Programme Outcome (PO)

PO-1: Knowledge and Problem Solving: Acquire in-depth scientific knowledge of their discipline both in theory and practical, demonstrate basic skills, investigate, apply, and solve the problems in a variety of contexts related to science and technology.

PO-2: Communication and Teamwork: Develop skills to communicate effectively to diverse platforms and contribute meaningfully to different capacities as a leader, team member or individual.

PO-3: Modern tools and techniques for Scientific Experiments: Apply modern tools and techniques to carry out scientific experiments accurately, record, analyze and predict the result for valid conclusion with clear understanding of limitations.

PO-4: Logical thinking: Develop logical thinking and expertise with precision, analytical mind, innovative thinking, clarity of thought, and systematic approach for proving or disproving the facts after mathematical formulation. with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach

PO-5: Skill development and Employability: develop elementary computing and soft skills to prepare students for industry, entrepreneurship and higher education with precision, analytical mind, innovative thinking, clarity of thought, expression, and systematic approach.

PO-6: Ethics and citizenship: Able to recognize different value systems and ethical principles; and commit to professional ethics, norms, and responsibilities of the science practice and act with informed awareness to participate in civic life activities.

PO-7: Society, Environment and Sustainability: Enhance ability to elicit views of others and understand the impact of various solutions in the context of societal, economic, health, legal, safety and environment for sustainable development.

PO-8: Life-long learning: Acquire fundamental knowledge for lifelong learning to participate in the extensive context of socio-technological change as a self-directed member and a leader.

Programme Specific Outcomes (PSO)

PSO-1: To acquire sound knowledge in the key areas of biology.

PSO-2: To develop global competencies in the area of basic and applied biological sciences.

PSO-3: To conceptualize and apply biotechnology skills in molecular & microbiology, immunology & genetic engineering, bio-process & fermentation, enzyme & food technology and bioinformatics fields and its execution in core and allied fields.

PSO-4: To impart in-depth practical/project-based knowledge to students in various emerging areas of biotechnology to meet the industry and academic needs.

PSO-5: To acquire technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology.

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

School of Science, Department of Biotechnology

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Scheme of B. Sc. Hons. in Biotechnology [03UG024]

Sem.	CC (14)	Credit	AEC C (2)	Credit	SEC (2)	Credit	VA (2)	Credit	DSE (4)	Credit	GE (4)	Credit	Total Credit
1	CC I	6	AEC C I	2	SEC I	2					GE I	6	**22**
	CC II	6											
2	CC III	6	AEC C II	2	SEC II	2					GE II	6	**22**
	CC IV	6											
3	CC V	6			SEC III	2					GE III	6	**26**
	CC VI	6											
	CC VII	6											
4	CC VIII	6			SEC IV	2	VA I	2			GE IV	6	**28**
	CC IX	6											
	CC X	6											
5	CC XI	6					VA II	2	DSE I	6			**26**
	CC XII	6							DSE II	6			
6	CC XIII	6					VA III	2	DSE III	6			**26**
	CC XIV	6							DSE IV	6			

SCHEME OF TEACHING AND EXAMINATION

For CC, DSE and GE Subject (6 credit)

- Theory (4 periods/week) + Lab (4 periods/week)
  Or
- Theory (5 periods/week) +Tutorial (1 periods/week)

SN	Subject Code	Category	Name of Subject	Periods per week			Scheme of Examination and Marks							Credits: L+ (T+P)/2
				L	T	P	Theory			Practical			Total Marks	
							Mid Sem	TA	ESE	Mid Sem	TA	ESE		
1		CC / DSE / GE	Theory (4) + Lab (4)	4	0	4	30	20	50	-	25	25	150	6
OR														
2		CC / DSE / GE	Theory (5) + Tutorial (1)	5	1	0	45	30	75	-	-	-	150	6

For Project /Dissertation

SN	Subject Code	Category	Name of Subject	Periods per week			Scheme of Examination and Marks							Credits: L+ (T+P)/2
				L	T	P	Theory			Practical			Total Marks	
							Mid Sem	TA	ESE	Mid Sem	TA	ESE		
1		DSE	Project / Dissertation	0	0	12	-	-	-	-	75	75	150	6

For AECC and SEC Subject (2 credit)

1. Theory (2) Or Lab (4)

SN	Subject Code	Category	Name of Subject	Periods per week			Scheme of Examination and Marks							Credits: L+ (T+P)/2
				L	T	P	Theory			Practical			Total Marks	
							Mid Sem	TA	ESE	Mid Sem	TA	ESE		
1		AECC / SEC	Theory (2)	2	0	0	-	25	25	-	-	-	50	2
OR														
2		AECC / SEC	Lab (4)	0	0	4	-	-	-	-	25	25	50	2

For VA Subject (3 credit)

SN	Subject Code	Category	Name of Subject	Periods per week			Scheme of Examination and Marks							Credits: L+ (T+P)/2
				L	T	P	Theory			Practical			Total Marks	
							Mid Sem	TA	ESE	Mid Sem	TA	ESE		
1		VA	Theory (3)	3	0	0	30	20	50	-	-	-	100	3

Core Course (CC) Papers: (06 Credits each)

1. CC I: Cell Biology[SOS-B-BT101**]** / NPTEL Course
2. CC II: Chemistry [SOS-B-BT102**]**
3. CC III: Mammalian Physiology [SOS-B-BT201**]** / NPTEL Course
4. CC IV: Plant Physiology [SOS-B-BT202**]**
5. CC V: Classical Genetics [SOS-B-BT301**]**
6. CC VI: General Microbiology [SOS-B-BT302**]**
7. CC VII: Biochemistry [SOS-B-BT303**]**
8. CC VIII: Molecular Biology [SOS-B-BT401**]**
9. CC IX: Immunology [SOS-B-BT402**]**
10. CC X: Environmental Biotechnology [SOS-B-BT403**]** / NPTEL Course
11. CC XI: Bioprocess Technology [SOS-B-BT501**]** / NPTEL Course
12. CC XII: Recombinant DNA Technology [SOS-B-BT502**]**
13. CC XIII: Bio analytical tools [SOS-B-BT601**]** / NPTEL Course
14. CC XIV: Proteomics and Genomics [SOS-B-BT602**]**

Discipline Specific Elective (DSE) Papers: (06 Credits each)

For Vth Semester: One paper from each DSEI and DSE II

For VIth Semester: One paper from each DSE III and DSE IV

1. DSE-I : (i) [SOS-B-BT503 (i)]: Bioinformatics
   (ii) [SOS-B-BT503 (ii)]: Intellectual Property Right, Bioethics & Biosafety
   (iii) [SOS-B-BT503 (iii)]: Ecology and Environment Management
2. DSE-II: (i) [SOS-B-BT504 (i)]: Pharmaceutical Microbiology
   (ii) [SOS-B-BT504 (ii)]: Medical Microbiology
   (iii) [SOS-B-BT504 (iii)]: Industrial Fermentation
3. DSE-III: (i) [SOS-B-BT603 (i)]: Industrial Chemistry
   (ii) [SOS-B-BT603 (ii)]: Biotechnology and Human Welfare
   (iii) [SOS-B-BT603 (iii)]: Developmental Biology
4. DSE-IV: (i) [SOS-B-BT604 (i)]: Project / Dissertation / Internship
   (ii) [SOS-B-BT604 (ii)]: Plant Diversity
   (iii) [SOS-B-BT604 (iii)]: Animal Diversity

Note: Batch Size should not be less than 10 students for choosing a DSE subject

Generic Elective (GE) Papers: (06 Credits each) GE I - IV

1. GE I: Biostatistics[SOS-B-BT103]
2. GE II: Entrepreneurship Development[SOS-B-BT203]
3. GE III: Nutraceuticals and Food Processing [SOS-B-BT304**]**
4. GE IV: Plant & Animal Biotechnology [SOS-B-BT404**]**

Ability Enhancement Compulsory Course (AECC): (02 Credits each) AECC I – II

1. Communicative English (2) (SOS-B-AE101)
2. Environmental Science (2) (SOS-B-AE201)

Skill Enhancement Courses (SEC): (02 Credits each) SEC I – IV

1. Computer Fundamentals (SOS-B-SE101)
2. Disaster Management (SOS-B-SE201)
3. Professional Development (SOS-B-SE301)/ NPTEL Course
4. Basics of Forensic Science (SOS-B-SEB401)

Value Added Courses (VA): (02 Credits each) VA I – III

1. Indian Knowledge System (SOS-B-VA401)
2. The One Thing and Extreme Ownership (SOS-B-VA501)
3. Public Administration(SOS-B-VA601)

Generic Elective (GE) Papers (Minor-Biotechnology): (Those who choose Biotechnology as generic elective, 06 Credits each) GE I – IV

1. GEI: Cell Biology[SOS-B-BT101]
2. GEII: Physiology[SOS-B-BT204]
3. GEIII: Biochemistry [SOS-B-BT303]
4. GEIV: Environmental Biotechnology [SOS-B-BT403]

NPTEL Courses: List (Semester I to Semester VI)

S No	Semester	Course Code	Name of the Course	Category
1	I	noc23-bt50	Introduction to Cell Biology	CC
2	II	noc23-bt67	Animal Physiology	CC
3	III	noc23-bt70	Biomedical Nanotechnology	SEC
4	IV	noc23-bt60	Environmental Biotechnology	CC
5	V	noc23-bt61	Industrial Biotechnology	CC
6	VI	noc23-bt56	Experimental Biotechnology	CC

CC: Core Course DSE: Discipline Specific Elective

AECC: Ability Enhancement Compulsory Course

GE: Generic Elective

SEC: Skill Enhancement Course

VA: Value Added Course

Note: [SOS-B-BT604 (i)]: Project / Dissertation / Internship: Will of 45 Days to be start just after Vth Semester End Examination.

Credit	6	No. Of Hours	8 Hours/Week
Max Marks	150		

COURSE DESCRIPTION:

Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles of a cell. Student will understand how these cellular components are used to generate and utilize energy in cells. Students will understand the cellular components underlying mitotic cell division. Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes or alterations of cell function brought about by mutation.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	This course will introduce the students to the basics of cell and its components. This will help them to comprehend detail knowledge about cell and its different types.
CO2	This gives them a strong foundation on the basics of cell membrane and its permeability. It will help them understand about various processes of cell motility.
CO3	Students will acquire the knowledge of structure and functions of various cell organelles and their interaction within cell to promote cell growth, division and development.
CO4	The student will gain in depth knowledge about cellular architecture and its extracellular matrix.
CO5	The student has a general idea about cancer and the mechanisms responsible for causing cancer.

SYLLABUS:

UNIT I: Introduction to Cell Biology

Introduction and History of Cell Biology, Cell Theory, Application of Cell Biology in other Biological Branches (Cytotaxonomy, Cytogenetics, Cell Physiology, Cytochemistry, Cytomolecular Biology, Cytopathology, Cytoecology). Classification of organisms by cell structure, Unit of Measurement of Cell, Cytosol, compartmentalization of eukaryotic cells, cell fractionation, .

UNIT II: Cell Membrane & Cell Motility

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

UNIT III: Cell Organelles (I)

Endoplasmic reticulum: Structure, function including role in protein segregation.

Golgi complex: Structure, biogenesis and functions including role in protein secretion.

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

UNIT IV: Cell Organelles (II)

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

UNIT V: Extracellular Matrix & Cancer

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics of cancer.

PRACTICAL

1. Study of structure of any Prokaryotic and Eukaryotic cell.
2. Study of plasmolysis and de-plasmolysis.
3. Study the effect of temperature and organic solvents on semi permeable membrane.
4. Demonstration of dialysis.
5. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
6. Cell division in onion root tip/ insect gonads.
7. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READING

1. Verma P.S., Agarwal V.K. Cell Biology, S Chand Publication
2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
3. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. 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.

CO-PO & PSO CORRELATION

Course Name: Cell Biology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		1						3	1	2	1	1
CO2	2		1						3	1	1	1	1
CO3	2		1						3	1	1	1	1
CO4	2		1						3	2	1	1	1
CO5	2		2				1		3	1	1	1	1

Note: 1- Low, 2-Moderate, 3-High

Programme:	B.Sc. Hons. Biotechnology	Semester	I
Name of the Course	Chemistry	Course Code	SOS-B-BT102
Credit	6	No. Of Hours	8 Hours/Week
Max Marks	150		

COURSE DESCRIPTION:

To introduce the basic concepts and principles of general chemistry, and be familiarized with the principles, fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO 1	Learn about the principle, methodology, calculation and application involved in quantitative, chemical and spectrophotometric methods.
CO 2	Learn the essential concepts of chirality, configuration, isomerism in organic chemistry, nomenclature of isomers with the elementary concept of saturated aliphatic hydrocarbons reactions
CO 3	Learn about the fundamentals of organic chemistry with references to structure and reactivity, reagents and reactions & reaction and mechanism.
CO 4	Learn about ionic, covalent bonding in molecules compare/contrast the properties of molecular and ionic compounds.
CO 5	Learn the elementary concepts of ionic chemical equilibrium with respect to acid – base, salt hydrolysis and solubility of ionic substances, including the IUPAC nomenclature, stereochemistry, structures, reactivity, and mechanism of the chemical reactions.

SYLLABUS

Unit I : Quantitative methods

Significant figures. Mole concept. Empirical and molecular formula. Molar and molal solutions, mole fraction, ppm and ppb solutions. Stoichiometry and calculations based on it involving acid-base, precipitation, redox, and complex formation reactions. Chemical methods: Principle, methodology and calculations involved in for dissolved oxygen (Winkler method), biological oxygen demand, chemical oxygen demand, and hardness of water. Determination of nitrogen in proteins (Kjeldahl method). Spectrophotometric methods: Determination of ammonia (by indophenol formation), nitrate (by nitrophenol formation), nitrite (by azo dye formation), and phosphorus (by molybdenum blue formation).

Unit II: Chemical bonding and molecular structure

Kossel-Lewis theory, octet rule, electrovalent and covalent bond. Formal charge. Polarity of bonds. The valence shell electron pair repulsion (VSEPR) theory, its postulates and geometry of molecules. Valence bond theory, orbital concept, hybridisation (sp, sp2, sp3, sp3d and sp3d2). Molecular orbital theory.

Linear combination of atomic orbitals (LCAO). Types and energy level diagram of molecular orbitals. Bond order. Bonding in homonuclear diatomic molecules. Magnetic properties.

Unit III: Fundamental organic chemistry

Structure and reactivity. Inductive and electromeric effects. Tautomerism, hyperconjugation and resonance. Intramolecular and intermolecular hydrogen bonding. Structure and stability of carbocations, carbanions and free radicals. Relative strength of organic carboxylic acids, phenols and amines. pKa and pKb values.

Reagents and reactions. Periodic acid, Grignard reagent, ethyl acetoacetate and diethyl malonate.

Reaction and mechanism. Claisen condensation, Benzoin condensation, Perkin reaction, Pinacol-pinacolone rearrangement,

Unit IV: Stereochemistry of organic compounds

Conformations. Fisher, sawhorse and Newman structures. IUPAC nomenclature of conformational isomers. Conformations and their analysis of ethane, n-butane, cyclohexane and decalins.

Configurations. Chirality. Elements of symmetry. Optical activity, specific rotation. Enantiomers, diastereomers, and meso compounds. Racemic modification. Thereo and erythro compounds. R and S configuration, sequence rules. Geometrical isomerism, E and Z nomenclature.

Stereochemical aspects of chemical reactions. Addition of bromine to Z- and E-butene. E2 reactions.

Unit V: Ionic equilibria

Ostwald dilution law and its experimental verification. Application of Ostwald dilution law. Ionization of water. The pH value, relation between pH and pOH, the pH scale (numerical problems). The salt hydrolysis, and application to (i) salts of strong acids and strong bases, (ii) salts of weak acids and strong bases, (iii) salts of strong acids and weak bases, and (iv) salts of weak acids and weak bases. Hydrolysis constant and degree of hydrolysis.

Buffer solutions. Solubility and solubility product of sparingly soluble salts. Applications of solubility product principle.

PRACTICAL

1. Determination of hardness of water by titration with EDTA.
2. Determination of dissolved oxygen in environmental waters by the Winkler method.
3. Determination of strength of a solution of sulphuric acid by titration with sodium hydroxide using pH meter.
4. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given colored compound ($KMnO_4$/$CuSO_4$) and estimate the concentration of the same in a given solution.
5. To verify Beer-Lambert law for $KMnO_4$/$K_2Cr_2O_7$ and determine the concentration of the given solution of the substance.
6. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos, and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
7. Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide
   (iii) Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

SUGGESTED READING

1. G.D. Christian, Analytical Chemistry John Wiley & Sons (Asia), Singapore
2. D.S. Skoog, D.M. West, F.J. Holler and S.R. Cruch, Fundamentals of Analytical Chemistry Thomson, Singapore.
3. R.T. Morrison and R.N. Boyd, Organic Chemistry Pearson Education, Delhi.
4. P.Y. Bruice, Organic Chemistry, Pearson Education, Delhi.
5. P.Sykes, A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi.
6. A. Bahl, B.S. Bahl and G.D. Tuli, Essentials of Physical Chemistry, S. Chand & Company Ltd, New Delhi.

CO-PO & PSO CORRELATION

Course Name: Chemistry													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1		1						1	1			1
CO2	1		1						1				1
CO3	1		1						1				1
CO4	1		1						1	1			1
CO5	1		1				1		1				1

Note:1: Low 2.: Moderate 3: High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**II**
Name of the Course	**Mammalian Physiology**	**Course Code**	**SOS-B-BT201**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description

Mammalian Physiology is the study of how higher animals work. In this course, we will learn about the structures and functions that allow mammals to adapt and survive in different ecosystems around the world. This course examines the physiology of animals at the molecular, cellular, system and organism levels. Therefore, the proper studying of animal physiology is crucial for understanding and evaluating underlying biological processes, behavioral stats and animal response to different biological, social and environmental stimuli.

Course Outcomes:

On successful completion of this course, students will be able to

CO Number	Course Outcome
CO1	Students will be able to explain the physiological function of digestion in mammals.
CO2	Using one or more model systems, students will be able to integrate the regulation of organ system functions in a whole animal using a conceptual model of feedback to explain circulation and haemopoisis..
CO3	Using one or more model systems, students will be able to explain structure-function relationship of respiratory and excretory system in mammals.
CO4	This will enable students to learn the undergoing chemical and electrical processes of muscle physiology.
CO5	This will enable students to learn the undergoing chemical and electrical processes of nerve impulse and endocrinology.

SYLLABUS:

Unit I: Digestion

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleicacids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice

Unit II: Circulation

Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heartbeat.

Unit III: Respiration and Osmoregulation

Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.
Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

Unit IV: Muscle physiology

Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction.

Unit V: Nervous and endocrine coordination

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters Mechanism of action of hormones (insulin and steroids).
Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.

PRACTICAL

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Demonstration of action of an enzyme
6. Determination of Haemoglobin

SUGGESTED READING

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

CO-PO& PSO CORRELATION

Course Name: Mammalian Physiology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		1						3	1	1		1
CO2	2		1						3	1	1		1
CO3	2		1						2	1	1		1
CO4	2		1						2	1	1		1
CO5	2		2						2	1	1		1

Note:1: Low 2.: Moderate 3: High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**II**
Name of the Course	**Plant Physiology**	**Course Code**	**SOS-B-BT202**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description

This course is an introduction to the physiological processes underlying plant growth and development and plant responses to the environment. An introduction to basic principles of plant function including physical processes occurring in plants, water relations in whole plants and plant tissues, cell physiology and biochemistry, and growth and development.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Students will able to understand the various aspects of plant water relationship.
CO2	The students will able to develop knowledge associated with macro and micro nutrients.
CO3	Students will able to understand principles underlying Carbon and Nitrogen metabolism..
CO4	Students will able to understand the growth and development of plants and role of phytohormones..
CO5	Students will learn the concept of photomorphogenesis and movement by plants.

SYLLABUS:

Unit I: Plant water relations

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, Water potential, transpiration, stomata & their mechanism of opening & closing. Mechanism of absorption of water by root, Ascent of Sap.

Unit II: Micro & Macro nutrients

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: Translocation in the phloem.

Unit II1: Carbon and Nitrogen metabolism

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photphosphorylation, calvin cycle, CAM plants, photorespiration, compensation point.

Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

Unit IV: Plant Growth and Hormones

Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene): Physiological role and mode of action.

Unit V: Photomorphogenesis & Plant Movement

Phytochromes: Forms, phytochome mediated responses, Cryptochrome, Photo-periodism, Vernalization, seed dormancy and seed germination.

Turgor and growth movement, Tropic movement, Tactic movement, Nastic movement.

PRACTICAL

1. Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf.
2. Demonstration of plasmolysis by Tradescantia leaf peel.
3. Demonstration of opening & closing of stomata
4. Demonstration of guttation on leaf tips of grass and garden nasturtium.
5. Separation of photosynthetic pigments by paper chromatography.
6. Demonstration of aerobic respiration.
7. Preparation of root nodules from a leguminous plant.

SUGGESTED READING

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 Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4th 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, 4th edition, Sinauer Associates Inc .MA, USA

CO-PO & PSO CORRELATION

Course Name: Plant Physiology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1		1				1		3	1	1		1
CO2	1		1				1		3	1	2		1
CO3	1		1				1		3	1	2		1
CO4	1		1				1		3	2	2		1
CO5	1		1				1		3	1	1		1

Note:1: Low 2.: Moderate 3: High

Programme:	B.Sc. Hons. Biotechnology	Semester	III
Name of the Course	Classical Genetics	Course Code	SOS-B-BT301
Credit	6	No. Of Hours	8 Hours/Week
Max Marks	150		

Course Description

The purpose of this course is to provide the student with the basic principles of genetics. It includes physical basis of inheritance, the mechanics of inheritance, probability, sex chromosomal abnormalities, autosomal anomalies, gene structure and function, molecular genetics, behavioral genetics, twinning and contemporary issues in genetics.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Students will learn the basic history of genetics. This will help them to study in detail about different laws on which genetics work.
CO2	The students will gain depth knowledge of interactions between genes, to understand both the structure and function of genetic pathways and the evolutionary dynamics of complex genetic systems.
CO3	Students will study the detailed structure of Chromosome. They will also be aware about the packaging of DNA within the chromosome with its basic mechanism. This will also help in gaining the knowledge of functional and nonfunctional part of chromosome for information flow.
CO4	Students will acquire knowledge about the molecular mechanisms underlying mutations, detection of mutations and DNA damage and repair mechanisms.
CO5	This will help the students to gain the knowledge of sex linked chromosome, their role in sex determination and inheritance
CO6	Students will learn the concept of recombination, linkage mapping and elucidate the gene transfer mechanisms in prokaryotes and eukaryotes.

SYLLABUS:

UNIT I: Introduction & Mendelian genetics

Historical developments in the field of genetics, Mendelian genetics: Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance.

UNIT II: Allelic and Non allelic interactions

Allelic interactions: Concept of dominance, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity. Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

UNIT III: Chromosome

Concept of euchromatin and heterochromatin, packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT IV: Mutation & Sex determination

Gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, variations in chromosomes structure, chromosomal aberrations in human beings, abonormalities: Aneuploidy and Euploidy. Sex determination and sex linkage: Mechanisms of sex determination, sex differentiation, Barr bodies, dosage compensation, sex linked inheritance.

UNIT V: Crossing over & Inheritance

Genetic linkage, crossing over and chromosome mapping: Cytological basis of crossing over, Molecular mechanism of crossing over, Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance. Evolution and population genetics, Hardy Weinberg law, natural selection.

PRACTICAL

1. Experiments on monohybrid, dihybrid, test cross and back cross.
2. Mendelian deviations in dihybrid crosses.
3. Determination of linkage and cross over analysis
4. Sex determination by Barr body.
5. Karyotyping with the help of photographs.
6. Pedigree charts of some common characters like blood group, color blindness etc.

SUGGESTED READING

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons In
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Verma, P.S., Agarwal V.K., (2006). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. XXVI Edition S Chand & Company ltd.

CO-PO& PSO CORRELATION

Course Name: Classical Genetics													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		1						3	2	3	2	2
CO2	3		2						3	2	2	2	2
CO3	3		2						3	2	2	2	2
CO4	3		2						3	2	2	2	3
CO5	3		2						3	2	3	2	3

Note: 1- Low, 2-Moderate, 3-High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**III**
Name of the Course	**General Microbiology**	**Course Code**	**SOS-B-BT302**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description

This course introduces the basic principles of microbiology examining the microbes that inhabit our planet and their effect on the biosphere. Introduction to Microbiology explores this impact through the lens of all areas of microbiology. Students will assess the influence of microbiology and 21st century challenges and opportunities that arise from our changing relationship with and understanding of microbes.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Students will able to understand the various aspects of morphology and cell structure of microorganisms: Bacteria, Algae, Fungi, and Protozoa and Unique features of viruses.
CO2	The students will able to develop skills associated with screening, cultivation and maintenance of microorganisms
CO3	Students will able to understand principles underlying factors affecting growth of bacteria.
CO4	Students will able to understand the Transformation, Transduction and Conjugation.
CO5	Students will learn the concept of food and water related microbiology.

SYLLABUS:

UNIT I: History & classifications of Microbiology

Fundamentals, history and evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization, Prokaryotic and Eukaryotic cells, Morphology and cell structure of microorganisms: Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II: Cultivation & control of microorganisms

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation, staining techniques. Control of Microorganisms: physical, chemical and chemotherapeutic agents.

UNIT III: Microbial growth

Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

UNIT IV: Microbial metabolism & genetic variation

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways, Methods of genetic variation: Transformation, Transduction and Conjugation. Endospore and sporulation in bacteria.

UNIT V: Water & Food Microbiology

Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal, Food Microbiology: Important microorganism: Molds, Yeasts, bacteria. Major food borne infections and intoxications, Preservation of various types of foods. Fermented foods.

PRACTICAL

1. Preparation of media & sterilization methods.
2. Isolation of bacteria from different sources.
3. Isolation of Fungi from suitable source.
4. Staining methods: simple staining, Gram staining, spore staining, and negative staining.
5. Determination of bacterial cell size by micrometry.
6. Enumeration of microorganism - total & viable count.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4th edition. John and Sons,Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7thedition, CBS Publishers and Distributors, Delhi,India.
3. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
4. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
6. Tortora GJ, Funke B R, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

CO-PO & PSO CORRELATION

Course Name: General Microbiology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		2				1		2	2	3	2	2
CO2	3		3						2	2	2	2	3
CO3	3		2				1		2	2	3	2	3
CO4	3		2						2	2	2	2	2
CO5	3		2				1		2	2	2	2	2

Note: 1- Low, 2-Moderate, 3-High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**III**
Name of the Course	**Biochemistry**	**Course Code**	**SOS-B-BT303**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description

Biochemistry, involves the study of the molecular composition of living cells, the organization of biological molecules within the cell, and the structure and function of these biological molecules. The biological macromolecules which this course focuses on are proteins, polysaccharides, and Lipid including the monomeric units of these macromolecules. The coarse also includes introduction to enzymes and the inhibition mechanisms.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Students will able to understand the concept of thermodynamics, interactions among th biomolecules and introduction to metabolic activities.
CO2	Students will able to develop skills associated with the types and functions of Carbohydrates.
CO3	Students will able to understand principles underlying proteins and its building mechanisms.
CO4	Students will able to understand the biomolecules Lipid and vitamins.
CO5	Students will learn the introductory concept of Enzymology .

SYLLABUS:

UNIT I: Bioenergetics

Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction), Laws of thermodynamics, Gibbs free energy, endergonic & exergonic reactions, Standard state free energy changes, High energy compounds. Introduction to Metabolism – Catabolism and Anabolism.

UNIT II: Carbohydrates

Families of monosaccharide: aldoses and ketoses, Classification of monosaccharides. Isomerism of monosaccharides: Structural and Stereoisomers; Geometrical and optical stereoisomers, epimers, Mutarotation and anomers. Formulations of monosaccharide: Furanose and pyranose forms, Haworth projection formula, chair and boat forms. Disaccharides: concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose. Polysaccharides: Homopolysaccharides: starch, cellulose, glycogen and chitin, Heteropolysaccharides: peptidoglycan, and Hyaluronic acid.

UNIT III: Amino acids & Proteins

Amino acids: General formula of amino acid and concept of zwitterions, titration curve of amino acid and it's Significance, Classification, Ninhydrin reaction. Peptide unit and its salient features. Proteins: Types of proteins and their general functions,. Different Level of structural organization of proteins: primary, secondary (alpha helix and beta pleated sheet), tertiary and quarternary. Forces stabilizing protein structure and shape.

UNIT IV: Lipids and Vitamins

Lipids: Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipid, sphingolipid, glycolipids, cerebrosides, Gangliosides, Prostaglandins, Cholesterol. Vitamins: Fat soluble and Water soluble Vitamins, importance and Deficiency.

UNIT V: Enzymes

Nomenclature and classification of Enzymes, Holoenzyme, Apoenzyme, Cofactors: coenzyme, prosthetic groups, metalloenzymes, activation energy and transition state, active sites, Lock and key hypothesis, and Induced Fit hypothesis, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive and non-competitive.

PRACTICAL

1. Concept of pH using pH meter.
2. Preparation of buffers.
3. Numerical based on Gibb's free energy change.
4. Qualitative tests for Carbohydrates
5. Qualitative tests for lipids
6. Qualitative tests for proteins
7. To study the effect of pH, temperature on the activity of salivary amylase enzyme.

SUGGESTED READINGS

1. Jain JL (2008)Fundamentals of Biochemistry S Chand Publication.
2. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
3. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company.
4. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman & co.
5. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.

CO-PO & PSO CORRELATION

Course Name: Biochemistry													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		1						3	2	3	2	2
CO2	2		1						3	2	2	1	2
CO3	3		1		2				3	2	3	3	2
CO4	3		1						3	2	3	2	2
CO5	3		2		3				3	2	3	3	3

Note: 1- Low, 2-Moderate, 3-High

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

School of Science, Department of Biotechnology

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	B.Sc. Hons. Biotechnology	Semester	IV
Name of the Course	Molecular Biology	Course Code	SOS-B-BT401
Credit	6	No. Of Hours	8 Hours/Week
Max Marks	150		

Course Description:

This course contains the scientific process, in the context of learning the fundamental biological and chemical facts of molecular biology. More specifically, students will learn to implement the scientific method by proposing hypotheses to explain biological phenomena, designing and conducting experiments to test these hypotheses, and critically interpreting the resulting data related to molecular level of the organism which generally includes the genetic material and its expression.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Have a conceptual knowledge about DNA as a genetic material.
CO2	The students will be able to understand DNA replication and recombination at molecular level.
CO3	Students will study the factors causing DNA damage and their repair mechanism.
CO4	Students will acquire knowledge about the molecular mechanisms of prokaryotic and eukaryotic central dogma.
CO5	Describe the regulation and processing at post transcriptional level of genetic material.

SYLLABUS:

UNIT I: DNA structure and replication

DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semi conservative nature of DNA replication, Bi-directional replication, ,Primosome, Replisome, Rolling circle replication.

UNIT II: DNA damage, repair and homologous recombination

DNA damage and repair: causes and types of DNA damage. Mechanism of DNA repair: Photo reactivation, base excision repair, nucleotide excision repair, mismatch repair. Homologous recombination: models and mechanism.

UNIT III: Transcription

Structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase; role of sigma factor; promoter; mechanism of transcription- Initiation, elongation and termination. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers; mechanism of transcription initiation, promoter clearance and elongation.

UNIT IV: RNA processing and Regulation of gene expression

RNA splicing and processing: 5' cap formation, polyadenylation, mRNA, rRNA and tRNA splicing. Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system).

UNIT V: Translation

Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides. Post-translational modifications of proteins.

PRACTICAL

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of genomic DNA from bacterial cells.
3. Isolation of Plasmid DNA from bacterial cells.
4. Agarose gel electrophoresis of DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Klein smith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. 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 Harbour Lab. Press, Pearson Pub.

CO-PO & PSO CORRELATION

Course Name: Molecular Biology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		3						3	3	3	1	2
CO2	3		3						3	3	3	2	2
CO3	3		2						3	3	3	2	2
CO4	3		2						3	3	2	1	2
CO5	3		3						3	3	3	2	2

Note: 1- Low, 2-Moderate, 3-High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**IV**
Name of the Course	**Immunology**	**Course Code**	**SOS-B-BT402**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description:

The course includes the study of the molecular and cellular interactions and principles of the immune system. Topics include immune system development, humoral & cell-mediated immunity, disease and treatments involving immunization, immunodeficiency, and autoimmunity.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	The students will aware about the cell and organs of immune system.
CO2	The students will be able to understand the concept of antigen and antibodies
CO3	Students will study the about the different types of immune responses generated against foreign materials.
CO4	Students will acquire knowledge about the MHC and its function. They also came across the diseases related to immune system.
CO5	Student will able to learn about the vaccination and the advance immune techniques.

SYLLABUS:

UNIT I: Introduction of Immunity and Immune system

Introduction to Innate and Adaptive immunity, components of mammalian immune system: Immune cells- Hematopoietic stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs- primary and secondary lymphoid organ.

UNIT II: Antigens and Antibodies

Antigens: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens

Antibodies: Molecular structure of Immunoglobulins or Antibodies, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); allelic exclusion, gene rearrangements of immunoglobulins, antibody diversity- germ line & somatic mutation, Antibody affinity maturation- somatic hypermutaion and clonal selection; antibody class switching.

UNIT III: Generation of Immune Response

Immune Response - Primary and Secondary Immune Response; Generation of Humoral Immune Response; T-cell receptors, Generation of Cell Mediated Immune Response, Killing Mechanisms by CTL and NK cells.

UNIT VI: MHC and Immunological disorder

Major Histocompatibility complexes – class I & class II MHC antigens, Antigen processing and presentation (Cytosolic and Endocytic pathways. Pathogen defense strategies, Autoimmune diseases, Immunodeficiency-AIDS, Hypersensitivity.

UNIT V: Vaccination and Immuno techniques

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – Principles of Precipitation, Agglutination, Immunodiffusion, Immuno electrophoresis, RIA, ELISA.

PRACTICAL

1. Differential leucocytes count
2. Separation of serum from blood
3. Study of Identification of human blood groups.
4. Double Immune diffusion test.
5. Radial Immuno Diffusion test
6. Enzyme Linked Immuno Sorbent Assay.

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th editions Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

CO-PO & PSO CORRELATION

Course Name: Immunology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		1						3	3	3	2	2
CO2	3		1						3	3	3	2	3
CO3	3		1						3	2	3	3	2
CO4	3		1						3	3	3	3	2
CO5	3		2				1		3	3	3	3	3

Note: 1- Low, 2-Moderate, 3-High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**IV**
Name of the Course	**Environmental Biotechnology**	**Course Code**	**SOS-B-BT403**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description:

The Environmental Biotechnology course aims to introduce and elaborate the fundamental concepts and applications of biotechnology in all aspects of environment including its protection, restoration and sustainability. The course is structured to provide the students with fundamental concepts of environmental biotechnology, highlighting the importance of microbial and plant ecology for bioremediation, waste treatment and bioleaching.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	To get an insight difference between conventional and modern fuel.
CO2	To have an idea about the concept of Bioremediation of soil and water.
CO3	To acquire the knowledge of the methods of treatment of solid and liquid municipal and industrial waste.
CO4	To gain knowledge on Bio-fertilizers, Nitrogen fixers with or without symbiotic association.
CO5	Student will able to learn about the enrichment of ores with different microorganisms and the process of bioleaching.

SYLLABUS:

UNIT I: Conventional & modern fuels

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.

UNIT II: Microbial bioremediation

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products. Degradation of lignin and cellulose

UNIT III: Phytoremediation

Remediation of toxic soil heavy metals .Treatment of municipal waste and Industrial effluents. Examples of Phytoremediation.

UNIT IV: Bio fertilizers& PGPR

Bio-fertilizers, Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, Nitrogen fixation, Nitrogenase complex, Plant Growth Promoting bacteria, Algal and fungal biofertilizers.

UNIT V: Bioleaching & GMOs

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

PRACTICAL

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of DO of water sample.
3. Calculation of BOD and COD of water sample.
4. Isolation of Bio-fertilizers (any one: Rhizobium/Azolla/Azospirillium/Blue green Algae).
5. Case Studies on bioremediation of soil and water.
6. Degradation of cellulose using bacteria.

SUGGESTED READING

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
5. Introduction to Environmental Biotechnology, Milton Wainwright
6. Principles of Environmental Engineering, Gilbert Masters
7. Wastewater Engineering – Metcalf & Eddy

CO-PO & PSO CORRELATION

Course Name: Environmental Biotechnology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		2			1	2		3	2	2	2	2
CO2	3		2			1	3		3	2	2	2	2
CO3	2		2			1	3		3	2	2	2	3
CO4	3		2			2	3		3	2	2	2	2
CO5	2		2			1	2		3	2	2	2	2

Note: 1- Low, 2-Moderate, 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**V**
Name of the Course:	**Bioprocess Technology**	**Course Code:**	**SOS-B-BT501**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

Bioprocess technology is the industrial application of biological processes involving living cells or their components to effect desired transformation of substrates. It is used when producing medicine, within agriculture and the industrial areas such as enzyme production, fuel, and waste treatment. The course is beneficial to develop knowledge and skills to deal with diverse and complex processes and products that exist in bio-manufacturing and an essential understanding of the range of technology and techniques available to support this activity.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Understand the basic concept of bioprocess technology
CO2	Learn the design, types and the principles of upstream processing.
CO3	Learn the requirement and factors affecting bioprocess and its control process.
CO4	Learn the product recovery process and purification of the products.
CO5	Understand the application and uses of Bioprocess Technology.

SYLLABUS:

UNIT I: Introduction to Bioprocess Technology

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II: Design and Types

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing- Media preparation, Inoculation and sterilization.

UNIT III: Process Control

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV: Downstream Processing

Introduction to downstream processing, product recovery and purification, Effluent treatment.

UNIT V: Application

Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

PRACTICAL

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

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

CO-PO & PSO CORRELATION

Course Name: Bio process Technology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		3						3	2	2	3	3
CO2	3		2						3	2	3	3	3
CO3	3		3						3	2	3	3	3
CO4	3		3						3	2	3	3	3
CO5	3		2						3	2	3	3	3

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**V**
Name of the Course:	**Recombinant DNA Technology**	**Course Code:**	**SOS-B-BT502**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

Recombinant DNA technology comprises altering genetic material outside an organism to obtain enhanced and desired characteristics in living organisms or as their products. This technology involves the insertion of DNA fragments from a variety of sources, having a desirable gene sequence via appropriate vector. It discusses molecular biology of the gene and the cell along with the recent advancement of recombinant DNA technology.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Understand the basic concept of recombinant DNA technology.
CO2	Learn the principles of PCR and RTPCR.
CO3	Learn the different steps of recombinant DNA Technology and its uses in genome mapping.
CO4	Learn the use of genetic engineering in Animals and their therapeutic products.
CO5	Learn the use of genetic engineering in Plants.

SYLLABUS:

UNIT I: Molecular Tools and Application

Restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication.

UNIT II: Polymerase Chain Reaction

Principle, applications and types of Polymerase chain reaction (PCR), primer-design, and RT-PCR (Reverse transcription PCR).

UNIT III: Restriction-Modification System

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting.

UNIT IV: Genetic Engineering in Animals

Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each)

UNIT V: Genetic Engineering in Plants

Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

PRACTICAL

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from E.coli
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

SUGGESTED READING

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

CO-PO & PSO CORRELATION

Course Name: Recombinant DNA Technology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		3						3	3	3	2	2
CO2	3		3		2				3	3	3	3	3
CO3	3		3		2				3	3	3	2	3
CO4	3		3						3	3	3	3	3
CO5	3		3						3	3	3	2	2

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**VI**
Name of the Course:	**Bio Analytical Tools**	**Course Code:**	**SOS-B-BT601**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

This course introduces to the principles and methods of analytical technique as they relate to quantitative measures of determination. This course is designed to teach various laboratory experiments including instructions in the use of balances and volumetrics, spectrophotometric analysis, and a variety of titrimetric methods etc.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Understand the basic concept of Microscopy.
CO2	Learn the various Centrifugation techniques and also gain knowledge of spectrophotometry.
CO3	Learn chromatographic techniques and their uses in biological applications.
CO4	Learn the electrophoresis techniques and their uses in research.
CO5	Able to understand the applications of bioinstrumentation.

SYLLABUS:

UNIT I: Microscopy

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy.

UNIT II: Spectrophotometry and Centrifugation

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infra-red), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III: Chromatography

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV: Electrophoresis

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing.

UNIT V: Western Blotting, Biosensor and Nanotechnology

Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

PRACTICAL

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

SUGGESTED READING

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.

CO-PO & PSO CORRELATION

Course Name: Bio Analytical Tools													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		3		2				3	2	2	2	2
CO2	3		3		2				3	2	2	2	3
CO3	3		3		2				3	2	2	2	2
CO4	3		3		2				3	2	2	2	3
CO5	3		3		2				3	2	2	2	2

Note: 1-low; 2-Moderate; 3-High

Name of the Course:	**Genomics and Proteomics**	**Course Code:**	**SOS-B-BT602**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

The course is designed to provide students with a comprehensive and concise overview of technologies pertinent to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries. This course will also help the science students to appreciate the surplus value of combining data from different omics-applications as a systems approach.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Know the basics of DNA sequencing and genomics platforms.
CO2	know the genomic databases, sequence retrieval and analysis.
CO3	Learn the structure of proteins and their interactions.
CO4	Learn how to determine the size of a protein by various techniques.
CO5	Learn about proteomics and different techniques used in proteomics.

SYLLABUS:

UNIT I: Introduction to Genomics

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II: Genomic Databases

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases

UNIT III: Introduction to Protein Structure

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions.

UNIT IV: Techniques to determine Protein Size

Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures- Edman degradation.

UNIT V: Proteomics

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

PRACTICAL

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Hydropathy plots
7. Native PAGE
8. SDS-PAGE

SUGGESTED READING

1. Genes IX by Benjamin Lewin, Johns and Bartlett Publisher, 2006.
2. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
4. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.
5. Principles of Gene Manipulation 6th Edition, S.B.Primrose, R.M.Twyman and R.W. Old. Blackwell Science, 2001.
6. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
8. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
9. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

CO-PO & PSO CORRELATION

Course Name: Genomics and Proteomics													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		3						3	2	3	2	2
CO2	3		2						3	2	3	2	2
CO3	3		2						3	3	2	2	2
CO4	3		3						3	2	3	2	2
CO5	3		3						3	3	3	2	2

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**V**
Name of the Course:	**Bioinformatics**	**Course Code:**	**SOS-B-BT503 (i)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

Bioinformatics is a modern, interdisciplinary study field that tries to curate methods and online tools for understanding and researching biological data, particularly made available in large and complex data sets. Bioinformatics deals with applying technology, engineering, and statistics to biological data processing.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Understand the basic concept of bioinformatics platform.
CO2	Understand how DNA sequences can be analyzed to identify genes.
CO3	Learn how 3 dimensional structure and function might be predicted from the sequences.
CO4	Learn how sequences may be aligned to other similar, but not identical sequences.
CO5	Learn how the genome is sequenced and annotated.

SYLLABUS:

UNIT I: Introduction and History of Bioinformatics

Introduction of Bioinformatics and tools, History of Bioinformatics, The notion of Homology.

UNIT II: Genome Data

Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

UNIT III: Protein Data

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT IV: Sequence Analysis

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT V: Genome Annotation

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

PRACTICAL

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR).
3. Understanding and using: PDB, Swissprot, TREMBL.
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

CO-PO & PSO CORRELATION

Course Name: Bioinformatics													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		2						3	2	3	3	2
CO2	2		2						2	2	3	2	3
CO3	2		2						2	2	3	3	3
CO4	2		2						2	2	3	3	2
CO5	2		2						3	2	3	2	2

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**V**
Name of the Course:	**Intellectual Property Right, Bioethics & Biosafety**	**Course Code:**	**SOS-B-BT503 (ii)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

Intellectual property is a category of property that includes intangible creations of the human intellect. Bioethics is the study of ethical, social, and legal issues that arise in biomedicine and biomedical research. Biosafety deals with the safety concerns of the workers, organization, and environment. This course is going to introduce about basics of IPR and understand the way findings of research can be protected in the form of patents. Also, deals with uses of specific practices, safety equipment, and specially designed buildings to ensure that workers, the community, and the environment are protected from accidental exposure or unintentional release of infectious agents, toxins, and other biological hazards

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Understand the basics of property and rights.
CO2	Understand the importance of intellectual ideas and their protection.
CO3	Learn the industrial properties, their legal rights as well as entrepreneurship skills.
CO4	Learn what are the ethical concerns are associated with biological research.
CO5	Learn how to research while keeping the environment safe and non-hazardous.

SYLLABUS:

UNIT I: IPR and Indian Patent Law

Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions.

UNIT II: Industrial Property

Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations

UNIT III: Entrepreneurship

Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock the product and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.

UNIT IV: Bioethics

Necessity of Bioethics, different paradigms of Bioethics: National & International. Ethical issues against the molecular technologies.

UNIT V: Biosafety

Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

PRACTICAL

1. Proxy filing of Indian Product patent
2. Proxy filing of Indian Process patent
3. Planning of establishing a hypothetical biotechnology industry in India
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence.
7. Case study on handling and disposal of radioactive waste.

SUGGESTED READING

1. Entrepreneurship: New Venture Creation : David H. Holt.
2. Patterns of Entrepreneurship : Jack M. Kaplan.
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

CO-PO & PSO CORRELATION

Course Name: Intellectual Property Right, Bioethics & Biosafety													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1						2	1					1	1
CO2						2	1					1	1
CO3						2	1					1	1
CO4						3	1					1	1
CO5			1			1	1					1	1

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**V**
Name of the Course:	**Ecology and Environment Management**	**Course Code:**	**SOS-B-BT503 (iii)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

Ecological management can be defined as a process of protecting the organisms and their interaction with the environment. Ecology and environment management focuses on the management of biological components with their interaction with the physical environment and their effects on the planet. This course deals with the sustainable uses of resources such that the harmful effects can be minimized and environment remains in liveable condition.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Understand the basics of our environment and ecology.
CO2	Understand the importance of ecosystems.
CO3	Learn how the energy transfer happens in an ecosystem and importance of bio-geochemical cycle.
CO4	Learn what causes pollution and how pollution impacts our health.
CO5	Learn how Biotechnological approaches can help in protection and preservation of environment.

SYLLABUS:

UNIT I: Environment

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology.

UNIT II: Ecosystems

Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

UNIT III: Energy transfer in ecosystems

Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles).

UNIT IV: Pollution and Environment Health

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations, Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup: Case studies

UNIT V: Biotechnology and Environment

Environmental biotechnologies, Biotechnologies in protection and preservation of environment, Bioremediation, Waste disposal.

PRACTICAL

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon.
6. Study any five endangered/ threatened species- one from each class.

SUGGESTED READING

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2 nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House.
4. Mohapatra Textbook of environmental biotechnology IK publication.
5. Rana SVS, Environmenta lpollution – health and toxicology, Narosa Publication
6. Sinha, S. 2010. Handbook on Wildlife Law Enforsement in India. TRAFFIC, India.
7. Thakur, I S, Environmental Biotechnology, I K publication.

CO-PO & PSO CORRELATION

Course Name: Ecology and Environment Management													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2					2	2		1	1			
CO2	2					2	2		1	1			
CO3	2					2	2		1	1			
CO4	2					2	2		1	1			
CO5	2		2			2	2		1	1	2	1	1

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**V**
Name of the Course:	**Pharmaceutical Microbiology**	**Course Code:**	**SOS-B-BT504 (i)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

Pharmaceutical Microbiology deals with the development of drugs, medicines, and vaccines to solve the ailments of the human race. It is the study of biopharmaceuticals, from the conception stage to the delivery stage. The Pharmaceutical Biotechnology course is a mixture of molecular biology and biotechnology.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Learn basics of microorganism and pharmaceutical products.
CO2	Learn how to prevent pharmaceutical product from microbiological spoilage.
CO3	Learn about antimicrobial agents and chemicals.
CO4	Learn principles of chemotherapy and antibiotics functioning.
CO5	Learn how to perform drug sensitivity assay and obtain MIC.

SYLLABUS:

UNIT I: Introduction Pharmaceutical Microbiology

The ecology of microorganisms affecting pharmaceutical industry. Types of microorganisms occurring in pharmaceutical products. Introduction to Pharmacokinetics. Production of recombinant products: Growth Hormones, Human interferon, Vaccines & Monoclonal Antibodies.

UNIT II: Microbiological Spoilage and Prevention

Microbiological spoilage prevention of pharmaceutical products; antimicrobial agents used as preservatives, evaluation of the microbial stability of formulation. The sterilization in pharmaceutical industry: Heat, radiation, gaseous and filtration sterilization, injectable, sterile fluids.

UNIT III: Antimicrobial Agents

Bacteriostatic and bactericidal agents, factors affecting antimicrobial activity, antimicrobial chemicals: sanitizers, disinfectants, antiseptics, phenols and phenolic compounds, alcohols, halogens, heavy metals, dyes, aldehydes, detergents, selective toxicity and target sites of drug action in microbes. Development of synthetic drugs.

UNIT IV: Chemotherapy and Antibiotics

Principles of chemotherapy: Clinical and lab diagnosis, sensitivity testing, choice of drug, dosage, route of administration. Antibiotics :Classification and applications; Mode of action of important drugs: Cell wall inhibitors

(Betalactam eg. Penicillin), membrane inhibitors (polymyxins), macromolecular synthesis inhibitors (streptomycin), antifungal antibiotics (nystatin).

UNIT V: Microbiological Assay

The clinical basis of drug resistance, biochemistry and genetics of drug resistance. Microbiological assays: growth promoting and inhibiting substances, nutritional mutants and their importance, vitamin assay, amino acid assay. antimicrobials (Phenol coefficient/RWC), Drug sensitivity testing methods. Assay for antibiotics: MIC, the liquid tube assay, solid agar tube assay, agar plate assay.

PRACTICAL

1. Sterility testing methods for pharmaceutical products.
2. Testing for sterilization equipment.
3. Tests for disinfectants (Phenol coefficient/RWC).
4. Determination of antibacterial spectrum of drugs/antibiotics.
5. Chemical assays for antimicrobial drugs.
6. Determination of MIC valued for antimicrobial chemicals.
7. Microbiological assays for vitamins/amino acids.
8. Microbiological assays for antibiotics (Liquid tube assay, agar tube assay, agar plate assays).

SUGGESTED READING

1. Disinfection, sterilization and preservation. Block, S.S. (ed). Lea and Febigor, Baltimore.
2. Pharmaceutical Microbiology. Huge, W.B. and Russel, AD.Blackwell Scientific, Oxford.
3. Principles and methods of sterilization in health sciences. Perkins, JK. Pub: Charles C. Thomos, Springfield.
4. Manual of Clinical Microbiology. Lennette, EH. (ed).Pub: American Society for Microbiology, Washington.
5. Principles and Practices of disinfection. Russell, AP.,Hugo,WB., and Ayliffe, GAJ.(eds). Publ. Blackwell Science.

CO-PO & PSO CORRELATION

Course Name: Pharmaceutical Microbiology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		2			1	1		2	2	1	2	2
CO2	2		2			1	1		2	2	2	3	2
CO3	2		2			1	1		2	2	3	3	2
CO4	2		2			1	1		2	2	3	3	2
CO5	2		2			1	1		2	2	2	2	2

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**V**
Name of the Course:	**Medical Microbiology**	**Course Code:**	**SOS-B-BT504 (ii)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

Medical microbiology is a discipline of medicine and microbiology that studies microorganisms such as viruses, bacteria, fungi, and parasites that are important in medicine and can cause diseases in humans. It is connected to the study of disease pathology and immunology and encompasses microbial pathogenesis and epidemiology. This course provides learning opportunities in the basic principles of medical microbiology and infectious disease. It covers mechanisms of infectious disease transmission, principles of aseptic practice, and the role of the human body's normal micro flora.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Understand the normal microflora of human body and infectious microorganisms.
CO2	Learn about Gram positive bacteria and infections caused by them.
CO3	Learn about Gram negative bacteria and their pathogenesis.
CO4	Learn how viruses controls host system and causes diseases.
CO5	Understand fungal and protozoan infections.

SYLLABUS:

UNIT I: Introduction to infections

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

UNIT II: Gram positive bacteria: Morphology, Pathogenesis and Symptoms

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. Leprae.

UNIT III: Gram negative bacteria: Morphology, Pathogenesis and Symptoms

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: E.coli, N. gonorrhoea, N. meningitidis, P. aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae, Rickettsiaceae, Chlamydiae.

UNIT IV: Viral Diseases

Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT V: Fungal and Protozoan Infections

Dermatophytoses (Trichophyton, Microsporun and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides) and opportunistic fungal infections (Candidiasis, Aspergillosis), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria).

PRACTICAL

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of Aspergillus and Candida by apprpriate staining.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

SUGGESTED READING

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology 4th edition. Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

CO-PO & PSO CORRELATION

Course Name: Medical Microbiology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		2						2	2	2	1	2
CO2	3		3						2	2	3	2	2
CO3	3		3						2	2	3	2	2
CO4	3		3			1			2	2	3	3	2
CO5	3		2						2	2	2	2	2

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**V**
Name of the Course:	**Industrial Fermentation**	**Course Code:**	**SOS-B-BT504 (iii)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

Industrial fermentation is a chemical engineering term used to describe the processes that utilize a chemical change induced by a living organism or enzyme, in particular bacteria, yeasts, molds, or fungi, that produces a specific product.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Learn the industrial production of various biochemical, Biofuels etc.
CO2	Learn about microbial metabolites, their signification and economic importance.
CO3	Learn about cell and enzyme immobilization and their uses in organic synthesis.
CO4	Learn about downstream processing and purification of synthesized bioproducts.
CO5	Understand the enzyme kinetics and metabolic engineering.

SYLLABUS:

UNIT I: Industrial Chemicals

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT II: Microbial Metabolites and their Significance

Microbial products of pharmacological interest, steriod fermentations and transformations. Over production of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity.

UNIT III: Immobilization of Enzymes and Cells

Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT IV: Purification of Products

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultra centrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT V: Enzyme Kinetics and Metabolic Engineering

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

PRACTICAL

1. Study the effect of pH and temperature on rate of enzyme reaction.
2. Comparative analysis of design of a batch and continuous Fermenter.
3. Calculation of Mathematical derivation of growth kinetics.
4. Solvent extraction & analysis of a metabolite from a bacterial culture.
5. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/ glucosidase etc.).

SUGGESTED READING

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology.

CO-PO & PSO CORRELATION

Course Name: Industrial Fermentation													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		2		1				2	2	2	2	2
CO2	1		2		1				2	2	2	2	2
CO3	3		3		1				2	2	3	3	2
CO4	3		3		1				2	2	3	3	2
CO5	2		3		1				2	2	3	3	2

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**VI**
Name of the Course:	**Industrial Chemistry**	**Course Code:**	**SOS-B-BT603(i)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

The course deals with transforming, processing, and manufacturing raw materials in various industries to make them useful to humankind

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Understand the basics of drug discovery and development process.
CO2	Learn the basics of catlysis.
CO3	Learn the importance of essential oils and their uses.
CO4	Learn about food and their nutritional value.
CO5	Understand what is Green chemistry?

SYLLABUS:

UNIT I: Drugs and Pharmaceuticals

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lbuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryltrinitrate), antilaprosy (Dapsone), HIV AIDS related drugs (AZT- Zidovudine).

UNIT II: Catalysis

General principles and properties of catalysts, Homogenous and heterogeneous catalyst, Basic principles of catalysis, Mechanism of catalysis, Factors affecting the catalysis reactions, Industrial uses of catalysis reactions, application of zeolites as catalysts. Enzyme catalyzed reaction: Industrially important reactions, Basic chemical calculations: Atomic weight, molecular weight, equivalent weight.

UNIT III: Distillation and essential oils

Introduction, types of distillation: Simple distillation, Fractional distillation, Steam distillation, Distillation under reduced pressure, Batch & continuous distillation, Plate columns & packed columns distillation. Essential oils and their importance in cosmetic industries - Eugenol, Geraniol, Sandalwood oil, Eucalyptus, Rose oil, Jasmine, Civetone, and Muscone.

UNIT IV: Food additives and adulterants

General study of food flavors, colors, preservatives, artificial sweeteners and antioxidants. Analysis of food products: Nutritional value of food, idea about food processing, food preservations and adulteration. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

UNIT V: Green Chemistry

Need for Green Chemistry, Goals of Green Chemistry, Limitations/Obstacles in the pursuit of the goals of Green Chemistry, Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles.

PRACTICAL

1. Preparation of Aspirin and its analysis.
2. Preparation of soap.
3. Production of Eugenol by distillation.
4. Extraction of natural coloring and flavoring agent from flowers and fruits.
5. Testing of turmeric powder, milk and mustard oil for adulterants.
6. Estimation of glucose in food samples.

SUGGESTED READING

1.E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd.UK.
2. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, UK.
3. Hakishan, V.K. Kapoor: Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi.
4. B.K. Sharma, Industrial Chemistry, Goel publishing house.
5. Arun Sethi, Systematic Lab Experiments in Organic Chemistry 2ndEd.
6. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
7. S. C. Bhatia: Chemical Process Industries, Vol. I & II, CBS Publishers, New Delhi.

CO-PO & PSO CORRELATION

Course Name: Industrial Chemistry													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		2			1			2	2	2	2	2
CO2	2		2			1	1		2	2	3	2	2
CO3	2		2			1	1		2	2	2	2	2
CO4	2		2			1	2		2	2	2	2	2
CO5	2		2			1	3		2	2	2	2	2

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**VI**
Name of the Course:	**Biotechnology and Human Welfare**	**Course Code:**	**SOS-B-BT603 (ii)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

The course is designed to give a multidisciplinary, vast and highly divergent scope of Biotechnology. It is a basically the controlled use of biological agents, such as micro-organisms or cellular components for human beneficial use at different sectors such as Industry, Agriculture, Forensic Science and human health.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Learn industrial applications of Biotechnology.
CO2	Understand the use of Biotechnology at agriculture sector.
CO3	Learn the use of Biotechnological approach for environment protection.
CO4	Learn how biotechnology can help in solving criminal cases.
CO5	Learn how biotechnology can help in betterment of human health.

SYLLABUS:

UNIT I: Biotechnology at Industrial Scale

Industry: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.

UNIT II: Biotechnology at Agricultural Scale

Agriculture: N2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III: Biotechnology at Environmental Scale

Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.

UNIT IV: Forensic Science

Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.

UNIT V: Biotechnology and Human Health

Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in E.coli, human genome project.

PRACTICAL

1. Perform of ethanolic fermentation using Baker's yeast.
2. Study of a plant part infected with a microbe.
3. To perform quantitative estimation of residual chlorine in water samples.
4. Isolation and analysis of DNA from minimal available biological samples.
5. Case studies on Bioethics (any two).

SUGGESTED READING

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers.
3. Modern Biotechnology, 2nd Edition, S.B. Primrose, Blackwell Publishing, 1987.
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.

CO-PO & PSO CORRELATION

Course Name: Biotechnology and Human Welfare													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1		3			1	1		2	2	3	3	2
CO2	2		3			1	2		2	2	3	2	2
CO3	2		3			1	2		2	2	3	2	2
CO4	1		3			1	1		2	2	3	2	2
CO5	1		3			1	2		2	2	3	3	2

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**VI**
Name of the Course:	**Developmental Biology**	**Course Code:**	**SOS-B-BT603 (iii)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

The course Developmental Biology is designed to study the process by which organisms grow and develop. This will help in understanding the development of a mammalian organism from gametogenesis to organogenesis through various differentiation steps involved in the process.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Know the basics of developmental biology and the historical perspective of it.
CO2	Understand the process of gametogenesis and fertilization process.
CO3	Learn how early embryonic development starts and proceeds.
CO4	Understand the embryonic differentiation process.
CO5	Learn how organogenesis starts in vertebrates and various layers of germ line cells.

SYLLABUS:

UNIT I: Introduction to Developmental Biology

Definition, scope & historical perspective of development Biology.

UNIT II: Gametogenesis and Fertilization

Gametogenesis- Spermatogenesis, Oogenesis Fertilization - Definition, mechanism, types of fertilization. Different types of eggs on the basis of yolk.

UNIT III: Early Embryonic Development

Cleavage: Definition, types, patterns & mechanism Blastulation: Process, types & mechanism Gastrulation: Morphogenetic movements– epiboly, emboly, extension, invagination, convergence, de-lamination. Formation & differentiation of primary germ layers, Fate Maps in early embryos.

UNIT IV: Embryonic Differentiation

Differentiation: Cell commitment and determination- the epigenetic landscape: a model of determination and differentiation, control of differentiation at the level of genome, transcription and post-translation level Concept of embryonic induction: Primary, secondary & tertiary embryonic induction, Neural induction and induction of vertebrate lens.

UNIT V: Organogenesis

Neurulation, notogenesis, development of vertebrate eye. Fate of different primary germlayers Development of behaviour: constancy & plasticity, Extra embryonic membranes, placenta in Mammals.

PRACTICAL

1. Identification of developmental stages of chick and frog embryo using permanent mounts.
2. Preparation of a temporary stained mount of chick embryo.
3. Study of developmental stages of Anopheles.
4. Study of the developmental stages of Drosophila from stock culture/ photographs.
5. Study of different types of placenta.

SUGGESTED READING

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.

CO-PO & PSO CORRELATION

Course Name: Developmental Biology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1		1						2	2	1		1
CO2	1		1						2	2	1		1
CO3	2		1						2	2	2		1
CO4	2		1						2	2	2		1
CO5	1		1						2	2	2		1

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**VI**
Name of the Course:	**Plant Diversity**	**Course Code:**	**SOS-B-BT604 (ii)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

The course is designed to equip the students about the morphology, biology and importance of algal organisms, fungal organisms, lichens, bryophytes and pteridophytes. The course will enable students to know the earlier plants, their vegetative and reproductive structures and their importance.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Know about algae and their characteristics.
CO2	Learn the general characteristics of fungi and their classification.
CO3	Learn about lichens and the economic importance of them.
CO4	Know about bryophytes, their classification and economic importance.
CO5	Know about pteridophytes, their classification and economic importance.

SYLLABUS:

UNIT I: Algae

General character, classification and economic importance. Life histories of algae belonging to various classes: Chlorophyceae – Volvox, Oedogonium; Xantho phyceae –Vaucheria; Phaeophyceae – Ectocarpus; Rhodophyceae- Polysiphonia.

UNIT II: Fungi

General characters, classification & economic importance. Life histories of Fungi: Mastigomycontina- Phytophthora; Zygomycotina- Mucor; Ascomycotina- Saccharomyces; Basidomycotina-Agaricus; Deutromycotina- Colletotrichum.

UNIT III: Lichens

Classification, general structure, reproduction and economic importance. Plant diseases: 4 of 36 Casual organism, symptoms and control of following plant diseases: Rust & Smut of Wheat; White rust of Crucifers; Late blight of Potato; Red rot of Sugarcane; Citrus Canker.

UNIT IV: Bryophytes

General characters, classification & economic importance. Life histories of following: Marchantia, Funaria.

UNIT V: Pteriodophytes

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – Rhynia; Life histories of Selaginella- (Heterospory and seed habit), Equisetum, Pteris, Lycopodium.

PRACTICAL

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory.
2. Comparative study of vegetative and reproductive parts of various fungi mentioned in theory.
3. Study and section cutting and lectophenol mount of plant disease materials studied in theory.
4. Study of various types of lichens.
5. Study of external features & anatomy of vegetative and reproductive parts of Marchantia and Funaria.
6. Collection of algae, fungi, plant diseases materials and bryophytes available locally.
7. Examination of morphology and anatomy of vegetative and reproductive parts of Selaginella, Equisetum & Pteris.

SUGGESTED READING

1. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996 Introductory Mycology, 4th edition,
3. John Wiley and Sons (Asia) Singapore.
4. Bold, H.C. & Wayne, M.J. 1996 (2nd Ed.) Introduction to Algae.
5. Kumar, H.D. 1999. Introductory Phycology. Aff. East-West Press Pvt Ltd., Delhi.
6. Lee, R.E. 2008. Phycology, Fourth Edition, Cambridge University Press, USA.
7. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. IK International Publishers.
8. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
9. Van den Hoek, C.; Mann, D.J. & Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
10. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.

CO-PO & PSO CORRELATION

Course Name: Plant Diversity													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1		1				1		2	1	1	1	1
CO2	1		1				1		2	1	1	1	1
CO3	1		1				1		2	1	1	1	1
CO4	1		1				1		2	1	1	1	1
CO5	1		1				1		2	1	1	1	1

Note: 1-low; 2-Moderate; 3-High

Programme	**B.Sc. Hons. Biotechnology**	**Semester:**	**VI**
Name of the Course:	**Animal Diversity**	**Course Code:**	**SOS-B-BT604 (iii)**
Credits:	**6**	**No. of Hours:**	**8 hours/week**
Max Marks	**150**		

Course Description:

The course deals with the classification system of animals. This course will help in learning about the general characteristics of non-chordates, study of protozoa, annelida, mollusca and their interaction with other organisms.

Course Outcomes:

On successful completion of this course, students will be able to:

CO Number	Course Outcomes
CO1	Understand classification system of non-chordates and study the protozoa.
CO2	Learn about worms and their general characters.
CO3	Learn about Annelida, Apiculture and sericulture.
CO4	Learn about Mollusca and their classification.
CO5	Learn about Pisces and amphibians.

SYLLABUS:

UNIT I: Non- Chordates

Outline of classification of Non- Chordates upto subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes. Protozoa: Locomotion, Reproduction, evolution of Sex, General features of Paramoecium and Plasmodium. Pathogenic protozoans. Porifera: General characters, outline of Classification; skeleton, Canal System

UNIT II: Coelenterata

Coelenterata: General Characters, Outline of classifications Polymorphism, Various types of stinging cells; Metagenesis, coral reefs and their formation. Platyhelminthes- General Characters; Outline of classification; Pathogenic flatworms: Parasitic adaptations. Aschelminthes: General features, Outline of classification, Pathogenic roundworms and their vectors in relation to man: Parasite adaptation.

UNIT III: Annelida

Annelida: - General features, Outline of classification, Coelom: Metameric segmentation, General features of Earthworm, Vermicomposting. Arthropoda: General Features, Outline of Classification; Larval forms of crustacean, Respiration in Arthropoda; Metamorphosis in insects; Social insects; Insect vectors of diseases; Apiculture, Sericulture.

UNIT IV: Mollusca

Mollusca : general features, Outline of classification, Shell Diversity; Torsion in gastropoda, Echinodermata: General features, Outline of Classification Larval forms. Hemichordata: Phylogeny: Affinities of Balanoglossus.

UNIT V: Proto-chordates & Chordates

Proto-chordates, Pisces and Ambhibia. Proto-chordates: Outline of classification, General features and important characters of Herdmania, Branchiostoma. Origin of Chordates. Pisces: Migration in Pisces, Outline of classification. Amphibia: Classification, Origin, Parental care, Paedogenesis.

PRACTICAL

1. Identification and Classification of Any these of the following- Porifera: Scypha, Leucosolenia, Euspongia, Hylonema, Euplectella. Cnidaria: Medrepora, Millepora, Physalia, Porpita, Valella, Aurelia, Metridium. Platyhelminthes: Taenia, Fasciola, Aschelminthes: Ascaris, Ancylostoma, Enterobius. Annelida: Pheretima, Hirudinaria, Chaetopterus, Nereis, Aphrodite Arthropoda: Julus, Scolopendra, Peripatus, Carcinus, Limulus, Lepisma, Dragonfly, Musca, Acheta. Mollusca: Pila, Unio, Mytilus, Loligo, Sepia, Octopus, Solen. Echinodermata: Asterias, Ophiothrix, Echinus, Holothuria, Astrophyton. Hemichordata: Balanoglossus.
2. Identification of slides with two points of identification. Amoeba, Paramoecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules of sponges, L.S. Hydra, Obelia, Bougainvillia, Larvae of Fasciola, Seta of Earthworm, Radula
3. Ecological Note – On any of the specimens in Exercise No 1, Models of dissection of Earthworm, Cockroach. Earthworm: Digestive, Nervous System. Cockroach: Digestive Reproductive, Nervous System.
4. dentification & Classification upto order of the following: Proto-chordata: Salpa, Doliolum, Herdmania, Branchiostoma. Cyclostomata: Myxine, Petromyzon. Chondrichthyes: Scoliodon, Zygnea, Pristis, Trygon, Raja, Chimaera. Ostiechthyes: Labeo, Mystus, Catla, Hippocampus, Anabas, Echeneis, Lophius, Polypeterus. Amphibia: Rana, Hyla, Amblystoma, Necturus, Proteus.

SUGGESTED READING

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. & J.I., Spicer (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
4. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.
5. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-HillCompanies.

CO-PO & PSO CORRELATION

Course Name: Animal Diversity													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1		1				1		1	1			1
CO2	1		1				1		1	1			1
CO3	1		1				1		1	1			1
CO4	1		1				1		1	1			1
CO5	1		1				1		1	1			1

Note: 1-low; 2-Moderate; 3-High

O P JINDAL UNIVERSITY

O P Jindal Knowledge Park, Punjipathra, Raigarh-496109

School of Science, Department of Biotechnology

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	B.Sc. Hons. Biotechnology	Semester	I
Name of the Course	Biostatistics	Course Code	SOS-B-BT103
Credit	6	No. Of Hours	8 Hours/Week
Max Marks	150		

COURSE DESCRIPTION:

The objective of the course is to make the students to understand the basic concept of statistics, probability and elementary calculus. To make the student aware of the basic concept and applications of correlation and regression. In this course, probability distributions, Sampling techniques and testing of hypothesis for large and small samples has been introduced. It aims to students learn the use of basic statistical concepts, methods and principles in the field of biotechnology.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Learn about different types of data, variables and distribution
CO2	Study about central tendency, Measures of dispersion; skewness, kurtosis. Elementary Probability.
CO3	Compare discrete random variables and continuous random variables. Illustrate the concept of Binomial distribution. Poisson distribution and Normal distribution.
CO4	Analyze the correlation and regression data Evaluate correlation coefficient and rank correlation coefficient for the given data. Explain the need of correlation and regression and learn about the curve fitting with the help of method of least squares. Evaluate fitting of straight line, parabola and exponential curves.
CO5	Explain and summarize the various types of sampling procedures, test of significance for large samples. Evaluate problems on testing of hypothesis. Explain the method of small sample: t-distribution, Chi-square test and ANOVA for one way classification

SYLLABUS:

Unit I: Data: Classification, Collection & Presentation

An introduction, types of data, collection, classification and tabulation of the Primary data, Secondary data, Discrete data and continuous data, diagrammatic and graphical representation of grouped data, frequency distribution (univariate and bivariate), cumulative frequency distribution and their graphical

representation, histogram frequency polygon and ogives. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

Unit II: Probability and Distributions

Elementary Probability and basic laws. Discrete and Continuous Random variable, Mathematical Expectation, Mean, Variance, standard deviation, skewness and kurtosis of Distributions, Elementary ideas of Binomial, Poisson and Normal distributions.

Unit III: Tests for Hypothesis

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

Unit IV: Correlation & Regression

Correlation and regression, rank correlation, curve fitting, method of least squares, fitting of other curves straight line, parabola, $y=ax^b$, $y=ae^{bx}$. Emphasis on examples from Biological Sciences.

Unit V: Mathematical Basics

Intuitive idea of polynomial, trigonometric, exponential and logarithmic functions, Differentiation. Conception to be motivated through simple concrete examples from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives. Integration as reverse process of differentiation. Integrals of the functions introduced above. A basic idea about differential equation, solution of 1^{st} order separable and linear differential equation with application.

PRACTICAL

1. Based on graphical Representation
2. Based on measures of Central Tendency (Mean, Median, Mode of grouped and ungrouped Data set)
3. Based on measures of Dispersion (Standard Deviation and Coefficient of Variation)
4. Calculation of measures of skewness and kurtosis
5. Based on Distributions: Binomial, Poisson, Normal
6. Based on t test
7. Based on z - test
8. Based on Chi-square test
9. Based on Regression and Correlation
10. Word Problems based on Differential Equations

SUGGESTED READING

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.

4. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
5. E. Batschelet : Introduction to Mathematics for Life Scientists, Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
6. W Daniel: Biostatistics – A Foundation for Analysis of Health Sciences by
7. B. K. Mahajan: Methods in Biostatistics

CO-PO & PSO CORRELATION

Course Name: Biostatistics													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		2						2	2	1	1	1
CO2	2		2						2	2	1	1	1
CO3	2		2						2	2	1	1	1
CO4	2		2						2	2	1	1	1
CO5	2		2						2	2	1	1	1

Note:1: Low 2.: Moderate 3: High

Programme:	**B.Sc. Biotechnology**	**Semester :**	**II**
Name of the Course:	**Entrepreneurship Development**	**Course Code:**	**SOS-B-BT203**
Credits :	**6**	**No of Hours :**	**6 Hours/week**
Max Marks:	**150**		

COURSE DESCRIPTION:

This course is to create awareness about entrepreneurship among students. This course focuses on motivating students for entrepreneurship. The more focus is given on creativity and innovation.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	Students will able to understand Identify qualities of entrepreneurs for biotechnology entrepreneurial activities
CO2	Students will able to write project proposal
CO3	Students will able various entrepreneurship models
CO4	Students will able understand various schemes supporting biotechnology entrepreneurship
CO5	Students will enhance creative and innovative by learning financial knowledge

SYLLABUS:

Unit-I: Introduction to Entrepreneurship in Biotechnology

Entrepreneur, Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology, pillars of bio-entrepreneurship and major start-ups in Biotechnology, Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, Government schemes for commercialization of technology (Biotech Consortium India Limited)

Unit-II: Project Management

Search for a business idea, concept of project and classification, project identification, project formulation, project design and network analysis, project report, project appraisal.

Unit-III: Financial Analysis

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

Unit-IV: Funding in Biotechnology

Funding of biotech business(Financing alternatives, Venture Capital funding, funding for biotech in India, Exit strategy, licensing strategies, valuation), support mechanisms for entrepreneurship (Bio entrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotechgrowth, areas of scope, funding agencies in India, biotech policy initiatives)

Unit-V: Biotech Enterprises

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

SUGGESTED READING

1. Gupta and Srinivasan, Entrepreneurship development in India
2. Desai V.: Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, 2005.
3. Sarugadharan and Begum R.: Women Entrepreneurship; institutional support and problems
4. Deshpande M.W.: Entrepreneurship of small Scale Industries
5. SaxonD.L. and Smilor R. W.: The Art and Science of Entrepreneurs
6. Ono R. D.: The Business of Biotechnology: From the Bench of the Street, Butterworth- Heinemann, 1991.
7. Mann M. G.: Entrepreneurship in Biotechnology: Managing for growth from start-up,2003
8. Hyne D.& JohnK.: Innovation and entrepreneurship in biotechnology: Concepts, theories & cases, 2006
9. Prasannan, Projects Planning Analysis, Selection, Implementation & Review.
10. Friedman Y.: Best Practices in Biotechnology Education, Logos Press, 2008.

CO-PO & PSO CORRELATION

Course Name: Entrepreneurship Development													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1					2								
CO2					2								
CO3					2								
CO4					2								
CO5					2								

Note:1: Low 2.: Moderate 3: High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**III**
Name of the Course	**Nutraceuticals and Food Processing**	**Course Code**	**SOS-B-BT304**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description:

This course will provide a broad grounding in concepts, techniques and issues involved in food products and their processing. It also deals with health promoting nutritional factors and bioactive constituents, their potential health implications and mechanisms of action.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Students will get introduced with the basic concepts of food and nutraceutical industries. They will able to classify food according to their functions.
CO2	The students will gain depth knowledge of processing technologies of cereals, pulses, fruit and vegetable products, dairy products, bakery and brewing products.
CO3	Students will study the detailed structure of different industrial nutraceutical products of plants.
CO4	Students will study the detailed structure of different industrial nutraceutical products of animals.
CO5	Students will acquire knowledge about the microbial nutraceuticals.

SYLLABUS:

UNIT I: Introduction to Food & Nutraceuticals Industries

Scope and importance of food industry in Indian and global scenario, Organizational elements, classification of Nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutracuticals. GM food and GM crops. Single Cell Protein: Production, Recovery and Nutritional and Safety Evaluation.

UNIT II: Food Processing Technologies

Cereals and Pulses processing: Conventional and modern methods, Fruits and Vegetables processing: dehydration techniques and canning. Milk processing: filtration, clarification, standardisation, homogenisation and pasteurisation, cream separation and chilling techniques. Sugar processing: chocolate and confectionary manufacturing. Manufacturing process of bread. Production of baker's yeast. Brewing industry.

UNIT III: Nutraceuticals of Plant origin

Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Extraction and purification, applications with specific examples with reference to skin, hair, eye, bone, muscle, heart, brain, liver, kidney, general health and stimulants. Concept of cosmoceuticals and aquaceuticals.

UNIT IV: Nutraceuticals of Animal origin

Animal metabolites - Sources and extraction of nutraceuticals of animal origin. Examples: chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides of animal origin, uses and applications in preventive medicine and treatment.

UNIT V: Microbial and Algal Nutraceuticals

Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources. Synbiotics for maintaining good health. Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment.

PRACTICAL

1. Isolation and purification of colour/flavor from plant sources.
2. Extraction of plant secondary metabolites by different methods.
3. Biochemical determination of food samples.
4. Bacteriological analysis of food samples.
5. Isolation of Lactobacillus from milk/milk product.
6. Sterility testing of canned food.
7. Microbial analysis of water and milk- MPN method.
8. Case study of food bioentrepreneurs in India/Global.

SUGGESTED READINGS

1. Food Biotechnology - 2. 1988. R.D. King and P.S.J. Cheetham (Eds.). Elsevier Applied Science, NY.
2. Introduction to Food Biotechnology. Green, Perry Johnson. 2002. CRC Press, Boca Raton, Florida.
3. Food Biotechnology-Techniques and Applications. Gauri S. Mittal. 1992. Technomic Publishing Co.,Inc., Lancaster, PA.
4. Microbiology by Pelczar, Chan and Krieg, (2015) Tata Mac Graw Hills Publications.
5. Food Microbiology, William Freizer Fifth Edition (2014) Tata MacGraw Hills Publications.
6. Intellectual Property rights: Unleashing the Knowledge Economy Ganguli, Tata Macgraw Publishing Company (2001).
7. Regulations and Quality: Pharmaceutical Manufacturing Handbook, Shayne Cox God (Ed.), Wiley Interscience 2008.

CO-PO & PSO CORRELATION

Course Name: Nutraceuticals and Food Processing													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	1		1		2				1	2	1	2	1
CO2	1		1		2				1	2	2	2	1
CO3	1		1		2				1	2	2	2	1
CO4	1		1		2				1	2	2	2	1
CO5	1		1		2				1	2	1	2	1

Note:1: Low 2.: Moderate 3: High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**IV**
Name of the Course	**Plant & Animal Biotechnology**	**Course Code**	**SOS-B-BT404**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description:

The course is designed to provide the basic concepts of tissue culture techniques and methods of gene transfer. It deals with In vitro fertilization and embryo transfer technology. It also describes the production of therapeutic proteins.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Understand the methods of different plant tissue culture.
CO2	Gain knowledge of applications of plant tissue culture
CO3	Understand the methods of different animal cell culture.
CO4	Gain knowledge of applications of animal cell culture
CO5	Aware about the secondary metabolites production through culture.

SYLLABUS:

UNIT I: Introduction to Plant Tissue Culture

Types of Plant Cultures: Introduction to organogenesis. Production of haploid plants and their applications: Ovary and ovule culture, In vitro pollination and fertilization, Pollen and Anther culture. Single cell suspension cultures and bioreactors. Protoplast isolation and culture. Meristem, axillary and shoot tip culture: micropropagation

UNIT II: Embryo Culture

Embryo culture: Embryo rescue after wide hybridization and Applications. Shortening the breeding cycle and overcoming dormancy, Somatic embryogenesis. Endosperm culture and production of triploids.

UNIT III: Application of Plant Tissue Culture

Applications of Plant Tissue Culture. Somaclonal variation and applications. Somatic Hybridization and its applications. Virus free plants. Germplasm conservation. Synthetic seeds. DNA transformation methods in plants and applications. Secondary metabolite production.

UNIT IV: Introduction to Animal Cell Culture

Types of Animal cell culture. Organ culture. Primary explant cultures. Established cell lines. Commonly used cell lines: origin and characteristics. Growth kinetics and cells in culture. Bioreactors for large scale culture of cells. Cell fusion. Transplantation of cultured cells (Grafting).

UNIT V: Application of Animal Cell Culture

Applications of animal cell culture, Limitations and ethical issues. Transfection and transgenic animals. Expressing cloned products in animal cells, Over production and processing of chosen proteinin animal cells. Production of special secondary metabolites/ products (insulin, growth hormone, interferon, t – plasminogen activator, factor VIII etc). Production of vaccines using animal cell culture. Production of monoclonal antibodies and its applications. In vitro fertilization.

PRACTICAL

1. Study of laboratory equipments.
2. Stocks and Media preparation.
3. Sterilization techniques in plant tissue culture.
4. Explant selection, treatment and inoculation.
5. Subculture of initiated cultures.
6. Extraction of proteins from plants and its estimation.
7. Extraction of DNA/RNA from plants and its estimation.
8. Study of β – amylase enzyme from germinated pulses.
9. Demonstration of animal cell culture technique.

SUGGESTED READING

1. Plant Tissue Culture, Theory and Practice, Rev Ed – S. S. Bhojwani, M.K. Razdan
2. Animal Cell Culture and Technology– M Butler
3. Freshney's Culture of Animal Cells
4. Biotechnology – B.D. Singh

CO-PO & PSO CORRELATION

Course Name: Plant and Animal Biotechnology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		3				1		2	3	3	2	2
CO2	3		3				1		2	2	3	2	2
CO3	3		3						2	3	3	3	2
CO4	3		3						2	3	3	3	2
CO5	3		3						2	3	3	3	2

Note:1: Low 2.: Moderate 3: High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**IV**
Name of the Course	**Basics of Forensic Science**	**Course Code**	**SOS-B-SE401**
Credit	**2**	**No. Of Hours**	**2 Hours/Week**
Max Marks	**50**		

Course Description:

The course deals with the significance of forensic science in human society. It will reveal the fundamental principles and functions of the forensic science and its division related to laboratory and branches.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Competence in the collection, processing, analyses, and evaluation of evidence.
CO2	Understand of the scientific method and the use of ballistics and explosives.
CO3	Identify the role of the forensic scientist and physical evidence within the criminal justice system.
CO4	Develop the ability to document and describe crime using chemical and biological practices
CO5	Identify and examine current and emerging concepts and practices within the forensic science field in terms of cyber crime.

SYLLABUS:

UNIT I: Introduction of Forensic Science

Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modus operandi in criminal investigation.

UNIT II: Ballistics

Classification of injuries and their medico-legal aspects, method of assessing various types of deaths. Classification of fire arms and explosives, introduction to internal, external and terminal ballistics.

UNIT III: Fingerprint, handwriting and ink analysis

Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification. General and individual characteristics of handwriting, Analysis of ink various samples.

UNIT IV: Toxicology & DNA Fingerprinting

Role of the toxicologist, significance of toxicological findings, Principle of DNA fingerprinting, application of DNA profiling in forensic medicine, Rape, murder and parental disputes

UNIT V: Cybercrime

Introduction to Cybercrime, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.

SUGGESTED READING

1. Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press,Washington.
2. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
3. M.K. Bhasin and S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
4. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
5. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).

CO-PO & PSO CORRELATION

Course Name: Basics of Forensic Science													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		3						2	2	3	1	2
CO2	2		2						2	2	2	1	2
CO3	2		3						2	2	3	2	2
CO4	2		2						2	2	2	1	2
CO5	2		2						2	2	2	1	2

Note:1: Low 2.: Moderate 3: High

O P JINDAL UNIVERSITY

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School of Science, Department of Biotechnology

OPJU

UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**I**
Name of the Course	**Cell Biology**	**Course Code**	**SOS-B-BT101**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

COURSE DESCRIPTION:

Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles of a cell. Student will understand how these cellular components are used to generate and utilize energy in cells. Students will understand the cellular components underlying mitotic cell division. Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes or alterations of cell function brought about by mutation.

COURSE OUTCOMES:

On successful completion of this course, students will be able to:

CO Number	Course Outcome
CO1	This course will introduce the students to the basics of cell and its components. This will help them to comprehend detail knowledge about cell and its different types.
CO2	This gives them a strong foundation on the basics of cell membrane and its permeability. It will help them understand about various processes of cell motility.
CO3	Students will acquire the knowledge of structure and functions of various cell organelles and their interaction within cell to promote cell growth, division and development.
CO4	The student will gain in depth knowledge about cellular architecture and its extracellular matrix.
CO5	The student has a general idea about cancer and the mechanisms responsible for causing cancer.

SYLLABUS:

UNIT I: Introduction to Cell Biology

Introduction and History of Cell Biology, Cell Theory, Application of Cell Biology in other Biological Branches (Cytotaxonomy, Cytogenetics, Cell Physiology, Cytochemistry, Cytomolecular Biology,

Cytopathology, Cytoecology). Classification of organisms by cell structure, Unit of Measurement of Cell, Cytosol, compartmentalization of eukaryotic cells, cell fractionation, .

UNIT II: Cell Membrane & Cell Motility

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

UNIT III: Cell Organelles (I)

Endoplasmic reticulum: Structure, function including role in protein segregation.

Golgi complex: Structure, biogenesis and functions including role in protein secretion.

Lysosomes: Vacuoles and micro bodies: Structure and functions

Ribosomes: Structures and function including role in protein synthesis.

UNIT IV: Cell Organelles (II)

Mitochondria: Structure and function, Genomes, biogenesis.

Chloroplasts: Structure and function, genomes, biogenesis

Nucleus: Structure and function, chromosomes and their structure.

UNIT V: Extracellular Matrix & Cancer

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics of cancer.

PRACTICAL

8. Study of structure of any Prokaryotic and Eukaryotic cell.
9. Study of plasmolysis and de-plasmolysis.
10. Study the effect of temperature and organic solvents on semi permeable membrane.
11. Demonstration of dialysis.
12. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
13. Cell division in onion root tip/ insect gonads.
14. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READING

6. Verma P.S., Agarwal V.K. Cell Biology, S Chand Publication
7. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

8. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
9. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress & Sunderland, Washington, D.C.; Sinauer Associates, MA.
10. 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.

CO-PO & PSO CORRELATION

Course Name: Cell Biology													
	Program Outcome								PSOs				
Course Outcomes	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	2		1						3	1	2	1	1
CO2	2		1						3	1	1	1	1
CO3	2		1						3	1	1	1	1
CO4	2		1						3	2	1	1	1
CO5	2		2				1		3	1	1	1	1

Note:1: Low 2.: Moderate 3: High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**II**
Name of the Course	**Physiology**	**Course Code**	**SOS-B-BT204**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description

In this course, we will learn about the structures and functions that allow mammals to adapt and survive in different ecosystems around the world. This course examines the physiology of animals at the molecular, cellular, system and organism levels. This course also introduce to the physiological processes underlying plant growth and development and plant responses to the environment.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Students will able to understand the various aspects of plant water relationship and macro micro nutrient requirement.
CO2	Students will able to understand the growth and development of plants and role of phytohormones..
CO3	Students will able to understand the mechanism of digestion and excretion.
CO4	Students will able to know the mechanism of circulation and respiration.
CO5	Students will acquire the knowledge of physiology of muscle and nerve.

SYLLABUS:

Unit I: Water and Nutrients for plants

Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Mechanism of absorption of water by root, Ascent of Sap. roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport: Translocation in the phloem.

Unit II: Metabolism & Plant growth

Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point. Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

Unit III: Digestion and Osmoregulation

Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleicacids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice. Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation.

Unit IV: Circulation & Respiration

Composition of blood, Plasma proteins & their role, blood cells, Haemopoisis, Mechanism of coagulation of blood. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heartbeat.

Unit V: Muscle & Nervous physiology

Physical, chemical & electrical events of mechanism of muscle contraction. threshold stimulus, All or None rule, single muscle twitch, muscle tone, isotonic and isometric contraction.

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction.

PRACTICAL

1. Finding the coagulation time of blood
2. Determination of blood groups
3. Counting of mammalian RBCs
4. Determination of TLC and DLC
5. Determination of Haemoglobin
6. Separation of photosynthetic pigments by paper chromatography.
7. Demonstration of plasmolysis by Tradescantia leaf peel.

SUGGESTED READING

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI 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. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.
5. Mauseth, J.D. 1988 Plant Anatomy. The Benjammin/Cummings Publisher, USA.
6. Nelson, D.L., Cox, M.M. 2004 Lehninger Principles of Biochemistry, 4thedition, W.H.Freeman and Company, New York, USA.
7. Salisbury, F.B. and Ross, C.W. 1991 Plant Physiology, Wadsworth Publishing Co. Ltd.

CO-PO & PSO CORRELATION

Course Name: Physiology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		2				1		2	2	1	1	2
CO2	3		2				1		2	2	1	1	2
CO3	3		2				1		2	2	1	1	2
CO4	3		2				1		2	2	1	1	2
CO5	3		3				1		2	2	1	1	2

Note:1: Low 2.: Moderate 3: High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**III**
Name of the Course	**Biochemistry**	**Course Code**	**SOS-B-BT303**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description

Biochemistry, involves the study of the molecular composition of living cells, the organization of biological molecules within the cell, and the structure and function of these biological molecules. The biological macromolecules which this course focuses on are proteins, polysaccharides, and Lipid including the monomeric units of these macromolecules. The coarse also includes introduction to enzymes and the inhibition mechanisms.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	Students will able to understand the concept of thermodynamics, interactions among th biomolecules and introduction to metabolic activities.
CO2	Students will able to develop skills associated with the types and functions of Carbohydrates.
CO3	Students will able to understand principles underlying proteins and its building mechanisms.
CO4	Students will able to understand the biomolecules Lipid and vitamins.
CO5	Students will learn the introductory concept of Enzymology .

SYLLABUS:

UNIT I: Bioenergetics

Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction), Laws of thermodynamics, Gibbs free energy, endergonic & exergonic reactions, Standard state free energy changes, High energy compounds. Introduction to Metabolism – Catabolism and Anabolism.

UNIT II: Carbohydrates

Families of monosaccharide: aldoses and ketoses, Classification of monosaccharides. Isomerism of monosaccharides: Structural and Stereoisomers; Geometrical and optical stereoisomers, epimers, Mutarotation and anomers. Formulations of monosaccharide: Furanose and pyranose forms, Haworth projection formula, chair and boat forms. Disaccharides: concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose. Polysaccharides: Homopolysaccharides: starch, cellulose, glycogen and chitin, Heteropolysaccharides: peptidoglycan, and Hyaluronic acid.

UNIT III: Amino acids & Proteins

Amino acids: General formula of amino acid and concept of zwitterions, titration curve of amino acid and it's Significance, Classification, Ninhydrin reaction. Peptide unit and its salient features. Proteins: Types of proteins and their general functions,. Different Level of structural organization of proteins: primary, secondary (alpha helix and beta pleated sheet), tertiary and quarternary. Forces stabilizing protein structure and shape.

UNIT IV: Lipids and Vitamins

Lipids: Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipid, sphingolipid, glycolipids, cerebrosides, Gangliosides, Prostaglandins, Cholesterol. Vitamins: Fat soluble and Water soluble Vitamins, importance and Deficiency.

UNIT V: Enzymes

Nomenclature and classification of Enzymes, Holoenzyme, Apoenzyme, Cofactors: coenzyme, prosthetic groups, metalloenzymes, activation energy and transition state, active sites, Lock and key hypothesis, and Induced Fit hypothesis, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive and non-competitive.

PRACTICAL

8. Concept of pH using pH meter.
9. Preparation of buffers.
10. Numerical based on Gibb's free energy change.
11. Qualitative tests for Carbohydrates
12. Qualitative tests for lipids
13. Qualitative tests for proteins
14. To study the effect of pH, temperature on the activity of salivary amylase enzyme.

SUGGESTED READINGS

6. Jain JL (2008)Fundamentals of Biochemistry S Chand Publication.
7. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
8. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company.
9. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman & co.
10. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley andSons.

CO-PO & PSO CORRELATION

Course Name: Biochemistry													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	3		1						3	2	3	2	2
CO2	2		1						3	2	2	1	2
CO3	3		1		2				3	2	3	3	2
CO4	3		1						3	2	3	2	2
CO5	3		2		3				3	2	3	3	3

Note:1: Low 2.: Moderate 3: High

Programme:	**B.Sc. Hons. Biotechnology**	**Semester**	**IV**
Name of the Course	**Environmental Biotechnology**	**Course Code**	**SOS-B-BT403**
Credit	**6**	**No. Of Hours**	**8 Hours/Week**
Max Marks	**150**		

Course Description:

The Environmental Biotechnology course aims to introduce and elaborate the fundamental concepts and applications of biotechnology in all aspects of environment including its protection, restoration and sustainability. The course is structured to provide the students with fundamental concepts of environmental biotechnology, highlighting the importance of microbial and plant ecology for bioremediation, waste treatment and bioleaching.

Course Outcomes:

On successful completion of this course, students will be able to

CO Numbers	Course Outcomes
CO1	To get an insight difference between conventional and modern fuel.
CO2	To have an idea about the concept of Bioremediation of soil and water.
CO3	To acquire the knowledge of the methods of treatment of solid and liquid municipal and industrial waste.
CO4	To gain knowledge on Bio-fertilizers, Nitrogen fixers with or without symbiotic association.
CO5	Student will able to learn about the enrichment of ores with different microorganisms and the process of bioleaching.

SYLLABUS:

UNIT I: Conventional & modern fuels

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.

UNIT II: Microbial bioremediation

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products. Degradation of lignin and cellulose

UNIT III: Phytoremediation

Remediation of toxic soil heavy metals .Treatment of municipal waste and Industrial effluents. Examples of Phytoremediation.

UNIT IV: Bio fertilizers& PGPR

Bio-fertilizers, Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, Nitrogen fixation, Nitrogenase complex, Plant Growth Promoting bacteria, Algal and fungal biofertilizers.

UNIT V: Bioleaching & GMOs

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

PRACTICAL

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of DO of water sample.
3. Calculation of BOD and COD of water sample.
4. Isolation of Bio-fertilizers (any one: Rhizobium/Azolla/Azospirillium/Blue green Algae).
5. Case Studies on bioremediation of soil and water.
6. Degradation of cellulose using bacteria.

SUGGESTED READING

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
4. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
5. Introduction to Environmental Biotechnology, Milton Wainwright
6. Principles of Environmental Engineering, Gilbert Masters
7. Wastewater Engineering – Metcalf & Eddy

CO-PO & PSO CORRELATION

Course Name: Environmental Biotechnology													
	Program Outcome								PSOs				
Course Outcomes	1	2	3	4	5	6	7	8	1	2	3	4	5
CO1	2		2			1	2		3	2	2	2	2
CO2	3		2			1	3		3	2	2	2	2
CO3	2		2			1	3		3	2	2	2	3
CO4	3		2			2	3		3	2	2	2	2
CO5	2		2			1	2		3	2	2	2	2

Note:1: Low 2.: Moderate 3: High