DAV UNIVERSITY JALANDHAR

SCHEME FOR

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

1st and 4thSEMESTER

Examinations 2019–2020 Session Onwards

Applicable For Admissions in 2019 Onwards

Programme Name: M.Sc. (Hons.) Biotechnology

Programme Mission:

M. Sc. (Biotechnology) at DAV UNIVERSITY has been designed to meet the human resources needs of existing and futuristic biotech industries, biotech research organizations and academic institutions. The programme deals with courses on cell biology, Genetics, Plant biotechnology, Micro biology, genetic engineering, biochemistry, medical, animal, forensic and environmental biotechnology, biochemical techniques and processes, entrepreneurship and many other related courses.

Programme Learning Outcomes:

1. The programme is designed to produce post-graduates with higher order critical, analytical, problem solving and research skills with ability to find valid conclusions related to field of Biotechnology acquiring a sustainable approach.
2. The Post graduates will be able to think rigorously and independently to meet higher level expectations of biotech industries, research organization and academic institutions with decisive capability in selection of bioanalytical techniques in biotechnological processes.
3. Post-Graduates will be able to understand his/her responsibilities in biotechnological practices and product/technique development. They will be able to justify societal, health, safety and legal/ethical issues related to biotechnology processes or product use.
4. The programme also provides sufficient skills and training on entrepreneurship development in Biotechnology.
5. They will have the knowledge about the research problem designing and scientific project management.

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

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	BTY515A	Biochemistry	Core	4	0	0	4
2	BTY516A	Biochemistry Laboratory	Core	0	0	3	2
3	MIC531	General Microbiology	Core	4	0	0	4
4	MIC532	General Microbiology Laboratory	Core	0	0	3	2
5	BTY513	Cell Biology	Core	4	0	0	4
6	BTY511	Molecular Biology	Core	4	0	0	4
7	BTY512	Molecular Biology Laboratory	Core	0	0	3	2
8	**Open Elective/Interdisciplinary Course-I**						4
Total							26

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

List of Open Elective							
1	CHE616	Medicinal Chemistry	Open Elective	4	0	0	4
2	ZOO257	Human Physiology	Open Elective	4	0	0	4
3	BOT521	Algae, Fungi and Phytopathology	Open Elective	4	0	0	4
4	BOT621	Scientific Writing and Research Methodology	Open Elective	3	1	0	4

Semester-II

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	BTY527A	Bioanalytical Techniques	Core	3	0	0	3
2	BTY541	Biostatistics	Core	4	0	0	4
3	BTY521	Recombinant DNA Technology	Core	4	0	0	4
4	BTY522	Recombinant DNA Technology Laboratory	Core	0	0	3	2
5	BTY523	Animal Biotechnology	Core	4	0	0	4
6	BTY524	Animal Biotechnology Laboratory	Core	0	0	3	2
7	**Departmental Elective Course-I**						4
Total							23

List of Departmental Electives							
1	BTY542	Genetics	Departmental Elective	4	0	0	4
2	BTY684	Phytochemicals and Herbal Medicines	Departmental Elective	4	0	0	4

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

Semester-III

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	BTY631	Environmental Biotechnology	Core	4	0	0	4
2	BTY632	Environmental Biotechnology Laboratory	Core	0	0	3	2
3	BTY633	Plant Biotechnology	Core	4	0	0	4
4	BTY634	Plant Biotechnology Laboratory	Core	0	0	3	2
5	BTY525	Fermentation and Bioprocess Technology	Core	3	0	0	3
6	BTY526	Fermentation and Bioprocess Technology Laboratory	Core	0	0	2	1
7	BTY636A	Nanobiotechnology	Core	4	0	0	4
8	BTY661/ BTY663*	Project Part-I / Seminar		0	0	0	2
	Open Elective/Interdisciplinary Course-II						4
Total							26

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

List of Open Elective							
1	BCH605A	Plant Biochemistry	Open Elective	4	0	0	4
2	MIC631	Immunology	Open Elective	4	0	0	4
3	BOT527	Approaches for Crop Improvement	Open Elective	4	0	0	4
4	MIC543	Clinical Microbiology	Open Elective	4	0	0	4

Semester-IV

S. No	Paper Code	Course Title	Course Type	L	T	P	Cr
1	BTY635	Computational Biology and Bioinformatics	Core	3	0	0	3
2	BTY641	Intellectual Property Rights, Biosafety and Bioethics	Core	2	0	0	2
3	BTY642	Genomics, Proteomics and Metabolomics	Core	4	0	4	4
4	BTY643	Food Biotechnology	Core	4	0	0	4
		Project Part-II / Two Departmental Elective Courses					8
Total							21

List of Departmental Electives							
1	BTY681	Virology	Departmental Elective	4	0	0	4
2	BTY682	Medical Biotechnology	Departmental Elective	4	0	0	4
3	BTY683	Plant Stress Biology	Departmental Elective	4	0	0	4
4.	BTY637	Enzymology	Departmental Elective	4	0	0	4
5.	BTY662**	Project Part II	Project	0	0	0	8

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

Course Title: Biochemistry

Course Code: BTY515A

L	T	P	Credits
4	0	0	4

Course Objectives: The course is intended for master's course students. This course is a broad survey of all the major concepts of biochemistry with emphasis on all the important categories of biomolecules and their metabolism.

Unit I **(10 lectures)**

Principles of biophysical chemistry: Chemical bonds and stabilizing interactions, Water as a biological solvent, pH, pKa, dissociation and ionization of acids and bases, physiological buffers and their buffering mechanism, Henderson-Hasselbalch equation

Carbohydrates: Structure and classification of carbohydrates, stereoisomerism and optical isomerism in sugars, 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 II **(8 lectures)**

Lipids: Definition, importance and functions, classification of lipids, fatty acids and essential fatty acids, general structure and functions of major lipid subclasses, acylglycerols, phosphoglycerides, sphingolipids, terpenes, steroids, eicosanoids. Vitamins and Minerals: Definition, chemistry and functions of water and fat soluble vitamins, major trace minerals, their bound forms and functions.

Unit III **(12 lectures)**

Amino acids: structure and classification of amino acids, stereochemistry of amino acids, un-common amino acids, titration curve of amino acids. Proteins: structural classification of proteins, Ramachandran plot, stability of proteins and denaturation, function of proteins. Enzymes: classification of enzymes, overview of enzyme kinetics, mechanism of enzyme catalysis, factors affecting activity of enzymes

Unit IV **(8 lectures)**

Porphyrins: Nucleus and classification of porphyrins, important metallo porphyrins occurring in nature, chemical nature and physiological significance of bile pigment. Nucleic acids: Structure and functions of different nitrogeneous bases, nucleosides, nucleotides and different types of nucleic acids (DNA, RNA). DNA with unusual structures, DNA denaturation and renaturation.

Unit V **(10 lectures)**

Carbohydrate metabolism: ATP and electron carriers, glycolysis, fermentation, citric acid cycle, electron transport chain, oxidative phosphorylation, gluconeogenesis, pentose phosphate pathway, glycogen breakdown, glycogen synthesis glyoxylate cycle

Unit VI **(12 lectures)**

Lipid, protein and nucleic acid metabolism: fatty acid oxidation and biosynthesis, ketone bodies, transamination reactions, oxidative deamination reaction, glucogenic amino acids, ketogenic amino acids, urea cycle and its significance, biosynthesis of nucleotides, degradation of nucleotides

Learning outcomes: Through this course the student should be able to describe about importance of various biomolecules, explain the relationship between structure and function of biomolecules, recognize basic biochemical processes for energy production and their regulation, and interpret pathways of synthesis of various biomolecules.

Reference Books:

1. Nelson DL and Cox MM. (2013) Lehninger Principles of Biochemistry, 6thEdition. Macmillan Worth Publishers, New Delhi.
2. Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Weil PA (2015) Harper's Illustrated Biochemistry, 30th Edition, McGraw- Hill Medical Canada.
3. Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman &Co., New York.
4. Voet D, Voet JG and Pratt CW (2015). Fundamentals of Biochemistry, 4th Edition. John Wiley & Sons. New York.

Course Title: Biochemistry Laboratory

L	T	P	Credits
0	0	3	2

Paper Code: BTY516A

Experiments:

1. Quantitative estimation of blood glucose by Folin-Wu/Anthrone/DNSO - Toluidine/Enzymatic method.
2. Estimation of proteins by Biuret method
3. Quantitative estimation of cholesterol in the blood
4. Estimation of alkaline and acid phosphatases
5. Estimation of blood glucose.
6. Estimation of cholesterol
7. Sugar Fermentation in Microorganisms.
8. Estimation of Glucose 6-Phosphate.
9. Estimation of Urea.
10. Estimation of Uric acid.
11. Estimation of Creatinine.

Course Title: General Microbiology

L	T	P	Credits
4	0	0	4

Course Code: MIC531

Course Objectives: The main objective of the course is to provide students with the basis to face the study of the major fundamentals of microbiology including bacteriology, virology and immunology

Unit I (12 lectures)

History of microbiology. Spontaneous generation *vs*. biogenesis. Germ theory of disease. Discovery of anaerobic life form. Discovery of first antibiotic penicillin. Development of key techniques for isolation and pure culture of microorganisms. History of soil microbiology and enrichment culture techniques. History of medical microbiology and immunology.

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification system. Difference between three kingdoms.

General characteristics of acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Unit II (12 lectures)

Bacterial Cellular organization: Cell size, shape and arrangement, outer membrane, lipopolysaccharide, cell wall, inner membrane, capsule, flagella, endoflagella, fimbriae and pili, cytoplasm, ribosomes, mesosomes. Endospores. Effect of antibiotics and enzymes on the cell wall. Sphaeroplasts and protoplasts.

Basics of microscopy and observation of microbes. Light microscopy: bright field microscopy, dark field microscopy, phase contrast microscopy, fluorescence microscopy, transmission electron microscopy, scanning electron microscopy.

Unit III (10 lectures)

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.

Physical methods involving heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation to control microbes. Chemical methods involving antiseptics, disinfectants, sanitizers, sterilizers and antibiotics to control microbes.

Unit IV (12 lectures)

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

of population in exponential phase. Synchronous growth, continuous culture, fed batch culture and measurement of growth. Catabolism vs. anabolism. Energy currency and reducing power of a living cell. Fermentation vs. aerobic and anaerobic respiration. Bacterial cell division and genes involved in the process.

Learning outcomes:

On completion of the course students will be able to gain knowledge about history, principle and application of microbiology and various types of Microscopy, to Classify and explain the structure and general characteristics of Microorganisms, to prepare various Bacteriological, Algal, and Fungal Media, to control the microbial growth or have knowledge about the factors that control microbial growth, to have an insight on microbial reproduction.

Reference Books:

1. Reba Kanungo (2017) Ananthanarayan and Paniker's Textbook of Microbiology Tenth edition with booklet, Tenth edition, Universities Press.

2. Michael Pelczar Jr. (2001) Microbiology, 5 edition, McGraw Hill Education.

3. Joanne Willey, Linda Sherwood, Christopher J. Woolverton (2017) Prescott's Microbiology, 10 edition, McGraw-Hill Education.

4. D K Maheshwari and R C Dubey (2013) A Textbook of Microbiology, Fourth edition, S Chand Publishing.

5. Tortora/Funke/Case (2016) Microbiology 11e, Eleventh edition, Pearson Education India.

Course Title: General Microbiology Laboratory

L	T	P	Credit
0	0	3	2

Course Code: MIC532

1. Microbiology Good Laboratory Practices and Biosafety.
2. Study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, hot air oven, light microscope, pH meter, spectrophotometer) used in the microbiology laboratory
3. Preparation of general purpose culture media for bacterial cultivation
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air
8. Use of compound light microscope
9. Motility by hanging drop method
10. Simple staining
11. Negative staining
12. Study of different shapes of microorganisms under microscope.
13. Isolation of pure cultures of bacteria by streaking method
14. Preservation of bacterial cultures by various techniques
15. Gram’s staining
16. Acid fast staining
17. Endospore staining
18. Spread plate technique
19. Pour plate technique
20. Estimation of CFU count by spread plate method/pour plate method.

Course Title: Cell Biology

Course Code: BTY513

L	T	P	Credits
4	0	0	4

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.

Unit I **(6 lectures)**

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: evolutionary steps in the origin of cells (Chemical evolution).

Unit II **(8 lectures)**

Microscopic techniques for study of cells: Bright field, Fluorescence, Phase contrast, DIC, dark field, Confocal. Electron Microscopy: TEM, SEM, AFM, Preparation of samples for EM. Applications of Light Microscopy and EM in cell biology. Sub cellular fractionation: Fractionation and marker enzymes and functional integrity

Unit III **(12 lectures)**

Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton; cilia, flagella and its role in motility). Membrane structure and function: lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

Unit IV **(10 lectures)**

Cell Trafficking: Targeting proteins to endoplasmic reticulum, signal recognition particle, signal recognition particle receptor; Protein sorting and export from Golgi Apparatus; SNARE hypothesis; 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, Cell synchronization.

Unit V **(10 lectures)**

Cellular responses to environmental signals in plants and animals: Mechanism of signal transduction. 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, c- AMP pathway of signal transduction ; Ras, Raf , MAP kinase pathway, JAK –STAT pathway.

Learning outcomes:

On completion of the course students will be able to understand the basic unit of the organism, to differentiate the organisms by its cell structure, to know Components of the Cell and their division, to do microscopic study of cells to have knowledge about structural organization and function of intracellular organelles, to have knowledge about cellular signalling, cell divison and cell cycle.

Reference Books:

1. Cell biology: A laboratory handbook Vol 1, 2, 3 (2006). Celis. J.E. (Academic Press, UK). ISBN 13: 9780121647308
2. Stryer, L. (1995). Biochemistry, 4th edition, W.H. Freeman and Co., New York. ISBN-13: 978-0716720096
3. Nelson, D.L. and Cox, M.M. (2000). Lehninger Principles of Biochemistry, 3rd ed., Worth Publishers, New York. ISBN 1-57259-9316
4. Damal, J., Lodish, H. and Baltimore, D. (2000). Molecular Cell Biology, 4th ed., Scientific American Books, New York. ISBN-10: 0-7167-3136-3
5. Cell Biology by Gerald Karp, 6th ed., ISBN-13: 978-0470505762.
6. Essential of Cell Biology by Albert, B., Bray, D., Hopkin, K., Johnson, A.D., Lewis, J., Raff, M. And Walter, P., 4th ed. ISBN-13: 9780815344544
7. The Cell: A molecular approach, by Cooper, G.M. and Hausman, R.E. (2015). ISBN: 9781605352909
8. Cell Biology by G.Karp, (2013) Wiley; Seventh edition.

Course Title: Molecular Biology

Course Code: BTY511

L	T	P	Credits
4	0	0	4

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.

Unit I **(10 lectures)**

Introduction to molecular biology: DNA structure and brief history of its discovery, various forms of DNA,DNA packaging, DNA melting, repetitive sequences, cot and rot curves, C value paradox, linking number and super-helical density of DNA. RNA structure and function, DNA-Protein interaction, DNA supercoiling, mechanism of action of topoisomerases, ribozymes and riboswitches.

Unit II **(10 lectures)**

Prokaryotic & eukaryotic DNA replication, enzymes and accessory proteins involved in DNA replication, replication origin & replication fork, fidelity of replication, telomeres and regulation of telomere length, extra chromosomal replicons.DNA mutability, damage and repair mechanisms, mobile genetic elements, homologous and site specific recombination.

Unit III **(12 lectures)**

Prokaryotic and eukaryotic transcription, RNA polymerase, transcription factors, promoters, enhancers, silencers, insulators and other regulatory elements.Transcriptional activators, repressors& mechanism of transcriptional regulation, operons, post-transcriptional processing of rRNA & tRNA. Capping, RNA splicing and polyadenylation of eukaryotic mRNAs.

Unit IV **(10 lectures)**

Protein synthesis and processing: Ribosome, mRNA, tRNA structure, aminoacyl tRNA synthetases and tRNA charging,genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanism and regulation of translation & translation proof-reading, translational inhibitors, post-translational modifications of proteins and intracellular protein targeting, import into nucleus, mitochondria and peroxisome.

Unit V **(4 lectures)**

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). Basic techniques in molecular biology.

Learning outcomes: On completion of the course students will be able to understand about the Nucleic acids, to know the structure of nucleic acid, types of Nucleic acid and its Forms, to explain genome organization in Prokaryotes and Eukaryotes, to describe Nucleic acids Replication, Recombination and its Repair Mechanisms, to understand the mechanisms of central dogma of life. Study the molecular mechanisms of gene regulation in prokaryotes and eukaryotes.

Reference Books:

1. Molecular cell biology (2008). Harvey F. Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher (W.H.Freeman). ISBN-13: 978-1464183393
2. Genes IX (2008). Benjamin Lewin (Jones and Bartlett Publishers). **ISBN**-13: 978-0763740634
3. Molecular cloning: A laboratory manual, 3rd ed. (2001). J. Sambrook, E.F. Fritish and T. Maniatis (Cold Spring Harbor Laboratory Press,New York). ISBN: 0879695773 (pbk.)
4. Molecular Biology of the Gene. J D Watson (7th edn) 2017. Pearson Publn. ISBN-13: 9780321762436

Course Title: Molecular Biology Laboratory

Course Code: BTY512

L	T	P	Credits
0	0	3	2

- Isolation of genomic DNA from bacteria.
- Isolation of genomic DNA from plant.
- Isolation of total RNA from tissue.
- Isolation of Plasmid DNA
- Determination of melting temperature of DNA samples
- Demonstration of DNA protein interaction.
- Quantitation of nucleic acids.
- Quantitation of proteins.
- Qualitative analysis of nucleic acid through electrophoresis
- Qualitative analysis of Protein through electrophoresis
- Elution of DNA from agarose gel.

Course Name: Medicinal Chemistry

Course Code: CHE616

L	T	P	Credits
4	0	0	4

Course Objectives:

This course is intended to learn the basic concepts of Medicinal Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic interest.

Unit I **(12 lectures)**

Enzymes: Basic considerations. Proximity effects and molecular adaptation. Introduction and historical prospective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-menten and lineweaver-Burk plots, reversible and irreversible inhibition.

Mechanism of Enzyme Action: Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonucleases, lysozyme and carboxypeptidase A.

Unit II **(10 lectures)**

Kinds of Reaction Catalysed by Enzymes: Nucleophilic displacement on a phosphorus atom, multiple displacement reaction and the coupling of ATP cleavage to endergonic processes. Transfer of sulphates, addition and elimination reactions, enolic intermediates in isomerization reactions, β-cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

Unit III **(10 lectures)**

Co-Enzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, LIPOIC ACID, vitamin B12. Mechanisms of reactions catalysed by the above cofactors.

Unit IV **(14 lectures)**

Drug Design: Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity

relationship (SAP), factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptors interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials. LD-50, ED-50 (Mathematical equations excluded)

Learning outcomes: On the completion of course students will be equipped with the necessary medicinal chemistry knowledge concerning the fundamentals in the basic areas of pharmaceutical sciences. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers.

Reference Books:

1. Lehninger, *Principles of Biochemistry*, WH-Freeman, 5th edition. ISBN-13: 9780716771081

2. Silverman, R. B. *The organic chemistry of drug design and drug action,* Academic press 2nd edition, 2004. ISBN: 9780126437324.

3.Pandeya S. S. and Dimmock, J.R. *An introduction to drug design,* New Age International. ISBN : 978-81-224-0943-7

4.Sriram/Yogeeswari (2010) Medicinal Chemistry, Pearson Education India; 2 edition, ISBN-10: 9788131731444.

5.Ashutosh Kar (2018) Medicinal Chemistry, New Age International Publishers; Seventh edition, ISBN-10: 9386649721.

6. Beale (2010) Wilson & Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Wolters Kluwer India Pvt. Ltd.; Twelfth edition, ISBN-10: 8184733968

Course Name: Human Physiology

Course Code: ZOO257

L	T	P	Credits
4	0	0	4

Course Objective: To acquaint students with the functioning of all systems of the human body.

Unit I **(12 lectures)**

Nutrition: Types of nutrition and nutrients; sources and functions of nutrients and the diseases associated with their excess or lesser intake.

Digestive System: Alimentary canal; Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and Hormonal control of Digestion

Unit II **(12 lectures)**

Respiratory System: Ventilation; External and Internal Respiration; Transport of oxygen and carbon dioxide in blood; Factors affecting transport of gases.

Circulatory System: Composition of blood; Lymph; Blood groups; Blood coagulation**;** Structure of heart; co-ordination of heart beat, Cardiac cycle; ECG

Excretory System: Functional anatomy of kidney; Mechanism and regulation of urine formation.

Unit III **(12 lectures)**

Endocrine System: Structure of pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, testes; and the diseases associated with them

Reproductive System: Spermatogenesis; Oogenesis; Physiology of male and female reproductive systems; hormonal and neuronal control

Unit IV **(10 lectures)**

Nervous System: Structure of Neuron; Propagation of nerve impulses (myelinated and non-myelinated nerve fibres); neuromuscular junctions

Muscular system: Structure of skeletal muscle, Mechanism of muscle contraction (sliding filament theory)

Learning outcomes: On the completion of course students will be able to have integrated understanding of physiological mechanisms, describe the physiology of digestive and respiratory system of human beings, understood the blood composition, types, groups and

circulatory system, describe the physiology of excretory system and nervous system of human beings, know the physiology of sense organs, muscles and reproductive system.

Reference books

1. Guyton, A.C., Hall, J.E. Text Book of Medical Physiology, XIIth edition, Harcourt Asia Pvt. Ltd./W.B. Saunders Company, 2011. ISBN 0-7216-0240-1
2. Best, J.P., Best and Taylor's physiological basis of medical practice, 11th ed., William and Wilkins, 1985.
3. Hoar, W.S., General and comparative physiology, Adaptation and Environment, 3rd ed., Cambridge University Press, 1983. ISBN: 9780521570985
4. Rhoades, R.A., Tanner, G.A., Medical Physiology, 2nd ed., Lippincott Williams and Wilkins, 2003. ISBN: 0781719364.
5. Tortora, G.J., Derrickson, B.H. Principles of Anatomy and Physiology, XII Edition, John Wiley and Sons, Inc., 2009. ISBN: 9781119055525.

Course Name: Algae, Fungi and Phytopathology

Course Code: BOT521

L	T	P	Credits
4	0	0	4

Objective: To acquaint the students with the origin, history, morphology, biology and importance of prokaryotic and eukaryotic algal and fungal organisms.

UNIT-I (12 lectures)

Algae: Algal classification, Salient features of major divisions (Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta; Phaeophyta and Rhodophyta). Algal ecology:Ecological importance of Algae, Algal indicators, Algal blooms – damage and control, Carbon capture by algae, Algal biofouling, Symbiotic association. Economic importance of Algae: Algae as food, fodder, biofertilizer, medicine, industrial uses and other useful products, algae as indicator of water pollution, biofuels from algae, algae and global warming.

UNIT-II (12 lectures)

Fungi: Recent trends in classification of fungi; general account of phylum Chytridiomycota, Ascomycota, Deuteromycota, Basidiomycota, Zygomycota and Myxomycota and their classification (major orders). Fungal associations and their significance: (a) Symbionts - Lichens, Mycorrhiza, Fungusinsect mutualism; (b) Parasites - Common fungal parasites of plants; (c) Saprophytes - Fungal decomposition of organic matter, coprophilous fungi, cellulolytic fungi, lignolytic fungi. Agricultural significance of Fungi - Mycoparasite, mycoherbicide.

UNIT-III (12 lectures)

Phytopathology: Introduction; Process of infection and pathogenesis: penetration and entry of pathogen into host tissue – mechanical, physiological and enzymatic; Host-parasite interaction, enzymes and toxins in pathogenesis. Defense mechanism in plants: Pre-existing structural and biochemical defense mechanisms, induced structural and biochemical defense mechanisms, hypersensitive reaction, role of phytoalexins and other phenolic compounds, PR proteins, role of Jasmonic acid and Salicylic acid.

UNIT-IV (10 lectures)

Diseases in plants: Symptoms, etiology and disease cycle. Wheat- rust, smut; Rice-sheath blight; Cucurbits-Powdery mildew; Sugarcane-red rot; Potato-late and early blight; Crucifers-

white rust; dieback disease of grasses. Plant disease management: Exclusion, eradication and protection. Chemical means of disease control; biological means of disease control; biotechnological approaches to diseaseresistance: transgenic approaches to disease resistance, engineering chemicals that elicit defense responses in plants.

Learning outcomes. This will enable the students to learn the evolutionary and recent trends in lower plants.

Reference Books

1. Alexopoulos, Constantine John, and Meredith Blackwell. Introductory Mycology.4.th ed. New York [u.a.: Wiley, 1996. Print.

2. Bilgrami, K. S., andVerma, R. N. Physiology of Fungi. New Delhi: Vikas Pub. House, 1978. Print.

3. Bold, Harold Charles, and Michael James Wynne. Introduction to the Algae: Structure and Reproduction. Englewood Cliffs, N.J.: Prentice-Hall, 1978. Print.

4. Burnett, J. H. Fundamentals of Mycology. New York: St. Martin's, 1976. Print.

5. Carlile, M. J., and Sarah C. Watkinson. The Fungi. 2nd ed. San Diego: Academic, 2001. Print.

6. Chapman, N. J., and Chapman, D.J. The Algae. London: ELBS and Macmillan;, 1977. Print.

7. Fritsch, F. E. The Structure and Reproduction of the Algae.(Vol.I, Vol II).Vikas House Pvt. Ltd, 1979. Print.

8. Graham, Linda E., and Lee Warren Wilcox. Algae. Upper Saddler River, NJ: Prentice Hall, 2000. Print.

9. Kumar, H. D. Introductory Phycology. New Delhi: Affiliated East-West, 1999. Print.

10. Lee, Robert Edward. Phycology. Cambridge: Cambridge UP, 2008. Print.

11. Landecker, Elizabeth. Fundamentals of the Fungi. Englewood Cliffs, N.J.: Prentice-Hall, 1972. Print.

12. South, G. Robin, and Alan Whittick. Introduction to Phycology. Oxford: Blackwell Scientific Publications, 1987. Print.

13. Hoek, C. Van Den, and Mann, D. G. Algae: An Introduction to Phycology. Cambridge: Cambridge UP, 1995. Print.

Course: Scientific Writing and Research Methodology

L	T	P	Credits
3	1	0	4

Course Code: BOT621

Course Objectives: To make the students learn how to design an experiment and what are the various research strategies.

UNIT-I **(13 lectures)**

Biostatistics: Definition and relevance in biological research; Measures of Central Tendency: Arithmetic Mean, median, mode, quartiles and percentiles; Measures of Dispersion: Range, variance, standard deviation, coefficient of variation; Skewness and Kurtosis. Correlation and Regression: Correlation coefficient (r), properties, interpretation of r, partial and multiple correlations, linear regression: Fitting of lines of regression, regression coefficient, Bivariate and Multiple Regression. Probability theory: Origin and concept, deterministic and random experiments, concept of events, sample space, mutually exclusive and equally likely events; classical concept of probability, addition theorem and multiplication theorem in probability.

UNIT-II **(12 lectures)**

Inferential Statistics: Hypothesis testing, Errors in Hypothesis Testing- Null Hypothesis, Alternative Hypothesis, Type I and Type II errors, Confidence Limits. Setting up of level of significance. One tailed and Two- tailed tests. Parametric and Non-Parametric Statistics: Definition, Advantages, Disadvantages, Assumptions; Parametric Tests: Student's t-test, One Way Analysis of Variance, Two Way Analysis of Variance; Non-Parametric Tests: Analysis of Variance, Chi square and Kendall Rank Correlation Experimental Set-up: Basic principles and significance of research design; Randomized Block Designs (RBD), completely randomized designs (CRD); Latin square design and Factorial design

UNIT-III **(14 Lectures)**

Data collection, organization and interpretation. Research articles, research papers, popular research articles and reviews; difference between periodicals; journals; monographs, magazines; proceedings. How to write a research paper, reference styles, process of submission of a paper; process of proof reading of a research manuscript; process of reviewing. Important journals in plant sciences.

UNIT-IV **(10 Lectures)**

An introduction to Science citation index; H-index, i10 index, Impact factor calculation, Impact factor of a journal; Eigen factor, Major journal search engines. Copyright act; Academic frauds; Plagiarism; Software's to check plagiarism.

Learning outcomes: On the completion of the course students will have knowledge about the basic concept of biostatistics, will be able to Data collection, organization and interpretation, will have knowledge about Basic principles and significance of research design, students will get updated with scientific writing and importance of Impact factor. They will have information about the Plagiarism.

Reference Books

1. Kothari, C.R. Research Methodology – Methods and Techniques. 2nd revised ed. New Delhi: New Age International (P) Ltd. Publishers, 2007. Print.

2. McKillup, S. Statistics Explained. An Introductory Guide for Life Scientists. Cambridge, UK: Cambridge University Press, 2006. Print.

3. Selvin, S. Biostatistics – How it Works. First Impression. New Delhi: Pearson Education Inc., 2007. Print.

4. Agarwal, B.L. Basic Statistics. New Delhi: New Age International, 2006. Print.

Course Title: Bioanalytical Techniques

L	T	P	Credits
3	0	0	3

Course Code: BTY527A

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

Unit I **(8 lectures)**

Quantitative and real time PCR, Various methods of DNA sequencing (Nucleotide sequencing of DNA); Protein DNA interaction assays. Radioimmunoassay, ELISA, Flow cytometery.

Unit II **(6 lectures)**

Overview of Chemical and Physical cell disruption techniques for biomolecules. Methods of separation of proteins by electrophoresis and chromatography; Methods of separation of DNA by electrophoresis and chromatography.

Unit III **(8 lectures)**

Advanced techniques of separation: 2D gel electrophoresis, HPLC and GC. Detection of molecular mass by MALDI, ESI-MS.

Unit IV **(8 lectures)**

Principle and applications-Nuclear Magnetic Resonance spectroscopy, ^{1}H NMR, ^{13}C NMR, X-ray Crystallography,

Unit V **(5 lectures)**

Microtomy: Techniques and applications; Radiotracer technology in Biology

Learning outcomes: On the completion of the course students will able to understand the working principles of analytical instruments, separate biomolecules using membrane and chromatographic techniques and knowledge about cell disruption, understand the principle and applications of advanced methods in biotechnology, understand the application of radioactivity in the analysis of biomolecules.

Reference Books:

1. Radioisotopes in Biology-A Practical Approach. Slater, R.J. 2nd Edition. Oxford University Press, New York. 2002. Print. ISBN-0-19-963827-6(Hbk), ISBN o-19-963826-8 (Pbk)

2. Physical Biochemistry: Principles and Applications (2009). Sheehan, D. 2nd Edition. John Wiley & Sons Ltd. Print. ISBN 978-0-470-85602-4 (hb) – ISBN978-0-470-85603-1 (pb)
3. Biophysical Chemistry: Principles & Techniques (2002). Upadhayaye, A., Upadhyaye, K. and Nath, N. Himalaya Publication House, New Delhi. Print. ISBN Number : 978-93-5142-227-3
4. Principle and Practice of Bioanalysis (2008). Venn, R.E. 2nd Edition. CRC Press. Print. ISBN 13: 9780849338571.
5. Practical Biochemistry: Principles and Techniques (2005). Wilson, K. and Walker, J. 5th Edition. Cambridge University Press. Print. ISBN-13: 978-0521799652

Course Title: Biostatistics

L	T	P	Credits
4	0	0	4

Course Code: BTY541

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

UNIT-I **(10 lectures)**

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.

UNIT-II **(10 lectures)**

Probability (Addition and Multiplication Theorem), Bayes theorem, Binomial, Poisson and Normal distribution. Correlation and linear regression. 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.

UNIT-III **(10 lectures)**

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).

UNIT-IV **(8 lectures)**

Analysis of variance (ANOVA) one and two way. Pearson correlation test. Biological experimental designs- CRD, RBD, factorial designs, latin square designs.

UNIT-V **(8 lectures)**

Application of statistics biological experimental design: Data collection and explanation and conclusion case studies. Sampling theory and different techniques,Applications of statistical methods using statistical software , SAS.

Learning outcomes: on the completion of the course students will able to have knowledge about the data collection, tabulation and presentation, will be able to describe the mean, median, mode and SD. will be able to describe and understand the Analysis of Variance, will be able to describe Student‘t’ test and probability, will be able to understand the Correlation and Regression.

Reference Books:

1. Biostatistics (2012). Arora, P.N. and Malhan, P.K. Himalaya Publishing House. Print.
2. Introduction to Biostatistics (2013). Banerjee, P.K. 4th Edition. S. Chand & Co. Ltd. Print.
3. Biostatistics: A foundation for analysis in the Health Sciences (2013). Daniel, W.W. and Cross, C.L. 10th Edition. John Wiley and Sons. Print.
4. Introduction to Biostatistics (2006). Forthfer, R.H., Lee, E.S. and Hernandez, M. Academic Press. Print.
5. Statistical Methods (2013). Gupta, S.P. 43rd Edition. S.Chand & Co. Print.
6. Introduction to Biostatistics (2009). Sokal, R.R. and Rohlf, F.J. 2nd Edition. Dover Publications. Print.

Course Title: Recombinant DNA Technology

Course Code: BTY521

L	T	P	Credits
4	0	0	4

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.

Unit I **(8 lectures)**

Introduction and scope of Recombinant DNA Technology. 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.

Unit II **(10 lectures)**

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. 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.

Unit III **(10 lectures)**

Cloning and expression hosts: Characteristics of cloning and expression host, bacterial, yeast, plant and mammalian host systems for cloning and expression of genes.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.

Unit IV **(10 lectures)**

Nucleic acid Blotting and Hybridization: Southern and northern blotting and hybridization techniques, radioactive and non-radioactive labeling of probe, western blotting. 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. 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).

Unit V **(8 lectures)**

Polymerase chain reaction and site directed mutagenesis: Principle and application of polymerase chain reaction, Real Time PCR, random mutagenesis, site-directed mutagenesis and protein engineering. Impact of rDNA on human genetics: Mapping & cloning of human disease genes, DNA based diagnosis, gene targetting, human genome project history and scope. Applications of r-DNA technology in industry, agriculture and forensic science. Introduction to CRISPR/Cas9 genome editing technology.

Learning outcomes: On the completion of the course students will have knowledge about the basic concept of RDT. Understand basic and advanced techniques in recombinant DNA technology. Select appropriate host and vector system for cloning and expression. Understand the cloning strategies and expression of recombinant molecules. Understand the mechanism of PCR. Apply genetic engineering principles for biotechnological and biomedical applications.

Reference Books:

1. Gene cloning and DNA analysis – An Introduction (2006). 5th edition, T.A. Brown, Blackwell publisher. ISBN-10: 1405181737; ISBN-13: 978-1405181730
2. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes (1998). S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford.
3. Molecular Cloning : A Laboratory Manual (2000). J. sambrook, E.F. Fritsch and T.Maniatis, Cold Spring Harbor Laboratory Press, New York. ISBN 978-1-936113-42-2. (pbk.)
4. Molecular Biotechnology-Principles and Applications of Recombinant DNA (2003). 3rd edition, Bernard R Glick and Jack J pasternak. ASM press, Washington. ISBN 10: 1555810713 ISBN 13: 9781555810719
5. Principles of Genetic Engineering (2009). Mousumi Debnath, pointer publisher, Jaipur. ISBN: 9788171325818.
6. Principles of gene manipulation and Genomics (2006). 7th edition, S.B Primose and R.M Twyman, Blackwell publishing. ISBN-13: 978-1405135443.

Course Title: Recombinant DNA Technology Laboratory

Course Code: BTY522

L	T	P	Credits
0	0	3	2

- Preparation of competent cells
- Preparation and purification of plasmid DNA.
- Preparation and purification of genomic DNA
- Preparation and purification of RNA
- Restriction digestion
- DNA ligation
- Experiment designing for foreign gene expression
- RFLP of given DNA samples and Gel electrophoresis
- *In silico* RFLP of DNA sequences.
- Bacterial transformation
- Southern blotting and hybridization with non-radioactive probes.
- Primer designing for PCR
- Amplification of DNA with PCR Temperature cycler.
- TaqMan probes and molecular beacons designing.

Course Title: Animal Biotechnology

Course Code: BTY523

L	T	P	Credits
4	0	0	4

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

Unit I **(9 lectures)**

Animal Biotechnology- Scope, global perspective and new horizons, Historical perspective. Culture Media and Reagents-Types of cell culture media, physiochemical properties, Balanced salt solution, Constituents of serum, Serum free media (SFM), Design of SFM, Advantages and disadvantages of serum supplemented and serum free media, Conditioned media.

Unit II **(12 lectures)**

Primary culture methods, Culture of attached cells and cells in suspension, phases of cell growth and determination of cell growth data (calculation of *in vitro* age, multiplication rate, population doubling time, cell counting, phases of cell cycle) Commonly used animal cell lines, their origin and characteristics, Organ Culture, Cell synchronization methods and their applications.

Unit III **(8 lectures)**

Concept of stem cells, tissue engineering and its application. 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 fibre system & their application.

Unit IV **(8 lectures)**

Preservation and maintenance of animal cell lines, cryo-preservation and transport of animal germplasm (i.e. semen, ova and embryos).Gene cloning techniques for mammalian cells, cloning in mammalian cells.

Unit V **(9 lectures)**

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. Sericulture and Pisciculture.

Learning outcomes: On the completion of the course students will be able to understand the basics of animal cell culture. Apply aseptic techniques for cell culture. Design cell culture

media for cell growth and product development. Characterize the animal cell using biochemical and molecular biology techniques. Apply the principles of genetic engineering to modify animal cell for research and industrial use. Understand the concept of transgenic animal and animal breeding

Reference Books:

1. Methods of Tissue Engineering (2001). Atala, A. and Lanza, R. 1st Edition. Academic Press. Print. ISBN-13: 978-0124366367
2. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (2010). Freshney, R. I. 6th Edition. Wiley-Blackwell. Print. ISBN: 978-1-118-87365-6.
3. General Techniques of Cell Culture (1997). Harrison, M.A. and Rae, I.F. 1st Edition. Cambridge University Press. Print. ISBN: 9780521574969.
4. Animal Cell Culture: A Practical Approach (2000). Masters, J.R.W. 3rd Edition. Oxford University Press. Print. ISBN-10: 0199637962; ISBN-13: 978-0199637966.
5. Animal Cell Biotechnology (1994). Spier, R.E. and Griffiths, J.B. Vol. 1-6. Academic Press. Print. ISBN9780126575569, 9780080925998.
6. Animal Biotechnology: Models in Discovery and Translation (2013). Verma, A. and Singh, A. 1st Edition. Academic Press. Print. ISBN 9780124160026, 9780123914347
7. Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies (2010).Twine, R. 1st Edition.Routledge Publishers. Print. ISBN-10: 1138867004; ISBN-13: 978-1138867000.

Course Title: Animal Biotechnology Laboratory

Course Code: BTY524

L	T	P	Credits
0	0	3	2

- Animal cell culture lab design.
- Preparation of culture media
- Concept of sterilization in animal cell culture.
- Sub-culturing and Passaging
- Maintenance of continuous cell lines such as myeloma,
- Maintenance of continuous cell lines such as Hep-2
- Maintenance of continuous cell lines such as 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: Genetics

Course Code: BTY542

L	T	P	Credits
4	0	0	4

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.

Unit I **(12 lectures)**

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.

Unit II **(12 lectures)**

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.

Unit III **(10 lectures)**

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. 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.

Unit IV **(4 lectures)**

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Unit V **(8 lectures)**

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. Recombination in bacteria, fungi and viruses; Homologous and non-homologous recombination. Human genetics:Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

Learning outcomes: On the completion of the course students will be able to demonstrate Mendelian inheritance. Calculate recombinant frequencies and construct pedigree analysis. Study chromosomal aberrations in humans. They will have conceptual knowledge on gene and its principles. They will be able to describe mapping and genetics of microbes.

Reference Books:

1. Genetics (2010). Aggarwal, V.K. and Verma, V.S. 9th Edition. S. Chand, India. Print. ISBN: 9788121931144.
2. The Language of the Genes (2012). Jones, S. HarperCollins Publishers. Print. ISBN: 9780006552437.
3. Genetics: A Conceptual Approach (2010). Pierce, B.A. 4th Edition. W.H. Freeman & Company. Print. *ISB.N*-10: 1429232528; ISBN-13: 978-1429232524
4. Nature via Nurture: Genes, Experience, & What Makes Us Human (2004). Ridley, M. HarperCollins Publishers. Print. ISBN-10: 1841157465; *ISBN*-13: 978-1841157467
5. Genetics (2008). Strickberger M.W. 3rd Edition. Prentice-Hall, India. Print. ISBN 10: 8120309499 / ISBN 13: 9788120309494
6. Principles of Genetics (2011). Snustad, D.P. and Simmons, M.J. 6th Edition. John Wiley & Sons. Print. ISBN*:* 978 0470903599.
7. Fundamentals of Genetics (2011).Singh, B.D. 4th Edition. Kalyani Publishers. Print. *ISBN*-10: 8127232920; ISBN-13: 978-8127232924

L	T	P	Credits
4	0	0	4

Course Title: Phytochemicals and Herbal Medicines

Course Code: BTY684

Course Objective: The objective of this course is to introduce the students to various plant based pharmaceuticals and herbal medicines.

Unit I **(8 lectures)**

Crude Drugs – Scope & Importance, Classification (Taxonomical, Morphological, Chemical, Pharmacological); Cultivation, Collection & processing of Crude Drugs.

Indian System of medicine: Ayurveda, Siddha and Unani and its significance

Unit II **(10 lectures)**

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 endanagered medicinal plants.

Unit III **(8 lectures)**

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 chirayita, Andrographis paniculata, Aconitum* sp.); Anticancer, Antiinflammatory, Antidiabetic, Analgesic drugs, Biogenesis of Phytopharmaceuticals.

Unit IV **(12 lectures)**

Methods of Drug evaluation (Morphological, Microscopic, Physical & Chemical). Preliminary screening, Assay of Drugs – Biological evaluation / assays, Microbiological methods. Characterization of drugs.

Types of Phytochemicals: Carbohydrates & derived products; Glycosides - extraction methods (Digitalis, Aloe, Dioscorea,); Tannins (Hydrolysable & Condensed types); Volatile Oils - extraction methods (Clove, Mentha);

Alkaloids - extraction methods (Taxus, Papaver, Cinchona); Flavonoids- extraction methods, Resins- extraction methods; Lectins.

Unit V **(8 lectures)**

Application of phytochemicals in industry and healthcare; Biocides, Biofungicides, Biopesticides. Nutraceuticals; nutraceutical plants and their significance.

Learning outcomes: On the completion of the course students will be able to understand the traditional systems of medicines. Have basic information regarding cultivation and utilization of Medicinal & Aromatic Plants in India. Describe phytochemicals and plant based drugs. Demonstrate the importance of conservation of medicinal plants, biotechnological means of conservation and herbal based industry.

Reference Books:

1. Pharmacognosy, C. K. Kokate, A. P. Purohit & S. B. Gokhale Nirali Prakashan, 4th Ed.1996. ISBN-10: 8185790094
2. Medicinal Natural Products: A Biosynthetic approach Wiley 1997. ISBN: 9780470846278.
3. Hornok,L. (ed.) Cultivation & Processing of Medicinal Plants, Chichister, U. K:J. Wiley & Sons 1992. ISBN-10: 0471923834; ISBN-13: 978-0471923831.
4. Trease & Evans, Pharmacognosy – William Charles Evans, 14th ed. Harcourt Brace & Company 1989.

Course Title: Environmental Biotechnology

Course Code: BTY631

L	T	P	Credits
4	0	0	4

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.

Unit I **(10 lectures)**

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.

Unit II **(8 lectures)**

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. Anaerobic processes: Anaerobic digesters, upward flow anaerobic sludge blanket reactors.

Unit III **(8 lectures)**

Bioremediation- Biotechnology for clean environment. Biodegradation of xenobiotics in the environment-Ecological considerations, decay behaviour, derivative plasmids, Degradation of hydrocarbons, substituted hydrocarbons, surfactants and pesticides. Bioremediation of contaminated soil. Biopesticides and Integrated Pest Management.

Unit IV **(10 lectures)**

Solid waste management: Sources, types, composition, characteristics and composition of municipal solid waste, recycling and transformation.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.

Unit V **(10 lectures)** Conservation biotechnology, remote sensing and GIS (Principal and applications in ecological mapping and environmental hazard predictions), ecological modeling. Bioindicators and biosensors for detection of pollution.

Learning outcomes: The course will explain the importance of microbial diversity in environmental systems, processes and biotechnology as well as the importance of molecular approaches in environmental microbiology and biotechnology. It will describe biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling. Students can implement a range of practical approaches relevant to environmental microbiology and biotechnology and record, report and discuss data.

Reference Books:

1. Principles of gene manipulation (2006). Sandy Primrose, Richard Twyman, Bob Old, Giuseppe Bertola (Black Well Publication). **ISBN-13:**9781405135443 **ISBN:** 1405135441.
2. Biodegradation and Bioremediation: Soil Biology (2004).Singh A. and Ward O.P. Springer. ISBN: 978-3-540-21101-3.
3. Environmental Chemistry. A.K. De, Wiley Eastern Ltd., New Delhi. ISBN 9781420059205.
4. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold. *ISBN*-13: 978-0521528870
5. Environmental Controversies (1998). Agarwal S. K., APH Publishing Corporation, New Delhi. ISBN 13: 9788176482912
6. Waste Water Engineering, Metcalf and Eddy Wastewater Engineering: Treatment, Disposal, Reuse (Mcgraw-Hill Series in Water Resources and Environmental Engineering) Hardcover – Import, 1 Dec 1990, by George Tchobanoglous (Author), Frank Burton (Author) ISBN-13: 978-0070416901.
7. Environmental Biotechnology- Concepts and Applications, Hans-Joachim Jordening and Jesef Winter, *ISBN*: 978-3-527-30585-8.
8. Environmental Biotechnology, Pradipta Kumar Mohapatra, ISBN: 9788188237548

Course Title: Environmental Biotechnology Laboratory

Course Code: BTY632

L	T	P	Credits
0	0	3	2

- To determine BOD of the given industrial effluent.
- To determine COD of the given industrial effluent.
- To check the faecal contamination.
- Microbiological examination of water
- To check the chlorine content of water
- To check the pH and TDS of water samples
- Isolation of nitrogen fixing and phosphate solubilizing bacteria
- Isolation of phosphate solubilizing bacteria
- Isolation of dye degrading organisms from different sources.
- Isolation of pesticide degrading organisms from soil.

Course Title: Plant Biotechnology

Course Code: BTY633

L	T	P	Credits
4	0	0	4

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.

Unit I **(10 lectures)**

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.

Unit II **(8 lectures)**

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.

Unit III **(10 lectures)**

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. 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.

Unit IV **(8 lectures)**

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.

Unit V (10 lectures)

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. 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.

Learning outcomes: The course will describe methods for obtaining and application of genetically modified plants, Germplasm conservation and Plant secondary metabolites. It define regulatory issues for genetically modified plant production with the fruitful use of molecular markers and molecular aspects in transformation for production of transgenics.

Reference Books:

1. Plant tissue culture – Theory and Practice (2005). Bhojwani, S.S. and Razdan, M.K. Elsevier Publication. Print. **ISBN:** 9780080539096.
2. Biotechnology in Crop Improvement (1998). Chawla, H.S. International Book distributing company. Print. *ISBN*: 8185860424.
3. Introduction to Plant Biotechnology (2009). Chawla, H.S. 3rd Edition. CRC Press. Print. ISBN 9781578086368
4. Plant Biotechnology (2000). Hammond, J., McGarvey, P. and Yusibov, V. Springer verlag, Germany. Print. *ISBN*-13:978-3-540-66265-5
5. Recent Advances in Plant Biotechnology (2009). Kirakosyan, A. and Kaufman, P.B. Springer. Print. *ISBN* 978-1-4419-0193-4
6. Plant Biotechnology: The Genetic Manipulation of Plants (2008). Slater, A., Scott, N.W. and Fowler, M.R. 2nd Edition. Oxford University Press. Print. ISBN-13: 978-0199282616

Course Title: Plant Biotechnology Laboratory

Course Code: BTY634

L	T	P	Credits
0	0	3	2

- Methods of sterilization
- Preparation of different media
- Callus induction & sub culturing,
- Tissue and Organ culture and its maintanence
- 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: Fermentation and Bioprocess Engineering

Course Code: BTY525

L	T	P	Credits
3	0	0	3

Course Objective: This course deals 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.

Unit I **(8 lectures)**

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. Design of a bioreactor, animal, plant and microbial type bioreactors, body, agitator (impeller), baffles, spargers, valves, different types of bioreactors.

Unit II **(10 lectures)**

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. 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.

Unit III **(10 lectures)**

Introduction & 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. Microbial enzymes, metabolites, recombinant products and biotransformation products.

Unit IV **(10 lectures)**

Isolation, preservation and maintenance of industrial microorganisms, screening methods, improvement of industrial microorganism and use of different strategies, quality control of preserved industrial strains. 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, disposal of effluents.

Unit V **(8 lectures)**

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. Industrial processes and production of alcohol (ethanol), citric acid, glycerol, acetone-butanol, penicillin antibiotics, glutamic acid and lysine, single cell protein.

Learning outcomes: The students will be able to evaluate factors that contribute in enhancement of cell and product formation during fermentation process. They will analyse kinetics of cell and product formation in batch, continuous and fed-batch cultures and will differentiate the rheological changes during fermentation process.

Reference Books:

1. Bioprocess Engineering: Basic concepts (1996). Shuler, M.L. and Kargi, F., 2nd ed., Prentice Hall, Engelwood Cliffs. ISBN-13: 978-8120321106
2. Process Engineering in Biotechnology (1997). Jackson, A.T., 2nd ed., Prentice Hall, Engelwood Cliffs. *ISBN*-10: 0070032122
3. Biochemical Engineering Fundamentals (2000). Bailey, J.E. and Ollis, D.F., 2nd ed., McGraw-Hill Book Co., New York. *ISBN*-10: 0070032122
4. Biotechnology (2004). Crueger, W., A text book of Industrial Microbiology. ISBN-13: 978-0878931316
5. Principle of Fermentation Technology (2001). Stanbury, P.F., Whitaker, A and Hall, S.J., 2nd ed., Aditya Books (P) Ltd., New Delhi. *ISBN*: 9780444634085
6. Comprehensive Biotechnology (2004). Moo-Young,M. ed., Vol.I-IV Pergamon Press, Oxford. *ISBN*: 9780444533524.
7. Bioseparation Engineering (2001). Ladisch, M.R., Principle, Practice and Economics. ISBN: 978-0-471-24476-9
8. Food Microbiology (2004). Doyle, M.P., Fundamental and Frontiers. *ISBN*-13: 978-1-55581-407-6
9. Environmental Microbiology (2004). Maier, R.M. *ISBN*-13: 978-0125506564
10. Biotechnology, A text book of Industrial Microbiology (2004). Crueger, W. *ISBN*-13: 978-0878931354

Course Title: Fermentation and Bioprocess Engineering Laboratory

Course Code: BTY526

L	T	P	Credits
0	0	2	1

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

Course Title: Nanobiotechnology

Course Code: BTY636A

L	T	P	Credits
4	0	0	4

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.

Unit I **(8 lectures)**

Nanotechnology & Nanobiotechnology, Molecular biology for drug discovery: Vaccines, Diagnostics and Forensics. Gene therapy: Vectors and other delivery systems for gene therapy Viruses as vectors, Non-viral DNA delivery systems, synthetic particles as vectors.

Unit II **(10 lectures)**

Nanoparticles in biological labeling and cellular imaging: Science of nanoparticles functionalization protein-based nanostructures: Nanomotors: Bacterial (*E. coli*) and Mammalian (Myosin family). Applications of Nano-Materials in Biosystems: Proteins - Lipids - RNA and DNA Protein Targeting - Small molecule/nanomaterial - Protein interactions.

Unit III **(10 lectures)**

Nanomaterial-Cell interactions-Manifestations of surface modification (Polyvalency). 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).

Unit IV **(8 lectures)**

Applications of Nanostructures in Drug: Discovery, delivery, and controlled release Nanotechnology for tissue engineering: Applications in regenerative therapy.

Unit V **(10 lectures)**

Nanostructures in Cancer Research: Examples of nanostructures in research and therapy. Targeted delivery systems: Collodial drug carriers, nanoparticles and liposomes. Bioadhesives, prodrugs. Protein and peptide drug delivery.

Learning outcomes: Students will learn about the Nanomaterials, their structure and application in Biosystems. It will give insights for the fabrication of Nanobiosensors, Nanochips, Nanofluidics, Nanoparticle based drug delivery systems, nanostructures in cancer research and therapy.

Reference Books:

1. Burger's Medicinal Chemistry, Drug Discovery and Development (2010). Abraham, D.J. and Rotella, D.P. 8 Volume Set. 7th Edition. John Wiley & Sons Ltd. Print. *ISBN*: 978-0-470-27815-4.
2. Wilson & Gisvold's textbook of organic medicinal and pharmaceutical Chemistry (2010). Beale, J.M. and Lock, J. 12th Edition. Lippincott Williams & Wilkins. Print. *ISBN*-10: 0781779294.
3. Textbook of Drug Design and Discovery (2002). Liljefors, T., Krogsgaard-Larsen, P. and Madsen, U. 3rd Edition. CRC Press. Print. *ISBN* 9781498702782.
4. Modern Concepts in Nanotechnology (2008).Prasad, S.K. Discovery Publishing House. Print.
5. Nanobiotechnology (2008). Trivedi, P.C. Pointer Publishers. Print. *ISBN*: 81-7132-543-6

Course Title: Project Part-I

Course Code: BTY661

L	T	P	Credits
0	0	0	2

Note: Selection of the students for project will be based upon merit. The students who do not fulfil the criteria for the Project Part-I will opt for seminar. The topics for seminars will be decided by the Department and the students will be evaluated based on their presentation.

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.

Contents:

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

- Title
- Introduction
- Objectives
- Review of Literature
- Materials and Methods
- Expected outcome
- Conclusion/recommendations

Examination Scheme (Weightage in %):

Literature study/ Fabrication/ Presentation	50
Synopsis	25
Question answer session	25

Course Title: Seminar

Course Code: BTY663

L	T	P	Credits
0	0	0	2

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. 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.

Contents of seminar presentation:

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

- Title
- Introduction
- Objectives
- Review of Literature
- Materials and Methods
- Expected outcome
- Conclusion/recommendations

Examination Scheme (Weightage in %):

Presentation	50
Content	30
Question answer session	20

Course Title: Immunology

Course Code: MIC631

L	T	P	Credits
4	0	0	4

Course Objective: The course will give an overview of the field of immunology. The overview includes the history of immunity and its relation to immunology, and the cells and organs that make up the immune system. The students will be able to distinguish and compare innate and adaptive immunity. Students will distinguish the unique cell-based recognition of three major classes of immune system cells. Students will recognize the fundamental properties of techniques based on antigen-antibody interactions.

Unit I **(12 lectures)**

History of immunology. Three fundamental concepts in immunology: Specificity, discrimination of self from non-self and memory. Structure, Functions and origin of Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell and Immune Organs like Bone marrow, Thymus, Lymph Node, Spleen. Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes, Adjuvants, Structure, Types and Functions of antibodies. Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA. Classification of immune system: innate and adaptive components and humoral and cell mediated

Unit II **(10 lectures)**

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). Markers of suppressor / regulatory T cells - CD4+ CD25+

Unit III **(12 lectures)**

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. Complement system. Classical, lectin and alternative pathway for complement activation.

Unit IV **(12 lectures)**

Major cytokines and their role in immune system: TNF, IFN, IL-1, IL-2, IL-4, 1L-6, IL-10, IL-12, IL-17, TGFβ. 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.

Hypersensitivity and allergy. Comparative study of Type I-V hypersensitivities with examples. Vaccines and their modes of production

Learning outcomes: As a result of successfully completing this course, the student will be able to demonstrate a comprehensive and practical understanding of basic immunological principles involved in research and clinical/applied science. Differentiate between innate and adaptive immunity, role of antigen presenting cells, lymphocytes, and phagocytic cells in immune responses. Differentiate between humoral and cell mediated immunity.

Reference Books

1. Basic Immunology: Functions and disorders of the Immune system, Abul K abbas, Andrew H Lichtman and Shiv Pillai
2. Immunology, Kuby, by Kindt, Goldsby, Osborne, Sixth Edition.
3. Immunobiology, The Immune system in Health and Disease, Seventh Edition by Janeway, Travers et al, Garland Publishing, 2008.
4. Research articles and reviews from scientific publications.

Course Title: Approaches for Crop Improvement

Course code: BOT527

L	T	P	Credits
4	0	0	4

Course Objective: To introduce the students about plant breeding, regeneration of plants and genetic variations under artificial conditions. The course will give an overview on Plant cell and tissue culture, Totipotency, Haploids, Synthetic seeds, Microprpagation, Gene approach to plant genetic engineering.

UNIT I **(10 lectures)**

Plant Breeding: Introduction, objectives of plant breeding, genetic variability, green revolution, Domestication and centers of origin of cultivated plants. Systems of reproduction in plants: Reproductive systems, Sexual reproduction - Cross and self-pollination; asexual reproduction, Incompatibility and Male sterility, pollination control mechanisms. Hybridization: Role and methods, Back-cross breeding. Heterosis, Inbreeding depression. Mass and pure line selection. Breeding for resistance: Breeding for biotic and abiotic stresses, physical and chemical mutagens; Gamma gardens.

UNIT II **(12 lectures)**

Plant Cell and Tissue Culture: Principles of plant tissue culture- historical perspectives, Organization of laboratory media composition and preparation, Different types of culture media Cell culture and cell cloning. Cellular totipotency. Somatic embryogenesis and synthetic seeds: Induction and controlling factors. Organogenesis Haploids: Androgenic and gynogenic. Somatic hybridization: Isolation, culture and fusion of protoplasts, Selection of fusion products; regeneration of hybrids and cybrids. Application in biotechnology Clonal propagation: Micropropagation. Somaclonal and gametoclonal variation and their applications.

UNIT III **(12 lectures)**

Micro-propagation: application in horticulture and forestry. Cryopreservation and germplasm storage; Anther and pollen culture and their importance; Isolation, culture and fusion of protoplasts In-vitro production of secondary metabolites from medicinal plant culture; Microbial production of vitamins, organic acids and alcohols. Energy plantations and petro plants. (6 Lectures) Gene Cloning and DNA Analysis in Agriculture History of Genetic modified crops; The gene addition approach to plant genetic engineering; Plants that make their own insecticides; Herbicide resistant crops. Gene subtraction; Antisense RNA and the engineering of fruit ripening. Problems with genetically modified plants; Safety concerns with selectable markers; The terminator technology; The possibility of harmful effects on the environment.

UNIT IV **(12 lectures)**

Recombinant DNA technology: Gene Transfer Methods in Plants (direct gene transfer methods: particle bombardment, electroporation, PEG-mediated); Plant transformation vectors; Cloning vehicles, gene engineering through cutting and joining DNA molecules, restriction endonucleases, ligases, applications of genetic engineering; floral-dip. Cloning vectors for plants: Agrobacterium tumefaciens—nature's smallest genetic Engineer, Using the Ti plasmid to introduce new genes into a plant cell, Production of transformed plants with the Ti plasmid, The Ri plasmid, Limitations of cloning with Agrobacterium plasmids, Cloning genes in plants by direct gene transfer, Direct gene transfer into the nucleus, Transfer of genes into the chloroplast genome, Attempts to use plant viruses as cloning vectors; Caulimo virus vectors, Gemini virus vectors.

Learning outcomes: The course will impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and breeding methods for crop improvement. The studies will acquire the knowledge of regeneration power of a cell and how a single cell can be used to grow disease free plants. Further, the subject will make the students to understand that how an acquired character can be transferred from one plant to another for some specific function.

Reference Books

1. Allard, R. W. Principles of Plant Breeding. John Wiley & Sons, 1981. Print.
2. Chopra, V. L. Breeding Field Crops. New Delhi: Oxford and IBH Pub., 2001. Print.
3. Chopra, V. L. Breeding Field Crops. New Delhi: Oxford and IBH Pub., 2004. Print.
4. Gupta, S. K. Practical Plant Breeding. 2nd ed. Jodhpur: Agrobios (India), 2010. Print.
5. Poehlman, John Milton, and Dhirendranath Borthakur. Breeding Asian Field Crops, with Special Reference to Crops of India. Calcutta: Oxford & IBH Pub., 1969. Print.
6. Roy, Darbeshwar. Plant Breeding: Analysis and Exploitation of Variation. Pangbourne, UK: Alpha Science International, 2000. Print.
7. Bhojwani, S. S., and Razdan, M. K. Plant Tissue Culture: Theory and Practice. Amsterdam: Elsevier ;, 1983. Print.
8. Chawla, H. S. Introduction to Plant Biotechnology. New Delhi: Oxford & IBH Pvt.Ltd., 2002. Print. 9. Hammond, J., McGarvey, P., and Yusibov, V. Plant Biotechnology: New Products and Applications. Berlin: Springer, 2000. Print.
10. Kumar, H.D. A Text Book of Biotechnology.Affiliated East West, Pvt., 2010. Print.

11. Murray, David R. Advanced Methods in Plant Breeding and Biotechnology. Melksham: Redwood Press Pvt.Lmt., 1991. Print.
12. Old, R.W., and Primrose, S.B. Principles of Gene Manipulation: An Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications, 1985. Print.
13. Razdan, M. K. Introduction to Plant Tissue Culture. New Delhi: Oxford and IBH Pvt. Ltd., 1983. Print.
14. Rainert, J. and Yeoman, M.M. Plant Cell and Tissue Culture ; A Laboratory Manual. Berlin: Springer-Verlag, 1982. Print.
15. Street, H. E. Plant Tissue and Cell Culture. London: Blackwell Scientific Publications, 1973. Print.
16. Smith, Roberta H. Plant Tissue Culture: Techniques and Experiments. New York: Academic, 2000. Print.
17. Trevan, M.D., Buffey, S., Goulding, K.H., and Stanbury, P. Biotechnology–The Biological Principles. New: Delhi: Tata McGraw-Hill Publishing Company Ltd., 1988. Print

Course Title: Clinical Microbiology

Course Code: MIC543

L	T	P	Credits
4	0	0	4

Course Objective: The aim of clinical Microbiology course is to introduce basic principles and application relevance of clinical disease, microflora of the human body, Immune system. The content of rigorous course includes many etiological agents responsible for global infectious diseases.

Unit I **(10 lectures)**

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections.

Unit II **(12 lectures)**

Immune system. Types of immunity. Mediators of immunity. Collection, transport and culturing of clinical samples, principles of laboratory diagnosis of infectious diseases. Staining and microscopy. Isolation and identification of causal organism. Selective and differential medium. Growth mediums specific to isolate or differentiate various pathogenic bacteria. Immunologic tests like ELISA, Immunofluorescence, Agglutination based tests, Complement fixation and western blotting. Nucleic acid analysis based tests like PCR, restriction digestion, northern and southern hybridization.

Unit III **(12 lectures)**

Control of microbes. Disinfection, pasteurization and sterilization. Physical and chemical agents to control microbes. Mechanism of action of different agents used to control microbes. Kinetics of microbial killing. Epidemiology of infectious disease. Epidemic, endemic and pandemic with example. Communicable diseases and modes of transmission. Strategies to control epidemics.

Unit IV **(12 lectures)**

History of antibacterial agents. Minimal inhibitory concentration. Bactericidal and bacteriostatic. Laboratory tests for checking antimicrobial activity. Trends in antibiotic and antiviral discovery. Source and spectrum of antibacterial agents. Cell wall biosynthesis inhibitor. Protein synthesis inhibitor. Nucleic acid synthesis inhibitors. Membrane active agents. Antiviral agents. Inhibitors of uncoating, penetration and neuraminidase. DNA polymerase, RNA polymerase and reverse transcriptase inhibitor. Viral protease inhibitor. Prophylactic and curative treatment. Susceptibility and resistance to antimicrobials. Intrinsic

and acquired resistance. Mechanisms of resistance development. Strategies to avoid development and spread of resistance. Vaccines: their types and future trends.

Learning outcomes: The course will impart theoretical knowledge of Normal microflora of the human body, Immune system, Control of microbes and practical knowledge for immunological tests, Student will learn about ELISA, Immunofluorescence, Agglutination based tests, Laboratory tests for checking antimicrobial activity etc,

Reference Books:

1. Basic Immunology: Functions and Disorders of the Immune System (2006-2007). Abbas, A.K., Litchman, A.H., 2nd Ed. (updated edition), Philadelphia, Pennsylvania: W.B. Saunders Company Publishers. *ISBN*-10: 1455707074; *ISBN*-13: 978-1455707072.
2. Immunology: A Short Course (2009). Benjamini, E., Coico, R. and Sunshine, G., 6th Ed., New York, Wiley-Blackwell. ISBN-13: 978-0470081587
3. Essential Immunology (2016). Roitt, I.M., Delves, P. Seamus M. and Burton D., 13th Ed., Willey- Blackwell. ISBN: 978-1-118-41577-1
4. Reba Kanungo (2017) Ananthanarayan and Paniker's Textbook of Microbiology Tenth edition with booklet, Tenth edition, Universities Press.
5. Joanne Willey, Linda Sherwood, Christopher J. Woolverton (2017) Prescott's Microbiology, 10 edition, McGraw-Hill Education.

Course Title: Computational Biology and Bioinformatics

Course Code: BTY635

L	T	P	Credits
3	0	0	3

Course Objective: To train the students in the area of computational biology and bioinformatics, Analysis and processing of data, Bioinformatics databases, Structure prediction methods for biomolecules and application of bioinformatics in fields.

Unit I **(6 lectures)**

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.

Unit II **(5 lectures)**

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).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.

Unit III **(5 lectures)**

Bioinformatics databases, Type of databases, Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases. Protein structure prediction: Protein Secondary Structure Prediction: Secondary Structure Prediction for Globular Proteins, Transmembrane Proteins, Coiled Coil Prediction.

Unit IV **(5 lectures)**

Protein Tertiary Structure Prediction: Methods, Homology Modeling, Threading and Fold Recognition, Ab Initio Protein Structural Prediction, CASP. Sequence motif databases -Pfam, PROSITE, Protein structure databases, Protein Data Bank-SCOP, CATH, KEGG, Chembank, Sequence, structure and function relationship.

Unit V **(5 lectures)**

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.

Learning outcomes: The course will impart theoretical knowledge on nature and scope of Computational Biology and Bioinformatics, Basic Algorithms in Computational Biology, Bioinformatics databases and practical knowledge on Structure Prediction methods of biomolecules. Students will learn about applications of bioinformatics in different fields of sciences.

Reference Books:

1. Bioinformatics: Sequence and genome analysis (2004). D.W. Mount, Cold Spring Harbor Laboratory Press. *ISBN* 978-087969712-9.
2. Bioinformatics: A practical guide to the analysis of genes and proteins (2004). A.D. Baxevanis and BFF Ouellette, Wiley Interscience. *ISBN* 0-471-38391-0
3. Computational Molecular Biology: An Algorithmic Approach (2001). P. A. Pevzner, MIT Press. *ISBN*: 9780262161978
4. Computer Methods for Macromolecular Sequence Analysis (1998). R.F. Doolittle, J.N, Abelson, M.I. Simon, Academic press. *ISBN* 0-935702-54-7
5. Essentials of Genomics and Bioinformatics (2007). C.W. Sensen, John Wiley and Sons Inc. ISBN: 9783527305414.

Course Title: Intellectual Property Rights, Biosafety and Bioethics

Course Code: BTY641

L	T	P	Credits
2	0	0	2

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 i.e. 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.

Unit I **(5 lectures)**

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.

Unit II **(5 lectures)**

Basic requirements of patentability, Patentable subject matter novelty and the public domain, non-obviousness. 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.

Unit III **(4 lectures)**

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.

Unit IV **(5 lectures)**

Public acceptance issues for biotechnology: Case studies/ experiences from developing and developed countries, biotechnology and hunger, challenges for the Indian biotechnological research and industries. Bioethics: Social and ethical implications of biotechnology and biological weapons.

Unit V **(4 lectures)**

Good safety practices, GLP standards, lab contaminants, GMPs, The Cartagena protocol on

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

Learning outcomes: As a result of successfully completing this course, the student will be able to distinguish different IPs. How to apply and documentation for different IPs in India and abroad in the field of Biotechnology. Student will learn about Bioethics, Good safety practices, GLP standards and Biosafety management.

Reference Books:

1. New developments in biotechnology: Patenting life-special report (1990) Office of Technology Assessment (OTA), US Congress (Washington D.C. Dekker). Library of Congress Catalog Card Number 88-600596
2. Evolution of patent laws: "developing countries' perspective" (2006) by D.N. Choudhary, (Capital Law House).
3. Evolution of patent laws: developing countries, perspective / D.N. Choudhary; foreword by S.S. Kang. Delhi: Capital Law House, 2006. 476p.; 24cm. 346.0486 P6 B174893
4. Draft manual of patent practice and procedure (2008) Patent Office, India.
5. Research articles and reviews from publications.

Course Title: Genomics, Proteomics and Metabolomics

Course Code: BTY642

L	T	P	Credits
4	0	0	4

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.

Unit I **(8 lectures)**

Introduction to –omes and –omics. Gene, Genome and Genomics. Whole genome analysis: Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, shotgun libraries. FISH, Sequencing: Conventional sequencing (Sanger, Maxam and Gilbert methods), automated sequencing, analysis of sequence information FISH.

Unit II **(10 lectures)**

Transcriptomics. Microarray, EST, SAGE. Bioinformatical methods in transcriptomics. 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), Single nucleotide polymorphisms (SNP) in medical genetics and basic research.

Unit III **(10 lectures)**

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.

Unit IV **(10 lectures)**

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. Protein structure prediction. The proteome. High throughput proteomics and its use to the biologists.

Unit V **(8 lectures)**

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.

Learning outcomes: As a result of successfully completing this course, the student will have a theoretical as well as practical knowledge for the analysis of whole genome, Bioinformatical methods in transcriptomics, Bioinformatics tools, technologies and application of proteomics and metabolomics.

Reference Books:

1. A primer of genome science (2009). Gibson G. and Muse S. V., (Sinauer Associates, Inc. Sunderland, MA). *ISBN*-13: 978-0878932368
2. Knowledge discovery in proteomics (2006). Igor Jurisica, Dennis Wigle (Chapman & Hall / CRC). ISBN: 9781584884392.
3. Proteomics: From protein sequence to function (2002). Pennington SR, Dunn M. J. (Viva Books Pvt. Ltd). *ISBN* 13: 9788176492904
4. Informatics in proteomics (2005). Srivastava Sudhir (Taylor & Francis Group / CRC). *ISBN*, 1574444808
5. Wiley Encyclopedia of Biomedical Engineering, 6 Volume, (2007). Akay M. (Wiley-Interscience John Wiley & Sons, Inc. Publication, USA). ISBN: 978-0-471-24967-2
6. Essentials of genomics and bioinformatics (2002). Christoph W. Sensen (Wiley-VCH, Weinheim). *ISBN*:3527305416
7. Current protocols in bioinformatics (2004). Baxevanis A.D., Davison, D.B., Page, R.D.M. & Petsko, G.A (John Wiley & Sons, Inc. Publications, New York). *ISBN*: 978-0-471-25093-*7*

Course Title: Food Biotechnology

Course Code: BTY643

L	T	P	Credits
4	0	0	4

Course Objective: To acquaint the students with fundamentals and recent trends in food biotechnology. The course will provide overview on development of novel food and food ingredients, Food fermentation technology, Food spoilage and preservation and packaging of food.

Unit I **(10 lectures)**

Bioreactors in Food Fermentations: Cultivation of microorganisms, Instrumentation regulation and process control, Laboratory scale submerged and solid state fermentation, Pilot scale submerged and solid state fermentation.

Unit II **(10 lectures)**

Development of Novel Food and food Ingredients Single cell protein, Polysaccharides, Low calorie sweeteners, Naturally produced flavor modifiers, Amino acids, Vitamins, Food supplements, Food coloring, Neutraceuticals, Water binding agents

Unit III **(8 lectures)**

Food Fermentation Technology : Origin, scope, and development of fermented products, Primary feed stock, raw materials and conversions, Fermented food and microbial starters, Commercial potential, Food fermentation industries, their magnitude, R & D innovations

Unit IV **(10 lectures)**

Food Spoilage and Preservation: General principle of spoilage, Microbial toxins (endotoxins and exotoxins), Contamination and preservation, Factors affecting spoilage, Methods of food preservation (Thermal processing, Cold preservation, Chemical preservatives, food dehydration, Food irradiation, Biological control), Monitoring of food quality

Unit V **(10 lectures)**

Packaging of Food: Need for packaging, Requirements for packaging, Containers forpackaging (Glass, Metal, Plastics, Moulded pulp and Aluminium foil), Dispensing devices.

Learning outcomes: As a result of successfully completing this course, the student will have a theoretical as well as practical knowledge for the appropriate use of bioreactor and fermentor for lab as well as pilot scale submerged and solid state fermentation for the production of various food products, R & D innovations, food preservation and packaging.

Reference Books:

1. Biotechnology: Food Fermentation Vol I and II, Eds. V. K. Joshi and A. Pandey. ISBN 13: 9788187198055
2. Food Processing: Biotechnological Applications- Eds. S. S. Marwaha and J. K. Arora *ISBN* 81-87680-04-0.
3. Research articles and reviews from scientific publications.

Course Title: Virology

Course Code: BTY681

L	T	P	Credits
4	0	0	4

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.

Unit I **(10 lectures)**

History and development of virology, taxonomy of viruses (earlier classification systems) and viroids, significance of virology and latest ICTV classification of viruses. Origin and evolution of viruses. Principles of biosafety, containment facilities, maintenance and handling of laboratory animals and plants.

Unit II **(8 lectures)**

Propagation, purification, characterization, identification and genomics of viruses. Methods of virus diagnosis, detection, assays and comparison of their sensitivities. Structure of viruses and methods employed in structural and functional genomics of the viruses.

Unit III **(10 lectures)**

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. Microbial viruses: Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses. Virus-like agents: Prions, satellite DNAs and RNAs, satellite viruses; defective interfering particles and virophages.

Unit IV **(10 lectures)**

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.

Unit V **(8 lectures)**

Anti-viral strategies: prevention and control of viral diseases. Introduction to recent trends in management and control of viral diseases. Introduction to applications of plant and animals viruses.

Learning outcomes: The course will impart theoretical knowledge on taxonomy and latest ICTV classification of viruses. Students will learn about Symptoms of plant virus diseases,

transmission, Virus replication Strategies. Anti-viral strategies: prevention and control of viral diseases.

Reference Books:

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses (2003). Flint, S.J., Enquist, L.W., Racaniello, V.R. and Skalka, A.M. 2nd Edition, ASM Press, Washington, DC. Print. *ISBN*: 978-1-55581-479-3.
2. Introduction to Modern Virology (2007). Dimmock, N., Easton, A. and Leppard, K.6th Edition. Wiley-Blackwell. Print. ISBN-13: 978-1405136457
3. Basic Virology (2007). Wanger, E.K., Hewiett, M., Bloom, D. and Camerini, D. 3rd edition, Wiley-Blackwell. Print. ISBN : 978-1-4051-4715-6
4. Principles of Molecular Virology (2011). Cann, A.J. 5th Edition. Elsevier Academic Press. Print. *ISBN:* 9780123849397, 9780123851741
5. Plant Virology (2013). Hull, R. 5th Edition. Academic Press. Print. *ISBN* 9780123848710, 9780123848727.
6. Principles of Molecular Virology (2001). Alan J. Cann, 3rd edition, Elsevier Academic Press. *ISBN* 9780080886909
7. Plant Virology (2002). Roger Hull, 4th edition, Academic press. 978-0-12-361160-4.

Course Title: Medical Biotechnology

Course Code: BTY682

L	T	P	Credits
4	0	0	4

Course objectives: The aim of clinical Microbiology course is to introduce basic principles on immune cells and cellular response. The course will give knowledge on Infection and immunity, Vaccine development and overview on Stem cells & tissue engineering and their clinical applications.

Unit I **(8 lectures)**

Introduction: Cells of immune system; innate and acquired immunity; primary and secondary organs; antigens: chemical and molecular nature; haptens; adjuvants; types of immune responses; theory of clonal selection.

Unit II **(10 lectures)**

Cellular responses :Development, maturation, activation and differentiation of T-cells and B-cells; TCR; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions; monoclonal antibodies: principles and applications; antigen presenting cells; major histocompatibility complex; antigen processing and presentation; regulation of T-cell and B-cell responses.

Unit III **(10 lectures)**

Infection and immunity :Injury and inflammation; immune responses to infections: immunity to microbs; allergy and hypersensitivity; Vaccine development; recombinant vaccines and clinical applications. AIDS and Immunodeficiencies; resistance and immunisation.

Unit IV **(8 lectures)**

Stem cells & tissue engineering and their clinical applications:Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells.

Unit V **(10 lectures)**

Concept of tissue engineering, Recombinant therapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone. Autoimmunity: Autoimmunity, Autoimmune disorders and diagnosis.

Learning outcomes: The course will impart theoretical knowledge on immune cells and cellular response. Students will get knowledge on Stem cells & tissue engineering, Recombinant therapy; Clinical applications of recombinant technology.

Reference Books:

1. Basic Immunology: Functions and Disorders of the Immune System (2006-2007). Abbas, A.K., Litchman, A.H., 2nd Ed. (updated edition), Philadelphia, Pennsylvania: W.B. Saunders Company Publishers. *ISBN*-10: 1455707074; *ISBN*-13: 978-1455707072.
2. Immunology: A Short Course (2009). Benjamini, E., Coico, R. and Sunshine, G., 6th Ed., New York, Wiley-Blackwell. ISBN-13: 978-0470081587
3. Essential Immunology (2016). Roitt, I.M., Delves, P. Seamus M. and Burton D., 13th Ed., Willey- Blackwell. ISBN: 978-1-118-41577-1
4. Animal Cell Biotechnology (1994). Spier, R.R. and Griffttths, J.B., 6th Ed., Academic Press, London. Animal Cell Biotechnology (1994). Spier, R.R. and Griffttths, J.B., 6th Ed., Academic Press, London.
5. Textbook of Drug Design and Discovery (2009). Krogsgaard-larsen P. , Liljefors T., Madsen U. and Larsen K, Liljefors T. Madsen U., Taylor and Francis Publications, Washington D.C. 4th ed. *ISBN* 9781420063226.

Course Title: Plant Stress Biology

Course code: BTY683

L	T	P	Credits
4	0	0	4

Course objectives: The course will cover principles of plant physiology and biochemistry as affected by abiotic and biotic stress. The course will include a brief review of the basic principles of plant physiology and effects of various stresses on the growth and development of plants

Unit I **(8 lectures)**

Defining plant stress: Acclimation and adaptation

Unit II **(10 lectures)**

Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

Unit III **(8 lectures)**

Role of nitric oxide: Calcium modulation, Phospholipid signaling

Unit IV **(12 lectures)**

Developmental and physiological mechanisms that protect plants against environmental stress: Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; osmotic adjustment; Compatible solute production.

Unit V **(6 lectures)**

Reactive oxygen species: Production and scavenging mechanisms

Learning outcomes: The course will impart theoretical knowledge on principles of plant physiology affected by abiotic and biotic stress. Students will learn about various mechanisms that protect plants against environmental stresses.

Reference Books:

1. Introduction to Plant Physiology (2008) 4th ed., Hopkins, W.G. and Huner, A. John Wiley and Sons, (U.S.A). *ISBN* 978-0-470-24766-2.
2. Plant Physiology and Development (2015) Taiz, L., Zeiger, E., Muller, I.M. and Murphy, A. ISBN: 9781605352558.
3. Research articles and reviews from scientific publications.

Course Title: Enzymology

Course code: BTY637

L	T	P	Credits
4	0	0	4

Course objective: This course provides a comprehensive understanding of the enzymes and techniques to be used in enzyme technology. The course also introduces students to basic and advanced enzymology.

Unit I **(10 lectures)**

Introduction to Enzymes : Classification of enzymes – Mechanisms of enzyme action – Concept of active site and energetics of enzyme substrate complex formation – Specificity of enzyme action – Principles of catalysis – Collision theory and transition state theory – Role of entropy in catalysis.

Unit II **(10 lectures)**

Kinetics of Enzyme Action, Kinetics of single substrate reactions; estimation of Michelis-Menten parameters – Multisubstrate reactions – Mechanisms and kinetics – Turnover number LB Plot.

Unit III **(8 lectures)**

Enzyme Inhibition, Types of inhibition and models for substrate and product – Allosteric regulation of enzyme – Monod Changeux Wyman model – pH and temperature effect on enzymes & deactivation kinetics.

Unit IV **(10 lectures)**

Enzyme Immobilization and Biosensors, Physical and chemical techniques for enzyme immobilization – Adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding and suitable examples – Advantages and disadvantages – Design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.

Unit V **(8 lectures)**

Purification and Characterization of Enzymes From Natural Sources, Production and purification of crude enzyme extracts from plant, animal and microbial sources – Methods of characterization of enzymes – Development of enzymatic assays.

Learning outcomes: The course will impart theoretical knowledge on Classification of enzymes. Students will learn about the kinetics of Enzyme Action, Enzyme Inhibition, Enzyme Immobilization and Biosensors. Students will get the practical knowledge on Purification and Characterization of Enzymes.

Reference Books:

1. Enzymes (Trevor Palmer)
2. Biochemistry (2004). Voet D & Voet JG, , 3rd Edition, John Wiley & Sons Inc., Singapore
3. Lehninger Principles of Biochemistry (2008).Nelson DL & Cox M.M., , 5th Edition, WH Freeman & Company, New York.

Project Part II

Course Code: BTY662

L	T	P	Credits
0	0	0	8

Note: The students who do not qualify for Project Part I (BTY661) will not be able to take up Project Part II and they will have to pass two departmental elective courses of equal credits.

Course Objective:

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 report 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 report should be comprehensive and should 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 & Evaluation

The report preparation and evaluation will be as per DAV University guidelines.

Assessment:

For Theory Courses:

Mid Semester Examination (MSE)	25 Marks
Written Quiz (Objective Type MCQs)	10 Marks
Assignment/ Project Work/Seminar (evidence based)	10 Marks
End Semester Examination (ESE)	50 Marks
Attendance	5 Marks

For Practical Courses:

End Semester Practical Exam	80 Marks
Continuous Assessment	20 Marks

Question Paper pattern for Mid Semester Examination (MSE)

DAV University, Jalandhar.
(Term-…….)

MSE
Month, Year

Name: ……..... **Regd. No.: ……**

Course Code: BTYXXX **Time: 1 Hour 30 Minutes**

Course Name: ……. **Maximum Marks: 25**

Section – A **(Maximum Marks: 1 x 5 = 5)**

All Questions are compulsory.

Very Short Answer Type: Each question should be answered within 5-8 lines.

Q.1 Write short notes on:

i.
ii.
iii.
iv.
v.

Section – B **(Maximum Marks: 4 x 3 = 12)**

Short Answer Type: Attempt any **3 Questions out of 5 Questions** and each question should be answered in maximum 2 pages

Q.2
Q.3
Q.4
Q.5
Q.6

Section – C **(Maximum Marks: 8 x 1 = 8)**

Long Answer Type: Attempt **1 Questions out of 2 Questions** and each question should be answered in maximum 4 pages.

Q. 7
Q. 8.

DAV UNIVERSITY, JALANDHAR

Question Paper pattern for End Semester Examination (ESE)

DAV University, Jalandhar. **(Term-…….)**	**ESE** **Month, Year**
Name: ……..	**Regd. No.: ……**
Course Code: BTYXXX	**Time: 3 Hours**
Course Name: ……	**Maximum Marks: 50**

Section – A **(Maximum Marks: 1 x 10 = 10)**

All Questions are compulsory.

Very Short Answer Type: Each question should be answered within 5-8 lines.

Q.1 Write short notes on:

i.
ii.
iii.
iv.
v.
vi.
vii.
viii.
ix.
x.

Section – B **(Maximum Marks: 4 x 6 = 24)**

Short Answer Type: Attempt any **6 Questions out of 8 Questions** and each question should be answered in maximum 2 pages

Q.2
Q.3
Q.4
Q.5
Q.6
Q. 7
Q. 8.
Q. 9.

Section – C **(Maximum Marks: 8 x 2 = 16)**

Long Answer Type: Attempt **2 Questions out of 4 Questions** and each question should be answered in maximum 4 pages.

Q.10
Q.11
Q.12
Q.13