DAV UNIVERSITY JALANDHAR

SCHEME FOR

Bachelor of Science (Hons.) Biotechnology

(Program ID-3)

1st TO 6th SEMESTER

Examinations 2018–2019 Session Onwards

Applicable For Admissions in 2018 Onwards

DAV UNIVERSITY, JALANDHAR

Scheme of Courses

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	BTY231	Core	Genetics	4	0	0	4
4	BTY232	Core	Genetics Laboratory	0	0	3	2
5	ENG151B	AECC1*	Basic Communication Skills	3	0	0	3
6	ENG152A	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*

List of Generic Electives							
1	BOT131	Generic Elective	Plant Diversity	4	0	0	4
2	BOT132	Generic Elective	Plant Diversity Laboratory	0	0	3	2
3	BCH216	Generic Elective	Membrane Biology and Bioenergetics	4	0	0	4
4	BCH217	Generic Elective	Membrane Biology and Bioenergetics Laboratory	0	0	3	2

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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	Human Values and General Studies	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

List of Generic Electives							
1	BCH103	Generic Elective	Metabolism	4	0	0	4
2	BCH104	Generic Elective	Metabolism Laboratory	0	0	3	2
3	MIC113	Generic Elective	Bacteriology	4	0	0	4
4	MIC114	Generic Elective	Bacteriology Laboratory	0	0	3	2

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Semester III

S.No.	Paper Code	Course Type	Course Title	L	T	P	Cr
1	MIC111A	Core	General Microbiology	4	0	0	4
2	MIC112A	Core	General Microbiology 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	BTY361	Core	Bioanalytical Tools	4	0	0	4
6	BTY362	Core	Bioanalytical Tools Laboratory	0	0	3	2
7	BTY381	SEC*	Fundamentals of Nanobiotechnology	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*

List of Generic Electives							
1	ZOO101	Generic Elective	Animal Diversity-I	4	0	0	4
2	ZOO102	Generic Elective	Animal Diversity-I Laboratory	0	0	3	2
3	ZOO321	Generic Elective	Fundamentals of Developmental Biology	4	0	0	4
4	ZOO322	Generic Elective	Fundamentals of Developmental Biology Laboratory	0	0	3	2
5	MIC221	Generic Elective	Microbial Physiology	4	0	0	4
6	MIC222	Generic Elective	Microbial Physiology Laboratory	0	0	3	2

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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	BTY111	Core	Plant Biotechnology	4	0	0	4
4	BTY112	Core	Plant Biotechnology Laboratory	0	0	3	2
5	CHE257	Core	General Chemistry –II	4	0	0	4
6	CHE258	Core	General Chemistry –II Laboratory	0	0	3	2
7	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

List of Generic Electives							
1	ZOO103	Generic Elective	Animal Diversity-II	4	0	0	4
2	ZOO104	Generic Elective	Animal Diversity-II Laboratory	0	0	3	2
3	MIC225	Generic Elective	Microbial Genetics	4	0	0	4
4	MIC226	Generic Elective	Microbial Genetics Laboratory	0	0	3	2
5	BCH218	Generic Elective	Proteins and Enzymes	4	0	0	4
6	BCH219	Generic Elective	Proteins and Enzymes Laboratory	0	0	3	2

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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

List of Discipline Specific Electives (DSE) For Semester V							
1	BTY243	DSE	Biotechnology and Human Welfare	4	0	0	4
2	BTY244	DSE	Biotechnology and Human Welfare Laboratory	0	0	3	2
3	BTY399	DSE	Medical Microbiology	4	0	0	4
4	BTY400	DSE	Medical Microbiology Laboratory	0	0	3	2
5	BTY395	DSE	Biostatistics and Bioinformatics	4	0	0	4
6	BTY396	DSE	Biostatistics and Bioinformatics Laboratory	0	0	3	2
7	BTY397	DSE	Food Biotechnology	4	0	0	4
8	BTY398	DSE	Food Biotechnology Laboratory	0	0	3	2

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Semester VI

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	BTY391	Core	Animal Biotechnology	4	0	0	4
2	BTY392	Core	Animal Biotechnology 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

List of Discipline Specific Electives (DSE) For Semester VI							
1	BTY393	DSE	Virology	4	0	0	4
2	BTY394	DSE	Virology Laboratory	0	0	3	2
3	BTY383	DSE	Enzymology	4	0	0	4
4	BTY384	DSE	Enzymology Laboratory	0	0	3	2
5	BTY385	DSE	Environmental Biotechnology	4	0	0	4
6	BTY386	DSE	Environmental Biotechnology Laboratory	0	0	3	2
7	BTY387	DSE	Herbals and Nutraceuticals	4	0	0	4
8	BTY388	DSE	Herbals and Nutraceuticals Laboratory	0	0	3	2
9	BTY371	DSE	Immunology	4	0	0	4
10	BTY372	DSE	Immunology Laboratory	0	0	3	2

Course Code: BCH101

Course Title: Biomolecules

L	T	P	Credits
4	0	0	4

Unit A

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, algenic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch. Bacterial cell wall polysaccharides. Glycoproteins.

Unit B

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

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

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*, 5th Edition, W.H. Freeman & Company, New York, 2008. Print.
2. Voet, Donald and Voet, Judith G., *Biochemistry*, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004. Print.
3. Murray, R.K., Granner, D.K. and Rodwell, V.W. *Harper's Illustrated Biochemistry*, 27th Edition, McGraw Hill Company Inc. Singapore, 2006. Print.

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Course Title: Biomolecules Laboratory

Course Code: BCH102

L	T	P	Credits
0	0	3	2

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.

GENETICS

Course Code: BTY231

L	T	P	Credits
4	0	0	4

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

The chromosome theory of heredity, sex chromosomes, sex linkage, the parallel behavior of autosomal genes and chromosomes.

Unit II

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

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 chormosomes), banding patterns in human chromosomes. Structural and numerical aberrations involving chromosomes; hereditary defects - Kleinefelter, Turner, Cri-du-Chat and Down syndromes. Mutations - spontaneous and induced, chemical and physical mutagens.

Unit IV

Extrachromosomal inheritance and molecular genetics: 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. 3rd Edition. Prentice-Hall, India. 2008. ISBN: 9789332555105

2. Jones, S. The Language of the Genes. Harper Collins Publishers. 2012. ISBN: 9780006552437

3. Ridley, M. Nature via Nurture: Genes, Experience, & What Makes Us Human. HarperCollins Publishers. 2004. ISBN: 9781841157467

4. Aggarwal, V.K. and Verma, V.S. Genetics. 9th Edition. S. Chand, India. 2010. ISBN: 9788121931144

5. Snustad, D.P. and Simmons, M.J. Principles of Genetics. 6th Edition. John Wiley & Sons. 2011. ISBN: 9780470903599

6. Pierce, B.A. Genetics: A Conceptual Approach. 4th Edition. W.H. Freeman & Company, 2010. ISBN: 9781429232524

GENETICS LABORATORY

L	T	P	Credits
0	0	3	2

Course Code: BTY232

EXPERIMENTS

1. 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*
2. Preparation of karyograms from the given photographs for karyotypic formula
3. To study through photographs normal and deviant cytogenetic mechanisms
4. 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
5. Isolation of chloroplasts by sucrose gradient. Photographs of restriction site variation of chloroplast DNA
6. Exercises wrt determination of correct sequence and distance between the linked genes
7. Induction and recovery of mutants in bacteria by UV irradiation
8. Segregation demonstration in preserved material (Maize)
9. Detection of Blood groups (A B O & Rh factors)
10. Inheritance of other human characteristics, ability to test PTC, Thiourea
11. Paternity disputes (blood groups)

DAV UNIVERSITY, JALANDHAR

L	T	P	Credits
3	1	0	3

Course Title: Basic Communication Skills
Course Code: ENG151 B
Course Objectives:

- To enhance students' vocabulary and comprehension skills through the prescribed texts.
- To hone students' reading and writing skills.
- To teach the rules of English grammar descriptively.
- To make students aware about the socio-cultural aspect of English.

Learning Outcomes: Students will

- Have developed a wide vocabulary and be able to summarize ideas.
- Be able to read and analyze texts and display competence in written communication.
- Show a considerable understanding of English Grammar.
- Demonstrate sensitivity to cultural differences while communicating

Unit – A

1. **Applied Grammar (in Socio-Cultural Context)**
    - Tenses
    - Passives
    - Reported/Reporting Speech

Unit – B

1. **Reading (Communicative Approach to be Followed)**

    - Nissim Ezekiel : The Patriot (Poem)

(Sub-topic: Basic Introduction to Indianisms and Difference between Indian English & Standard English)

2. **Writing**

    - Paragraph Writing : Topic Sentence, Inductive logic, and Deductive logic
    - Essays: Narrative, Descriptive, Expository, and Persuasive
    - Notice: Format, Characteristics, and 5 W's,
    - Email: Structure, Characteristics of Effective Emails, and Advantages

Unit – C

1. **Applied Grammar (in Socio-Cultural Context)**

    - Parts of Speech: Noun, Pronoun, Adjective, Verb, Adverb, Preposition, Conjunction, and Interjection
    - Modals: Can, Could, May, Might, Will, Would, Shall, Should, and Must

Unit – D

1. **Reading (Communicative Approach to be Followed)**

    Alleen Pace Nilsen: Sexism in English (Prose)

    (Sub-topic: Relationship between Society & Language and Sexist Language)

2. **Writing**

    Letter Writing: Formal and Informal

Teaching Methodology:

a. **Grammar:** Grammar must be taught descriptively in socio-cultural context. The contextual teaching of grammar helps a learner understand the application of grammar rules in real life situations. The learner who learns grammar in isolation is unable to use the language fluently, whereas the learner who learns grammar in context uses the language confidently and fluently in real life situations.

b. **Literary Texts:** Communicative approach should be followed to teach the texts. Classroom activities guided by the communicative approach are characterised by trying to produce meaningful and real communication, at all levels. As a result there may be more emphasis on skills than systems, lessons are more learner-centred, and there may be use of authentic materials.

    Teachers can introduce the topic or theme of the text, pre-teach essential vocabulary items and use prediction tasks to arouse the interest and curiosity of students.

c. **Writing**: Some of the strategies that should be adopted are as follows:

- Regularly assign brief writing exercises in your classes.
- Provide guidance throughout the writing process, i.e. Pre-Writing, Drafting, Revising, Editing, and Publishing.
- Give students opportunities to talk about their writing.
- Encourage students to revise their work.

Testing: The examinations will be conducted as per the norm of the university.

References:

a. Books

1. Eschholz, Paul and Rosa, Alfred (ed.), *Subject and Strategy*. NY: St. Martin's Press, 1978. Print.
2. Ezekiel, Nissim. *Collected Poems 1952-1988*. New Delhi: Oxford University Press, 1999. Print.
3. Hosler, Mary Margaret. *English Made Easy*. Delhi: McGraw, 2013. Print.
4. Koneru, Aruna. *Professional Communication*. Delhi: McGraw, 2008. Print.
5. Mahanand, Anand. *English for Academic and Professional Skills*. Delhi: McGraw, 2013. Print.
6. Rani, D Sudha, TVS Reddy, D Ravi, and AS Jyotsna. *A Workbook on English Grammar and Composition*. Delhi: McGraw, 2016. Print.
7. Rizvi, M. Ashraf. *Effective Technical Communication*. Delhi: McGraw, 2018. Print.
8. Sharma, R.C. and Krishna Mohan. *Business Correspondence and Report Writing*. Delhi: McGraw, 2013. Print.
9. Tyagi, Kavita and Padma Misra. *Basic Technical Communication*. Delhi: PHI Learning, 2013. Print.

b. Websites

1. www.youtube.com (to watch standard videos)
2. http://learnenglish.britishcouncil.org/en
3. https://owl.english.purdue.edu/

DAV UNIVERSITY, JALANDHAR

Course Title: Basic Communication Skills Lab.

Course Code: ENG 152A

L	T	P	Credits
0	0	2	1

Course Objectives:

- To improve the preparation and presentation competencies necessary for oral communication in a variety of contexts, as both a speaker and a listener.
- To improve pronunciation.
- To promote interactive skills through Group Discussions and role plays.

Learning Outcomes: Students will be able to:

- Develop proper listening skills
- Articulate and enunciate words and sentences clearly and efficiently
- Show confidence and clarity in public speaking projects

Unit – A Speaking and Listening
• IPA for Language Learning - Basic Phonetics
• Movie-Clippings
• Role Plays
• Group Discussions
• Mock Interviews

Project File: Each student will prepare a project file on any of the topics given by class teacher. Student should be able to justify the contents of his/her scrap file. The file must be handwritten, not typed. Students must acknowledge all the sources of information in his/her scrap file.

Testing: The end term lab. examination will be conducted as per the norm of the university. The distribution of marks in the end-term lab. examination is as follows:

Component	**Weightage**
Project File Marks will be given for originality, creativity and presentation. Student will receive credit for his/her command of the language also.	**30 %**

Lab. Activity It may include dialogue writing (Dialogue to Prose and Prose to Dialogue), writing about a picture/some object, writing a report, writing on a topic of general interest, listening exercise, English phonetic exercise, etc. It will be decided by examiner on the spot.	**30%**
Viva Voce Questions will be based on the project file. Examiner may ask other non-technical questions related to student's life and interests.	**40%**
Total	**100%**

For the final result, marks will be calculated as per the criterion laid down by the university:

Component	**Weightage**
Marks Obtained in the lab examination	**80%**
Continuous Assessment (Based on Student's Regularity & Class Performance)	**20%**
Total	**100%**

Reference Books

c. Books

10. Crystal, David. *The Gift of the Gab – How Eloquence Works*. Connecticut: Yale University, 2016. Print.

11. Gangal, J. K. *A Practical Course in Spoken English*. India: Phi Private Limited, 2012. Print.

12. Hosler, Mary Margaret. *English Made Easy*. Delhi: McGraw, 2013. Print.

13. Koneru, Aruna. *Professional Communication*. Delhi: McGraw, 2008. Print.

14. Mahanand, Anand. *English for Academic and Professional Skills*. Delhi: McGraw, 2013. Print.

15. Rani, D Sudha, TVS Reddy, D Ravi, and AS Jyotsna. *A Workbook on English Grammar and Composition*. Delhi: McGraw, 2016. Print.

16. Rizvi, M. Ashraf. *Effective Technical Communication*. Delhi: McGraw, 2018. Print.

17. Sharma, R.C. and Krishna Mohan. *Business Correspondence and Report Writing*. Delhi: McGraw, 2013. Print.

18. Suzana, Roopa. *A Practical Course in English Pronunciation*. Delhi: McGraw Hill Education, 2017. Print.

19. Tyagi, Kavita and Padma Misra. *Basic Technical Communication*. Delhi: PHI Learning, 2013. Print.

d. Websites

4. www.youtube.com (to watch standard videos)
5. http://learnenglish.britishcouncil.org/en
6. https://owl.english.purdue.edu/

DAV UNIVERSITY, JALANDHAR

Course Title: Plant Diversity

Course Code: BOT131

L	T	P	Credits
4	0	0	4

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. 10th 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. 4th 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.

DAV UNIVERSITY, JALANDHAR

Course Title: Plant Diversity Laboratory

Course Code: BOT132

L	T	P	Credits
0	0	3	2

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 Title: Membrane Biology and Bioenergetics

Paper Code: BCH216

L	T	P	Credits
4	0	0	4

Unit A (15 hours)

Introduction to biomembranes

Composition of biomembranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems.

Membrane structures

Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. CMC, critical packing parameter. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture.

Unit B (15 hours)

Membrane dynamics

Lateral, transverse and rotational motion of lipids and proteins. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.

Membrane transport

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na+-glucose symporter. ABC family of transporters - MDR, CFTR. Group translocation. Ion channels - voltage-gated ion channels (Na+/K+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

Vesicular transport and membrane fusion

Types of vesicle transport and their function - clathrin, COP I and COP II coated vesicles. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin. Membrane biogenesis

Unit C (15 hours)

Introduction to bioenergetics

Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of

high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

Oxidative phosphorylation

Mitochondria. Electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo F1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways in plants.

Unit D (15 hours)

Photophosphorylation

General features of photophosphorylation, historical background, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer. Bacterial photophosphorylation in purple bacteria, Green sulfur bacteria and Halobacterium salinarum. Photophosphorylation in plants -structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides. Cyclic photophosphorylation and its significance. Photo inhibition. Evolution of oxygenic photosynthesis.

Recommended Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641- 0962-1.

2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2.

3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.

4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W.,John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2

Course Title: Membrane Biology and Bioenergetics Laboratory

L	T	P	Credits
0	0	3	2

Paper Code: BCH217

Experiments:

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. RBC ghost cell preparation and to study the effect of detergents on membranes.
4. Separation of photosynthetic pigments by TLC.
5. Isolation of mitochondria from liver and assay of marker enzyme SDH.
6. Study photosynthetic O_2 evolution in hydrilla plant.
7. Isolation of chloroplast from spinach leaves, estimation of chlorophyll and photosynthetic activity.
8. Study of changes in erythrocyte membrane permeability under hypotonic and hypertonic consitions.

L	T	P	Credits
4	0	0	4

CELL BIOLOGY

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: 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.

Unit II

Eukaryotic cell organelles and functions: 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

Unit III

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

Unit IV

Molecule and Protein Trafficking: 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.

Reference Books:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Molecular Biology of the Cell. 4th Edition. Garland Science. 2007. ISBN: 0815332181 ISBN: 0815340729
2. Lodish, H.F. Molecular Cell Biology. 6th Edition. W.H. Freeman & Company. 2007. ISBN: 9780716776017
3. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. The World of the Cell. 7th Edition. Benjamin Cummings. 2008. ISBN: 9780805393934
4. Powar, C.B. Cell Biology. Himalaya Publishing House. 2007. ISBN: 9789350246696
5. G Karp. Cell and molecular Biology. John wiley and sons 7th edition. ISBN: 9781118653227
6. Cooper G.M. The Cell .6th edition. ISBN: 978-0878939640

CELL BIOLOGY LABORATORY

L	T	P	Credits
0	0	3	2

Course Code: BTY122

EXPERIMENTS:

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

Course Code: CHE157

Course Title: General Chemistry - I

L	T	P	Credits
4	0	0	4

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 ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic 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 (ms). 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 polarizabilty. 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+. Comparison of VB and MO approaches.

Section B: Organic Chemistry-1 **(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. $KMnO_4$) 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_2 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 $KMnO_4$ozonolysis and oxidation with hot alk. $KMnO_4$

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 Alexader: *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
0	0	3	2

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 $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ with internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

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 Rf 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.

DAV UNIVERSITY, JALANDHAR

Course Title: Environmental Studies

Course Code: EVS100

L	T	P	Credits
4	0	0	4

Course Objective: This course aims at understanding the students in aspects of environmental problems, its potential impacts on global ecosystem and its inhabitants, solutions for these problems as well as environmental ethics which they should adopt to attain sustainable development.

Unit 1

Introduction to Environmental Studies

- Definition, components and types of Environment.
- Meaning of Environmental Studies and its Multidisciplinary nature;
- Scope and importance; Concept of sustainability and sustainable development.

6 hours

Natural Resources: Renewable and Non-Renewable Resources

- Land resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

8 hours

Unit II

Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :
    a) Forest ecosystem
    b) Grassland ecosystem

c) Desert ecosystem

d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

2 hours

Biodiversity and Conservation

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots

- India as a mega---biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man---wildlife conflicts, biological invasions; Conservation of biodiversity: In---situ and Ex---situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

8 hours

Unit III

Environmental Pollution

Environmental Pollution: types, causes, effects and controls; Air, water, soil and noise pollution

- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Pollution case studies.

8 hours

Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).

- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

7 hours

Unit IV

Human Communities and the Environment

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management: floods, earthquake, cyclones and landslides.
- Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

6 hours

Field work

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc.

5 hours

Suggested Readings:

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999.*Global Ethics and Environment*, London, Routledge.

4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll.*Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science,* 339: 36---37.
7. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29---64). Zed Books.
8. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
9. Odum, E.P., Odum, H.T. & Andrews, J. 1971.*Fundamentals of Ecology*. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.*Environment*. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. *Tripathi 1992*.
14. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*. John Wiley & Sons.
17. Thapar, V. 1998. *Land of the Tiger*: *A Natural History of the Indian Subcontinent*.
18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E. O. 2006.*The Creation: An appeal to save life on earth*. New York: Norton.

DAV UNIVERSITY, JALANDHAR

Course Code: SGS107

Course Title: Human Values and General Studies

L	T	P	Credits
4	0	0	4

Part - A

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, Panachayati 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, Muktikanta 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: BCH103

L	T	P	Credits
4	0	0	4

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. β-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 LABORATORY

Paper Code: BCH104

L	T	P	Credits
0	0	3	2

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: MIC113

Course Title: BACTERIOLOGY

L	T	P	Credits
4	0	0	4

Course Objective:

This course will allow the student to develop an understanding about bacteria, including their structural organization, reproduction and classification. This course will also expose the students to the commonly used techniques in the field of bacteriology.

Course Content:

Unit 1 Cell organization **No. of Hours: 14**

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.

Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall.

Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.

Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids

Endospore: Structure, formation, stages of sporulation.

Unit 2 Bacteriological techniques No. of Hours: 5

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Unit 3 Microscopy **No. of Hours: 6**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

Unit 4 Growth and nutrition **No. of Hours: 8**

Nutritional requirements in bacteria and nutritional categories;

Culture media: components of media, natural and synthetic media, chemically defined media,

complex media, selective, differential, indicator, enriched and enrichment media, Diauxic growth, Synchronous growth

Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation

Chemical methods of microbial control: disinfectants, types and mode of action

Unit 5 Reproduction in Bacteria **No. of Hours: 3**

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit 6 Bacterial Systematics **No. of Hours: 8**

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences.

Differences between eubacteria and archaebacteria

Unit 7 Important archaeal and eubacterial groups **No. of Hours: 16**

Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)]

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups:

Gram Negative:

Non proteobacteria: General characteristics with suitable examples

Alpha proteobacteria: General characteristics with suitable examples

Beta proteobacteria: General characteristics with suitable examples

Gamma proteobacteria: General characteristics with suitable examples

Delta proteobacteria: General characteristics with suitable examples

Epsilon proteobacteria: General characteristics with suitable examples

Zeta proteobacteria: General characteristics with suitable examples

Gram Positive:

Low G+ C (Firmicutes): General characteristics with suitable examples

High G+C (Actinobacteria): General characteristics with suitable examples

***Cyanobacteria*:** An Introduction

SUGGESTED READINGS

1. Atlas RM. *Principles of Microbiology*. 2nd edition. WM.T.Brown Publishers. 1997. Print

2. Black JG. *Microbiology: Principles and Explorations*. 7th edition. Prentice Hall. 2008. Print

3. Madigan MT, and Martinko JM. *Brock Biology of Micro-organisms*. 14th edition. Parker J. Prentice Hall International, Inc. 2014. Print

4. Pelczar Jr MJ, Chan ECS, and Krieg NR. *Microbiology*. 5th edition Tata McGraw Hill. 2004. Print

5. Srivastava S and Srivastava PS. *Understanding Bacteria*. Kluwer Academic Publishers, Dordrecht. 2003. Print

6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. *General Microbiology*. 5th edition McMillan. 2005. Print

7. Tortora GJ, Funke BR, and Case CL. *Microbiology: An Introduction*. 9th edition Pearson Education. 2008. Print

8. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott's Microbiology*. 9th edition. McGraw Hill Higher Education. 2013. Print

9. Cappucino J and Sherman N. *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education Limited. 2010. Print

DAV UNIVERSITY, JALANDHAR

L	T	P	Credits
0	0	3	2

Course Code: MIC114

Course Title: BACTERIOLOGY LABORATORY

Experiments:

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

Course Code: MIC111A

Course Title: General Microbiology

L	T	P	Credits
4	0	0	4

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

DAV UNIVERSITY, JALANDHAR

Course Code: MIC112A

Course Title: General Microbiology Laboratory

L	T	P	Credits
0	0	3	2

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 Code: BOT241

Course Title: Plant Physiology and Metabolism

L	T	P	Credits
4	0	0	4

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; C3, C4 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. 6th edition.
2. Hopkins, W.G., Huner, N.P., (2009). *Introduction to Plant Physiology*. John Wiley & Sons, U.S.A. 4th Edition.

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

DAV UNIVERSITY, JALANDHAR

Course Title: Plant Physiology and Metabolism Laboratory

Course Code: BOT242

L	T	P	Credits
0	0	3	2

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_2 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.

BIO-ANALYTICAL TOOLS

Course Code: BTY361

L	T	P	Credits
4	0	0	4

Course Objective: To give an introduction to various analytical methods for quantitative measurement of biological molecules (proteins, DNA, metabolites) in various conditions.

Course Contents:

UNIT I

Simple microscopy, phase contrast microscopy, florescence microscopy and principles of electron microscopy, pH meter.

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 their applications.

Reference Books:

1. Wilson, K. and Walker, J. Practical Biochemistry: Principles and Techniques. 5th Edition. Cambridge University Press. 2005. ISBN: 9780521651042

2. Iserentant, D. M. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes. 1st Edition. Springer-verlag Gmbh. 1997. ISBN: 9789048149544

3. Ho, P. S., Johnson, C. and van Holde, K. E. Principles of Physical Biochemistry. 2nd Edition. Pearson. 2005. ISBN: 978-0130464279

4. Venn, R. F. Principles and Practice of Bioanalysis. 1st Edition. Taylor & Francis. 2000. ISBN: 9780849338571

5. Hoppert, M. Microscopic Techniques in Biotechnology. John Wiley & Sons. 2006. ISBN: 9783527605231

BIOANALYTICAL TOOLS LABORATORY

Course Code: BTY362

L	T	P	Credits
0	0	3	2

EXPERIMENTS

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.

FUNDAMENTALS OF NANOBIOTECHNOLOGY

Course Code: BTY381

L	T	P	Credits
2	0	0	2

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 nanobiotechnology, 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, nano-sensors, 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, data management. Regulatory affairs and pharmacovigilance, ICH, FDA, investigational new drug applications, classifications of adverse events, scope of drug safety problems.

Reference Books:

1. Abraham, D.J. and Rotella, D.P. Burger's Medicinal Chemistry, Drug Discovery and Development. 8 Volume Set. 7th Edition. John Wiley & Sons Ltd. 2010. Print. ISBN: 978-0-470-27815-4

2. Beale, J.M. and Lock, J. Wilson & Gisvold's text book of organic medicinal and pharmaceutical Chemistry. 12th Edition. Lippincott Williams & Wilkins. 2010. Print. ISBN: 978-0-7817-7929-6

3. Liljefors, T., Krogsgaard-Larsen, P. and Madsen, U. Textbook of Drug Design and Discovery.3rd Edition. CRC Press. 2002. Print. ISBN: 9780415282888

4. Prasad, S.K. Modern Concepts in Nanotechnology. Discovery Publishing House. 2008. Print. ISBN: 9788183562966

5. Trivedi, P.C. Nanobiotechnology. Pointer Publishers. 2008. Print. ISBN: 978-81-7132-543-6

6. Shah MA and Shah KA. Nanotechnology The science of Small. Wiley India. 2013. ISBN: 9788126538683.

DAV UNIVERSITY, JALANDHAR

Course Title: Animal Diversity I

Paper Code: ZOO101

L	T	P	Credits
4	0	0	4

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. Dhami, P.S. and Dhami, J.K., *Invertebrate Zoology*, 5th ed., R. Chand & Co., New

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
0	0	3	2

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 andcentipede, *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.

L	T	P	Credits
4	0	0	4

Course Title: Fundamentals of Developmental Biology

Paper Code: ZOO321

Course Objective: To give students a brief overview of the developmental processes in animals.

UNIT-A

Introduction: Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division

UNIT-B

- **Early Embryonic Development**: Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers

UNIT-C

- **Late Embryonic Development**: Fate of Germ Layers; Extra- embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)
- **Post Embryonic Development**: Metamorphosis-Changes, hormonal regulations in amphibians and insects; Regeneration- Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing-Concepts and Theories

UNIT-D

- **Implications of Developmental Biology**: Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis

Reference books:

1. Balinsky B. I. and Fabian B. C. *An Introduction to Embryology*, V Edition, International Thompson Computer Press, 1981.

2. Carlson, R. F. *Patten's Foundations of Embryology*

3. Gilbert, S. F. *Developmental Biology*, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA, 2010.

4. Kalthoff. *Analysis of Biological Development*, II Edition, McGraw-Hill Publishers, 2008.

5. Lewis Wolpert. *Principles of Development*. II Edition, Oxford University Press, 2002.

DAV UNIVERSITY, JALANDHAR

Course Title: Fundamentals of Developmental Biology Laboratory

L	T	P	Credits
0	0	3	2

Paper Code: ZOO322

The following practicals will be conducted using charts/models/e-resources.

- Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
- Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
- Study of the developmental stages and life cycle of Drosophila from stock culture
- Study of different sections of placenta (photomicropgraph/ slides)
- Project report on Drosophila culture/chick embryo

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum are allowed subject to the availability of resources.

DAV UNIVERSITY, JALANDHAR

Course Code: MIC221

Course Title: MICROBIAL PHYSIOLOGY

L	T	P	Credits
4	0	0	4

Course Objective:

This course will introduce the students to the diversity of microbial life-styles including heterotrophy, chemolithotrophy, photolithotrophy, fermentation, aerobic and anaerobic respiration. The students will also come to know carbon and nitrogen nutrition in microbes.

Course Content:

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth

No. of Hours: 12

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve, Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic.

Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Unit 2 Nutrient uptake and Transport **No. of Hours: 10**

Passive and facilitated diffusion

Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake

Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration **No. of Hours: 16**

Concept of aerobic respiration, anaerobic respiration and fermentation

Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle

Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation

No. of Hours: 6

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)

Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 5 Chemolithotrophic and Phototrophic Metabolism **No. of Hours: 10**

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction)

Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic *vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria, Autotrophy in photosynthetic bacteria

Unit 6 Nitrogen Metabolism - an overview **No. of Hours: 6**

Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction,denitrification

SUGGESTED READINGS

1. Madigan MT, and Martinko JM. *Brock Biology of Microorganisms*. 14th edition. Prentice Hall International Inc. 2014. Print

2. Moat AG and Foster JW. *Microbial Physiology*. 4th edition. John Wiley & Sons. 2002. Print

3. Reddy SR and Reddy SM. *Microbial Physiology*. Scientific Publishers India. 2005. Print

4. Gottschalk G. *Bacterial Metabolism*. 2nd edition. Springer Verlag. 1986. Print

6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. *General Microbiology*. 5th edition, McMillan Press. 1987. Print

7. Willey JM, Sherwood LM, and Woolverton CJ. *Prescott's Microbiology*. 9th edition. McGraw Hill Higher Education. 2013. Print

DAV UNIVERSITY, JALANDHAR

Course Code: MIC222

Course Title: MICROBIAL PHYSIOLOGY LABORATORY

L	T	P	Credits
0	0	3	2

Experiments:

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli.*
9. Determination of thermal death point of the given culture.

MOLECULAR BIOLOGY

L	T	P	Credits
4	0	0	4

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

UNIT III

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 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. Atala, A. and Lanza, R. Methods of Tissue Engineering. 1st Edition. Academic Press. 2001. ISBN: 978-0124366367

2. Harrison, M.A. and Rae, I.F. General Techniques of Cell Culture. 1st Edition. Cambridge University Press. 1997. ISBN: 9780521574969

3. Masters, J.R.W. Animal Cell Culture: A Practical Approach. 3rd Edition. Oxford University Press. 2000. ISBN: 978-0199637966

4. Friefelder, D. Molecular Biology. 2nd Edition. Narosa Book Distributors Pvt. Ltd. 2008. ISBN: 9780123785954

5. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Molecular Biology of the Cell. 5th Edition. Garland Science. 2007. ISBN: 978-0-8153-4105-5.

6. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub. ISBN: 78-0-321-90537-6.

MOLECULAR BIOLOGY LABORATORY

L	T	P	Credits
0	0	3	2

Course Code: BTY242

EXPERIMENTS

1. Isolation of DNA from animal and plant tissue using classical methods
2. Isolation of RNA from animal and plant tissue using classical methods
3. Isolation of plasmid DNA from *E. coli* using boiling-prep and alkali lysis method
4. Quantitation of nucleic acids
5. Restriction fragment length polymorphism
6. Agarose gel electrophoresis
7. Polyacrylamide gel electrophoresis
8. Elution of nucleic acids from agarose gel
9. Primer Designing
10. Polymerase Chain Reaction

PLANT BIOTECHNOLOGY

Course Code: BTY111

L	T	P	Credits
4	0	0	4

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.

Course contents:

UNIT-I

Introduction, cyto and organogenic differentiation, Types of culture: seed, embryo, callus, organs, cell and protoplast culture. Micropopagation: 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 and ogenesis. Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, 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 and relevant effects. Nitrogen fixation, nitrogenase, hydrogenase, nodulation, biocontrol of pathogens.

Reference Books:

1. Chawla, H.S. Introduction to Plant Biotechnology. 3rd Edition. Oxford & IBH Publishing Co. Pvt. Ltd. 2008. Print. ISBN 9781578086368
2. Bhojwani, S.S. and Razdan, M.K. Plant Tissue Culture: Theory and Practice. 5th Edition. Elsevier Science. 2005. Print. ISBN: 9780080539096

3. Gupta, P.K. An Introduction to Biotechnology. Rastogi Publications, India. 1990. Print. ISBN: 978-81-7133-937-2
4. Reinert, J. and Bajaj, Y.P.S. Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Springer Verlang, Berlin, 1977. Print. ISBN 978-3-662-02279-5
5. Razdan, M.K. Introduction to Plant Tissue Culture. 2nd Edition. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi. 2006. Print. ISBN1578082374, 9781578082377
6. Singh, B.D. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi. 2013. Print. ISBN: 8127220744, 9788127220747

PLANT BIOTECHNOLOGY LABORATORY

Course Code: BTY112

L	T	P	Credits
0	0	3	2

EXPERIMENTS:

1. Methods of sterilization
2. Preparation of simple growth nutrient (Knop's medium) full strength, solid and liquid.
3. Preparation of simple growth nutrient (Knop's medium) half strength, solid and liquid.
4. Preparation of complex nutrient medium (Murashige &Skoog's medium)
5. Callus induction and sub-culturing.
6. To select, prune, sterilize and prepare an explant for culture.
7. Significance of growth hormones in culture medium.
8. To demonstrate various steps of Micropropagation.
9. Isolation of plant genomic DNA from the leaf sample
10. Suspension cultures and their maintenance.

Course Code: CHE257

Course Title: General Chemistry – II

L	T	P	Credits
4	0	0	4

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

Section A: Physical Chemistry-1

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 ΔG and ΔG^o, Le Chatelier's principle. Relationships between *Kp*, *Kc* and *Kx* 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

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: KNH2/NH3 or NaNH2.

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. $KMnO_4$, acidic dichromate, conc. 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, $NaHSO_3$, NH-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensen reduction and Wolff Kishner reduction. Meerwein-PondorffVerley 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.

• 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 Lening 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
0	0	3	2

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_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

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

• 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.

MOLECULAR DIAGNOSTICS

Course Code: BTY382

L	T	P	Credits
2	0	0	2

Course objective: The aim is to understand the molecular basis of various diagnostic techniques. To gain an exposure to recent techniques in genome and proteome analysis.

Course Contents:

UNIT-I

Immunoassays: Direct, indirect, competitive, dot and sandwich ELISA. Enzymes and types of antisera available in immunoassays, purification and standardization of antigen and specific antibodies. Radioimmunoassay (RIA), western blotting, immuno-tissue printing and immune-capture PCR

UNIT-II

Nucleic acid based methods: Nucleic acid hybridization methods, methods of radiolabeled and non-radiolabeled probe preparation. Polymerase chain reaction, real-time and quantitative PCR, reverse transcription PCR, DNA fingerprinting

UNIT-III

DNA Sequencing: Maxam-Gilbert method and Sanger method of DNA sequencing, Next Generation Sequencing (NGS).

UNIT-IV

Protein identification methods: 2D gel electrophoresis, MALDI-TOF, GLC, HPLC, Electron microscopy, flow cytometry and cell sorting.

Reference Books:

1. Wilson, K. and Walker, J. Practical Biochemistry: Principles and Techniques. 5th Edition. Cambridge University Press. 2005. ISBN: 0-521-65873-X

2. Brown,T.A. Gene cloning and DNA analysis: An introduction.5thEdition. Wiley-Blackwell. 2010.ISBN: 978-1-4051-8173-0

3. Willey, J.M, Sherwood, L.M, and Woolverton, C.J. Prescott, Harley and Klein's Microbiology. 7th edition (2008). McGraw Hill Higher Education. ISBN: 978–0–07–2992915.

4. Hoppert, M. Microscopic Techniques in Biotechnology (2006). Wiley-Blackwell. ISBN: 9783527605231.

5. Goldsby, R.A., Kindt, T.J., Osborne, B.A. Kuby's Immunology (2007). 6th edition W.H. Freeman and Company, New York. ISBN: 978-1429202114

DAV UNIVERSITY, JALANDHAR

Course Title: Animal Diversity II

Paper Code: ZOO103

L	T	P	Credits
4	0	0	4

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. Dhami, P.S., Dhami, 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.

DAV UNIVERSITY, JALANDHAR

Course Title: Animal Diversity II Lab

Paper Code: ZOO104

L	T	P	Credits
0	0	3	2

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, Labeorohita, Cirrhinusmrigala, Cyprinuscarpio, 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, RhacophorusIchthyophis*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, Casuarius;* 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

DAV UNIVERSITY, JALANDHAR

L	T	P	Credits
4	0	3	4

Course Code: MIC225

Course Title: MICROBIAL GENETICS

Course Objective: This course will introduce the students to various aspects of microbial genetics including genome organization in bacteria and phages, plasmids, genetic recombination and transposition in bacteria.

Course Content:

Unit 1 Genome Organization and Mutations **No. of Hours: 18**

Genome organization: *E. coli, Saccharomyces, Tetrahymena*

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens;

Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of

mutations

Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes, Genome organization of *Aspergillus nidulans*

Unit 2 Plasmids **No. of Hours: 10**

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

Unit 3 Mechanisms of Genetic Exchange **No. of Hours: 12**

Transformation - Discovery, mechanism of natural competence

Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping

Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers, Recombination and genome mapping in viruses

Unit 4 Phage Genetics **No. of Hours: 8**

Features of T4 genetics, Genetic basis of lytic *versus* lysogenic switch of phage lambda

Unit 5 Transposable elements **No. of Hours: 12**

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon

Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds)

Uses of transposons and transposition.

SUGGESTED READINGS

1. Klug WS, Cummings MR, Spencer, C, Palladino, M. *Concepts of Genetics*, 10th Ed., Benjamin Cummings. 2011. Print

2. Krebs J, Goldstein E, Kilpatrick S. *Lewin's Essential Genes*, 3rd Ed., Jones and Bartlett Learning. 2013. Print

3. Pierce BA. *Genetics: A Conceptual Approach*, 4th Ed., Macmillan Higher Education Learning. 2011. Print

4. Watson JD, Baker TA, Bell SP et al. *Molecular Biology of the Gene*, 6th Ed., Benjamin Cummings. 2008. Print

5. Gardner EJ, Simmons MJ, Snustad DP. *Principles of Genetics*. 8th Ed. Wiley-India. 2008. Print

6. Russell PJ. *i Genetics- A Molecular Approach*. 3rd Ed, Benjamin Cummings. 2009. Print

7. Sambrook J and Russell DW. *Molecular Cloning: A Laboratory Manual*. 4th Edition, Cold Spring Harbour Laboratory press. 2001. Print

8. Maloy SR, Cronan JE and Friefelder D. *Microbial Genetics.* 2nd Ed., Jones and Barlett Publishers. 2004. Print

DAV UNIVERSITY, JALANDHAR

Course Code: MIC226

Course Title: MICROBIAL GENETICS LABORATORY

L	T	P	Credits
0	0	3	2

Experiments:

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E.coli*
5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

DAV UNIVERSITY, JALANDHAR

Course Title: Proteins and Enzymes

L	T	P	Credits
4	0	0	4

Paper Code: BCH218

Unit A (15 hours)

Introduction to proteins

Polypeptides and proteins. Subunit structures, conjugated proteins, diversity of function.

Isolation and analysis of proteins

Techniques to isolate and analyze proteins- salt fractionation, ion-exchange chromatography, gel permeation, HPLC, SDS-PAGE, IEF. Protein primary structure - sequencing by Edman degradation, use of enzymes and chemical reagents to obtain overlap peptides. Synthesis of peptides using Merrifeld method.

Unit B (15 hours)

Introduction to protein three-dimensional structures

Secondary structure: alpha-helices and beta-sheets, Ramachandran maps. Nature of non-covalent bonds and covalent bonds in protein folding. Tertiary and quaternary structures.

Myoglobin and haemoglobin - structure and function

Oxygen binding curves, cooperativity models for haemoglobin.

Unit C (15 hours)

Introduction to enzyme catalysis

Features of enzyme catalysis, superior catalytic power. General mechanisms of catalysis. Nomenclature.

Enzyme kinetics

Principles of reaction rates, order of reactions and equilibrium constants. Derivation of Michaelis-Menten equation. Significance of Km and Vmax. Catalytic efficiency parameters. Competitive and mixed inhibitions. Kinetics and diagnostic plots. Types of irreversible inhibitors.

Unit D (15 hours)

Mechanisms of enzyme action and regulation

Mechanism of action of chymotrypsin. Inhibitors of enzymes - antibiotics. Regulation of enzyme activity and its importance - aspartate transcarbamoylase.

Enzymes in medicine and industry

Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry.

Recommended Books

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13; 978-1-4641-0962-1 / ISBN:10-14641- 0962-1.

2. Fundamentals of Enzymology (1999) 3rd ed., Price, N.C and Stevens, L., Oxford University Press Inc., (New York), ISBN:13: 978-0-19-806439-8.

DAV UNIVERSITY, JALANDHAR

Course Title: Proteins and Enzymes Laboratory

L	T	P	Credits
0	0	3	2

Paper Code: BCH219

Experiments:

1. Protein estimation by UV absorbance and Biuret method.

2. Protein microassay by Lowry/Bradford method.

3. Ammonium sulphate fractionation of crude homogenate from germinated mung bean.

4. Setting up assay for acid phosphatase and activity measurements of the ammonium sulphate fractions (progress curve and effect of pH).

5. Determination of Km and Vmax of enzyme enriched fraction.

6. Inhibition of acid phosphatase activity by inorganic phosphate.

BIOPROCESS TECHNOLOGY

L	T	P	Credits
4	0	0	4

Course Code: BTY351

Course objective: The aim is to study how living matter, in the form of organisms or various biomolecules, under specific optimal conditions can be implied to make a desired product.

Course Contents:

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. ISBN: 9780122208515

2. Shuler, M and Kargi, F, Bioprocess Engineering Basic Concepts 2nd Edition, Prentice-Hall India.2006. ISBN: 9780130819086

3. Doran, P. M. Bioprocess Engineering Principles, Elsevier Science & Technology Books. 2002. ISBN: 9788131200018

BIOPROCESS TECHNOLOGY LABORATORY

L	T	P	Credits
0	0	3	2

Course Code: BTY352

EXPERIMENTS

1. Methods of sterilization.
2. Media preparation and inocula development.
3. Calculation of bacterial growth curve.
4. Calculation thermal death point (TDP) of a microbial sample.
5. Production and analysis of ethanol.
6. Production and analysis of amylase.
7. Production and analysis of lactic acid.
8. Isolation of industrially important microorganism from natural resource.
9. Demonstration of fermenters.

RECOMBINANT DNA TECHNOLOGY

Course Code: BTY353

L	T	P	Credits
4	0	0	4

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.

Course Contents:

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: PCR based methods of site directed 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. 3rd Edition. W.H. Freeman & Company. 2006. ISBN: 978-0716728665

2. Primrose, S.B. and Twyman, R.M. Principles of Gene Manipulation & Genomics.7th Edition. Oxford University Press. 2006. ISBN: 978-1405135443

3. Lodge, J., Lund, P. and Minchin, S. Gene Cloning: Principles and Applications. 1st Edition. Taylor & Francis. 2006. ISBN: 978-0748765348

5. Brown,T.A. Gene cloning and DNA analysis: An introduction.6th Edition. Wiley-Blackwell. 2010. ISBN: 978-1405181730

6. Sambrook, J., Fritsch, E.F. and Maniatis, T. Molecular cloning: A Laboratory Manual. Vol. I-III.2nd Edition. Cold Spring Harbor Laboratory, 1989. ISBN: 978-0-87969-309-1

RECOMBINANT DNA TECHNOLOGY LABORATORY

Course Code: BTY354

L	T	P	Credits
0	0	3	2

EXPERIMENTS

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. DNA extraction from agarose gel
7. Making competent cells
8. Transformation of competent cells.
9. Demonstration of PCR

BIOTECHNOLOGY AND HUMAN WELFARE
Course code: BTY 243

L	T	P	Credits
4	0	0	4

Course Objective: To study application of biotechnology in various areas e.g. industry, agriculture, environment, forensic and health.

Course contents:

UNIT I

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

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

UNIT II

Agriculture: N_2 fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock.

UNIT III

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

UNIT IV

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

Reference Books:

1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd. ISBN: 978-8190675703
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international Publishers. ISBN: 978-8122420852
3. B B et al Kaliwal (2017) Role of Animal Science in National Development Vol-2 Biotechnology for Human Welfare ISBN: 978-8170195597
4. BD Singh (2015) Biotechnology: Expanding Horizons. Kalyani publishers. ISBN: 978-9327222982

BIOTECHNOLOGY AND HUMAN WELFARE LABORATORY
Course code: BTY 244

L	T	P	Credits
0	0	3	2

EXPERIMENTS

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

MEDICAL MICROBIOLOGY

Course code: BTY399

L	T	P	Credits
4	0	0	4

Course objective: The aim is to study the prevention, diagnosis and treatment of infectious diseases. In addition, various clinical applications of microbes for the improvement of health

Course Contents:

UNIT I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock,septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriae M.tuberculosis, M. leprae*.

UNIT II

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

UNIT III

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

UNIT IV

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

Reference Books:

1. Brooks, G.F., Carroll, K.C., Butel, J.S. and Morse, S.A. Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication. 2007. ISBN: 9780071815789

2. Goering, R, Dockrell, H, Zuckerman, M and Wakelin, D. Mims' Medical Microbiology. 5th edition. Elsevier. 2007. ISBN: 9780808924401

3. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. Prescott, Harley and Klein's Microbiology. 8th edition. McGraw Hill Higher Education. 2008. ISBN: 9780071313674

4. Murray, P., Rosenthal, K., Pfaller, M. Medical Microbiology 8th Edition. Elsevier Paperback. 2015. ISBN: 9780323299565

5. Baron, S. Medical Microbiology. 4th edition Univ of Texas Medical Branch. 1996. ISBN: 978-0963117212

MEDICAL MICROBIOLOGY LABORATORY

Course code: BTY400

L	T	P	Credits
0	0	3	2

EXPERIMENTS

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

BIOSTATISTICS AND BIOINFORMATICS

Course Code: BTY395

L	T	P	Credits
4	0	0	4

Course Objective: The course focuses on design, analysis, and interpretation of data for research studies. It also gives insight into the uses of computation to better understand biology which involves analysis of biological data, particularly DNA, RNA, and protein sequences.

Course Contents:

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. Alignments: Pairwise and multiple sequence alignment, using it on the web, interpreting results, phylogenetic analysis

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.

Reference Books:

1. Banerjee, P.K. Introduction to Biostatistics. 4th Edition. S. Chand & Co. Ltd. 4th Edition. 2013. ISBN: 9788121923293

2. Sokal, R.R. and Rohlf, F.J. Introduction to Biostatistics. 2nd Edition. Dover Publications. 2009. ISBN: 978-0486469614

3. Pevzner, P. and Shamir, R. Bioinformatics for Biologists. 1st Edition. Cambridge University Press. 2011. ISBN: 978-1107648876

4. Lesk, A.M. Introduction to Bioinformatics. 3rd Edition. Oxford University Press. 2008. ISBN: 978-0199208043

5. Bourne, P.E. and Weissig, H. Structural Bioinformatics. 2nd Edition. John Wiley & Sons Ltd. 2009. ISBN: 0 471201995

BIOSTATISTICS AND BIOINFORMATICS LABORATORY

Course Code: BTY396

L	T	P	Credits
0	0	3	2

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. Introduction to SPSS and MATLAB
6. Sequence information resource
7. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene,
8. Protein information resource (PIR)
9. Understanding and using: PDB, Swissprot, TREMBL
10. Using various BLAST and interpretation of results.
11. Retrieval of information from nucleotide databases.
12. Sequence alignment using BLAST.
13. Multiple sequence alignment using Clustal W.

FOOD BIOTECHNOLOGY

Course Code: BTY397

L	T	P	Credits
4	0	0	4

Course objective: The aim is to study the microbiology of food and methods related to processing.

Course Contents:

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. 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. Food borne diseases.

UNIT-II

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-III

Introduction to packaging - packaging principles and operation - package functions and design - methods to extend shelf life. Food fermentation, alcoholic beverages, fermented milk products, fermented sauces.

UNIT-IV

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. Jelen, P. Introduction to Food Processing. Prentice Hall, Reston Virginia, USA. 1985. ISBN: 978-0835931946

2. Branen, A.L. and Davidson, P.M (Ed). Antimicrobials in Foods. Marcel Dekker, New York. 1983. ISBN: 9780824770266

3. Jay, J.M., Loessner, M. J., Golden, D.A. Modern Food Microbiology. 7th Ed. Springer. 1986. ISBN: 9780387231808

4. Ranganna, S. Handbook of Analysis and Quality Control for Fruits and Vegetable Products. Tata McGraw Hill. 1986. ISBN: 9780074518519

5. Sacharow, S. and Griffin, R.C. Food Packaging. 2nd Ed. AVI, Westport. 1970. ISBN 9780870553479

6. William C., Frazier W.C., Westhoff D.C. Food Microbiology. Fourth Ed. McGraw-Hill Inc., ISBN-13: 978-0070219212

FOOD BIOTECHNOLOGY LABORATORY

Course Code: BTY398

L	T	P	Credits
0	0	3	2

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.
7. Staining methods of bacteria
8. Measurement of bacterial size

ANIMAL BIOTECHNOLOGY

Course Code: BTY391

L	T	P	Credits
4	0	0	4

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

Animal propagation – Artificial insemination, animal clones. Conservation biology – Embryo transfer techniques. Introduction to stem cell technology and its applications.

UNIT IV

Introduction to transgenesis. Transgenic Animals – Mice, cow, pig, sheep, goat, bird, insect. Animal diseases need help of biotechnology – Foot and mouth disease, Trypanosomiasis. 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. 6th Edition. Wiley-Blackwell, 2010. ISBN: 978-1-118-87365-6

2. Masters, J.R.W. Animal Cell Culture: A Practical Approach. 3rd Edition. Oxford University Press. 2000. ISBN: 9780199637966

3. Twine, R. Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies. 1st Edition. Routledge Publishers. 2010. ISBN: 978-1138867000

4. Verma, A. and Singh, A. Animal Biotechnology: Models in Discovery and Translation. 1st Edition. Academic Press. 2013. ISBN: 9789351073420

ANIMAL BIOTECHNOLOGY LABORATORY

Course Code: BTY392

L	T	P	Credits
0	0	3	2

EXPERIMENTS

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

GENOMICS AND PROTEOMICS

Course Code: BTY363

L	T	P	Credits
4	0	0	4

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

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

Unit - II

Restriction mapping, DNA & RNA finger printing, DNA sequencing-chemical and enzymatic methods, the human genome.

Unit - III

Phylogeny, SAGE, ESTs, AFLP & RFLP analysis. 2D– gel electrophoresis and mass spectroscopy for proteome analysis. Protein – protein interactions: Yeast- two hybrid method, GFP tags, proteome- wide interaction maps

Unit – IV

Modelling 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.

Reference Books:

1. Brown, T.A. Genomes III. 3rd Edition. Garland Science. 2006. ISBN: 978-0815341383

2. Lengauer, T., Mannhold, R., Kubinyi, H. and Timmerman, H. Bioinformatics: From Genomes to Drugs. 1st Edition. John Wiley and Sons Ltd. 2001. ISBN: 978-3527299881

3. Mount, D. Bioinformatics: Sequence and Genome Analysis. 2nd Edition. Cold Spring Harbor Laboratory Press. 2013. ISBN: 978-0879697129

4. Schena, M. DNA Microarrays: A Practical Approach. 1st Edition. Oxford University Press. 1999. ISBN: 9780199637768

5. Gibson, G. and Muse, S.V. A Primer of Genome Science. 3rd Edition. Sinauer Associates, Inc. 2009. ISBN: 978-0878932368

6. Caudy, A.A., Watson, J.D., Myers, R.M. and Witkowski, J.A. Recombinant DNA: Genes and Genomes. 3rd Edition. W.H. Freeman & Company. 2006. ISBN: 978-0716728665

7. Xiong, J. Essential Bioinformatics. 1st Edition. Cambridge University Press. 2006. ISBN: 9780521600828

8. Twyman, R. Principles of Proteomics. 2nd Edition. Garland Science. 2013. ISBN: 9780815344728

GENOMICS AND PROTEOMICS LABORATORY

Course Code: BTY364

L	T	P	Credits
0	0	3	2

EXPERIMENTS

1. Electrophoretic separation of plasmid DNA.
2. Restriction, digestion & ligation of DNA.
3. Native PAGE
4. SDS PAGE
5. Gene finding tools and genome annotation- Gen Scan, Net Gene, Hmm gene.
6. Use of SNP databases at NCBI and other sites
7. Detection of Open Reading Frames using ORF Finder
8. Proteomics 2D PAGE database
9. Comparison of two given genomes- Mummer.
10. Homology modelling of 3-D structure from amino acid sequence: SWISS- MODELLER
11. Graphics tools: SWISS- PDB Viewer.

VIROLOGY

L	T	P	Credits
4	0	0	4

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. Defective particles, multiparticles, viroids, virusoids, prions, mycoviruses, bacteriophage, cynophage, virophage, baculoviruses.

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.

Reference Books:

1. Hull, R. Matthews Plant Virology. 4th Edition. Academic Press. 2001. ISBN: 978-0123611604

2. Knipe, D.M. and Howley, P.M. Fields Virology.Vol:2 6th Edition. Lippincott Williams & Wilkins. 2006. ISBN: 978-1451105636

3. Cann, A.J. Principles of Molecular Virology. 5th Edition. Academic Press. 2011. Print. ISBN: 9780123849397

4. Carter, J. and Saunders, V. Virology: Principles and Applications. 2nd Edition. John Wiley & Sons Ltd. 2013. ISBN: 978-1119991427

5. Flint, S.J., Enquist, L.W., Racaniello, V.R. and Skalka, A.M. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses. 2nd Edition, ASM Press, Washington, DC.2003. ISBN: 978-1555812591

VIROLOGY LABORATORY

L	T	P	Credits
0	0	3	2

Course Code: BTY394

EXPERIMENTS

1. Virus diagnosis using ELISA
2. Virus diagnosis using PCR
3. Virus diagnosis using slot-blot hybridization
4. Study of symptoms of virus diseases through visit to local diseases fields and/or photographs
5. Collection and processing of viral samples
6. Effect of virus infection on chloroplast number and cell size
7. Transmission of plant viruses
8. Collection and identification of local insect vectors
9. Determination of disease progress curve

ENZYMOLOGY

L	T	P	Credits
4	0	0	4

Course Code: BTY383

Course objective: The aim is to understand enzymes, their kinetics, structure, and function, as well as their relation to each other. Recent advancements related to enzymes.

Course Contents:

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 Km and Vmax 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 Ki, 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, Lysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feedback control, covalent modification.

UNIT – III

Allosteric enzymes with special reference to aspartate transcarbomylase 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 acid synthase.

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. Price, N.C. and Stevens, L. Fundamentals of Enzymology, Oxford University Press, 2003.

2. Engal, P. Enzyme kinetics John Willey and Sons Inc. 1977. Print. ISBN: 9780198552970

3. Cornish, A, Principles of enzyme kinetics. Bowden and Butterworth and Co., 1976. ISBN: 978-0-408-10617-7

4. Jayaraman, J. Laboratory manual in Biochemistry. New Age International. 2006. ISBN: 978-8122430493

5. Source book of Microbiology by Primrose. ISBN: 978-0632013180

L	T	P	Credits
0	0	3	2

ENZYMOLOGY LABORATORY

Course Code: BTY384

EXPERIMENTS:

1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as Km, Vmax, Kcat

ENVIRONMENTAL BIOTECHNOLOGY

Course Code: BTY385

L	T	P	Credits
4	0	0	4

Course objective: The aim is to study the natural environment and to gain knowledge related to the use of microorganisms and their products in the prevention of environmental pollution through bio-treatment, bioremediation and biomonitoring of environment. To understand biological process to harness them for commercial uses and exploitation

Course Contents:

UNIT I

Conventional fuels and their environmental impact – firewood, plant, animal, water, coal and gas. Modern fuels and their environmental impact – Methanogenic bacteria, biogas, microbial hydrogen production, conversion of sugar to alcohol gasohol

UNIT II

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

UNIT III

Treatment of municipal waste and Industrial effluents. Bio-fertilizers role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT IV

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

Reference Books:

1. Santra, S.C. Environmental Science. 3rd revised Ed. New Central Book Agency (P) Ltd. 2011. ISBN 9788173814044

2. Mohapatra, P.K. Environmental Biotechnology. 1st Ed. Edition I.K. International Publishing House. 2007. ISBN: 978-8188237548

3. Jordening, H.J. (Ed.) and Winter, J. (Ed.). Environmental Biotechnology – Concepts and Applications. Wiley-Blackwell.2004 ISBN: 978-3-527-30585-8

4. Burton, F.L., H. David Stensel metcalf George Tchobanoglous. Waste Water Engineering: Treatment And Reuse, Metcalf and Eddy, 4th edition Tata McGraw Hill.
ISBN: 9780070495395
5. Wainwright, M. Introduction to Environmental Biotechnology. 1st Edition. Springer US.
ISBN:9781461373940

ENVIRONMENTAL BIOTECHNOLOGY LABORATORY

Course Code: BTY386

L	T	P	Credits
0	0	3	2

EXPERIMENTS

1. Sampling techniques.
2. Calculation of Total Dissolved Solids (TDS) of water sample.
3. Calculation of BOD of water sample.
4. Calculation of COD of water sample.
5. To check the faecal contamination.
6. Bacterial Examination of Water by MPN Method.
7. Optimum coagulant dose estimation through turbidity measurement.
8. Methods of measurement chlorine content of water.
9. Isolation of nitrogen fixing bacteria.
10. Isolation of phosphate solubilizing bacteria.
11. Isolation of pesticide degrading organisms from soil.

DAV UNIVERSITY, JALANDHAR

HERBALS AND NEUTRACEUTICALS

L	T	P	Credits
4	0	0	4

Course code: BTY387

Course objective: The course focuses on study of various plants and their products intended for medicinal purposes and for supplementing a diet. It involves study the cultivation, extraction and analysis of the plant products and their applications.

Course Contents:

Unit I

Crude Drugs – scope & importance, classification (taxonomical, morphological chemical, pharmacological); cultivation, collection & processing of crude drugs.

Unit II

Cultivation and utilization of medicinal & aromatic plants in India. Genetics as applied to medicinal herbs. Modern biotechnological tools and its influence in medical and aromatic plant cultivation. Plant tissue culture as a mean of conservation of rare and endangered medicinal plants.

Unit III

Plant tissue culture as source of medicines, secondary metabolite production in plants; plant tissue culture for enhancing secondary metabolite production (*Withania somnifera*, *Rauwolfia serpentina*, *Swertia chirayit*, *Andrographis paniculata*, *Aconitum* sp.); anticancer, anti-inflammatory, antidiabetic, analgesic drugs, biogenesis of phyto-pharmaceuticals.

Unit IV

Analysis of phytochemicals: Preliminary screening, and characterization of drugs.

Types of phytochemicals: Carbohydrates & derived products; glycosides - extraction methods; alkaloids - extraction methods; flavonoids- extraction methods, resins- extraction methods; lectins.

Application of phytochemicals in industry and healthcare; biocides, biofungicides, biopesticides. Nutraceuticals.

Reference Books:

1. Kokate, C.K., Purohit, A. P. & Gokhale, S. B. Pharmacognosy 14th Ed. Gokhale Nirali Prakashan, 2008. ISBN-13: 978-8185790091

2. Dewick, P.M. Medicinal Natural Products: A Biosynthetic approach 3rd Ed.Wiley. ISBN: 978-0-470-74168-9

3. Hornok, L. (ed.) Cultivation & Processing of Medicinal Plants, Chichister, U. K:J. Wiley & Sons 1992. ISBN: 978-0471923831

4. Trease & Evans, Pharmacognosy – William Charles Evans, 16th ed. Harcourt Brace & Company. ISBN: 9780702029349

DAV UNIVERSITY, JALANDHAR

HERBALS AND NEUTRACEUTICALS LABORATORY

Course code: BTY388

L	T	P	Credits
0	0	3	2

EXPERIMENTS

1. Isolation of secondary metabolites from various plant organs
2. Identification of secondary metabolites by classic separation methods
3. Quantitation of secondary metabolites by spectral methods
4. Sterilization of explants for micro propagation of medicinal plants
5. Mass propagation of medicinal plants through plant tissue culture
6. Standardisation of plant Tissue Culture for Secondary metabolite production.
7. Demonstration of Capillary electrophoresis
8. Demonstration of Secondary metabolites analytical technique – HPLC

IMMUNOLOGY

Course Code: BTY371

L	T	P	Credits
4	0	0	4

Course objective: The aim is to study immune system and its various lines of defense. Components of immune system, autoimmunity, hypersensitivity and immunodeficiency, antigen-antibody structure, function and interaction. Various antibody related techniques.

Course Contents:

Unit I

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. 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 II

Characteristics of an antigen (foreignness, molecular size and heterogeneity); haptens; epitopes (T& B cell epitopes); T-dependent and T-independent antigens; adjuvants.

Structure, types, functions and properties of antibodies; antigenic determinants on antibodies (isotypic, allotypic, idiotypic); VDJ rearrangements; monoclonal and chimeric antibodies. organization of MHC locus (Mice & Human); structure and functions of MHC I & II molecules; antigen processing and presentation (cytosolic and endocytic pathways).

Components of the complement system; activation pathways (classical, alternative and lectin pathways); biological consequences of complement activation

Unit III

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

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 IV

Principles of precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA, ELISPOT, Western blotting, immunofluoresence, flow cytometry, immunoelectron microscopy.

Reference Books:

1. Abbas, A.K., Lichtman, A.H., Pillai, S. Cellular and Molecular Immunology. 8th edition Saunders Publication, Philadelphia. 2007. ISBN: 9780323222754

2. Delves, P., Martin, S., Burton, D., Roitt, I.M. Roitt's Essential Immunology.13th edition Wiley-Blackwell Scientific Publication, Oxford. 2006. ISBN: 9781118415771

3. Goldsby, R.A., Kindt, T.J., Osborne, B.A. Kuby's Immunology. 6th edition W.H. Freeman and Company, New York. 2007. ISBN-13: 9781429202114

4. Murphy, K., Travers, P., Walport, M. Janeway's Immunobiology. 7th edition Garland Science Publishers, New York. 2008. ISBN 9780815341239

5. Peakman, M., and Vergani, D. Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg. 2009. ISBN**:** 9780443100826

6. Richard, C. and Geiffrey, S. Immunology. 7th edition. Wiley Blackwell Publication. 2009. ISBN : 978-1-118-39691-9

IMMUNOLOGY LABORATORY

Course Code: BTY372

L	T	P	Credits
0	0	3	2

EXPERIMENTS

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 immunodiffusion by Mancini method.
7. Perform DOT ELISA.
8. Perform immunoelectrophoresis.