DAVUNIVERSITY JALANDHAR

SCHEME FOR

Masters of Science (Biotechnology Hons.)
(Program ID-38)

1st TO 4th SEMESTER
Examinations 2014–2015 Session Onwards

Syllabi Applicable For Admissions in 2014

Course Scheme
M.Sc. Biotechnology (Hons.)
Semester-I

S. No	Paper Code	Course Title	L	T	P	Cr	A	B	C	D	E
1	BTY501	Biotechnology-I	4	1	0	4	25	25	25	25	**100**
2	BTY502	Molecular Biology	4	1	0	4	25	25	25	25	**100**
3	BTY503	Cell Biology	2	1	0	2	25	25	25	25	**50**
4	BTY504	Genetics	4	1	0	4	25	25	25	25	**100**
5	MIC513	General Microbiology	2	0	0	2	25	25	25	25	**50**
6	BTY505	Biotechnology-I - LAB	0	0	3	2	-	-	-	-	**50**
7	BTY506	Molecular Biology - LAB	0	0	3	2	-	-	-	-	**50**
8	BTY507	Cell Biology - LAB	0	0	2	1	-	-	-	-	**25**
9	BTY508	Genetics - LAB	0	0	3	2	-	-	-	-	**50**
10	MIC514	General Microbiology - LAB	0	0	2	1	-	-	-	-	**25**
			16	**4**	**13**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits

Semester-II

S. No	Paper Code	Course Title	L	T	P	Cr	A	B	C	D	E
1	BTY551	Recombinant DNA Technology	4	1	0	4	25	25	25	25	**100**
2	BTY552	Biotechnology-II	4	1	0	4	25	25	25	25	**100**
3	BTY553	Biostatistics	4	1	0	4	25	25	25	25	**100**
4	BTY554	Instrumentation in Biology	2	1	0	2	25	25	25	25	**50**
5	BCH551	Biochemistry	2	0	0	2	25	25	25	25	**50**
6	BTY555	Recombinant DNA Technology - LAB	0	0	3	2	-	-	-	-	**50**
7	BTY556	Biotechnology-II-LAB	0	0	3	2	-	-	-	-	**50**
8	BTY557	Biostatistics - LAB	0	0	3	2	-	-	-	-	**50**
9	BTY558	Instrumentation in Biology - LAB	0	0	2	1	-	-	-	-	**25**
10	BCH552	Biochemistry - LAB	0	0	2	1	-	-	-	-	**25**
			16	**4**	**13**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits

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Semester-III

S. No	Paper Code	Course Title	L	T	P	Cr	A	B	C	D	E
1	BTY601	Biotechnology and Healthcare	2	1	0	2	25	25	25	25	**50**
2	BTY602	Computational Biology & Bioinformatics	4	0	0	3	25	25	25	25	**75**
3	MIC603	Immunology	4	1	0	4	25	25	25	25	**100**
4	BTY603	Industrial Biotechnology	2	1	0	2	25	25	25	25	**50**
5	BTY604	Virology	4	1	0	4	25	25	25	25	**100**
6	BOT601	Scientific Writing and Research Methodology	2	0	0	2	25	25	25	25	**50**
7	BTY606	Computational Biology & Bioinformatics - LAB	0	0	2	1	-	-	-	-	**25**
8	MIC604	Immunology - LAB	0	0	3	2	-	-	-	-	**50**
9	BTY605	Industrial Biotechnology - LAB	0	0	2	1	-	-	-	-	**25**
10	BTY607	Virology - LAB	0	0	3	2	-	-	-	-	**50**
11	BTY608	Seminar-I	0	0	0	1	**-**	**-**	**-**	-	**25**
			18	**4**	**10**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits

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Semester-IV

S. No	Paper Code	Course Title	L	T	P	Cr	A	B	C	D	E
1	BTY651	Environmental Biotechnology	4	1	0	4	25	25	25	25	**100**
2	BTY652	Genomics, Proteomics & Metabolomics	4	1	0	4	25	25	25	25	**100**
3	BTY653	Intellectual Property Rights, Bio safety and Bioethics	2	1	0	2	25	25	25	25	**50**
4	BTY654	Project Dissertation	0	0	0	8	-	-	-	-	**200**
5	BTY655	Seminar-II	0	0	0	1	-	-	-	-	**25**
6	BTY656	Genomics, Proteomics & Metabolomics - LAB	0	0	3	2	-	-	-	-	**50**
7	BTY657	Environmental Biotechnology-LAB	0	0	3	2	-	-	-	-	**50**
8	BTY658	Educational Tour	0	0	0	1	-	-	-	-	**25**
			10	**3**	**6**	**24**					**600**

A: Continuous Assessment: Based on Objective Type Tests
B: Mid-Term Test-1: Based on Objective Type & Subjective Type Test
C: Mid-Term Test-2: Based on Objective Type & Subjective Type Test
D: End-Term Exam (Final): Based on Objective Type Tests
E: Total Marks
L: Lectures T: Tutorial P: Practical Cr: Credits

Course Title: Biotechnology-I

Course Code: BTY501

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: The objective of this course to familiarize the students with integrated use of different biological sciences. Plant tissue culture has contributed greatly to understanding the factors responsible for growth, differentiation and other vital processes of plant cells, tissues & organs *in vitro*. The technique has contributed immensely towards plant improvement, plant protection and also for large-scale production of industrially important compounds by gene manipulation.

1. Introduction & basic techniques in tissue culture. Conventional breeding vs tissue culture. Tissue culture media (composition & preparation), sterilization techniques, tissue culture as a technique to produce novel plants & hybrids, Green house and Green home technology. Concept of cellular totipotency. Basic techniques in cell culture and somatic cell genetics. Regulation of cell cycle and cell division. Initiation and maintenance of callus and suspension cultures, single cell clones, nurse culture technique, differentiation, organogenesis & somatic embryogenesis, Production and application of artificial seeds. **10 hours**
2. Clonal propagation & production of virus-free plants, stages of micropropagation, propagation by direct and indirect organogenesis. Transfer and establishment of whole plants in soil, *in situ* and *ex situ* rooting & difference. Changes during hardening of micropropagated plants. Importance of variability, somaclonal and gametoclonal variations, practical application of somaclonal variations. **10 hours**
3. Protoplast culture, fusion & culture, somatic hybridization and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids and **role** of protoplast culture and somatic hybridization in crop improvement. **7 hours**
4. Haploid production and its significance, anther, pollen culture, monoploid production. Hybrid embryo culture/embryo rescue and ovary culture. Endosperm culture, production of triploids. Role of haploids, monoploids and triploids in agriculture. **8 hours**
5. Germplasm conservation: Cryopreservation in germplasm storage, factors affecting revival of frozen cells, slow growth & DNA banking for germplasm conservation. Plant secondary metabolites a general account, (synthesis & extraction) central

mechanism and manipulation of phenylpropanoid pathway, shikimate pathway, Biotransformation and elicitation. Plant tissue culture repository. **10 hours**

6. Molecular marker-aided breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (Sequence Characterized Amplified Regions), SSCP (Single Stand Conformational Polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection in plant breeding. **10 hours**
7. Transgenic Plants Technology: Genetic Transformation, Methods for gene transfer in plants, Molecular mechanism of *Agrobacterium* mediated transformation. Selectable markers, Reporter gene and Promoters used in plant transformation vectors. Selection of transgenic (verification of transgene and agronomic traits). Marker free transgenics. **5 hours**

Reference Books:

1. Slater, A., Scott, N.W. and Fowler, M.R. *Plant Biotechnology: The Genetic Manipulation of Plants.* 2nd Edition. Oxford University Press. 2008. Print.
2. Hammond, J., McGarvey, P. and Yusibov, V. *Plant Biotechnology*. Springer verlag, Germany. 2000. Print.
3. Chawla, H.S. *Biotechnology in Crop Improvement.* International Book distributing company. 1998. Print.
4. Chawla, H.S. *Introduction to Plant Biotechnology*. 3rd Edition. CRC Press. 2009. Print.
5. Bhojwani, S. S. and Razdan, M. K. *Plant tissue culture – Theory and Practice*. Elsevier Publication. 2005. Print.
6. Kirakosyan, A. and Kaufman, P.B. *Recent Advances in Plant Biotechnology.* Springer. 2009. Print.

Course Title: Biotechnology-I-LAB

Course Code: BTY505

L	T	P	Credits	Marks
0	0	3	2	50

- Methods of sterilization
- Preparation of different media
- Callus induction & sub culturing, organogenesis, Suspension cultures and their maintenance.
- Micro propagation.
- Protoplast isolation and culture.
- Agro bacterium culture, selection of transformants.
- Isolation of Plant genomic DNA from the leaves tissue
- Restriction digestion of plant genomic DNA
- Developing RFLP and RAPD maps

Course Title: Molecular Biology

Course Code: BTY502

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: A comprehensive knowledge of molecular aspects of biological function at the molecular level, particular emphasis on the structure and regulation of genes, as well as, the structure and synthesis of proteins and applications of these concepts in human medicine and health, agriculture, study evolution and other areas.

1. Introduction to molecular biology, basic techniques in molecular biology. DNA and its various forms, super coiling of DNA, DNA melting, repetitive sequences, cot and rot curves, C value paradox, DNA protein interaction, DNA super coiling. Prokaryotic & eukaryotic DNA replication, enzymes and accessory proteins involved in DNA replication, replication origin & replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, gene amplification, mobile genetic elements, homologous and site specific recombination. **12 hours**
2. Prokaryotic and eukaryotic transcription, RNA polymerase, transcription factors, regulatory elements, transcriptional activator, repressor & mechanism of transcription regulation, post-transcriptional processing of mRNA, rRNA & tRNA. **12 hours**
3. Protein synthesis and processing: Ribosome structure, genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanism and regulation of translation & translation proof-reading, translational inhibitors, Post- translational modification of proteins and intracellular protein targeting, import into nucleus, mitochondria and peroxisome. **10 hours**
4. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). Cell signaling: signal transduction pathways and their regulation. **10 hours**
5. Genome sequencing: Genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, and strategies for sequencing genome, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. **8 hours**
6. Photoregulation and phytochrome regulation of nuclear and chloroplastic gene expression. Molecular mechanism of nitrogen fixation. Molecular biology of various

stresses, viz. abiotic stresses like drought, salt, heavy metals and tempreture; and biotic stresses like bacterial, fungal and viral disease. Signal transduction and its molecular basis, molecular mechanism of plant hormone action mitochondrial control of fertility, structure, organization and regulation of nuclear gene concerning storage proteins and starch synthesis. **8 hours**

Reference Books:

1. Lodish, H.F. *Molecular Cell Biology*. 6th Edition. W.H. Freeman & Company. 2007. Print.
2. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. *Lewin's GENES XI*. 11th Edition. Jones & Bartlett Learning. 2012. Print.
3. Sambrook, J., Fritsch, E.F. and Maniatis, T. *Molecular cloning: A Laboratory Manual.* Vol. I-III. 2nd Edition. Cold Spring Harbor Laboratory, 1989. Print.
4. Watson, J.D. *Molecular Biology of the Gene.* 7th Edition. Benjamin Cummings. 2013. Print.

Course Title: Molecular Biology-LAB

Course Code: BTY506

L	T	P	Credits	Marks
0	0	3	2	50

- Isolation of genomic DNA from bacteria.
- Isolation of genomic DNA from plant.
- Isolation of total RNA from tissue.
- Demonstration of DNA protein interaction.
- Quantitation of nucleic acids and proteins.
- Gel electrophoresis:
    - Nucleic acid
    - Protein

Course Title: Cell Biology

Course Code: BTY503

L	T	P	Credits	Marks
2	1	0	2	50

Course Objective: The object of the present course is to develop basic knowledge in cell biology to understand the structure and function of the cellular and sub cellular components of cells and tissues with the help of recent techniques. The course will help students to get an understanding of cell function at the molecular level including the fundamentals of biology. They will become aware of the complexity and harmony of the cell.

1. History of cell biology: Development of cell theory Diversity of cell size and shape: General organization and diversity of prokaryotic and eukaryotic cells. Origin of cells: Assembly of macromolecules (proteins and nucleic acid), mechanism of assembly, evolutionary steps in the origin of cells (Chemical evolution). **3 hours**
2. Microscopic techniques for study of cells: Bright field, Fluorescence, Phase contrast, DIC, dark field, Polarization, Confocal. Electron Microscopy: TEM, SEM, AFM, STEM, Preparation of samples for EM. Applications of Light Microscopy and EM in cell biology. **4 hours**
3. Sub cellular fractionation: Fractionation and marker enzymes and functional integrity, FACS, separation techniques for membrane proteins. Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

   6 hours
4. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. **5 hours**
5. Cell Trafficking : Targeting proteins to endoplasmic reticulum, signal recognition parcticle, signal recognition particle receptor, protein folding and processing in ER protein export from ER; Protein sorting and export from Golgi Apparatus; SNARE hypothesis; Protein import into Mitochondria, mitochondrial genome; Import and

sorting of chloroplast protein. Cellular energy transactions: Role of mitochondria and chloroplasts. **5 hours**

6. Cell division and Cell cycle & its regulation: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle. Molecular events and model systems; the role of the cyclins and cyclin-dependent kinases, cell cycle checkpoints, methods for synchronizing the cell cycle in cell populations.

   3 hours

7. Cellular responses to environmental signals in plants and animals: Mechanism of signal transduction. Cell signaling - Modes of cell signaling, steroid hormone receptors, plant hormones, G-protein coupled receptors; regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing, c- AMP pathway of signal transduction ; c GMP, phospholipids and calcium ions , Ras, Raf , MAP kinase pathway , JAK – STAT pathway , Apoptosis –role of caspases. **4 hours**
8. Cell motility: Cilia, flagella of eukaryotes and prokaryotes, their molecular mechanism. **2 hours**

Reference Books:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. *Molecular Biology of the Cell*. 5th Edition. Garland Science. 2007. Print.
2. Lodish, H.F. *Molecular Cell Biology*. 6th Edition. W.H. Freeman & Company. 2007. Print.
3. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. *The World of the Cell.* 7th Edition. Benjamin Cummings. 2008. Print.
4. Celis, J.E. *Cell biology: A laboratory handbook.* Vol 1-3. Academic Press, UK. 1994. Print.
5. Berg, J.M., Tymoczko, J.L. and Stryer, L. *Biochemistry*. 7th Edition. W.H. Freeman and Co., New York. 2010. Print.
6. Nelson, D.L. and Cox, M.M. *Lehninger Principles of Biochemistry*. 6th Edition. W.H. Freeman. 2012. Print.

Course Title: Cell Biology-LAB

Course Code: BTY507

L	T	P	Credits	Marks
0	0	2	1	25

- Microscopy: Bright field.
- Instrumental methods for cell biology-centrifugation, chromatography.
- Preparation of permanent slides of cell division.
- Vital staining for visualizing cell organelles.

Course Title: Genetics

Course Code: BTY504

L	T	P	Credits	Marks
4	1	0	4	100

Course objective: Genetic principles are unifying principles applicable across all the living forms. "Gene" is central to genetics, molecular biology and genetic engineering. Therefore the basic objectives of this course are to apprise the students with both classical and molecular genetics.

1. Molecular organization of chromosomes: Genome size and complexity, structure of eukaryotic and prokaryotic chromosome, polytene chromosomes, euchromatin and heterochromatin, satellite DNA, centromere and telomere structure, chromosomal staining, Organization of prokaryotic and eukaryotic genes and genomes including operon, unique and repetitive DNA, interrupted genes, gene families, exon, intron, enhancer promoter sequences and other regulatory elements. Structure of chromatin and chromosomes, heterochromatin, euchromatin, transposon. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. **12 hours**
2. Mendelian principles: Dominance, segregation, independent assortment. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. Linkage and chromosome mapping: linkage and crossing over; sex linkage, sex limited and sex influenced characters; genetic systems of Neurospora and yeast: tetrad analysis, centromere mapping, gene conversion and mating type, Extrachromosomal inheritance**:** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. **12 hours**
3. Gene Concept: Molecular concept of gene, complementation test for functional allelism, fine structure of genes. Methods of gene isolation and identification, Split genes, overlapping genes and pseudo genes. **8 hours**
4. Mutagenesis: Spontaneous vs induced mutation, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis, site directed mutagenesis, molecular basis of mutagenesis, test for mutagenicity, mutation frequency., transformation, transduction, conjugation, transposable elements and transposition. **10 hours**

5. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. **8 hours**
6. Microbial genetics: Transformation, conjugation, transduction and sex-duction mapping genes by interrupted mating, RecA, plasmids, their replication, copy number and compatibility, drug resistance; transposable elements and transposition. Recombinatio in bacteria, fungi and viruses; Homologous and non-homologous recombination. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. **10 hours**

Reference Books:

1. Strickberger M.W. *Genetics*. 3rd Edition. Prentice-Hall, India. 2008. Print.
2. Jones, S. *The Language of the Genes*. HarperCollins Publishers. 2012. Print.
3. Ridley, M. *Nature via Nurture: Genes, Experience, & What Makes Us Human*. HarperCollins Publishers. 2004. Print.
4. Aggarwal, V.K. and Verma, V.S. *Genetics.* 9th Edition. S. Chand, India. 2010. Print.
5. Snustad, D.P. and Simmons, M.J. *Principles of Genetics*. 6th Edition. John Wiley & Sons. 2011. Print.
6. Pierce, B.A. *Genetics: A Conceptual Approach.* 4th Edition. W.H. Freeman & Company 2010. Print.
7. Singh, B.D. *Fundamentals of Genetics*. 4th Edition. Kalyani Publishers. 2011. Print.

Course Title: Genetics-LAB

Course Code: BTY508

L	T	P	Credits	Marks
0	0	3	2	50

- Microscopy (Light Microscopes and electron microscopes)
- Prepararion and use of fixatives and stains for light microscopy;
- Prepararion of permanents slides and identification of various stages of cell division (mitosis and meiosis)
- Drosophila genetics
- Demonstration of induction of mutations with chemical mutagens.
- Identification of blood groups.

Course Title: Recombinant DNA Technology

Course Code: BTY551

L	T	P	Credits	Marks
4	1	0	4	100

Course objective: The basic objective of the paper is to present the principles of gene manipulation and its associated technologies. How developments in gene manipulation have revolutionized medicine, agriculture and health.

1. Introduction and scope of Recombinant DNA Technology. **2 hour**
2. DNA modifying enzymes- Terminal deoxynucleotidyl transferase, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Methylases, Ligases- *E. coli* and T4 DNA ligases, Linker, Adaptor, Homopolymer tailing, Restriction Endonucleases. **8 hours**
3. Isolation and Purification of nucleic acid: Basic techniques and considerations criteria of purity, isolation and purification of phage DNA plasmid, chromosomal DNA, RNA and mRNA. **4 hours**
4. Cloning and expression vector: Characteristics of cloning and expression vectors; plasmid, phage and cosmid vectors, multipurpose cloning vectors, shuttle vectors; bacterial, yeast, plant and mammalian expression vectors. **10 hours**
5. Cloning and expression hosts: Characteristics of cloning and expression host, bacterial, yeast, plant and mammalian host systems for cloning and expression of genes. **4 hours**
6. DNA Cloning Strategies: Preparation of genomic and cDNA libraries, criteria for selection of cloning vectors - plasmid, bacteriophage and cosmid, transformation and transfection, electroporation, screening of gene library and selection of clone. **6 hours**
7. Nucleic acid Blotting and Hybridization: Southern and northern blotting and hybridization techniques, radioactive and non-radioactive labeling of probe, western blotting. **4 hours**
8. Expression of cloned genes :Expression of cloned genes in *E. coli*, *Bacillus subtilis*, s*treptomyces*, yeast and mammalian cells, detection and analysis of proteins expression from cloned genes. **8 hours**
9. Protein-Protein interactions-Phage display (*in vivo*, *in vitro* and *in planta*, Yeast two hybrid system, Yeast three hybrid system. Bicomplementation and Florescence Resonance Energy Transfer (FRET). **3 hours**

10. Polymerase chain reaction and site directed mutagenesis: Principle and application of polymerase chain reaction, random mutagenesis, site-directed mutagenesis and protein engineering. **4 hours**
11. Impact of rDNA on human genetics: Mapping & cloning of human disease genes, DNA based diagnosis, gene targetting, human genome project history and scope. **4 hours**
12. Applications of r-DNA technology in industry, agriculture and forensic science. **3 hours**

Reference Books:

1. Brown, T.A. *Gene cloning and DNA analysis: An introduction*. 5th Edition. Wiley-Blackwell. 2010. Print.
2. Sambrook, J., Fritsch, E.F. and Maniatis, T. *Molecular cloning: A Laboratory Manual.* Vol. I-III. 2nd Edition. Cold Spring Harbor Laboratory, 1989. Print.
3. 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. Print.
4. Primrose, S.B. and Twyman, R.M. *Principles of Gene Manipulation & Genomics.* 7th Edition. Oxford University Press. 2006. Print.
5. Lodge, J., Lund, P. and Minchin, S. Gene Cloning: Principles and Applications. 1st Edition. Taylor & Francis. 2006. Print.
6. Glick, B.R., Pasternak, J.J. and Patten, C.L. *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 4th Edition. ASM Press. 2009. Print.

Course Title: Recombinant DNA Technology-LAB
Course Code: BTY555

L	T	P	Credits	Marks
0	0	3	2	50

- Preparation and purification of pUC plasmid.
- Preparation and purification of genomic DNA
- Restriction digestion of plasmid and genomic DNA and gel electrophoresis.
- Gene cloning
- Bacterial transformation
- Southern blotting and hybridization with non-radioactive probes.
- Amplification of DNA with PCR Temperature cycler.

Course Title: Biotechnology-II

Course Code: BTY552

L	T	P	Credits	Marks
4	1	0	4	100

Course objective: This course provides a comprehensive understanding of the cell culture and techniques to be used in laboratory. The course also introduces students to techniques like hybridoma technology, transformation and cloning, etc.

1. Animal Biotechnology- Scope, global perspective and new horizons, Historical perspective, and economically important livestock breeds, Model animals in animal biotechnology and genetic engineering. **6 hours**
2. Source of some important mammalian cell lines. Basic techniques of scale up of animal cell culture. : roller bottles modification of roller bottles, multiunit system and concept of bioreactors including hollow fiber system & their application. **8 hours**
3. Preservation and maintenance of animal cell lines, cryo-preservation and transport of animal germplasm (i.e. semen, ova and embryos). **6 hours**
4. Concept of stem cells, tissue engineering and its application **6 hours**
5. Production of monoclonal antibodies by hybridoma technique, scale up (*in vivo* and *in vitro*), brief concept of trioma and thymoma. **6 hours**
6. Gene cloning techniques for mammalian cells, cloning in mammalian cells. **6 hours**
7. Transgenic animals, *in vitro* fertilization and embryo transfer. Molecular biological techniques for rapid diagnosis of genetic diseases and gene therapy. Transgenic mice: Methodology and applications; Transgenic cattle, Livestock transgenesis- production of drugs using animals. **10 hours**
8. Chemical carcinogenesis, transfection, oncogenes and antioncogenes. **6 hours**
9. Cell synchronization methods and their applications, Concept of idiotype/antoidiotype and their application. **6 hours**

Reference Books:

1. Spier, R.E. and Griffiths, J.B. *Animal Cell Biotechnology*. Vol. 1-6. Academic Press. 1994. Print.
2. Freshney, R. I. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.* 6th Edition. Wiley-Blackwell, 2010. Print.
3. Atala, A. and Lanza, R. *Methods of Tissue Engineering*. 1st Edition. Academic Press. 2001. Print.
4. Harrison, M.A. and Rae, I.F. *General Techniques of Cell Culture*. 1st Edition. Cambridge University Press. 1997. Print.
5. Masters, J.R.W. *Animal Cell Culture: A Practical Approach*. 3rd Edition. Oxford University Press. 2000. Print.
6. Verma, A. and Singh, A. *Animal Biotechnology: Models in Discovery and Translation*. 1st Edition. Academic Press. 2013. Print.

7. Twine, R. *Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies.* 1st Edition. Routledge Publishers. 2010. Print.

Course Title: Biotechnology-II- LAB

Course Code: BTY556

L	T	P	Credits	Marks
0	0	3	2	50

- Preparation of culture media and concept of sterilization in animal cell culture.
- Subculturing and maintenance of continuous cell lines such as myeloma, Hep-2 and HeLa cells.
- To determine doubling time of a given cell line.
- Cytotoxic assay of a given antibiotic for a cell line.
- Effect of nutrient (serum) on growth of given cell line.
- Cryopreservation of animal cells.

Course Title: Biostatistics

Course Code: BTY553

L	T	P	Credits	Marks
4	1	0	4	100

Course objective: The course aims to develop expertise in the application of statistical methods applied to biological data obtained in experimental findings.

1. Brief description and tabulation of data and its graphical representation. Measures of Central Tendency (Mean, Median, Mode), Measures of dispersion (Range, Mean Deviation, Standard Deviation, Quartile Deviation), combined mean and variance, covariance, Graphs (Bar Chart, Pie Chart, Box Plot, Histogram, Ogive, scatter plot) Probability: Experimental probability, probability when outcomes are equally likely, subjective probabilities. **12 hours**
2. Probability (Addition and Multiplication Theorem), Bayes theorem, Binomial, Poisson and Normal distribution. Correlation and linear regression **8 hours**
3. Random variables and distributions, Discrete and continuous random variables, Cumulative distribution function, Probability mass function and probability, Density function, Expectation of random variable– experimental Approach and theoretical approach. **10 hours**
4. Formulation of Hypothesis (One-tailed & Two-tailed), Type I and Type II errors, power of a test, Significance of a test, P-value testing, Hypothesis Testing (students T-test, Chi-square test). Analysis of variance (ANOVA) one and two way. Pearson correlation test. **8 hours**
5. Biological experimental designs- CRD, RBD, factorial designs, latin square designs. **6 hours**
6. Application of statistics biological experimental design: Data collection and explanation and conclusion case studies. **8 hours**
7. Sampling theory and different techniques,Applications of statistical methods using statistical software , SAS. **8 hours**

Reference Books:

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

3. Daniel, W.W. and Cross, C.L. *Biostatistics: A foundation for analysis in the Health Sciences*. 10th Edition. John Wiley and Sons. 2013. Print.
4. Arora, P.N. and Malhan, P.K. *Biostatistics*. Himalaya Publishing House. 2012. Print.
5. Forthfer, R.H., Lee, E.S. and Hernandez, M. *Introduction to Biostatistics*. Academic Press. 2006. Print.
6. Gupta, S.P. *Statistical Methods*. 43rd Edition. S.Chand & Co. 2013. Print.

Course Title: Biostatistics – LAB

Course Code: BTY557

L	T	P	Credits	Marks
0	0	3	2	50

- Experiments based on measures of central tendency.
- Experiments based on measures of dispersion.
- Experiments based on analysis of data obtained in lab for different biological experiments
- Questions based on various distributions like Binomial, Poisson, Bernoulli.
- Practical on question of probability.
- Practical based on hypothesis testing.
- Biological experimental designs- CRD, RBD, factorial designs, latin square designs.

Course Title: Instrumentation in Biology

Course Code: BTY554

L	T	P	Credits	Marks
2	1	0	2	50

Course Objective: A comprehensive knowledge of functioning and applications of the equipment used in molecular biology will be offered in the course.

1. Quantitative and real time PCR, DNA sequencer (Nucleotide sequencing of DNA); Protein DNA interaction assays. **8 hours**
2. Radioimmunoassay, ELISA, Flow cytometery. **4 hours**
3. Overview of Chemical and Physical cell disruption techniques for biomolecules. **2 hours**
4. Methods of separation of peptides and proteins by electrophoresis and chromatography; Methods of separation of oligonucleotides and DNA by electrophoresis and chromatography. **4 hours**
5. Advanced techniques of separation: 2D gel electrophoresis, HPLC and GC. **4 hours**
6. Detection of molecular mass by MALDI, ESI-MS. **4 hours**
7. Determination of structure of molecules by Nuclear Magnetic Resonance spectroscopy, ^{1}H NMR, ^{13}C NMR, Magnetic Resonance Imaging. **3 hours**
8. Spatial arrangement of atoms in a crystal by X-ray Crystallography and analysis of data to predict a protein structure. **3 hours**

Reference Books:

1. Wilson, K. and Walker, J. *Practical Biochemistry: Principles and Techniques.* 5th Edition. Cambridge University Press. 2005. Print.
2. Sheehan, D. *Physical Biochemistry: Principles and Applications*. 2nd Edition. John Wiley & Sons Ltd. 2009. Print.
3. Upadhayaye, A., Upadhyaye, K. and Nath, N. *Biophysical Chemistry : Principles & Techniques*. Himalaya Publication House, New Delhi. 2002. Print.
4. Slater, R.J. *Radioisotopes in Biology-A Practical Approach*. 2nd Edition. Oxford University Press, New York. 2002. Print.
5. Venn, R.E. *Principle and Practice of Bioanalysis*. 2nd Edition. CRC Press. 2008. Print.

Course Title: Instrumentation in Biology-LAB

Course Code: BTY558

L	T	P	Credits	Marks
0	0	2	1	25

- Electrophoresis of proteins-Native and denaturing PAGE.
- Demonstration of ultra centrifugation.
- Demonstration of sample preparation for electron microscopy.
- Ion exchange chromatography of proteins.
- Thin layer chromatography for lipids and carbohydrates.

Course Title: Biotechnology and Healthcare

Course Code: BTY601

L	T	P	Credits	Marks
2	1	0	2	50

Course Objective: The objective of this course to utilise the biotechnology research into healthcare and deliver a drug substance at the biological target site. This course will give as insight to different drug delivery system including nanoparticles.

1. Molecular biology for drug discovery
   Vaccines, Diagnostics and Forensics. **3 hours**
2. Gene therapy: Vectors and other delivery systems for gene therapy
   Viruses as vectors, Non viral DNA delivery systems, synthetic particles as vectors. **4 hours**
3. The Science of Nano - What is Nanobiotechnology. **1 hours**
4. Nanoparticles in biological labeling and cellular imaging: Science of nanoparticles functionalization protein-based nanostructures: Nanomotors: Bacterial (E.coli) and Mammalian (Myosin family). **3 hours**
5. Applications of Nano-Materials in Biosystems: Proteins - Lipids - RNA and DNA
   Protein Targeting - Small molecule/nanomaterial - Protein interactions.
   Nanomaterial-Cell interactions-Manifestations of surface modification(Polyvalency). **4 hours**
6. Nanobiosensors: Science of Self-assembly - From Natural to Artificial Structures Nanotechnology Meets Microfluidics: Nano Printing of DNA, RNA, and Proteins Biochips Applications in Nano Scale Detection Lab-on-a-chip Devices (LOC). **4 hours**
7. Applications of Nanostructures in Drug: Discovery, delivery, and controlled release Nanotechnology for tissue engineering: Applications in regenerative therapy. **4 hours**
8. Nanomaterials and Diagnostics/Drug Delivery and Therapeutics Nanostructures in Cancer Research: Examples of nanostructures in research and therapy.
   Targeted delivery systems: Collodial drug carriers, nanoparticles and liposomes. Bioadhesives, prodrug and ligand appended carrier approach to site directed drug delivery. Protein and peptide drug delivery. Novel delivery systems. **8 hours**

Reference Books:

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

2. 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.
3. Beale, J.M. and Lock, J. *Wilson & Gisvold's textbook of organic medicinal and pharmaceutical Chemistry*. 12th Edition. Lippincott Williams & Wilkins. 2010. Print.
4. Trivedi, P.C. *Nanobiotechnology*. Pointer Publishers. 2008. Print.
5. Prasad, S.K. *Modern Concepts in Nanotechnology.* Discovery Publishing House. 2008. Print.

Course Title: Computational Biology & Bioinformatics

Course Code: BTY602

L	T	P	Credits	Marks
4	0	0	3	75

1. Introduction to Computational Biology: Nature and scope of Computational Biology and Bioinformatics, Basic Algorithms in Computational Biology, Introduction to sequence alignment. Analysis of the whole genome sequencing data: Processing and assembly of whole genome sequence data, Base-calling (PHRED), Vector and E-coli masking. Assembly using PHRAP, CAP3, Assessment of final data quality (Coverage, PHRAP score International guidelines for data quality) Types of Misassembles and their solution. **10 hours**
2. Analysis and submission of EST and GSS data: Processing and quality trimming of nascent sequences; Preparation of submission files; Clustering of ESTs (overview of clustering procedure, pros and cons of clustering). **6 hours**
3. Whole Genome annotation strategies: Basic overview of whole genome annotation strategies, strategies for Human and Arabidopsis genomes. Introduction to DNA and Protein sequencing, Human Genome Project. **6 hours**
4. Bioinformatics databases, Type of databases, Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases. **5 hours**
5. Protein structure prediction: Protein Secondary Structure Prediction: Secondary Structure Prediction for Globular Proteins, Transmembrane Proteins, Coiled Coil Prediction. **3 hours**
6. Protein Tertiary Structure Prediction: Methods, Homology Modeling, Threading and Fold Recognition, Ab Initio Protein Structural Prediction, CASP. **3 hours**
7. Sequence motif databases -Pfam, PROSITE, Protein structure databases, Protein Data Bank-SCOP, CATH, KEGG, Chembank, Sequence, structure and function relationship. **5 hours**
8. Applications of bioinformatics: Bioinformatics in pharmaceutical industries, Bioinformatics in immunology, Bioinformatics in agriculture, Bioinformatics in forestry, Geoinformatics, Legal, ethical and commercial ramifications of bioinformatics, Biosensing. **7 hours**

Reference Books:

1. Mount, D. *Bioinformatics: Sequence and Genome Analysis.* 2nd Edition. Cold Spring Harbor Laboratory Press. 2013. Print.
2. Lengauer, T., Mannhold, R., Kubinyi, H. and Timmerman, H. *Bioinformatics: From Genomes to Drugs*. 1st Edition. John Wiley and Sons Ltd. 2001. Print.
3. Xiong, J. *Essential Bioinformatics*. 1st Edition. Cambridge University Press. 2006. Print.
4. Baxevanis, A.D. and Ouellette, B.F.F. *Bioinformatics: A practical guide to the analysis of genes and proteins*. 3rd Edition. Wiley India Pvt. Ltd. 2009. Print.
5. Pevzner, P.A. *Computational Molecular Biology: An Algorithmic Approach*. 1st Edition. MIT Press. 2000. Print.
6. Doolittle, R.F. *Computer Methods for Macromolecular Sequence Analysis.* Academic Press. 1996. Print.
7. Sensen, C.W. *Essentials of Genomics and Bioinformatics.* John Wiley and Sons Inc. 2002. Print.
8. Waterman, M.S. *Introduction to Computational Biology: Maps, Sequences and Genomes.* Chapman and Hall/CRC. 1995. Print.
9. Heijne, G.V. *Sequence Analysis in Molecular Biology: Treasure Trove or Trivial Pursuit.* Academic Press. 1987. Print.

Course Title: Computational Biology & Bioinformatics-LAB

Course Code: BTY606

L	T	P	Credits	Marks
0	0	2	1	25

- Detailed study of NCBI Homepage.
- To perform BLAST for Nucleotide Sequence
- BLAST for a protein sequence
- To perform multiple sequence alignment via CLUSTAL
- Phylogenetic analysis
- To display PDB structure using Rasmol
- Comparative study of the two formats: Gene Bank/ Genepept and FASTA
- Analysis of Prosite pattern
- Motif search database study
- Prediction of protein structure

Course Title: Industrial Biotechnology

Course Code: BTY603

L	T	P	Credits	Marks
2	1	0	2	50

Course Objective: This course deal with utilization of various biological processes especially gene expression, gene manipulation, protein engineering at large scale in field of medicine, agriculture and environmental management in terms of new products and services. During the course the students are introduced to the fundamentals of processes such as enzymatic conversion, fermentation, bioconversion, cell cultivation and sterile techniques and are trained using examples from industry.

1. Introduction to bioprocess engineering. Microbial growth parameters and its kinetics, microbial growth yield and concepts of the yield coefficient, maintenance energy and its significance, stoichiometry of production. **2 hours**
2. Design of a bioreactor, animal, plant and microbial type bioreactors, body, agitator (impeller), baffles, spargers, valves, different types of bioreactors. **2 hours**
3. Instrumentation, measurement and control of the bioprocess parameter, methods of measuring process variables, temperature, flow measurement, pressure, agitation, foam, microbial biomass, dissolved oxygen and Kla, redox and PH, control systems: manual control, automatic control PID (Proportional plus Integral plus Derivative) control. **4 hours**
4. Design of the batch sterilization processes, calculation of del factor, Richards rapid methods for designing the sterilization cycles, scale up of the sterilization, design of the continuous sterilization, filter sterilization, theory of the depth filter, design of the depth filters. **2 hours**
5. Types of fermentation processes, analysis of batch, plug flow, fed batch and continuous bioreactors, stability of microbial bioreactors, steady state condition and feedback bioreactors, fluid rheology and factors affecting bioreactor processes. **3 hours**
6. Introduction to fermentation processes, microbial enzymes, metabolites, recombinant products, biotransformation products. **2 hours**
7. Isolation, preservation and maintenance of industrial microorganisms, screening methods, improvement of industrial microorganism and use of different strategies, quality control of preserved industrial strains. **5 hours**

8. Downstream processing, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruption, liquid extraction, aquous two phage separation, membrane process, drying and crystallization, effluent treatment, BOD & COD treatment and disposal of effluents. **5 hours**
9. Media designing for industrial fermentation, medium formulation, energy sources, carbon sources, nitrogen sources, nutrient recycle & medium optimization for the industrial processes. Scale up of fermentation processes. **3 hours**
10. Industrial processes and production of alcohol (ethanol), citric acid, glycerol, acetone-butanol, penicillin antibiotics, glutamic acid and lysine, single cell protein. Food products, bread, cheese, idli. Industrial enzymes and biodegradable plastics. **3 hours**

Reference Books:

1. Shuler, M.L. and Kargi, F. *Bioprocess Engineering: Basic concepts*. 2nd Edition. Prentice Hall, Engelwood Cliffs. 2001. Print.
2. Jackson, A.T. *Process Engineering in Biotechnology*. 2nd Edition. Prentice Hall, Engelwood Cliffs. 2001. Print.
3. Bailey, J., Bailey, J. and Ollis, D.F. *Biochemical Engineering Fundamentals*. 2nd Edition. McGraw-Hill Book Co., New York. 1986. Print.
4. Stanbury, P.F., Whitaker, A and Hall, S.J. *Principle of Fermentation Technology*. 2nd Edition. Butterworth-Heinemann. 2003. Print.
5. Moo-Young, M. *Comprehensive Biotechnology*. 2nd Edition. Pergamon Press, Oxford. 2011. Print.
6. Ladisch, M.R. *Bioseparation Engineering, Principle, Practice and Economics*. 1st Edition. Wiley-Interscience. 2001. Print.
7. Doyle, M.P. and Buchanan, R.L. *Food Microbiology: Fundamental and Frontiers*. 4th Edition. ASM Press. 2012. Print.
8. Pepper, I.L., Gerba, C.P., Gentry, T.J. and Maier, R.M. *Environmental Microbiology*. 2nd Edition. Academic Press. 2008. Print.
9. Crueger, W. *Biotechnology, A text book of Industrial Microbiology.* 2nd Sub edition. Sinauer Associates Inc; 1990. Print.

Course Title: Industrial Biotechnology-LAB

Course Code: BTY605

L	T	P	Credits	Marks
0	0	2	1	25

- Isolation of industrially important microorganisms for microbial processes.
- Determination of thermal death point and thermal death time of microorganism for design of a sterilizer.
- Determination of growth curve of a supplied microorganism and also determines substrate degradation profile. Compute specific growth (m), growth yield (Yx/s) from the above.
- Production and estimation of alkaline protease.
- Production and estimation of alcohol.
- Demonstration of fermenters and its functioning.

Course Title: Virology

Course Code: BTY604

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: This course deal with the classical as well as modern concept of virology plant as well as animal virology, as biological concept arising from the virology. Role of plant and animal viruses in agriculture and human health.

A. Plant and microbial viruses

1. History and development of plant virology, cryptograms, and classification of plant viruses and viroids: Brief history of virology highlighting the significant contributions of scientists to the development of plant virology; significance of plant virology and modern classification of plant viruses and viroids according to ICTV; and cryptograms of various plant viruses and virus groups. **4 hours**
2. Propagation, purification, characterization and identification and genomics of plant viruses: General methods of propagation of plant viruses; purification of plant viruses using centrifugation, chromatography and electrophoresis techniques, their assay and comparison of the sensitivity of assay methods; methods employed in identification of plant viruses and structural and functional genomics. **6 hours**
3. Symptoms of plant virus diseases, transmission of plant viruses, viral and viroid diseases and their control: General discussion on symptoms caused by viruses and viroids in diseased economically important trees and agricultural crops, and their control including development of virus disease resistant transgenics. **5 hours**
4. Microbial viruses: Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses. **3 hours**

B. Animal Viruses

5. Classification, Morphology and Chemistry of Viruses: Virus evolution and classification, properties of viruses, virus structure. **3 hours**
6. Working with viruses: Techniques for visualisation and enumeration of viral particles, measuring biological activity of viruses, assays for virus estimation and manipulation, characterization of viral products expressed in infected cells, Diagnostic virology, Physical and chemical manipulation of viruses. **10 hours**
7. Virus replication Strategies: Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking,

assembly, maturation and release, viral-host interaction, Host response to viral infection. **5 hours**

8. Replication patterns of specific viruses: Replicative strategies employed by animal DNA viruses. Replicative strategies employed by animal RNA viruses. Identification of virus prototypes associated with different virus replication schemes; Details on important viruses namely Herpesvirus, Poliovirus, Influenza virus, VSV, SV40 and Adeno Virus, Poxviruses, Hepatitis Viruses, coronaviruses, Retroviruses. Subviral pathogens: HDV, Prions, Viroids. **8 hours**
9. Pathogenesis of viral infection: Stages of infection, Patterns of some viral diseases-epidemiology, transmission, infection, symptoms, risk, transformation and oncogenesis, emerging viruses. **6 hours**
10. Anti-viral strategies-prevention and control of viral diseases: Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Contributions of various host defence mechanisms in viral infections; Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines, anti-idiotype and DNA vaccines. **10 hours**

Books:

1. 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. Print.
2. Dimmock, N., Easton, A. and Leppard, K. *Introduction to Modern Virology.* 6th Edition. Wiley-Blackwell. 2007. Print.
3. Wanger, E.K., Hewiett, M., Bloom, D. and Camerini, D. *Basic Virology.* 3rd edition, Wiley-Blackwell. 2007. Print.
4. Cann, A.J. *Principles of Molecular Virology.* 5th Edition. Elsevier Academic Press. 2011. Print.
5. Hull, R. *Plant Virology*. 5th Edition. Academic Press. 2013. Print.
6. Principles of Molecular Virology by Alan J. Cann, 3rd edition, Elsevier Academic Press, 2001.
7. Plant Virology by Roger Hull, 4th edition, Academic press, 2002.

Course Title: Virology-LAB

Course Code: BTY607

L	T	P	Credits	Marks
0	0	3	2	50

- Mechanical inoculation and study of host range of different plant viruses
- Maintenance of viral culture
- Viral transmission
- Serological and molecular diagnostics for detection of viruses
- Molecular characterization of RNA and DNA viruses (common one)

Course Title: Seminar-I
Course Code: BTY608

L	T	P	Credits	Marks
0	0	0	1	25

Seminar Objective:

During the course students will come to know about the general understanding of the most common problems, recent advances in biotechnology research. Each student shall be allotted a topic by the instructor. Student will have to understand the topic, collect literature and prepare the presentation. Through this the students will develop habit of reading newer topics, will become inquisitive and develop confidence of presentation and discussion before audience.

The students shall submit a project report on the allotted topic, which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic. The students will be encouraged to explore all available literature as well as the internet to prepare the seminar report and present the same using informative slides made using Power Point or projectors.

Seminar Contents:

Students will present their work on a selected topic with the following headings:

- Title
- Objectives
- Review of Literature
- Materials and Methods
- Results
- Conclusion/recommendations

Examination Scheme (Weightage in %):

Literature study/ Fabrication/ Presentation	50
Written Report	25
Question answer session	25

Course Title: Environmental Biotechnology

Paper Code: BTY651

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: The basic object of the course is to familiarize the students with the gene manipulation processes and microorganisms used for a cleaner environment with respect to various microbial treatments, biofuels, biofertilizers, biopesticides, biomineralization, biodegradation etc.

1. Renewable and Non-renewable energy resources, Biofuels: Bioethanol, Biodiesel, Biogas and Algal fuels Bioremediation and Biodegradation of major environmental pollutants- heavy metals, pesticides and hydrocarbons. Biomineralization- Use of microbes for mining of metals from ores Biofertilizers- Concept of N_2-fixation, nodule formation, azolla, cyanobacteria, rhizobium and VAM. **7 hours**
2. Microbiology of waste water treatment, aerobic processes, activated sludge, oxidation ponds, trickling filters, and rotating biological contactors. Treatment strategies for wastewaters of dairy, distillery, tannery, sugar, antibiotic industry. **5 hours**
3. Anaerobic processes: Anaerobic digesters, upward flow anaerobic sludge blanket reactors. **2 hours**
4. Bioremediation- Biotechnology for clean environment. Biodegradation of xenobiotics in the environment-Ecological considerations, decay behavior, degradative plasmids, Degradation of hydrocarbons, substituted hydrocarbons, surfactants and pesticides. Bioremediation of contaminated soil. Biopesticides and Integrated Pest Management. **6 hours**
5. Solid waste management: Sources, types, composition, characteristics and composition of municipal solid waste, recycling and transformation. **2 hours**
6. Environmental impact assessment, eco-planning and sustainable development: Indian standards IS2490, IS3360, IS3307, IS2296, ISO14000 series, Minas for industries and Ecomarks, public liability insurance act, ElA guidelines and assessment methods, environmental priorities in India and agenda, conservation biotechnology, remote sensing and GIS (Principal and applications in ecological mapping and environmental hazard predictions), ecological modeling. **6 hours**
7. Bioindicators and biosensors for detection of pollution. **2 hours**

Books:

1. Primrose, S.B., Twyman, R.M., Old, R.W. *Principles of gene manipulation.* 6th Edition. Wiley-Blackwell. 2002. Print.

2. Singh, A. and Ward, O.P. *Biodegradation and Bioremediation: Soil Biology*. Springer. 2004. Print.
3. Sheehan, D. *Bioremediation Protocols.* 1st Edition. Humana Press, New Jersey.1997. Print.
4. Allsopp, D., Seal, K.J. and Gaylarde, C.C. *Introduction to Biodeterioration.* 2nd Edition Cambridge University Press. 2004. Print.
5. Agarwal, S.K. *Environmental Biotechnology*. APH Publishing Corporation, New Delhi. 1998. Print.
6. Metcalf & Eddy, Tchobanoglous, G., Stensel, H.D., Tsuchihashi, R., Burton, F. *Wastewater Engineering: Treatment and Resource Recovery*. 5th Edition. McGraw-Hill Science/Engineering/Math. 2013. Print.
7. Jordening, H.J. and Winter, J. *Environmental Biotechnology- Concepts and Applications.* 1st Edition. Wiley-Blackwell. 2005. Print.
8. Mohapatra, P.K. *Environmental Biotechnology.* 1st Edition. I.K. International Publishing House. 2007. Print.

L	T	P	Credits	Marks
0	0	3	2	50

Course Title: Environmental Biotechnology-LAB

Paper Code: BTY657

- Maintenance of different bacterial culture and antibiotic selection media.
- To determine TDS, DO, COD, BOD of given water sample
- Total bacterial population of given samples of water by standard plate count technique (SPC)
- To check the potability of given water sample
- To check the presence of coliform in given water sample by Multiple- tube fermentation test or most probable number test (Presumptive, confirmed and completed test)
- To check the presence of coliforms using membrane filter method
- To determine the quality of given milk sample

Isolation and immobilization of dye-degrading microbes

Course Title: Genomics, Proteomics and Metabolomics
Course Code: BTY652

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: The aim of the course is to provide students practical and bioinformatical skills in genomics, transcriptomics, proteomics and metabolomics, knowledge and the notion about how the methods are applied in real-life scientific research.

1. Introduction to –omes and –omics. Gene, Genome and Genomics. **2 hour**
2. Whole genome analysis: Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, shotgun libraries. Genome analysis for global patterns of gene expression using fluorescent-labelled cDNA or end-labelled RNA probes. **6 hours**
3. FISH, Sequencing: Conventional sequencing (Sanger, Maxam and Gilbert methods), automated sequencing, analysis of sequence information FISH. Analysis of single nucleotide polymorphism using DNA chips. **4 hours**
4. Transcriptomics. Microarray, EST, SAGE. Bioinformatical methods in ranscriptomics.

   Application of transcriptomics. Genome sequencing projects (technology of sequencing and assembly, bioinformatics of genome annotation, current status of genome sequencing projects) Genomic browsers and databases Orthology prediction (comparative genomics), Search for transcription factor binding sites (TFBS), Computational prediction of miRNA target genes *De novo* prediction of regulatory motifs in genome, Single nucleotide polymorphisms (SNP) in medical genetics and basic research. **10 hours**
5. Next generation sequencing using new technologies. Alignment of pairs of sequences of DNA and proteins. Multiple sequence alignment. Searching databases for similar sequences. Phylogeny: Different approaches to tree construction. Analyze sequences and its role in understanding the evolution of organisms and genes. **6 hours**
6. **Proteomics.** Aims, strategies and methods. Bioinformatics tools in proteomics. Application of proteomics. Protein microarrays. Proteomics technologies: 2D-electrophoresis, MALDI-TOF mass spectrometry, yeast 2-hybrid system. Protein-protein interactions: experimental and computational methods, databases. **8 hours**
7. Types of data and databases, quality of annotation. Protein structure prediction. The proteome. High throughput proteomics and its use to the biologists. **4 hours**

8. Novel approaches to protein expression analysis: Scope of functional proteomics. Proteome analysis: 2DE based strategy. Alternatives to 2DE for protein expression analysis. **5 hours**
9. Application of proteome analysis to drug development and toxicology: Basic principle and making use of the data. **4 hours**
10. Protien-DNA interactions. Cancer profiling using DNA microarrays. Proteomics as tool for plant genetics and breeding. **5 hours**
11. Introduction to metabolomics. Technologies in metabolomics. Nutrigenomics. Nuclear Magnetic Resonance Spectroscopy and Mass Spectrometry in metabolomics. Metabolic pathways resources: KEGG, Biocarta. Nutrigenomics and metabolic health. Solved problems and future challenges. **6 hours**

Books:

1. Gibson, G. and Muse, S.V. *A primer of genome science.* 3rd Edition. Sinauer Associates, Inc. Sunderland, MA. 2009. Print.
2. Jurisica, I. and Wigle, D. *Knowledge discovery in proteomics*. 1st Edition. Chapman & Hall / CRC). 2004. Print.
3. Pennington, S.R. and Dunn, M.J. *Proteomics: From protein sequence to function.* 1st Edition. Springer-Verlag Telos. 2001. Print.
4. Srivastava, S. *Informatics in proteomics.* 1st Edition. Taylor & Francis Group / CRC. 2005. Print.
5. Akay, M. *Genomics and proteomics engineering in medicine and biology.* 1st Edition. Wiley-IEEE Press. 2007. Print.
6. Sensen, C.W. *Essentials of genomics and bioinformatics.* 1st Edition. Wiley-Blackwell. 2002. Print.
7. Baxevanis, A.D., Francis Ouellette, B.F. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. 3rd Edition. Wiley-Interscience. 2004. Print.

Course Title: Genomics, Proteomics and Metabolomics-LAB

Course Code: BTY656

L	T	P	Credits	Marks
0	0	3	2	50

- Site directed mutagenesis. Deleting a DNA sequence from a plasmid and introduction into *E. coli.*
- Functional validation of gene expression.
- Analysis of mutants using Southern blot and PCR analysis.
- Introduction to DNA sequencing.

Course Title: Intellectual Property Rights, Bio Safety and Bioethics

Course Code: BTY653

L	T	P	Credits	Marks
2	1	0	2	50

Course Objective: This course has been designed to cover various aspects of IPR, Biosafety and bioethics. Lot of advances have been made in application of biotechnology for the benefit of human being in field of agriculture, medical application, animal husbandry, industrial production and environmental management. Intellectual property ie legal rights resulting from intellectual activity in the Industrial and scientific fields is very important. In this course, safety concerns and ethical issues on application of biotechnology will be discussed under the current issues associated with the benefits and risk concerns on biotechnology.

1. Fundamentals of IPR: Intellectual Property Rights, general introduction patent claims, ownership of tangible and intellectual property. Patents, copyrights, trademarks, trade secrets, geographical indications, industrial designs, protection of IC layout designs, WIPO, TRIPS agreement. **5 hours**
2. Basic requirements of patentability, Patentable subject matter novelty and the public domain, non obviousness. **2 hours**
3. Special issues in biotechnology patents: Disclosure requirements, collaborative research, competitive research, foreign patents, patenting of microorganisms and cells, patenting animals and plants, PPA, PVPA, PVPC, utility patents. **4 hours**
4. Patent litigation: Substantive aspects of patent litigation, procedural aspects of patent litigation, recent development in patent system and patentability of biotechnology inventions, IPR issues of the Indian content, current patent laws, International Depository Authority (IDA), International agreements relevant to biological inventions: PCT, UPOV, Budapest Treaty, EPC, Pan- S Union Convention. **6 hours**
5. Public acceptance issues for biotechnology: Case studies/ experiences from developing and developed countries, biotechnology and hunger, challenges for the Indian biotechnological research and industries. **3 hours**
6. Bioethics: Social and ethical implications of biotechnology and biological weapons. **2 hours**
7. Good safety practices, GLP standards, lab contaminants, GMPs, The Cartagena protocol on biosafety. **3 hours**

8. Biosafety management: Key to the environmentally responsible use of biotechnology, Regulatory bodies- EPA, USDA, FDA, APHIS. **5 hours**

Books:

1. Lokganathan, E. T. *Intellectual Property Rights (IPRs): TRIPS Agreement & Indian Laws*. New Century Publications. 2012. Print.
2. Goel, D. *IPR, Biosafety and Bioethics*. 1st Edition. Pearson Education. 2013. Print.
3. Krishna, V.S. *Bioethics and Biosafety in Biotechnology*. New Age International (P) Limited. 2007. Print.
4. Choudhary, D.N. *Evolution of patent laws: "developing countries' perspective"*. Capital Law House. 2006. Print.

Project Dissertation
Course Code: BTY654

L	T	P	Credits	Marks
0	0	0	8	200

Guidelines for Project:

Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-art instrumentation. Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of research project are publishable, the project should be communicated in the form of a research report written by the student.

Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be criticized by the faculty guide and corrected by the student at each stage.

The file is the principal means by which the work carried out will be assessed and therefore great care should be taken in its preparation.

In general, the File should be comprehensive and include:

- A short account of the activities that were undertaken as part of the project
- A statement about the extent to which the project has achieved its stated goals.
- Assessment about the outcomes of the experimentation processes engaged in as part of the project;
- Any activities planned but not yet completed as part of the project, or as future initiative directly resulting from the project;
- Any problems that have arisen that may be useful to document for future reference.

Report Layout

The report should contain the following components:

- **Title or Cover Page**
  The title page should contain the following information: Project Title; Student' name; Course; Year; Supervisor' name
- **Acknowledgements** (optional)
  Acknowledgement to any advisory or financial assistance received in the course of work may be given
- **Abstract**
  A good abstract should be straight to the point; not too descriptive but fully informative. First paragraph should state what was accomplished with regard to the objectives. The abstract does not have to be an entire summary of the project, but rather a concise summary of the scope and results of the project.
- **Table of Contents**
  Title and subtitles are to correspond exactly with those in the text
- **Introduction**
  Here brief introduction to the problem that is the central to the project and an outline of the structure of the rest of the report should be provided. The introduction should aim to catch the imagination of the reader, so excessive details should be avoided.
- **Materials and Methods**
  This section should aim at experimental designs, materials used. Methodology should be mentioned in details including modification if any.
- **Results and Discussion**
  Present results, discuss and compare these with those from other workers etc. In writing these section, emphasis should be given on what has been performed and was achieved in the course of the work, rather than discuss in detail what is readily available in the text

books. Avoid abrupt changes in the contents from section to section and maintain a lucid flow throughout the thesis. An opening and closing paragraph ins every chapter should be included in a smooth flow.

Note that in writing the various sections, all figures and tables should as far as possible be next to the associated text, in the same orientation as the main text, numbered, and given appropriate titles or captions. All major equations should also be numbered and unless it is really necessary never write in "point" form.

- **Conclusion**

  A conclusion should be the final section in which the outcome of the work is mentioned briefly.

  Future Prospects
- **Appendices**

  The appendix contains material which is of interest to the reader but not an integral part of the thesis and any problem that have arisen that may be useful to document for future reference.
- **References**

  This should include papers and books referred to in the body of the report. These should be ordered alphabetically on the authors surname. The titles of the journals preferably should not be abbreviated; if they are, abbreviations must comply with an internationally recognized system.

Examples

For research article

Voravuthikunchai, SP, Lortheeranuwat, A, Ninrprom, T. Popaya, W, Pongpaichit Sanjay, Supawita T.(2002) Antibacterial activity of Thai medicinal plant against enterohaemorrhagic *E.coli* 157:H7.Clin Microbiol Infect, 8(SUPPL 1):116-117

For Book

Kowalski, M.(1976) Transduction of effectiveness in Rhizobium Meliloti. SYMBIOTIC NITROGEN FIXATION PLANTS (editor P.S. Nutman IBP), 7:63-67

ASSESSMENT OF THE PROJECT FILE

Essentially, marking will be based on the following criteria: the quality of the report, the technical merit of the project and the project execution.

Technical merit attempts to assess the quality and depth of the intellectual efforts put into project.

The file should fulfil the following assessment objectives:

Range of Research Methods used to Obtain Information

Execution of Research

Data Analysis

Analyse Quantitative/Qualitative information

Control quality

Draw Conclusions

Assessment Scheme:

Continuous Evaluation: 40% (Based on punctuality, regularity of work, adherence to plan and methodology, refinements/mid-course corrections etc. as reflected in the Project File)

Final Evaluation: 60% (Based on the documentation in the file, Final report layout, analysis and results, achievements of objectives, presentations/viva)

Course Title: Seminar-II
Course Code: BTY655

L	T	P	Credits	Marks
0	0	0	1	25

Seminar Objective:

During the course students will come to know about the general understanding of the most common problems, recent advances in biotechnology research. Each student shall be allotted a topic by the instructor. Student will have to understand the topic, collect literature and prepare the presentation. Through this the students will develop habit of reading newer topics, will become inquisitive and develop confidence of presentation and discussion before audience.

The students shall submit a project report on the allotted topic, which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic. The students will be encouraged to explore all available literature as well as the internet to prepare the seminar report and present the same using informative slides made using Power Point or projectors.

Seminar Contents:

Students will present their work on a selected topic with the following headings:

- Title
- Objectives
- Review of Literature
- Materials and Methods
- Results
- Conclusion/recommendations

Examination Scheme (Weightage in %):

Literature study/ Fabrication/ Presentation	50
Written Report	25
Question answer session	25

L	T	P	Credits	Marks
2	0	0	2	50

Course Title: General Microbiology
Paper Code: MIC513

Course Objective: This course is to learn basic microbiology, microbial growth and control methods of microbes.

Unit-A

Characteristics of microorganisms: Prokaryotic cell structure and function, size, shape, capsule and slime layer, spore, cell wall, cell membrane, outer membrane, ribosome, motility organelle, fimbriae and nuclear region. **4 hours**

Unit-B

Cultivation of microorganisms: nutrition, cultivation methods and environmental factors affecting microbial growth. **3 hours**

Bacterial growth curve. Maintenance of cells in exponential phase, synchronous growth, continuous culture, fed batch culture and measurement of growth. **3 hours**

Unit-C

Microbial metabolism: Metabolic pathways of carbohydrate metabolism common (Embden Meyerhof pathway, pentose phosphate pathway, Entner- Doudoroff pathway, pyruvate decarboxylation, TCA cycle) **6 hours**

Unique to heterotrophic and phototrophic microorganisms (Ketoadipate pathway), Electron transport chain, Calvin cycle, patterns of energy yielding metabolism in microorganisms (respiration and fermentation) **6 hours**

Unit-D

Control of microorganisms: control of microorganisms by physical and chemical agents, patterns of microbial death, factors affecting effectiveness of antimicrobial agents activity. **4 hours**

Antimicrobial chemotherapy: Development of chemotherapy, general characteristics of antimicrobial drugs, and mechanisms of action of antimicrobial agents. Origin of drug resistance and its transmission in microorganisms. **4 hours**

Reference books

1. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. *Microbiology.* 5th edition. New Delhi. Tata McGraw Hill Publishing Company Limited. 1993. Print.
2. Stainer, Roger Y., Ingraham, John L., Wheelis, Mark L. and Painter, Page R. *General microbiology.* 5th edition. Macmillan Press Ltd. 1987. Print.
3. Tortora, G.J., Funke, B. R. and Case, C. L. *Microbiology-An Introduction*. 7th edition. Carson, USA. Benjamin Cummings, 2001. Print.
4. Madigan, Michael T., Martinko, John M., Paul V. Dunlap and David P. Clark. *Brock Biology of Microorganisms*. 12th edition. Benjamin Cummings. 2008. Print.

Course Title: General Microbiology Lab
Paper Code: MIC514

L	T	P	Credits	Marks
0	0	2	1	25

1. Preparation of media
2. Preparation of buffer
3. Culture transfer and pure culture by streaking method
4. Storage of pure culture – slant culture, glycerol stock
5. Bright Field microscopy
6. Phase contrast microscopy
7. Bacterial motility
8. Negative staining
9. Smear preparation and simple staining
10. Gram staining

L	T	P	Credits	Marks
2	0	0	2	50

Course Title: Biochemistry
Course Code: BCH 551

Course Objective: The course is intended for master's course students in disciplines other than Biochemistry. This course is a broad survey of all the major concepts of biochemistry with emphasis on all the important categories of biomolecules and their biochemistry.

Unit A (10 hours)

Introduction - Atoms, molecules and chemical bonds. Water: biological importance, pH and acid - base balance. Buffers - biological importance.

Carbohydrates - Monosaccharides: Classification and nomenclature, Biological importance, Structural representations of sugars- Acetal and hemiacetal, ketal and hemiketal linkages, Glucose, fructose, galactose, mannose and ribose. Isomerism – structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars. Glycosidic bond. Disaccharides: Sucrose, Lactose, Maltose, Isomaltose, Cellobiose and Trehalose. Polysaccharides: Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrans, Inulin, Pectin. Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratan sulphate, Dermatan sulphate and Agar-agar. Glycoproteins and Mucoproteins.

Proteins Structure, classification and properties of amino acids. Amphoteric properties of amino acids, pK value and iso-electric point of amino acids. Peptide bond formation and peptides. Reactions (due to carboxyl group, amino group and side chains). Colour reactions of amino acids and proteins. Classification and properties of proteins. Conformation of proteins- chemical bonds involved, Secondary structure- Alpha helix, Collagen helix, Beta pleated sheet, Ramachandran angles and Ramachandran map. Fibrous proteins- examples (Keratin, Collagen, Elastin, Fibrous muscle proteins). Chaperons. Tertiary structure- e.g. Myoglobin. Quaternary structure – e.g. Haemoglobin.

Unit B (10 hours)

Lipids - Classification of lipids: simple, compound and derived lipids. Biological importance of lipids. Fatty acids: classification, nomenclature. Simple fats: Triacylglycerol (Triglycerides) - Physical properties. Reactions-Hydrolysis, Saponification, Rancidity. Acid number, Saponification number, Iodine number, Polenske number and Reichert-Meissl number of lipids. Waxes. Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Plasmologens. Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins. Prostaglandins- structure, types, synthesis and functions.

Unit C (5 hours)

Nucleic Acids - Structure of nucleic acids and nucleotides: Structural organization of DNA (Watson –Crick model) Characteristic features of A, B, C and Z DNA. Structural organization of tRNA; Protein-nucleic acid interaction. DNA regulatory proteins, folding

motifs, conformation flexibilities, denaturation, renaturation, DNA polymerases, Restriction endonucleases. Biological roles of nucleotides and nucleic acids.

Unit D (5 hours)

Enzymes - Classification- (I.U.B. system), co-enzymes, isoenzymes, ribozyme. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Various theories, Active site. Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition. Enzyme regulation: Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering.

Recommended Books:

1. Nelson, David L., and Cox, Michael M., *Lehninger Principles of Biochemistry*, 5th Edition, WH 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.

4. Conn, E.E., Stumpf, P.K., Bruening, G., and Doi, R.H. *Outlines of Biochemistry*. 5th edition, John Wiley & Sons Inc, 1987. Print.

Course Title: Biochemistry-LAB
Course Code: BCH 552

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. Quantitative estimation of blood glucose by Folin-Wu/Anthrone/DNS/O-Toluidine/Enzymatic method

2. Estimation of proteins by Biuret/ Lowry et al. method

3. Quantitative estimation of blood urea/ creatine/ uric acid

4. Quantitative estimation of cholesterol in the blood

5. Estimation of alkaline and acid phosphatases

L	T	P	Credits	Marks
4	1	0	4	100

Course Title: Immunology
Course Code: MIC603
Course Objective: This course is to learn basic and advanced immunology.

Unit-A

History of immunology.
Three fundamental concepts in immunology: Specificity, discrimination of self from non-self and memory.
Lymphocytes : B lymphocyte, T lymphocyte
Antibodies : structure , classes and function **10 hours**

Unit-B

Immune cell receptors: Detailed structure and development of B cell (Ig) and T cell (TcR) receptors;
Structure of CD4, CD8, MHC-I, MHC-II molecules, cellular adhesion molecules (ICAM, VCAM, MadCAM, selectins, integrins); Pattern Recognition Receptors (PRRs) and Toll-like receptors (TLR); **8 hours**
Markers of suppressor / regulatory T cells - CD4+ CD25+
Genetic organization: Organization of the genes for B and T cell receptors.
Genetic organization of MHC-I and MHC-II complex, Peptide loading and expression of MHC-I and MHC-II molecules.
Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors.;
Hybridoma technology and monoclonal antibodies. **12 hour**

Unit-C

Immune response and signaling: Humoral and cell-mediated immune response; Innate immune response and pattern recognition; Recent advances in innate immune response especially NK-DC interactions; **6 hours**
Major cytokines and their role in immune mechanisms: TNF, IFN, IL-1, IL-2, IL-4, 1L-6, IL-10,IL-12, IL-17, TGFβ; Cell signaling through MAP kinases and NF-κB. **4 hours**
Tolerance and autoimmunity and their mechanism; Mechanisms of autoimmunity; Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), experimental autoimmune encephalitis (EAE); Infections leading to autoimmune diseases. **6 hours**

Unit-D

Immunological disorders and hypersensitivity: Deficiencies / defects of T cells, B cells, complement and phagocytic cells; **4 hours**
Comparative study of Type I-V hypersensitivities with examples. **4 hours**
Transplantation and tumor immunology: Alloreactive response; Graft rejection ; HLA-matching;
3 hours
Transgenic animals for xenotransplantation; Tumor antigens, immune response to tumors and immunotherapy of tumors. **3 hours**

Reference books

1. Kindt, Thomas J., Goldsby, Richard A. and Osborne, Barbara A. *Kuby Immunology.* 6th edition. W.H. Freeman and Co. Publishers. 2007. Print
2. Murphy, Kenneth. Trevers, Paul and Walpart, Mark. *Janeway's Immunobiology.* Garland Science Publishers. 2012. Print.
3. Roitt, Ivan M. and Delves, Peter J. *Roitt's Essential Immunology.* 10th edition. Blackwell Publishing Limited. 2001. Print.
4. Paul, William E., Williams, Lippincott and Wilkins, *Fundamental Immunology.* 6th edition. Wolters Kluwer business. 2008. Print.

L	T	P	Credits	Marks
0	0	3	2	50

Course Title: Immunology Lab
Course Code: MIC604

1. Agglutination of bacteria
2. SDS-PAGE electrophoresis
3. Separation of IgG by ammonium sulfate precipitation
4. Reduction of IgG with mercaptoethanol to four chain
5. Papain digestion of IgG
6. Pepsin digestion of IgG
7. Gel precipitation
8. ELISA
9. Western Blotting
10. Separation of white blood cells from blood
11. Total leukocyte count and differential leukocyte count
12. Blood typing

Paper: Scientific Writing and Research Methodology

L	T	P	Credits	Marks
2	0	0	2	50

Code: BOT601

Objective:
To make the students learn how to design an experiment and what are the various research strategies?

Teaching Methodology:
Class room Lectures, practicals, models, charts, power point presentations.

Learning outcomes

This course will impart the comprehensive knowledge of designing a research experiment, how to write a research paper, the relevant ethics, copy right, impact factor etc.

Instruction for candidates:

- The question paper for end-semester examination will have a weightage of 25%. It will consist of 100 objective questions of equal marks. All questions will be compulsory.
- Two preannounced test will be conducted having a weightage of 25% each. Each preannounced test will consist of 20 objective type, 5 short questions/problems on the UGC-NET (objective type) pattern as well as one long answer type question. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt all question. Choice will be given only in long answer type. The question paper is expected to contain problems to the extent of 40% of total marks.
- Four objective/MCQ type surprise test will be taken. Two best out of four objective/MCQ type surprise test will be considered towards final each of 12.5% weightage to the final. Each surprise test will include 20-25 questions.
- The books indicated as text-book(s) are suggestive However, any other book may be followed.

UNIT-I

Basic principles and significance of research design
Experimental set-up
Randomized Block Designs (RBD), completely randomized designs **(5 Lectures)**

UNIT-II

Research articles research papers, popular research articles and reviews;

How to write a research paper, reference styles. **(4 Lectures)**

UNIT-III

Process of reviewing
Process of submission of a paper
Important journals in plant sciences, **(3 Lectures)**

UNIT-IV

An introduction to Science citation index; Impact factor of a journal;
Copyright act; Academic frauds; plagiarism. **(5 Lectures)**

Suggested Readings

1. Kothari, C.R. *Research Methodology – Methods and Techniques.* 2nd revised edition. New Age International (P) Ltd. Publishers: New Delhi, 2007.
2. McKillup, S. *Statistics Explained. An Introductory Guide for Life Scientists.* Cambridge University Press: Cambridge, UK, 2006.
3. Selvin, S. *Biostatistics – How it Works. First Impression.* Pearson Education Inc.: New Delhi, 2007.