

Punyashlok Ahilyadevi Holkar Solapur University, Solapur



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

Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM

Syllabus: Biotechnology

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

(Syllabus to be implemented from June 2022)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science and Technology
Choice Based Credit System (CBCS)

B. Sc. I Biotechnology

(w.e.f. June 2022- 2023)

Preamble

Choice Based Credit System: With the view to ensure worldwide recognition, acceptability, horizontal as well as vertical mobility for students completing under graduate degree, PAH Solapur University, Solapur has implemented Choice Based Credit System (CBCS) at under graduate level. The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations.

• **Outline of Choice Based Credit System:**

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective

Course.

3. **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective.

4. **Ability Enhancement Courses (AEC):** The Ability Enhancement (AE) Courses maybe of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). “AECC” courses are the courses based upon the content that leads to Knowledge enhancement; (i) Environmental Science and (ii) English/MIL Communication. These are mandatory for all disciplines. SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

- **Credit:** Credit is a numerical value that indicates students work load (Lectures, Lab work, Seminar, Tutorials, Field work etc.) to complete a course unit. In most of the universities 15 contact hours constitute one credit. The contact hours are transformed into credits. Moreover, the grading system of evaluation is introduced for B.Sc. course wherein process of Continuous Internal Evaluation is ensured. The candidate has to appear for Internal Evaluation of 20 % and University Evaluation for 80 %. It is applicable for theory and practical as well.

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The syllabus is consisting of:

1) Introduction

This course provides a broad overview of Biotechnology and to produces expert hands that would have sufficient knowledge and expertise to solve the urgent problems of the region by using Biotechnology. The course structure is basic science centric where students learn core science and are taught necessary fundamental subject for that purpose.

2) Advantages of Course

Biotechnology has tremendous job potential.

a) The successful students will be able to establish research organizations with the help of Agriculture, environment protection and also their own industry for Biofertilizer, microbial byproducts. Clinical pathology, transgenic plant and animals, vaccines, antibiotics etc.

b) Scientific Research Organizations.

c) Universities in India & abroad.

3) Objectives of the Course

The objectives of B. Sc. Biotechnology course are:

a. To provide an intensive and in depth learning to the students in field of Biotechnology.

b. Beyond simulating, learning, understanding the techniques, the course also addresses the underlying recurring problems of disciplines in today scientific and changing world.

c. To develop awareness & knowledge of different organization requirement and subject knowledge through varied branches and research methodology in students.

d. To train the students to take up wide variety of roles like researchers, scientists, consultants, entrepreneurs, academicians, industry leaders and policy.

4) Title of the Course: B. Sc. I Biotechnology

5) Eligibility of Course

A Candidate passing 10+2 with biology, MLT, dairy science, Fisheries, Agricultural science as one of the subject and passed from state syllabus / CBSE /equivalent with minimum passing percentage of as per the directives of the higher education and Solapur university, Solapur.

6) Fees for Course

The fees for B. Sc. I Biotechnology will be as per the norms of PAH Solapur University, Solapur (Displayed at university and college website).

7) Strength of the Students

The intake capacity for B. Sc. I Entrepreneurship is 60 Seats.

8) Admission/Selection procedure

Admissions will be provided on First come first serve basis at the college offering B. Sc. Biotechnology degree or decision taken by university time to time.

9) Duration of the Course

The duration for this program is of 3 (three) years having semester pattern (Six Semester 06)

10) Medium of Instruction: English

11) Syllabus Structure:

The University follows semester system.

- An academic year shall consist of two semesters.
- Each B.Sc. Course shall consist of 3 (three) years i.e. 6 (six) semesters.
- B.Sc. Part-I Biotechnology shall consist of two semesters: Semester - I and Semester – II. In semester I, there will be four core subjects. Each subject is having 2 (two) papers of 50 marks for each. Similarly in Semester II there will be four core subjects. Each subject is having 2 (two) papers of 50 marks for each. English will be as Ability Enhancement

Course (AECC) in both semesters I and II. English paper carries 50 marks in each semester. The scheme of evaluation of performance of candidates shall be based on University assessment as well as College internal assessment as given below. For B.Sc. Part-I Biotechnology Sem I & II the internal assessment will be based on Internal tests, Home assignment, Viva, Seminar, Group discussion etc. Practical course examination of 100 marks for each course shall be conducted at the end of II semester. The practical examination of 100 marks shall also consist of 80 marks for University practical assessment and 20 marks for college internal assessment. For University practical examination both examiners will be internal. Both examiners will be appointed by the College. The internal practical assessment shall be done as per scheme given below.

12) Scheme of Evaluation

As per the norms of the grading system of evaluation, out of 50 marks, the candidate has to appear for college internal assessment of 10 marks and external evaluation (University assessment) of 40 marks. The respective B.O.S. may decide the nature of college internal assessment after referring to scheme given below or may be used as it is.

Semester	Nature of Assessment	University Assessment	College Assessment	Total
Sem I	Theory 9 Papers	40 marks (As per template provided)	10 marks (As per template provided)	50 marks
Sem II	Theory 10 Papers	40 marks (As per template provided)	10 marks (As per template provided)	50 marks
Annually	Four (4) Practical	80 marks (As per template provided)	20 marks (As per template provided)	100 marks

Theory Examination Pattern UA (University Assessment) 40 marks / paper:

Question No.	1	2	3	4	5	Total
Nature of Question	Multiple Choice	Short Answer	Short Notes	Answer or Describe in brief	Answer or Describe in detail	-

Available Options	8	5	3	3	2	21
Compulsory to Solve	8	4	2	2	1	17
Each Option carrying marks	1	2	4	4	8	-
Total Marks	8	8	8	8	8	40

Theory Examination Pattern CA (Continuous Assessment) 10 marks / paper:

Continuous Internal Assessment (CA) for each paper of theory examination should carry 10 marks. College may conduct one examination having 10 marks or two examinations each of 5 marks. Nature of assessment may be open book examination, home assignment, group discussion, classroom test, seminar, field work report, project report etc.

13) Practical Examination:

Total four practical courses of 100 marks each should be assessed. The assessment pattern is 80+20 i.e. 80 marks assessment should be university assessment, UA and 20 marks for Continuous assessment, CA. Nature of question paper is given below for both examinations i.e. UA and CA

Practice Examination Pattern UA (University Assessment) 80 marks / paper:

Question No.	Nature of Question	No. of Questions	Marks	Total Marks
1	Major Practical	1	16	16
2	Major Practical	1	16	16
3	Minor Practical	1	8	8
4	Minor Practical	1	8	8
5	Spotting	5	2	10
6	Principle Writing	3	4	12
7	Certified Journal + Viva	-	-	10
Total Marks				80

Practical Examination Pattern CA (Continuous Assessment) 20 marks / paper:

Continuous Internal Assessment, CA should be (20 marks) and follow the given scheme of marking:

Question No.	Nature of Question Paper	Frequency	Marks	Total
1	Test/exam on single practical	1	5	5
2	Test/exam on single practical	1	5	5
3	Certified Journal + Viva	1	5	5
4	Attendance	1	3	3
5	Attitude	1	2	2
Total				20

14) Passing Standard:

The student has to secure a minimum of 4.0 grade points (Grade C) in each paper. A student who secure less than 4.0 grade point (39% or less marks, Grade FC/FR) will be declared fail in that paper and shall be required to reappear for respective paper. A student who failed in University Examination (theory) and passed in internal assessment of a same paper shall be given FC Grade. Such student will have to reappear for University Examination only. A student who fails in Continuous Internal assessment, CA and passed in University examination UA (theory) shall be given FR Grade. Such student will have to reappear for both University examination, UA as well as Continuous internal assessment, CA.

15) ATKT:

Candidate passed in all papers, except 5 (five) papers combined together of semester I and II of B.Sc. Part-I Biotechnology examination shall be permitted to enter upon the course of Semester III of B.Sc. Part-II Biotechnology.

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Subject/ Core Course	Name and Type of the Paper		No. of papers/ Practical	Hrs/week			Total Marks Per Paper	UA	CA	Credits
	Type	Name		L	T	P				
Class : B.Sc.- I Semester – I										
Ability Enhancement Compulsory Course (AECC)		English Paper I Part-A (communication skill)		4.0			50	40	10	2.0
Core Courses		DSC 1A	Paper- I: Chemistry	2.5	--	--	50	40	10	4.0
			Paper-II: Biochemistry	2.5	--	--	50	40	10	
		DSC 2A	Paper-I: Biophysics	2.5	--	--	50	40	10	4.0
			Paper-II: Cell Biology	2.5	--	--	50	40	10	
		DSC 3A	Paper-I: Animal Physiology	2.5	--	--	50	40	10	4.0
			Paper-II: Developmental Biology	2.5	--	--	50	40	10	
		DSC 4A	Paper-I: Ecology	2.5	--	--	50	40	10	4.0
	Paper-II: Biotechnology in Human Welfare	2.5	--	--	50	40	10			
Total				24	--	--	450	360	90	18
Class : B.Sc.- I Semester – II										
Ability Enhancement Course(AECC)		English Paper I Part-B (communication skill)		4.0			50	40	10	2.0
Core Courses		DSC 1B	Paper-III: Metabolism	2.5	--	--	50	40	10	4.0
			Paper-IV: Enzymology	2.5	--	--	50	40	10	
		DSC 2B	Paper-III: Cell Physiology	2.5	--	--	50	40	10	4.0
			Paper-IV: Bioinstrumentation	2.5	--	--	50	40	10	
		DSC 3B	Paper-III: Plant Physiology	2.5	--	--	50	40	10	4.0
			Paper-IV: Tissue Culture	2.5	--	--	50	40	10	
		DSC 4B	Paper-III: Computer Science	2.5	--	--	50	40	10	4.0
	Paper-IV: Biostatistics	2.5	--	--	50	40	10			
		Democracy, Elections and Good Governance		3			50	40	10	NC
Total (Theory)				24	--	--	450	360	90	18
Core Practical		DSC 1 A & 1B	Practical I	--	--	4	100	80	20	4.0
		DSC 2 A & 2B	Practical II	--	--	4	100	80	20	4.0
		DSC 3A & 3B	Practical III	--	--	4	100	80	20	4.0
		DSC 4A & 4B	Practical IV	--	--	4	100	80	20	4.0
Total (Practical)						16	400	320	80	16
Grand Total				48		16	1300	1040	260	52

Summary of the Structure of B.Sc. Biotechnology Program as per CBCS pattern

Class	Semester	Marks-Theory	Credits-Theory	Marks-Practical	Credits-Practical's	Total - credits
B.Sc.-I	I	450	18	--	--	18
	II	450	18	400	16	34
B.Sc.-II	III	300	12	--	--	12
	IV	300	12	600	24	36
B.Sc.-III	V	450	18	--	--	18
	VI	450	18	400	16	34
Total		2400	96	1400	56	152
	SEC sem.- III & V	200	8			8

B.Sc. Programme :

Total Marks : Theory + Practicals = 2400(+200) +1400 =3800+200

Credits : Theory + Practicals = 96(08) + 56 = 152+08

Numbers of Papers Theory: Ability Enhancement Compulsory Course (AECC) 04

Theory: Discipline Specific Core Paper (DSC) 20

Theory: Discipline Specific Elective paper (DSE) 02

Skill Enhancement Course (SEC) 04

Total : Theory Papers (Core paper-22) 30

: Practical Papers 11

Abbreviations:

L: Lectures T: Tutorials P: Practical UA : University Assessment CA : College Assessment

CC: Core Course AEC : Ability Enhancement Course DSE : Discipline Specific Elective

Paper SEC : Skill Enhancement Course, AIC: Additional Interdisciplinary Courses

Note: Each theory papers of 50 Marks should be of two Units.

Each theory papers of 100 Marks should be of four Units.

Each theory paper Unit is of 15 Lectures.

Practical paper of 100 Marks is of at least 20 practical.

SEMESTER-I

Subject Code: DSC 1A (Total 4 Credits);
Subject Name: Chemistry and Biochemistry

Paper-I: Chemistry

(Course Code BT101)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Atoms and bonds (15 Lectures)

- A Basics of chemical sciences: Mendeleev's and Modern periodic law, Valency, Atomic mass, size, definition and formation of atomic bonds- Ionic, covalent bonds with suitable examples.
- B Types of bonds in biomolecules: Covalent (glycoside, peptide, phosphodiester), ionic, hydrogen, Van der Waals, hydrophobic, co-ordinate their formation and interaction.
- C Concept of Hybridization: sp , sp^2 , sp^3 hybridization with respect to C_2H_2 , C_2H_4 , CH_4 (with respect to bond length, bond angle, bond energy and shape of the molecule). Dipole moment: Definition and significance.

Unit No. 2: Biophysical chemistry (15 Lectures)

- A Solutions: Solutions, types of solutions, solubility & factors affecting solubility; Mole concept: Definition & introduction to molarity, normality, molality, percentage by mass and volume with examples of solution preparation. Classification of solvents, Dilution factor. Colligative properties: Definition, osmosis, osmotic pressure, elevation in boiling point, depression in freezing point, lowering vapor pressure
- B Chemical kinetics: Integrated rate expressions for zero, 1st and 2nd order reactions, Reaction Kinetics: Introduction, Meaning and definitions of rate constant, order and molecularity of reaction, energy of activation.
- C pH and buffers: pH and pOH, buffer capacity. Henderson equation for acidic and basic buffers with derivation.

References:

1. University General Chemistry by C.N. R. Rao, Macmillan
2. Principles of Physical Chemistry, 4th edition by S.H. Marron and C.F. Prutton
3. Essentials of Physical Chemistry by B.S. Bahel and G.D. Tuli
4. College Chemistry by Linus Pauling
5. Concise Inorganic Chemistry by J. D. Lee 5th Edition
6. Basic Inorganic Chemistry by Cotton and Wilkinson
7. Organic Chemistry, 5th Edition by Morrison Prentice Hall of India Pvt. Ltd. Boyd, New Delhi

Paper-II: Biochemistry

(Course Code BT102)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Carbohydrates, Amino Acids and Proteins (15 Lectures)

- A Carbohydrates: Structure, properties and function of monosaccharide (glucose, fructose, mannose, galactose, ribose), disaccharide (sucrose, lactose), polysaccharide (starch, glycogen, cellulose, peptidoglycan).

- B Amino acids: General structure and properties of amino acids, zwitter ion, titration curve of amino acid (glycine), classification of amino acids based on R-group with structure, essential and non-essential amino acids.
- C Proteins: Peptide bond, primary structure, secondary structure, tertiary structure, quaternary structure, forces stabilizing protein structure, classification of proteins based on composition.

Unit No. 2: Lipids, Nucleic Acid and Vitamins (15 Lectures)

- A Lipids: Structure and properties of fatty acids, storage lipid (triacylglycerol, wax), membrane lipid (phospholipids, sphingolipids, sterol)
- B Nucleic acid: Composition, structure and nomenclature of nucleotides, Structure of B-form of DNA, RNA and its types.
- C Vitamins: Source, daily requirements, physiological role, deficiency/hypervitaminosis of water soluble and fat soluble vitamins.

References:

- 1) Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
- 2) Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- 3) Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGrawHill Companies Inc.
- 4) Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
- 5) Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.
- 6) Biochemistry – U. Satyanarayan

Subject Code: DSC 2A (Total 4 Credits);
Subject Name: Biophysics and Cell Biology

Paper-I: Biophysics

(Course Code BT103)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Water, Solutes and Protein Hydration (15 Lectures)

- A Biophysics of Water: Molecular structure, Association of water through H-bonding, Nature of hydrophobic interactions, physicochemical properties of water.
- B Solutes: Hydrophiles and Hydrophobes, The Influence of Ions on water: Structure-Making and Structure Breaking.
- C Protein Hydration: Specific Roles of Water in Structure and Function, Secondary Structure, Protein-Protein Interactions, Involvement of Bound Water in Catalytic Action, Water and Nucleic Acids.

Unit No. 2: Thermodynamics and Molecular Interactions (15 Lectures)

- A Laws of thermodynamics: concept of free energy, unavailable energy & Entropy, Negative entropy change in living system, heat content of food, Bomb calorimetry, Energy generation & energy transfer processes in biochemical reactions.
- B Macromolecular Interactions: binding of small molecules by polymer, identical and independent sites model, Scatchard plot, interaction between binding sites, MWC model, Sequential model.
- C Ligand-receptor interaction: oxygen-hemoglobin binding, binding of two different ligands, cooperative binding, anti-cooperative binding, energetics & dynamics of binding, structures of protein ligand complexes.

References:

1. Ackerman E.A. Ellis, L.E.E. & Williams L.E. (1979), Biophysical Science, Prentice-Hall Inc.
2. Barrow. C. (1974), Physical Chemistry For Life Sciences, McGraw-Hill.
3. Berns M.W. (1982), Cells, Holt Sounders International Editors.
4. Bloomfield V.A. and Harrington R.E. (1975), Biophysical chemistry, W.A.Freeman and CO.
5. Bulter I.A.V. And Noble D.Eds. (1976), Progress in Biophysics and Molecular Biology (all volumes) pergamon, Oxford.
6. Cantor C.R. and Schimmel P.R. (1980), Biophysical chemistry, W.A.Fremman and Co.
7. Casey E.J. (1967), Biophysics, concepts and mechanisms. Affiliated East west press.

Paper-II: Cell Biology

(Course Code BT104)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Cell Organization (15 Lectures)

- A **Introduction of Cell**
Historical account of cell biology; cell theory and protoplasm theory, Prokaryotic and Eukaryotic cell, Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.
- B **Mitochondria & Chloroplasts:** Structure and function, Genomes, biogenesis.
Nucleus: Structure and function; types of chromosomes based on centromere and their structure; Vacuoles and micro bodies: Structure and functions.

C Cell organization

Viruses, Prokaryotic cells, Non-Photosynthetic Eubacteria, Photosynthetic Bacteria, Eukaryotic Cell, Shape, Numbers, Size, Plasma membrane, Cell wall, Golgi Bodies, Lysosomes, Endoplasmic Reticulum, Ribosomes, Peroxisomes, Plastids, Vacuoles.

Unit No. 2: Cell growth, cytoskeleton and cancer

(15 Lectures)

A Cell growth:

Concept of cell growth and differentiation, Cell cycle and division: Events of cell cycle, Mitosis, and Meiosis; Cell synchrony and its applications, Cell senescence, Apoptosis

B Cytoskeleton:

Structure and function of microfilament, intermediate filament and microtubules.

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. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Subject Code: DSC 3A (Total 4 Credits);

Subject Name: Animal Physiology and Developmental Biology

Paper-I: Animal Physiology

(Course Code BT105)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Digestion, Circulation and Reproductive system (15 Lectures)

- 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 heart beat, Composition of blood, Mechanism of coagulation of blood.
- C Reproductive system: Male and female reproductive system with hormonal regulation.

Unit No. 2: Coordination, Respiration and Excretory system (15 Lectures)

- A Nervous & chemical coordination: Neural tissue and nerve cells (Structure and function), Synapse (Electric and chemical), Endocrine gland and their hormones (Pituitary and Thyroid)
- B Respiration: Respiratory system, mechanism, Exchange of gases, Transport of O₂ and CO₂, Oxygen dissociation curve, Chloride shift.
- C Excretory system: Structure of Kidney, Ultrafiltration (function of Bowman capsule, Malphigian body), Urine formation

References:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt 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 Chattergy

Paper-II: Developmental Biology

(Course Code BT106)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Animal Development (15 Lectures)

- 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 reaction 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 No. 2: Plant Development (15 Lectures)

- A Gametogenesis and fertilization: pollen development, embryo sac development and double fertilization in angiosperm
- B Early development: Embryogenesis, establishment of symmetry in plants; seed formation and germination.
- C Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem, floral meristems 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 and Bhatnagar, "Plant Embryology".

Subject Code: DSC 4A (Total 4 Credits);

Subject Name: Ecology and Biotechnology in Human Welfare

Paper-I: Ecology

(Course Code BT107)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Elements of ecology (15 Lectures)

- A Introduction to 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, groupism 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 No. 2: Ecosystem (15 Lectures)

- 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. II Edition. Wiley, John and Sons, Inc.
- 2) Krebs, C. J. (2001). Ecology. VI 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. V Edition. Chiron Pres

Paper-II: Biotechnology in Human Welfare

(Course Code BT108)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Introduction and Scope of Biotechnology (15 Lectures)

- 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 No. 2: Biotechnology-Applications

(15 Lectures)

- A **Agribiotechnology and Pharmaceuticals** : Golden Rice, Bt cotton, Bt-Brinjal, Edible vaccines, Importance of Medicinal plants in therapeutics, Genetically engineered insulin, vermitechnology.
- B **Transgenic organisms and reproductive technology** : Transgenic pioneers – Nancy, Ethal and Herman, Knock out mice, transgenic fish, Transgenic cattle, birds, pigs. Test of Infertility [Male and Female], Donated sperm – Artificial insemination, Donated uterus – Surogate motherhood, *In vitro* fertilization.
- C **Biotechnology in Human Welfare** : Effects, Prevention and Control of human diseases [Pneumonia, Common cold, Malaria, Amoebiosis, Ascariasis, Elephantiasis], Active and Passive immunity, Vaccination and Immunization.

References:

1. Genetics B. D. Singh
2. Molecular biology – P.K. Gupta

SEMESTER-II

Subject Code: DSC 1B (Total 4 Credits);
Subject Name: Metabolism and Enzymology

Paper-I: Metabolism

(Course Code BT109)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Bioenergetics and metabolism of carbohydrates (15 Lectures)

- A Bioenergetics: Laws of thermodynamics, concept of free energy, redox reactions and redox potential, coupled reactions, anabolism and catabolism.
- B Oxidative Phosphorylation: Components of electron transport chain, process of electron transport chain, chemiosmotic hypothesis, ATP synthase complex and ATP synthesis, stoichiometry, inhibitors and uncouplers.
- C Carbohydrate Metabolism: Enzymatic reaction, regulation and energetics of glycolysis, gluconeogenesis, fate of pyruvate, TCA cycle, glycogen metabolism and HMP shunt.

Unit No. 2: Metabolism of lipids, amino acids and nucleotide. (15 Lectures)

- A Metabolism of lipids: Breakdown of triacylglycerol, β -oxidation (e.g. palmitic acid), biosynthesis of fatty acids, biosynthesis of cholesterol.
- B Metabolism of Amino acids: General reactions of amino acid metabolism (transamination, deamination and decarboxylation), outline of amino acid synthesis and breakdown (w.r.t. carbon skeleton), urea cycle.
- C Metabolism of nucleotide: Introduction to denovo biosynthesis (with role of aminopterin) and salvage pathway (with special emphasis on HGPRT), sources of atoms of nucleotide structure.

References:

- 1) Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
- 2) Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- 3) Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGrawHill Companies Inc.
- 4) Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
- 5) Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.
- 6) Biochemistry – U. Satyanarayan

Paper-II: Enzymology

(Course Code BT110)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Basics of enzymology (15 Lectures)

- A Enzyme: Principle of catalysis, types of enzyme (simple and conjugated), coenzymes, active site, activators and inhibitors.

- B Nomenclature of Enzyme: Trival system of nomenclature and classification, IUB system of classification and nomenclature (each class with two examples), enzyme commission number.
- C Factors affecting enzyme activity: substrate concentration, enzyme concentration, pH, temperature; Non-genetic regulation of enzyme activity.

Unit No. 2: Advances in Enzymology (15 Lectures)

- A Enzyme Kinetics: Steady state reaction, Michaelis-Menten equation, Significance of K_m and V_{max} , Lineweaver Burk plot.
- B Isoenzymes: Reasons for existence of isoenzyme, isoenzymes of lactate dehydrogenase and its application in disease diagnosis. Allosteric enzymes.
- C Enzyme Immobilization: Advantages, support/matrix, types of immobilization (adsorption, covalent bonding, ionic interaction, cross-linking, gel entrapment), applications.

References:

- 1) Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
- 2) Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- 3) Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGrawHill Companies Inc.
- 4) Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
- 5) Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.
- 6) Biochemistry – U. Satyanarayan

Subject Code: DSC 2B (Total 4 Credits);
Subject Name: Cell Physiology and Bioinstrumentation

Paper-I: Cell Physiology

(Course Code BT111)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Cell communication and Cell recognition (15 Lectures)

- A General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, cell-ECM interactions, integrins, neurotransmission 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 Cell structure and function in different systems – Cells involved in the functioning of systems -Digestive, circulatory, respiratory, excretory and nervous system.

Unit No. 2: Membrane and microbial physiology (15 Lectures)

- 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 - Growth yield and characteristics, strategies of cell division, stress response

References:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 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. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Stanier R Y General microbiology

Paper-II: Bioinstrumentation

(Course Code BT112)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Spectroscopy, Electrophoresis and Imaging Techniques (15 Lectures)

- A Beer Lambert's law - Colorimeter and its applications. Spectrophotometer-Principle and its applications. Types of Spectrophotometer- UV, visible.
- B Electrophoresis - Principle and its applications - Types of electrophoresis- Agarose Gel, SDS- PAGE and 2 D Gel, Blotting- Southern, Northern, Western & Immuno blotting. Gel-Documentation.
- C Imaging techniques –Principles and applications of ECG, CT SCAN, MRI SCAN, X-RAY.

Unit No. 2: Centrifugation, Biosensor and Radiotechniques (15 Lectures)

- A Centrifuge - Principle and its applications - ultracentrifugation, Chromatography - Principle and its applications, Types- Paper, TLC.
- B Biosensors- Principle and its applications- Electrochemical, Thermometric Biosensors
- C Autoradiography, GM Counter, Flow Cytometry. Care and Maintenance of Laboratory

Instruments – Autoclave, Incubator and Hot air oven

References:

1. Principles of Biochemistry - L. Stryer (W.H. Freeman & Co.)
2. Principles of Biochemistry - A.L.Lehninger, D.W.Nelson & M.M.Cox(Macmillan)
3. Biochemistry - D.Voet & J.G.Voet (John Willey)
4. Biophysics, Vasant Pattabhi, Gautam (2002), Narosa .
5. Biomembrane structure and Function, Chapman D.
6. Introduction to Biological Membrane, Jain R K
7. Biophysics, Hopp, Lohman, Mark and Ziegler
8. Molecular and Cellular Biophysics, Meyer B Jackson (2006), Cambridge)

Subject Code: DSC 3B (Total 4 Credits);
Subject Name: Plant Physiology and Tissue Culture

Paper-I: Plant Physiology

(Course Code BT113)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Plant Anatomy and Nutrients (15 Lectures)

- 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).
- B **Plant water relations:** Importance of water for plant life, mechanism of water absorption, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, Stomata - mechanism of opening & closing,
- C **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 No. 2: Plant Growth and Physiology (15 Lectures)

- A **Photosynthesis:** Photosynthesis pigments, concept of two photo systems, photophosphorylation, Calvin cycle, 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, gibberlins, 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. Pergmon 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. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4 edition, W.H. Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.
8. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4 edition, Sinauer Associates Inc.MA, USA

Paper-II: Tissue Culture

(Course Code BT114)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Introduction to Tissue Culture (15 Lectures)

- A **Introduction:** History, Laboratory Design, Characteristics of animal Cell in Culture, Substrate for cell growth. Equipment's required for animal cell culture- laminar air flow, CO₂ incubator, Sterilization of apparatus.
- B **Culture Media:** Natural media-Clots, Biological fluids, Serum, Tissue Extract, Synthetic media-Balanced salt Solution, Serum containing media, complete media. Physiochemical 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 No. 2: Process in Tissue Culture (15 Lectures)

- A Methods of organ culture: Plasma clot technique, raft method, agar gel method, Cryopreservation.
- B Establishment of cell lines: Cell line selection, secondary and transformed cell lines. Anchorage dependent of growth, non-anchorage dependent cells, measurement of viability (Evans blue).
- C Cell line Identification by isozymes, Analysis of cell cycle: Tritiated thymidine pulse method, Applications of animal cell culture.

References:

1. Introduction to plant tissue culture- M.K. Razdan
2. Plant tissue culture-Theory & practice-S. S. Bhojwani & M.K. Razdan
3. Plant tissue culture-Kalyankumar Dey
4. Biotechnology- B.D. Singh
5. A text book of Biotechnology- R.C. Dubey
6. Biotechnology- H.S. Chawla

Subject Code: DSC 4B (Total 4 Credits);
Subject Name: Computer Science and Biostatistics

Paper-I: Computer Science

(Course Code BT115)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Basics of Computer **(15 Lectures)**

- A Introduction to Computers: History of Computers, Data, Information and Program, Hardware and Software, Types of Computers
- B Number Systems: Introduction, Bits and Bytes, Decimal Number System, Binary Number System, Hexadecimal Number System, Decimal to Binary Conversion, Conversion of fractional decimal to binary, Conversion of Decimal to Hexadecimal, Octal Representation, Representation of signed numbers
- C Computer Organization: Basic Components of a Digital Computer, Central Processing Unit, Arithmetic and Logic Unit – ALU, Memory Unit, Input and Output Devices

Unit No. 2: Operating and Application Softwares **(15 Lectures)**

- A Operating Systems: Introduction to Operating System (OS).
- B MS-Office (Word, Excel, PowerPoint)- Word Features, Font, Font Style, Formatting, Copying and Pasting, Format Painter, Columns, Page Formatting. Excel- Cell, Cell Address, Formula, Working with Excel, Creating charts, PowerPoint- Preparing presentations (using Clip arts, shapes, moves etc)
- C Internet, Communication Protocol, Future of Internet, Uses of Internet, Popular Uses of the Web. Different types of Search engines, Infilbnet

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 Every One by Alexis Leon and Mathews Leon; Vikas Publishing House Pvt. Ltd., Jungpura, New Delhi
5. A First Course in Computer 2003 Edition with CD 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 Information Technology by Leon and Leon; Vikas Publishing House Pvt. Ltd., Jungpura, New Delhi

Paper-II: Biostatistics

(Course Code BT116)

Total Credit: 02

Total Theory Lectures: 30

Unit No. 1: Fundamentals of Statistics **(15 Lectures)**

- A Introduction: Importance and application, Tabulation and classification of Data, Frequency distribution, Diagrammatic and Graphical representation of data (problems).
- B Measures of central tendencies: Measures of central tendencies (with problems): Mean median and mode, their properties (with problems).
- C Measures of dispersion: Measures of dispersion - Range, mean deviation, Variance, Standard deviation

Unit No. 2: Parametric Test in Statistics

(15 Lectures)

- A Coefficient of variation, Correlation and linear regression (with problems)
- B Probability: Definition of probability and distributions, concept and problems on probability, binomial, Poisson and normal distribution and their applications
- C Hypothesis testing: parametric and non parametric tests, t and z tests, chi-square tests, Analysis of variance (ANOVA)

References:

1. Fundamentals of Biostatistics: Khan and Khanum; Ukaaz Publication.
2. Statistical Methods in Biology: Baily, N.T.J; English University Press
3. Statistics in Biology: Bliss C. I; MacGraw Hill, New York
4. Statistic for Biologists: 2nd Edition; Campbell R.C.; University Press, Cambridge
5. Statistical Methods: Gupta S. P.; Sultan Chand and Sons, New Delhi
6. test book of biostatistics- khumbhojkar

**PRACTICAL COURSE IN BIOTECHNOLOGY FOR B.Sc.–I FOR BOTH
SEMESTER I AND II**

Practical Course I: Based on DSC 1 A & 1B (Chemistry, Biochemistry, Metabolism and Enzymology)

Course Code: BP01

(Credits 4; 100 Marks)

Based on Chemistry	
1.	To determine viscosity of given liquids.
2.	Preparation of Molarity, normality and percentage solutions.
3.	Determination of conductivity of solution.
4.	Determination of an order of reaction.
5.	Preparation of buffers (Phosphate buffer, acetate buffer).
Based on Biochemistry	
6.	Qualitative analysis of carbohydrates
7.	Qualitative analysis of amino acids
8.	Qualitative analysis of lipids
9.	Determination of titration curve of amino acids
10.	Determination of acid value of fat/oil
Based on Metabolism	
11.	Estimation of glucose by DNSA method.
12.	Estimation of protein by biuret method.
13.	Estimation of blood urea level by DAM method.
14.	Estimation of DNA by spectroscopy method.
15.	Estimation of blood cholesterol by Zak's method.
Based on Enzymology	
16.	Determination of enzyme activity (amylase/invertase)
17.	Study the effect of pH on enzyme activity.
18.	Study the effect of temperature on enzyme activity.
19.	Study the effect of activator/inhibitor on enzyme activity.
20.	Electrophoretic separation of lactate dehydrogenase

Practical Course II: Based on DSC 2A & 2B (Biophysics, Cell Biology, Cell Physiology and Bioinstrumentation)

Course Code: BP02

(Credits 4; 100 Marks)

Based on Biophysics	
1.	Study of Lambert's & Beer's law
2.	Study of UV spectra of protein/DNA
3.	Purification of substances by Dialysis
4.	Measurement of viscosity by Ostwald's viscometer
5.	Surface tension measurement by Jaegers method
Based on Cell Biology	
6.	Study of animal cell and plant cell structure under microscope.
7.	Isolation of chloroplast from plant material.
8.	Observation of mitochondria under microscope by Janus Green B staining method.
9.	Study of cell division under microscope (mitosis / meiosis)
10.	Measurement of cell size by micrometry.
Based on Cell Physiology	
11.	Study of membrane permeability.
12.	Study of histology of stomach/ileum/liver/pancreas/kidney.
13.	Study of effect of adrenalin and atropine sulphate on chromatophores.
14.	Study of chemotaxis in bacteria.
15.	Study of bacterial growth curve.
Based on Bioinstrumentation	
16.	Washing of glassware & sterilization techniques.
17.	Study of differential centrifugation for separation of cell fractionates.
18.	Separation of amino acids by thin layer chromatography
19.	To study use & care of Compound microscope, pH electrodes etc.
20.	Visit any nearest hospital to understand imaging techniques.

Practical Course III: Based on DSC 3A & 3B (Animal Physiology, Developmental Biology, Plant Physiology and Tissue Culture)

Course Code: BP03

(Credits 4; 100 Marks)

Based on Animal Physiology	
1.	Qualitative analysis of abnormal constituents of urine.
2.	Finding the coagulation time of blood
3.	Determination of blood groups
4.	Determination of Haemoglobin content
5.	Determination of Total Leukocyte Count.
Based on Developmental Biology	
6.	Study of sperm morphology by smear technique
7.	To perform sperm motility test and sperm counting.
8.	Study of style and stigma
9.	Study of floral patterning in any suitable flower
10.	Study of pollen germination by T.T.C. or Acetocarmine test
Based on Plant Physiology	
11.	Demonstration of Osmosis
12.	Separation of photosynthetic pigments by paper chromatography
13.	Demonstration of transpiration
14.	Study of T.S. of leaf
15.	Preparation of stained mounts of anatomy of monocot and dicot's root/stem.
Based on Tissue Culture	
16.	Animal cell culture media preparation.
17.	Plant tissue culture media preparation.
18.	Separation of serum & plasma from blood by centrifugation technique
19.	Isolation of explant & establishment of callus
20.	Cell Separation by Trypsinization

Practical Course IV: Based on DSC 4A & 4B (Ecology, Biotechnology in Human Welfare, Computer Science and Biostatistics)

Course Code: BP04

(Credits 4; 100 Marks)

Based on Ecology	
1.	To determine the minimum size of the quadrat by species area-curve method.
2.	To study communities by quadrat method and to determine % Frequency, Density and Abundance
3.	Estimation of CO ₂ content in water.
4.	Estimation of O ₂ in water by Wrinckler's method
5.	Testing of hardness of water.
Based on Biotechnology in Human Welfare	
6.	Study and preparation of Watson and Crick Model of DNA.
7.	Qualitative analysis of milk by Methylene Blue Reduction Test.
8.	Synthesis of silver nanoparticles by biological method.
9.	Study of vermicompost/vermiwash
10.	Applications of remote sensing in precision agriculture.
Based on Computer Science	
11.	Preparing letter /purchase order chart/ designing registration form/ bio-data using MS-Word
12.	Creating email Id and sending email
13.	Preparing presentation with PowerPoint- on bio-technology subject
14.	To study different types system hardwares
15.	Preparation of excel sheet for calculation purpose
Based on Biostatistics	
16.	Measures of central Tendency (on MS-Excel): To calculate mean, median and mode
17.	Measures of dispersion (by calculation): To calculate mean deviation, standard deviation, and variance
18.	Diagrammatic representation of data (on MS-Excel): Pie chart/ / Simple /Multiple bar diagram/Sub-divided/percentage bar diagram.
19.	Graphical representation of data (on MS-Excel): Simple line graph/ Histogram / Ogive Curve.
20.	Carry out an ANOVA using biological problems

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Equivalent Subject for Old Syllabus

Sr. No.	Name of the Old Paper	Name of the New Paper
1	Paper-I: Chemical Sciences	Paper- I: Chemistry
2	Paper-I Biochemistry	Paper-II: Biochemistry
3	Paper-II: Biophysics	Paper-I: Biophysics
4	Paper-I: Cell Biology-I	Paper-II: Cell Biology
5	Paper-I: Mammalian Physiology-I	Paper-I: Animal Physiology
6	Paper-I: Developmental Biology-I	Paper-II: Developmental Biology
7	Paper-II Developmental Biology-II	Paper-I: Ecology
8	Paper-II: Mammalian Physiology-II	Paper-II: Biotechnology in Human Welfare
9	Paper-II Metabolism	Paper-III: Metabolism
10	Paper-II: Plant Physiology-II	Paper-IV: Enzymology
11	Paper-II: Cell Biology-II	Paper-III: Cell Physiology
12	Paper-II: Plant Tissue Culture	Paper-IV: Bioinstrumentation
13	Paper I: Plant Physiology-I	Paper-III: Plant Physiology
14	Paper-I: Animal Tissue Culture	Paper-IV: Tissue Culture
15	Paper-I: Computer	Paper-III: Computer Science
16	Paper-II Biostatistics	Paper-IV: Biostatistics

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Nature of Question Paper

For Choice Based Credit System (CBCS) Semester Pattern

Faculty of Science (w.e.f. June 2022 for B.Sc. I and from June 2023 B.Sc. II)

Time: 2 Hrs.

Total Marks - 40

Instructions: (Instructions may differs for course to course)

1. All questions are compulsory.
 2. Draw neat diagrams and give equations wherever necessary.
 3. Figures to the right indicate full marks.
 4. Use of non-storage calculator is allowed.
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Q. No. 1	Multiple Choice Questions (8 out of 8)	(08 marks)
	a) b) c) d)	
	1)	
	2)	
	3)	
	4)	
	5)	
	6)	
	7)	
	8)	
Q. No. 2	Answer the following (4 out of 5)	(08 marks)
	1)	
	2)	
	3)	
	4)	
	5)	
Q. No. 3	Write Short Notes (2 out of 3)	(08 marks)
	1)	
	2)	
	3)	
Q. No. 4	Answer the following (2 out of 3)	(08 marks)
	1)	
	2)	
	3)	
Q. No. 5	Answer the following (1 out of 2)	(08 marks)
	1)	
	2)	