Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022
'B^{++}'Grade (CGPA 2.96)

Name of the Faculty: Science &Technology

(As per New Education Policy 2020)

Syllabus: Biotechnology

Name of the Course: B.Sc. I (Sem. I &II)

(Syllabus to be implemented from June 2024)

Structure as per NEP-2020
B. Sc. I (Biotechnology)

Level	Sem.	Major		Minor	VSC/ SEC	GE/ OE	IKS, AEC, VEC	CC	Total Credits	Cumulative Credits
		T	P	T						
4.5	I	2	2	--	SEC-1 (2)	--	IKS-1 (2) AEC: L1-1 (2) VEC-1 (2)	CC-1 (2)	22	44
		2	2	--						
		2	2	--						
	II	2	2	--	SEC-2 (2)	2	AEC: L1-2 (2) VEC-2 (2)	CC-2 (2)	22	
		2	2	--						
		2	2	--						
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credit score NSQF course/ Internship OR Continue with Major and Minor										

Abbreviations:

VSC: Vocational Skill Course **SEC:** Skill Enhancement course **VSEC:** Vocational Skill and Skill Enhancement Course	**GE/OE:** Generic/ Open Elective	**IKS:** Indian Knowledge System **AEC:** Ability Enhancement Course **VEC:** Value Education Course
CC: Co-curricular Course	**FP:** Field project **RP:** Research Project	**OJT:** On Job Training

B. Sc. I (Biotechnology)

SEMESTER-I				
Sr.No.	**Course Type**	**Course Code**	**Paper Title**	**Credit**
1.	Major	DSC 1-1 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 1-1 (P)	Practical of DSC 1-1	2
2.	Major	DSC 2-1 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 2-1 (P)	Practical of DSC 2-1	2
3.	Major	DSC 3-1 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 3-1 (P)	Practical of DSC 3-1	2
4.	(SEC/VSC)	SEC-1	Basic laboratory Skills in Biotechnology - I	2
5.	AEC	L1-1	English (Paper - I)	2
6.	IKS	IKS-1	Introduction to IKS in Science	2
7.	VEC	VEC-1	Constitution of India	2
8.	CC1	CC-1	Community Engagement & Services	2
			Total	**22**

SEMESTER-II				
Sr.No.	**Course Type**	**Course Code**	**Paper Title**	**Credit**
1.	Major	DSC 1-2 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 1-2 (P)	Practical of DSC 1-2	2
2.	Major	DSC 2-2 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 2-2 (P)	Practical of DSC 2-2	2
3.	Major	DSC 3-2 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 3-2 (P)	Practical of DSC 3-2	2
4.	OE/GE	OE-I/GE-I	To be selected from the Basket of OE-I/GE-I, listed in this syllabus.	2
5.	SEC	SEC-2	Basic laboratory Skills in Biotechnology - II	2
6.	AEC	L1-2	English (Paper - II)	2
7.	VEC	VEC-2	Environmental studies	2
8.	CC2	CC-2	Community Engagement & Services	2
			Total	**22**

BIOTECHNOLOGY - BASKET OF MAJOR SUBJECTS

SEMESTER - I		SEMESTER II	
DSC 1-1 (Any One)	Biophysics and Chemical Science	**DSC 1-2** (Any One)	Developmental Biology
	Biochemistry		Ecology
DSC 2-1 (Any One)	Fundamentals of Microbiology	**DSC 2-2** (Any One)	Cell Biology
	Taxonomy and Classification		Cell Physiology
DSC 3-1 (Any One)	Animal Physiology	**DSC 3-2** (Any One)	Plant Tissue Culture
	Plant Physiology		Animal Tissue Culture

BIOTECHNOLOGY – BASKET OF OE-1/GE-1 SUBJECTS

SEMESTER - II	
OE-1/GE-1 (Any One)	Biotechnology in Human Welfare
	Computer Science
	Any Open Elective subject offered by other Discipline/ Faculty

SEMESTER-I

SEMESTER-I				
Sr.No.	**Course Type**	**Course Code**	**Paper Title**	**Credit**
1.	Major	DSC 1-1 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 1-1 (P)	Practical of DSC 1-1	2
2.	Major	DSC 2-1 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 2-1 (P)	Practical of DSC 2-1	2
3.	Major	DSC 3-1 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 3-1 (P)	Practical of DSC 3-1	2
4.	(SEC/VSC)	SEC-1	Basic laboratory Skills in Biotechnology - I	2
5.	AEC	L1-1	English (Paper - I)	2
6.	IKS	IKS-1	Introduction to IKS in Science	2
7.	VEC	VEC-1	Constitution of India	2
8.	CC1	CC-1	Community Engagement & Services	2
			Total	**22**

BIOTECHNOLOGY - BASKET OF MAJOR SUBJECTS

SEMESTER - I	
DSC 1-1 (Any One)	Biophysics and Chemical Science
	Biochemistry
DSC 2-1 (Any One)	Fundamentals of Microbiology
	Taxonomy and Classification
DSC 3-1 (Any One)	Animal Physiology
	Plant Physiology

DSC 1-1: BIOPHYSICS AND CHEMICAL SCIENCE (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	2 Credits	30 Hours	50 (30:20)

Objectives:	• To understand basic concepts in physics applicable for biological science. • To understand basic concepts of chemistry applicable for biological science.
Outcomes:	• Students learn about the correlation between physics concepts and biology. • Students learn about the correlation between chemistry concepts and biology.

Unit I	BASICS OF BIOPHYSICS	15

A. Biophysics of Water: Molecular structure, Association of water through H-bonding, Nature of hydrophobic interactions, physicochemical properties of water.

B. Physical properties in biology: Molecular weight, molecular charge, affinity, pH, pOH, Buffer, Handerson Hasselbalch equation, Sedimentation, Centrifugal force, Density, Surface tension, Laws of thermodynamics, concept of: Free Energy, Enthalpy and Entropy

C. Electromagnetic spectrum, Properties of light, Absorption, Transmittance, Refractive index, Molar absorption coefficient, Beer Lambert's Law

Unit II	BASICS OF CHEMICAL SCIENCE	15

A. Mendeleev's and Modern periodic law, Types of bonds in biomolecules
Concept of Hybridization: sp, sp^2, sp^3 hybridization with respect to C2H2, C2H4, CH4 (bond length, bond angle, bond energy and shape of the molecule). Dipole moment: Definition and significance.

B. Solutions: Solutions, types of solutions, solubility & factors affecting solubility; Mole concept: Definition & introduction to molarity, normality, molality, percentage by mass and volume

C. Classification of solvents, Dilution factor. Colligative properties: Osmosis, reverse osmosis, osmotic pressure, boiling point, freezing point, vapor pressure

References:

1. Ackerman E.A. Ellis, L.E.E.& Williams L.E.(1979), Biophysical Science, Prentice-HallInc.
2. Casey E J.(1967),Biophysics,conceptsandmechanisms.AffiliatedEastwestpress.
3. Barrow C.(1974), Physical Chemistry For Life Sciences, McGraw-Hill.
4. Essentials of Physical Chemistry by B.S. Bahel and G.D.Tuli
5. College Chemistry: by Linus Pauling, An Introductory Textbook of General Chemistry, 2nd Edition, W. H. Freeman and Company
6. Basic Inorganic Chemistry by Cotton and Wilkinson
7. Organic Chemistry, Bhupinder Mehta and Manju Mehta, 2nd edition, PHI Learning Private Limited
8. Organic Chemistry Morrison, Boydand Bhattacharjee, 7th edition Pearson Education India

DSC 1-1: BIOCHEMISTRY(Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	2 Credits	30 Hours	50 (30:20)

Objectives	• To get introduced with the structure, function and role of biomolecules. • To understand the structure, function and role of important bioactive components.
Outcomes	• Students learn about basic structure, function and role of biomolecules. • Students get knowledge about the structure, function and role of important bioactive components.

Unit I — **INTRODUCTION TO BIOMOLECULES** — **15**

A. Carbohydrates: Structure, properties and function of Monosaccharide (glucose, fructose, mannose, galactose, ribose), Disaccharide (sucrose, lactose), Polysaccharide (starch, glycogen, cellulose, peptidoglycan).

B. Proteins: Classification of amino acids, Proteins: Peptide bond, forces stabilizing protein structure, classification of proteins based on composition.

C. Lipids:Structure And Properties Of Fatty Acids, storage lipid (triacylglycerol,wax), membrane lipid (phospholipids, sphingolipids, sterol)
Nucleic acids: Composition, structure and nomenclature of nucleotides, Structure of B-form of DNA, RNA and its types.

Unit II — **BIOACTIVE COMPONENTS** — **15**

A. Vitamins: Source, daily requirements, physiological role, deficiency/ hyper-vitaminosis of water soluble and fat soluble vitamins.

B. Enzymes: Structure of enzyme: Apoenzyme, Coenzyme, Cofactor, Prosthetic group, Lock and key model, Induced fit hypothesis, concept of activation energy, Classification of enzymes

C. Hormones: Classification of human hormones, biological role of pituitary, thyroid, adrenal and gonadotropic hormones

References:

1) Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, Vth Edition, W.H. Freeman and Co., New York.
2) Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
3) Voet and Voet's Biochemistry, D. Voet and J. Voet 5th edition, 2016, John Wiley and Sons Inc., 2005
4) Biochemistry–U. Satyanarayan, U. Chakrapani, [ISBN-13 : 978-8131264355] 6th Ed., Elsevier

DSC 2-1: FUNDAMENTALS OF MICROBIOLOGY (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives:	• To get information about the history and development of microbiology. • To understand the diversity of the microbial world and organization of microorganisms.
Outcomes:	• Students get information about the history and development of microbiology. • Students understand the aspects of microbial structure and organization.

Unit I	**HISTORY AND DEVELOPMENT OF MICROBIOLOGY**	**15**

A. Development of microbiology as a discipline, Spontaneous generation vs. biogenesis.

B. Contributions of Antonie van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Paul Ehrlich, Elie Metchnikoff, Edward Jenner, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman. Germ theory of disease, Hargovind Khorana.

C. An overview of Scope of Microbiology in different fields : Environment, Agriculture, Medical, Fermentation and dairy Industry, Vaccine and Pharmaceuticals, Genetic Engineering

Unit II	**MICROBIAL WORLD**	**15**

A. Aim and principles of Bacterial classification, systematics and taxonomy, concept of species,taxa, strain; Differences between: prokaryotic-eukaryotic microorganisms, characteristics of eubacteria-Archaebacteria, Actinomycetes, Rickettsia, Mycoplasma, Chlamydia

B. General characteristics ofAcellular microorganisms (Viruses,Viroids, Prions) and Cellular microorganisms (Algae, Fungi and Protozoa)

C. Study of bacteria- Size, Shape, Morphological arrangement, Structure and functions of: Cell wall, Cell membrane, Flagella, Nuclear equivalent, Ribosome, Capsule, Slime layer. Mesosomes, Pili.

References:

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms.14th edition. Pearson International Edition
3. Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology.5th edition. McGraw Hill Book Company
4. Stanier R Y General Microbiology Wiley JM, Sherwood LM and Woolverton CJ. (2013)
5. Prescott's Microbiology.9th Edition. McGraw Hill International

DSC 2-1: TAXONOMY AND CLASSIFICATION (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives:	• To learn about systems, concepts and importance of taxonomy and classification. • To learn about the taxonomy and classification of animals, plants and microorganisms.
Outcomes:	• Students learn about systems, concepts and importance of taxonomy and classification. • Students get knowledge about the taxonomy and classification of animals, plants and microorganisms.

Unit I — **ANIMAL TAXONOMY** — **15**

A. Systems of Classification: History, systematics and taxonomy, Two-, Three- and Five Kingdom system, Concepts of Domains, Units of Classification (Taxa), Binomial Nomenclature, Roles and Importance of Systematics, Taxonomy and Classification, Aims and Principles of Taxonomy, Concepts of Phylogeny and Natural Classification

B. Non-chordates Classification -Salient features and classification up to classes with the non chordate phyla with suitable examples: - Protozoa, Porifera, Coelenterata, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca, Echinodermata

C. Chordates Classification: General organization and classification of chordates up to the classes with suitable examples: - Urochordata, Cephalochordata, Agnatha, Fishes, Amphibia, Reptilia, Aves, Mammals

Unit II — **PLANT AND MICROBIAL TAXONOMY** — **15**

A. Plant Taxonomy: General characters and Economical importance of Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms. Introduction to the classification by G. M. Smith for (Algae, Bryophytes, Pteridophytes), Sporne 1965 for (Gymnosperms) and Bentham and Hooker's for (Angiosperms), Salient features of ICBN.

B. Microbial Taxonomy: General and Important characters of Archaebacteria, Actinomycetes, Rickettsia, Mycoplasma, Chlamydia. Criteria for classification (Morphological, Cultural, Biochemical)

C. Introduction to Phenetic, Phylogenetic, Conventional and Numerical Taxonomy. Outline of Ainsworth classification of Fungi, Economic Importance of Fungi.

References:

1. Five Kingdoms: Illustrated Guide to the Phyla of Life on Earth, Lynn Margulis, Karlene V. Schwartz , W.H.Freeman & Co Ltd; 3rd edition (31 December 1998)
2. G.G.-Simpson-Principle of animal taxonomy Oxford IBH Publication
3. Kapoor, V.C, Theory and Practice Of Animal Taxonomy And Biodiversity, (2019) Oxford & IBH Publishing; 8th edition,
4. Modern Text Book of Invertebrates – R. L. Kotpal (Rastogi)
5. Modern Text Book of Vertebrates – R. L. Kotpal (Rastogi)
6. Taxonomy of Angiosperm R Pandey, S Chand and Co. Ltd, Ramnagar New Delhi.
7. Vashishta, P.C., Sinha, A.K. and Kumar, A. 2010. Pteridophyta. S. Chand, Delhi, India.
8. Vashishta, B.R., Sinha, A.K. and Kumar, A. 1971. Botany for Degree Students: Pteridophyta. S. Chand & Company Pvt. Ltd., New Delhi.
9. Vashishta, B. R., Sinha, A. K. and V. P. Singh. Botany for Degree Students Algae. S. Chand, New Delhi
10. Annie Ragland, V Kumaresan& N Arumugam (2015), Bryophytes, Saras Publication, New Delhi.
11. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms. New Age International (P) Ltd., New Delhi, India.
12. Bergey's Manual Trust. *Bergey's Manual of Systematics of Archaea and Bacteria*, *Taxonomic Outline*. 2012
13. Pelczar MJ Jr., Chan ECS and Kreig NR. Microbiology, 5th Edition, Tata McGraw Hill, 1993

DSC 3-1: ANIMAL PHYSIOLOGY (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives	• To learn about the working of different physiological systems in animals. • To learn about mechanisms of important physiological systems in animals.
Outcomes	• Students learn about the working of different physiological systems in animals. • To get knowledge about mechanisms of important physiological systems in animals.

Unit I	**DIGESTION, CIRCULATION AND REPRODUCTIVE SYSTEM**	**15**

A. Digestion: digestive system, Digestive fluids: Composition of bile, Saliva, Pancreatic, gastric and intestinal juice, Mechanism of digestion, absorption and assimilation of carbohydrates, proteins and lipids.

B. Circulation: Mechanism of working of heart, Cardiac output, cardiac cycle, Origin & conduction of heartbeat, Composition of blood, Mechanism of coagulation of blood.

C. Reproductive system: Male and female reproductive system with hormonal regulation.

Unit II	**COORDINATION, RESPIRATION AND EXCRETORY SYSTEM**	**15**

A. Nervous & chemical coordination: Neural tissue and nerve cells (Structure and function), Synapse (Electric and chemical), Endocrine gland and their hormones (PituitaryandThyroid)

B. Respiration: Respiratory system, mechanism, Exchange of gasses, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.

C. Excretory system: Structure of Kidney, Ultra-filtration (function of Bowman's capsule, Malphigian body), Urine formation

References:

1. Guyton, A.C.& Hall, J.E.(2006).Textbook of Medical Physiology. XIth Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John Wiley & Sons, Inc.
3. Human physiology by C.C. Chatterjee 11th edition, Medical Agency Allied, Calcutta.
4. A Textbook of Human physiology, Sarada Subrahmanyam et al., 2010, S. Chand & Company

DSC 3-1: PLANT PHYSIOLOGY (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives:	• To learn about anatomy of plants and components of plant nutrition. • To understand the concept of plant growth and physiology.
Outcomes:	• Students learn about the anatomy of plants and components of plant nutrition. • Students get knowledge about the concept of plant growth and physiology.

Unit I	**PLANT ANATOMY AND NUTRIENTS**	**15**

A. Plant anatomy: Plant cell, The shoot and root apical meristem and its histological organization, simple, complex, permanent tissues; leaf anatomy (dorsi-ventral and isobilateral leaf).

A. Plant water relations: Importance of water for plant life, mechanism of water absorption, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, Stomata- mechanism of opening & closing

B. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, Mechanism of uptake of nutrients, mechanism of food transport, source to sink transport

Unit II	**PLANT GROWTH AND PHYSIOLOGY**	**15**

A. Photosynthesis: Photosynthesis pigments, concept of two photo systems, photophosphorylation, Calvincycle, CAM pathway, photorespiration, compensation point

B. Nitrogen metabolism: Nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

C. Growth and development: Definition, phases of growth, growth curve, growth hormones- Physiological role and mode of action - auxins, gibberellins, cytokinins, abscisic acid and ethylene, seed dormancy.

References:

1. Dickinson, W.C. 2000 Integrative Plant Anatomy Harcourt Academic Press, USA.
2. Esau, K.1977 Anatomy of Seed Plants, Wiley Publishers.
3. Fahn, A. 1974 Plant Anatomy Pergamon Press, USA and UK.
4. Hopkins,W.G. and Huner,P.A.2008 Introduction to Plant Physiology John Wiley and Sons.
5. Mauseth,J.D.1988 Plant Anatomy. The Benjamin/Cummings Publisher, USA.
6. Salisbury,F.B.andRoss,C.W.1991 Plant Physiology,Wadsworth Publishing Co.Ltd.
7. Taiz,L.and Zeiger,E.2006 Plant Physiology,4th edition,SinauerAssociatesInc.MA,USA.

DSC 1-1 (Major) Practicals - Semester I

Based on: BIOPHYSICS AND CHEMICAL SCIENCE (2 Credits)	
1	Study of Lambert's & Beer's law using colorimeter.
2	Study of UV spectra of protein/DNA using spectrophotometer.
3	Preparation of Molarity, normality and percentage solutions.
4	Measurement of pH and preparation of buffers (Phosphate buffer, acetate buffer).
5	To determine viscosity and/or conductivity of given liquids.
6	Determination of boiling point of a liquid.
7	Study of osmosis using a dialysis bag.

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Based on: BIOCHEMISTRY (2 Credits)	
1	Qualitative analysis of carbohydrates
2	Qualitative analysis of amino acids
3	Protein estimation by Biuret method
4	Estimation of reducing sugar by DNSA method.
5	Qualitative analysis of lipids
6	Qualitative analysis of nucleic acids (DNA and RNA)
7	Study of enzyme activity (amylase/invertase)

DSC 2-1 (Major) Practicals - Semester I

Based on: FUNDAMENTALS OF MICROBIOLOGY (2 Credits)	
1	Introduction to Microbiology laboratory Glassware: petri-plates, slants, incubation flasks, glass spreader, suspension tube etc.
2	Introduction to Microbiology laboratory Equipment: Nichrome wireloop, Microscope, Autoclave, Incubator, Hot Air Oven, Laminar Air flow, Rotary Shaker etc.
3	Introduction to Microbiology Culture media – Nutrient broth, selective medium, differential medium, minimal medium, concept of sterilization.
5	Study of morphology and colony characteristics of microbial culture.
6	Gram staining and motility test by Hanging drop technique.
7	Study of biochemical characteristics of microbial culture.
8	Mounting & Identification of Fungi

Based on: TAXONOMY AND CLASSIFICATION (2 Credits)	
1	Study of Morphological characters of Bryophytes and Pteridophytes
2	Study of Morphological characters of Gymnosperms and Angiosperms.
3	Study of Morphological characters of Monocotyledons and Dicotyledons.
5	Study of Morphological characters of Chordates
6	Study of Morphological characters of Non-chordates
7	Study of Morphological characters of Algae and Fungi.
8	Study of Morphological characters of Bacteria

DSC 3-1 (Major) Practicals - Semester I

Based on: ANIMAL PHYSIOLOGY (2 Credits)	
1	Study of Mechanism of working of human heart using a model.
2	Study of Mechanism of working of human kidney using a model.
3	Study of permanent histological sections of stomach/ileum/liver/pancreas/kidney.
4	Study of permanent histological sections of pituitary and thyroid gland
5	Effect of salt concentrations on RBCs.
6	Determination of bleeding time and clotting time of human blood.
7	Estimation of sugar in human blood.
8	Measurement of human blood pressure.

Based on: PLANT PHYSIOLOGY (2 Credits)	
1	Separation of photosynthetic pigments by paper chromatography
2	Preparation of stained mounts of anatomy of monocot root/stem.
3	Preparation of stained mounts of anatomy of dicot root/stem.
4	Determination of plant cell size by micrometry.
5	Determination of microflora from root nodules of leguminous plant
6	To determine the seed germination time & percentage in monocot & Dicot
7	Demonstration Of Transpiration in plants.
8	Demonstration of guttation on leaf tips of grass and garden nasturtium
9	Demonstration of Osmosis in plant cells.

SKILL ENHANCEMENT COURSE (SEC - 1)			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
SEC	**2 Credits**	**30 Hours**	**50 (30:20)**
SEC - 1: BASIC LABORATORY SKILLS IN BIOTECHNOLOGY			
1	Washing and sterilization of glassware		
2	Handling of laboratory chemicals		
3	Preparation of laboratory solutions (Acid, Base, Buffer, Saline etc.) and reagents (Biuret, DNSA, DPA, Orcinol, Ninhydrin etc.)		
4	Handling and care of common laboratory equipment: weighing balance, colorimeter, pH meter, microscope, centrifuge, laminar air flow, incubator, oven etc.		
5	Study of Qualitative and quantitative estimation (sugar/protein/lipid/chemical compound)		
6	Microbiology Culture techniques (Preparation of media, suspension, smear, inoculation)		
7	Microbiology pure culture techniques (Dilution, Spreading, Streaking)		
8	Staining and microscopic observation of bacteria and fungi.		
9	Biotechnology Laboratory Waste disposal		
10	Biotechnology Laboratory safety		
11	Introduction to basic computer operating systems (Windows and Mac).		
12	Record keeping in Biotechnology laboratory using Microsoft word and / Microsoft excel (SOPs, Stock Report, Requisition, Registers).		

Ability Enhancement Course (AEC) L1-1 (2) ENGLISH (PAPER - I)			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
AEC	**2 Credits**	**30 Hours**	**50 (30:20)**

INDIAN KNOWLEDGE SYSTEM (IKS) IKS – 1			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
IKS	**2 Credits**	**30 Hours**	**50 (30:20)**
Introduction to IKS in Science			

VALUE EDUCATION COURSE VEC-1			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
VEC	**2 Credits**	**30 Hours**	**50 (30:20)**
Constitution of India			

CO CURRICULAR CC-1			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
CC	**2 Credits**	**30 Hours**	**50 (30:20)**
Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts			

SEMESTER-II

SEMESTER-II				
Sr.No.	**Course Type**	**Course Code**	**Paper Title**	**Credit**
1.	Major	DSC 1-2 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 1-2 (P)	Practical of DSC 1-2	2
2.	Major	DSC 2-2 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 2-2 (P)	Practical of DSC 2-2	2
3.	Major	DSC 3-2 (T)	To be selected from the Basket of Major Subjects in Biotechnology, listed in this syllabus.	2
		DSC 3-2 (P)	Practical of DSC 3-2	2
4.	OE/GE	OE-I/GE-I	To be selected from the Basket of OE-I/GE-I, listed in this syllabus.	2
5.	SEC	SEC-2	Basic laboratory Skills in Biotechnology - II	2
6.	AEC	L1-2	English (Paper- II)	2
7.	VEC	VEC-2	Environmental studies	2
8.	CC2	CC-2	Community Engagement & Services	2
			Total	**22**

BIOTECHNOLOGY - BASKET OF MAJOR SUBJECTS

SEMESTER II	
DSC 1-2 (Any One)	Developmental Biology
	Ecology
DSC 2-2 (Any One)	Cell Biology
	Cell Physiology
DSC 3-2 (Any One)	Plant Tissue Culture
	Animal Tissue Culture

BIOTECHNOLOGY – BASKET OF OE-1/GE-1 SUBJECTS

SEMESTER - II	
OE-1/GE-1 (Any One)	Biotechnology in Human Welfare
	Computer Science
	Any Open Elective subject offered by other Discipline/ Faculty

DSC 1-2: DEVELOPMENTAL BIOLOGY (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives	• To learn about the processes in developmental biology. • To learn about the stages of animal and plant development.
Outcomes	• Students learn about the processes in developmental biology. • Students get knowledge about the stages of animal and plant development.

Unit I	**ANIMAL DEVELOPMENT**	**15**

A. Gametes: Structure of egg and sperm, types of eggs, spermatogenesis and oogenesis, insemination and transport of sperm. Spawning and copulation.

B. Fertilization: External vs internal fertilization, encounter of spermatozoa and ova, capacitation and contact, acrosome action and penetration, activation of ovum, Migration of pronuclei and amphimixis

C. Cleavage (plane, pattern and types), morulation, blastulation, fate map construction, gastrulation (morphogenetic movements), three germ layers.

Unit II	**PLANT DEVELOPMENT**	**15**

A. Gametogenesis and Fertilization:
pollen development,embryo sac development and double fertilization in angiosperms.

B. Early Development:
Embryogenesis, establishment of symmetry in plants; seed formation and germination.

C. Morphogenesis and organogenesis in plants:
Organization Shoot and root apical meristem, floral meristem and floral development in *Arabidopsis*.

References:

1. Gilbert, S.F.(2006) Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
2. Balinsky, B.I.(2008) An introduction to Embryology, International Thomson Computer Press.
3. Kalthoff, (2000) Analysis of Biological Development, II Edition, McGraw-Hill Professional.
4. Bhojwani, S.S. & Bhatnagar, S.P. (1999), Embryology of Angiosperms, 4th ed. Vikas Pub
5. Raghavan V (2000) Developmental Biology of Flowering Plants, Springer-Verlag, New York
6. Widmaier E.P., Raff, H., Strang, K.T. (2004) 9th ed. Vander's Human Physiology, McGraw Hill
7. Evolutionary and developmental Biology (978-9358709247) V.K. Agarwal, S.Chand Publishing (2024)

DSC 1-2: ECOLOGY (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives	• To learn about different elements of the ecological system. • To learn about components of the ecosystem and their characteristics.
Outcomes	• Students learn about different elements of the ecological system. • Students get acquainted with the components of the ecosystem and their characteristics.

Unit I	**ELEMENTS OF ECOLOGY**	**15**

A. Ecology: History of ecology, Autecology and synecology; Brief idea about attributes of population: Density, natality, mortality, life tables, fecundity tables,survivorship curves

B. Animal Associations- Brief idea and definitions:Intraspecific associations: Parental care in fishes, groups and social behavior; Interspecific associations: commensalism, mutualism, predation and parasitism.

C. Abiotic Factors: Introduction & Effects on animals: Temperature, light, water, soil, oxygen and carbon dioxide.

Unit II	**ECOSYSTEM**	**15**

A. Community: Community characteristics:
Species richness, dominance, diversity indices (types), abundance.

B. Ecosystem: General characteristics & faunal adaptations in:
Aquatic (freshwater ecosystem: lotic and lentic) & Terrestrial (grassland and desert ecosystem).

C. Food chain: with reference to pond ecosystem, ecological pyramid, energy flow and ecological succession.Applied Ecology: Brief idea of: Biodiversity hot-spots and sacred groves in India with examples.

References:

1) Colinvaux, P.A.(1993) Ecology IInd Edition. Wiley ,John and Sons,Inc.
2) Krebs, C.J. (2001) Ecology VIth Edition. Benjamin Cummings.
3) Odum, E.P.,(2008) Fundamentals of Ecology. Indian Edition.Brooks/Cole
4) Robert Leo Smith Ecology and field biology Harper and Row publisher
5) Ricklefs, R.E., (2000) Ecology Vth Edition Chiron Press

DSC 2-2: CELL BIOLOGY (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives:	• To learn about the structure and functions of cell organelles and cytoskeleton. • To understand the mechanism of cell growth and concept of cancer development.
Outcomes:	• Students learn about the structure and functions of cell organelles and cytoskeleton. • Students can understand the mechanism of cell growth and the concept of cancer development.

Unit I	**CELL ORGANIZATION**	**15**

A. Introduction of Cell, Historical account of cell biology; cell theory and protoplasm theory,
B. Organization of cells - Prokaryotic, Eukaryotic, animal, plant, bacterial, Virus, yeast.
C. Structure and functions of Cell Organelles: Mitochondria, Chloroplasts, Vacuoles, microbodies, Golgi Bodies, Lysosomes, Endoplasmic Reticulum, Ribosomes and Peroxisomes.
Nucleus, types of chromosomes based on centromere and their structure.

Unit II	**CYTOSKELETON, CELL GROWTH AND CANCER**	**15**

A. Cytoskeleton: Structure and function of microfilament, intermediate filament and microtubules.
B. Cell growth: Concept of cell growth and differentiation, Cell cycle, Mitosis, and Meiosis.
C. Cancer: Characteristics and molecular basis of cancer, Carcinogenesis, agents promoting carcinogenesis.

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, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7 th edition. Pearson Benjamin Cummings Publishing, San Francisco.

DSC 2-2: CELL PHYSIOLOGY (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives:

- To learn principles of cell communication and recognition in biological systems.
- To learn the concept of cell signaling and ultra structure of the cellular structures involved.
- To get introduced with membrane and microbial physiology and important physiological processes associated with them.

Outcomes:

- Students understand the principles of cell communication and recognition process.
- Students get knowledge about the cellular structures and the concept of cell signaling.
- Students get knowledge about the membrane and microbial physiology and important physiological processes associated with them.

Unit I — CELL COMMUNICATION AND CELL RECOGNITION — 15

A. General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, cell-ECM interactions, integrins, neuro-transmission and its regulation.

B. Cell signaling – Chemical nature of signaling molecules and their receptors, secondary messengers, signal transduction pathway (e.g. epinephrine signaling in glycogen metabolism), bacterial chemotaxis and quorum sensing.

C. Structure and function of cells involved in cell physiology–Epithelial, Nerve, Muscle and Connective tissue

Unit II — MEMBRANE AND MICROBIAL PHYSIOLOGY — 15

A. Membrane transport - lipid bilayer and membrane protein diffusion, osmosis, ion channels, active/passive transport, membrane pumps

B. Role of golgi and ER in protein synthesis, Vesicle trafficking, endocytosis and exocytosis

C. Microbial Physiology - Microbial growth rate and growth yield and characteristics, strategies of cell division, stress Response.

References:

1. Karp,G.2010.CellandMolecular Biology:ConceptsandExperiments.6thEdition.JohnWiley&Sons.Inc.
2. Cooper, G.M. and Hausman, R.E.2009. TheCell:A MolecularApproach. 5th edition ASM Press & Sunderland, Washington, D.C. Sinauer Associates, MA.
3. Becker, W.M., Kleinsmith, L.J., Hardin J. and Bertoni, G.P.2009. TheWorld oftheCell.7th edition.PearsonBenjamin Cummings Publishing,SanFrancisco.
4. Stanier R. Y. General Microbiology

DSC 3-2: PLANT TISSUE CULTURE (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives:	• To learn about the basics of plant tissue culture. • To learn about the terminologies and techniques in plant tissue culture.
Outcomes:	• Students learn about the basics of plant tissue culture. • Students get knowledge about the terminologies and techniques in plant tissue culture.

Unit I	**INTRODUCTION TO PLANT TISSUE CULTURE**	**15**

A. Introduction and Infrastructure: History and scope of plant tissue culture. Aseptic techniques in preparation, sterilization of glassware, laboratory fumigation, surface disinfection.

B. General laboratory setup: Significance and importance of laboratory equipments, instruments, glassware and other requirements in plant tissue culture laboratory

C. Culture Techniques: Concept of totipotency, Culture media composition with significance and preparation. Culture techniques – callus, suspension, organ culture, Endosperm culture, Protoplast culture: Protoplast isolation, gene transfer in protoplast, fusion, cell wall regeneration & culture.

Unit II	**PLANT TISSUE CULTURE TECHNIQUE**	**15**

A. Somaclonal variation: Introduction, terminology, origin and mechanism selection at plant level, selection at cellular level. Production of hybrids & cybrids.

B. Clonal Propagation: Micropropagation: through callus and its Stages, auxiliary Branching, Adventitious buds, Factors affecting, limitations & applications of micropropagation.

C. Organogenesis: somatic embryogenesis, factors affecting somatic embryogenesis. Plant hardening, artificial seed production. Cryopreservation & its advantages.

References:

1. Introduction to plant tissue culture- M.K. Razdan (2019): 978-8120417939
2. Plant tissue culture-Theory & practice-S. S. Bhojwani & M.K. Razdan (1996): 978-0444816238
3. Plant tissue culture- Kalyankumar Dey (2020): 978-9352551651
4. Plant tissue culture by Jha & Ghosh (2016): 978-8189874407
5. Trends in plant tissue culture by L. K. Pareek (2002): 978-8177540895
6. Plant cell & tissue culture by S. Narayaswami (1994): 9780074602775

DSC 3-2: ANIMAL TISSUE CULTURE (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
Major	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives	• To learn about the basics of animal tissue culture. • To learn about the terminologies and techniques in animal tissue culture.
Outcomes	• Students learn about the basics of animal tissue culture. • Students get knowledge about the terminologies and techniques in animal tissue culture.

Unit I	**INTRODUCTION TO ANIMAL TISSUE CULTURE**	**15**

A. Introduction: History, Laboratory Design, Characteristics of animal Cell in Culture, Substrate for cell growth. Equipment required for animal cell culture- laminar air flow, CO_2 incubator, Sterilization of apparatus, flow cytometry.

B. Culture Media: Natural media-Clots, Biological fluids, Serum, Tissue Extract, Synthetic media-Balanced salt Solution, Serum containing media, complete media. Physicochemical properties of media, sterilization of media.

C. Culture Techniques: Primary cell Culture, Cell Separation: Mechanical-Sieve, chopping, pipetting etc. Enzymatic: Trypsinization (Warm & Cold), Collagenase. Criteria for subculture.

Unit II	**ANIMAL TISSUE CULTURE TECHNIQUE**	**15**

A. Methods of organ culture: Plasma clot technique, raft method, agar gel method, Cryopreservation, Cell Synchronization: By physical mean & chemical blockade.

B. Establishment of cell lines: Cell line selection & routine maintenance of cell lines, cell counting and monitoring. Indirect method of cell determination: protein, DNA, LDH, Glucose determination.

C. Cell line Identification: Tests of identification- Karyotyping, Isozymes, Analysis of cell cycle: Tritiated thymidine pulse method, Applications of animal cell culture.

References:

1. Culture of animal cell 3rd edition-R Ian Freshney (2021): 978-1119513018
2. Animal cell culture- J. R.W.Masters (2000): 978-0199637966
3. Animal biotechnology-M.M. Ranga 3rd Ed. (Reprint), 2010: 9788177543094
4. Animal biotechnology-R. Sasidhara (2023): 978-8180940262
5. Animal cell culture technique-Ed. Martin Clynes Springer (1998): 978-3540630081
6. Animal cell culture and technology by Michael Butler (2003): 978-1859960493

DSC 1-2 (Major) Practicals: Semester - II

Based on: DEVELOPMENTAL BIOLOGY (2 Credits)	
1	Identification of developmental stages of chick and frog embryo using permanent mounts
2	Study of the developmental stages of Drosophila from stock culture/ photographs.
3	Study of different types of embryos and placenta.
4	Study of different types of sperms by smear technique- Frog, Hen, Rat and Human
5	To perform a Sperm motility test.
6	Study of different types of eggs - Insects, Amphioxus, Frog and Hens egg.
7	Study of style and sigma
8	Study of pollen germination by T.T.C. or Acetocarmine test
9	Collection of seed and storage of seeds for seed bank

Based on : ECOLOGY (2 Credits)	
1	Study of Intra specific associations with suitable examples.
2	Study of Inter specific associations with suitable examples.
3	To determine the minimum size of the quadrat by species area-curve method.
4	To study communities by quadrat method and to determine % Frequency, Density and Abundance
5	Study of terrestrial ecosystem with suitable examples.
6	Study of aquatic ecosystem with suitable examples.
7	Study of pond ecosystem from nearby waterbody.
8	Study of endangered or threatened wild animals of India through photographs / specimens / models

DSC 2-2 (Major) Practicals: Semester - II

Based on: CELL BIOLOGY (2 Credits)	
1	Study of structure of any Prokaryotic and Eukaryotic cell.
2	Preparation of Nuclear, Mitochondrial & cytoplasmic fractions
3	Study of mitochondria using Janus Green B stain.
4	Cell division in onion root tip/ insect gonads.
5	Meiosis in Flower Buds of *Allium cepa*- Acetocarmine Stain
6	Demonstration of Microtomy: Fixation, block making, section cutting, double staining of animal tissues.

Based on: CELL PHYSIOLOGY (2 Credits)	
1	Study of cells involved in cell physiology (Epithelial, Nerve, Muscle and Connective tissue)
2	Isolation of chloroplast from plant material.
3	Measurement of cell size by micrometry.
4	Study of chemotaxis in bacteria.
5	Study on Quorum Sensing.
6	Study of Membrane transport
7	Study of Microbial Growth curve

DSC 3-2 (Major) Practicals: Semester - II

Based on: PLANT TISSUE CULTURE (2 Credits)	
1	Study of the sources of contamination and decontamination measures in PTC lab.
2	Isolation and surface sterilization of explants.
3	Initiation and maintenance of callus.
4	Micropropagation by proliferation of axillary bud.
5	Micropropagation by adventitious shoot proliferation.
6	Initiation and establishment of cell suspension cultures.
7	Microspore/anther culture for haploid production.
8	Protoplast isolation and culture.
9	Embryogenesis and embryo culture, synthetic seeds.
10	In vitro pollination and culture of ovary/ovule.

Based on: ANIMAL TISSUE CULTURE (2 Credits)	
1	Study of the sources of contamination and decontamination measures in ATC lab.
2	Study of types of animal cell culture (Primary and Secondary)
3	Study of types of cell lines (Finite and Continuous)
4	Preparation of Hank's Balanced Salt Solution.
5	Animal Cell Culture Media Preparation.
6	Separation of serum & plasma from blood by centrifugation technique.
7	Cell Separation by Trypsinization.
8	Staining of animal cells
9	Viability and Cell Counting by Hemocytometer.
10	Maintenance of cell lines.

OE-1/GE-1 : BIOTECHNOLOGY IN HUMAN WELFARE (Theory)			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
OE/GE	**2 Credits**	**30 Hours**	**50 (30:20)**

Objectives:	• To get information about the scope of biotechnology in various fields. • To get knowledge about applications of biotechnology in various fields. • To understand the interdisciplinary scope of biotechnology.
Outcomes:	• Students get information about the scope of biotechnology in various fields. • Students get knowledge about applications of biotechnology in various fields. • Students can understand the interdisciplinary scope of biotechnology.

Unit I	**INTRODUCTION AND SCOPE OF BIOTECHNOLOGY**	**15**

A. Introduction to Biotechnology: History, Contribution of Biotechnology [Waldeyer, Rosalind Franklin, J.D. Watson, Karry Mullis, Norman Borlaug], National Institutes of Biotechnology in India.

B. Biotechnological Milestones: Green Revolution, White Revolution, Blue Revolution, Yellow Revolution, Grey Revolution, Red Biotechnology.

C. Biotechnology and Interdisciplinary scope: Chemical science, Physics, Mathematics, Statistics, Computer application, Pharmacy, Remote sensing, Robotics, Artificial Intelligence, Nanotechnology.

Unit II	**BIOTECHNOLOGY-APPLICATIONS**	**15**

A. Agri Biotechnology and Pharmaceuticals : Golden Rice, Bt cotton, Bt-Brinjal, Edible vaccines, Importance of Medicinal plants in therapeutics, Genetically engineered insulin, vermi-technology.

B. Transgenic organisms and reproductive technology : Transgenic pioneers – Nancy, Ethal and Herman, Knockout mice, transgenic fish, Transgenic cattle, birds, pigs. Test of Infertility [Male and Female], Donated sperm – Artificial insemination, Donated uterus – Surrogate motherhood, *In vitro* fertilization.

C. Biotechnology in Human Welfare : Effects, Prevention and Control of human diseases [Pneumonia, Common cold, Malaria, Amoebiasis, Ascariasis, Elephantiasis], Active and Passive immunity, Vaccination and Immunization.

References:

1. Introduction to Biotechnology, 2014, 3rd ed. William J. Thieman, Michael A. Palladino, Pearson Education India.
2. Biotechnology: Principles and Applications, S.C. Rastogi, Alpha Science International, 2007.
3. A textbook of Biotechnology by R.C. Dubey, 1993
4. Biotechnology U. Satyanarayana, 2020
5. Biotechnology for beginners, Renneberg, R. &Berkling,V. Academic Press, 2017
6. A textbook of Biotechnology- R.C. Dubey
7. Biotechnology- H.S. Chawla
8. Biotechnology and Human Welfare for Competitive Examinations McGraw-Hill; First Edition (30 January 2020) (ISBN-10 : 9387432467).

OE-1/GE-1: COMPUTER SCIENCE (Theory)

Course Type	Course Credits	Total No. of Teaching Hours	Total marks
OE/GE	2 Credits	30 Hours	50 (30:20)

Objectives:	• To learn about basic components of a computer system. • To learn about computer operating and application softwares.
Outcomes:	• Students learn about basic components of a computer system. • To get acquainted with computer operating and application softwares.

Unit I	BASICS OF COMPUTER	15

A. Introduction to Computers: History of Computers, Data, Information and Program, Components of Computer System - Central Processing Unit (CPU), Arithmetic and Logic Unit – ALU, Keyboard and Mouse, Other input/output Devices, Hardware and Software, Computer Memory, Types of Computers.

B. MS-Office (Word, Excel, PowerPoint) - Word Features, Font, Font Style, Formatting, Copying and Pasting, Format Painter, Columns, Page Formatting.

C. Excel- Cell, Cell Address, Formula, Working with Excel, Creating charts, PowerPoint- Preparing presentations (using Clip arts, shapes, movies etc).

Unit II	COMPUTER AND INTERNET	15

A. Basic of Computer Networks - Local Area Network (LAN) , Wide Area Network (WAN), Concept of Internet, Internet Communication Protocols, Uses of Internet

B. World Wide Web (www), Hypertext Transfer Protocol (HTTP), Uniform Resource Locator (URL), HyperText Markup Language (HTML), web browsing softwares, types of Search engines, Inflibnet, DigiLocker and ABC-ID. Basic introduction to programming language – JAVA, C, C++, Python

C. Online security and privacy - Threats to computer, Virus and its types, Anti-Virus software and Examples, Firewall and its use, Data Backup and Restore, Cyber-crime and Computer ethics

References:

1. Fundamentals of Computer by V. Rajaraman; Prentice Hall of India Pvt. Ltd., New Delhi
2. Computers Today by SK Basandara, Galgotia publication Pvt. Ltd. Daryaganj, New Delhi
3. MS-Office 2000 for Everyone by Sanjay Saxena;Vikas Publishing House Pvt. Ltd., New Delhi
4. Internet for Everyone by Alexis Leon and Mathews Leon;Vikas Publishing House Pvt. Ltd., Jungpura, New Delhi
5. A First Course in Computer 2003 Edition by Sanjay Saxena;Vikas Publishing House Pvt.Ltd., Jungpura,New Delhi
6. Mastering Windows 95, BPB Publication, New Delhi
7. Computer Fundamentals by PK Sinha; BPB Publication, New Delhi
8. Fundamentals of InformationTechnology by Leon and Leon;Vikas Publishing House Pvt. Ltd., Jungpura, New Delhi

SKILL ENHANCEMENT COURSE (SEC - 2)			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
SEC	**2 Credits**	**30 Hours**	**50 (30:20)**
SEC - 2: BASIC LABORATORY SKILLS IN BIOTECHNOLOGY - II			
1	Collection of biological sample (sample from natural habitat/location)		
2	Collection of human biological sample (blood/swab)		
3	Identification of the blood cell types in human blood smear.		
4	Determination of blood group		
5	Measurement of blood Hemoglobin		
6	Standardization of plant tissue culture media.		
7	Maintenance of cell culture in PTC laboratory.		
8	Standardization of animal tissue culture media.		
9	Viability and Cell Counting by Hemocytometer.		
10	Maintenance of cell lines in ATC laboratory.		
11	Introduction to the common databases in Bioinformatics.		
12	Use of Microsoft powerpoint for scientific presentation.		

Ability Enhancement Course (AEC) L2- (2) ENGLISH (PAPER - II)			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
AEC	**2 Credits**	**30 Hours**	**50 (30:20)**

VALUE EDUCATION COURSE VEC - 2			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
VEC	**2 Credits**	**30 Hours**	**50 (30:20)**
Environmental Studies			

CO CURRICULAR CC - 2			
Course Type	**Course Credits**	**Total No. of Teaching Hours**	**Total marks**
CC	**2 Credits**	**30 Hours**	**50 (30:20)**
Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts			

Punyashlok Ahilyadevi Holkar Solapur University, Solapur.
Faculty of Science & Technology.
Nature of Question Paper for B.Sc./B.C.A.(Part-I)

w.e.f. A.Y. 2024-25

External Evaluation (UA)

Time: Total Marks:30

Instructions

1) All Questions are compulsory.
2) Figure to the right indicates full marks.

Q.1	**Choose correct alternative (MCQ)** **6 Marks**
1)	Question _____ a) b) c) d)
2)	
3)	
4)	
5)	
6)	
Q.2.	**Answer the following (Any three)** **6 Marks**
A)	
B)	
C)	
D)	
E)	
Q.3.	**Answer the following(Any two)** **6 Marks**
A)	
B)	
C)	
Q.4.	**Answer the following (Any two)** **6 Marks**
A)	
B)	
C)	
Q.5.	**Answer the following (Any one)** **6 Marks**
A)	
B)	

Punyashlok Ahilyadevi Holkar Solapur University, Solapur.
Faculty of Science & Technology.
Nature of Question Paper for CBCS Pattern B.Sc./B.C.A.(Part-I)

w.e.f. A.Y. 2024-25

Internal Evaluation (CA)

Time: Total Marks:20

- **Internal Evaluation System for 20 Marks**

  Choose any two of the following:

  - ➢ Home Assignment/ Unit Test/ Tutorial/ Seminar
