: Introduction to recombinant DNA technology **No. of Hours: 10**

Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules, separation of DNA by gel electrophoresis. Extraction and purification of plasmid DNA.

Unit II: Cloning vectors for prokaryotes and eukaryotes **No. of Hours: 10**

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Joining of DNA fragments: ligation of DNA molecules. DNA ligases, sticky ends, blunt ends, linkers and adapters.

Unit III: Introduction of DNA into cells **No. of Hours: 15**

Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. Identification for recombinants - insertional inactivation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Methods for clone identification: The problem of selection, direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

Unit IV: Applications of RDT **No. of Hours: 10**

Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy. Applications in agriculture - plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns. Introduction to DNA sequencing, polymerase chain reaction, expression vectors.

Text and References:

1. Brown, T.A. (2010). Gene Cloning and DNA Analysis (6th Edn). Wiley-Blackwell publishing (Oxford, UK).
2. Primrose, S.B., and Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics (7th Edn) Blackwell publishing (Oxford, UK).
3. Bernard R. Glick, Jack J. Pasternak (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th Edn). American Society for Microbiology
4. K Rajagopal (2012). Recombinant DNA Technology and Genetic Engineering. McGraw Hill Education
5. Keya Chaudhuri (2012). Recombinant DNA Technology. The Energy and Resources Institute, TERI

Course Code	**:**	**BSC301**
Course Title	**:**	**Metabolism and Integration**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**V**

Course Objectives:

The objectives of this course are to provide students with a comprehensive understanding of the principles of bioenergetics, the metabolic roles of ATP, and the methodologies used to study metabolism. Students will explore both primary and secondary metabolism, along with the detailed pathways of carbohydrate and lipid metabolism, including associated disorders. The course aims to integrate knowledge of metabolic changes during various physiological and pathological states, such as the starve-feed cycle, exercise, diabetes, and alcohol abuse. Moreover, students will gain a thorough understanding of oxidative phosphorylation, including the components and function of the electron transport system and the chemiosmotic hypothesis.

Course Outcome:

- Upon completing this course, students will have a comprehensive knowledge of the fundamental principles of bioenergetics and the role of ATP in metabolism.
- They will be proficient in various experimental approaches to studying metabolism and distinguishing between primary and secondary metabolic processes.
- Students will have an in-depth understanding of carbohydrate and lipid metabolic pathways, along with the ability to identify and explain disorders related to these pathways.
- They will be adept at integrating metabolic changes in different physiological and pathological states, such as during exercise, fasting, and diseases like diabetes.
- The students will be well-versed in oxidative phosphorylation, understanding the components and function of the electron transport system and the chemiosmotic hypothesis.

Course content (Metabolism and Integration):

Unit I: Concept of Metabolism **No. of Hours: 10**

Principles of bioenergetics-Standard free energy change, metabolic roles of ATP-Phosphoryl group transfer, nuleotidyl group transfer. Experimental approaches to study of metabolism; Primary and secondary metabolism. Energetics.

Unit II: Metabolic Pathways **No. of Hours: 15**

Carbohydrates metabolism - Glycolysis, alcoholic and lactic acid fermentation, Pasteur Effect, gluconeogenesis, Coricycle, glucose-alanine cycle, futile cycle. TCA cycle, HMP shunt, glycogenolysis & glycogen synthesis. Disorders associated with defects in carbohydrate metabolism. Lipid metabolism - Mobilization of triglycerides, metabolism of glycerol, β-*oxidation* of saturated, monounsaturated and poly-unsaturated fatty acids, even and odd chain fatty acids. Ketogenesis and significance. Biosynthesis of C-16 palmitic acid. Nutritional disorder- PEM (Kwashiorkar and Marasmus), Obesity. Metabolic disorders- Diabetes. Inborn errors of metabolism- i) Protein-PKU, Alkaptonuria and Maple syrup and Gauchers. Protein catabolism - Transamination and deamination, Urea cycle, glucogenic and keogenic amino acids.

Unit III: Metabolic Integration **No. of Hours: 10**

Metabolic changes during starve-feed cycle, exercise , diabetes and alcohol abuse.

Unit IV: Oxidative phosphorylation **No. of Hours: 10**

Components, properties and function of electron transport system, chemiosmotic hypothesis, inhibitors and uncouplers, Shuttle systems

List of Experiments:

1. Estimation of blood glucose – Glucose Oxidase method
2. Estimation of Cholesterol – Hyper Cholesteremia samples
3. Estimation of SGPT and SGOT
4. Estimation of Bilirubin
5. Estimation of creatinine
6. Identification of organelles by marker enzymes – SDH, LDH and acid phosphatase

Text and References:

1. U. Satyanarayan and U. Chakrapani (2023). Biochemistry (6^{th} Ed.). Elsevier publications
2. Nelson, D. L. and Cox, M. M. (2021). Lehninger, Principles of Biochemistry, (8^{th} Ed.). W.H. Freeman and Company (New York, USA).
3. Lubert Stryer (2019). Biochemistry (9^{th} Edition). W.H. Freeman
4. Voet, D. and Voet, J.G. (2020). Biochemistry. (4^{th} Ed), John Wiley & Sons, Inc. USA
5. Thomas M. Devlin (2002). Textbook of Biochemistry with Clinical Correlations (5th edition). John Wiley & Sons

Course Code	**:**	**BSC302**
Course Title	**:**	**Growth and Reproduction**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**V**

Course Objectives:

The objectives of this course are to provide students with a comprehensive understanding of growth patterns in animals and plants, focusing on plant cell growth and the role of the cell wall. Students will learn about the phases of growth, including meristem dynamics and genetic regulation. The course will cover the analysis of plant growth and concepts of senescence, ageing, abscission, and programmed cell death. Additionally, students will study pre-fertilization changes, including reproductive patterns and gametogenesis in animals and plants. The course will delve into post-fertilization events and early development, covering cleavages, gastrulation, and the formation of extra-embryonic membranes and placenta. The students will also explore differentiation and organogenesis, with a focus on the formation of the central nervous system and secondary growth in plants.

Course Outcome:

- Upon completing this course, students will understand growth patterns in animals and plants, focusing on the regulatory mechanisms of the cells.
- They will be proficient in analyzing plant growth kinetics and understanding concepts such as senescence, programmed cell death, and their implications.
- Students will also gain insights into reproductive patterns, post-fertilization events like cleavage and gastrulation, and organogenesis, particularly in the central nervous system and secondary growth in plants.
- This knowledge will prepare them for advanced studies or careers in biological sciences with a strong foundation in developmental biology.

Course content (Growth and Reproduction):

Unit I: Introduction **No. of Hours: 13**

General growth patterns in plants: plant cell as a model of growing system; biophysical basis of plant cell growth; the role of cell wall in cell growth; extension growth of multicellular organs in plants. Vegetative and reproductive phases in growth: meristem identity; Primary meristem: shoot apical meristem- dynamics of shoot apicalmeristem; root apical meristemas an organized structure; post-embryonic meristems in plants with special reference to Arabidopsis embryogenesis. Concept of stem cell; homeobox genes in plant and animal, Analysis of plant growth: kinetics and kinematics. Senescence, ageing, abscission and programmed cell death: a general account, with special reference to hyperplasia and hypertrophy in plants; tumours in plants.

Unit II: Pre-Fertilization Changes **No. of Hours: 12**

Alternation of generations and reproductive patterns in animals and plants; Asexual andsexual reproduction- an overview (regeneration, archegonium, heterospory, siphonogamy, apogamy, apospory, apomixis etc.). Pre- fertilization events- gametogenesis- spermatogenesis and oogenesis, types of eggs in animals; relative sexuality in plants and heterothallism in fungi.

Unit III: Post-Fertilization Changes and Early Development **No. of Hours: 10**

Post Fertilization Events; Types of Cleavages; Blastula; Fate Maps, Morphogenetic movements during gastrulation; Gastrulation in frog and chick and humans; Fate of Germlayers; Neural tube formation, brief account one mbryonic induction, Extra Embryonic membranes in chick and mammal, Placenta: Functions and types.

Unit IV: Differentiation **No. of Hours: 10**

Organogenesis: Formation and types of Germ layers, Formation of Central Nervous System, Parts and function of Brain, formation and spinal cord, Organogenesis of secondary girth

List of Experiments:

1. Study of whole mounts of frog and chick- early developmental stages
2. Study of section of chick embryo through selective developmental stages
3. Videos showing selective embryonic events like cleavage; gastrulation
4. Micro and mega sporogenesis in higher plants- slides only
5. Study of gamete/ spores in algae, moss, liverwort, pteridophyte and gymnosperm
6. Embryo development in flowering plant- slides only
7. Study of apical and lateral meristem, hypertrophy and hyperplasia
8. Survey of dispersal mechanisms of seeds

Recommended Texts:

1. Scott F. Gilbert, Susan R. Singer (2020). Developmental Biology (8th Edition). Sinauer Associates Inc.,U.S.
2. Bruce M. Carlson (2014). Patten's Foundation of Embryology (6th Edition). McGraw Hill Education.
3. Wolpert, L., & Tickle, C. (2011). *Principles of Development* (4 edition). Oxford; New York: OUP Oxford.
4. Gerald P. Schatten (2006). Current Topics in Developmental Biology. Academic Press
5. Kalthoff, K. O. (2000). *Analysis of Biological Development* (2 edition). Boston: McGraw-Hill.
6. S. L. Kochhar and Sukhbir Kaur Gujral (2020) Plant Physiology: Theory and Applications (2nd Edn). Cambridge University Press
7. S.K. Verma and Mohit Verma (2007). A Textbook of Plant Physiology, Biochemistry and Biotechnology (6th Edition). S Chand.

Course Code	**:**	**BSC303**
Course Title	**:**	**Evolutionary Biology - I**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**V**

Course Objectives:

The objective of this course is to provide students with a thorough understanding of the evolutionary concepts and the scientific principles underlying the diversity of life. Students will delve into the historical development of evolutionary thought, from pre-Darwinian ideas to modern theories, and explore the origins and early development of life. The course will cover the evidence supporting evolution, including paleobiological, anatomical, taxonomic, and phylogenetic studies, as well as the sources and forces driving evolutionary change. By examining natural selection, genetic drift, and other evolutionary mechanisms, students will gain insight into the dynamic processes shaping the biological world. Through a combination of theoretical knowledge and empirical studies, the course aims to develop students' analytical and critical thinking skills, preparing them for advanced studies and research in evolutionary biology.

Course Outcome:

- By the end of this course, students will have gained a comprehensive understanding of the evolution of life on Earth.
- They will be equipped to analyze historical and modern theories of evolution, assess various forms of evidence for evolutionary processes, and understand the origins and development of life.
- Students will gain insights into the origins of life and the mechanisms driving evolutionary change, such as natural selection, genetic drift, and variations.
- They will be able to critically evaluate the evidence supporting evolutionary processes, including fossil records, anatomical features, and molecular data.
- This knowledge will enable them to critically evaluate scientific data, fostering their ability to pursue further studies or research in evolutionary biology.

Course content (Evolutionary Biology - I):

Unit I: Historical Review of Evolutionary Concept **No. of Hours: 10**

Pre-Darwinian ideas – List of contributors influencing Darwin indicated as a *timeline.* Lamarckism – Merits and demerits. Darwinism – Merits and demerits, post- Darwinian era – Modern synthetic theory; biomathematics and the theory of population genetics leading to Neo-Darwinism.

Unit II: Life's Beginnings **No. of Hours: 10**

Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Origin of photosynthesis – Evolution of oxygen and ozone build- up. Endosymbiotic theory – Evolution of Eukaryotes from Prokaryotes.

Unit III: Evidences of Evolution **No. of Hours: 15**

Paleobiological – Concept of Stratigraphy and geological timescale; fossil study (types, formation and dating methods). Anatomical – Vestigial organs; Homologous and Analogous organs (concept of parallelism and convergence in evolution). Taxonomic – Transitional forms/evolutionary intermediates; living fossils. Phylogenetic – a) Fossil based – Phylogeny of horse as a model. b) Molecule based – Protein model (Cytochrome C); gene model (Globin gene family).

Unit IV: Sources of Evolution – Variations as Raw Materials of Change **No. of Hours: 10**

Types of variations – Continuous and discontinuous; heritable and non-heritable. Causes, classification, and contribution to evolution – Gene mutation; chromosomal aberrations; recombination and random assortment (basis of sexual reproduction); gene regulation. Concept of micro- and macro-evolution – A brief comparison

Unit V: Forces of Evolution – Qualitative Studies Based on Field Observations

No. of Hours: 15

Natural selection as a guiding force- Its attributes and action, basic characteristics of natural selection. Colouration, camouflage and mimicry, co-adaptation, and co-evolution; man-made causes of change- Industrial mechanism; brief mention of drug, pesticide, antibiotic, and herbicide resistance in various organisms. Modes of selection, Polymorphism, Heterosis and Balanced lethal systems. Genetic Drift (Sewall Wright effect) as a stochastic/random force- Its attributes and action. Basic characteristics of drift; selection vs drift, Bottleneck effect. Founder principle.

Text and References:

1. Charles Darwin (2021). The Origin of Species. Fingerprint Publishing.
2. Michael Keller and Nicolle Rager Fuller (2009). Charles Darwin's On the Origin of Species: A Graphic Adaptation. Rodale Books
3. Brian K. Hall, Benedikt Hallgrímsson(2013). Strickberger's Evolution (5th Edn). Jones and Bartlett Publishers, Inc
4. Mark Ridley (2003). Evolution (3rd Edn). Wiley-Blackwell
5. Veer bala rastogi 2021. Organic Evolution (Evolutionary Biology) Medtech publication
6. Prosanta Chakrabarty 2022. Explaining Life Through Evolution. Penguin Allen Lane.

Course Code	**:**	**BSE104**
Course Title	**:**	**Microbiology**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**V**

Course Objectives:

This syllabus aims to provide students with a comprehensive understanding of microbiology. It focuses on the historical development of microbiology, from the debate of spontaneous generation to the establishment of fields like medical microbiology and environmental microbiology. It also covers molecular methods for assessing microbial phylogeny and the major divisions of life. The course delves into microbial nutrition and growth, covering nutritional types, culture media, growth curves, and the effects of environmental factors. It also explores microbial cell organization, including cell size, structure, cell walls, membranes, cytoplasmic components, and endospores. The course details about viruses, their structure, classification, cultivation, and replication strategies. It also discusses applied microbiology, emphasizing its significance in food production, industry, wastewater treatment, and disease management through antimicrobial chemotherapy.

Course Outcome:

- Upon completing this syllabus, students will have gained a comprehensive understanding of microbiology including its historical development, discerning between theories like spontaneous generation and biogenesis.
- Students will be proficient in using modern molecular techniques to assess microbial phylogeny and comprehend the major divisions of life.
- They will also have a thorough knowledge of microbial nutrition, growth dynamics, and the effects of environmental factors.
- The students will be familiar with the intricate organization of microbial cells, including their structure, membranes, and the formation of endospores.
- They will have a detailed understanding of viruses, encompassing their structure, classification, cultivation methods, and replication strategies.
- The students will also understand the practical applications of microbiology in industries such as food production, wastewater treatment, and disease management through antimicrobial therapies.

Course content (Microbiology):

Unit I: History of Microbiology and classification **No. of Hours: 10**

History of development of microbiology as a discipline, Spontaneous generation versus biogenesis, development of various microbiological techniques, concept of fermentation, establishment of fields of medical microbiology, immunology, and environmental microbiology Molecular methods of assessing microbial phylogeny- molecular chronometer, phylogenetic trees, rRNA, DNA and proteins as indicator of phylogeny. Major Divisions of life- Domains, Kingdoms.

Unit II: Microbial Nutrition and Growth **No. of Hours: 10**

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; general concept of effect of environmental factors on growth of microbes; sterilization and disinfection; activity, use of physical methods (heat, low temperature, filtration, radiation)and chemical agents (phenolics, halogens, heavy water, sterilization gases).

Unit III: Microbial Cell organization **No. of Hours: 10**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, fimbriae and pili; Cell-wall: Composition and detailed structure of Gram positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS) and protoplasts. Effect of antibiotics and enzymes on the cell wall; Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes; Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids; Endospore: Structure, formation, stages of sporulation.

Unit IV: Viruses **No. of Hours: 10**

Induction - general properties of viruses; Structure of viruses - viral envelopes and enzymes; Isolation, purification, and cultivation of viruses; Viral Taxonomy; Bacteriophages - diversity, classification, lytic and lysogenic phages; Viral multiplication and replication strategies – replication and transcription in DNA viruses-Influenza virus, retroviruses-HIV; Viroids, Virusoids and Prions.

Unit V: Applied Microbiology **No. of Hours: 05**

Importance of microbiology in food and industry; basic design of fermenter– continuous and discontinuous; treatment of wastewater (municipal treatment plant) and sewage; Microbial diseases of plants and animals, antimicrobial chemotherapy.

List of Experiments:

1. To study disinfectants and sterilization techniques.
2. To study types of Media and perform media preparation.
3. To perform subculturing- streaking techniques (T streaking).
4. To study Growth Curve of bacteria.
5. To study the effect of pH/temperature/UV light on bacterial growth.
6. To perform Gram's staining.
7. To perform Negative staining
8. To perform Antibiotic resistance assay.
9. Enumeration of CFU of E. coli by serial dilution and spread plate method.
10. Conjugation experiment
11. Milk quality testing by Methylene Blue dye reductase test.

Text and References:

1. Michael Pelczar, Jr. (2001). Microbiology (5th Edn). McGraw Hill Education
2. Lansing Prescott, John Harley, Donald Klein (2004). Microbiology (6th Edn). McGraw-Hill Education
3. D.K. Maheshwari (2015). A Textbook of Microbiology. S Chand
4. Madigan Michael T. , Martinko John M. , Bender Kelly S. , Buckley Daniel H. , Stahl David A. (2017) . Brock Biology of Microorganisms (14th Edition). Pearson Education

Course Code	**:**	**BSG108**
Course Title	**:**	**Biotechnology and Human Welfare**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**V**

Course Objectives:

This course aims to provide students with a comprehensive understanding of biotechnological applications across various domains. Students will explore protein engineering and the synthesis of enzymes and polysaccharides, emphasizing their roles in alcohol production, antibiotic synthesis, and other industrial processes. The students will learn about nitrogen fixation, the transfer of pest resistance genes, and plant-microbe interactions crucial for enhancing crop quality. Environmental applications will cover the degradation of pollutants like chlorinated compounds and hydrocarbons, as well as the development of biodegradable polymers. The students will study also study the application of DNA fingerprinting methods for solving crimes and paternity disputes in forensic sciences. The course will explore biotechnological advancements in health, including the development of therapeutic agents, recombinant vaccines, gene therapy, diagnostics, and the role of the human genome project in medical research. This course will prepare students to contribute to advancements in biotechnology across diverse fields.

Course Outcome:

- The course aims to equip students with comprehensive skills and knowledge across various biotechnological disciplines.
- Students will delve into advanced techniques such as protein engineering, enzyme synthesis, and polysaccharide production crucial for industrial applications.
- The students will gain knowledge enabling them to optimize crop quality through nitrogen fixation and pest resistance gene transfer.
- The students will possess sufficient knowledge regarding pollutant degradation and the development of biodegradable polymers.
- Furthermore, students will be well-versed in health-related biotechnologies, including the development of therapeutic agents, vaccines, gene therapies, diagnostics, and leveraging insights from the Human Genome Project.
- These outcomes prepare students to contribute effectively to biotechnological advancements across various sectors, promoting innovation and sustainability in global contexts.

Course content (Biotechnology and Human Welfare):

UNIT I: Industry **(No. of Hours: 15)**

Introduction to Biotechnology, Definition, Scope, and importance, production of industrial enzymes, Protein engineering; enzyme synthesis, enzyme technology, chemicals and pharmaceuticals, alcohol, and antibiotic formation, bio-based fuel, and energy.

UNIT II: Agriculture **(No. of Hours: 13)**

N2 fixation: transfer of pest resistance genes to plants; virus resistance, herbicide resistance interaction between plants and microbes;modification of seed protein quality, Golden rice; qualitative improvement of livestock.

UNIT III: Environments **(No. of Hours: 12)**

Bioremediation, Microbial, and Phytoremediation; degradation of hydrocarbons and agricultural wastes, stress management, waste treatments, xenobiotic compounds, development of biodegradable polymers such as PHB.

UNIT IV: Forensic science **(No. of Hours: 10)**

VNTR loci and alleles, preparation of DNA samples; Solving violent crimes such as murder and rape; solving claims of paternity and theft, etc. using various methods of DNA fingerprinting. Application and advancements

UNIT V: Health **(No. of Hours: 10)**

Development of non-toxic therapeutic agents, recombinant live vaccines,transplant rejection, Disease diagnosis, detection of genetic disease, gene therapy, diagnostics, monoclonal in E.coli, human genome project.

Text and References:

1. Expanding Horizon Biotechnology, B. D. Singh, Kalyani Publications.
2. Biswas S, Biswas A (2020). Biotechnology and Human Welfare. McGraw-Hill
3. Saranraj P, Filho MB, Jayaprakash A (2021). Biological Sciences for Human Welfare. JPS Scientific Publications, India
4. Saha T (2024). Microbes, Environment and Human Welfare. Nova Science Publishers Inc

Course Code	**:**	**BSC351**
Course Title	**:**	**Evolutionary Biology - II**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VI**

Course Objectives:

The objective of this course is to equip students with a comprehensive understanding of the forces driving evolution, the processes of speciation, and the factors leading to extinction, with a focus on quantitative studies and biomathematics. Students will delve into population genetics, exploring gene pools, allele frequencies, and the Hardy-Weinberg equilibrium, while learning to calculate the impacts of selection and genetic drift. The course aims to elucidate the mechanisms and patterns of speciation, as well as the isolating mechanisms that facilitate the formation of new species. Students will also examine the history of plant and fungal evolution, tracing the origin of land plants and the phylogeny of major angiosperm groups. Additionally, the course will cover human ancestry and phylogeny, emphasizing primate characteristics, human migration theories, and molecular analyses of human origin. Through this curriculum, students will develop a solid foundation in evolutionary biology, honing their analytical and quantitative skills for advanced studies and research in the field.

Course Outcome:

- Upon successful completion of this course, students will possess a thorough understanding of the quantitative aspects of evolutionary biology, including population genetics.
- They will be adept at analyzing gene frequencies and understanding the effects of natural selection, genetic drift, and other evolutionary forces.
- Students will have a clear comprehension of speciation mechanisms and patterns, as well as the factors contributing to periodic and mass extinctions.
- They will be informed about the evolutionary history of plants and fungi, from early terrestrial algae to complex angiosperms.
- The students will gain insights into human ancestry and phylogeny, supported by molecular evidence.

Course content (Evolutionary Biology - II):

Unit I: Forces of Evolution – Quantitative Studies Based on Biomathematics
No. of Hours: 15

Population genetics – Gene pool; gene/allele frequency; genotypic frequency; phenotypic frequency (simple problems for calculation). Conservation of gene frequencies (when selection does not operate) – Hardy-Weinberg's Law of Genetic Equilibrium. Alterations in gene frequency (when selection operates) – Calculation based on Selection Coefficient and Fitness). Fluctuations in gene frequency (when drift operates) – Calculation based on standard deviation

Unit II: Product of Evolution – Speciation **No. of Hours: 15**

Concept of species as a real entity, Mechanisms of speciation – Allopatric; sympatric; peripatric, Patterns of speciation – Anagenesis and Cladogenesis; Phyletic Gradualism and Punctuated Equilibrium (Quantum Evolution), Basis of speciation – Isolating mechanisms

Unit III: End of Evolution – Extinction **No. of Hours: 10**

Periodic extinctions, Mass-scale extinctions – Causes and events

Unit IV: Evolution of Plants and Fungi **No. of Hours: 10**

Origin of land plants – Terrestrial algae and Bryophytes; alternation of generations. Early vascular plants – Stelar evolution; Sporangium evolution. Angiosperms – Phylogeny of major groups. Fungi

Unit V: Human Ancestry and Phylogeny **No. of Hours: 10**

Primate characteristics and unique Hominin characteristics. Primate phylogeny leading to Hominin line. Human migration – Theories. Brief reference to molecular analysis of human origin – Mitochondrial DNA and Y-chromosome studies.

List of Experiments:

(A) Evidences of fossils

1. Study of types of fossils (e.g. trails, casts and moulds and others) and Index fossils of Palaeozoic era

2. Connecting links/transitional forms - Eg. *Euglena, Neopilina, Balanoglossus, Chimaera, Tiktaalik, Archaeopteryx, Ornithorhynchus*

3. Living fossils - Eg. *Limulus, Peripatus*,*Latimeria, Sphaenodon*

4. Vestigial, Analogous and Homologous organs using photographs, models or specimen

(B) Variations

1. Sampling of human height, weight and BMI for continuous variation

2. Sampling for discrete characteristics (dominant vs recessive) for discontinuous variations e.g hitch-hiker's thumb, dexterity, tongue rolling, ear lobe (data categorization into 16 groups based on the combination of 4 traits; assigning each subject to the respective group)

(C) Selection Exemplifying Adaptive strategies (Colouration, Mimetic form, Co-adaptation and co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life**)** using Specimens

(D) Neo-Darwinian Studies

1. Calculations of genotypic, phenotypic and allelic frequencies from the data provided

2. Simulation experiments using coloured beads/playing cards to understand the effects of Selection and Genetic drift on gene frequencies

(E) Phylogeny

1. Digit reduction in horse phylogeny (study from chart),

2. Study of horse skull to illustrate key features in equine evolution

3. Study of monkey and human skull - A comparison to illustrate common primate and unique Hominin features.

Text and References:

1. Charles Darwin (2021). The Origin of Species. Fingerprint Publishing
2. Michael Keller and Nicolle Rager Fuller (2009). Charles Darwin's On the Origin of Species: A Graphic Adaptation. Rodale Books
3. Brian K. Hall, Benedikt Hallgrímsson(2013). Strickberger's Evolution (5^{th} Edn). Jones and Bartlett Publishers, Inc
4. Ridley, M. (2004) Evolution. III Edn. Blackwell
5. Veer bala rastogi 2021. Organic Evolution (Evolutionary Biology) Medtech publication
6. Prosanta Chakrabarty 2022. Explaining Life Through Evolution. Penguin Allen Lane
7. Zimmer, C. and Emlen, D. J. (2013) Evolution: Making Sense of Life. Roberts & Co.
8. Barton, Briggs, Eisen, Goldstein and Patel. (2007) Evolution. Cold Spring Harbor Laboratory Press

Course Code	**:**	**BSC352**
Course Title	**:**	**Immunology**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-0-1**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**VI**

Course Objectives:

The objective of this course is to provide students with a comprehensive understanding of the immune system's mechanisms in animals, encompassing both innate and adaptive immunity. Students will gain foundational knowledge in hematopoiesis, immune cells, and lymphoid organs, as well as the regulation and biological implications of immune responses. The course will also cover the intricacies of immune responses, including cell adhesion, chemokines, and complement activation, emphasizing their regulation and biological implications. Students will learn to critically analyze immune dysfunctions, such as hypersensitivity, autoimmune diseases, and immunodeficiencies, and their relevance to health and disease. The course aims to highlight the practical applications of immunology in fields like pharmaceuticals, agriculture and biopest control, fostering an appreciation for immunological research.

Course Outcome:

- Upon completing this course, students will have a comprehensive understanding of the immune system's defense mechanisms in plants and animals.
- They will be proficient in identifying and explaining the roles of various immune cells, lymphoid organs, and tissues.
- Students will be able to analyze the intricacies of both innate and adaptive immunity, including the processes of complement activation and the generation of antibody diversity.
- They will be equipped to recognize and evaluate immune dysfunctions, such as hypersensitivity, autoimmune diseases, and immunodeficiencies, and understand their implications for health.
- The students will appreciate the practical applications of immunological and knowledge in real-world scenarios.

Course content (Immunology):

Unit I: Introduction **No. of Hours: 10**

Overview of defence mechanisms in plants and animals; Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT).

Unit II: Innate immunity in animals **No. of Hours: 10**

Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response. Complement activation by classical, alternate and MBL pathway, biological consequences of complement activation, regulation and complement deficiencies.

Unit III: Adaptive Immunity in Animals **No. of Hours: 15**

Antigens and haptens, Factors that dictate immunogenicity, B and T cell epitopes. Structure and distribution of classes and subclasses of immunoglobulins (Ig), effector functions of antibody. Monoclonal antibodies; Immunological methods- Antigen-antibody interactions; Histocompatibility antigens; T cell differentiation – Positive and Negative selection, Antigen Presentation, Activation of T and B cells. Cytokines and Chemokines.

Unit IV: Immune dysfunction and applications **No. of Hours: 10**

Immunological tolerance; Immunological disorders – Hypersensitivity and Autoimmune diseases. Immunodeficiencies; Transplantation Immunology; Immune response against major classes of pathogens. Applications in agriculture, pharmaceuticals, and biopest control.

List of Experiments:

1. Characterization of diseases symptoms and identification of pathogenic organisms (at least one each from viral, fungal, pest and nematodes injection).
2. Partial purification of Immunoglobulin's by Ion Exchange chromatography
3. Immunodiffusion – DID and SRID.
4. Immunoelectrophoresis (IEP)
5. Countercurrent IEP, Rocket IEP

Recommended Texts:

1. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A Owen (2018). Kuby Immunology (8^{th} Edition). WH Freeman
2. David Male, R.S. Peebles, Victoria male (2020). Immunology (9^{th} Edition). Elsevier
3. Leslie Hudson & Frank C. Hay (1980). *Practical Immunology*. Oxford: Blackwell Scientific
4. Madhavee P. Latha (2012). A Textbook of Immunology. S Chand
5. K. Murphy, P. Travers, M. Walport. 2008. Janeway'sImmunobiology, Garland Science, Taylor and Francis Group, LLC
6. Brian J. Deverall (2009). Defence Mechanisms of Plants (1^{st} Edn). Cambridge University Press

Course Code	**:**	**BSC353**
Course Title	**:**	**Genetics**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**VI**

Course Objectives:

The objective of this course is to provide students with a thorough understanding of fundamental and advanced concepts in genetics and heredity. Students will explore Mendelian genetics, including monohybrid, dihybrid, and trihybrid crosses, and learn about the laws of segregation and independent assortment. The course will delve into genetic organization, covering prokaryotic, viral, and eukaryotic genomes, as well as chromosome morphology and packaging. Students will gain insights into the causes and types of mutations, mechanisms of sex determination, and the principles of chromosomal inheritance, including genetic linkage and chromosome mapping. The course will introduce population genetics, emphasizing gene and allele frequency calculations and the Hardy-Weinberg equilibrium. The course aims to equip students with a comprehensive understanding of genetics, preparing them for advanced studies and research in biotechnology, medicine, and related fields.

Course Outcome:

- Upon completing this course, students will have a comprehensive understanding of key genetic principles and their applications.
- They will be adept at analyzing Mendelian genetics, including the laws of segregation and independent assortment, and conducting various genetic crosses.
- Students will be able to explain the genetic organization of prokaryotic, viral, and eukaryotic genomes, as well as the structure and function of chromosomes.
- They will understand the types, causes, and implications of mutations, and the mechanisms of sex determination and linkage.
- The students will be proficient in performing genetic linkage and chromosome mapping, conducting pedigree analysis, and understanding population genetics principles such as gene frequency and the Hardy-Weinberg equilibrium.
- This course will prepare students for advanced studies and careers in genetics, biotechnology, and related fields.

Course content (Genetics):

UNIT I: Genetics & heredity **No. of Hours: 08**

Mendelian genetics: monohybrid, di-hybrid and tri-hybrid crosses, Law of segregation & Principle of independent assortment. Test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, incomplete dominance, co-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity. Non allelic interactions: Complementary genes, Epistasis (dominant & recessive), duplicate genes and inhibitory genes.

UNIT II: Genetic organization **No. of Hours: 10**

Genetic organization of prokaryotic and viral genome. Chromosome and genomic organization of eukaryotes: unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, VNTRs, transposons, noncoding DNA. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, packaging, karyotype, giant chromosomes.

UNIT III: Chromosome and gene mutations **No. of Hours: 10**

Definition and types of mutations, causes of mutations, chromosomal aberrations in human beings.Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

UNIT IV: Chromosomal inheritance **No. of Hours: 09**

Genetic linkage, crossing over and chromosome mapping. Introduction to Pedigree analysis.Extra chromosomal inheritance: maternal effects, maternal inheritance, cytoplasmic inheritance, genomic imprinting. Basics of bacteriophage genetics: Lytic cycle & Lysogenic cycle.

UNIT V: Population genetics **No. of Hours: 08**

Gene pool; gene/allele frequency; genotypic frequency; phenotypic frequency (simple problems for calculation). Conservation of gene frequencies (when selection does not operate) – Hardy-Weinberg's Law of Genetic Equilibrium.

List of Experiments:

1. Preparation of pre-treating / fixing agents/ stains for cytological studies.
2. Study of Mitosis using root tips
3. Study of Meiosis using flower buds/ grasshopper testes
4. Blood grouping and Rh in humans
5. Blood typing in humans for multiple alleles and Rh factor
6. Histological study of Cancer types using permanent slides
7. Genetic Problems on Monohybrid cross,
8. Genetic Problems on Dihybrid cross
9. Demonstration of prenatal diagnosis
10. Detection of inborn errors of metabolism– mucopolysaccharidosis, Galactosemia, PKU.
11. Construction and analysis of Pedigree
12. Risk calculation
13. Assessment of inheritance of quantitative characters

Text and References:

1. Pierce, B. A. (2012). Genetics: a conceptual approach. Macmillan publication.
2. Roberts, K., Alberts, B., Johnson, A., Walter, P., & Hunt, T. (2002). Molecular biology of the cell. New York: Garland Science.
3. Lodish, Harvey, et al. Molecular cell biology. Macmillan, 2008.
4. Snustad, D. P., & Simmons, M. J. (2015). Principles of genetics. John Wiley & Sons.
5. Karp, G. (2009). Cell and molecular biology: concepts and experiments. John Wiley & Sons
6. Cooper, G. M., Hausman, R. E., & Hausman, R. E. (2007). The cell: a molecular approach. Washington, DC: ASM press.
7. Gupta, P.K. (2010). Cytogenetics. Rastogi Publications, Meerut, India.
8. Lewin, B., Krebs, J., Kilpatrick, S. T., & Goldstein, E. S. (2011). Lewin's genes X. Jones & Bartlett Learning.

Course Code	**:**	**BSE106**
Course Title	**:**	**Stress Biology**
Total Credits	**:**	**4 (Theory 3; Practical 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Practical 30**
Semester	**:**	**VI**

Course Objectives:

The objective of this course is to provide students with an in-depth understanding of plant stress biology, focusing on the mechanisms of acclimation and adaptation. Students will explore the history, characteristics, and types of free radicals, including reactive oxygen and nitrogen species, and the role of enzymatic and non-enzymatic antioxidants in scavenging free radicals. The course will examine various environmental stress factors such as water, salinity, high light, and temperature stress, along with plant responses like hypersensitive reaction and systemic acquired resistance. Moreover, students will learn about stress sensing mechanisms in plants, including the roles of nitric oxide, calcium modulation, and phospholipid signaling. The course will also cover tolerance mechanisms that protect plants against environmental stress, highlighting physiological and developmental adaptations like changes in root-to-shoot ratio, aerenchyma development, osmotic adjustment, and compatible solute production. This comprehensive approach aims to equip students with the knowledge to understand and address plant stress, preparing them for advanced studies and careers in plant science and related fields.

Course Outcome:

- Upon completing this course, students will have gained a profound understanding of how plants respond and adapt to environmental stresses.
- They will be able to identify and analyze the mechanisms of acclimation and adaptation in plants, including the roles of free radicals and antioxidants in stress mitigation.
- Students will comprehend the impacts of water stress, salinity, light intensity, and temperature fluctuations on plant physiology, and understand key defense mechanisms like hypersensitive reactions and systemic acquired resistance.
- They will also grasp the significance of stress sensing mechanisms such as nitric oxide and calcium signaling.
- The students will be equipped to advance agricultural practices, environmental conservation, and sustainable biotechnological innovations to enhance plant resilience against global climate challenges.

Course content (Stress Biology):

Unit I: Defining plant stress **No. of Hours: 05**

Acclimation and adaptation, characteristics and mechanism of action

Unit II: Free radicals **No. of Hours: 10**

History of free radicals, characteristics and types (reactive oxygen species, reactive nitrogen species), antioxidants- enzymatic and Non-enzymatic antioxidants, Production and scavenging of free radicals, beneficial and hazardous effects of free radicals, free radical associated diseases

Unit III: Environmental factors **No. of Hours: 10**

Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis–related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

Unit IV: Stress sensing mechanisms in plants **No. of Hours: 10**

Role of nitric oxide. Calcium modulation, Phospholipid signaling

Unit V: Tolerance mechanisms against environmental stress **No. of Hours: 10**

Developmental and physiological mechanisms that protect plants against environmental stress**,** Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; osmotic adjustment; Compatible solute production.

List of Experiments:

1. Determination of antioxidant activity of the plants
2. Identification and quantification of plant stress markers
3. Induction of Abiotic stress condition on plant such as drought, salinity, temperature etc.
4. Analysis of stress induced morphological changes in plants.
5. Evaluation of plant growth under stress conditions such as Measurement of plant growth parameters including root and shoot length, biomass content.
6. Analysis of osmolyte accumulation (Eg. proline, glycine betaine) in plants under stress condition
7. Treatment of plants with hormones and growth regulators such as abscisic acid (ABA) or salicylic acid (SA) and study of their effects on stress mitigation.
8. Assessment of Reactive Oxygen Species (ROS) in stressed plants (Eg. Hydrogen peroxide).

Recommended Texts:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology (4th ed.). John Wiley and Sons. U.S.A.
2. Taiz, L., Zeiger, E. Moller, I.M. and Murphy, A. (2015). Plant Physiology and Development (6th ed), Sinauer Associates Inc. U.S.A.
3. Nobel, P.S. (2009). Physicochemical and Environmental Plant Physiology (4th ed), Academic Press.
4. Noggle, G.R. and Fritz, G.J. (1986). Introduction to Plant Physiology, (2nd Ed). Prentice- Hall of India Ltd., New Delhi.
5. Uprety, D.C. and Reddy, V.R. (2016). Crop response to global warming, Springer

Course Code	**:**	**BSG112**
Course Title	**:**	**Bioentrepreneurship Development**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VI**

Course Objectives:

The course aims to provide students with a comprehensive understanding of bioentrepreneurship by exploring innovation strategies in biotech companies, biotechnology-based products and services, licensing, and protection, alongside the intricacies of IPR issues and biosafety. It delves into the concepts and theories of entrepreneurship, the importance of entrepreneurial traits and motivation, and examines government schemes for technology commercialization. The course covers funding mechanisms for biotech businesses in India, support systems for entrepreneurship, challenges faced, organizations supporting biotech growth, and biotech policy initiatives. Additionally, it provides insights into setting up and managing biotech enterprises of various scales, including quality control, location considerations, and exploring export possibilities. Students will also gain proficiency in financial analysis, including ratio analysis, investment processes, break-even analysis, profitability analysis, and budgeting and planning.

Course Outcome:

- Upon completing this course, students will be able to develop and implement innovation strategies in biotech companies, effectively navigate licensing, protection, and IPR issues, and address biosafety concerns.
- They will understand key entrepreneurial concepts, traits, and motivations, and utilize government schemes for technology commercialization.
- Students will secure funding for biotech businesses, leverage support systems, identify challenges, and utilize organizations and policy initiatives for biotech growth in India.
- They will be equipped to set up and manage biotech enterprises of various scales, ensure quality control, select strategic locations, and explore export opportunities.
- The students will also be proficient in financial analysis, including ratio analysis, investment processes, break-even analysis, profitability analysis, and budgeting and planning, ensuring the financial sustainability of biotech ventures.

Course content (Bioentrepreneurship Development):

UNIT I: Innovation and bioentrepreneurship **No. of Hours: 10**

Innovation as strategy in Biotech Companies – Biotechnology based products and services – license and protection – IPR issues in bioentrepreneurships – biosafety

UNIT II: Major start-ups in Biotechnology **No. of Hours: 15**

Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, Government schemes for commercialization of technology (eg. Biotech Consortium India Limited)

UNIT III: Funding of biotech business **No. of Hours: 10**

Funding for biotech in India - support mechanisms for entrepreneurship - Bioentrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, biotech policy initiatives

UNIT IV: Biotech enterprises **No. of Hours: 15**

Desirables in start-up, Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities

UNIT 5: Financial analysis **No. of Hours: 10**

Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process

Text and References:

1. Vasant Desai (2005). Dynamics of Entrepreneurial Development and Management. Himalaya Publishing House.
2. Prasannan. Projects Planning Analysis, Selection, Implementation & Review.
3. Yali Friedman (2008). Best Practices in Biotechnology Education. Published by Logos Press.
4. Richard Dana Ono (1991). The Business of Biotechnology: From the Bench of the Street. Published Butterworth- Heinemann.
5. Martin Gross Mann (2003). Entrepreneurship in Biotechnology: Managing for growth from start-up.
6. D. Hyne & John Kapeleris (2006). Innovation and entrepreneurship in biotechnology: Concepts, theories & cases.

Course Code	**:**	**BSC401**
Course Title	**:**	**Genomics and Proteomics**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**4-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VII**

Course Objectives:

This course aims to equip students with a deep understanding of the foundational and advanced principles in genomics and proteomics. Students will explore the organization of prokaryotic and eukaryotic genomes, as well as extra-chromosomal DNA elements, and will gain proficiency in genome mapping and sequencing techniques, including the analysis and retrieval of genome data from major sequencing projects like the Human Genome Project. The course will also develop students' abilities to utilize comparative genomics for organism identification, evolutionary studies, disease tracking, and drug design. In the field of proteomics, students will learn about the key technologies and methodologies used for protein analysis and interaction studies, and will gain insight into functional genomics, including gene expression analysis and the characterization of chromosomes. The course will also introduce emerging fields such as metabolomics, lipidomics, metagenomics, and systems biology, providing a comprehensive understanding of the applications of genomics and proteomics in clinical and biomedical contexts.

Course Outcome:

- Upon completing this course, students will have acquired a thorough understanding of both the structural and functional aspects of genomes and proteomes in prokaryotic and eukaryotic organisms.
- They will understand genome mapping and sequencing techniques, capable of interpreting and utilizing data from significant genome projects like the Human Genome Project.
- Students will be able to apply comparative genomics to classify organisms, understand evolutionary processes, and contribute to the development of new therapeutics.
- In proteomics, they will learn related techniques such as mass spectrometry and protein interaction studies, enabling them to analyze protein function and interaction networks.
- The students will be well-versed in functional genomics, including gene expression analysis and chromosome characterization,
- They will have foundational knowledge in emerging fields such as metabolomics, lipidomics, metagenomics, and systems biology.

Course content (Genomics and Proteomics):

UNIT I: Basics of genomics and proteomics **No. of Hours: 10**

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast.

UNIT II: Genome mapping & Genome sequencing projects **No. of Hours: 15**

Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, in situ hybridization, comparative gene mapping.Human Genome Project, genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from the web.

UNIT III: Comparative genomics **No. of Hours: 10**

Identification and classification of organisms using molecular markers-16S rRNA typing/ sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.

UNIT IV: Proteomics **No. of Hours: 10**

Aims, strategies and challenges in proteomics; proteomics technologies: 2D-PAGE, isoelectric focusing, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.

UNIT V: Functional genomics and proteomics **No. of Hours: 15**

Transcriptome analysis for identification and functional annotation of gene, PCR, Gene expression analysis (relative quantitation and absolute quantitation using qRT PCR), Contig assembly, chromosome walking and characterization of chromosomes, mining functional genes in genome, gene function-forward and reverse genetics, gene ethics; Protein-protein and protein-DNA interactions; protein chips and functional proteomics; clinical and biomedical applications of proteomics;introduction to metabolomics, lipidomics, metagenomics and systems biology.

List of Experiments:

1. Isolation of genomic DNA from various biological samples.
2. Targeted DNA amplification using polymerase Chain reaction (PCR).
3. Visualization of DNA fragments using agarose gel electrophoresis.
4. Quantification of DNA or RNA using quantitative PCR (qPCR).
5. Protein extraction and estimation.
6. Transformation of GFP plasmid in chemically competent *E.coli* cells.
7. Separation of proteins based on molecular weight using SDS-PAGE.

Text and References:

1. T.A. Brown. Gene Cloning and DNA Analysis – An introduction (Fourth Edition).
2. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006). Principles of Gene Manipulation and Genomics.Malden, MA: Blackwell Pub.
3. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.
4. Arthur M. Lesk. Database Annotation in Molecular Biology: Principles and Practice
5. Lesk, A. M. (2010) Introduction to Protein Science: Architecture, Function and Genomics. Oxford University Press, UK.
6. Branden, C. I. and Tooze, T. (1999) Introduction to Protein Structure. Garland Publishing, USA.
7. Daniel C. Liebler. Introduction to proteomics: Tools for new biology. Humana Press.
8. Smith and Albala. Protein array, Biochips and Proteomics. Marcel Dekkar, New York.
9. James D. Watson and Mark Zoller. Recombinant DNA (Second Edition).
10. D.W. Mount. Bioinformatics: Sequence and genomic analysis. Cold Spring Harbour Laboratory Press.

Course Code	**:**	**BSG114**
Course Title	**:**	**Research Methodology and Science Communication**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VII**

Course Objectives:

The course provides a comprehensive overview of research problem formulation, effective research communication, and essential aspects of biosafety and bioethics. It begins with the fundamentals of defining research problems and planning experiments, including selecting research areas, conducting literature surveys, designing protocols, and managing time-bound work plans. Students will develop skills in formulating research aims, utilizing state-of-the-art techniques, and mastering technical writing for various types of research articles. The course covers data collection and analysis, focusing on data types, sampling techniques, probability, statistical methods, and Analysis of Variance (ANOVA). It also addresses bioethics, providing insights into its historical background, guidelines, and ethical issues related to biotechnology and molecular technologies. The course explores biosafety, including the importance of containment levels, Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP), and the roles of regulatory bodies in GMO regulation, along with risk assessment and management practices.

Course Outcome:

- Upon successful completion of this course, students will have the expertise to effectively formulate and plan research projects, including defining research problems, designing experiments, and employing advanced methodologies.
- They will demonstrate proficiency in conducting comprehensive literature reviews, analyzing data using statistical methods and ANOVA, and producing high-quality technical research articles.
- Students will be well-versed in bioethics, understanding regulatory guidelines and ethical considerations relevant to biotechnology.
- They will possess in-depth knowledge of biosafety practices, including containment levels, Good Laboratory Practices (GLP), and regulatory frameworks for GMOs, enabling them to manage and assess risks in research and industrial settings.

Course content (Research Methodology and Science Communication):

Unit I: Formulating research problem and effective research communication No. of Hours: 18

Formulating research problem and experimental planning selection of an area for research; Importance and need of research in that field; Literature survey; Planning of experimental work: Importance and designing of the problem to be undertaken, Defining the aim and objectives of the research work planned, Importance of prior collection of protocols, Time bound frame of work plan, Designing of experimental protocol; Description of strategies to meet the objectives using state-of-the-art techniques and proper citation of standard procedures. Types of research articles and technical writing skills.

Unit II: 1. Data Collection and Analysis No. of Hours: 12

Understand the basics of data types, sampling techniques, and data analysis. Probability: Grasp the basic concepts of probability and their application. Statistical Basis of Biological Assay. Learn the statistical methods used in biological assays. Analysis of Variance (ANOVA) Understand principles of experimental design and variance analysis.

Unit III: Bioethics No. of Hours: 12

Introduction and historical background, terminology, and regulations, Bioethics Guidelines, different paradigms of Bioethics – National & International standards, A brief account of bioethics in Biotechnology, Rules and regulations, Necessity of Bioethics. Ethical issues against molecular technologies. Release of Genetically modified Organisms and Recombinant drugs, Regulating Agencies regarding ethical committees.

Unit IV: Biosafety No. of Hours: 18

Importance of biosafety in biotechnology, Health hazards related to biotechnology). Concept of containment levels, Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP). Evolution of biosafety practices, Biological Safety Cabinets: purpose and types. Primary containment methods for biohazards, Understanding different Biosafety Levels (BSL), Specific biosafety levels for various microorganisms. Biosafety guidelines by the Government of India, Recommended biosafety levels for infectious agents and animals. Definitions of GMOs and Living Modified Organisms (LMOs), Roles of Institutional Biosafety Committee, RCGM, GEAC in GMO regulation. Environmental release of GMOs, Risk Analysis: assessment, management, and communication.

Text and References:

1. Bhattacharyya, D.K. Research methodology. Excel Books, New Delhi.
2. Kumar, R. Research methodology: A step-by-step guide for beginners. SAGE Publications, California.
3. Singh, Y.K. Research methodology. APH Publishing Corporation, New Delhi.
4. Khan, J.A. Research methodology. APH Publishing Corporation, New Delhi.
5. Gupta, S. Research methodology and statistical techniques. Deep and Deep Publications, New Delhi.
6. Khanzode, V.V. Research methodology. APH Publishing Corporation, New Delhi.
7. Goddard, W. and Melville, S. Research methodology: An introduction. Juta and Company Limited, Landsdown.
8. Dawson, C. Practical research methods: A user-friendly guide to mastering research techniques and projects. How to Books Limited, London.
9. Daniel, P.S. and Sam, A.G. Research methodology. Gyan Publishing House, New Delhi.
10. Murray, R. How to write a thesis. McGraw-Hill, New York.

Course Code	**:**	**BSE114**
Course Title	**:**	**Plant Biotechnology**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VII**

Course Objectives:

The course aims to provide students with a comprehensive understanding of various techniques in plant tissue culture, including cellular totipotency, somaclonal variation, embryogenesis, and protoplast isolation and culture. It covers the production of virus-free plants, the basics of tumor formation, and the mechanisms of DNA transfer via Ti plasmids, emphasizing the development of genetically modified crops for biotic and abiotic stress tolerance. The course delves into genetic improvement for quality enhancement of plant proteins, lipids, carbohydrates, vitamins, and mineral nutrients, utilizing plants as bioreactors and exploring molecular breeding techniques. Students will also study the manipulation of plant secondary metabolites, biodegradable plastics, therapeutic proteins, edible vaccines, and greenhouse technology, alongside advanced molecular breeding methods such as RFLP maps, RAPD, STS, SCAR, QTL, and map-based cloning.

Course Outcome:

- Upon completion of this course, students will have acquired a robust understanding of plant tissue culture techniques and their applications in crop improvement, including the production of virus-free plants and somatic hybridization.
- They will be proficient in the principles of genetic engineering, capable of developing genetically modified crops for both biotic and abiotic stress tolerance.
- Students will be adept at improving the quality of plant-derived proteins, lipids, carbohydrates, vitamins, and minerals, and utilizing plants as bioreactors.
- They will also gain expertise in manipulating plant secondary metabolites for industrial and therapeutic purposes.
- They will also be proficient in applying advanced molecular breeding techniques such as RFLP, RAPD, STS, SCAR, QTL, and map-based cloning for the enhancement of crop traits.

Course content (Plant Biotechnology):

UNIT I: **No. of Hours: 10**

Introduction to the techniques of plant tissue culture, Cellular totipotency, Single cell culture, Somoclonal variation, Embryogenesis, protoplast isolation and culture, Somatic hybridization, cybrid production and their application in crop improvement, production of virus free plants using meristem culture.

UNIT I: **No. of Hours: 15**

Basic of tumor formation, hairy root culture, Ti plasmids mechanisms of DNA transfer and use of vectors, Genetically modified crops, plants and Genetic engineering for biotic stress tolerance (insects,fungi,bacteria, virus and fungi) Genetic engineering for abiotic stress (Drought, flooding, Salt and temperature).

UNIT III: **No. of Hours: 15**

Genetic improvement for quality improvement of proteins, lipids, carbohydrates, vitamins and mineral nutrients , plants as bioreactor, molecular breeding, constructing molecular maps,(molecular tagging of traits), Marker assisted selection of Qualitative and quantitative traits), physical maps of chromosomes and concept of map based cloning and their use in transgenics.

UNIT IV: **No. of Hours: 10**

Plant secondary metabolites: Control mechanisms and manipulation of alkaloids and industrial enzymes (Shikimate and PHA pathway), biodegradable plastics, therapeutic proteins, edible vaccines, Green house technology.

UNIT V: **No. of Hours: 10**

Molecular aided breeding, RFLP maps, RAPD, STS, SCAR QTL, Map based cloning, molecular assisted selection.

List of Experiments:

1. Organizing Plant tissue culture Laboratory
2. Preparation of Tissue Culture Media
3. Callus Induction
4. Shoot tip culture
5. Embryo / Endosperm Culture
6. Somatic Embryogenesis
7. Hardening and Planting infield
8. Isolation of protoplasts
9. Cell suspension culture
10. Economics of micropropagation project

Text and References:

1. Hamish A Collin, Sue Edwards (1998). Plant Cell Culture
2. Chawla H S, Introduction to Plant Biotechnology by, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, 3rd Ed., ISBN- 9788120417328.
3. Gupta P K, 2004. Biotechnology and Genomics.
4. Primrose and Twyman. Principles of Gene Manipulation & Genomics (7th Ed.).
5. Singh BD and Shekhawat NS, 2018. Molecuar Plant Breeding, Scientific Pub.
6. Rastogi Smita and Pathak Neelam (2009) Genetic Engineering, 1st Ed. Oxford.
7. John H Dodds; Lorin W Roberts, 3rd edition, 2004. Experiments in Plant tissue Culture
8. Plant tissue culture by MK Razdan & SS Bhojwani(1996) Elsevier.
9. Robert H Smith, 3rdedition. Plant Tissue Experiments
10. Plant physiology by L Tiaz & E Zeiger 4th edition (2006) Sinauer Associates Inc publishers.
11. Plant Biotechnology and transgenic plants, Edited by Kirsi Marja Oksman-Caldentey, Wolfgang Barz Marcel Dekker 2002.
12. Plant tissue culture concepts and laboratory exercises, Second edition, Robert N Trigiano, Dennis J Gray, CRC Press November 1999.

Course Code	**:**	**BSE107**
Course Title	**:**	**Microbial Pharmaceutical Technology**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VII**

Course Objectives:

This course aims to provide a comprehensive understanding of antimicrobial chemotherapy, including the principles of antimicrobial agent selection, bioassay concepts, and molecular aspects of antimicrobial action. Students will explore mechanisms of action and examples of chemical disinfectants, antiseptics, preservatives, and various antibiotics (antiviral, antifungal, and antitumor). Students will also examine microbial production and spoilage of pharmaceutical products, including vaccine manufacturing and therapeutic enzyme production, and learn about contamination control and biosensor applications. Regulatory practices, including FDA standards and IP, BP, and USP significance, will be studied, alongside rational drug design. Finally, the course will cover quality assurance and validation processes, including ISO, WHO, and USFDA certifications, microbial limit tests, sterility and pyrogen testing, and various sterilization methods.

Course Outcome:

- Upon completing this course, students will have a thorough understanding of antimicrobial chemotherapy, including the selection and mechanisms of action for various antimicrobial agents.
- The students will gain expertise in microbial production and spoilage of pharmaceutical products, including the manufacturing and control of various vaccines and therapeutic enzymes.
- They will be familiar with contamination control, biosensor applications, and regulatory practices, including FDA standards and the significance of IP, BP, and USP.
- They will also be proficient in conducting microbial limit tests, sterility and pyrogen testing, and implementing various sterilization methods.

Course content (Microbial Pharmaceutical Technology):

UNIT I: No. of Hours: 12

Principles of Antimicrobial chemotherapy. Introduction of antimicrobial agents. Introduction of Bioassay, therapeutic index, MIC and LD50. Definition, classification, Mechanism of action and examples of chemical disinfectants, antiseptic and preservatives. Definition, classification, Mechanism of action and examples of antiviral, Antifungal and Antitumor antibiotics.

UNIT II: No. of Hours: 18

Microbial Production and spoilage of Pharmaceutical Products. Manufacturing procedure and in-process control of Pharmaceutical products: Bacterial and Viral vaccine, New Vaccine production. Microbial production and applications of therapeutic/diagnostic enzymes: Asparaginase, Streptokinase, beta lactamases. Microbial production contamination and spoilage of Pharmaceutical products and their sterilization. Applications of Biosensors in pharmaceutical industries.

UNIT III: No. of Hours: 15

Regulatory Practices and Policies in Pharmaceutical Industries. FDA, Govt. regulatory practices and policies. Significance of IP, BP and USP. Rational drug design (Quantitative structure activity relation QSAR of drug) and computational aspect of drug design. Screening and utilization of bioactive phytochemicals.

UNIT IV: No. of Hours: 15

Quality Assurance and Validation. ISO, WHO, USFDA certification. Microbial Limit test of Pharma products. Sterility testing, pyrogen testing and LAL test of Sterile Pharma products. Sterilization- heat, D-value, Z-value and survival curve, radioactive, gaseous and filtration. Chemical and biological indicators.

List of Experiments:

1. Spectrophotometeric/ Microbiological methods for the determination of Fungus.
2. Microbial production and Bioassay of Penicillin.
3. Bioassay of Chloramphenicol/ Streptomycin by plate assay method or turbitometric assay methods.
4. Determination of MIC.
5. Sterility testing by using B. sterothermophilus/ B. subtilis.
6. Testing for microbial contamination.
7. Determination of antimicrobial activity of chemical compounds (like phenol, resorcinol and formaldehydes) Comparison with standard products.

Text and References:

1. Pharmaceutical Microbiology- Edited by W. B. Hugo & A.R. Russel Sixth Edition. Blackwell Scientific Publications.
2. Lippincott's illustrative Reviews: Pharmacology Edition: 02 Maryjnycck by Lippincott's review Publisher Pheladelphia 1997.
3. Principles of medicinal chemistry Vol. 1 by Kadam S.S., Mahadik K.R., Bothra K.G. Edition: 18, Nirali Publication.
4. Pharmacognosy by Gokhle S.D., KoKateC.K.. Edition: 18, Nirali Publication.
5. Biotechnology – Expanding Horizon by B.D. Singh ., First Edition, Kalyani Publication, Delhi.
6. Analytical Microbiology- Edited by Fredrick Kavanagh volume I &II. Academic Press New York.

Course Code	**:**	**BS08C16**
Course Title	**:**	**Bioprocess Technology**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**4-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VIII**

Course Objective:

The course aims to provide students with a thorough understanding of the fundamental and applied aspects of bioprocess technology. It provides the students with knowledge of bioprocess engineering principles, including the kinetics of microbial growth and death, and the optimization of bioprocesses for enhanced product formation. The course will develop proficiency in various fermentation processes, including batch, fed-batch, and continuous modes, and will cover the design and operation of bioreactors and production vessels. Students will also gain skills in upstream processing, focusing on inoculum development, media formulation, and the scale-up of bioprocesses from laboratory to industrial scales. The course will also introduce downstream processing techniques, preparing students to effectively recover and isolate bioproducts using advanced methods. The course is designed to prepare students for careers in bioprocessing and related fields by providing them with the essential knowledge and practical skills needed to optimize and implement bioprocesses in industrial applications.

Course Outcome:

- Upon completing this course, students will have developed an understanding of bioprocess technology, enabling them to apply key principles of bioprocess engineering in real-world scenarios.
- They will be adept at analyzing and optimizing microbial growth and product formation within various fermentation processes, including batch, fed-batch, and continuous modes.
- Students will possess the skills to design and operate different types of bioreactors and production vessels, as well as to scale up bioprocesses from laboratory settings to industrial applications.
- They will be proficient in upstream processing, including inoculum development and media formulation, and will have practical experience in downstream processing techniques for product recovery and isolation.

Course content (Bioprocess Technology):

Unit I: Basic principles of Bioprocess Technology **No. of Hours: 18**

Introduction to concepts of bioprocess engineering, Overview of bioprocesses with their various components, Microbial growth and death kinetics with respect to fermenters, optimization of bioprocesses, yield coefficient, doubling time, specific growth rate, metabolic and biomass productivities, effect of temperature, pH and salt concentration on product formation. Application of Bioprocess Technology.

Unit II: Concepts of basic mode of fermentation processes **No. of Hours: 18**

Bioreactor designs; Types of fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Solid substrate, surface and submerged fermentation; Fermentation media; Design and types of culture/production vessels- Batch, Fed batch, CSTBR, airlift, packed bed and bubble column fermentor; Impeller, Baffles, Sparger.

Unit III: Upstream Process **No. of Hours: 12**

Inoculum development, formulation of production media, scale up of the process from shake flask to industrial level. Growth of culture in fermenter, choosing cultivation methods, Modifying batch and continuous reactors, immobilization cell systems, active and passive immobilization, solid state fermentation process.

Unit IV: Downstream processing **No. of Hours: 12**

Introduction, Recovery of particulates filtration, centrifugation, sedimentation, emerging technologies for cell recovery, product isolation, extraction, solvent extraction, aqueous two phase system, sorption, precipitation, reverse osmosis, ultra-filtration.

List of Experiments:

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

Text and References:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition, Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
5. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
6. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
7. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
8. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
9. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.
10. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.

Course Code	**:**	**BSG116**
Course Title	**:**	**Environmental Biotechnology**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VIII**

Course Objectives:

The course aims to provide an in-depth exploration of environmental biotechnology, focusing on wastewater treatment, toxicity testing, biodegradation, and biogeotechnology. Students will gain a thorough understanding of wastewater characterization and treatment methods, including primary, secondary, and tertiary processes, as well as various technologies like activated sludge and trickling filters. The course will cover toxicity testing using microorganisms, anaerobic digestion fundamentals, and composting techniques, including vermicomposting. It will delve into the mechanisms and factors influencing the biodegradation of organic pollutants and the principles of bioremediation, including techniques for oil spills and heavy metal pollution. The course will also introduce biogeotechnology topics such as bioleaching, biobeneficiation, microbially enhanced oil recovery, and biodesulfurization of coal, along with microbial insecticides and biofertilizers for pest management and soil enrichment.

Course Outcomes:

- Upon completion of this course, students will have a comprehensive understanding of environmental biotechnology applications, including advanced knowledge in wastewater treatment processes, such as primary, secondary, and tertiary methods, and various treatment technologies.
- They will be proficient in assessing wastewater characteristics, conducting toxicity testing, and applying anaerobic digestion and composting techniques, including vermicomposting.
- Students will be skilled in analyzing the biodegradation of organic pollutants and implementing bioremediation strategies for oil spills, heavy metals, and other contaminants.
- They will also have expertise in biogeotechnology, including bioleaching, biobeneficiation, microbially enhanced oil recovery, and biodesulfurization.
- The students will understand the role of microbial insecticides and biofertilizers in pest management and soil health, equipping them with practical skills for addressing environmental challenges through biotechnological solutions.

Course Content (Environmental Biotechnology):

Unit I: **No. of Hours: 18**

Issues and scopes of environmental biotechnology. Waste water treatment-Waste water characterization and its significance: COD, BOD, Inorganic constituents, solids, biological components. Primary, secondary and tertiary treatment of waste water. Principles and aims of biological wastewater treatment processes. Biochemistry and microbiology of inorganic phosphorus and nitrogen removal. Suspended growth technologies: Activated sludge, oxidation ditches, waste stabilization ponds. Fixed film technologies: Trickling filters, rotating biological contactors, fluidized bed and submerged aerated filters.

Unit II: **No. of Hours: 12**

Toxicity testing in waste water treatment plants using microorganisms. Anaerobic digestion: microbiological and biochemical fundamentals, factors influencing anaerobic digestion. Anaerobic waste water treatment systems: RBC, UASB, anaerobic filters. Merits and demerits of anaerobic treatment of waste.Composting: Objectives, fundamentals, microbiology, factors influencing composting and composting systems. Compost quality and uses. Vermicomposting.

Unit III: **No. of Hours: 18**

Biodegradation of organic pollutants: Mechanisms and factors affecting biodegradation. Pollution problems and biodegradation of simple aliphatic, aromatic, polycyclic aromatic hydrocarbons, halogenated hydrocarbons, azo dyes, lignin and pesticides. Bioremediation: Intrinsic bioremediation, Biostimulation and Bioaugmentation. In situ and ex situ bioremediation technologies. Bioremediation of oil spills. Bioremediation of heavy metal pollution, Phytoremediation. Use of GMO in bioremediation. Biological treatment of waste gas (polluted air): biofilters, bioscrubbers, membrane bioreactors, biotrickling filters.

Unit IV: **No. of Hours: 12**

Biogeotechnology- Bioleaching of metals: Characteristics of commercially important microbes, mechanisms of bioleaching, factors affecting bioleaching and current biomining processes. Biobeneficiation of gold ores. Microbially enhanced oil recovery. Biodesulfurization of coal: Removal of organic and inorganic sulfur from coal. Microbial Insecticides: Bacterial, fungal and viral insecticides in pest management. Biofertilizers: Nitrogen fixing and phosphate solubilizing biofertilizers.

Text and References:

1. MurrayMoo Young. Comprehensive Biotechnology Vol-4.
2. Rehm and Reid. Biotechnology.
3. G. Bitton. Waste water microbiology
4. M. Alexander. Biodegradation and bioremediation
5. Arceivala. Waste water treatment for pollution control, 2nd edition.
6. H. Jordening and Josef Winter. Environmental Biotechnology.

Course Code	**:**	**BSE111**
Course Title	**:**	**Bioinformatics**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VIII**

Course Objectives:

The course aims to provide students with a comprehensive understanding of bioinformatics fundamentals, including the use of computational tools and databases for biological data analysis. Students will learn to navigate and utilize various biological databases, perform sequence analysis, and apply pattern matching algorithms. The course aims to develop skills in DNA sequence analysis, including sequence alignment, motif discovery, and the identification of structural variants. Students will gain expertise in multiple sequence alignment and phylogenetic analysis using tools such as FASTA3 and CLUSTALW. The course will also cover advanced topics in protein modeling and structure prediction, including force field methods, secondary structure prediction, loop searching, and homology modeling. The students will be prepared to conduct in-depth protein structure analysis, evaluate model accuracy, and apply in silico methods for drug design and functional prediction.

Course Outcome:

- Upon completion of this course, students will have developed a robust skill set in bioinformatics, enabling them to effectively utilize computational tools and databases for biological data analysis.
- They will be proficient in navigating and leveraging various biological databases for sequence identification and analysis, including DNA and protein sequences.
- Students will be adept at performing DNA sequence analysis, including sequence alignment, motif discovery, and the identification of structural variants.
- They will be capable of conducting multiple sequence alignments and phylogenetic analyses using tools such as FASTA3 and CLUSTALW.
- The students will be capable of applying advanced protein modeling techniques, including force field methods, secondary structure prediction, and homology modeling.
- They will be skilled in evaluating protein structure predictions, constructing models, and applying in silico methods for drug design and protein function prediction.

Course content (Bioinformatics):

UNIT I: Bioinformatics basics **No. of Hours: 10**

Bioinformatics basics: Computers in biology and medicine; Database concepts; Protein and nucleic acid databases; Structural databases; Biological XML DTDs; pattern matching algorithm basics; databases and search tools: biological background for sequence analysis; Identification of protein sequence from DNA sequence; searching of databases similar sequence; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools.

UNIT II: DNA sequence analysis **No. of Hours: 10**

DNA sequence analysis: gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; local structural variants of DNA, their relevance in molecular level processes, and their identification; assembly of data from genome sequencing.

UNIT III: Multiple sequence analysis **No. of Hours: 10**

Multiple sequence analysis; multiple sequence alignment; flexible sequence similarity searching with the FASTA3 program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centers; submitting aligned sets of sequences, updating submitted sequences, methods of phylogenetic analysis.

UNIT IV: Protein modeling **No. of Hours: 15**

Protein modelling: introduction; force field methods; energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment- methods, evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; software accessibility; building peptides; protein displays; substructure manipulations, annealing.

UNIT V: Protein structure prediction **No. of Hours: 15**

Protein structure prediction: protein folding and model generation; secondary structure prediction; analyzing secondary structures; protein loop searching; loop generating methods; homology modelling: potential applications, description, methodology, homologous sequence identification; align structures, align model sequence; construction of variable and conserved regions; threading techniques; topology fingerprint approach for prediction; evaluation of alternate models; structure prediction on a mystery sequence; structure aided sequence techniques of structure prediction; structural profiles, alignment algorithms, mutation tables, prediction, validation, sequence based methods of structure prediction, prediction using inverse folding, fold prediction; significance analysis, scoring techniques, sequence-sequence scoring; protein function prediction; elements of in silico drug design.

List of experiments:

1. Understanding the use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR).
2. Pair wise sequence alignment using BLAST
3. Multiplesequence alignment (MSA) using various tools(ClustalW, BioEdit, MEGA).
4. Protein structure visualization using various tools (eg. PyMOL)

Text and References:

1. Lesk, A. M. (20014). Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell.
5. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
6. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press
7. Jin Xiong (2006). Essential Bioinformatics, Cambridge University Press.
8. Primrose SB, Twyman RM, Blackwell Science (2002). Principles of Genome analysis and genomics.
9. Teresa Attwood, David Parry-Smith, (2016). Introduction to Bioinformatics. Addison Wesley Longman ltd.
10. Bryan Bergeron. Bioinformatics Computing, Publisher: Prentice Hall PTR.
11. Rastogi, Mendritta and Rastogi (2013). Bioinformatics: Methods and Applications. PHI earnin publishers.
12. Des Higgins, Willie Taylor, (2000). Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (The Practical Approach Series, 236), Oxford Univ Press.

Course Code	**:**	**BSE115**
Course Title	**:**	**Animal Biotechnology**
Total Credits	**:**	**4 (Theory 3; Tutorial 1)**
L-T-P	**:**	**3-1-0**
Total Hours	**:**	**Theory 45; Tutorial 15**
Semester	**:**	**VIII**

Course Objectives:

This course aims to provide comprehensive knowledge and practical skills in various aspects of animal biotechnology, emphasizing cell culture, reproductive technologies, genomics, and applications in pharmaceuticals and diagnostics. It covers the history and foundational principles of animal cell culture, including media requirements, culture techniques, and applications of stem cells. The course delves into reproductive biotechnology, focusing on cryopreservation, artificial insemination, in vitro fertilization, and transgenic animal technology. Students will explore animal genomics, learning methods for genome characterization, genetic disease resistance, and cloning for conservation purposes. Moreover, the course addresses the production and application of cell culture-based products, vaccines, monoclonal antibodies, and pharmaceutical proteins. It also covers immunological and nucleic acid-based identification methods, including DNA barcoding and detection of adulteration in meat and animal products. Through this curriculum, students will be equipped with the theoretical knowledge and practical expertise necessary for innovation and application in animal biotechnology.

Course Outcome:

- Upon completing this course, students will possess a comprehensive understanding of animal biotechnology, including expertise in animal cell culture, reproductive biotechnology, and genomics.
- They will be adept at using cell culture techniques, transfection methods, and stem cell applications.
- Proficiency will be gained in cryopreservation, artificial insemination, embryo recovery, in vitro fertilization, and transgenic animal technology.
- Students will be skilled in genome characterization, gene knock-out technology, and cloning for conservation.
- They will understand the mechanisms for producing vaccines, monoclonal antibodies, and pharmaceutical proteins, and proficient in immunological and nucleic acid-based identification methods.

Course Content (Animal Biotechnology):

UNIT I: Animal cell culture **No. of Hours: 10**

History; Basic requirements; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Transfection andtransformation of cells; Stem cells and their application; Induced Pluripotency.

UNIT II: Animal reproductive biotechnology **No. of Hours: 10**

Structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; embryo recovery and in vitro fertilization; cryopreservation of embryos; embryo transfer technology. Transgenic Animals: applications of transgenic animal technology; Techniques of gene transfer: Microinjection, Lipofection, Electroporation, Chemical based transformation, Viral Vectors.

UNIT III: Animal Genomics **No. of Hours: 15**

Introduction to animal genomics; Different methods for characterization of animal genomes, SNP, STR, RFLP, RAPD, proteomics, metabolomics; Genetic basis for disease resistance; Gene knock out technology and animal models for human genetic disorders. Animal cloning - basic concept, cloning for conservation for conservation endangered species

UNIT IV: Applications of Animal Cell Cultures **No. of Hours: 15**

Cell Culture based products, Vaccines, Hybridoma technology, Monoclonal antibodies, In vitro testing of drugs; Production of pharmaceutical proteins; Stem Cells and their Use, Using Animals Cells for heterologous gene expression. Introduction to the concept of vaccines, conventional methods of animal vaccine production.

UNIT V: Immunological, Biochemical and molecular based applications **No. of Hours: 10**

Immunological and nucleic acid based methods for identification of animal species; DNA Barcoding; Detection of adulteration in meat using DNA based methods; Detection of food/ feed adulteration with animal protein; Identification of wild animal species using DNA based methods.

List of Experiments:

1. Sterilization techniques and biosafety
2. Preparation of media for animal cell culture.
3. Prerequisites for starting animal cell culture lab.
4. Peripheral blood lymphocyte culture
5. Nuclear and Mitochondrial staining of cells
6. Passaging of cultured cells.
7. Determination of viable cells by trypanblue test or MTT Assay
8. Observation of permanent slides- CHO Cells, BHK, Vero, HEK, SP2/0-Ag14.
9. Effect of drugs on cell culture
10. Growth kinetics of animal cells

Text and References:

1. T. A. Brown. (2020) Gene Cloning and DNA Analysis: An Introduction, 8th Edition. Wiley-Blackwell
2. Primrose S.B. (2014) Principles of Gene Manipulation and Genomics, 7th Edn. John Wiley Blackwell
3. Smita Rastogi **,** Neelam Pathak. (2009). Genetic Engineering. Oxford University Press.
4. Razdan M.K. “Introduction to Plant Tissue Culture”, Science Publishers, Third Edition (2005).
5. Slater A, Scott N.W and Fowler M.R. “Plant Biotechnology: The Genetic Manipulation of Plants”, Oxford University Press, Third Edition (2008).
6. Gelvin S (2003) Agrobacterium-Mediated Plant Transformation: The Biology behind the Gene-Jockeying Tool, Microbiology and Molecular Biology Reviews, 67: 16-37.
7. Voytas D.F and Gao C (2014) Precision Genome Engineering and Agriculture: Opportunities and Regulatory Challenges, Plos One. 12, e1001877.