Annexure-I

COURSE CURRICULUM AND SCHEME OF EXAMINATION

Under
Choice Based Credit System

For

M. Sc. (Biotechnology)

(w.e.f Academic Session 2016-17 (3rd and 4th Semester) & 2017 – 2018)

Department of Biotechnology
Chaudhary Devi Lal University
Sirsa – 125 055

M.Sc. Biotechnology (1st Semester)									
Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	BT-101	Basic Microbiology	CC	4	4	30	70	100	3
2	BT-102	Structure and function of biomolecules	CC	4	4	30	70	100	3
3	BT-103	Cell Biology	CC	4	4	30	70	100	3
4	BT-104	Microbial Biotechnology	CC	4	4	30	70	100	3
5	BT-105	Biotechnology and Human Welfare-I	OEC	4	4	30	70	100	3
6	BT-106	Lab – I Microbial Biotechnology	CC	4	8	--	100	100	6 Two sessions of 3 Hrs. each
7	BT-107A	Lab – II Microbiology	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	BT-107B	Lab – II Biochemistry		4	8	--	100	100	6 Two sessions of 3 Hrs. each
Total				28	44	120	480	600	

*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

M.Sc. Biotechnology (2nd Semester)									
Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	BT-201	Genetic Engineering	CC	4	4	30	70	100	3
2	BT-202	Intermediary Metabolism	CC	4	4	30	70	100	3
3	BT-203	Genetics	CC	4	4	30	70	100	3
4	BT-204A	Plant Biotechnology	CEC (Any One)	4	4	30	70	100	3
	BT-204B	Animal Biotechnology		4	4	30	70	100	3
5	BT-205	Biotechnology and Human Welfare-II	OEC	4	4	30	70	100	3
6	BT-206	Lab – III Genetic Engineering	CC	4	8	--	100	100	6 Two sessions of 3 Hrs. each
7	BT-207 A	Lab – IV Plant Biotechnology	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	BT-207 B	Lab – IV Animal Biotechnology		4	8	--	100	100	6 Two sessions of 3 Hrs. each
Total				28	48	90	410	500	

*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

M.Sc. Biotechnology (3rd Semester)									
Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	BT-301	Bioinformatics and Biostatistics	CC	4	4	30	70	100	3
2	BT-302	Biosafety, Bioethics and IPR	CC	4	4	30	70	100	3
3	BT-303	Molecular Biology	CC	4	4	30	70	100	3
4	BT-304 A	Biophysical Techniques and Nanotechnology	CEC (Any One)	4	4	30	70	100	3
	BT-304 B	Enzyme Technology		4	4	30	70	100	3
5	BT-305	Lab – V Bioinformatics and Biostatistics	CC	4	8	--	100	100	6 Two sessions of 3 Hrs. each
6	BT-306 A	Lab – VI Cell and Molecular Biology	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	BT-306 B	Lab – VI Advanced techniques in Biotechnology		4	8	--	100	100	6 Two sessions of 3 Hrs. each
7	BT-307	Summer Training**	CC	2	2	25	25	50	To be evaluated by Internal and External examiners
Total				26	46	145	505	650	

*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

** = Six week compulsory training after second semester examination (Students have to submit their training report upto 31st March)

M.Sc. Biotechnology (4th Semester)									
Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	BT-401	Immunology	CC	4	4	30	70	100	3
2	BT-402A	Bioprocess Technology	CEC (Any One)	4	4	30	70	100	3
	BT-402B	Environmental Biotechnology		4	4	30	70	100	3
3	BT-403 A	Agricultural Biotechnology	CEC (Any One)	4	4	30	70	100	3
	BT-403 B	Medical Biotechnology		4	4	30	70	100	3
4	BT-404	Lab – VII Immunology	CC	4	8	--	100	100	6 Two sessions of 3 Hrs. each
5	BT-405 A	Lab – VIII Bioprocess Technology	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	BT-405 B	Lab – VIII Environmental Biotechnology		4	8	--	100	100	6 Two sessions of 3 Hrs. each
6	BT-406	Seminar	CC	2	2	50	--	50	To be evaluated by a committee of two members
Total				22	46	170	480	650	

*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

M. Sc. (Biotechnology) – 1st Semester
BT – 101 – Basic Microbiology (Core Course)

Credits: 4 **Marks: 100**
Time: 3 Hrs. **Theory: 70**
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

History of Microbiology: Discovery of the microbial world. Development of microbiology in the twentieth century. Scope of microbiology.

Microbial Systematics and Taxonomy: Microbial Taxonomy- Criteria used including biochemical and molecular biological tools. Characteristics of primary domains. Microbial phylogeny and current classification of bacteria (Bergey's Manual).

Microbial Diversity: Prokaryotic and Eukaryotic cells. Morphology and cell structure of major groups of microorganisms *e.g.* archaea, bacteria, fungi, algae, protozoa and viruses. Classification of viruses. Retroviruses, viroids and prions.

Unit – II

Cultivation and Maintenance of Microorganism: Methods of isolation, purification and preservation of microorganisms. Theory, principles and methods of sterilization.

Concepts of Microbial Nutrition: Culture media, requirement for carbon, nitrogen, phosphorus, sulfur and growth factors. Nutritional categories of microorganisms.

Control of Microorganism: Physical and Chemical agents.

Unit – III

Microbial physiology: Definition of growth. Growth curve and generation time. Mathematical expression of growth. Measurement of microbial growth and factors affecting growth. Synchronous, batch, fed batch and continuous cultures, bacterial endospores.

Bacterial genetics: Transformation, conjugation, transduction, recombination, plasmids and transposons.

Unit – IV

Host-Parasite Relationship: Normal microflora of skin, oral cavity, gastrointestinal tract. Entry of pathogen into the host: colonization and factors predisposing to infections. Types of toxins (exo-, endo- and enterotoxins), their structure and mode of action. Virulence and pathogenesis.

Microbial Diseases: Disease reservoirs. Infectious disease transmission. Diseases caused by bacteria and viruses: Tuberculosis, Rabies, Plague, Dengue, Swine flu, Rickettsias, Lyme disease, Malaria, food and water borne human diseases.

Text/References Books:

1. Microbiology 9th Revised Edition. Prescott L.M.; Harley J.P. (2013) Tata McGraw Hill, USA.
2. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. (2010) Tata McGraw Hill, New Delhi.
3. Brock Biology of Microorganisms 14th Edition. Madigan, M.T.; Martinko, J. M. and Parker, J. (2015), Prentice Hall, New Jersey.
4. General Microbiology. Stainer, R.Y.; Ingraham, J.L.; Wheelis, M.L. and Painter, P.R. (2003) The MacMillan Press.
5. Tortora, G.J., Funke, B.R., Case, C.L. (2012) Microbiology -An Introduction, 11th Edition, Pearson education Pvt. Ltd. Singapore.
6. Microbiology: Principles and Explorations, 8th Ed. J.G. Black (2005) John Wiley & Sons Inc.

M. Sc. (Biotechnology) – 1st Semester
BT – 102- Structure and Function of Biomolecules (Core Course)

Credits: 4 **Marks: 100**
Time: 3 Hrs. **Theory: 70**
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Biomolecules: An introduction, general structure of biomolecule.
Carbohydrates: Structure, occurrence and biological importance of important monosaccharides, oligosaccharide and polysaccharide. Ring structure and anomeric forms, mutarotation, reactions of monosaccharides, homo and hetero polysaccharides and mucopolysaccharides.

Unit – II

Amino acid and proteins: Structure and properties of amino acids. Essential and nonessential amino acids, peptide bond. Type of proteins and their classification. Forces stabilizing protein structure and shape. Different levels of structural organization of proteins. Structure of hemoglobin and myoglobin.

Unit – III

Lipids: Classification, structure of lipids and their general function. Essential fatty acids. Hydrolysis of fats, sponification value, rancidity of fats iodine number and acid value. Cholesterol-its structure and biological function.

Unit – IV

Nucleic acids: Structure and properties of purine and pyrimidine bases. Nucleosides and nucleotides. Biologically important nucleotides. Double helix model of DNA structure, structural polymorphism of DNA [A, B & Z] and RNA. Biological function of nucleotides.
Vitamins: Structure and biochemical roles of water soluble vitamins and coenzymes.

Text/References Books:

1. Lehninger; Principle of Biochemistry, 6th Edition by David L. Nelson and M.M Cox [2013] Free and company. New York.
2. Fundamental of Biochemistry. D. Voet and J. G. Voet [2013] John Wiley and Sons New York.
3. Biochemistry 8th Edition by L. Stryer [2015], W.H Freeman and New York
4. Biochemistry 6th Edition by R.H Garrett and C.M. Grisham [2017] Saunders college Publishing, New York
5. Biochemistry 4th edition by G. Zubay [1998] Wm .C Brown Publishers.
6. Outline of Biochemistry by Conn E.E, Stumpf P.K. Bruening G. and Dvi R.H [1999] John Wiley and Sons Inc New York and Toronto.
7. Biochemistry by J.L. Jain (2004) S. Chand & Company Ltd.

M. Sc. (Biotechnology) – 1st Semester
BT – 103- Cell Biology (Core Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Structural organization of cell and subcellular organelles: Size, shape complexity and functions of various types of cells, structural organization and diversity of eukaryotic and prokaryotic cells. Microscopic techniques for study of cell.

Unit-II

Cell organelles-Plasma membrane, cell wall and their structural organization, Transport of nutrients, ions, and macromolecules across membranes
Cell motility-cilia, flagella of eukaryotes and prokaryotes

Unit-III

Cellular energy transactions: role of mitochondria and chloroplast
Cellular response to environmental signals in plants and animals – mechanisms of signal transductions. Intracellular protein localization and transport.

Unit-IV

Cell cycle: molecular events and model systems
Cellular basis of differentiation and development – gametogenesis and fertilization.
Cancer: types of tumors, characteristics of cancerous cell, etiology and clinical evaluation, oncogenes, tumor suppressor genes, function and mechanism of action of pRB and p53 tumor suppressor proteins, cancer and the cell cycle, programmed cell death (apoptosis).

Text/Reference Books:

1. Molecular biology of cell 6th Edition Alberts, Bruce; Watson, JD (2015) Garland Science Publishing, New York.
2. Molecular cell biology 8th Edition, Lodish, H.; Berk, A.; Matsudaira, P.; Kaiser, C.A.; Krieger, M. *et al.* (2016) W.H. Freeman and Co., New York.
3. Cell and Molecular Biology 8th Edition, Robertis, EDP De & Robertis, EMF De (2002) lippincott Williams & Wilkins international student edition, Philadelphia.
4. Cell and Molecular Biology: concepts and experiments. Karp, Gerald (2012) John Wiley and sons, New York.
5. The Cell-a molecular approach, 3rd ed Cooper, GM and Hausman, RE (2004) ASM Press, Washington DC.
6. Lehninger; Principle of Biochemistry, 6th Edition by David L. Nelson and M.M Cox [2013] Free and company. New York.
7. Cell Biology: Organelle structure and function, Sadava, DE (2004) Panima pub., New Delhi

M. Sc. (Biotechnology) – 1st Semester

BT – 104 - Microbial Biotechnology (Core Course)

Credits: 4 **Marks: 100**

Time: 3 Hrs. **Theory: 70**

IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Microbial Biotechnology: Scope, application and challenges

Industrially important microbes: Ecological approaches to isolation, screening for new metabolites, test systems, inoculum development of industrially important microorganisms. Improvement of industrially important microorganisms, selection of mutants, use of rDNA technology

Unit – II

Vaccines: Types of vaccines and their production.

Process technology for the Production of various Products: Production of alcoholic beverages (wine and beer), vitamins, enzymes (amylase and protease) and their applications

Unit – III

Isolation and purification of Enzymes: Extraction of enzymes, preparation of crude enzymes, purification of enzymes, processing of enzymes.

Single Cell protein (SCP): Introduction, conventional protein source, substrates, microorganisms used, SCP from CO_2, carbohydrates, hydrocarbons.

Unit – IV

Microbes and Microbial Genomics for Industry: Analysis of microbial genomes and their use for designing. Microbial transformations, transformation of steroids, L-ascorbic acid and antibiotics. Microbes in paper industry, biohydrometallurgy and biomineralization.

Molecular Breeding of Biosynthetic pathways: Metabolic engineering for carotenoid, polyhydroxy- alkanoates and alkaloid biosynthesis. Pathway analysis, metabolic control analysis, metabolomics.

Text/references books:

1. Biotechnology and Genomics. Gupta, P.K. (2004) Rastogi Publications, Meerut, India.
2. Principles of fermentation technology- 3rd Edition, Stanbury, P.F., Whitaker, A. and Hall, S.J. (2016), Elsevier.
3. Manual of Industrial Microbiology and Biotechnology – second edition. Demain, A. L. and Davies, J.E. (2004) American Society for Microbiology Press, USA.
4. Industrial Microbiology - An introduction. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, A.G. (2014) Blackwell Science Ltd. France.
5. Biotechnology – A text book of industrial microbiology (Second Edition) Crueger, W and Crueger, A. (2004) Panima Publishing Corporation, New Delhi.
6. Principles of Gene Manipulations 6th Edition. Primrose S.B.; Twyman, R. and Old B. (2002) Blackwell Publishing.

M. Sc. (Biotechnology) – 1st Semester

BT – 105 – Biotechnology and Human welfare – I (Open Elective Course)

Credits: 4 **Marks: 100**
Time: 3 Hrs. **Theory: 70**
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Biotechnology: Introduction, scope, application, social and ethical issues in biotechnology.
Microbial Biotechnology: Introduction to microorganisms (bacteria, fungi, algae and virus), fermented food, SCP, ethanol, vitamins, probiotics and prebiotics.

Unit – II

Environment Biotechnology: Role of biotechnology in waste water treatment and solid waste management, Overview of Bioremediation, Biofertilizers, Biopesticides and Biofuels.

Unit – III

Animal Biotechnology: *In-vitro* fertilization and embryo transfer in humans and livestock, animal cloning and its applications.

Unit – IV

Food Biotechnology: An overview, importance and scope.
Protein engineering its methods, Targets and applications in foods. Impact of Biotechnology on microbial testing of foods-current/traditional methodology and new approaches.

Text/References Books:

1. http://patentoffice.nic.in
2. Salar et al. (2013) Biotechnology: Prospects and Applications. Springer, Germany.
3. Principles of fermentation technology- 3rd Edition, Stanbury, P.F., Whitaker, A. and Hall, S.J. (2016), Elsevier
4. Biotechnology – A text book of industrial microbiology (Second Edition) Crueger, W and Crueger, A. (2004) Panima Publishing Corporation, New Delhi.
5. Animal Biotechnology: Muray Moo Young (1989) Pergamon Press, Oxford.
6. Yadav, P.R. and Tyagi, R. (2006) Environmental Biotechnology. Discovery Publishing House, New Delhi.
7. Das H.K. (2004), Textbook of Biotechnology, Willey Dreamtech. Pvt. Ltd, New Delhi.
8. Kumar H.D. (2004), A Text Book of Biotechnology, Eastern Willey Press, New Delhi.
9. Gupta P.K. (2010), Biotechnology & Genomics, 5th Reprint, Rastogi Publications Meerut.
10. Singh B.D. (2010), Biotechnology, 4th edition, Kalyani Publication.

M. Sc. (Biotechnology) – 1st Semester
Laboratory – I
BT – 106 – Microbial Biotechnology (Core Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. General Laboratory-safety and Bio-safety measures in microbial biotechnology laboratory.
2. Introduction to various instruments and their working principles used in microbial biotechnology.
3. Isolation of industrially important microorganisms for microbial processes.
4. Production of various products in the lab. Alcohol and wine.
3. Comparative studies of ethanol production using different substrates.
4. Microbial production of citric acid using *Aspergillus niger*.
5. Microbial production of antibiotics (Penicillin) and testing of antimicrobial activity.
6. Isolation of streptomycin resistant mutants.
7. Isolation of U.V. induced auxotrophic mutants.
8. The Ames test: for detecting potential carcinogens.
9. Isolation of rhizobia from root nodules.
10. Production and estimation of alkaline proteases.
11. Production of Sauerkraut by fermentation.

Text/References Books:

1. Experiments in Microbiology, Plant Pathology and Biotechnology 4th Edition. Aneja, K.R. (2010) New Age International Publishers, New Delhi.
2. Microbiology – a laboratory manual 4th edition. Cappuccino J. and Sheeman, N. (2000) Addison Wesley, California.
3. Environmental Microbiology – A laboratory manual 3rd Edition. Pepper, I.L.; Gerba, C.P. and Brendecke, J.W. (2015) Academic Press, New York

M. Sc. (Biotechnology) – 1st Semester
Laboratory – II
BT – 107 A – Microbiology (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Introduction to various instruments and their working principles used in microbiology laboratory.
2. **Microscopy:** Care, handling and use of microscopes
3. **Micrometry:** Calibration, microscopic measurement of microorganisms.
4. **Staining methods**
5. **Preparation of liquid and solid culture media for growth of microorganisms.**
6. **Pure Culture Techniques:** Streak plate, pour plate, spread plate. Preparation of slants and stab cultures. Storage of microorganisms
7. **Isolation and enumeration of microorganisms from soil and water.**
8. **Measurement of microbial growth and study of effect of various factors on growth of microorganisms:** temperature, pH, U.V. and carbon and nitrogen sources on growth.
9. **Biochemical characterization of selected microbes.**
10. **Milk Microbiology**- SPC, testing the quality of milk.

Text/References Books:

1. Experiments in Microbiology, Plant Pathology and Biotechnology 4th Edition. Aneja, K.R. (2010) New Age International Publishers, New Delhi.
2. Microbiology- a laboratory manual 4th edition. Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.
3. Environmental Microbiology – A laboratory manual. Pepper, I.L.; Gerba, C.P. and Brendecke, J.W. (2015) Academic Press, New York.
4. Introductory practical biochemistry by S. K. Sawhney and Randhir Singh (2000)-Narosha Publishing House, New Delhi.

M. Sc. (Biotechnology) – 1st Semester
Laboratory – II
BT – 107 B – Biochemistry (Core Elective Course)

Credits: 4 **Marks: 100**
Duration of exam: (3+3 hour)

1. Introduction to various instruments and their working principles used in biochemistry laboratory.
2. Qualitative estimation of amino acid and protein
3. Qualitative estimation of lipids.
4. Qualitative estimation of carbohydrates.
5. Quantitative estimation of protein by Lowry's method.
6. Determination of total soluble sugars by ferricynide method.(Volumetric procedure)
7. Separation of various components in the different lipid fraction by thin layer chromatography.
8. To measure the activity of enzyme (alpha amylase)/ any other.
9. To study the effect of temperature on enzyme activity.
10. To study the effect of substrate conc. on enzyme activity.

Text/References Books:

1. Experiments in Microbiology, Plant Pathology and Biotechnology 4th Edition. Aneja, K.R. (2010) New Age International Publishers, New Delhi.
2. Introductory practical biochemistry by S. K. Sawhney and Randhir Singh (2000)-Narosha Publishing House, New Delhi.
3. Principles and techniques of practical biochemistry by K. Wilson and Wolker (1994) Cambridge University Press, Cambridge.
4. An introduction to practical biochemistry by David T. Plummer (1988) Tata McGraw Hill, Book Company, U.K.

M. Sc. (Biotechnology) –2nd Semester
BT – 201 – Genetic Engineering (Core Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Introduction: Historical background, Restriction enzymes and modifying enzymes, Restriction mapping, construction of chimaeric DNA-staggered cleavage, Addition of poly dA and dT tails, Blunt end ligation. Molecular probes and its preparation, labeling of probes, applications of molecular probes, Molecular markers its type and applications.

Vehicles for gene cloning- Plasmids, Bacteriophages, cosmids and phasmids as vectors, (Construction and characterization), Agrobacterium as vector system – Binary and co-integrate vectors, Artificial chromosome as vectors (YAC, BAC, MAC), Direct gene transfer methods, Plant and animal viruses as vectors.

Unit – II

Cloning strategies and recombinant selection- Cloning strategy, methods of gene isolation, Construction of genomic and cDNA library, chromosome walking, chromosome jumping, Map based cloning, different screening methods (genetic method, immunochemical method, nucleic acid hybridization method), Hybrid release translation (HRT), Hybrid arrested translation (HART).

How to study gene regulation? DNA transfection, Polymerase chain reaction, Northern blot, western blot, primer extension, S1 mapping, RNase protection assay, Reporter assays.

Unit – III

Expression strategies for heterologous genes: Chromosome engineering, vector engineering and codon optimization, host engineering, *in vitro* transcription and translation, expression in prokaryotes and eukaryotes.

Phage display technology, T-DNA and Transposon tagging.

Unit – IV

Processing of recombinant proteins: Purification, refolding and characterization of recombinant proteins.

Transgenic and gene knockout technologies.

Gene therapy: Vector engineering strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene silencing.

Text/Reference Books:

1. Brown TA (2011) Genomes. John Wiley, New York.
2. Watson JD (2009) A passion for DNA: Genes, Genomes & Society. Cold spring harbor laboratory press (CSHL).
3. Brown T.A. (2010), Gene Cloning & DNA Analysis, 6nd Edition, Wiley-Blackwell, New York.
4. Glover DM and BD Hames (1995) DNA cloning: A practical Approach, IRL press, Oxford.
5. Sambrook J, EF Fritech and Maniatis T. (2000) Molecular cloning: A laboratory Manual, cold spring Harbor Laboratory Press, New York.
6. Old and Primrose (1995) Principles of gene manipulation, Blackwells Publishers.

M. Sc. (Biotechnology) –2nd Semester
BT – 202 – Intermediary Metabolism (Core Course)

Credits: 4 **Marks: 100**
Time: 3 Hrs. **Theory: 70**
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Metabolic concept: Metabolism and its type, Intermediary metabolism, Function of metabolism.
Carbohydrate metabolism: Glycolysis, Fate of pyruvate under aerobic and anaerobic condition. Pentose Phosphate pathway and its significance. Gluconeogenesis pathway. Biosynthesis of lactose, sucrose and starch, Glycogenolysis, glycogenesis and control of glycogen metabolism. Maintenance of blood glucose level. Glyoxylate cycle.

Unit – II

Lipid metabolism: Beta-oxidation of saturated fatty acid, oxidation of unsaturated and odd carbon fatty acids, Alpha and omega oxidation of fatty acid. Formation and utilization of keton bodies. Degradation of triacylglycerols by lipases. Biosynthesis elongation and desturation of saturated fatty acids. Biosynthesis of triacylglycerols, phospholipids and cholesterol.

Unit – III

Amino Acids Metabolism: General reaction of amino acid metabolism –transamination, oxidative and non-oxidative deamination and decarboxylation. General pathways of amino acids degradation. Urea cycle and its regulation.
Nucleic acids metabolism: Catabolism, de novo-biosynthesis and regulation of purine and pyrimidine nucleotide. Salvage pathway. Formation of deoxyribonucleotides.

Unit – IV

Mitochondrial oxidative phosphorylation: Mitochondrial electron transport chain. Hypothesis of mitochondrial oxidative phosphorylation. Inhibitors and uncouplers of oxidative phosphorylation.
Integration of metabolism: Basic concept.

Text /References Books:

1. Lehninger; Principle of Biochemistry, 6th Edition by David L. Nelson and M.M Cox [2013] Free and company. New York.
2. Fundamental of Biochemistry. D. Voet and J. G. Voet [2013] John Wiley and Sons New York.
3. Biochemistry 8th Edition by L. Stryer [2015], W.H Freeman and New York
4. Biochemistry 6th Edition by R.H Garrett and C.M Grisham [2017] Saunders college Publishing, New York
5. Biochemistry 4th edition by G. Zubay [1998] Wm .C Brown Publishers.
6. Outline of Biochemistry by Conn E.E, Stumpf P.K. Bruening G. and Dvi R.H [1999] John Wiley and Sons Inc New York and Toronto.
7. Biochemistry by J.L. Jain (2004) S. Chand & Company Ltd.

M.Sc. (Biotechnology) 2nd Semester

BT – 203 (Genetics) (Core Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

UNIT – I

Principles of heredity and variation: Mendel's law and his experiments, penetrance and expressivity, phenocopy.

Concept of gene: Classical concept, Fine structure of the gene, Molecular concept of the gene, pseudogenes, overlapping genes, repeated genes, gene amplification.

UNIT – II

Genes and chromosomes: General features of chromosomes, chromosomal theory of inheritance, sex determination. Sex-linked, sex-limited and sex-influenced inheritance, chromosomal aberrations.

Extra-chromosomal inheritance, sex chromosomal abnormalities-syndrome and autosomal abnormalities.

UNIT – III

Mutation: Types of mutation and molecular mechanism, nonsense, missense and frame shift mutations, Ames test for mutagenesis; Mutagenesis by nitrous acid, hydroxylamine, alkylating agents, intercalators and UV. DNA repair mechanisms - excision, mismatch, SOS, photo-reactivation, recombination repair.

UNIT – IV

Gene Linkage and chromosome Mapping: Complete and incomplete linkage, recombination of genes in a chromosome, crossing over, gene mapping by 2-point and 3-point test crosses, somatic cell hybridization.

Population Genetics and Evolution: Allele frequencies and genotype frequencies, random mating and Hardy- Weinberg principle, inbreeding, mutation, migration, natural selection, random genetic drift, quantitative inheritance.

Text /References Books:

1. Principles of Genetics, 8th ed., Gardener et al. (2001), John Weley, New York.
2. Genetics, 6th ed., Snustad P.D. and Simmons M.J. (2012), John Weley, New York.
3. Concept of Genetics, 10th ed., Klug and Cummings (2012), Pearson Education, Singapore.
4. Genetics: Analysis and Principles (2016), Brooker, RJ, McGraw Hill, New York.
5. Genetics: B.D. Singh (2004), Kalyani Publishers.
6. Genetics principles and analysis, 4th Edition (2012) DL Hart and EW Jones, Jones and Bartett Publishers, Massacheusetts, USA

M. Sc. (Biotechnology) –2nd Semester

BT – 204 A – Plant Biotechnology (Core Elective Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Introduction- Historical background, basic techniques in tissue culture, cell, Tissue and Organ Culture (an introduction), Callus and Suspension Culture (Induction, sub culturing and maintenance), estimation of growth and growth characteristics, Organogenesis and somatic embryogenesis

Micropropagation – Techniques, Factors affecting morphogenesis and proliferation rate, Technical problem in micropropagation, Meristem culture for the production of pathogen free plants, Applications of micropropagation.

Unit – II

Haploid production – Meaning and significance, anther, pollen, ovary and ovule culture (technique, advantages, disadvantages), ultrastructure of pollen embryogenesis, genetic stability in haploid cell culture,

Protoplast Culture – Protoplast isolation, Fusion and culture, somatic hybridization, selection systems for hybrids, Asymmetric hybrids, Production of hybrids and organellic recombinants. Role of protoplast culture and somatic hybridization in the improvement of crop plants. Embryo culture and embryo rescue.

Unit – III

Plant Transformation technology : Agrobacterium mediated transformation, binary vectors and co-integrate vector, use of 35S and other promoters, use of reporter genes, methods of nuclear transformation, viral vectors and their applications, multiple gene transfer, direct DNA transfer, Transgene stability and gene silencing.

Chloroplast transformation its success with tobacco and potato.

Unit – IV

Cryopreservation and germplasm storage - Cyopreservation and germplasm conservation, Production of synthetic and artificial seeds, cryobiology of plant cell cultures and establishment of plant banks, Factors affecting revival of frozen cells.

Metabolic engineering and industrial products: Plant secondary metabolites, control mechanism and manipulation of phenylpropanoid pathway, shikimate pathway, alkaloids.

Text/Reference Books:

1. Gahlawat et al. (2017) Plant Biotechnology: Recent Advancement and Developments, Springer Nature, Germany.
2. Bhojwani S.S. and Rajdan MK (2004) Plant Tissue Culture: Theory and Practice –A revised edition, Reed Elsevier, India, New Delhi.
3. Bhojwari SS (2003) Agrobiotechnology & Plant Tissue Culture.
4. Rajdan MK (2003), Plant Tissue Culture (2nd ed.) IBH Publishing House, New Delhi.
5. Glick BR and Pasternak J.J. (1998), Molecular Biotechnology: Principles and Applications, ASM Press, Washington DC.
6. Chawla H.S. Introduction to Plant Biotechnology (2nd edition), Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
7. Rup Lal and Sukanya Lal (2000), Crop improvement utilizing Biotechnology, CRC Press, Inc. Bra Raton, Florida.

M. Sc. (Biotechnology) –2nd Semester

BT -204 B – Animal Biotechnology (Core Elective Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Introduction: History, scope & applications of animal biotechnology.

Culture Media: Balanced salt solutions & simple growth media. Brief discussion on chemical, physical and metabolic functions of different constituents of culture medium. Role of serum & supplements, serum & protein free defined media & their applications.

Primary Cell Culture and continuous cell lines: Establishment & evolution of primary cell culture, disaggregation of tissue & primary culture, characteristics of limited life-span cultures, maintenance of cell culture, establishment and properties of continuous cell lines.

Unit – II

Measuring parameters of growth, viability and cytotoxicity: Growth phase, cell counting, cell weight, DNA content, protein, rates of synthesis, growth cycle, pulsating efficiency, labeling index, cell cycle time (generation time), measurement of viability and cytotoxicity.

Applications of animal cell Culture: *In vitro* toxicity testing, production of viral vaccines, growth hormones, interferon, cytokines & cell culture based vaccines, embryonic stem cell culture and applications.

Unit – III

Gene transfer into Animal Cells: DNA transfer techniques into mammalian cells; Calcium phosphate precipitations, DEAE dextran procedure, microinjection, electroporation.

Viral vectors for gene transfer into mammalian cells: SV40, adenovirus, bovine papilloma virus, baculovirus and retrovirus.

Unit – IV

Biotechnology for animal improvement: Super ovulation, Embryo transfer, *in vitro* fertilization & embryo culture.

Animal Cloning: Concepts, principles & techniques of cloning, human cloning- reproductive and therapeutic cloning, applications of animal cloning, ethical & policy issues of animal cloning.

Text/references books:

1. Principles of Gene Manipulations 6th Edition, Primrose S.B., Twyman, R. & Old B. (2002) Blackwell Publishing.
2. Molecular Biotechnology: Principles & Applications of recombinant DNA 2nd Edition, Glick, B.R. & Pasternak J.J. (1998) ASH Press, Washington D.C.
3. Animal Cell Biotechnology: Spier, R.E. & Griffiths J.B. (1988) Academic Press.
4. Animal Biotechnology: Muray Moc Young (1989) Pergamon Press, Oxford.
5. Animal Cell Culture: Freshney R.T. (1987), IRL Press Oxford, Washington.
6. Culture of Animal Cells: Freshney R.T. (2003), John Wiley & sons, New York.
7. Animal Cell Technology – Principles & Practices: Butlor M. (1987) Oxford Uni. Press.
8. Animal Cell Culture & Technology: Basics from Background to Bench, Butlor M (2004), Taylor & Francis.
9. Animal Cell Technology: From Biopharmaceuticals to Gene Therapy. Edited By: Castilho, Moraes, Augusto & Butler. Taylor & Francis Press.

M. Sc. (Biotechnology) –2nd Semester

BT – 205 – Biotechnology and Human welfare – II (Open Elective Course)

Credits: 4 **Marks: 100**
Time: 3 Hrs. **Theory: 70**
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Bioinformatics: (A brief account) Importance, Scope of Bioinformatics, Bioinformatics institutes and biological databases.

Unit – II

Nanobiotechnology: An Overview, Insights and intervention into the Nano world, Applications of Nanobiotechnology in agriculture, medical and environment.

Unit – III

Medical Biotechnology: (A brief account) Biotechnology in Diagnostic, Vaccines, Gene therapy, PCR, LCR and hybridoma technology.

Unit – IV

Micropropagation – Introduction to plant tissue culture and its applications, Micropropagation: Technical problem and its application. Bt cotton and Golden rice (A brief introduction).

Text/Reference Books:

1. Salar et al. (2013) Biotechnology: Prospects and Applications. Springer, Germany.
2. Das H.K. (2004) Textbook of Biotechnology, Willey Dreamtech. Pvt. Ltd, New Delhi.
3. Natesh S., Chopra V.L. and Ramachandran S. (1987), Biotechnology in Agriculture Oxford & IBH, New Delhi.
4. Kumar H.D. (2004) A Text Book of Biotechnology, Eastern Willey Press, New Delhi.
5. Tizard I.R. (2013) Immunology- An introduction, 5th Edition, Philadelphia Saunders College press.
6. Lesk, A.M. (2013), Introduction to Bioinformatics, 4thEdn. Oxford University Press, Oxford.
7. Bhushan, Bharat (Ed.) 2012 Encyclopedia of Nanotechnology. Springer.
8. Bhushan, Bharat (Ed.) 2010 Handbook of Nanotechnology. Springer.
9. Gupta P.K. (2010) Biotechnology & Genomics, 5th Reprint, Rastogi Publications Meerut.
10. Singh B.D. (2010) Biotechnology, 4th edition, Kalyani Publication.
11. Black J.G (2008) Microbiology- Principles and Explorations, 7th Edition, John Wiley & Sons.
12. Brown S.M. (2000), A Biologist Guide to Bio-computing and the Internet, A Biotechniques Books Publication, Eaton Publishing, USA.
13. Lee B.H. (1996), Fundamental of Food Biotechnology, VCH Publishers.

M. Sc. (Biotechnology) –2nd Semester
Laboratory – III
BT – 206 – Genetic Engineering (Core Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. General Laboratory-safety and Bio-safety measures in genetic engineering laboratory
2. Introduction to various instruments and their working principles used in genetic engineering.
3. Bacterial culture and antibiotic selection media.
4. Preparation of competent cells.
5. Isolation & quantification of genomic DNA from microbes/ plant/ animal.
6. Quantification of DNA samples using Nanodrop spectrophotometer.
7. Isolation & quantitation of RNA
8. Isolation of plasmid DNA and quantification.
9. Agarose gel electrophoresis of DNA samples to check quality
10. Restriction digestion of DNA samples
11. Ligation of digested sample of DNA
12. Agarose gel electrophoresis and restriction mapping of DNA
13. Construction of restriction map of plasmid DNA
14. Demonstration of Cloning in plasmid vectors.
15. Preparation of single stranded DNA template
16. Demonstration of DNA sequencing
17. Polymerase Chain Reaction (PCR) of a known gene
18. RT- Polymerase Chain Reaction of a known gene
19. Demonstration of Southern blotting

Text/Reference Books:

1. Benjamin Lewin. Gene X, 10th Edition, Jones and Barlett Publishers 2010.
2. J D Watson et al., Biology of Gene, 6th Edition, Benjamin Cummings, publishers Inc. 2007
3. Alberts et al., Molecular Biology of the Cell, Garland, 2015
4. S B Primrose, R M Twyman, and R W Old. Principles of Gene manipulation. S B University Press, 2001
5. Brown T A. Genomes, Garland Science 2011.
6. J Sambrook and DW Russel, Molecular Cloning: A laboratory Manual Vols1-3. CSHL, 2001.
7. D.M. Glover and B D Hames, DNA cloning, Oxford 1995.
8. Recent reviews in scientific journals.

M. Sc. (Biotechnology) –2nd Semester
Laboratory – IV
BT – 207 A – Plant Biotechnology (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. To draw the basic requirements and design for setting up for a tissue culture laboratory.
2. To study the various sterilization techniques adopted while carrying out the various tissue culture experiments.
3. To prepare the stock solutions of various growth regulators as well as of Murashige and Skoog's medium.
4. To carry out in-vitro germination of seeds of sunflower/carrot.
5. Induction of callus from highly differentiated tissue (*e.g.* cambial part of carrot tap-root) and to record the growth rate of callus tissue by forming growth curves.
6. To induce somatic embryogenesis/organogenesis in callus cultures of carrot obtained in expt. No.5 and to record the effect of different growth hormones in this process.
7. To carry out anther culture of Datura and to examine the effect of activated charcoal on anther culture.
8. To perform the embryo culture of any available plant (*e.g.* wheat, rice, sweet corn, barley *etc.*) and to record the effect of ABA on embryo development in vitro.
9. Preparation and maintenance of cell suspension cultures of any available plant (*e.g.* *Nicotiana tabacum*, carrot etc.) and form the growth curves.
10. To carry out Agrobacterium-mediated transformation in *Nicotiana tabacum*.

Text/Reference Books:

1. Bhojwani S.S. and Rajdan M.K. (2004), Plant Tissue Culture: Theory and Practice – A revised edition, Reed Elsevier, India, New Delhi.
2. Smith H.R (2000), Plant Tissue Culture: Techniques and Experiments – Secord edition, Academic Press.
3. Purohit S. S. (2006) A Laboratory Manual of Plant Biotechnology – Secord revised edition, Agrobios (India).
4. Evans D.A. (2003), Plant Cell Culture, Taylor & Francis.

M. Sc. (Biotechnology) –2nd Semester

Laboratory – IV

BT – 207 B – Animal Biotechnology (Core Elective Course)

Marks: 100

Credits: 4

Duration of exam: (3+3 hour)

1. General Laboratory-safety and Bio-safety measures in animal biotechnology laboratory
2. Routine techniques in handling laboratory animals: feeding, cleaning and general hygienic measures.
3. Preparation of tissue culture medium & membrane filtration.
4. Sterilizing test of media and serum
5. Preparation of cell suspension culture.
6. Cell counting using haemocytometer.
7. Determination of cell viability
8. Preparation of macrophage from tissue
9. Trypsinization of monolayer & sub culturing
10. Isolation of genomic DNA from blood sample
11. Designing of primer for PCR/ RT-PCR
12. Calculation of Tm of nucleic acid
13. LAMP/ PCR/ RT-PCR
14. Multiplex PCR
15. Cell disruption using Sonicator
16. Determination of antimicrobial activity of probiotics

Text/References Books:

1. Culture of animal cells (2003). Freshney R.T. John Wiley and sons, New York.
2. Animal Cell Culture (1987). Freshney R.T. IRL Press Oxford, Washington.
3. Animal Cell Culture and Technology: Basics from background to bench. Butlor M (2004). Taylor & Francis.
4. Benjamin Lewin. Gene X, 10th Edition, Jones and Barlett Publishers 2010.
5. J D Watson et al., Biology of Gene, 6th Edition, Benjamin Cummings, publishers Inc. 2007
6. Alberts et al., Molecular Biology of the Cell, Garland, 2002
7. S B Primrose, R M Twyman, and R W Old. Principles of Gene manipulation. S B University Press, 2001
8. Brown T A. Genomes, 3rd Edition, Garland Science 2006.
9. J Sambrook and DW Russel, Molecular Cloning: A laboratory Manual Vols1-3. CSHL, 2001.
10. DM Glover and B D Hames, DNA cloning, Oxford 1995.
11. Recent reviews in scientific journals.

M. Sc. (Biotechnology) – 3rd Semester

BT – 301 – Bioinformatics and Biostatistics (Core Course)

Credits: 4 **Marks: 100**
Time: 3 Hrs. **Theory: 70**
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Scope of computers in biological research: Basic operations, architecture of computer. Introduction of digital computers. Organization, binary number system. The soft side of the computer – Different operating systems – Windows, Linux, Internet and its applications.

Introduction to Bioinformatics: Definition, role, scope and limitation of bioinformatics. Different branches of bioinformatics. Terminologies: Internet browser, software, hardware, database, Network, Inflibnet, algorithm.

Unit – II

Biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, Genbank, DDBJ. Specialized genomic resources.

Biodiversity databases: IUCN, Species 2000, Tree of life, ATCC, MTCC, NCCS, IPNI 1999, Fishbase 2001, ICTV, IT IS. Basic Local Alignment Search Tool (BLAST), FASTA.

Unit – III

DNA sequence analysis, cDNA libraries and EST, EST analysis, GSS, pairwise alignment techniques, database searching, multiple sequence alignment. Genome Mapping, Genome Sequence Assembly, Genome Annotation, Comparative Genomics.

Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR.

Unit – IV

Biostatistics: Define statistics, biostatistics and biomathematics. Basic quantitative methods. Brief description and tabulation of data and its graphical representation.

Measures of central tendency and dispersion: Mean, Median, Mode, Range, Standard deviation, Variance, Idea of two types of errors and level of significance, tests of significance (F & t-test), chi-square (χ^2) tests, Analysis of Variance (ANOVA).

Text/Reference Books:

1. Attwood TK & Parry-Smith DJ. 2003. Introduction to Bioinformatics. Pearson Education.
2. Rastogi SC, Mendiratta N & Rastogi P. 2004. Bioinformatics: Concepts, Skills and Applications. CBS.
3. Krane .2003. Fundamental concept of bioinformatics, Pearson Education, Singapore.
4. Singh, R and Sharma, R. (2010) Bioinformatics: Basics, Algorithms and Applications, Universities Press.
5. Introduction to Biostatistics. Glover T. and Mitchell K. (2016) Tata McGraw Hill, New York.
6. Fundamentals of Biostatistics. Rosner Bernard (1999), Duxbury Press.

M. Sc. (Biotechnology) – 3rd Semester

BT – 302 - Biosafety, Bioethics and IPR (Core Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Biosafety and risk assessment issues, regulatory framework, National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, cross border movement of germplasm, risk management issues-containment.

Unit – II

General principles for the laboratory and environmental biosafety, health aspects, toxicology, allergenicity, antibiotic resistance etc. Impact on environment, gene flow in natural and artificial ecologies, source of gene escape, tolerance of target organisms, creation of superweeds/superviruses, etc.

Unit – III

Ecological aspects of GMOs and impact on biodiversity, monitoring strategies and methods for detecting transgenics, radiation safety and non-radio isotonic procedure, benefits of transgenics to human health, society and the environment

Unit – IV

The WTO and other international agreements, intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications etc. protection of plant variety and farmers right act, Indian patent act and amendments, patent filing, convention on biological diversity, implications of intellectual property rights on the commercialization of biotechnology products.

Textbooks/suggested readings-

1. Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani.
2. http://patentoffice.nic.in
3. www.wipo.org
4. www.dbtindia.nic.in
5. www.dbtbiosafety.nic.in

M. Sc. (Biotechnology) – 3rd Semester
BT – 303 – Molecular Biology (Core Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Nucleic acid – structure: DNA and RNA as genetic material, Chemical structure and base composition of nucleic acids, Double helical structures, Supercoiled DNA, Forces stabilizing nucleic acid structure, properties of DNA, Renaturation and denaturation of DNA. Tm and Cot curves, Structure of RNA.

DNA Replication: General features of DNA replication, Enzymes and proteins of DNA replication, of replication, Prokaryotic and eukaryotic replication mechanism. Replication in phages, Replication in retroviruses.

Unit – II

Transcription: Mechanism of transcription in prokaryotes and eukaryotes, RNA polymerases and promoters, Post-transcriptional processing of tRNA, rRNA and mRNA (5′ capping, 3' polyadenylation and splicing).

Antisense and ribozyme technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, biochemistry of ribozyme, hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications for antisense and ribozyme.

Unit – III

Translation: Genetic code, General features, Deciphering of genetic code, Code in mitochondria. Translational mechanism in prokaryotes and eukaryotes. Post translational modification and transport, Protein targeting (in brief), Non ribosomal polypeptide synthesis, Antibiotic inhibitors and translation.

Unit – IV

Regulation of Gene Expression in Prokaryotes and Eukaryotes: Operon concept, Positive and negative control, lac, trp and arb operon. Catabolite repression, attenuation, regulation of gene expression in eukaryotes (a brief account).

Homologous recombination: Holiday junction, FLP/FRT and Cre/Lox combination, RecA and other recombinases

Text/Reference Books:

1. Adams et al. (1992) Biochemistry of Nucleic Acids, 11th ed., Chapman and Hall, New York.
2. Lewin B. (2010) Gene X, Pearson Prentice and Hall, New Delhi.
3. Karp G. (2010) Cell and Molecular Biology - Concept and Experiments, 5th Edition, John Wiley, NY.
4. Lodish et al. (2013) Molecular Cell Biology, 7th Edition, W.H. Freeman Publisher.
5. Gardener et al. (2001) Principles of Genetics, 8th ed., John Weley, New York.
6. Klug and Cummings (2012) Concept of Genetics, 10th ed., Pearson Education, Singapore.
7. Cooper G.M. and Hausman R.E (2013) The Cell: A molecular approach. Sinnaur Associates Inc. Publisher, USA, 6th edition.
8. Alberts B. and Johnson A (2016). Molecular Biology of Cell. Garland Science publisher.

M. Sc. (Biotechnology) – 3rd Semester

BT – 304 A – Biophysical Techniques and Nanotechnology (Core Elective Course)

Credits: 4 **Marks: 100**
Time: 3 Hrs. **Theory: 70**
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit-I

Interactions in biological systems: Intra and inter-molecular forces, electrostatic interactions and hydrogen bonding, Vander Waals and Hydrophobic interactions, Disulphide bridges, Role of water and weak interactions.

Biophysical techniques to purify and study proteins. Dialysis, salting out and precipitation by organic solvents.

Ultracentrifugation: Sedimentation velocity and equilibrium, determination of molecular weights.

Unit-II

Bioanalytical Techniques: Ion exchange, gel filtration, reversed phase, HPLC, Circular dichroism spectroscopy, X-ray diffraction, Nuclear magnetic resonance, SEM/TEM, UV-Visible spectroscopy techniques, FTIR etc.

Unit-III

Bionanotechnology: An Overview From biotechnology to Bio-nanotechnology.

Biological production of nanoparticles: fungi, bacteria, yeast and actinomycetes.

Chemical, physical and biological properties of biomaterials, Biomineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides) antimicrobial properties of Nanoparticles.

Unit-IV

Bio-nanotechnology Applications: Nanobiotechnology for human health and food applications: nanoparticles for drug delivery, gene delivery

Use of nanoparticles as Biosensors, Disease Diagnosis and Screening

Nanoparticles for cleaning environment particularly heavy metal bioremediation

Text/Reference books:

1. Principles and techniques of Practical Biochemistry, 7th Edition, K. Wilson and J. Walker (2010), Cambridge University Press, Cambridge.
2. Bophysical Chemistry: Principle and Techniques, 2nd Edition by A. Upadhyay, K. Upadhyay and N. Nath. (1998) Himalya Publication House. Delhi
3. Nalwa H.S. (2005) Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publications.
4. Rietdorf, J. (2010) Microscopy Techniques, Springer, Berlin
5. Niemeyer CM & Mirkin CA. 2005. Nanobiotechnology. Wiley Interscience.
6. David S. Goodsell, Bionanotechnology: Lessons from Nature, 1st Edition, Wiley-Liss, 2004.
7. Bhushan, Bharat (Ed.) 2012 Encyclopedia of Nanotechnology. Springer.
8. Bhushan, Bharat (Ed.) 2010 Handbook of Nanotechnology. Springer.

M. Sc. (Biotechnology) – 3rd Semester
BT – 304 B – Enzyme Technology (Core Elective Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Introduction: Historical background, Enzyme vs chemical catalyst. Enzyme nomenclature and classification, Units of enzyme activity. Methods for enzyme assays. Extraction and purification of enzymes. Holoenzyme, apoenzyme, prosthetic group, cofactor and coenzymes.

Unit – II

Enzyme specificity: Substrate and reaction specificity, Lock and key hypothesis, Induced fit hypothesis, Wrong way binding hypothesis and Three point attachment hypothesis, Mechanism of action of selected enzyme i.e. chymotrypsin, trypsin, papain, lysozyme and ribonuclease

Unit – III

Enzyme kinetics: Factor affecting velocity of enzyme catalyzed reaction, Michaelis-Menten hypothesis, Transformation of Michaelis-Menten equation and determination of Km and Vmax. Haldane relationship. Multireactant enzyme, Enzyme inhibition i.e. reversible and irreversible inhibition, competitive, noncompetitive and uncompetitive inhibition.

Regulatory enzyme: Allosteric enzyme, sequential and symmetry model, covalently regulated enzyme.

Unit – IV

Enzyme technology: Large scale production of enzymes, Uses of isolated enzyme in food and chemical industries, Therapeutic and medicinal uses of enzymes.

Protein Engineering: Concept and methods, Site directed mutagenesis, Active site mapping and nature of active site, Identification of functional groups at the active site. Immobilized enzymes - methods and application.

Text/references books:

1. Palmer T. (2014) Enzyme Biochemistry Biotechnology and Clinical Chemistry. Howood Publishing chishester, England.
2. Marangoni A.G. (2003) Enzyme Kinetics-A Modern Approach.
3. Price N.C and Stevens L. (2014) Fundamental of Enzymology. Oxford University Press, New York.
4. Dixon M and Webb E.C. (1979) Enzyme 3rd edition. Academic Press, New York
5. Uhlig H.(1998) Industrial Enzyme and their Application, Jone Wiley, New York

M. Sc. (Biotechnology) – 3rd Semester

Laboratory – V

BT – 305 – Bioinformatics and Biostatistics (Core Course)

Marks: 100

Credits: 4

Duration of exam: (3+3 hour)

Windows

Desktop, managing the computer system through windows (control panel), working with files and folders

Word Processor

Creating a document, navigating in document, Adding text and external objects, changing the look of document, Automating your writing, Using graphics, Adding a table, adding a figure.

Spreadsheet

Using worksheet, Entering data, Using external data, Changing the look of the data, Using formulas, measurement of central tendency using available software (origin, SPSS), Adding graphics, Using the web, Analyzing the data, Managing lists.

Power point

Creating presentation, Generating slides, Adding text, including multimedia, Preparing presentation.

INTERNET

WWW, working with internet and its applications.

Databases and Tools

Retrieval of Gene and Protein Sequences, Clustal W, BLAST, Pubmed, FASTA, PIBWIN, ORF finder, NCBI map viewer, ATCC, MTCC, Species 2000, Tree of life, IPNI 1999, Fishbase 2001, ICTV, Web cutter, Translation tools, DAMBE.

Text/references books:

1. Introduction to Biostatistics: Glover, T. and Mitchell, K. (2016) McGraw-Hill, NewYork.
2. How computers work. Ron White. (2000). Techmedia.
3. How the Internet works. Preston Gralla. (2000). Techmedia.
4. Nucleic Acids Research. Genome Database issue. 2001 Jan.
5. Practical statistics for Experimental Biologists. Wardlaw, A.C. (1985). John Wiley and Sons., Inc., NY.

M. Sc. (Biotechnology) – 3rd Semester
Laboratory – VI
BT – 306 A – Cell and Molecular biology (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Introduction to various instruments and their working principles used in Cell and Molecular Biology laboratory.
2. Preparation of normal and molar solutions, buffers, pH setting etc.
3. To study various parts of microscope and demonstration of microscopic techniques
4. To discriminate between viable and non-viable cells using staining techniques
5. Effect of solution concentration on cells (RBCs)
6. To study the structural diversity of prokaryotic and eukaryotic cells.
7. Cell division: mitosis and meiosis.
8. Microtomy
9. Histochemical techniques
10. Isolation of Nucleic acid
11. Gel electrophoretic separation of nucleic acid.
12. Molecular size determination of DNA samples by Agarose gel electrophoresis.
13. Isolation of proteins.
14. PAGE

Text/Reference Books:

1. Sambrook J, EF Fritech and T. Maniatis (2000) Molecular Cloning: A laboratory Manual, cold spring Harbor laboratory Press, New York.
2. Glover DM and BD Hames (2006), DNA cloning: A practical Approach, IRL Press, Oxford.
3. Priyanks Siwach and Namita Singh (2007) Molecular Biology, Theory and Practices, Laxmi Publication.
4. Lodish et al., Molecular Cell Biology Freeman and Company 2016.
5. Smith and Wood. Cell Biology, Chapman and Halls 1996
6. Watson et al. Molecular Biology of the gene. Pearson Prentice Hall, USA 2003

M. Sc. (Biotechnology) – 3rd Semester

Laboratory – VI

BT – 306 B – Biophysical Techniques and Nanotechnology (Core Elective Course)

Marks: 100

Credits: 4

Duration of exam: (3+3 hour)

1. Principle and demonstration of various advanced analytical techniques
   a) Chromatography (HPLC, TLC, Paper Chromatography, Column chromatography)
   b) Centrifugation
   c) UV-visible spectrophotometer
   d) Nanodrop
   e) ELISA reader
   f) Transmission electron microscope/Scanning electron microscope
   g) FTIR
   h) AFM
   i) AAS
   j) Sonicator
2. Extraction and separation of plant pigments by chromatography.
3. Absorption and action spectra of plant pigments.
4. Isolation and separation of amino acids by chromatography.
5. Isolation of bacteria & fungi for synthesis of nanoparticles.
6. Biosynthesis of nanoparticles using microorganisms/ plants.
7. Characterization of nanoparticles using UV-Spectrophotometer and other techniques
8. Synthesis and characterization of polymeric nanoparticles.
9. Determination of antimicrobial activity of nanoparticles
10. Encapsulation of drugs with polymeric nanoparticles.
11. Role of nanoparticles in heavy metal absorption and estimation of heavy metals by Atomic absorption spectrophotometer

Text/Reference Books:

1. Lincoln Taiz, Eduardo Zeiger, Plant Physiology, Sinauer Associates, 2010.
2. Hamms GD, Spectroscopy for the Biological Sciences, Wiley Interscience, USA, 2005.
3. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge .
4. Bophysical Chemistry: Principle and Techniques, 2nd eddition by A.Upadhyay, K. Upadhyay and N. Nath. (1998). Himalya Publication House.Delhi
5. Nalwa HS. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.
6. Niemeyer CM & Mirkin CA. 2005. Nanobiotechnology. Wiley Interscience.

M. Sc. (Biotechnology) – 4th Semester
BT – 401 – Immunology (Core Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit-I

Introduction: Phylogeny of immune System, innate & acquired Immunity, clonal nature of immune system, primary & secondary lymphoid organs

Cells of Immune System: Haematopoesis & differentiation, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic Cells, Natural Killer & lymphokine activated Killer Cells, Eosinophils, Neutrophils & Mast Cells, lymphocyte trafficking, humoral & cell mediated immune response.

Unit-II

Immune System: Nature & Biology of antigens & superantigens, Immunoglobulins- structure & functions of different classes, Antigenic determinants (Isotype, Allotype & Idiotype), Antigen-antibody interactions, Antibody engineering.

MHC, Antigen processing & presentation, structure of MHC I & II, Genomic organization and MHC polymorphism.

Unit-III

Regulation of Immune Response: Genomic organization and generation of diversity of B-Cell and T-Cell receptors, B-Cell and T-cell Regulation.

Antibody dependent cell mediated cytotoxicity & macrophage mediated cytotoxicity, cytokines & their role in immune regulation, Complement system

Unit-IV

Immunological Techniques: Immunoprecipitation reactions, Agglutination reactions, Complement tests, ELISA, RIA, Immunofluorescences.

Immune System in Health & Diseases: Hypersensitive Reactions, Auto immunity, AIDS and other immunodeficiencies.

Text/references books:

1. Immunology, 8th Edition., Goldsby, R.A., Kindt T.J., Osborne B.A. (2012) W.H. Freedom & Comp, NY.
2. Essential of Immunology, 10th Ed. Riott, Ivon, Delves, Peter (2001) Blackwell Scientific Publications, Oxford.
3. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York.
4. Immunology – A short course – Eli Benzamini, R Coico, G Sunshine (Wiley-Liss).
5. Immunology – An introduction 5th Edition (2013) Tizard I.R. Philadelphia Sauders College Press.
6. Basic Immunology, Sharon J (1998) Williams and Wilkins, Battimore.
7. Janeway et al., Immunobiology, 8th Edition, Current Biology publications, 2012.

M. Sc. (Biotechnology) – 4th Semester

BT – 402 A - Bioprocess Technology (Core Elective Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Introduction: History and role of bioprocess engineering in biotechnology industries, concept of unit operation and unit processes. Isolation, preservation and maintenance of industrial microorganisms. Air and media sterilization.

Growth Kinetics and fermentation processes: Kinetic of microbial growth and death. Analysis of batch, continuous and fed-batch fermentation process. Mixed cultures- major classes, models, mixed cultures in nature, industrial utilization of mixed cultures with examples.

Unit – II

Fluid Mechanics: Principle of microbial nutrition, formulation of culture media, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals precursors and antifoam agents. Gas-liquid mass transfer in cellular system, heat transfer, agitation. Non-Newtonian fluids

Bioreactors: Mechanical design of bioreactors. Types of bioreactors: Fed Batch reactors, plug flow reactors (PFR), continuous stirred tank reactor (CSTR), fluidized bed reactor, bubble column, air lift fermenter, residence time distribution, optimization of reactor system.

Unit – III

Downstream processing: Introduction, history and scope of downstream processing in biotechnology. Separation of particulates by filtration, centrifugation, settling, sedimentation, decanting and micro filtration. Primary isolation method including solvent extraction, sorption, precipitation, ultra filtration and reverse osmosis. Fractional precipitation, electrophoresis and various kinds of chromatography, drying and crystallization. Application of above methods in purification of antibiotics and enzymes.

Unit – IV

Industrial production of chemicals: Alcohol (ethanol). Acids (citric, acetic and gluconic). Solvents (glycerol, acetone, butanol). Amino acids (lysine, glutamic acid). Single cell protein (quorn).

Health Care Products: Production of antibiotics (penicillin, streptomycin, tetracycline). Recombinant therapeutic peptides and proteins (insulin and interferon)

Text/references books:

1. Bioprocess Engineering – Basic Concepts, second edition, Shuler ML; Kargi F (2002), prentice Hall PTR, New Jersey
2. Bioseperations-Downstream processing for biotechnology. Reinhold van Nonstrand, Belter P.A, Cussler E.L, Hu W.S (1988), John Wiley and Sons. New York.
3. Process engineering in biotechnology. Jackson, A.T. Prentice Hall, Engelwood Cliffs.
4. Bioprocess Engineering: Systems, equipments and facilities. Eds. Lydersen K.B., D'elia, N.A. and Nelson K.L. (1994), John Wiley and Sons, New York.
5. Principles of fermentation technology. Stanbury et al. (2016), Elsevier.
6. Unit operation of Chemical Engineering 6th ed. McCabe, W.L; Smith J.C. and Harriott P. (2000) Tata McGraw Hill, New York.
7. Separation Process Principles, Seader, J.D. (1998) John Willey and Sons, Oxford.
8. Bioseparation: Downstream Processing for Biotechnology. Belter, P.A.; Cussler E.L. and Hu W.S. (2003) John Wiley and Sons. Oxford.
9. Bioseparations Science and Engineering, Harrison R.G.; Todd P.; Rudge S.R. and Petrides D.P. (2003). Oxford Press.

M. Sc. (Biotechnology) – 4th Semester

BT – 402 B – Environment Biotechnology (Core Elective Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Environment Biotechnology: Introduction, issues and scope of environmental biotechnology
Solid Waste: Sources and management (composting, wormicomposting and methane production).

Unit – II

Waste Water Treatment: Microbiology of waste water treatment, biological processes of industrial effluent treatment, aerobic and anaerobic biological treatments, periodic biological reactor, membrane bioreactor, use of immobilized enzyme and microbial cells.
Pollution: Air pollution and its control through biotechnology, metal pollution and its bio-abatement. Bioleaching and biosorption.

Unit – III

Bioremediation: Bioremediation and its type, Bioremediation of contaminated soil and waste land. Role of biosensors for detection of pollutants.
Biodegradation of Xenobiotics: Xenobiotics compounds and recalcitrance. Aerobic vs anaerobic degradation, sequential degradation. Bio-oxidation/degradation of phenolic compounds, pesticides, hydrocarbons and halogenated compounds. Microbial treatment of oil spills and treatment of hazardous waste.

Unit – IV

Bioproducts for Environmental Health: Biopesticides, biofertilisers, bioenergy & fuel and biodegradable plastics.
Global Environmental Problems: Ozone depletion, greenhouse effect acid rain their impacts and biotechnological approaches for management (a brief account).

Text/references books:

1. Agarwal S.K. (1998) Environmental Biotechnology, APH Publishing Corp., New Delhi.
2. Glazer and Nikaido (2007) Microbial Biotechnology. WH Freeman & Company, New York.
3. Singh A. and Ward O.P. (2004) Biodegradation and Bioremediation: Soil Biology, Springer.
4. Foster, C.F. and Wase, D.A.J (1987) Environmental Biotechnology. Ellis H. Halsted Press
5. Yadav, P.R.and Tyagi R. (2006) Environmental Biotechnology. Discovery Publishing House, New Delhi.
6. Mohapatra, P.K. (2006) Text Book of Environmental Biotechnology. I.K. International Publishing House Pvt. Ltd .New Delhi.
7. Cheremisinoff, N.P (2003) Biotechnology for Waste and Waste Water Ttreatment. Prentice Hall Pvt. Ltd. New Delhi.

M. Sc. (Biotechnology) – 4th Semester

BT – 403 A – Agricultural Biotechnology (Core Elective Course)

Credits: 4 **Marks: 100**
Time: 3 Hrs. **Theory: 70**
IA: 30

Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

Unit – I

Agricultural Biotechnology: An overview.
Sustainable Agriculture: An Introduction, Role of biofertilizers and bio-pesticides in sustainable agriculture.
Biological N2 Fixation: Diazotrophic, microorganism, Free living and symbiotic nitrogen fixing microbes, Structure, function and regulation of nitrogenase enzyme, Molecular basis of legume Rhizobium symbiosis.

Unit – II

Crop Improvement: Comparison of strategies of crop improvement, Molecular mapping of genes of agricultural importance, Transgenic plants for herbicide resistance, insect resistances, virus resistance, biotic and abiotic stress resistance, Transgenic plants for improved nutritional quality of protein, starch, oil, vitamins and iron. Transgenic plants for increased shelf life.

Unit – III

Agriculture Biotechnology and Law: Patents, Plant Variety Protection Act, Procedure for patent application, International harmonization of patent laws, TRIPS and WTO, Patenting of life forms-plant, animals, microbes, gene, process and products, Plant Breeders Rights, International conventions on biological diversity.

Unit – IV

Agricultural Biotechnology and The Society: Transgenic plants, Commercial status and public acceptance, Bio-safety guidelines for research involving GMO's, Benefits and risks, Socio-economic impact and ecological considerations of GMO's, Gene flow.

Text/references books:

1. Shrivastava P.S., Narula A. and Shrivastava S.S (2004) Plant Biotechnology and Molecular Markers, Anamaya Publisher, New Delhi.
2. Altman A. (1998) Agricultural Biotechnology, Marcel Dekker.
3. Maria *et al.* (2002) Plant Biotechnology and Transgenic Plants, Marcel Dekker.
4. Adrianstater *et.al.* (2004) Plant Biotechnology: The Genetic Manupulation of Plants, Oxford University Press.
5. Brian C. (2004), Legal Aspect of Gene Technology, Thomson Severt Maxwell.
6. Sarad R.P. (2004) The GMO Hand Book: Genetically Modified Animals, Microbes and Plants, Humana Press, New Jersey.
7. Valpuseta V. (2004) Food and Vegetable Biotechnology, CRC Press, New Delhi.
8. Plant Biotechnology by Shain-dow Kung, (2014), Elsevier Science.

M. Sc. (Biotechnology) – 4th Semester

BT – 403 B – Medical Biotechnology (Core Elective Course)

Credits: 4
Time: 3 Hrs.

Marks: 100
Theory: 70
IA: 30

Note for the paper setter: *The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

Unit – I

Medical Biotechnology: An introduction and scope.
Biopharmaceuticals: Pharmaceutical applications of plant, animal and microbial origin, Relevance of medicinal plant, Therapeutic use of recombinant proteins, Proteins drug manufacturing, Design and engineering of proteins as therapeutic agents, Protein drug delivery.

Unit – II

Gene Therapy: Human diseases targeted delivery systems and targets, Gene therapy of genetic and acquired diseases, Biosensors and nano-technology for drug targeting and gene dilevery, Future and ethical issues, Genetic counseling.

Unit – III

Diagnostics: Use of nucleic acid probes and antibodies in clinical diagnosis, Mapping of human genome, Molecular Markers- types and applications, Molecular diagnosis of genetic diseases.
Diseases: Parkinson's disease, AIDS, Alzheimer's disease, Prion diseases, Molecular basis of cancer, Proto-oncogenes, Oncogenes and human suppressor genes.

Unit – IV

Drugs Produced through Biotechnology: Humulin, Activase Humatrope.
Biotechnological Innovations in Vaccines Development: DNA vaccines, Edible Vaccines, Development of malarial vaccine and Tuberculosis vaccine.
Pharmacogenetics: Pharmacogenomics and Personalized medicine – a brief Account.

Text/references books:

1. Wu S. Pong and Rojanasakul. Y. (1999) Biopharmaceutical Drug Design and Development, Humana Press, New Jersey.
2. Gary Walsh. (1998) Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley & Sons, New York
3. Vyas S.P. and Dixit. V.K. (2001) Pharmaceutical Biotechnology, CBS Publisher and Distributor, New Delhi.
4. Gupta P.K. (2004) Molecular Biology and Genetic Engineering, Rastogi Publications Meerut.
5. Pharmaceutical biotechnology, by M J Groves 2nd ed. (2006), Boca Raton, FL : Taylor & Francis

M. Sc. (Biotechnology) – 4th Semester
Laboratory – VII
BT – 404 – Immunology (Core Course)

Marks: 100

Credits: 4
Duration of exam: (3+3 hour)

1 General Laboratory-safety and Bio-safety measures in immunology laboratory.
2 Introduction to various instruments and their working principles used in immunology laboratory.
3 Blood film preparation and identification of cells
4 Lymphoid organs and their microscopic organization
5 Preparation and administration of antigens.
6 Isolation and purification of Immunoglobulins.
7 Quantification of immunoglobulins.
8 Immunodiagnostics (demonstration using commercial kits)
9 Immunodiffusion techniques:
a) Ouchterlony double diffusion
b) Radial immunodiffusion.
10 Immunoelectrophoresis:
   a. Counter current Immunoelectrophoresis
   b. Rocket Immunoelectrophoresis.
11 Latex agglutination technique.
12 ELISA technique
   a) Dot ELISA
   b) Sandwich ELISA

Text/references books:

1. A handbook of Practical Immunology (1983). Edited by G.P. Talwar, Vikas Publishing House Pvt. Ltd. New Delhi-110002.
2. Practical Immunology (1980), Hudson L. and Franks, C.H. Blackwell scientific Publication, Oxford.
3. Fundamental techniques in immunology and serology (2002) Singh A. International Book Distributing Co., Lucknow.
4. Current protocols in immunology, (1997), Marjorie, M. John Wiley and sons, Inc. USA.
5. Handbook of experimental immunology (1986). Bewesly, P. Blackwell Scientific publications, London.

M. Sc. (Biotechnology) – 4th Semester
Laboratory – VIII
BT – 405 A – Bioprocess Technology (Core Elective Course)

Credits: 4 **Marks: 100**

Duration of exam: (3+3 hour)

1. Introduction to various instruments and their working principles used in bioprocess technology laboratory.
2. Study of mechanical design of a bioreactor (CSTR)
3. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.
4. Determination of growth curve of a supplied microorganism and also determines substrate degradation profile.
5. Compute specific growth rate (m), growth yield (Yx/s) from the above experiment.
6. Use of alginate for cell immobilization.
7. Purify a bacterial protein
   i. Cell debris separation by different methods
   ii. Cell lysis by different methods
   iii. Column purification by molecular weight, charge, metal affinity
   iv. Dialysis
   v. Solvent extraction
   vi. Crystallization
   vii. Lyophilization

Text/Reference Book:

1. Gerba, L. L. and Brendeeke, J.W. (1995) Environmental Microbiology – A laboratory manual, Academic Press, New York.
2. Aneja K. R. (2010) Experiments in Microbiology, Plant Pathology and Biotechnology 4th edition. New Age International Publisher – New Delhi.
3. Cappuceino J. and Sheeman N. (2000) Microbiology – A laboratory manual 4th edition. Addison Wesley, California.
4. Belter, P. A., Cussler E. L. and Hu W. S. (2003) Bioseparation: Downstream Processing for Biotechnology. John Wiley and Sons.
5. Lydersen K.B., D'elia, N. A. and Nelson K. L. (1994) Bioprocess Engineering: Systems, equipments and facilities John Wiley and Sons, New York.
6. Harrison, R. G., Todd, P., Rudge S. R. and Petrides D. P. (2003) Bioseparations Science and Engineering, Oxford Press.

M. Sc. (Biotechnology) – 4th Semester
Laboratory – VIII
BT – 405 B – Environment Biotechnology (Core Elective Course)

Marks: 100

Credits: 4
Duration of exam: (3+3 hour)

1. Introduction to various instruments and their working principles used in environmental biotechnology laboratory.
2. Detection of coliform for determination of purity of potable water.
3. Determination of total dissolved solids of water.
4. Determination of dissolved oxygen concentration of water sample.
5. Determination of biological oxygen demand (BOD) of sewage sample.
6. Determination of chemical oxygen demand (COD) of sewage sample.
7. Isolation of Xenobiont degrading bacteria by selective enrichment technique.
8. Test for the degradation of aromatic hydrocarbon by bacteria.
9. Effect of sulphur dioxide on crop plants.
10. Estimation of nitrate in drinking water.

Text/Reference Book:

1. Environmental Microbiology – A laboratory manual, L.L. Gerba, C.P. and Brendeeke. J.W. (1995) Academic Press, New York.
2. Experiments in Microbiology, Plant Pathology and Biotechnology 4th edition Aneja K.R. (2010) New Age International Publisher – New Delhi.
3. Microbiology – A laboratory manual 4th edition. Cappuceino J. and Sheeman N. (2000) Addison Wesley, California.
4. Microbiology- a laboratory manual 4th edition. Cappuccino J. and Sheeman N.(2000) Addison Wesley, California.
5. Environmental Microbiology – A laboratory manual. Pepper, I.L.; Gerba, C.P. and Brendecke, J.W. (1995) Academic Press, New York.