

Level:- 5.0 (Second Year) Sem:III

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2or4), (T/P)(2)	24ScBioU3101	Functional Biology of Organisms	4		4		40	60	100
	24ScBioU3102	Lab Course on 24ScBioU3101	2		2		20	30	50
VSCP(2)	24ScBioU3501	Introductory Scientific Computing and modelling for biology		2		4	20	30	50
IKS(T/P)(2)	24ScBioU3901	Application of IKS in Biology	2		2		20	30	50
FPP(2)	24ScBioU3002	Field Project I		2		4	20	30	50
Minor (T/P)(2+2 or 4)	24ScBioU3301	Reactions and Synthesis	2		2		20	30	50
	24ScBioU3302	Lab Course on 24ScBioU3301		2		4	20	30	50
GE/OE(T/P)(2)	24ScBioU3401	Biology and Human Welfare III		2		4	20	30	50
AECT(2)	24CpCopU3703	English Communication Skills II	2		2		20	30	50
CCT(2)	24CpCopU3001	Online Course on Yoga	2		2		20	30	50
Total			14	08	14	16			550
Non CGPA credits	24ScBLEU3401	Vector calculus and Differential Equations	4		4		40	60	100
Non CGPA credits	24ScBLEU3401	Quantum mechanics and thermodynamics (Theory+ Practical)	2	2	2	4	40	60	100

Level:- 5.0 (Second Year) Sem: IV

Course Type	Course Code	Course Title	Credits		Teaching Scheme Hr/Week		Evaluation Scheme and Max Marks		
			TH	PR	TH	PR	CE	EE	Total
Major Core T(2+2or4), (T/P)(2)	24ScBioU4101	Genetics, Evolution and Ecology	4		4		40	60	100
	24ScBioU4102	Lab Course on 24ScBioU4101		2		4	20	30	50
VSCP(2)	24ScBioU4501	Introductory Scientific Computing and modelling for		2		4	20	30	50

		biology							
CEPP(2)	24ScCopU4003	Community Engagement Project		2		4	20	30	50
Minor (T/P)(2+2 or 4)	24ScBioU4301	Structure and Properties	2		2		20	30	50
	24ScBioU4302	Lab Course on 24ScBioU4301		2		4	20	30	50
	24ScBioU4401	Biology and Human Welfare IV	2		2		20	30	50
	24ScBioU4601	Introduction to Cyber security		2		4	20	30	50
	24CpCopU4701 / 24CpCopU4702	MIL-II(Hindi)/MIL-II(Marathi)	2		2		20	30	50
	24CpCopU4001	Health and Wellness	2		2		20	30	50
			12	10	12	20			550
	24ScBLEU3401	Probability and Statistics	4		4		40	60	100
	24ScBLEU3401	Electricity ,Magnetism , Special Relativity and Optics (T+P)	2	2	2	4	40	60	100

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Second Year B. Sc. Blended (Biosciences)
2024 Course under NEP 2020)

Semester III

Course Code: 24ScBioU3101

Course Name: Functional Biology of Organisms

Teaching Scheme: TH: 4 Hours/Week

Credit: 4 T

Examination Scheme: CIA: 40 Marks

End-Sem : 60 Marks

Prerequisite Courses:

Basic knowledge of Biology (SSC grade and HSC grade) and First Year Biology is required that will help to study in depth of its other divisions.

Course Objectives:

- In this course, the learning objective is to incorporate different processes that are important for animals, plants and microorganisms survival. It gives insight into the context of anatomy and physiology of various systems including plants, animals and microbes.

Course Outcomes:

- On completion of the course, student will be able to understand various systems of animals body (humans) and function of each of the system and its parts in our life.
- Students will gain elementary knowledge about how things work at micro level deep inside all organisms', cell to cell signaling and communication.

Course Contents

Chapter	Title	Lectures 36 Lectures + 12 Tutorials
Chapter-1	Functional Biology of Organisms	
	• Introduction to Functional Biology	1
Chapter-2	Animal biology (Humans as an example) (18 lectures)	
	• Anatomy and Function 1: Tissues, Organs and Viscera	1
	• Anatomy and Function 2: Skeletal & Muscular system	1

	Nervous system 1: The central nervous system (CNS) and nervous tissues	1
	Nervous system 2: Autonomic nervous system and motor responses	1
	Tutorial	2
	Endocrine system 1: Endocrine and Exocrine glands	1
	Endocrine system 2: HPA axis introduction	1
	Respiration and Metabolism 1: Breathing in air and water	1
	Respiration and Metabolism 2: Regulation of metabolism	1
	Tutorial	2
	Cardiovascular and circulatory system 1: Regulation of the circulatory system	1
	Cardiovascular and circulatory system 2: Peripheral circulation	1
	Digestive system	1
	Urinary and Excretion systems 1: Anatomy and function	1
	Urinary and Excretion systems 2: Osmoregulation in terrestrial & aquatic environments	1
	Tutorial	2
	Thermal dynamics	1
	Immunology 1: Innate immune system	1
	Immunology 2: Adaptive/Humoral immune system	1
	Reproduction and Development 1: Gonads and the Reproductive tract	1
	Reproduction and Development 2: Gametes, Fertilization and conception	1
	Tutorial	2
Chapter-3	Plant biology (15 lectures)	
	Growth and Development	2
	Photosynthesis	2
	Water Balance	2
	Phloem and translocation	1
	Mineral nutrition and nutrient assimilation	2
	Respiration and lipid metabolism	2
	Reproduction	1
	Signaling; hormones, light responses, control of flowering	1
	Abiotic stress	1

	• Secondary metabolism and defence	1
	Tutorial	2
Chapter-4	Microbial physiology	
	• Aerobic and anaerobic respiration • Extremophiles • Symbiotic associations • Enzymes	2
	Tutorial	4

References:

1. Reece, Taylor, Simon and Dickey - Campbell Biology: concepts and connections, 7th Edition, Pearson Education (Singapore) Pvt. Ltd.
2. General Zoology - By Goodnight and others, IBH Publishing Co.,
3. Plant Physiology and Development, 6th edition, by Lincoln Taiz and Eduardo Zeiger.

Prerequisite Courses: Knowledge of Basic biology from XI & XII Science.

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Semester III

Course Code: 24ScBioU1102

Course Name: Lab Course on 24ScBioU1101

Teaching Scheme: TH: 4 Hours/Week

Credit: 4 T

Examination Scheme: CIA: 20 Marks

End-Sem : 30 Marks

Course Objectives:

- To observe and study Physiological processes that take place in plant and animal body.
- To observe and study the use of different techniques for analysis of human physiology e.g. Sahli's haemometer, electrocardiogram etc.

Course Outcomes:

On completion of the course, student will be able to–

- Students will know about how different techniques work for analysis of human physiological conditions e.g. determination of blood groups, Osmolysis of RBC's etc.
- This course will also help students learn physiological activities taking place in plant bodies.
- Students also get to know the principle and applications of various aspects in Physiology field in case of both plants and animals.

Course Contents

Practicals	Title	No. of practicals 10 p
Practical-1	Study of Lung Capacity.	1 Practical
	• To find and study lung capacity/ vital capacity.	
Practical-2	Study of Blood group.	1 practical
	• To determine blood group by A, B, O system.	
Practical-3	Study of Osmolysis of RBC's.	1 practical
	• To learn Osmolysis of RBC's.	
Practical-4	Estimation of Haemoglobin.	1 practical
	• To estimate Haemoglobin by Sahli's method.	
Practical-5	Electrocardiography.	1 practical
	• To study the principle, working and	

	applications of Electrocardiogram.	
Practical-6	Demonstration of Photosynthesis.	1 Practical
	To demonstrate photosynthesis method using leaf discs in three different mediums.	
Practical-7	Determining rate of transpiration.	1 practical
	To determine rate of transpiration under different conditions of shade and light.	
Practical-8	Estimation of chlorophyll.	1 practical
	To estimate chlorophyll-a and chlorophyll-b by spectrophotometric method.	
Practical-8	Estimation of Potato tuber tissue Ψ .	1 practical
	To estimate potato tuber tissue Ψ (ψ) by liquid equilibrium and diffusion pressure deficit.	

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Semester III

Course Code: 24ScBioU3301

Course Name: Reactions and Synthesis

Teaching Scheme: TH: 2 Hours/Week

Examination Scheme: CIA: 20 Marks

Credit: 2T

End-Sem : 30 Marks

Prerequisite Courses: Knowledge of Basic chemistry.

Course Objectives:

- To Study Basics of chemistry
- important reactions which will help various processes in biological system
- To study importance of pH and buffer in chemical and biochemical reactions
- To understand chemical kinetics of chemical and biochemical reactions
- To expertize students in biochemical calculations

Course Outcomes:

On completion of the course, student will be able to—

- Study all basic fundamentals of chemistry
- Can extend their analytical thinking in research field.

Course Contents

Chapters	Title	No. of lectures
Chapter 1	Reactions and Synthesis 1	16Lectures
	• Organic Synthesis C-C bond Forming Reactions: Grignard Reagents and Organolithiums. Formation and reaction with Carbonyl compounds.	
	• Organometallic Reagents in Synthesis: Applications of Organocerium and Organocuprate reagents.	
	• Carbonyl Compounds and Reactions: Carbonyl compounds, tautomerism as a general	

	phenomen, keto-enol tautomerism of carbonyl compounds, mechanism of keto-enol tautomerism	
	Generating enolate anions, suitable base catalysts for enolising aldehydes, ketones ester and β-dicarbonyl compounds, general α-substitution reaction	
	Reactions of enols and enolates, α-substitution with H/D+ Stereochemical consequences and deuterium incorporation. Halogenation of carbonyl compounds, The haloform reaction	
	Halogenation of carbonyls, Hell-Volhard-Zelinsky reaction. Synthetic applications of α-halo carbonyl compounds	
	Alkylation of enolates, LDA, scope and limitations	
	Aldol reaction, mechanism and retrosynthesis, inter-and- intra-molecular variants, mixed Aldol reaction	
	Claisen reaction, mechanism and retrosynthesis, mixed Claisen and Dieckman reaction.	
	Malonate Diester Chemistry, Acetoacetate chemistry, Synthesis of substituted acetic acid and acetone derivatives. Scope, Mechanism and Retrosynthesis.	
	Michael addition Chemistry, reaction of enolates with various Michael electrophiles	
	Kinetic and Thermodynamic enolates, Enamines and silylenol ethers	
Chapter 2	Reactions and Synthesis 2	16 Lectures
	Redox (and important acid-base) Reactions: Oxidation of elements by halogens and dioxygen. Metal and main group halides and oxides. Discussion of selected syntheses, chemistry and structures of halides and oxides including amphoteric behaviour and hydroxide/aqua ion formation. Thermodynamic vs kinetic control of reactions.	
	Thermodynamic aspects of halide and oxide formation. Thermodynamic parameters, their estimation and uses of tabulations. Born-Haber cycle and construction and uses of Ellingham diagrams for these systems. (Electrides and sodides?)	
	Oxidation of metals by protons etc. and generation of aqua ions. Comparison of TM and main group systems and hydrolysis in TM aqua	

	ions (acid-base chemistry of coordinated water-hydroxide-oxo ligands). Connection between electrochemical and thermodynamic parameters. Construction and uses of Latimer and Frost diagrams.	
	Interpretations of Frost diagrams exemplified by the more complex chemistry of main group elements, such as nitrogen. Thermodynamic content of plots (free energy of formation vs oxidation state) and predictive power.	
	Nernst equation revisited and construction and uses of Pourbaix diagrams combining redox and acid base reactions. Comparison of chemistry of representative elements as reflected in Pourbaix diagrams.	
	Exchange reactions: Solid/gas phase systems exemplified by transport reactions and preparation of solid-state materials, in vulcanology, halogen lamps etc. Solution examples of double decomposition (metathesis). Solubility trends. Common ion effect.	
	Hard/soft acid/base theory. Thermodynamic basis for HSAB theory. Usefulness in predicting direction of equilibrium and solubility.	
	Substitution Reactions: Typical reactions and synthetic applications and examples. Inert and labile complexes. Stability (K, b) and factors affecting stability (metals, ligands). Irving-Williams series, Chelate effect. Applications of chelate effect. Siderophores. antioxidants, garden products, chelation therapy in medicine.	
	Mechanism of substitution reactions. Square planar Pt complexes and applications. Trans effect. Pt chemistry. Applications in synthesis of action of chemotherapeutic agents.	
	Dissociative, interchange and associative mechanisms in substitution, racemization etc in octahedral complexes.	
	Combination of substitution and redox chemistry in TM systems. Co(III) syntheses, Cr(II) catalysed substitution. Electron transfer, inner- and outer-sphere reactions.	
	Metal centred reactions: Template reactions and reactions of coordinated ligands. Atom transfer reactions (redox reactions). Metal directed ligand syntheses	
Chapter 3	Thermodynamics	16Lectures
	Temperature and the Zeroth Law of Thermodynamics. Thermal equilibrium.	

	Ideal gases, the kinetic theory of gases, equipartition theory, Boltzmann distribution	
	Heat, work, internal energy. First law of thermodynamics. Heat capacity and enthalpy. Compression of an ideal gas under various conditions. Latent heats	
	Transport, conduction, conductivity, diffusion in gases.	
	The two-state paramagnet and the Einstein model of a solid; quantum deviations from classical equipartition. Partition function. Interacting systems, large systems, Stirling's approximation	
	Multiplicity and ideal gases. Entropy, spontaneous change and the Second Law of Thermodynamics. Interacting ideal gases and the entropy of mixing.	
	Heat engines, Carnot Cycle, Otto Cycle, Stirling Cycle.	
	Gibbs Free energy and spontaneity, Helmholtz Free energy, standard free energies, free energy as a function of pressure and temperature The Fundamental equation, properties of internal energy and Maxwell's relations	
	Thermodynamics criteria for chemical and phase equilibria, chemical potential and partial molar quantities, the Gibbs Free Energy minimum and equilibrium, extent of reaction and equilibrium constant, molecular description of equilibrium, response of equilibria to temperature	

References:

- Stereochemistry: Conformation and mechanism by P.S.Kalsi
- Organic chemistry by Jonathan clayden, nick greeves and stuart warren
- University General Chemistry , 1st edition (2000), C.N. R. Rao, Macmillan Publishers, India ,
- Principles of Physical Chemistry, 4th edition (1965), S.H. Maron and C.F. Prutton, Collier Macmillan Ltd 3. The elements of Physical Chemistry, 5th edition (2009), Atkins P, de Paula J. , W. H. Freeman Publication, USA
- An Introduction to Electrochemistry , edition reprint, 2011, Samuel Glasstone, BiblioBazaar, USA
- Physical Chemistry for biological sciences, 1st edition, (2005), Chang R., University Science Books, USA 6. Physical Chemistry, 1st edition, (2003) David Ball, Thoson Learning, USA.
- Essentials of Physical Chemistry, 24th edition, (2000), B S Bahl, G D Tuli, ArunBahl, S. Chand Limited, India.
- Concise Inorganic Chemistry . 5th edition (2008), Author: J. D. Lee, John Wiley & Sons, USA.

- Organic Chemistry, 6 th edition, (1992), Morrison Robert Thornton, Pearson Publication, Dorling Kindersley (India Pvt. Ltd.)
- Guide book to Mechanism in Organic chemistry
- organic Chemistry by Peter Sykes, 6 th edition, (1996), Prentice Hall, India.

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Semester III

Course Code: 24ScBioU3302

Course Name: Lab Course on 24ScBioU3301

Teaching Scheme: TH: 4 Hours/Week

Credit: 2P

Examination Scheme: CIA: 20 Marks

End-Sem : 30 Marks

Prerequisite Courses: Knowledge of Basic chemistry from XI & XII Science.

Course Objectives:

- To Study Basics of chemistry
- To study extraction method
- To study importance of pH and buffer in chemical and biochemical reactions
- To understand chemical kinetics of ester hydrolysis reaction
- To expertize students in biochemical calculations

Course Outcomes:

On completion of the course, student will be able to–

- Study all basic fundamentals of chemistry
- Can extend their analytical thinking in research field.
- Develops practical hand

Course Contents

General Chemistry		
Practicals	Title	No. of practicals 12p
Practical-1	Thermodynamics 1	1 Practical
	• To find change in enthalpy and entropy of following exothermic reaction $\text{FeCl}_3 + \text{Mg} \longrightarrow \text{MgCl}_2 + \text{Fe}$	
Practical-2	Thermodynamics 2	1 practical
	• To find change in enthalpy and entropy of following exothermic reaction	

	$\text{CuSO}_4 + \text{Zn} \rightarrow \text{ZnSO}_4 + \text{Cu}$	
Practical-3	Synthesis of chloro derivative of chalcone	1 practical
Practical-4	Characterization of chloro derivative of chalcone	1 practical
	• TLC • Melting point • Recrystallization	
Practical-5	Synthesis of p- bromo acetanilide	1 practical
Practical-6	Characterization of p-bromo acetanilide	1 practical
	• TLC • Melting point • Recrystallization	
Practical-7	Synthesis of benzyl from benzoin	1 practical
Practical-8	Characterization of p-bromo acetanilide	1 practical
	• TLC • Melting point • Recrystallization	
Practical-9	• Basic techniques of separations	1 practical
Practical-10	• Synthesis of dibenzalidene acetone	1 practical
Practical-11	• Characterization of dibenzalidene acetone	1 practical
	• TLC • Melting point • Recrystallization	
Practical-12	Thin layer chromatography	1 practical

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Semester III

Course Code: 24ScBLEU3401

Course name: Vector Calculus and Differential Equations

Teaching Scheme: TH: 4 Hours/Week

Credits 4T

Examination Scheme: CIA: 40 Marks

End-Sem: 60 Marks

Prerequisite: Basic Mathematics of XI and XIIth standard

Course Objectives: To learn,

- **Linear Algebra**
- **Vector Calculus**
- **P.D.E's**

Course Outcomes:

On completion of the course, student will be able to solve problems using vector calculus and differentiation

Course Contents

Chapter 1	Linear Algebra	15 lectures
	• Change of basis and linear transformations • Definition of eigenvectors and eigenvalues • Calculating eigenvalues and eigenvectors • Diagonalisation of matrices; matrix powers • Orthogonal matrices, real symmetric matrices • Characteristic and minimal polynomial, Cayley-Hamilton Theorem • Applications of eigenvectors/diagonalisationeg Markov chains • Inner product axioms; examples/non-examples of inner products • Length, angle, Cauchy-Schwarz inequality in terms of inner product • Orthogonality, projections in terms of inner product • Gram-Schmidt algorithm	
Chapter 2	Vector Calculus	32 lectures

	• Functions of several variables; level curves and cross sections of surfaces • Common surfaces including paraboloid, ellipsoid, hyperboloid • Domains and ranges of functions of several variables • Limits and continuity of functions of several variables; Definition of C^N • Partial derivatives, tangent plane • Differentiability of functions of several variables • Directional derivative, gradient • Chain rule and total derivative • Stationary points of surfaces, classification of stationary points using second derivatives • Optimisation applications • Constrained extrema using Lagrange multiplier method • Double integrals, changing order of integration • Polar co-ordinates, change of variables for double integrals • Triple integrals • Change of variables for triple integrals; cylindrical co-ordinates • Spherical co-ordinates • Vector fields, div and curl operators • Parameterisation of paths • Line integrals of scalar functions • Line integrals of vector functions • Integrals of scalar functions over surfaces, applications of surface integrals eg surface area, mass • Integrals of vector functions over surfaces, flux • Green's Theorem • Gauss Divergence Theorem • Stokes' Theorem • Applications of integral theorems eg Maxwell's equations	
Chapter 3	PDEs	13 lectures
	• Fourier Series • Fourier series: Dirichlet, discontinuities and differentiation • Fourier series: Weak convergence and series summation • Linearity and Superposition	

	• Wave equation • Heat and Diffusion equation • Laplace equation and harmonic functions • Fourier transform • Fourier transform: properties	
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Semester III

Course Code: 24ScBLEU3401

Course Name: Quantum mechanics and thermodynamics (Theory+ Practical)

Teaching Scheme: TH: 2 Hours/Week

Credit: 2T+2P

P: 4 Hours/Week

Examination Scheme: CIA: 40 Marks

End-Sem: 60 Marks

Prerequisite Courses:

- Kinematics and basics of classical physics

Course Objectives:

- Students will be given the basic information of introductory classical physics.

Course Outcomes:

On completion of the course, student will be able to–

- Apply the basic knowledge of quantum mechanics and thermodynamics in day to day life

Course Contents

Chapter	Title	Lectures
Chapter-1	Linear Algebra	12 Lectures
	• Change of basis and linear transformations • Definition of eigenvectors and eigenvalues • Calculating eigenvalues and eigenvectors • Diagonalisation of matrices; matrix powers • Orthogonal matrices, real symmetric matrices • Characteristic and minimal polynomial, Cayley-Hamilton Theorem • Applications of eigenvectors/diagonalisationeg Markov chains • Inner product axioms; examples/non-examples of inner products • Length, angle, Cauchy-Schwarz inequality	

	in terms of inner product • Orthogonality, projections in terms of inner product • Gram-Schmidt algorithm	
Chapter-2	Quantum Mechanics	18 Lectures
	• The Breakdown of Classical Physics • Matter Waves and Quantum Interpretation • Quantum Mechanics in One Dimension • Expectation Values, Observables and Operators • Tunneling Phenomena • Quantum Mechanics in 3-dimensions • Hydrogen atom, hydrogenic ions, helium atom • Hydrogen molecule ion, hydrogen molecule	
Chapter-3	Thermodynamics	13 Lectures
	• Temperature and the Zeroth Law of Thermodynamics. Thermal equilibrium. • Ideal gases, the kinetic theory of gases, equipartition theory, Boltzmann distribution • Heat, work, internal energy. First law of thermodynamics. Heat capacity and enthalpy. Compression of an ideal gas under various conditions. Latent heats • Transport, conduction, conductivity, diffusion in gases. • The two-state paramagnet and the Einstein model of a solid; quantum deviations from classical equipartition. Partition function. Interacting systems, large systems, Stirling's approximation • Multiplicity and ideal gases. Entropy, spontaneous change and the Second Law of Thermodynamics. Interacting ideal gases and the entropy of mixing. • Heat engines, Carnot Cycle, Otto Cycle, Stirling Cycle. • Gibbs Free energy and spontaneity, Helmholtz Free energy, standard free energies, free energy as a function of pressure and temperature The Fundamental equation, properties of internal energy and Maxwell's relations • Thermodynamics criteria for chemical and phase equilibria, chemical potential and partial molar quantities, the Gibbs Free	

	Energy minimum and equilibrium, extent of reaction and equilibrium constant, molecular description of equilibrium, response of equilibria to temperature Thermodynamics of liquids and liquid mixtures, chemical potentials of liquids, ideal liquid mixtures and Raoult's Law, Henry's Law, vapor pressure diagrams, liquid-liquid phase diagrams Free energy and entropy of mixing, excess functions and real solutions, solute and solvent activity, activity coefficient, osmotic pressure	
Chapter-4	PDEs	5 Lectures
	- Fourier Series - Fourier series: Dirichlet, discontinuities and differentiation - Fourier series: Weak convergence and series summation - Linearity and Superposition - Wave equation - Heat and Diffusion equation - Laplace equation and harmonic functions - Fourier transform - Fourier transform: properties	

Prerequisite Courses: Knowledge of Basic physics from F.Y B.Sc.

Course Objectives:

- Students will be given the basic information of Thermodynamics and quantum mechanics

Course Outcomes:

On completion of the course, student will be able to–

- Apply the basic knowledge of physics in everyday life.

Course Contents

Practicals	Title	No. of practicals 12P
Practical-1	G.M. Counter	2Practicals
Practical-2	Michelson Interferometer	1 practical
Practical-3	Lees Method	1 practical
Practical-4	Four Probe	1 prcatical

Practical-5	• Use of Oscilloscope	1 practical
Practical-6	• e/m by Thomson Method	1 practical
Practical-7	• Rydberg constant	1 practical
Practical-8	• Thermal conductivity of rubber tube	1 practical
Practical-9	• Specific Heat of Graphite	1 practical
Practical-10	• Characteristics of laser	1 practical
Practical-11	• Platinum resistance Thermometer	1 practical

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Semester IV

Course Code: 24ScBioU4101
Ecology

Course Name: Genetics, Evolution and

Teaching Scheme: TH: 2 Hours/Week

Credit: 2T

Examination Scheme: CIA: 20 Marks

End-Sem : 30 Marks

Prerequisite Courses:

Basic knowledge of Biology (SSC grade and HSC grade) and First Year Biology is required that will help to study in depth of its other divisions.

Course Objectives:

- In this course, the learning objective is to incorporate students with the knowledge of Genetics, Evolution and Ecology and the mechanisms that drive these concepts.
- Students will learn different facets of ecology, ecosystems and communities.
- This course also combines field ecology techniques.

Course Outcomes:

- Students will gain knowledge about genetics and different topics in genetics and microevolution.
- On completion of the course, students will be able to understand various ecosystems and how they function.
- Students will be able to understand how comprehensive scale biodiversity and habitats are generated and what the underlying mechanisms behind it are.

Course Contents

Chapter	Title	Lectures 36 Lectures + 12 Tutorials
Chapter-1	Transmission Genetics	
	• Genetic variation and behaviour of genes	3
	• Linkage and recombination; Mapping genes	2
	• Chromosome maps and genetic	1

	markers	
	• Sex linkage and sex determination	2
	• Complementation	2
	• Chromosomal mutations	2
	• Non-Mendelian inheritance	1
	• Extrachromosomal DNA	2
	• Quantitative genetics	2
	Tutorial	4
Chapter-2	Population Genetics	
	• Genetic variation in populations	2
	• Mutation and Genetic drift	1
	• Natural selection	1
	• Mutation/Selection balance	1
	• Balanced polymorphism	1
	• Gene flow & inbreeding	1
	Tutorial	2
Chapter-3	Population Biology	
	• Nature of populations; numbers, mixing (dispersal), structure in age/stage	1
	• Density independent, density dependent growth (exponential and logistic growth equations)	2
	• R & K selection, life-histories and links to population growth parameters, (annual vs perennial life-histories, clonality)	1
	• Demography, Life tables, matrix models (requires simple matrix mathematics) and Epidemiology (simple functions)	1
	Tutorial	2
Chapter-4	Communities	
	• Nature of communities; Community structure: how it is described, measured; what drives it; species composition, diversity (alpha, beta, gamma)	1
	• Intracommunity (interspecific) interactions (bi-partite networks); Symbiosis, Predation, Competition, Host-parasite interactions	1
	• Dynamics of communities (perturbation and succession)	1
	• Biomes (communities on a global scale)	1
	Tutorial	2
Chapter-5	Ecosystems	

	• Pond ecosystem (or other integrated example)	1
	• Food chains and webs	1
	• Pyramids (numbers, biomass, energy), abstraction, defining trophic levels, the problem of omnivory (stable isotope tracers)	1
	• Biogeochemical cycles (water, C, N, P) pools and fluxes, mass budget models. Rates of processes: productivity, decomposition, trophic transfer, turnover and Mean Residence Time.	1
	Tutorial	2

References :

1. Brian K. Hall; Benedikt Hallgrímsson - Strickberger's Evolution, Fourth Edition, Jones and Bartlett Publishers, Inc.
2. Mark Ridley, 2004, 3rd Edition - Evolution, Blackwell Publishing.
3. Carl T. Bergstrom & Lee Alan Dugatkin - Evolution (second edition), W. W. Norton & Company; Second edition.
4. Douglas J. Futuyma - Evolution, 2nd/ 3rd Edition, Sinauer Associates.

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Semester IV

Course Code: 24ScBioU4102

Course Name: Lab Course on 24ScBioU4101

Teaching Scheme: TH: 4 Hours/Week

Credit: 2P

Examination Scheme: CIA: 20 Marks

End-Sem : 40 Marks

Prerequisite Courses: Knowledge of Basic biology from XI & XII Science.

Course Objectives:

- To observe and study the environment, ecology and components of ecosystem.
- As this course gives insights into field study students learn to prepare traps and locate smaller organisms, they also learn much about species diversity, species richness by performing quadrat method and line transect methods.
- To observe and study the probabilities of different genes and disorders using Genetics theory and problems.

Course Outcomes:

On completion of the course, student will be able to—

- Make a distinction between different ecosystems and habitats.
- Study organisms behaviour and identify organisms along with the habitats.
- Get knowledge of Biodiversity in general.

Course Contents

Practicals	Title	No. of practicals 7p
Practical-1	Trap Making.	1 Practical
	• To prepare various traps for capturing insects and observe diversity.	
Practical-2	Quadrat Method.	1 practical
	• To study plant population density by quadrat method.	
Practical-3	Line transect Method.	1 practical

	To monitor birds, observe and take bird count by line transect method and point count method..	
Practical-4	Mark and Recapture Method.	1 practical
	To study animal population density by mark and recapture method.	
Practical-5	Surveying terrestrial ecosystem.	1 practical
	To study components of terrestrial ecosystem, observing and enlisting the floral and faunal species.	
Practical-6	Physical analysis of soil, Part 1 and Part 2.	1 Practical
	- To determine the pH of given soil sample. - To determine the Water holding capacity (WHC) of given soil sample.	
Practical-7	Physical analysis of soil, Part 3 and Part 4.	1 practical
	- To determine the Moisture content of given soil sample. - To determine Bulk density of given soil sample.	

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Semester IV

Course Code: 24ScBioU4301

Course Name: Structure and properties

Teaching Scheme: TH: 2 Hours/Week

Credit: 2T

Examination Scheme: CIA: 20 Marks

End-Sem : 30 Marks

Prerequisite Courses: Knowledge of Basic chemistry from XI & XII Science.

Course Objectives:

- To Study Basics of chemistry
- important reactions which will help various processes in biological system
- To study importance of pH and buffer in chemical and biochemical reactions
- To understand chemical kinetics of chemical and biochemical reactions
- To expertize students in biochemical calculations

Course Outcomes:

On completion of the course, student will be able to–

- Study all basic fundamentals of chemistry
- Can extend their analytical thinking in research field.

Course Contents

Chapters	Title	No. of lectures
Chapter 1	Structure and Properties	36 L
	• Molecular shape and simple electronic structure, Isomerism: Orbitals, hybridization and shapes of molecules, stereochemical consequences of tetrahedral carbon (isomers, enantiomers, R/S, D/L, optical rotation)	1
	• Stereochemistry – optical activity: Molecules with more than one chiral centre (diastereomers, meso compounds, separation of racemic mixtures)	1
	• Symmetry operations and elements	1

	Group theory: Definition of reducible and irreducible representations, Use of group theory to determine the irreducible representation	1
	Tutorial 1	2L
	Assignment of point groups Leading to definition of components of character tables (irreducible representations, characters – at least the interpretation of the sign of the character)	1
	Simple applications, Label molecular shapes, isomers, Identify chiral molecules, Physical properties – e.g. dipole moment, possible optical isomers, Orbital symmetry labels (e.g. s, p & d orbitals in Td, Oh, D4h)	1
	Stereochemistry and Reactions: Prochirality, chirality in Nature, Stereochemistry on atoms other than carbon, Retrosynthetic analysis	1
	Stereochemistry and Mechanism (nucleophilic substitution, elimination from non-cyclic compounds)	1
	Alkene addition reactions – Hydrogenation, halogenation, HX addition. Elimination Reactions epoxide ring forming reactions	1
	Tutorial 2	2L
	Zeeman effect: Effect on the energies of a system by application of a magnetic field; Magnetochemistry, spin and orbital contribution to the magnetic moment	1
	Magnetic resonance spectroscopies: EPR spectroscopy, hyperfine coupling application to organic radicals and to transition metal complexes	1
	Nuclear Magnetic Resonance (NMR), energies of nuclei in magnetic fields	1
	Chemical shift and the δ scale, resonance of different nuclei, shielding, spin-orbit coupling and coupling constants, molecular symmetry	1
	¹³C NMR, ¹H NMR, integration, multiplicity, chemical shift typical ranges	1
	Introduction to molecular spectroscopy and spectroscopic transitions, absorbance, transmittance, the Beer-Lambert Law,	1

	intensities of spectroscopic transitions	
	Quantised vibration and simply harmonic oscillator model, wavefunctions,	1
	Molecular vibrational modes, vibrational spectroscopy infrared and Raman spectroscopy $3N-5$, $3N-6$ vibrational degrees of freedom	1
	Tutorial 3	2L
	Vibrational symmetry and IR/Raman activity: Symmetry properties of the vibrational degrees of freedom and to deduce IR, Raman activity. Use of internal coordinates to get symmetry properties of a subset of bands	1
	Vibrational spectroscopy: Local mode approximation. Characteristic infrared absorptions (alkyl CH, alcohol, amine $RN H_2$ and R_2NH, carboxylic acid, amide, ester, ketone, aldehyde, nitrile RCN, alkyne, alkene, aromatic), fingerprint regions, interpretation of IR spectra	1
	Molecular orbital theory: Electronic spectroscopy requires understanding of electronic structure leading to Molecular orbital theory – HOMO. LUMO	
	Diatomic molecules, LCAO-MO, Symmetry of MO's	1
	Tutorial 4	2L
	Photoelectron spectroscopy	1
	Generalisation of the application of MO approaches to polyatomic molecules	1
	Hückel Theory	1
	Aromatic and Heterocyclic Chemistry of compounds with delocalised p orbitals: Benzene and Aromaticity/Antiaromaticity, Reactions of Aromatic Compounds Electrophilic aromatic substitution. Reactions of Polycyclic and Heteroaromatic Compounds. Reactions via Aromatic Transition States Electrophilic aromatic substitution on naphthalene. Electrophilic aromatic substitution on heteroaromatics (e.g. pyridine and pyrrol). Non C-based aromatic systems	1
	Electronic spectroscopy: Chromophores and excited electronic states, electronic	3

	transitions, UV-Vis spectroscopy, Franck-Condon Principle, Franck-Condon factors	
	Fates of electronic excited states – fluorescence and phosphorescence, non-radiative transitions, internal conversion and intersystem crossing, fluorescence spectra	1
	Applications – light emitting polymers	1
	Organometallic chemistry. Types and broad applications of organometallic complexes and catalysts. Ligand types and examples.	1
	Group 1 (LiR) and group 2 (Grignard) and p-block chemistries. EPR spectroscopy as a tool to probe electron distribution in carbocyclic and organometallic species	1
	Covalent interactions in coordination compounds – rationalisation of spectrochemical series in terms of bonding interactions	1
	Tutorial 5	2L
	Binary metal carbonyl complexes Synergistic bonding and the 18-electron rule. IR and NMR spectroscopy	1
	Substitution at metal carbonyl. Other organometallic ligand types and complexes thereof. Alkyne and alkene complexes. etc.	1
	Redox reaction in organometallic chemistry. Hydrogen complexes and oxidative addition reactions. Reductive elimination reactions. Activation and reactions of organometallic ligands. Insertions, migrations.	1
	Catalysis involving transition metals : Catalytic systems. Water gas shift reaction, hydrogenations, acetic acid process etc. Metallocene complexes and their chemistry leading to advanced polymerization catalysts etc.	1
	Tutorial 6	2L

References:

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- Physical Chemistry for biological sciences, 1st edition, (2005), Chang R., University Science Books, USA 6. Physical Chemistry, 1st edition, (2003) David Ball, Thoson Learning, USA.
- Essentials of Physical Chemistry, 24th edition, (2000), B S Bahl, G D Tuli, ArunBahl, S. Chand Limited, India.
- Concise Inorganic Chemistry . 5th edition (2008), Author: J. D. Lee, John Wiley & Sons, USA.
- Organic Chemistry, 6 th edition, (1992), Morrison Robert Thornton, Pearson Publication, Dorling Kindersley (India Pvt. Ltd.)
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Semester IV

Course Code: 24ScBioU4302

Course Name: Lab Course on 24ScBioU4301

Teaching Scheme: TH: 4 Hours/Week

Credit: 2P

Examination Scheme: CIA: 20 Marks

End-Sem : 30 Marks

Prerequisite Courses: Knowledge of Basic chemistry from XI & XII Science.

Course Objectives:

- To Study Basics of chemistry
- To study extraction method
- To study importance of pH and buffer in chemical and biochemical reactions
- To understand chemical kinetics of ester hydrolysis reaction
- To expertize students in biochemical calculations

Course Outcomes:

On completion of the course, student will be able to–

- Study all basic fundamentals of chemistry
- Can extend their analytical thinking in research field.
- Develops practical hand

Course Contents

General Chemistry		
Practicals	Title	No. of practicals 12p
Practical-1	Aldol Reaction	1 Practical
Practical-2	Characterization of aldol condensed product	1 practical
	• TLC • Melting point • Recrystallization	
Practical-3	Oxalate Complex of Aluminium	1 practical
Practical-4	Oxalate Complex of Chromium	1 practical
Practical-5	Characterization of synthesized complexes using IR, NMR, UV-Vis spectroscopy	1 practical
Practical-6	Synthesis of Linkage Isomers	1 practical
Practical-7	Synthesis of Chloropentamine Cobalt Chloride	1 practical
Practical-8	• Synthesis Of Ru(bpy)₂Cl₂	1 practical
Practical-9	• Characterization of complex	1 practical

Practical-10	• Synthesis of linkage isomers of Ruthenium	1 practical
Practical-11	• Characterization of complex	1 practical
Practical-12	• Revision	1 practical

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Semester IV

Course Code: 24ScBLEU3401

Course name: Probability and Statistics

Teaching Scheme: TH: 4 Hours/Week

Credits 4T

Examination Scheme: CIA: 40 Marks

End-Sem : 60 Marks

Prerequisite: Basic knowledge of mathematics and statistics

Course Objectives: To learn the probability and statistics

Course Outcomes:

On completion of the course, student will be able to solve the problems using probability and statistics.

Course Contents

Chapter 1	Probability	26 lectures
	• Review of probability, events, laws of probability • Conditional probability, independent events • Random variables; discrete random variables and distributions; mean, variance and standard deviation of discrete random variable • Bernoulli trials, binomial distribution • Poisson distribution and Poisson process • Continuous random variables and distributions, probability density functions, cumulative distribution function • Mean, variance, standard deviation, median and percentiles of a continuous distribution • Normal distribution • Uniform and exponential distribution • Distributions of functions of a random variable • Sums/differences/scalar multiples of	

	random variables, independent random variables, distributions of sums/differences of independent random variables • Central Limit Theorem • Normal approximation to the binomial distribution, distribution of the sample mean • Distribution of sample proportion • Stochastic processes, Markov chains • Limiting behaviour of Markov chains	
Chapter 2	Statistics	34 lectures
	• Study design: bias, confounding, precision, comparison, control • Study design: observational studies vs designed experiments • Exploratory data analysis: describing and displaying categorical data (tables, frequencies, bar chart) • Exploratory data analysis: describing and displaying univariate numeric data (dotplots, boxplots, histograms, mean, median, quartiles/percentiles, standard deviation, variance, IQR) • Exploratory data analysis: describing and displaying bivariate numeric data (scatterplot, correlation) • Statistical modelling (single mean model, multiple means model, regression model) • Sampling distributions: population vs sample, parameter vs statistic; distribution of sample mean, proportion; standard error • Estimation: Confidence intervals, confidence interval for mean (using z), confidence interval for mean using t • Estimation: confidence interval for difference in mean, confidence intervals for proportion • Estimation: required sample size, confidence interval vs prediction interval • Theory of estimation: unbiased estimators, maximum likelihood estimators • Hypothesis testing: concepts and terminology, testing a single mean (z	

	and t) • Hypothesis testing: errors, power, 2-sample test, paired test, testing proportion • Hypothesis testing: Non-parametric tests for 2 samples • Comparing multiple means: one-way ANOVA • Theory of ANOVA • Regression: least squares method • Partitioning of variability in regression, significance testing in regression • Chi-squared test for independence • Chi-squared goodness-of-fit	
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Semester IV

Course Code: 24ScBLEU3401

Course Name: Electricity, Magnetism, Special Relativity and Optics (T+P)

Teaching Scheme: TH: 2 Hours/Week

Credit: 2T+2P

Examination Scheme: CIA: 40 Marks

End-Sem : 60 Marks

Prerequisite Courses: Kinematics, equation of motion, elasticity, waves and oscillations, fluid mechanics, geometrical optics

Course Objectives:

- Students will be given the basic information of electricity, magnetism and quantum mechanics

Course Outcomes:

On completion of the course, student will be able to—

- Apply the basic knowledge of classical mechanics in day to day life

Course Contents

Chapter	Title	Lectures
Chapter-1	Electricity and Magnetism	24Lectures
	• Coulomb's Law • Gauss's Law • Electric Field, Potential • Conductors, Insulators • Laplace equation • Curl and Stoke's theorem • Capacitors, capacitance and energy stored in E field • Current and continuity equation • Magnetic field and Moving Charges • Force on Moving charges • Magnetic Field and vector potential • Special relativity and E and B fields • Induction • Inductance and energy stored in B field • RC circuits • CL and RLC circuits	

	• Displacement current • Complete Maxwell's Equations • Electromagnetic Waves • Dielectrics and Electric Dipoles • Dielectrics • Magnetic Dipoles • Magnetism in Matter	
Chapter-2	Special relativity	12 Lectures
	• Space time and simultaneity. Einstein axioms for special relativity. The Lorentz transformation. • Relativistic kinematics; length contraction, time dilation. Doppler Effect. Twin paradox. • Relativistic dynamics. Mass-energy equivalence. Conservation of four-momentum. Centre of momentum frame. De Broglie waves and photons. • Nuclear reactions and thermonuclear power.	
Chapter-3	Optics- Applications and microscopy	12 Lectures
	• Classical optics: Fermat's Principle • Fourier Optics: Huygens-Fresnel Principle • Fourier Optics: Fresnel diffraction integral • Fourier Optics: Paraxial approximation • Fourier Optics: Fraunhofer diffraction • Fourier Optics: Apertures and imaging • Fourier Optics: phase contrast imaging • Microscopy applications	

Course Contents

Practicals	Title	No. of practicals 12P
Practical-1	• Use of Computer- Trigonometric Function	1 Practical
Practical-2	• Use of Computer- Geometrical Function	1 practical
Practical-3	• Study of Fourier series	1 practical
Practical-4	• Sorting of numbers (ascending, descending)	2 prcatical

Practical-5	• Testing for a prime number	1 practical
Practical-6	• Factorial of a number	1 practical
Practical-7	• Study of kinematic equation	1 practical
Practical-8	• Matrix multiplication	1 practical
Practical-9	• Testing of Palindrome number	1 practical
Practical-10	• Computer Interface- (I) RC time constant (II) Characteristics of Diode	2practicals