

DAV UNIVERSITY, JALANDHAR

**DAV UNIVERSITY JALANDHAR**



**SCHEME FOR**

**Bachelor of Science (Hons.) Biotechnology  
(Program ID-3)**

**1<sup>st</sup> TO 6<sup>th</sup> SEMESTER**

**Examinations 2016–2017 Session Onwards**

**Applicable For Admissions in 2016**

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**Scheme of Course B.Sc.  
B.Sc. (Hons.)Biotechnology  
Semester I**

S.No.	Paper Code	Course Type	Course Title	L	T	P	Credits
1	BCH101	Core	Biomolecules	4	0	0	4
2	BCH102	Core	Biomolecules Laboratory	0	0	3	2
3	MIC111A	Core	General Microbiology	4	0	0	4
4	MIC112A	Core	General Microbiology Laboratory	0	0	3	2
5	ENG151A	AECC1*	Basic Communication Skills	3	0	0	3
6	ENG152	AECC1*	Basic Communication Skills Laboratory	0	0	2	1
7	Generic Elective I						4
8	Generic Elective I Laboratory						2
Total							22

**L: Lectures T: Tutorial P: Practical Cr: Credits**

*\*Ability Enhancement Compulsory Course*

**Semester II**

S.No.	Paper Code	Course Type	Course Title	L	T	P	Cr
1	BTY121	Core	Cell Biology	4	0	0	4
2	BTY122	Core	Cell Biology Laboratory	0	0	3	2
3	CHE157	Core	General Chemistry-1	4	0	0	4
4	CHE158	Core	General Chemistry-1 Laboratory	0	0	3	2
5	EVS100	AECC 2	Environmental Studies	4	0	0	4
6	SGS107	AECC 3	General Knowledge and Human Value	4	0	0	4
7	Generic Elective II						4
8	Generic Elective II Laboratory						2
Total							26

**L: Lectures T: Tutorial P: Practical Cr: Credits**

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**Semester III**

S.No.	Paper Code	Course Type	Course Title	L	T	P	Cr
1	BTY231	Core	Genetics	4	0	0	4
2	BTY232	Core	Genetics Laboratory	0	0	3	2
3	BOT241	Core	Plant Physiology & Metabolism	4	0	0	4
4	BOT242	Core	Plant Physiology Laboratory	0	0	3	2
5	BTY111	Core	Plant Biotechnology	4	0	0	4
6	BTY112	Core	Plant Biotechnology Laboratory	0	0	3	2
7	BTY381	SEC*	Nanotechnology and drug designing	2	0	0	2
8	Generic Elective III						4
9	Generic Elective III Laboratory						2
Total							26

**L: Lectures T: Tutorial P: Practical Cr: Credits**

*\*Skill Enhancement Course*

**Semester IV**

S.No.	Paper Code	Course Type	Course Title	L	T	P	Cr
1	BTY241	Core	Molecular Biology	4	0	0	4
2	BTY242	Core	Molecular Biology Laboratory	0	0	3	2
3	MIC233	Core	Immunology	4	0	0	4
4	MIC234	Core	Immunology Laboratory	0	0	3	2
5	CHE257	Core	Chemistry -II	4	0	0	4
7	CHE258	Core	Chemistry –II Laboratory	0	0	3	2
8	BTY382	SEC	Molecular Diagnostics	2	0	0	2
9	Generic Elective IV						4
10	Generic Elective IV Laboratory						2
Total							26

**L: Lectures T: Tutorial P: Practical Cr: Credits**

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**Semester V**

S.No.	Paper Code	Course Type	Course Title	L	T	P	Cr
1	BTY351	Core	Bioprocess Technology	4	0	0	4
2	BTY352	Core	Bioprocess Technology Laboratory	0	0	3	2
3	BTY353	Core	Recombinant DNA technology	4	0	0	4
4	BTY354	Core	Recombinant DNA technology Laboratory	0	0	3	2
5	Discipline Specific Elective I						4
6	Discipline Specific Elective I Laboratory						2
7	Discipline Specific Elective II						4
8	Discipline Specific Elective II Laboratory						2
Total							24

**L: Lectures T: Tutorial P: Practical Cr: Credits**

**Semester VI**

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	BTY361	Core	Bioanalytical Tools	4	0	0	4
2	BTY362	Core	Bioanalytical Tools Laboratory	0	0	3	2
3	BTY363	Core	Genomics and Proteomics	4	0	0	4
4	BTY364	Core	Genomics and Proteomics Laboratory	0	0	3	2
5	Discipline Specific Elective III						4
6	Discipline Specific Elective III Laboratory						2
7	Discipline Specific Elective IV						4
8	Discipline Specific Elective IV Laboratory						2
Total							24

**L: Lectures T: Tutorial P: Practical Cr: Credits**

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<b>List of Generic Electives</b>							
1	BOT131	Generic Elective	Plant Diversity	4	0	0	4
2	BOT132	Generic Elective	Plant Diversity Laboratory	0	0	3	2
3	BCH103	Generic Elective	Metabolism	4	0	0	4
4	BCH104	Generic Elective	Metabolism Laboratory	0	0	3	2
5	ZOO101	Generic Elective	Animal Diversity-I	4	0	0	4
6	ZOO102	Generic Elective	Animal Diversity-I Laboratory	0	0	3	2
7	ZOO103	Generic Elective	Animal Diversity-II	4	0	0	4
8	ZOO104	Generic Elective	Animal Diversity-II Laboratory	0	0	3	2
9	ZOO321	Generic Elective	Developmental Biology	4	0	0	4
10	ZOO322	Generic Elective	Developmental Biology Laboratory	0	0	3	2
11	ZOO333	Generic Elective	Evolutionary Biology	4	0	0	4
12	ZOO334	Generic Elective	Evolutionary Biology Laboratory	0	0	3	2

<b>List of Discipline Specific Electives (DSE)</b>							
1	BTY243	DSE	Biotechnology and Human Welfare	4	0	0	4
2	BTY244	DSE	Biotechnology and Human Welfare Lab	0	0	3	2
3	BTY391	DSE	Animal Biotechnology	4	0	0	4
4	BTY392	DSE	Animal Biotechnology Laboratory	0	0	3	2
5	BTY393	DSE	Virology	4	0	0	4
6	BTY394	DSE	Virology Laboratory	0	0	3	2
7	BTY395	DSE	Biostatistics and Bioinformatics	4	0	0	4
8	BTY396	DSE	Biostatistics and Bioinformatics Laboratory	0	0	3	2
9	BTY397	DSE	Food Biotechnology	4	0	0	4
10	BTY398	DSE	Food Biotechnology Laboratory	0	0	3	2
11	BTY399	DSE	Medical Microbiology	4	0	0	4
12	BTY400	DSE	Medical Microbiology Laboratory	0	0	3	2
13	BTY382	DSE	Enzymology	4	0	0	4
14	BTY383	DSE	Enzymology Laboratory	0	0	3	2

**PLANT BIOTECHNOLOGY**

**Paper Code: BTY 111**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Objective:** The aim is to teach set of *in vitro* techniques, methods and strategies related to plant biotechnology. Students will learn how to create genetic variability for the improvement of crops, to improve the state of health of planted material and to increase the number of desirable germplasm.

**UNIT-I**

Introduction, Cyto and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropropagation: Axillary bud proliferation, Meristem and shoot tip culture, bud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

**UNIT- II**

*In vitro* haploid production Androgenic methods: Anther culture, Microspore culture androgenesis. Significance and use of haploids, Ploidy level and chromosome doubling, diploidization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

**UNIT - III**

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic hybridization, limitations. Somaclonal variation, methods, applications basis and disadvantages.

**UNIT - IV**

Plant Growth Promoting bacteria.

Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation,

Biocontrol of pathogens, Growth promotion by free-living bacteria.

**Reference Books:**

1. Chawla, H.S. *Introduction to Plant Biotechnology*. 3<sup>rd</sup> Edition. Oxford & IBH Publishing Co. Pvt. Ltd. 2008. Print.
2. Bhojwani, S.S. and Razdan, M.K. *Plant Tissue Culture: Theory and Practice*. 5<sup>th</sup> Edition. Elsevier Science. 2005. Print.
3. Gupta, P.K. *An Introduction to Biotechnology*. Rastogi Publications, India. 1990. Print.

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4. Reinert, J. and Bajaj, Y.P.S. *Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture*, Springer Verlag, Berlin, 1977. Print.
5. Razdan, M.K. *Introduction to Plant Tissue Culture*. 2<sup>nd</sup> Edition. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 2006. Print.
6. Singh, B.D. *Plant Breeding: Principles and Methods*. Kalyani Publishers, New Delhi. 2013. Print.

**PLANT BIOTECHNOLOGY**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Marks</b>
0	0	3	2	50

**LAB**

**Paper Code: BTY 112**

**Experiments:**

1. Preparation of simple growth nutrient (knop's medium), full strength, half strength, solid and liquid.
2. Preparation of complex nutrient medium (Murashige & Skoog's medium)
3. To select, Prune, sterilize and prepare an explant for culture.
4. Significance of growth hormones in culture medium.
5. To demonstrate various steps of Micropropagation.



**CELL BIOLOGY**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Code: BTY121**

**Course Objective:** To study in detail about the cell which encompasses the cell structure, structure and functions of organelles, locomotion, life cycle and division. To impart knowledge to students about the basics of stem cells and their applications as well as to introduce them to the world of cellular differentiation and cloning.

**Course Contents:**

**Unit I: Cells and organelles (18 lectures)**

Introduction: Cell as a basic unit of living system, Biochemical composition of cell, the cell theory, ultra structure of cell.

Cytoskeleton: The Nature of the Cytoskeleton and endomembrane system, intermediate filaments, microtubules, cilia and centrioles, actin filaments, actin-binding proteins.

Cell membranes: Architecture and dynamics (models); Membrane composition, the lipid bilayer/membrane; A summary of membrane functions - simple diffusion, Facilitated transports, Active transport, Endocytosis, Pinocytosis, Phagocytosis, Exocytosis. Introduction to important receptors in cell membrane.

**Unit II: Molecule and Protein Trafficking (16 lectures)**

The compartmentalization of higher cells, transport of molecules into and out of organelle membranes, the endoplasmic reticulum, transport from the ER through the Golgi Apparatus, transport from the trans Golgi network to lysosomes, transport from the plasma membrane via endosome: Endocytosis, molecular mechanisms of vesicular transport; introduction to transit peptide, signal peptide and translocons.

**Unit III: Nucleus and Cell Cycle (10 lectures)**

Genome organization, structure and function of nucleus, nuclear envelope, structure of chromatin, nucleosome and chromosome, cell cycle, mitosis and meiosis.

**Unit IV: Eukaryotic cell organelles and functions (16 lectures)**

Structure and functions of the following cell organelles: endoplasmic reticulum, Golgi complex, lysosome, ribosome and mitochondria. Principles & applications of differential

centrifugation in the fractionation of cellular organelles and Svedberg unit; endosymbiotic theories.

**Reference Books:**

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. *Molecular Biology of the Cell*. 5<sup>th</sup> Edition. Garland Science. 2007. Print.
2. Lodish, H.F. *Molecular Cell Biology*. 6<sup>th</sup> Edition. W.H. Freeman & Company. 2007. Print.
3. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. *The World of the Cell*. 7<sup>th</sup> Edition. Benjamin Cummings. 2008. Print.
4. Powar, C.B. *Cell Biology*. Himalaya Publishing House. 2007. Print.

**CELL BIOLOGY LAB**

**Course Code: BTY122**

L	T	P	Credits	Marks
0	0	3	2	50

- Understanding principle, working and handling of light microscope and microtome.
- Understanding microscope adjustments, light sources, microscopic measurements, calibration and types of microscopes available.
- Observation of microorganisms under phase contrast microscope and dark-field microscope.
- Preparation of different types of stains
- Cytological preparations, Fixation, dehydration and staining
- Squash preparation of meiotic and mitotic cells
- Embedding and sectioning.
- Examination of various stages of mitosis and meiosis

**PRINCIPLES OF GENETICS**

**Course Code: BTY 231**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Objective:**

This course is aimed at understanding the basic concepts of genetics at molecular level to develop analytical and quantitative skills from classical to molecular genetics.

**Course Contents:**

**Unit I: Chromosome Theory of Inheritance (6 lectures)**

The chromosome theory of heredity, Sex chromosomes, Sex linkage, the parallel behaviour of autosomal genes and chromosomes.

**Unit II: Mendelian Genetics (15 lectures)**

Mendelian laws of inheritance, Monohybrid cross and the law of segregation, Dihybrid cross and law of independent assortment, Chromosome theory of inheritance, Multiple allele, lethal allele, Blood group, Rh factor, Gene interactions, Modified dihybrid ratio. Basic eukaryotic chromosome mapping, The discovery of linkage, Recombination linkage symbolism, Linkage of genes on X chromosomes, Linkage maps, Three point testcross, Interference, Calculating recombinant frequencies from selfed dihybrids, examples of linkage maps, The X2 test mitotic segregation in humans.

**Unit III: Fine Structure of Genes and Chromosomes (14 lectures)**

The concept of promoter, Coding sequence, Terminator, Induction of gene for expression. Structural organisation of chromatids, Centromeres, Telomeres, Chromatin, Nucleosome organisation; Euchromatin and heterochromatin; Special chromosomes (e.g., polytene and lampbrush chromosomes), Banding patterns in human chromosomes. Structural and numerical aberrations involving chromosomes; Hereditary defects - Klinefelter, Turner, Cri-du-Chat and Down syndromes. Mutations - spontaneous and induced, Chemical and physical mutagens.

**Unit IV: Extrachromosomal inheritance and Molecular Genetics (10 lectures)**

Coiling of shell in snails, Mitochondrial and chloroplast genetic systems, population genetics: Hardy-Weinberg equilibrium, Gene and genotypic frequencies.

**Reference Books:**

1. Strickberger, M.W. *Genetics*. 3<sup>rd</sup> Edition. Prentice-Hall, India. 2008. Print.

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2. Jones, S. *The Language of the Genes*. Harper Collins Publishers. 2012. Print.
3. Ridley, M. *Nature via Nurture: Genes, Experience, & What Makes Us Human*. HarperCollins Publishers. 2004. Print.
4. Aggarwal, V.K. and Verma, V.S. *Genetics*. 9<sup>th</sup> Edition. S. Chand, India. 2010. Print.
5. Snustad, D.P. and Simmons, M.J. *Principles of Genetics*. 6<sup>th</sup> Edition. John Wiley & Sons. 2011. Print.
6. Pierce, B.A. *Genetics: A Conceptual Approach*. 4<sup>th</sup> Edition. W.H. Freeman & Company, 2010. Print.

**PRINCIPLES OF GENETICS LAB**

L	T	P	Credits	Marks
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Course Code: BTY232

0	0	3	2	50
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### Experiments

- To make squash preparations of pre-treated metaphase chromosomes, and PMCs to view diplotene, diakinesis, metaphase I and anaphase I in *Phlox drummondii*, *Allium cepa* and (or) *Rhoeo discolor*
- Preparation of karyograms from the given photographs for karyotypic formula
- To study through photographs normal and deviant cytogenetic mechanisms
- Study of Mendel's laws and deviations from Mendelian ratios using seed samples in the ratios of 9:7, 9:4:3, 13:3, 15:1, 12:3:1. Use Chi-Square Test for Testing the ratios
- Isolation of chloroplasts by sucrose gradient. Photographs of restriction site variation of chloroplast DNA
- Exercises wrt determination of correct sequence and distance between the linked genes
- Induction and recovery of mutants in bacteria by UV irradiation
- Segregation demonstration in preserved material (Maize)
- Detection of Blood groups (A B O & Rh factors)
- Inheritance of other human characteristics, ability to test PTC, Thiourea
- Paternity disputes (blood groups)

**NANOTECHNOLOGY AND DRUG DESIGNING**

L	T	P	Credits	Marks
2	0	0	2	50

**Course Code: BTY 381**

**Course Objective:**

To understand the applications of nanotechnology in medicine. To gain an exposure to recent techniques in biopharmaceutical drug discovery.

**Course Contents:**

**Unit I**

Introduction to nanotechnology and bio-nanotechnology, Important nano-particles / materials, bionano robots/molecular motors nano motors and their uses (in brief). Synthesis of nanoparticles, Common Strategies for synthesis of nano materials with examples, (Biological methods for nanoparticle synthesis), Characterization methods of nanomaterials.

**Unit II**

Applications of nanotechnology, Nanosensors, and Carbon nanotubes and their applications in biology and medical nanotechnology. Nano pharmaceuticals: Nano biotechnology for drug discovery and drug delivery, Nano-diagnostics: Nano particles for the detection and treatment of cancer, Nano arrays for molecular diagnostics, Nanoparticles for Molecular Diagnostics, Role of nanotechnology in biological therapy, nano devices in medicine and surgery.

**Unit III**

Drug Development: Steps involved in drug discovery, Production and characterization, Preclinical studies and Validation studies, Computer aided drug designing and docking: General Principles of CADD, Types of drug designing, Ligand based molecular interactions, Structure based Drug designing, Examples of Ligand and structure based drug designing, Applications and importance of CADD.

**Unit IV**

Clinical Research: Introduction, Good clinical practice guidelines, Ethical aspects of clinical research, Clinical research methodologies and management, Regulatory requirements, Data management. Regulatory Affairs and Pharmaco vigilance, ICH, FDA, Investigational New Drug Applications, Classifications of Adverse Events, Scope of Drug Safety Problems, Drug Safety and FDA

**Reference Books:**

1. Abraham, D.J. and Rotella, D.P. *Burger's Medicinal Chemistry, Drug Discovery and Development*. 8 Volume Set. 7<sup>th</sup> Edition. John Wiley & Sons Ltd. 2010. Print.

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2. Beale, J.M. and Lock, J. *Wilson & Gisvold's text book of organic medicinal and pharmaceutical Chemistry*. 12<sup>th</sup> Edition. Lippincott Williams & Wilkins. 2010. Print.
3. Liljefors, T., Krogsgaard-Larsen, P. and Madsen, U. *Textbook of Drug Design and Discovery*. 3<sup>rd</sup> Edition. CRC Press. 2002. Print.
4. Prasad, S.K. *Modern Concepts in Nanotechnology*. Discovery Publishing House. 2008. Print.
5. Trivedi, P.C. *Nanobiotechnology*. Pointer Publishers. 2008. Print.



**MOLECULAR BIOLOGY**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Code: BTY241**

**Course Objective:** The aim is to extend understanding of the molecular mechanisms via which genetic information is stored, expressed and transmitted among generations.

**Course Contents:**

**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, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

**UNIT II: DNA damage, repair and homologous recombination**

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translation synthesis, recombinational repair, non-homologous end joining. Homologous recombination : models and mechanism.

**UNIT III: Transcription and RNA processing**

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

**UNIT IV: Regulation of gene expression and translation**

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

**Reference Books:**

1. Freshney, R. I. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*. 6<sup>th</sup> Edition. Wiley-Blackwell, 2010. Print.

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2. Atala, A. and Lanza, R. *Methods of Tissue Engineering*. 1<sup>st</sup> Edition. Academic Press. 2001. Print.
3. Harrison, M.A. and Rae, I.F. *General Techniques of Cell Culture*. 1<sup>st</sup> Edition. Cambridge University Press. 1997. Print.
4. Masters, J.R.W. *Animal Cell Culture: A Practical Approach*. 3<sup>rd</sup> Edition. Oxford University Press. 2000. Print.
5. Friefelder, D. *Molecular Biology*. 2<sup>nd</sup> Edition. Narosa Book Distributors Pvt. Ltd. 2008. Print.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. *Molecular Biology of the Cell*. 5<sup>th</sup> Edition. Garland Science. 2007. Print.

**MOLECULAR BIOLOGY LAB**

L	T	P	Credits	Marks
0	0	3	2	50

**Course Code: BTY242**

**Experiments**

- Isolation of DNA from animal and plant tissue using classical methods
- Isolation of RNA from animal and plant tissue using classical methods
- Isolation of plasmid DNA from *E. coli* using boiling-prep and alkali lysis method
- Restriction fragment length polymorphism
- Agarose gel electrophoresis
- Polyacrylamide gel electrophoresis
- Elution of nucleic acids from agarose gel
- Primer Designing
- Polymerase Chain Reaction

**ENZYMOLGY**

L	T	P	Credits	Marks
2	0	0	2	50

**Course Code: BTY 382**

**UNIT - I**

Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis.

Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin).

Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of  $K_m$  and  $V_{max}$  and their physiological significance, factors affecting initial rate, E, S, temperature & pH. Collision and transition state theories, Significance of activation energy and free energy.

**UNIT – II**

Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of  $K_i$ , suicide inhibitor.

Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. Techniques for studying mechanisms of action, chemical modification of active site groups, specific examples:- chymotrypsin, Isozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feedback control, covalent modification.

**UNIT – III**

Allosteric enzymes with special reference to aspartate transcarbamylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes. Isoenzymes– multiple forms of enzymes with special reference to lactate dehydrogenase. Multi enzyme complexes. Ribozymes. Multifunctional enzyme-eg Fatty Acidsynthase.

**UNIT – IV**

Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes.

Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application of fundamental studies of biochemistry.

Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution.

Methods for protein sequencing. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *in vitro* and *in vivo*.

**Reference Books:**

1. Nicholas C. Price and Lewis Stevens. *Fundamentals of Enzymology*, Oxford University Press, 2003. Print.
2. Paul Engal, *Enzyme kinetics* John Willey and Sons Inc. 1977. Print.
3. Athel Cornish, *Principles of enzyme kinetics*. Bowden and Butterworth and Co., 1976.
4. Jayaraman, J. *Laboratory manual in Biochemistry*. New Age International. 2006.
5. Source book of Microbiology by Primrose.

**BIOPROCESS TECHNOLOGY**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Code: BTY 351**

**UNIT I**

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, Fed batch and Continuous culture.

**UNIT II**

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, Inocula development and sterilization.

**UNIT III**

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**

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

**Reference Books:**

1. Pauline M. Doran, *Bioprocess Engineering Principles*, Elsevier, South Asia Edition, 2005.
2. Shuler, M and Kargi, F, *Bioprocess Engineering Basic Concepts* 2<sup>nd</sup> Edition, Prentice-Hall India.2006.
3. Doran, P. M. *Bioprocess Engineering Principles*, Elsevier Science & Technology Books. 2002.

**BIOPROCESS ENGINEERING LAB**

L	T	P	Credits	Marks
0	0	3	2	50

**Course Code: BTY 352**

**Experiments**

1. Calculation of bacterial growth curve.
2. Calculation 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.

**RECOMBINANT DNA TECHNOLOGY**

**Course Code: BTY353**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Objective:** Recombinant DNA technology refers to the process of manipulating the characteristics and functions of the original genes of an organism. The objective of this process is to introduce new physiological and physical features or characteristics. The students will learn how the genes can be cut and pasted from one organism to another and what its implications are.

**UNIT I**

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

**UNIT II**

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, Applications of Genetic Engineering; 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 III**

Random and site-directed mutagenesis: Primer extension and PCR based methods of sitedirected mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

**UNIT IV**

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.

**Reference Books:**

1. Caudy, A.A., Watson, J.D., Myers, R.M. and Witkowski, J.A. *Recombinant DNA: Genes and Genomes*. 3<sup>rd</sup> Edition. W.H. Freeman & Company. 2006. Print.



2. Primrose, S.B. and Twyman, R.M. *Principles of Gene Manipulation & Genomics*. 7<sup>th</sup> Edition. Oxford University Press. 2006. Print.
3. Lodge, J., Lund, P. and Minchin, S. *Gene Cloning: Principles and Applications*. 1<sup>st</sup> Edition. Taylor & Francis. 2006. Print.
5. Brown, T.A. *Gene cloning and DNA analysis: An introduction*. 5<sup>th</sup> Edition. Wiley-Blackwell. 2010. Print.
6. Sambrook, J., Fritsch, E.F. and Maniatis, T. *Molecular cloning: A Laboratory Manual*. Vol. I-III. 2<sup>nd</sup> Edition. Cold Spring Harbor Laboratory, 1989. Print.

**RECOMBINANT DNA TECHNOLOGY**

**Course Code: BTY354**

L	T	P	Credits	Marks
0	0	3	2	50

**PRACTICALS**

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

**ANIMAL BIOTECHNOLOGY**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Code: BTY391**

**Course Objective:** The aim of the course is to provide equal importance to areas like *in vitro* fertilization, animal cell and tissue culture, hormone vaccine and important enzyme production through animal biotechnology.

**Course Contents:**

**UNIT-I**

Principles and objectives of animal biotechnology; physical and chemical procedures; aseptic techniques; types of chemical agents and their applications/limitations.

**UNIT II**

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer.

**UNIT III**

Introduction to transgenesis. Transgenic Animals – Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases need help of Biotechnology – Foot and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.

**UNIT IV**

Animal propagation – Artificial insemination, Animal Clones. Conservation Biology – Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

**UNIT V**

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

**Reference Books:**

1. Freshney, R. I. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications*. 6<sup>th</sup> Edition. Wiley-Blackwell, 2010. Print.
2. Masters, J.R.W. *Animal Cell Culture: A Practical Approach*. 3<sup>rd</sup> Edition. Oxford University Press. 2000. Print.
3. Verma, A. and Singh, A. *Animal Biotechnology: Models in Discovery and Translation*. 1<sup>st</sup> Edition. Academic Press. 2013. Print.

4. Twine, R. *Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies*. 1<sup>st</sup> Edition. Routledge Publishers. 2010. Print.

**ANIMAL BIOTECHNOLOGY LAB**

**Course Code: BTY392**

L	T	P	Credits	Marks
0	0	3	2	50

**Experiments**

- Sterilization techniques: Theory and Practices: Glass ware sterilization, Media sterilization, Laboratory sterilization
- Sources of contamination and decontamination measures.
- Preparation of Hanks Balanced salt solution
- Preparation of Minimal Essential Growth medium
- Isolation of lymphocytes for culturing
- Isolation of rat macrophages from peritoneum for culturing
- Primary Lymphoid culture
- DNA isolation from animal tissue
- Quantification of isolated DNA
- Resolving DNA on Agarose Gel.

**VIROLOGY**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Code: BTY393**

**Course Objective:** To give an introduction to the basics in virology. General information on morphology, architecture, transmission of plant and animal viruses and viruses infecting microbes and insects.

**Course Contents:**

**Unit-I**

Introduction & History of Virology, Origin & Evolution of Viruses, Taxonomy.

**Unit-II**

Morphology, Architecture and methods for its study, Host range, Transmission, Movement, Symptomatology, Serology, methods for assay, detection and diagnosis, Virus purification.

**Unit-III**

Biochemistry of Viruses & Viral Pathogenesis, Organization & Expression of Viral genomes. Replication of RNA and DNA Viruses.

**Unit-IV**

Management and control of viruses including development of virus disease resistant transgenics.

**Unit-V**

Defective Particles, Multiparticles, Viroids, Virusoids, Prions, Mycoviruses, Bacteriophage, Cynophage, Virophage, Baculoviruses.

**Reference Books:**

1. Hull, R. *Matthews Plant Virology*. 4<sup>th</sup> Edition. Academic Press. 2001. Print.
2. Knipe, D.M. and Howley, P.M. *Fields Virology*. 5<sup>th</sup> Edition. Lippincott Williams & Wilkins. 2006. Print.
3. Cann, A.J. *Principles of Molecular Virology*. 5<sup>th</sup> Edition. Academic Press. 2011. Print.
4. Carter, J. and Saunders, V. *Virology: Principles and Applications*. 2<sup>nd</sup> Edition. John Wiley & Sons Ltd. 2013. Print.

**VIROLOGY LAB**

L	T	P	Credits	Marks
0	0	3	2	50

**Course Code: BTY394**

### **Experiments**

- Virus diagnosis using ELISA
- Virus diagnosis using PCR
- Virus diagnosis using slot-blot hybridization
- Study of symptoms of virus diseases through visit to local diseases fields and/or photographs
- Collection and Processing of Viral Samples
- Effect of virus infection on chloroplast number and cell size
- Transmission of plant viruses
- Collection and Identification of local insect vectors
- Determination of disease progress curve

**BIO-ANALYTICAL TOOLS**

**Course Code: BTY361**

L	T	P	Credits	Marks
4	0	0	4	100

**UNIT I**

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

**UNIT II**

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

**UNIT III**

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**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

**Reference Books:**

1. Wilson, K. and Walker, J. *Practical Biochemistry: Principles and Techniques*. 5<sup>th</sup> Edition. Cambridge University Press. 2005. Print.
2. Iserentant, D. M. *Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes*. 1<sup>st</sup> Edition. Springer-verlag Gmbh. 1997. Print.
3. Ho, P. S., Johnson, C. and van Holde, K. E. *Principles of Physical Biochemistry*. 2<sup>nd</sup> Edition. Pearson. 2005. Print.
4. Venn, R. F. *Principles and Practice of Bioanalysis*. 1<sup>st</sup> Edition. Taylor & Francis. 2000. Print.
5. Hoppert, M. *Microscopic Techniques in Biotechnology*. 1<sup>st</sup> Edition. John Wiley & Sons. 2001. Print.



**BIOANALYTICAL TOOLS LABORATORY**

**Course Code: BTY362**

L	T	P	Credits	Marks
0	0	3	2	50

**PRACTICALS**

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.

**GENOMICS AND PROTEOMICS**

**Course Code: BTY 363**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Objective:**

The course helps in developing a detailed understanding of eukaryotic genome complexity and organization. The students will be familiarised with the techniques in Genomics and Proteomics.

**Course Contents:**

**Unit - I (5 lectures)**

The origin of genomes. Acquisition of new Genes. The origins of introns. Basic principles of protein structure.

**Unit - II (5 lectures)**

Restriction mapping, DNA & RNA finger printing, DNA sequencing-chemical and enzymatic methods, The Human Genome.

**Unit - III (6 lectures)**

Phylogeny, SAGE, ESTs, AFLP & RFLP analysis. 2D – gel electrophoresis and mass spectroscopy for proteome analysis.

**Unit - IV(8 lectures)**

Modeling of three-dimensional structure of a protein from amino acid sequence. Modeling mutants. Designing proteins. Analysis of nucleic acid / protein sequence and structure data, genome and proteome data using web-based tools.

**Unit - V: (6 lectures)**

Protein – protein interactions: Yeast- two hybrid method, GFP Tags, Proteome- wide interaction maps.

**Reference Books:**

1. Brown, T.A. *Genomes III*. 3<sup>rd</sup> Edition. Garland Science. 2006. Print.
2. Lengauer, T., Mannhold, R., Kubinyi, H. and Timmerman, H. *Bioinformatics: From Genomes to Drugs*. 1<sup>st</sup> Edition. John Wiley and Sons Ltd. 2001. Print.
3. Mount, D. *Bioinformatics: Sequence and Genome Analysis*. 2<sup>nd</sup> Edition. Cold Spring Harbor Laboratory Press. 2013. Print.
4. Schena, M. *DNA Microarrays: A Practical Approach*. 1<sup>st</sup> Edition. Oxford University Press. 1999. Print.

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5. Gibson, G. and Muse, S.V. *A Primer of Genome Science*. 3<sup>rd</sup> Edition. Sinauer Associates, Inc. 2009. Print.
6. Caudy, A.A., Watson, J.D., Myers, R.M. and Witkowski, J.A. *Recombinant DNA: Genes and Genomes*. 3<sup>rd</sup> Edition. W.H. Freeman & Company. 2006. Print.
7. Xiong, J. *Essential Bioinformatics*. 1<sup>st</sup> Edition. Cambridge University Press. 2006. Print.
8. Twyman, R. *Principles of Proteomics*. 2<sup>nd</sup> Edition. Garland Science. 2013. Print.

**GENOMICS AND PROTEOMICS LAB**

**Course Code: BTY 364**

L	T	P	Credits	Marks
0	0	3	2	50

**Experiments**

- Electrophoretic separation of plasmid DNA.
- Restriction, digestion & ligation of DNA.
- Gene finding tools and genome annotation- Gen Scan, Net Gene, Hmm gene.
- Comparison of two given genomes- Mummer.
- Homology modeling of 3-D structure from amino acid sequence: SWISS- MODELLER
- Graphics tools: SWISS- PDB Viewer.

**BIOSTATISTICS AND BIOINFORMATICS**

**Course Code: BTY 395**

L	T	P	Credits	Marks
4	0	0	4	100

**UNIT I**

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis. Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.

**UNIT II**

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), Correlation and Regression. Emphasis on examples from Biological Sciences.

**UNIT III**

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web. Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

**UNIT IV**

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 V**

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.

**Reference Books:**

1. Banerjee, P.K. *Introduction to Biostatistics*. 4<sup>th</sup> Edition. S. Chand & Co. Ltd. 4<sup>th</sup> Edition. 2013. Print.
2. Sokal, R.R. and Rohlf, F.J. *Introduction to Biostatistics*. 2<sup>nd</sup> Edition. Dover Publications. 2009. Print.

3. Pevzner, P. and Shamir, R. *Bioinformatics for Biologists*. Cambridge University Press. 2011. Print.
4. Lesk, A. *Introduction to Bioinformatics*. 3<sup>rd</sup> Edition. Oxford University Press. 2008. Print.
5. Bourne, P.E. and Weissig, H. *Structural Bioinformatics*. 2<sup>nd</sup> Edition. John Wiley & Sons Ltd. 2009. Print.

**BIOSTATISTICS AND BIOINFORMATICS LAB**

**Course Code: BTY 396**

L	T	P	Credits	Marks
0	0	3	2	50

**EXPERIMENTS**

1. Based on graphical Representation
2. Based on measures of Central Tendency & Dispersion
3. Based on Distributions Binomial Poisson Normal
4. Based on t, f, z and Chi-square
5. Sequence information resource
6. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
7. Understanding and using: PDB, Swissprot, TREMBL
8. Using various BLAST and interpretation of results.
9. Retrieval of information from nucleotide databases.
10. Sequence alignment using BLAST.
11. Multiple sequence alignment using Clustal W.

**FOOD BIOTECHNOLOGY**

**Course Code: BTY 397**

L	T	P	Credits	Marks
4	0	0	4	100

**UNIT-I**

History of microbiology of food - microbial growth pattern, physical and chemical factors influencing structure of micro-organisms - types of micro-organism normally associated with food - mold, yeast and bacteria.

**UNIT-II**

Micro-organisms in natural food products and their control - contaminants of foods -stuffs, vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing - biochemical changes caused by micro-organisms - deterioration of various types of food products - food poisoning and microbial toxins.

**UNIT-III**

Scope and importance of food processing - principles and methods of food preservation - freezing, heating, dehydration, canning, additives, fermentation, irradiation, extrusion cooking, hydrostatic pressure cooking, dielectric heating, microwave processing.

**UNIT-IV**

Introduction to packaging - packaging principles and operation - package functions and design - deteriorative changes in food stuff and packaging methods for prevention- shelf life of packaged foodstuffs - methods to extend shelf life.

**UNIT-V**

Objectives, importance and functions of quality control - methods of quality -assessment of food materials - fruits, vegetables, cereals, dairy products, meat, poultry, egg and processed food products - sampling and specification of raw materials and finished products - statistical quality controls - food regulations, grades and standards - food adulteration, food safety and evaluation.

**Reference Books:**

1. Der, A.E. *Food Processing and Nutrition*. Academic Press, London. 1978.
2. Lows, P. and Ellis H. *Food Processing*. Prentice Hall, Reston Virginia, USA. 1990.
3. Jelen, P. *Introduction to Food Processing*. Prentice Hall, Reston Virginia, USA. 1985.
4. Branen, A.L. and Davidson, P.M. *Antimicrobials in Foods*. Marcel Dekker, New York. 1983.
5. Jay, J.M. *Modern Food Microbiology*. 3rd Edn. VNR, New York. 1986.



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6. Ranganna, S. *Handbook of Analysis and Quality Control for Fruits andVegetable Products*. Tata McGraw Hill, New Delhi. 1986.
7. Scicharow, S. and Griffin, R.C. *Food Packaging*. AVI, Westport . 1970.

**FOOD BIOTECHNOLOGY LAB**

**Course Code: BTY 398**

L	T	P	Credits	Marks
0	0	3	2	50

**EXPERIMENTS**

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.

**Course Code: BCH101**

**Course Title: Biomolecules**

L	T	P	Credits	Marks
4	0	0	4	100

**Unit A**

**(15 hours)**

**Introduction to Biochemistry**

Water as a biological solvent. Weak acids and bases. pH and buffers. Henderson-Hasselbalch equation. Physiological buffers. Fitness of the aqueous environment for living organisms.

Carbohydrates Structure of monosaccharides. Stereoisomerism and optical isomerism of sugars. Reactions of aldehyde and ketone groups. Ring structure and anomeric forms, mutarotation. Reactions of sugars due to hydroxyl groups. Important derivatives of monosaccharides, disaccharides and trisaccharides (structure, function and occurrence of important ones). Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides - cellulose, chitin, agar, alginic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch. Bacterial cell wall polysaccharides. Glycoproteins.

**Unit B**

**(15 hours)**

**Proteins**

Introduction to proteins. Classification based on solubility, shape, composition and functions. Amino acids: common structural features, stereoisomerism and RS system of designating optical isomers. Classification and structures of standard amino acids as zwitterion in aqueous solutions. Physical and chemical properties of amino acids. Titration of amino acids. Separation of amino acids. Essential amino acids.

Structure of peptide bond. Solid-phase synthesis of peptides. Peptide sequencing. Chemical and enzymatic cleavage of polypeptide chains and separation of peptides. Levels of structure in protein architecture, denaturation and renaturation of proteins. Behaviour of proteins in solutions. Salting in and salting out of proteins. Structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (haemoglobin, myoglobin), lipoproteins, metalloproteins, glycoproteins and nucleoproteins.

**Unit C**

**(15 hours)**

**Nucleic Acids**

Nature of genetic material. Evidence that DNA is the genetic material. Composition of DNA and RNA. Generalized structural plan and Nomenclature of nucleic acids. DNA double helix. Structure and roles of different types of RNA. Size of DNA in prokaryotes and eukaryotes. Central dogma of molecular biology. Concepts of gene, genome and chromosome.

Porphyrins: Porphyrin nucleus and classification of porphyrins. Important metalloporphyrins occurring in nature. Detection of porphyrins. Bile pigments – chemical nature and physiological significance.

**Unit D**

**(15 hours)**

**Lipids**

Definition and classification of lipids. Fatty acids: introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Essential fatty acids, prostaglandins. Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats – hydrolysis, saponification value, rancidity of fats, Reichert-Meissel Number and reaction of glycerol. Biological significance of fats. Glycerophospholipids (lecithins, lysolecithins, cephalins, phosphatidylserine, phosphatidylinositol, plasmalogens), sphingomyelins, glycolipids – cerebrosides, gangliosides. Properties and functions of phospholipids, isoprenoids and sterols.

**Reference books:**

1. Nelson, David L., and Cox, Michael M., *Lehninger Principles of Biochemistry*, 5<sup>th</sup> Edition, W.H. Freeman & Company, New York, 2008. Print.
2. Voet, Donald and Voet, Judith G., *Biochemistry*, 3<sup>rd</sup> Edition, John Wiley & Sons Inc., Singapore, 2004. Print.
3. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27<sup>th</sup> Edition, McGraw Hill Company Inc. Singapore, 2006. Print.

**Course Title: Biomolecules Laboratory**

**Course Code: BCH102**

L	T	P	Credits	Marks
0	0	3	2	50

**Experiments:**

1. Preparation of normal, molar and percent solutions.
2. Titration curve of Glycine.
3. Buffer preparation.
4. Qualitative tests for Carbohydrates, Lipids, Amino acids, Proteins, Nucleic acids
5. Preparation of casein from milk and determination of its isoelectric point.
6. Titrimetric analysis of Vitamin C.

**Course Title: Plant Diversity**

**Course Code: BOT131**

L	T	P	Credits	Marks
4	0	0	4	100

### **UNIT-I**

Viruses: Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

### **UNIT-II**

Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus, Polysiphonia. Economic importance of algae.

Fungi: Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of Rhizopus (Zygomycota) Penicillium, Alternaria (Ascomycota), Puccinia, Agaricus (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

### **UNIT-III**

Introduction to Archegoniate: Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Bryophytes: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. Ecology and economic importance of bryophytes with special mention of Sphagnum.

### **UNIT-IV**

Pteridophytes: General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to family), morphology, anatomy and reproduction of Selaginella, Equisetum and Pteris. Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes.

Gymnosperms: General characteristics; Classification (up to family), morphology, anatomy and reproduction of Cycas and Pinus. Ecological and economical importance.

**Reference Books:**

1. Kumar, H.D. *Introductory Phycology*. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition. 1999.
2. Tortora, G.J., Funke, B.R., Case, C.L. *Microbiology: An Introduction*, Pearson Benjamin Cummings, U.S.A. 10<sup>th</sup> edition. 2010.
3. Sethi, I.K. and Walia, S.K. *Text book of Fungi & Their Allies*, MacMillan Publishers Pvt. Ltd., Delhi. 2011.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. *Introductory Mycology*, John Wiley and Sons (Asia), Singapore. 4<sup>th</sup> edition. 1996
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S. R., *Biology*. Tata McGraw Hill, Delhi, India. 2005.
6. Vashishta, P.C., Sinha, A.K., Kumar, A. *Pteridophyta*, S. Chand. Delhi, India. 2010.
7. Bhatnagar, S.P. and Moitra, A. *Gymnosperms*. New Age International (P) Ltd Publishers, New Delhi, India. 1996
8. Parihar, N.S. *An introduction to Embryophyta. Vol. I. Bryophyta*. Central Book Depot, Allahabad. 1991.

**Course Title: Plant Diversity Laboratory**

**Course Code: BOT132**

L	T	P	Credits	Marks
0	0	3	2	50

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Fucus\* and Polysiphonia through temporary preparations and permanent slides. (\* Fucus - Specimen and permanent slides)
5. Rhizopus and Penicillium: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. Alternaria: Specimens/photographs and tease mounts.
7. Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. Agaricus: Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ectomycorrhiza and endomycorrhiza (Photographs)
11. Marchantia- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
12. Funaria- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. Selaginella- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
14. Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
15. Pteris- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
16. Cycas- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).



17. Pinus- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m.dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. &r.l.s. stem (permanent slide).

Course Code: ENG151A

Course Title: Basic Communications Skills

L	T	P	Credits	Marks
3	0	0	3	75

**Unit – A Applied Grammar (Socio-Cultural Context)**

Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, Interjection	5 hours
Tenses (Rules and Usages in Socio-cultural contexts)	6 hour
Modals: Can, Could, May, Might, Will, Would, Shall, Should, Must, Ought to	5hours
Passive/Active	5 hours
Reported/Reporting Speech	5 hour

**Unit – B Reading (Communicative Approach to be Followed)**

J M Synge: Riders to the Sea (One Act Play)	7 hours
Anton Chekhov : Joy (Short Story)	5 hours
Swami Vivekanand : The Secret of Work (Prose)	7 hours

**Unit – C Writing**

Essay Writing and Letter Writing	5Hours
Report Writing	5 hours
Group Discussion & Facing an Interview	5hours

**References:**

**a. Books**

1. Kumar, Sanjay and Pushp Lata. *Communication Skills*. India: OUP, 2012. Print.
2. Vandana, R. Singh. *The Written Word*. New Delhi: Oxford University Press, 2008. Print.

**b. Websites**

1. [www.youtube.com](http://www.youtube.com) (to download videos for panel discussions). Web.
2. [www.letterwritingguide.com](http://www.letterwritingguide.com). Web.
3. [www.teach-nology.com](http://www.teach-nology.com). Web.
4. [www.englishforeveryone.org](http://www.englishforeveryone.org). Web.
5. [www.dailywritingtips.com](http://www.dailywritingtips.com). Web.
6. [www.englishworksheets.com](http://www.englishworksheets.com). Web.
7. [www.mindtools.com](http://www.mindtools.com). Web.

**Course Title: Basic Communications Skills Laboratory**

**Course Code: ENG152**

L	T	P	Credits	Marks
0	0	2	1	25

**Unit – A Speaking/Listening**

Movie-Clippings	10 hours
Role Plays	10 hours
Group Discussions	10 hours

**References Books:**

1. Gangal, J. K. *A Practical Course in Spoken English*. India: Phi Private Limited, 2012. Print.
2. Kumar, Sanjay and Pushp Lata. *Communication Skills*. India: OUP, 2012. Print.

**Websites**

1. [www.youtube.com](http://www.youtube.com) (to download videos for panel discussions). Web.
2. [www.englishforeveryone.org](http://www.englishforeveryone.org). Web.
3. [www.talkenglish.com](http://www.talkenglish.com). Web.
4. [www.mindtools.com](http://www.mindtools.com). Web.

Course Code: CHE157

Course Title: General Chemistry - I

L	T	P	Credits	Marks
4	0	0	4	100

## ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

### *Section A: Inorganic Chemistry-1 (30 Periods)*

**Atomic Structure:** Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure. What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of  $\psi$  and  $\psi^2$ , Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers  $n$ ,  $l$  and  $m$ . Shapes of  $s$ ,  $p$  and  $d$  atomic orbitals, nodal planes. Discovery of spin, spin quantum number ( $s$ ) and magnetic spin quantum number ( $m_s$ ). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

### **Chemical Bonding and Molecular Structure**

*Ionic Bonding:* General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

*Covalent bonding:* VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO<sup>+</sup>. Comparison of VB and MO approaches.

### **Section B: Organic Chemistry-I (30 Periods)**

#### **Fundamentals of Organic Chemistry**

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Huckel's rule.

#### **Stereochemistry**

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L *cis-trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

#### **Aliphatic Hydrocarbons**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**Alkanes:** (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

**Alkenes:** (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff rule); *cis* alkenes (Partial catalytic hydrogenation) and *trans* alkenes (Birch reduction). *Reactions:* *cis*-addition (alk. KMnO<sub>4</sub>) and *trans*-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

**Alkynes:** (Upto 5 Carbons) *Preparation:* Acetylene from CaC<sub>2</sub> and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

*Reactions:* formation of metal acetylides, addition of bromine and alkaline  $\text{KMnO}_4$  ozonolysis and oxidation with hot alk.  $\text{KMnO}_4$

**Reference Books:**

- J. D. Lee: *A new Concise Inorganic Chemistry*, E. L. B. S.
- F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.
- Douglas, McDaniel and Alexander: *Concepts and Models in Inorganic Chemistry*, John Wiley.
- James E. Huheey, Ellen Keiter and Richard Keiter: *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Publication.
- T. W. Graham Solomon: *Organic Chemistry*, John Wiley and Sons.
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman.
- E. L. Eliel: *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
- I. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall.
- ArunBahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand

Course Code: CHE158

Course Title: General Chemistry – I Laboratory

L	T	P	Credits	Marks
0	0	3	2	50

***Section A: Inorganic Chemistry - Volumetric Analysis***

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with  $\text{KMnO}_4$ .
3. Estimation of water of crystallization in Mohr's salt by titrating with  $\text{KMnO}_4$ .
4. Estimation of Fe (II) ions by titrating it with  $\text{K}_2\text{Cr}_2\text{O}_7$  with internal indicator.
5. Estimation of Cu (II) ions iodometrically using  $\text{Na}_2\text{S}_2\text{O}_3$ .

***Section B: Organic Chemistry***

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements).
2. Separation of mixtures by Chromatography: Measure the  $R_f$  value in each case (combination of two compounds to be given):
  - (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
  - (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Course Code: CHE257

Course Title: General Chemistry – II

L	T	P	Credits	Marks
4	0	0	4	100

## CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

### *Section A: Physical Chemistry-1 (30 Lectures)*

#### **Chemical Energetics**

Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

#### **Chemical Equilibrium:**

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

#### **Ionic Equilibria:**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

### *Section B: Organic Chemistry-2 (30 Lectures)*

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

#### **Aromatic hydrocarbons**

*Preparation* (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

*Reactions:* (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

#### **Alkyl and Aryl Halides**



**Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution reactions.

*Preparation:* from alkenes and alcohols.

*Reactions:* hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

**Aryl Halides** *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

*Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism:  $\text{KNH}_2/\text{NH}_3$  or  $\text{NaNH}_2$ .

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

**Alcohols:** *Preparation:* Preparation of primary, secondary and tertiary alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

*Reactions:* With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk.  $\text{KMnO}_4$ , acidic dichromate, conc.  $\text{HNO}_3$ ). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

**Phenols:** (Phenol case) *Preparation:* Cumenehydroperoxide method, from diazonium salts.

*Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten – Baumann reaction.

**Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.

**Aldehydes and ketones (aliphatic and aromatic):** (Formaldehyde, acetaldehyde, acetone and benzaldehyde)

*Preparation:* from acid chlorides and from nitriles.

*Reactions* – Reaction with HCN, ROH,  $\text{NaHSO}_3$ , NH-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf-Verley reduction.

### Reference Books:

- T. W. Graham Solomons: *Organic Chemistry, John Wiley and Sons.*
- Peter Sykes: *A Guide Book to Mechanism in Organic Chemistry, Orient Longman.*
- I.L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: *Organic Chemistry, Prentice Hall.*
- Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry, S. Chand.*

**DAV UNIVERSITY, JALANDHAR**

- G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill. 2007.
- G. W. Castellan: *Physical Chemistry* 4th Edn. Narosa. 2004.
- J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi. 2009.
- B. H. Mahan: *University Chemistry* 3rd Ed. Narosa. 1998.
- R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York. 1985.

Course Code: CHE258

Course Title: General Chemistry – II Laboratory

L	T	P	Credits	Marks
0	0	3	2	50

**Section A: Physical Chemistry**

**Thermochemistry**

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO<sub>3</sub>, NH<sub>4</sub>Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of  $\Delta H$ .

**Ionic equilibria**

pH measurements

- a) 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.
- b) Preparation of buffer solutions:
  - (i) Sodium acetate-acetic acid
  - (ii) Ammonium chloride-ammonium hydroxide

Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

**Section B: Organic Chemistry**

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallization, determination of melting point and calculation of quantitative yields to be done.
  - (a) Bromination of Phenol/Aniline
  - (b) Benzoylation of amines/phenols
  - (c) Oxime and 2, 4 dinitrophenylhydrazone of aldehyde/ketone

**Reference Books**

**DAV UNIVERSITY, JALANDHAR**

- A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
- F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman. 1960.
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

Course Code: EVS100

Course Title: Environmental Studies

L	T	P	Credits	Marks
4	0	0	4	100

**Unit 1**

**The multidisciplinary nature of environmental studies** (2 Hours)

Definition, scope and importance, Need for public awareness

**Natural Resources: Renewable and non-renewable resources:** (8 Hours)

Natural resources and associated problems.

(a) **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

(b) **Water resources:** Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

(c) **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

(d) **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

(e) **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.

(f) **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

**Ecosystem:** (4 Hours)

- Concept of an ecosystem
- Structure and function of an ecosystem
- Producers, consumers and decomposers
- Energy flow in the ecosystem
- Ecological succession
- Food chains, food webs and ecological pyramids
- Introduction, types, characteristic features, structure and function of the following ecosystem:

- a. Forest ecosystem
- b. Grassland ecosystem
- c. Desert ecosystem
- d. Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries)

## Unit II

### **Biodiversity and its conservation**

**4 Hours**

- Introduction – Definition: Genetic, Species and Ecosystem Diversity
- Bio-geographical classification of India
- Value of biodiversity: Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values
- Biodiversity at global, national and local levels
- India as a mega-diversity nation
- Hot-spots of biodiversity
- Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts
- Endangered and endemic species of India
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity, global and national efforts.

### **Environmental Pollution**

**8Hours**

- Definition, causes, effects and control measures of:
  - a. Air pollution
  - b. Water pollution
  - c. Soil pollution
  - d. Marine pollution
  - e. Noise pollution
  - f. Thermal pollution
  - g. Nuclear pollution
- Solid waste management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies
- Disaster management: floods, earthquake, cyclone and landslides

**Unit III**

**Social Issues and the Environment**

**7 Hours**

- Population growth, variation among nations, Population explosion – Family Welfare Programmes.
- Environment and human health,
- From unsustainable to sustainable development
- Urban problems and related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case studies.
- Environmental ethics: Issues and possible solutions
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation
- Consumerism and waste products
- Environmental Laws: The Environment Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and control of Pollution) Act 1974; The Wildlife Protection Act, 1972; Forest Conservation Act, 1980.
- Issues involved in enforcement of environmental legislation
- Public Awareness

**Unit IV**

**Human Population and Environment**

**5 Hours**

- Population Growth and Variations among Nations
- Population Explosion
- Human Rights
- Value Education
- HIV / AIDS
- Women and Child Welfare
- Role of Information Technology in Environment and Human Health
- Case Studies

**Field Work**

**5 Hours**

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- Visit to a local area to document environmental assets river/ forest/ grassland/hill/mountain
- Visit to a local polluted site – Urban / Rural / Industrial / Agricultural
- Study of common plants, insects, birds
- Study of simple ecosystems-Pond, river, hill slopes, etc (Field work equal to 5 lecture hours)

### **Suggested Readings:**

1. Odum, E.P. *Basic Ecology*. Japan: Halt Saundurs, 1983.
2. Botkin, D.B., and Kodler EA. *Environmental Studies: The Earth as a living planet*. New York: John Wiley and Sons Inc., 2000.
3. Singh, J.S., Singh, S.P., and Gupta S.R., *Ecology, Environment and Resource Conservation*. New Delhi: Anamaya Publishers, 2006.
4. De, A.K., *Environmental Chemistry*. New Delhi: Wiley Eastern Ltd., 1990.
5. Sharma, P.D., *Ecology and Environment*. Meerut Rastogi Publications, 2004.



Course Code: SGS107

Course Title: General Knowledge & Human Values

art - A

L	T	P	Credits	Marks
4	0	0	4	100

*Human Values*

- 1. Concept of Human Values:** Meaning, Types and Importance of Values. **2 Hrs**
- 2. Value Education :** Basic guidelines for value education **2 Hrs**
- 3. Value crisis and its redressal** **1 Hrs**

*Being Good and Responsible*

1. Self Exploration and Self Evaluation **2 Hrs**
2. Acquiring Core Values for Self Development **2 Hrs**
3. Living in Harmony with Self, Family and Society **3 Hrs**
4. Values enshrined in the Constitution: Liberty, Equality  
Fraternity and Fundamental Duties. **3 Hrs**

**Part - B**

*Value – based living*

1. Vedic values of life **2 Hrs**
2. *Karma Yoga* and *Jnana Yoga* **2 Hrs**
3. *AshtaMarga* and *Tri-Ratna* **2 Hrs**

*Ethical Living:*

1. Personal Ethics **2 Hrs**
2. Professional Ethics **3 Hrs**
3. Ethics in Education **2 Hrs**

**Part-C**

**General Geography**

**World Geography**

**3 Hrs**

The Universe, The Solar System, The Earth, Atmosphere, The World we live in, Countries rich in Minerals, Wonders of the World, Biggest and Smallest.

**Indian Geography**

**3 Hrs**

Location, Area and Dimensions, Physical Presence, Indian States and Union Territories, Important sites and Monuments, Largest-Longest and Highest in India.

**General History**

**3 Hrs**

Glimpses of India History, Ancient Indian, Medieval India, Modern India, Various Phases of Indian National Movement, Prominent Personalities, Glimpses of Punjab history with special reference to period of Sikh Gurus

**Glimpses of World History**

**3 Hrs**

Important Events of World History, Revolutions and Wars of Independence, Political Philosophies like Nazism, Fascism, Communism, Capitalism, Liberalism etc.

**Indian Polity: Constitution of India**

**3 Hrs**

Important Provisions, Basic Structure, Union Government, Union Legislature and Executive, State Government: State Legislature and Executive, Indian Judiciary, The Election Commission, Panchayati Raj System, RTI etc.

**General Economy**

**3 Hrs**

The process of liberalization, privatization, globalization and Major World Issues, Indian Economy, Indian Financial System, Major Economic Issues, Economic Terminology.

**Part-D**

**General Science**

**3 Hrs**

General appreciation and understandings of science including the matters of everyday observation and experience, Inventions and Discoveries

**Sports and Recreation**

**3 Hrs**

The World of Sports and recreation, Who's Who is sports, Major Events, Awards and Honours. Famous personalities, Festivals, Arts and Artists

**Current Affairs**

**3 Hrs**

National and International Issues and Events in News, Governments Schemes and Policy Decisions

**Miscellaneous Information**

**Who is who**

**2 Hrs**

Books and Authors, Persons in News, Awards and Honours, Abbreviations and Sports

**References:**

1. Tripathi, A. N., *Human Values, New Age International Publishers*, Third Edition, New Delhi, 2009.
2. Surbiramanian, R. *Professional Ethics*, Oxford University Press, New Delhi, 2013.
3. Human Values and Professional Ethics, Anand, R. Prakashan, S. New Delhi, 2012.

4. Human Values and Professional Ethics, Sanjeev Bhalla, Satya Prakashan, New Delhi, 2012.
5. Human Values and Professional Ethics, Ritu Soryan Dhanpat Rai & Co. Pvt. Ltd., First Edition, 2010.
6. Jayshree, S., and Raghavan, B.S., *Human Values and Professional Ethics*, S Chand & Co. Ltd., 2007.
7. Singh, Y and Garg, A *Human Values and Professional Ethics*, Aitbs publishers, 2011.
8. Kumar, V., *Human Values and Professional Ethics*, Kalyani Publishers, Ludhiana, 2013.
9. R. R. Gaur, R. Sangal, G.P. Bagaria, *Human Values and Professional Ethics*, Excel Books, New Delhi 2010.
10. Osula, B. and Upadhyay, S., *Values and Ethics*, Asian Books Pvt. Ltd., 2011.
11. Indian Philosophy, S. Radhakrishnan, George Allen & Unwin Ltd., New York: Humanities Press INC, 1929.
12. Dwivedi, A.N., *Essentials of Hinduism, Jainism and Buddhism*, Books Today, New Delhi – 1979.
13. Dayanand : His life and work, Suraj Bhan, DAVCMC, New Delhi – 2001.
14. Dwivedi, K.D., *Essence of Vedas*, Katyayan Vedic Sahitya Prakashan, Hoshiarpur, 1990.
15. Vedic Concepts, Prof. B. B. Chaubey, Katyayan Vedic Sahitya Prakashan, Hoshiarpur, 1990.
16. Advance Objective General Knowledge, R. S. Aggarwal, S. Chand Publisher (2013).
17. Concise General Knowledge Manual 2013, S. Sen, Unique Publishers, 2013.
18. Encyclopedia of General Knowledge and General Awareness by R. P. Verma, Penguin Books Ltd (2010).
19. General Knowledge Manual 2013-14, Edgar Thorpe and Showick Thorpe, The Pearson, Delhi.
20. General Knowledge Manual 2013-14, Mukhtikanta Mohanty, Macmillan Publishers India Ltd., Delhi.
21. India 2013, Government of India (Ministry of Information Broadcasting), Publication Division, 2013.
22. Manorama Year Book 2013-14, Mammen Methew, Malayalam Manorama Publishers, Kottayam, 2013.

**23.** Spectrum's Handbook of General Studies – 2013-14, Spectrum Books (P) Ltd., New Delhi

**CURRENT AFFAIRS**

**Magazines**

Economic and Political Weekly, Yojna, the Week, India Today, Frontline, Spectrum.

Competition Success Review, Competition Master, Civil Services Chronicle, Current Affairs, World Atlas Book

**Newspapers**

The Hindu, Times of India, The Hindustan Times, The Tribune

**METABOLISM**

**Paper Code: BCH 103**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Objectives:** The course is designed to survey the major metabolic pathways involved in energy generation and synthesis of biomolecules.

**Unit A (15 hours)**

**Introduction to Metabolism**

General features of metabolism, experimental approaches to study metabolism – intact organisms, bacterial mutants, tissue slices, radioisotopes.

**Carbohydrate Metabolism**

Reactions and energetics of glycolysis. Alcoholic and lactic acid fermentations. Reactions and energetics of TCA cycle. Gluconeogenesis, glycogenesis and glycogenolysis. Reactions and physiological significance of pentose phosphate pathway. Regulation of glycolysis and TCA cycle. Photosynthesis – a brief review.

**Unit B (10 hours)**

**Electron Transport Chain and Oxidative Phosphorylation**

Structure of mitochondria. Sequence of electron carriers. Sites of ATP production. Inhibitors of electron transport chain. Chemiosmotic hypothesis. Inhibitors and uncouplers of oxidative phosphorylation. Transport of reducing potentials into mitochondria.

**Unit C (20 hours)**

**Lipid Metabolism**

Introduction. Hydrolysis of triacylglycerols. Transport of fatty acids into mitochondria.  $\beta$ -oxidation of saturated fatty acids. ATP yield from fatty acid oxidation. Biosynthesis of saturated and unsaturated fatty acids. Metabolism of ketone bodies. Oxidation of unsaturated and odd chain fatty acids. Biosynthesis of triglycerides and important phospholipids, glycolipids, sphingolipids and cholesterol. Regulation of cholesterol metabolism.

**Amino Acid Metabolism**

General reactions of amino acid metabolism – transamination, oxidative deamination and decarboxylation. Urea cycle. Degradation and biosynthesis of amino acids. Glycogenic and ketogenic amino acids.

**Unit D (15 hours)**

**Nucleotide Metabolism**

Sources of atoms in the purine and pyrimidine nucleotides. Biosynthesis and degradation of purines and pyrimidines. Regulation of purine and pyrimidine biosynthesis.

**Porphyrin Metabolism**

Biosynthesis and degradation of porphyrins. Production of bile pigments.

**Recommended books**

1. Nelson DL & Cox M.M., *Lehninger Principles of Biochemistry*, 5th Edition, WH Freeman & Company, New York, 2008.
2. Conn, E.E., Stumpf, P.K., Bruening, G. and Doi, R.H. *Outlines of Biochemistry*. 5th edition, John Wiley & Sons Inc, 1987.
3. Voet, D. & Voet, J.G., *Biochemistry*, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004.
4. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27th Edition, McGraw Hill Company Inc. Singapore, 2006.

**METABOLISM LAB**

**Paper Code: BCH 104**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Marks</b>
0	0	3	2	50

**Experiments:**

1. Estimation of blood glucose.
2. Estimation of cholesterol
3. Sugar Fermentation in Microorganisms.
4. Estimation of Glucose 6-P.
5. Assay of serum transaminases.
6. Estimation of Urea.
7. Estimation of Uric acid.
8. Estimation of Creatinine.

Course Code: BOT241

Course Title: Plant Physiology and Metabolism

L	T	P	Credits	Marks
4	0	0	4	100

#### UNIT 1

**Plant-water relations:** Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

**Mineral nutrition:** Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

#### UNIT 2

**Translocation in phloem:** Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

**Photosynthesis:** Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C<sub>3</sub>, C<sub>4</sub> and CAM pathways of carbon fixation; Photorespiration.

#### UNIT 3

**Respiration:** Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

**Enzymes:** Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

**Nitrogen metabolism:** Biological nitrogen fixation; Nitrate and ammonia assimilation.

#### UNIT 4

**Plant growth regulators:** Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

**Plant response to light and temperature:** Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

#### SUGGESTED READINGS

1. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). *Plant Physiology and Development*. Sinauer Associates Inc. USA. 6<sup>th</sup> edition.
2. Hopkins, W.G., Huner, N.P., (2009). *Introduction to Plant Physiology*. John Wiley & Sons, U.S.A. 4<sup>th</sup> Edition.



3. Bajracharya, D., (1999). *Experiments in Plant Physiology- A Laboratory Manual*. Narosa Publishing House, New Delhi.

**Course Title: Plant Physiology and Metabolism Laboratory**

**Course Code: BOT242**

L	T	P	Credits	Marks
0	0	3	2	50

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O<sub>2</sub> evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

**Demonstration experiments (any four)**

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

**Course Code: MIC111A**

**Course Title: General Microbiology**

L	T	P	Credits	Marks
4	0	0	4	100

**UNIT I**

Fundamentals, History and Evolution of Microbiology.

Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

**UNIT II**

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

**UNIT III**

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

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways

Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

**UNIT IV**

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal.

Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria.

Major food born infections and intoxications, Preservation of various types of foods.

Fermented Foods.

**Reference books:**

1. Prescott, L.M., *Microbiology*, 6<sup>th</sup> Edition. McGraw-Hill Companies. 2002. Print.
2. Glazer, A. and Nikaido, H. *Microbial Biotechnology: Fundamentals of Applied Microbiology*. 2<sup>nd</sup> Edition. Cambridge University Press. 2007. Print.
3. Pelczar, M.J. *Microbiology*. 6<sup>th</sup> Edition. McGraw-Hill Companies. 1993. Print.
4. Atlas, R.M. *Principles of Microbiology*. 2<sup>nd</sup> Edition. William C Brown Pub. 1996. Print.

**Course Code: MIC112A**

**Course Title: General Microbiology Laboratory**

L	T	P	Credits	Marks
0	0	3	2	50

**PRACTICALS**

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

**Course Title: Animal Diversity I**

**Paper Code: ZOO101**

L	T	P	Credits	Marks
4	0	0	4	100

**Course Objective:** To acquaint students with the general characters and classification of invertebrate phyla and the affinities between different groups. To impart knowledge regarding the morphological, anatomical and physiological make up of a few representative organisms from each phylum.

#### UNIT-A

- Description of animal diversity. Principles of classification-salient features and classification upto orders in non-chordates. Structural organization in different classes of non-chordates. 6 hours
- **Protozoa:** locomotion, osmoregulation, nutrition and reproduction in Protozoa. 6 hours

#### UNIT-B

- Origin of Metazoa-metamerism and symmetry. 4 hours
- **Porifera:** skeleton and canal system. 3 hours
- **Coelenterata:** corals and coral reefs, polymorphism in Hydrozoa. 4 hours
- **Platyhelminthes:** reproduction, variation in life cycles, parasitic adaptations and evolution of parasitism in Helminthes. 4 hours
- **Nematoda:**pseudocoelom, parasitic adaptations 4 hours

#### UNIT-C

- **Annelida:** coelom, metamerism, excretion. 5 hours
- **Arthropoda:** vision, respiration and larval forms. Social life in insects. 10 hours

#### UNIT-D

- **Mollusca:** torsion and detorsion, shell and respiration. 10
- **Echinodermata:** water vascular system and larval forms. 5 hours

#### Reference books

1. Kotpal, R.L., *Modern Text Book of Zoology Invertebrates*, 10th ed., Rastogi Publishers, Meerut, 2012.
2. Kotpal, R.L., *Minor phyla*, 5th ed., Rastogi Publishers, Meerut, 2006.
3. Dhama, P.S. and Dhama, J.K., *Invertebrate Zoology*, 5th ed., R. Chand & Co., New

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Delhi, 2004.

4. Parker, T.J. and Haswell, W.A., *Text book of Zoology, Invertebrates*, 7th ed., Vol. I (eds. A.J. Marshall & W.D. Williams), CBS Publishers & Distributors., Delhi, 1992.
5. Hyman L.H. *The Invertebrates. Vol. I, II, III, IV and V*. McGraw Hill Book Company. Inc., New York. London. Toronto, 1959.

Course Title: Animal Diversity I Lab

Paper Code: ZOO102

L	T	P	Credits	Marks
0	0	3	2	50

General survey of invertebrate phyla through charts, models and e-resources:

- Protozoa: *Amoeba*, *Euglena*, *Paramecium* and *Vorticella*, *Balantidium*, *Nyctotherus*, *Opalina*, Radiolarians and Foraminiferans.
- Porifera: *Sycon*, *Grantia*, *Spongilla*, *Euplectella*, *Hyalonema*, *Chalina*, *Euspongia*, Temporary mounts of gemmules and spicules of *Sycon*.
- Coelenterata: *Hydra*, *Obelia*, *Porpita*, *Velella*, *Physalia*, *Aurelia*, *Metridium*, *Alcyonium*, *Tubipora*, *Zooanthus*, *Madrepora*, *Favia*, *Fungia*, *Gorgoni*, *Pennatula*, *Sertularia*, *Plumularia*, *Pennaria*, *Bougainvillea*, statocyst of *Aurelia*.
- Platyhelminthes: *Planaria*, *Fasciola* (W.M. & T.S.), larval stages of *Fasciola*, *Taenia* (scolex, proglottids-mature and gravid), *Ascaris* (male and female).
- Annelida: *Pheretima*, T.S. of typhlosolar region, setae, pharyngeal nephridia, septal nephridium and integumentary nephridium of *Pheretima*, *Eutyphoeus*, *Lumbricus*, *Nereis*, parapodium of *Nereis*, *Heteronereis*, *Polynoe*, *Aphrodite*, *Amphitrite*, *Chaetopterus*, *Anodonta*, *Mytilus*, *Pholas*, *Pecten*, *Haliotis*, *Aplysia*, *Doris*, *Limax*, *Pila*, *Sepia*, *Octopus*, *Nautilus*, *Chiton* and *Anodonta*. *Arenicola*, *Hirudinaria*, *Pontobdella*.
- Arthropoda: *Peripatus*, *Lepisma*, cockroach, trachea and mouth parts of cockroach, grasshopper, praying mantis, earwig, dragonfly, termite (queen and other castes), ant, butterfly, moth, beetle, wasp, honeybee, crab, prawn, *Lepas*, *Balanus*, *Apus*, *Limulus*, scorpion, spider, millipede and centipede, *Cypris*, *Cyclops*, *Daphnia*, Prawn, Gill and statocyst of Prawn.
- Mollusca: *Anodonta*, *Mytilus*, *Pholas*, *Pecten*, *Haliotis*, *Aplysia*, *Doris*, *Limax*, *Pila*, Glochidium larva and radula of *Pila*, *Sepia*, *Octopus*, *Nautilus*, *Chiton* and *Anodonta*.

Demonstration of anatomy of the following animals through charts/models/e-resources

- Earthworm: digestive, reproductive and nervous systems
- Cockroach: digestive, nervous and reproductive systems, mouth parts of cockroach
- Prawn: digestive and nervous systems. Appendages and gills of prawn.
- *Anodonta*: digestive and nervous systems,
- *Pila*: digestive and nervous systems, radula of *Pila*  
*Asterias*: Aristotle's lantern, tube feet.

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Course Title: Animal Diversity II

Paper Code: ZOO103

L	T	P	Credits	Marks
4	0	0	4	100

**Course Objective:** To acquaint students with the general characters and classification of chordates and the affinities between different groups.

**UNIT-A**

- Origin and general characters of chordates with detailed classification of each animal group with special emphasis on salient features and interrelationships 5 hours
- Hemichordata: Hemichordates as link between non-chordates and chordates 5 hours
- Urochordata: development, affinities, retrogressive metamorphosis. 5 hours
- Cephalochordata: development, affinities. 5 hours

**UNIT-B**

- Cyclostomata: migration. 5 hours
- Pisces: scales, fins, migration, parental care. 5 hours

**UNIT-C**

- Amphibia: Respiration, Parental care. 6 hours
- Reptilia: Terrestrial adaptations, parental care. 6 hours

**UNIT-D**

- Aves: Respiration, Flight, Endothermy. 8 hours
- Mammals: Integument, Dentition, Respiration, Reproduction 10 hours

**Reference books**

1. Dhama, P.S., Dhama, J.K., *Chordate Zoology*, 5th ed., R. Chand & Co., New Delhi, 2006.
2. Kotpal, R.L., *Text Book of Zoology- Vertebrates*, Rastogi Publications, Meerut, 2012.
3. Parker, T.J., and Haswell, W.A., *A Text Book of Zoology Vertebrates*, 7th ed. Vol. II (eds. A.J. Marshall & Williams, W.D.), Mac Millan, London, 1972.
4. Dodson, E.O., *A Text Book of Zoology*, CBS Publishers & Distributors, Delhi, 1976.



Course Title: Animal Diversity II Lab

Paper Code: ZOO104

L	T	P	Credits	Marks
0	0	3	2	50

General survey of chordates through charts/models and e-resources:

- Hemichordata: *Balanoglossus*
- Protochordata - *Herdmania*, pharynx and spicules of *Herdmania*, *Molgula*, *Ciona*, *Ascidia*, *Botryllus*, *Pyrosoma*, *Salpa*, *Doliolum*, *Oikopleura* and *Branchiostoma*, T.S. *Branchiostoma* through different regions
- Cyclostomata – *Myxine*, *Petromyzon* and *Ammocoetes* larva. Chondrichthyes - *Zygaena*, *Pristi.*, *Narcine*, *Trygon* and *Rhinobatos*.
- Actinopterygii – *Polypterus*, *Acipenser*, *Lepidosiren*, *Mystus*, *Catla*, *Labeo*, *Rohita*, *Cirrhinus*, *Mrigala*, *Cyprinus*, *Carpio*, *Hippocampus*, *Syngnathus*, *Exocoetus*, *Anabas*, *Diodon*, *Ostracion*, *Tetradon*, *Echeneis*, *Lophius*, *Solea* and *Anguilla*, cycloid and ctenoid scales of fishes.
- Dipneusti (Dipnoi) – Any of the lungfishes.
- Amphibia – *Necturus*, *Proteus*, *Amphiuma*, *Salamandra*, *Ambystoma*, *Triton*, *Hyla*, *Rhacophorus*, *Ichthyophis* and *Axolotl* larva.
- Reptilia- Tortoise, Turtle, *Hemidactylus*, *Calotes*, *Draco*, *Varanus*, *Phrynosoma*, *Chamaeleon*, *Typhlops*, *Python*, *Ptyas*, *Bungarus*, *Naja*, *Hydrus*, *Vipera*, *Crocodilus*, *Gavialis* and Alligator.
- Aves : *Anas*, *Ardea*, *Milvus*, *Pavo*, *Tyto*, *Alcedo*, *Eudynamis*, *Casuaris*; and *Struthio*.
- Mammalia – *Echidna*, *Ornithorhynchus*, *Macropus*, *Erinaceus*, *Sorex*, *Loris*, *Macaca*, *Manis*, *Hystrix*, *Funambulus*, *Felis*, *Capra*, *Canis*, *Herpestes*, *Pteropus* and *Leo*.

Demonstration of anatomy of the following animals through charts/models/e-resources

*Herdmania*: General Anatomy, pharynx and spicules

*Labeo*: Digestive and reproductive systems, skeleton

*Rana*: Digestive, arterial, venous and reproductive systems. Skeleton

*Varanus*: Digestive, arterial, venous and reproductive systems. Skeleton

Hen: Digestive, arterial, venous and reproductive systems. Skeleton

Rat: Digestive, arterial, venous, urinogenital systems, skeleton

**Course Code: MIC233**

**Course Title: Immunology**

L	T	P	Credits	Marks
4	0	0	4	100

**Unit 1 Introduction No. of Hours: 4**

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa

**Unit 2 Immune Cells and Organs No. of Hours: 7**

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

**Unit 3 Antigens No. of Hours: 4**

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

**Unit 4 Antibodies No. of Hours: 6**

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

**Unit 5 Major Histocompatibility Complex No. of Hours: 5**

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

**Unit 6 Complement System No. of Hours: 4**

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

**Unit 7 Generation of Immune Response No. of Hours: 10**

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co-stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

**Unit 8 Immunological Disorders and Tumor Immunity No. of Hours: 10**

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-Higashi syndrome,

Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

**Unit 9 Immunological Techniques No. of Hours: 10**

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy.

**SUGGESTED READINGS**

1. Abbas, A.K., Lichtman, A.H., Pillai, S. *Cellular and Molecular Immunology*. 6th edition Saunders Publication, Philadelphia. 2007.
2. Delves, P., Martin, S., Burton, D., Roitt, I.M., *Roitt's Essential Immunology*. 11th edition Wiley-Blackwell Scientific Publication, Oxford. 2006.
3. Goldsby, R.A., Kindt, T.J., Osborne, B.A. *Kuby's Immunology*. 6th edition W.H. Freeman and Company, New York. 2007.
4. Murphy, K., Travers, P., Walport, M. *Janeway's Immunobiology*. 7th edition Garland Science Publishers, New York. 2008.
5. Peakman, M., and Vergani, D., *Basic and Clinical Immunology*. 2nd edition Churchill Livingstone Publishers, Edinburgh. 2009.
6. Richard, C. and Geffrey, S. *Immunology*. 6th edition. Wiley Blackwell Publication. 2009.

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**Course Code: MIC234**

**Course Title: Immunology Laboratory**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Marks</b>
0	0	3	2	50

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum from the blood sample (demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Perform DOT ELISA.
7. Perform immunoelectrophoresis.