Syllabi and scheme

for

Master of Science in Biotechnology

Under CBCS

For academic session: 2017-19

Department of Biotechnology
Central University of Haryana
Jant-Pali, Mahendergarh-123031
Haryana-India

M.Sc. Biotechnology
(w.e.f. academic session 2017-19)

Total Credits: 100

Semester	Credits			Total Credits
	Core courses	**Elective courses**		
		DCEC (for Biotechnology Dept.)	**GEC** (for other Dept.)	
I	20		4	24
II	18	4	4	26
III	18	8		26
IV	***24***			***24***
	16	8		24
Total		20	8	***100**

Note: ***Italic Credits in IV semester is for Full semester dissertation, which is not added in *total Credits.***

#GEC courses can only be taken by the students of other departments.

SEMESTER-WISE STRUCTURE

Semester I

Sl. No.	Course Code	Course Title	Core/ GEC/ DCEC	C	L	T	P	S	Max Marks		Total Marks	Pass Marks
									Internal	TEE		
1	SIAL BT 01 101 C 5005	Principles of Genetics and Molecular Biology	Core	5	5	0	0	0	30	70	100	40
2	SIAL BT 01 102 C 4004	Biomolecules and Metabolism	Core	4	4	0	0	0	30	70	100	40
3	SIAL BT 01 103 C 5005	Cell Biology	Core	5	5	0	0	0	30	70	100	40
4	SIAL BT 01 104 C 00126	Practical I	Core	6	0	0	12	0	30	70	100	40
5	SIAL BT 01 101 E 4004	Principles of Biotechnology	GEC	4	4	0	0	0	30	70	100	40

L- Lecture, T-Theory- Practical , S- Seminar , GEC- General Elective Course ,DCEC- Discipline Centric Elective Course, C-Credits ,TEE-Term End Exam

Note: GEC course can only be taken by the students of other departments

Semester II

Sl. No.	Course Code	Course Title	Core/ GEC/ DCEC	C	L	T	P	S	Max Marks		Total Marks	Pass Marks
									Internal	TEE		
1	SIAL BT 01 205 C 4004	Tools and Techniques in Biotechnology	Core	4	4	0	0	0	30	70	100	40
2	SIAL BT 01 206 C 4004	Microbial Process Engineering and Technology	Core	4	4	0	0	0	30	70	100	40
3	SIAL BT 01 207 C 4004	Immunology	Core	4	4	0	0	0	30	70	100	40
4	SIAL BT 01 208 C 00126	Practical II	Core	6	0	0	12	0	30	70	100	40
5	SIAL BT 01 202 E 4004 (any one)	Genomics and Proteomics	DCEC	4	4	0	0	0	30	70	100	40
		Microbial growth, enzyme and fermentation kinetics	DCEC	4	4	0	0	0	30	70	100	40
6	SIAL BT 01 203 E 4004	Biosafety, Bioethics and IPR	GEC	4	4	0	0	0	30	70	100	40

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Note: GEC course can only be taken by the students of other departments

Semester III

Sl. No.	Course Code	Course Title	Core/ GEC/ DCEC	C	L	T	P	S	Max Marks		Total Marks	Pass Marks
									Internal	TEE		
1	SIAL BT 01 309 C 4004	Cell and Tissue Culture	Core	4	4	0	0	0	30	70	100	40
2	SIAL BT 01 310 C 4004	Genetic Engineering	Core	4	4	0	0	0	30	70	100	40
3	SIAL BT 01 311 C 4004	Bioinformatics and Biostatistics	Core	4	4	0	0	0	30	70	100	40
4	SIAL BT 01 312 C 00126	Practical III	Core	6	0	0	12	0	30	70	100	40
6	SIAL BT 01 304 E 4004	Medical Biotechnology	DCEC	4	4	0	0	0	30	70	100	40
		Pharmacogenomics	DCEC	4	4	0	0	0	30	70	100	40
7	SIAL BT 01 305 E 4004	Environmental Biotechnology	DCEC	4	4	0	0	0	30	70	100	40
		Metabolic Engineering	DCEC	4	4	0	0	0	30	70	100	40

L- Lecture, T-Theory- Practical , S- Seminar , GEC- General Elective Course ,DCEC- Discipline Centric Elective Course, C-Credits ,TEE-Term End Exam

Note: GEC course can only be taken by the students of other departments

Semester IV

Sl. No.	Course Code	Course Title	Core/ GEC/ DCEC	C	L	T	P	S	Max Marks		Total Marks	Pass Marks
									Internal	TEE		
1	SIAL BT 01 401 SEEC 00024	Dissertation (Full semester)	Core	24	0	0	24	0	150	350	500	200
1	SIAL BT 01401 SEEC 00016	Dissertation (along with courses)	Core	16	0	0	16	0	90	210	300	120
2	SIAL BT 01 406 E 4004	Seminar	DCEC	4	4	0	0	0	30	70	100	40
		Biopharmaceutical and entrepreneurship	DCEC	4	4	0	0	0	30	70	100	40
3	SIAL BT 01 407 E 4004	Nanobiotechnology	DCEC	4	4	0	0	0	30	70	100	40
		Biomass energy	DCEC	4	4	0	0	0	30	70	100	40

L- Lecture, T-Theory- Practical , S- Seminar , GEC- General Elective Course ,DCEC- Discipline Centric Elective Course, C-Credits ,TEE-Term End Exam

Note: GEC course can only be taken by the students of other departments

SEMESTER- I

Course - Principles of Genetics & Molecular Biology

Course Code - SIAL BT 01 101 C 5005 **Credits: 5**

Objective: *This course covers genetics, the science of heredity, from its basic principles to the most recent advances in the field. By the end of the course, you will have a working knowledge of classical (transmission) and molecular genetics. The course will require timely effort on your part. Read your textbook prior to class and don't skip classes.*

Course Contents:

UNIT - I

Inheritance and Molecular Organizations of Chromosomes: Historical background, Extra chromosomal inheritance, Inheritance of quantitative traits, Sex linked, Sex influenced and Sex limited traits, Viral and bacterial chromosomes, Nucleosome and chromatin structure, Structure of centromere and telomere, Euchromatin and heterochromatin, Polytene and lamp brush chromosomes, Genome complexity.

Linkage, Crossing over and Gene mapping in Eukaryotes: Linkage and recombination of gene, Gene mapping by three point test cross, Tetrad analysis, Positive and negative interference, Molecular mechanism of recombination, Postmeiotic segregation, Mapping through somatic cell hybridization.

UNIT- II

Mutation & Gene Concept: Molecular mechanism of spontaneous mutations, Molecular mechanism of mutations induced by known chemical mutagens, Types of DNA repair, Molecular mechanism of suppression, Somatic mutations, Classical concept and fin structure of gene, Molecular concept of the gene, Pseudogenes, Overlapping genes, Oncogenes, Repeated genes, Gene amplification.

Bacterial and Viral Genetics: Transformation, Conjugation and Transduction, Molecular mechanism of recombination in bacteria, IS and Tn elements in Bacteria, E. Coli recombination system, Bacterial plasmids, Lytic cascade and lysogenic repression.

UNIT- III

DNA Structure: DNA as genetic material, Chemical structure and base composition of nucleic acids, Double helical structures, Different forms of DNA, Forces stabilizing nucleic acid structure, Super coiled DNA, 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, Models of replication, Prokaryotic and eukaryotic replication mechanism, Replication in phages, Reverse transcription.

UNIT- IV

Transcription: Mechanism of transcription in prokaryotes and Eukaryotes, RNA polymerases and promoters, Post-trancriptional processing ot tRNA, rRNA and mRNA (5'capping, 3'polyadenylationa and splicing), RNA as enzyme- Ribozyme.

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

Suggested Readings:

1. Gardener et al., Principles of Genetics, John Wiley, New York
2. Brooker R.J., Genetics-analysis and Principles, Addison Wesley Longman Inc. California
3. Maloy S.R., Cronan Jr. J R and Freifelder D., Microbial Genetics, Jones and Bartlett Publishers, London.
4. Hartl, D.L., Essential of Genetics, Jones and Barlett Publishers, London.
5. Klug W.S., Cummings M.R., Spencer C.A. and Palladino M.A., Concept of Genetics, Pearson Education,Singapore.
6. Miglani, G.S., Advanced Genetics, Narosa Publishing House, New Delhi.
7. Snustad, Peter D., Summons M.J., Genetics, Wiley John & Sons.
8. Adams R.L.P., et al., The Biochemistry of Nucleic Acids, Chapman and Hall, New York.
9. Lewin B., Gene VIII, Pearson Prentice and Hall, New Delhi.
10. Karp G., Cell and Molecular Biology-Concept and Experiments, John Wiley, New York.
11. Lodish et al., Molecular Cell Biology, W H Freeman Publisher.
12. Malacinski G.M. and Freifelder D., Essential of Molecular Biology, John and Bartlett Publishers, London.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Biomolecules and Metabolism

Course Code - SIAL BT 01 102 C 4004 **Credits: 4**

Objective: *The main objective of this course is to consolidate the knowledge of students on the basic molecules of life, and to increase their understanding on the metabolism of the basic molecules.*

Course Contents:

UNIT - I

Biomolecules: An Introduction, General structure of biomolecules, Fundamental principles governing structure of biomolecules, Importance of covalent and non-covalent bonds.

Carbohydrates: Structure and function of biologically important mono, d and poly-saccharides, Glycoproteins & glycolopids. Metabolism of carbohydrates-Glycolysis, Feeder pathways, Citric acid cycle, Gluconeogenesis, Glyoxylate and Pentose phosphate pathway, and their regulations.

UNIT- II

Protein: Structure of amino acids, non-protein and rare amino acids. A brief account of amino acid biosynthesis and degradation, Urea cycle, Structural organization of protein, Reverse turns and Ramachandran plot, Supra-molecular complexes of proteins, Chemical synthesis of peptides and small proteins. Protein sequencing, Enzymes.

UNIT- III

Lipids: Structure of fatty acids, Classification of lipids, Structure and functions of major lipid subclasses-Acyl glycerols, Phospholipids, glycolipids, Sphingolipids, Waxes, Terpenes and Sterols, Fatty acids biosynthesis, degradation and their regulations, Ketone bodies synthesis, biosynthesis of TAG, Cholesterol, Phospholipids and Glycolipids

UNIT- IV

Nucleic Acids: Structure and properties of nucleic acid bases, nucleosides and nucleotides, Biosynthesis and degradation of purines and pyrimidines, Salvage pathway.

Translation: Structure and biochemical roles of fat and water-soluble vitamins and their co-enzymes.

Suggested Readings:

1. Nelson D.L. and Cox M.M., Lehninger Principles of Biochemistry, Freeman and Company, New York
2. Conn E.E., Stumpf P.K., Bruening G. and Doi R.H., Outlines of Biochemistry, John Willey and Sons Inc. New York and Toronto.
3. Voet D., Voet J.G., and Pratt C.W., Principle of Biochemistry, John Wiley and Sons Inc. New York
4. Elliott W.H. and Elliot D.C., Biochemistry and Molecular Biology, Oxford University press Inc. New York
5. Metzler D.E., Biochemistry, Academic Press, London and New York.
6. Berg J.M., Tymoczko J.L. and Stryer L., Biochemistry, WH Freeman Publishers, New York
7. Garret R.H. and Grisham C.M., Biochemistry, Brooks/Cole, Boston

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Cell Biology

Course Code - SIAL BT 01 103 C 5005 **Credits: 5**

Objective: *The objective of this course for the student to understand and gain knowledge about the cell and their role in this living world.*

Course Contents:

UNIT – I

Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

UNIT- II

Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle

Cell signaling: Hormones and their receptors, cell surface receptor, signalling through G-protein coupled receptors, signal transduction pathways, second messengers and regulation of signalling pathways

UNIT- III

Cellular communication: General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junction, extracellular matrix, integrins, neurotransmission and its regulation.

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth

UNIT- IV

Photosynthesis and Respiration: Photosynthetic apparatus, light reaction, cyclic and non-cyclic proto induced electron flow, C3 and C4 cycle and their regulation and CAM pathway, photorespiration, dark phase of photosynthesis.

Suggested Readings:

1. Alberts B. et al., Molecular Biolog of Cells, Taylor and Francis
2. Lodish et al., Molecular Cell Biology, W H Freeman Publisher.
3. Gilbert S.F., Developmental Biology, SF Sinauer Associates Inc.
4. Karp G., Cell and molecular biology: Concept and Experiments. John Willy, New York
5. Freedman L.P., Molecular Biology of Steroid and Nuclear Hormone Receptors, Birkhuser.
6. Nelson D.L. and Cox M.M., Lehninger Principles of Biochemistry, Freeman and Company, New York
7. Hardin J., Bertoni G. and Kleinsmith L.J., Beker's world of Cell, Pearson

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - PRACTICAL-I
Course Code - SIAL BT 01 104 C 00126 **Credits: 6**

Any fifteen (15)

1. General Laboratory-safety and Bio-safety measures in biotechnology laboratory.
2. Preparation of normal and molar solutions, buffers, pH setting etc.
3. Evaluation of various sterilization methods.
4. To study various parts of microscope and demonstration of microscopic techniques.
5. Quantitative estimation of proteins.
6. Quantitative estimation of reducing sugars and total sugars.
7. Estimation of total phenolic compounds.
8. Thin layer chromatography: sugars
9. Quantitative estimation of plant cell wall carbohydrates
10. Estimation of enzyme activities
11. Calculation of K_m and V_{max} of a given enzyme
12. Genomic DNA and plasmid DNA isolation from plant/bacteria
13. Qualitative and quantitative analysis of DNA.
14. Determination of gram –ve and gram +ve bacteria using gram staining.
15. Study of mitosis in onion root-tip cells.
16. Sub-cellular fractionation by differential centrifugation and demonstration of micrographs of different cell components.
17. Determination of protein sequence of a given polypeptide (Dry lab)
18. Calculating recessive gene frequency, sex –linked alleles frequency and Chi square test.
19. Inheritance patterns in Man – Numericals on Pedigree analysis- Autosomal patterns, X–linked patterns, Y–linked patterns, Mitochondrial inheritance patterns.
20. Gene mapping using three point test cross/tetrad analysis

Course - Principles of Biotechnology

Course Code - SIAL BT 01 101 E 4004 **Credits: 4**

Objective: *This course will give the knowledge to student about the scope of biotechnology in the different field of life science.*

Course Contents:

UNIT – I

Biotechnology: An overview-definition, Scope and importance of biotechnology, Concepts of recombinant DNA technology and Gene Cloning.

Microbial Biotechnology: A brief account of microbes in industry and agriculture, Metabolic engineering for over production of metabolites

UNIT- II

Plant Biotechnology: Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction), Chloroplast and mitochondria engineering.

Animal Biotechnology: *In-vitro* fertilization and embryo transfer in humans and livestock, Transfection techniques and transgenic animals, Animal Cloning.

UNIT- III

Medical Biotechnology: (A brief account) Biotechnology in medicine, Vaccines, Molecular diagnostics, Forensic, Gene therapy, Nano Medicine & Drug Delivery Cell & Tissue Engineering, Stem Cell therapy.

Environmental Biotechnology: (A brief account) Role of biotechnology in pollution control, Sewage treatment, Energy management, Bioremediation, Restoration of degraded lands and Conservation of biodiversity.

UNIT- IV

Nano Science & Technology: An Overview, Insights and intervention into the Nano world, Important Developments, Societal implications & Ethical issues in Nanotechnology, applications of Nano-biotechnology in different areas.

Intellectual Property Right Issues: PR Bio-business, Biotechnology for developing countries and IPR

Suggested Readings:

1. Nelson D.L. and Cox M.M., Lehninger Principles of Biochemistry, Freeman and Company, New York
2. Pelczar M.J. et. Al., Microbiology- Concepts and Applications, International Ed. McGraw Hill Publication, New York
3. Stanbury P.F., Hall S. and Whitaker A., Principles of Fermentation Technology, Butterworth-Heinemann Ltd
4. Slater A., Scott N. and Fowler M., Plant Biotechnology – The genetic manipulation of plants, Oxford University Press.
5. Jenni P.M. and David B., Animal Cell Culture Methods In: Methods in Cell Biology, Academic Press.
6. T.A Brown., Genome-3, Garland science, Taylor & Francis, NewYork.
7. Andrew J.T. and Catherine E. U.,Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine) Publisher: Humana Press.
8. Ajayan, P., Schadler, L.S. and Braun, P.V., Nanocomposite Science and Technology, Wiley-VCH Verlag.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

SEMESTER-II

Course - Tools and Techniques in Biotechnology

Course Code - SIAL BT 01 205 C 4004 **Credits: 4**

Objective: *This course provides knowledge of the techniques used in the field of biotechnology to pursue their research experiment in the daily lab practices.*

Course Contents:

UNIT – I

Microscopy: Principles, Resolving Power and applications of Light microscopy, Electron microscopy (SEM, TEM) and Confocal microscopy, Phase contrast microscopy.

Centrifugation: Brief history, Types of centrifugation, theory of centrifugation, Centrifugation techniques, Types of rotors, Density gradient centrifugation in isolation of cells, cell organelles and biomolecules.

UNIT- II

Electrophoresis: History, Principles, Application and factor affecting of electrophoresis with detail reference to Agarose, PAGE, PFGE, Capillary electrophoresis, continuous, 2D-PAGE, IEF.

Detection of Nucleic Acids and Proteins: Southern, Western and Northern blotting, PCR, Immuno-blotting, Immuno-electrophoresis, DNA finger printing and ELISA.

DNA Sequencing Techniques: DNA sequencing methods of Sanger, Maxim-Gilbert, Pyro-sequencing, Solid sequencing, Ion-torrent sequencing, SMR etc.

UNIT- III

Spectroscopy: Introduction, theory and principles of different types of Spectroscop: Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomic absorption spectroscopy, ESR and NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy, and their applications in biotechnology.

Chromatography: General principles and techniques of HPLC, FPLC, GLC, Adsorption Chromatography, partition chromatography, IEC, Gel permeation Chromatography, Affinity Chromatography. Applications of Chromatographic techniques in Biology

UNIT- IV

Radioisotope Technique: Nature of Radioactivity, characteristics of different radiolabels, detection and measurement in Radioactivity, Nature and types of radiations, preparation of labelled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Flow cytometry. Safety measures in handling radioisotopes, RIA, Applications of radioisotopes in biological sciences.

Suggested Readings:

1. Freifelder D., Physical Biochemistry- Application to Biochemistry and Molecular Biology, W.H. Freemen and Company, San Fransisco.
2. Rietdorf, J., Microscopy Techniques, Springer, Berlin
3. Walker J. and Wilson K., Principles and Techniques-Practical Biochemistry, Cambridge University Press, London.
4. Robyt, J.F. and White, B.J., Biochemical Techniques: Theory and Practice, Waveland Press
5. Skoog, D.A., Crouch S.R. and Holler F.J., Principles of Instrumental Analysis, Brooks/Cole, USA
6. Slater R.J., Radioisotopes in Biology-A Practical Approach, Oxford University Press, New York.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Microbial Process Engineering and Technology

Course Code - SIAL BT 01 206 C 4004 **Credits: 4**

Objective: *This course provide insight for the working principle of microbial production processes in lab and industrial scale*

Course Contents:

UNIT – I

Biotechnology of fermentation: Methods and types of fermentation, dual/multiple fermentation, continuous fermentation and late nutrient addition, growth kinetics of microorganisms, fermenter systems and fermentation. Types of fermentation process, analysis of batch fed batch and continuous bioreactions.

UNIT- II

Bioreactors: Basic concepts of bioreactors, parameters of biochemical process, packed bed, fed-batch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors, Reactor Dynamics and reactors with non-ideal characteristics, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.)

Bioreactor Control: Manual and automatic control system, on-line and off-line analytical instruments, methods of measurement of process variables, Data analysis and process control. Energy forming bio-processes for the production of liquid fuel (ethanol), and gaseous fuel (methane), Microbial production of hydrogen.

UNIT- III

Industrial microbial products: Production of Alcohols, Acids, Solvents, Antibiotics, Amino Acids, Single Cell Proteins, Bioemulsifiers, Biosurfactants, Antibiotics, Insulin, Steroids, Metabolic Engineering.

UNIT- IV

Scale-up Studies: Translation of laboratory, pilot and plant scale data, Criteria for translation between two scale of operation, Scale-up practices, Bases for scale-up methods, Comparison of various scale-up methods, Non-geometric scale-up.

Downstream processing: Introduction, removal of microbial cells and solid matters, foam separation, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment

Suggested Readings:

1. Pelczar M.J. et. al., Microbiology- Concepts and Applications, International Ed. McGraw Hill Publication, New York
2. Willey, J.M., Sherwood, L. and Woolverton, C., Prescott's Microbiology, McGraw Hill Higher Education, New York
3. Madigan M.T., Martinko J.M., Bender K., and Buckley D., Brock Biology of Microorganisms, Pearson Education, USA
4. Stanbury P.F., Hall S., Whitaker A., Principles of Fermentation Technology, Butterworth-Heinemann Ltd
5. Cruger W. and Kruger., Biotechnology –A Textbook of Industrial Microbiology, Panima Publishing Corporation, New Delhi.
6. Black J.G., Microbiology: Principles and Explorations, John Wiley and Sons, USA.
7. Pommerville J.C., Alcamo's Fundamentals of Microbiology, Jones and Bartlett Publishers.
8. Tortora G.J., Funke B.R. and Case C.L., Microbiology -An Introduction, Pearson education Pvt. Ltd. Singapore.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Immunology

Course Code - SIAL BT 01 207 C 4004 **Credits: 4**

Objective: *The objective of this course is to learn about the structural features of the components of the immune system as well as their functions, but the primary emphasis of this course will be on the mechanisms involved in immune system development and responsiveness.*

Course Contents:

UNIT – I

Introduction: History, Concept and Scope of Immunology.

Immunity: Innate and Acquired immunity, Passive and Active Immunity, Lymph and organs, Humoral and Cell Mediated immunity, Specificity and Memory, Major Histocompatibility Complex (MHC) and Complements.

UNIT- II

Antigen-Antibody interaction: Antibody structure and function, Antigen-Antibody reactions, Antigen type-hapten, Generation of antibody diversity and complement system, Serological reactions, Agglutination, Precipitation, Immuno-electrophoresis, ELISA, RIA, Immuno-electro microscopy.

Cells of immune system: Hematopoiesis and differentiation, Lymphocyte trafficking, B-lymphocyte, T-lymphocytes, Macrophages, Dentritic cells, Natural killer and lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells.

UNIT- III

Generation of B-cell and T-cell response: Activation of B and T- lymphocytes. Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity.

Antigen processing and presentation: Antigen processing and presentation, Generation of humoral and cell mediated immune responses, Cytokines and their role in immune regulation, T- cell regulation, MHC- regulation, Immunological tolerance, Hypersensitivity, Autoimmunity, Immonosenesence, Transplantation immunity.

UNIT- IV

Hybridoma Technology: Monoclonal antibody production, Myeloma cell lines, Fusion of myeloma cells without antibody producing B-cells, Selection and screening methods for positive hybrids, Production, purification and characterization of monoclonal antibodies without Hybridoma, Genetic manipulation of immunoglobins.

Diseases and Vaccines: T-cell cloning, mechanism of antigen recognition by T-and B-lymphocytes, Genetic control of immune response, autoimmune diseases, immunodiagnosis, AIDS, types of vaccines, Strategies for the development of vaccines for infectious diseases.

Suggested Readings:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A., Immunology, Freeman.
2. Brostoff J., Seaddin J.K., Male D. and Roitt I.M., Clinical Immunology, Gower Medical Publishing.
3. Janeway et al., Immunobiology, Current Biology publications.
4. Paul., Fundamental of Immunology, Lippincott Raven,
5. Goding., Monoclonal antibodies, Academic Press.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course – PRACTICAL-II **Credits 6**
Course Code - SIAL BT 01 208 C00126

Any Fifteen (15)

1. Separation of amino acids/ sugars/ lipids by Thin Layer Chromatography.
2. Determination of molar extinction coefficient of tryptophan / tyrosine and Ultra violet absorption spectra of nucleic acids and proteins.
3. Purification of protein/enzyme by Gel filtration/Ion exchange chromatography/Affinity chromatography.
4. Polyacrylamide gel electrophoresis of proteins.
5. Determination of isoelectric point of glycine.
6. Determination of A, B, O and Rh blood groups in human beings.
7. Radial immunodiffusion.
8. Quantitative precipitin assay.
9. Immunoelectrophoresis.
10. Latex agglutination test.
11. Enzyme Linked Immunosorbent Assay (ELISA).
12. Database search using BLAST and Sequence submission protocols
13. Sequence alignments (Pair wise and Multiple), Sequence and structure visualization.
14. Construction of phylogenetic tree and prediction
15. Isolation, culturing and maintenance of microorganisms and study of microbial growth kinetics
16. Estimation of enzyme activities of cellulases, xylanases, amylases etc.
17. Ethanol production from Saccharomyces cerevisiae and study of fermentation kinetics
18. To study the design of fermenter and its working
19. Production of extracellular enzymes and its purification by salt and solvent precipitation
20. To study the microbial decolorization of industrial dyes/ analogues

Course Code - SIAL BT 01 202 E 4004 **Credits: 4**
Genomics and Proteomics /Microbial Growth, Enzyme and Fermentation Kinetics

Course - Genomics and Proteomics

Objective: *The overall aim of the subject is to provide students an overview of Genomics and Proteomics including fundamentals, current techniques and applications. Including, understanding the aspects of diversity and complexity of eukaryotic and prokaryotic genomes.*

Course Contents:

UNIT – I

Origin and Evolution of genomics: Origin of genomics, The first DNA genomes, Microcollinearity, DNA based phylogenetic trees, Genomes and human evolution, Evolution of nuclear and organellar (mitochondrial and Chloroplast) genome, The concept of minimal genome.

Molecular maps of genomes and Comparative genomics: Genetic maps, Physical maps, EST and transcript maps, Functional maps, Comparative genomics and collinearity/synteny in maps

UNIT- II

Structural and Functional Genomics: Whole genome shotgun sequencing, Clone-by-clone or 'hiererchical stotgun' Sequencing, Microbial genomes (including yeast), Plant genomes (Arabidopsis and rice), Animal genomes (fruit fly, mouse, human), Annotation of whole genome sequence and functional genomics, In silico methods, Insertion mutagenesis (T-DNA and transport insertion), TILLING, Management of data, Gene expression and transcript profiling, EST contigs and unigene sets, Use of DNA chips and Microarrays.

Pharmacogenomics: Use in biomedicine involving diagnosis and treatment of diseases, genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases, use of SNP in pharmacogenomics, pharmacogenomics and industry.

UNIT- III

Study and Scope of proteomics: Introduction, definition concepts and approaches of proteomics studies and activities.

Quantitative and Qualitative proteome analysis technique: Separation technique- 2D PAGE, 2-DE (BN-PAGE), image analysis, Mass- spectrophotometery, LC-TMS, MALDI, and SALDI.

UNIT- IV

Protein interaction and Protein complex: Protein interaction, DNA- Protein interaction, Yeast two hybrid and 3- hybrid system and their applications.

Drug Discovery and Development: Current issues, drug targets, Drug efficacy, Drug toxicology, Protein chips and Antibody Microarray, proteomics in cancer research.

Suggested Readings:

1. Leister D., Plant Functional Genomics , Taylor & Francis
2. Weckwerth W., Metabolomics: Methods and Protocols , Humana Press
3. Lodish H. Berk A. et al., Molecular Cell Biology , W.H. Freeman and Company, New York
4. Primrose S.B. and Twyman R., Principles of Genome Analysis and Genomics. John Willey and Sons Ltd
5. Dubitzky W., Granzow M., Berrar D.P., Fundamentals of Data Mining in Genomics and Proteomics. Springer Science- Business Media.
6.. Mine Y., Miyashita K., Shahidi F., Nutrigenomics and Proteomics in Health and Disease: Food Factors and Gene Interaction. Wiley Blackwell

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Microbial Growth, Enzyme and Fermentation Kinetics Credits 4

Objective: *The main objective of this course for the students is to give an overview about how the different parameters are affecting the kinetics properties of different aspect of technology.*

Course Contents:

UNIT – I

Microbial Growth Kinetics: Thermodynamic principles, Stationary cell growth, Growth yield, Specific growth rate, Product yield, Yield equations, Maintenance energy, Kinetics of balanced growth, Transient growth kinetics, Growth kinetics of batch, fed-batch, plug flow and continuous culture, Comparison of batch and continuous culture system, Product synthesis kinetics, Growth and non-growth associated product synthesis

UNIT- II

Enzyme Kinetics: Classification and Nomenclature of Enzymes. Enzyme kinetics. Factors affecting the rates of enzyme catalysed reactions. Assay of enzyme activity – units of enzyme activity. Multi-substrate reactions. Enzyme – substrate (protein ligand) binding. Methods for measurement of km. Enzyme inhibition – Competitive, non-competitive and uncompetitive. Allosteric enzymes, Ribozymes and catalytic antibodies

UNIT- III

Fermentation kinetics: Methods and types of fermentation, Submerged fermentation, dual/multiple fermentation, continuous fermentation and late nutrient addition, growth kinetics of microorganisms, fermenter systems and fermentation. Solid state fermentation, Effect of environmental parameters on kinetics and growth of product formation and cellular physiology, Process variables and process control, Principles of solid state bioreactor design and operation and product leaching.

UNIT- IV

Mass Transfer in Microbial System: Fluids and its properties, Non-Newtonian fluids, introduction to transport phenomena, Gas–liquid mass transfer, Intra-particle diffusion, Oxygen transfer and utilization in gassed microbial system, mass transfer resistances, Oxygen transfer rate and factors affecting it, determination of oxygen transfer coefficient, oxygen transfer efficiency, transport bottlenecks in bioprocesses, heat transfer in biological processes, heat transfer coefficient correlations.

Suggested Readings:

1. Nelson D. L. and Cox M. M., Lehninger Principles of Biochemistry, Freeman and Company, New York
2. Pelczar, M.J. et al., Microbiology- Concepts and Applications, International Ed. McGraw Hill Publication, New York
3. Willey, J.M., Sherwood, L., and Woolverton, C., Prescott's Microbiology, McGraw Hill Higher Education, New York
4. Madigan, M.T., Martinko, J.M., Bender, K., and Buckley, D., Brock Biology of Microorganisms, Pearson Education, USA
5. Stanbury, P.F., Hall, S., Whitaker, A., Principles of Fermentation Technology, Butterworth-Heinemann Ltd
6. Cruger,W. and Cruger., Biotechnology –A Textbook of Industrial Microbiology, Panima Publishing Corporation, New Delhi.
7. Tortora, G.J., Funke, B.R. and Case, C.L., Microbiology -An Introduction, Pearson education Pvt. Ltd. Singapore.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course – Biosafety, Bioethics and IPR

Course Code - SIAL BT 01 203 E 4004 **Credits: 4**

Objective: *To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products. To understand ethical issues in biological research, and provide basic knowledge on intellectual property rights.*

Course Contents:

UNIT – I

Biosafety: introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops *vs* cisgenic plants or products derived from RNAi, genome editing tools.

Regulations: International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies.

UNIT- II

Bioethics: Introduction**,** ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

UNIT- III

Patenting: Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application-forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications, PCT and conventional patent applications.

UNIT- IV

International patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/Credits sharing among parties/community, commercial (financial) and non-commercial incentives.

Suggested Readings:

1. Ganguli, P. (2001). *Intellectual property rights: Unleashing the knowledge economy*. New Delhi: Tata McGraw-Hill Pub.
2. *Complete Reference to Intellectual Property Rights Laws*. (2007).

3. Kuhse, H. (2010). *Bioethics: An anthology*. Malden, MA: Blackwell.
4. Office of the Controler General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
5. World Trade Organisation. http://www.wto.org
6. World Intellectual Property Organisation. http://www.wipo.int
7. International Union for the Protection of New Varieties of Plants. http://www.upov.int
8. National Portal of India. http://www.archive.india.gov.in
9. National Biodiversity Authority. http://www.nbaindia.org
10. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf
11. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem formulation in the environmental risk assessment for genetically modified plants. *Transgenic Research*, 19(3), 425-436. doi:10.1007/s11248-009-9321-9 .
12. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). An overview of general features of risk assessments of genetically modified crops. *Euphytica, 164*(3), 853-880. doi:10.1007/s10681-007-9643-8
13. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
14. Guidelines and Standard Operating procedures for confined field trials of regulated genetically engineered plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp.
15. Alonso, G. M. (2013). Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments. Retrieved from http://biosafety.icgeb.org/inhousepublications/collectionbiosafetyreviews

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

SEMESTER III

Course - Cell and Tissue Culture
Course Code - SIAL BT 01 309 C 4004 **Credits: 4**
Objective: *This course is an introduction to the theory, standard practices, and methodologies of animal cell culture.*
Course Contents:

UNIT – I

Introduction to plant cell and tissue culture: Historical perspective, Laboratory organization, aseptic manipulations, culture media preparation, Use of plant growth regulators, Single cell culture, Initiation and maintenance of suspension culture- batch and continuous culture, Callus culture, Protoplast culture, Somatic hybridization.

UNIT- II

Plant tissue culture techniques: micropropagation, Meristem culture, Shoot tip culture and production of virus free plants, Somaclonal variations, In vitro production of haploid plants – Androgenesis (anther and pollen culture) and Gynogenesis (ovary and ovule culture), Doubled haploid production through distant hybridization, In vitro and in vivo pollination and fertilization, Embryo culture, embryo rescue, somatic embryogenesis, artificial seeds, germplasm conservation and cryopreservation.

UNIT- III

Animal cell and tissues culture: Historical background, terminology, advantages and limitations of cell & tissue culture, aseptic area, elements of aseptic environment, sterile handling, media sterilization, the substrate, choice of culture vessel, treated surfaces.
Defined media and supplements: physicochemical properties, balanced salt solutions, complete media, role of serum and supplements, serum free media: advantages and disadvantages of serum and serum free media, replacement of serum, development of serum free media.

UNIT- IV

Primary culture and Sub-culturing of animal cells: types of primary cell culture, isolation of the tissue, primary culture, Subculture and propagation, Criteria for subculture, Subculture of monolayer cells, growth cycle and split ratio, propagation and subculture in suspension, dilution and suspension cloning, scaling up in suspension and monolayer, large scale production of cells using bioreactors, microcarriers and perfusion techniques, cell synchronization methods and applications.
Cell line maintenance and characterization: Preservation and maintenance of animal cell lines, Stem cells, cryopreservation, transport of animal germplasm (i.e. semen, ova and embryos), cell characterization, antigen markers.

Suggested Readings:

1. Bhojwani S.S. and Razdan M.K., Plant tissue culture – Theory and Practice, Elsevier publication.
2. Clynes M., Animal Cell Culture Techniques, Springer-Verlag Berlin Heidelberg.
3. Davey M.R. and Anthony P., Plant Cell Culture: Essential Methods Wiley Publishers.
4. Davis J.M., Animal Cell Culture: Essential Methods, Wiley Publishers.
5. Freshney R.I., Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Wiley-Blackwell.
6. Gamborg O.L. and Phillips G., Plant Cell, Tissue and Organ Culture: Fundamental Methods (Springer Lab Manuals), Springer.
7. Jha T.B. and Ghosh B., Plant Tissue Culture: Basic and Applied, Orient Blackswan publishers.
8. John R.W.M., Animal Cell Culture - A Practical Approach, Oxford University Press.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Genetic Engineering

Course Code - SIAL BT 01 310 C 4004 **Credits: 4**

Objective: *Students will understand the basic processes involved in manipulating genetic information, examine different uses of genetic engineering, analyse a variety of opinions, and evaluate several issues surrounding the topic.*

Course Contents:

UNIT – I

Nucleic Acids: Isolation, Purification, and Yield Analysis, Radiolabelling of nucleic acids: End labelling, nick translation, labelling by primer extension, DNA sequencing.

Enzymes of recombinant DNA technology: Restriction endonucleases, DNA modifying enzymes, other nucleases, Polymerases, Ligase, kinases and phosphatases.

UNIT- II

Gene cloning and library construction: Gene cloning vectors (Plasmids, Phages, Cosmids, Artificial chromosomes, Shuttle vectors, Expression vectors), Joining of DNA Fragments to vectors, Homo polymer tailing, cohesive and blunt end ligation, adaptors, linkers, Genomic and c-DNA libraries.

Selection, screening and analysis of recombinants: Southern blotting, Polymerase chain reaction, Northern blotting, Western blotting, Nucleic acid microarrays

UNIT- III

Manipulating gene expression: Vector Engineering and codon optimization, host engineering, Strategies of gene delivery, in vitro transcription and translation, expression of cloned genes in bacteria, expression in yeast, expression in insect cells, expression in mammalian cells, expression in plants, Site-directed Mutagenesis, Protein Engineering.

UNIT- IV

Applications of genetic engineering: Animal transgenesis and live-stock improvement, Transgenic plants and applications in crop improvement, Medical applications: Molecular genetic diagnosis of human diseases, gene therapy, DNA vaccines, Biosafety and ethical considerations.

Suggested Readings:

1. Altman A. and Hasegawa P.M., Plant Biotechnology and Agriculture: Prospects for the 21st Century, Academic Press.
2. Brown T.A., Genomes, Garland science, Taylor & Francis, NewYork.
3. Brown T.A., Gene Cloning and DNA Analysis: An Introduction, Wiley-Blackwell.
4. Dale J.W., Schantz M.V. and Plant N., From Genes to Genomes: Concepts and Applications of DNA Technology, Wiley-Blackwell.
5. Saldana H. A., Genetic Engineering: Basics, New Applications And Responsibilities, Intech publishers.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Bioinformatics and Biostatistics

Course Code - SIAL BT 01 311 C 4004 **Credits: 4**

Objective: *To familiarize the students for the scope of computer in the field of research*.

Course Contents:

UNIT – I

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

Introduction of Bioinformatics: History, aims of Bioinformatics, Definition and Concepts, Components of Bioinformatics, Basic tools, Scope of Bioinformatics in molecular biology and Computers, Role of internet in Bioinformatics, Applications of Bioinformatics.

UNIT- II

Protein and Nucleic acid databases: DNA-the staff of life, molecular sequence alignments and sequence search (BLAST, FASTA, CLUSTALW), molecular visualization integrated molecular biology database. Protein and Nucleic acid databases, databases accession, database searching, NCBI based study.

Construction of phylogenetic tree and analysis: Predicting structure and function, Molecular Evolution and phylogenetic trees, Methods for Phylogenetic analysis: Sequence Alignment, Construction of Phylogenetic Tree, Softwares (Ssearch, Treeview, Phylip, Rasmol).

UNIT- III

Presentation of Data: Frequency distributions, graphical presentation of data by histogram, frequency polygon, frequency curve, and cumulative frequency curves.

Measures of central tendency and dispersion: Mean, Median, Mode and their simple properties (without derivations), and calculation of median by graphs, range, mean derivation, standard deviations, coefficient of variation.

UNIT- IV

Test of Significance and Experimental Design: Sampling distribution of mean and standard error, large scale sample tests(tests for an assumed mean and equality of two population means with known S.D.), small sample tests (t-tests for an assumed mean and equality of means of two populations when sample observations are independent, paired and unpaired t-test, t- test for correlation and regression coefficients), t-test for comparison of variances of two populations, chi-square test for independent of attributes, goodness of fit and homogeneity of samples. Principles of experimental designs, completely randomized, randomized block and Latin square designs, simple factorial experiments (mathematical derivation not required), analysis of variance (ANOVA) and its uses.

Suggested Readings:

1. Mount, D.W, Bioinformatics: Sequence & Genome Analysis, Cold Spring Harbor Laboratory Press.
2. Lesk, A.M., Introduction to Bioinformatics, Oxford University Press, Oxford.
3. Day, R.A., How to Write and Publish a Scientific Paper, Cambridge University Press, Cambridge
4. Krane, D.E., Fundamental Concept of Bioinformatics, Dorling Kindersley Pvt. Ltd.
5. Przytycka, T.M. and Sagot, M.F., Algorithms in Bioinformatics, Springer My Copy, UK.
6. Gupta, S.P.,Statistical Methods., S. Chand & Sons, New Delhi.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - PRACTICAL III **Credits: 6**

Course Code - SIAL BT 01 312 C 00126

Any fifteen (15)

1. To study the laboratory organization and aseptic manipulations in plant and animal cell culture lab.
2. Isolation and culturing of animal cells from primary tissue explant.
3. Sub-culturing of monolayer confluent cells.
4. Counting of animal cells using haemocytometer.
5. Staining of monolayer confluent cells using geimsa and crystal violet.
6. To discriminate between viable and non-viable cells using trypan blue.
7. Animal cell cloning in microtitration plates.
8. Preparation of Murashige and Skoog medium, stocks of macronutrients, micronutrients, vitamins and hormones, autoclaving, filter sterilization of hormones and antibiotics.
9. Callus culture using various explants, regeneration of shoots and root induction.
10. Anther/ Pollen and Ovary/ Ovule culture.
11. Protoplast isolation and culture.
12. Preparation of artificial seeds through gel entrapment.
13. DNA extraction and DNA estimation from plants
14. Melting temperature determination of DNA
15. PCR analysis and DNA finger printing methods, RAPD, SSR etc.
16. Preparation of genomic DNA library
17. mRNA isolation and preparation of cDNA library
18. Cloning of DNA in plasmid
19. Blue white screening of clones
20. Restriction Digestion of clones and visualization of bands

Course - Medical Biotechnology/Pharmacogenomics

Course Code - SIAL BT 01 304 E 4004 **Credits: 4**

Course - Medical Biotechnology

Objective: *Purpose of this course is to give an overview about the disease and its diagnostic techniques used in the field of medical; further student will know the application of this course in human life.*

Course Contents:

UNIT – I

Classification of genetic diseases: Chromosomal disorders- Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X- linked disorders, Mitochondrial disorders.

UNIT- II

Molecular basis of human diseases: Pathogenic mutations. Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor, Genomic, Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy, Mitochondrial diseases

UNIT- III

Diagnostic techniques: Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS), Noninvasive techniques- Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood, Diagnosis using protein and enzyme markers, monoclonal antibodies, DNA/RNA based diagnosis Hepatitis, CML – bcr/abl, HIV - CD 4 receptor, Microarray technology- genomic and cDNA arrays, application to diseases.

UNIT- IV

Clinical management and Metabolic manipulation: PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism, Gene therapy - Ex-vivo, In-vivo, In-situ gene therapy, Strategies of gene therapy: gene augmentation, Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer, Gene therapy trials – Familial Hypercholesterolemia, Cystic Fibrosis, Solid tumors, Cell and tissue engineering: Stem cell Potential use of stem cells – Cell based therapies, Nanomedicine.

Suggested Readings:

1. George A.J.T. and Urch C.E., Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine) Humana Press.
2. Glick B.R., Patton C.L. and Delovitch T.L., Medical Biotechnology, ASM Press.
3. Jochen Decker, U. Reischl, Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine), Humana Press.
4. Kayser O. and Warzecha H., Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Wiley-Blackwell.
5. Strachan T. and Read A., Human Molecular Genetics, Garland Science publisher.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Pharmacogenomics

Course Code - SIAL BT 01 304 E 4004 **Credits: 4**

Objective: *This course covers basic as well as practical uses of genomics in pharmacology.*

Course Contents:

UNIT-I

Pharmacogenomics; Pharmacogenetics; Benefits; Practical applications of pharmacogenomics; The Promise of Pharmacogenomics today leading to personalized medicines; Human genetic variation- examples of CYP gene variations leading to variable metabolism of drugs.

UNIT-II

Drug metabolism & Drug Excretion; Drug efficacy & toxicity; drug therapeutic levels; Therapeutic Index; Drug abuse; ADME of Drug- Drug absorption; Drug distribution.

UNIT- III

Drug response in patients by correlating gene expression; Genotyping; example of TPMT and DPD gene mutation and their impact in treatment strategy

UNIT- IV

Genetic markers-Biomarkers in early drug development; Biomarkers in Clinical development; Biomarkers for molecular Diagnostics- example of cancer biomarkers; Pharmacogenetics & drug development.

Suggested readings:

1. Wu R and Lin M, Statistical & Computational Pharmacogenomics, CRC Press, 2008.
2. Yan Q, Pharmacogenomics in Drug Discovery and Development, Springer-Verlag New York, LLC, 2008.
3. Meyer UA and Tyndale RF, Pharmacogenomics, 2nd Edition, CRC Press, 2005.
4. Innocenti F, Pharmacogenomics: Methods and Applications Springer-Verlag New York, LLC, 2005.
5. Rothstein MA and Collins FS, Pharmacogenomics: Social, Ethical, and Clinical Dimensions, Wiley John & Sons, Inc., 2003

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Environmental Biotechnology/Metabolic Engineering

Course Code - SIAL BT 01 305 E 4004

Course – Environmental Biotechnology **Credits: 4**

Objective: *This course is an introduction to the role of biotechnology in various aspects of environment.*

Course Contents:

UNIT - I

Environment; Basic concepts; Resources; Eco system: plants, animals, microbes; Ecosystem management; Renewable resources; Sustainability; Microbiology of degradation and decay; Role of Biotech in environmental protection; Control and management of biological processes.

UNIT - II

Enviromental pollution; Source of pollution; Air, water as a source of natural resource; Hydrocarbons, substituted hydro carbons; Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Biofilm; Soil pollution; Radioactive pollution; Radiation; Ozone depletion; Green-house effect; Impact of pollutants; Measurement techniques; Pollution of milk and aquatic animals.

UNIT-III

Need of solid waste treatment, characteristics of municipal, industrial and biomedical wastes; Collection, reduction of waste strength & volume; Classification and characterization of solid waste; Dry and wet waste treatments recovery and recycling of metals; Disposal methods for medical, industrial and biomedical wastes; Composting and vermin-composting.
Bioremediation of organic pollutants and odorous compounds; Use of bacteria, fungi, plants, enzymes, an GE organisms; Bioremediation of contaminated soils and waste land. Bioremediation of contaminated ground water; Macrophytes in water treatment; Phytoremediation of soil metals; Treatment for waste water from dairy, distillery, tannery, sugar and antibiotic industries.

UNIT - IV

Innovative techniques for prevention and control of Pollution: Use of solar radiation in industrial effluent treatment; Solar detoxification process; Carbon adsorption; Adsorption media filters; Micro-screening and other low cost treatment methods; Removal of chromium, phenol, mercury, nitrogen etc. from industrial effluents.

Suggested Readings:

1. Agarwal S.K. (1998), Environmental Biotechnology, APH Publishing Corporation, New Delhi.

2. David S. (1997), Bioremediation Protocols, Humana Press, New Jersey.

3. Stankey E. M. (1997), Environmental Science and Technology, Lewis Publishers, New York.

4. Glazer and Nikaido (1998), Microbial Biotechnology, WH Freeman & Company, New York.

5. Singh A. and Ward O.P. (2004), Biodegradation and Bioremediation: Soil Biology, Springer.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course - Metabolic Engineering **Credits: 4**

Objective: *This course covers basic as well as applied part of metabolic engineering.*

Course Contents:

UNIT- I

Elements of Metabolic Engineering

Historical perspective and introduction; Importance of metabolic engineering; Paradigm shift; Information resources; Scope and future of metabolic engineering; Building blocks of cellular components; Polymeric biomolecules; Protein structure and function; Biological information storage – DNA and RNA.

UNIT- II

Review of cellular metabolism

Transport mechanisms and their models; Enzyme kinetics; Mechanisms and their dynamic representation; Regulation of enzyme activity versus regulation of enzyme concentration; Regulation of metabolic networks; Regulation of at the whole cell level; Examples of important pathways; Case studies and analytical-type problems

UNIT- III

Metabolic Flux Analysis and control theory

The theory of flux balances; Derivation of the fundamental principle; Degree of freedom and solution methods; Moore-Penrose inverse and Tsai-lee matrix construction; Examples of applications of flux analysis introduction Metabolic Control Theory; Control coefficients; Elasticity coefficients; Summation and connectivity theorems; Case Studies and examples

UNIT-IV

Metabolic Engineering Practice

The concept of metabolic pathway synthesis; Need for pathway synthesis, Examples for illustration; Overall perspective of MFA, MCA and MPA and their applications; Three success case studies.

Suggested Readings:

1. Gregory N. Stephanopoulos, Aristos A. Aristidou, Metabolic Engineering – Principles and Methodologies, 1st Edition, Jens Nielsen Academic Press, 1998

2. Gerhard Gottschalk, Bacterial Metabolism, 2nd Edition, Springer Verlag, 1986

3. S. A. Teukolsky, W. T. Vellerling, B. P. Flannery, W. H. Press, Numerical Recipes in C, Cambridge University Press, 1993

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

SEMESTER IV

Course - Dissertation

Course Code - SIAL BT 01 401 SEEC 00024 **Credits-24**

The dissertation topics will be based on core or elective papers and/or topics of current interest. Departmental committee will distribute the topics according to the skill and merit of the students.
Each candidate have to carry out the dissertation work assigned to him/her and should submit bound copies of the research work performed by him/her duly certified by the guide/supervisor. The project report should include abstract, review of literature, introduction, materials and methods, observation & results, discussion, summary & conclusion followed by bibliography. The references should be arranged alphabetically under the format given below:

Referred Journal
Sharma TC, Sharma CT and Sharma T (2006) Expression of alkaline pectinase in *Bacillus* sp. Lett. Appl Microbiol 12:245-350

Book
Demartino, GN (1996) Purification of proteolytic enzyme. In: Cellulolytic enzyme: an advance approach. Maheshwari RJ and James JS eds, Springer Germany.

Thesis
Garg ML (2006) Screening, isolation and identification of thermotolerant *P. aeruginosa* amylase. PhD Thesis, Arunachal Pradesh University, Arunachal Pradesh, India.

Web-site: www.elsevier.com

Course - Dissertation

Course Code - SIAL BT 01 401 SEEC 00016 Credits-16

The dissertation topics will be based on core or elective papers and/or topics of current interest. Departmental committee will distribute the topics according to the skill and merit of the students.
Each candidate have to carry out the dissertation work assigned to him/her and should submit bound copies of the research work performed by him/her duly certified by the guide/supervisor. The project report should include abstract, review of literature, introduction, materials and methods, observation & results, discussion, summary & conclusion followed by bibliography. The references should be arranged alphabetically under the format given below:

Referred Journal
Sharma TC, Sharma CT and Sharma T (2006) Expression of alkaline pectinase in *Bacillus* sp. Lett. Appl Microbiol 12:245-350

Book
Demartino, GN (1996) Purification of proteolytic enzyme. In: Cellulolytic enzyme: an advance approach. Maheshwari RJ and James JS eds, Springer Germany.

Thesis
Garg ML (2006) Screening, isolation and identification of thermotolerant *P. aeruginosa* amylase. PhD Thesis, Arunachal Pradesh University, Arunachal Pradesh, India.

Web-site: www.elsevier.com

Course - Seminar/ Biopharmaceuticals and Entrepreneurship

Course - Seminar

Course Code - SIAL BT 01 406 E 4004 **Credits: 4**

Seminar will be of 45-minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members/student advisors well in advance so that the same may be displayed on the notice board. The presenter has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.

Course – Biopharmaceuticals and Entrepreneurship **Credits: 4**

Objective: *This course enhanced the knowledge of various biopharmaceuticals and enterpreneurship.*

Course Contents:

UNIT- I

Definition: Generics and its advantages; Biogenerics and Biosimilars; Why biosimilars are not (bio) generics; The advent of Biosimilars; Protein-based biopharmaceuticals; Manufacturing processes; Global market; International Non-proprietary Names (INN) nomenclature system biosimilars regulation (EU position, US pathways, Government initiatives)

UNIT-II

Approved follow-on proteins/Biosimilars; Characteristics of high-selling peptides and proteins,; Products with expired patents; Challenging originator's patents; Target products for FOB (follow-on biologicals)/ Biosimilars development peptides; Recombinant non-glycosylated proteins; Recombinant glycosylated proteins; Industries dealing with biogenerics and its market value; World scenario; Indian scenario.

UNIT-III

Case studies: Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon Granulocyte-macrophage- CSF, DNase, Factor VIIa, Factor IX, Factor VIII, Activated protein C, Tissue plasminogen activator, Monoclonal antibodies etc.

UNIT-IV

Role of knowledge Centre and R&D

Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies. Start-Up, Incubators, Support mechanism for entrepreneurship in India

Suggested readings:

1.Sarfaraz K. Niazi, Handbook of Biogeneric Therapeutic Proteins: Regulatory, Manufacturing, Testing, and Patent Issues, CRC Press, 2006.
2. Rodney J Y Ho, MILO Gibaldi, Biotechnology & Biopharmaceuticals Transforming proteins and genes into drugs, 1st Edition, Wiley Liss, 2003.
3. BIRAC-DBT websites.

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course – Nano Biotechnology /Biomass Energy

Course Code - SIAL BT 01 407 E 4004 **Credits: 4**

Course – Nano Biotechnology

Objective: *Purpose of this course is to give an overview about the use of nanotechnology and its applications in various biotechnological aspects.*

Course contents:

UNIT-I

Background to Nanoscience: Definition of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, Types of nanostructure and properties of nanomaterials, overview of application of Nanomaterials- biological and environmental, membrane based application, polymer based application, medical applications, Ethical, safety and regulatory issues of nano medicine.

UNIT-II

Instrumentation techniques for nanotechnology: FTIR, Thermal analysis, Scanning Probe Microscopy-principle of operation, instrumentation and probes, SEM, TEM, XRD (Powder/Single crystal), AFM, Scanning Tunelling Microscopy (STM), Particle size analyser and Zeta Sizer.

UNIT-III

Nanomolecular diagnostics and Biosensor: Nanodiagnostics - Nanoarrays for diagnostics, detection of single DNA, self-assembled protein nanoarrays, protein nanobiochip, nanoparticles for molecular diagnostics, DNA nanomachines, Nanobiosensor, CNT biosensor, DNA nanosensor, Nanowire biosensor, application of nanodiagnostics.

UNIT-IV

Nanopharmaceutical: Nanobiotechnology for drug discovery, protein and peptide based compounds for cancer and diabetes, drug delivery, nanoparticle based drug delivery, lipid nanoparticles, vaccination, cell therapy, Gene therapy.

Suggestive readings:

1. Robert A. Freitas Jr., Nanomedicine, Volume I: Basic Capabilities, Landes Bioscience, Georgetown, TX, 1999.
2. Robert A. Freitas Jr., Nanomedicine, Volume IIA: Biocompatibility, Landes Bioscience, Georgetown, TX, 2003.
3. Kewal K. Jain, The Hand book of Nanomedicine, Humana Press, Springer 2008.
4. Challa S.S.R. Kumar, Nanomaterials for medical diagnosis and therapy, Viley-VCH, 2007.
5. Dr.Parag Diwan and Ashish Bharadwaj (Eds), Nano Medicines, Pentagon Press, 2006

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.

Course – Biomass Energy **Credits: 4**

Objective: *Purpose of this course is to give an overview about the use of abundantly available biomass for various value added products*

Course contents:

UNIT-I

Introduction: Overview of biomass as energy source; Biomass availability in India, Production of biomass, Photosynthesis, efficiency of C3 and C4 plants on biomass production, Classification of biomass, Physicochemical characteristics of biomass as fuel, Thermal characteristics of biomass as fuel.

UNIT- II

Biochemical conversion of biomass for energy production: Anaerobic digestion, biogas production mechanism, Types of digesters, installation, operation and maintenance of biogas plants, Biogas plants manure-utilization and manure values, Biogas utilization and storage, Biogas for motive power generation etc.

UNIT- III

Chemical and thermochemical conversion of biomass for energy production: Chemical conversion processes, Hydrolysis and hydrogenation, Combustion in excess oxygen and oxygen deficient atmosphere, Pyrolysis, Biomass gasification- different types- power generation from gasification, Biomass based power generation

UNIT-IV

Biofuel synthesis: Biodiesel – the mechanism of transesterification, fuel characteristics of biodiesel, technical aspects of biodiesel engine utilization, Alcohols production from biomass- types of materials of alcohol production-process description, utilization; Modern biofuel synthesis, Bio- refinery

Suggested reading:

1. Mukunda HS. Understanding Clean Energy and fuels from biomass. Wiley-India Pvt. Ltd, 2011
2. Pandey A. Hand book of plant based biofuel. CRC Press, Taylor & Francis, 2008
3. Mital KM. Biogas Systems, Principle and Applications. New Age International Ltd. 1996
4. Rai GD. Nonconventional energy sources. Khanna Publication, 2001
5. Ravindranath NH. Hall DO. Biomass, Energy and Environment, A developing country perspective from India. Oxford University Press, 1995

Note: Latest edition of the readings may be considered.

Note: The list of cases, references and relevant articles will be provided by the faculty in the class.